

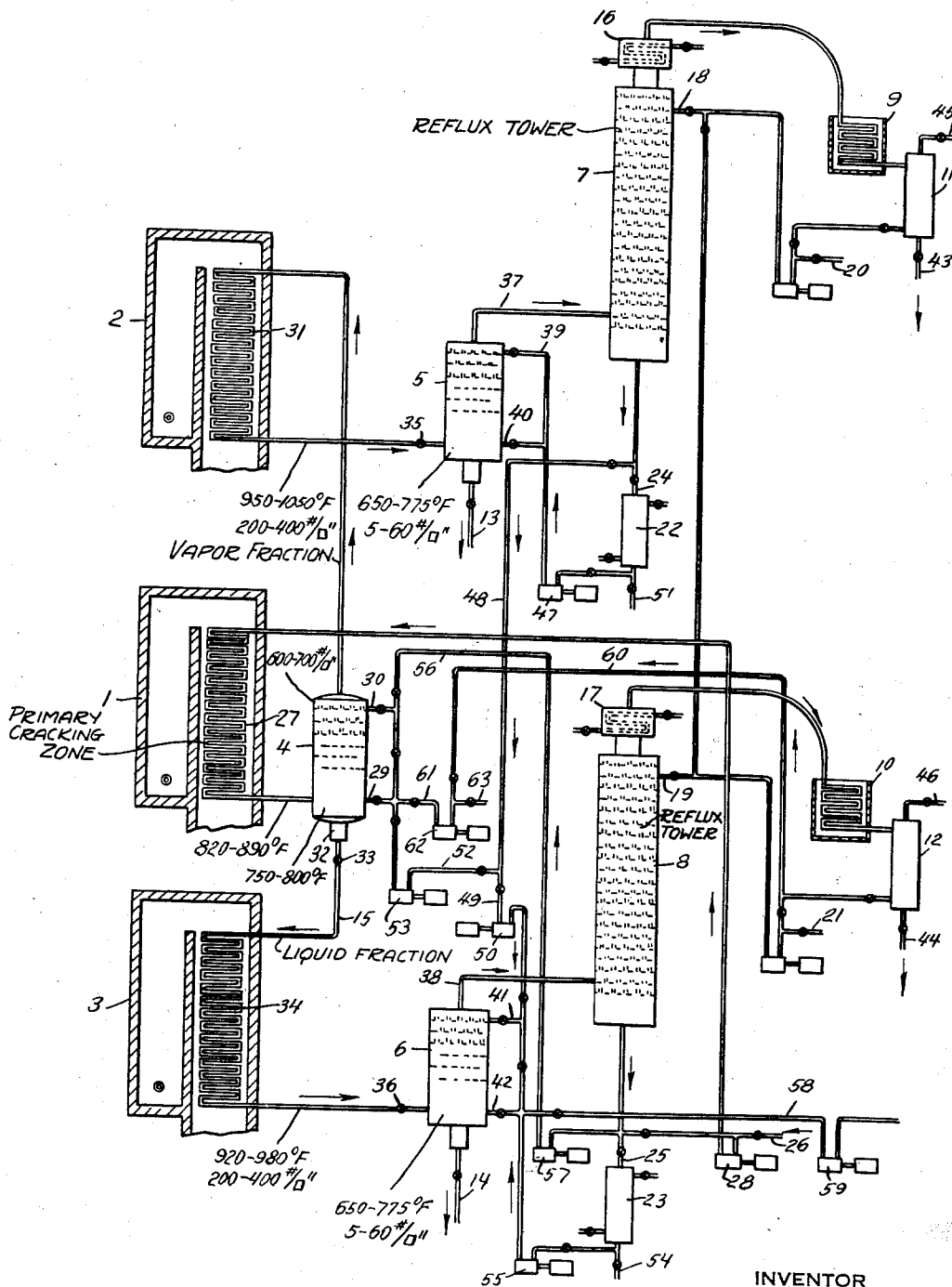
Oct. 10, 1939.

E. C. HERTHEL

2,175,663

ART OF CRACKING

Filed March 25, 1933



INVENTOR
Eugene C. Herthel

BY
Penne, Davis, Martin & Edwards
ATTORNEYS

UNITED STATES PATENT OFFICE

2,175,663

ART OF CRACKING

Eugene C. Herthel, Flossmoor, Ill., assignor to
Sinclair Refining Company, New York, N. Y., a
corporation of Maine

Application March 25, 1933, Serial No. 662,699

5 Claims. (Cl. 196—49)

This invention relates to improvements in the manufacture of motor fuel gasoline of high anti-knock value from higher boiling petroleum oils. The invention comprises a two-stage cracking operation, the second of which is divided, high boiling oil being subjected to moderate cracking in the first stage, the products of this stage being separated into vapor and liquid fractions under pressure and the separated vapor and liquid fractions being separately subjected to severe cracking in the second stage.

According to the present invention, a stream of high boiling petroleum oil, gas oil for example, is heated to a moderate cracking temperature, not exceeding about 900° F. for example, under a substantial superatmospheric pressure, upwards of 200 lbs. per square inch for example, the hot oil products of this heating operation being separated, under maintained pressure, into a vapor stream and a liquid stream, the separated vapor stream and liquid stream are separately heated, under maintained pressure, to high cracking temperatures, upwards of 900° F. for example, the pressures on the hot oil products of these heating operations are reduced and they are simultaneously cooled to temperatures at which substantial cracking ceases, the expanded and cooled products are separated into tar fractions and vapor fractions and the gasoline fractions are recovered, by appropriate fractionating operations for example, from these vapor fractions.

In the second stage of the combined operation, the vapor stream is with advantage heated to a higher cracking temperature than the liquid stream, each stream however being heated to a high cracking temperature. That component of the vapor fraction produced by the heating of the liquid stream in the second stage higher boiling than the recovered gasoline fraction may be supplied, in whole or in part and alone or in admixture with stock to be cracked from an extraneous source, to the heating operation comprising the first stage of the combined operation. That component of the vapor fraction produced by the heating of the vapor stream in the second stage higher boiling than the recovered gasoline fraction may, with advantage, be utilized as a cooling medium by direct introduction into the expanded products discharged from either or both of the heating operations comprising the second stage of the combined operation. The separation of the hot oil products from the first stage into the vapor stream and liquid stream supplied to the second stage is, with advantage, controlled

by the direct introduction, into the hot oil products discharged from the first stage and during or prior to separation, of a cooling medium. Gasoline fractions to be re-cracked, for improvement of their anti-knock value, may, with advantage, be so utilized as a cooling medium in this separation, such gasoline fractions being vaporized therein to form a part of the vapor stream subjected to severe cracking in the second stage of the combined operation. Gasoline fractions recovered from the vapor fraction produced by the heating in the second stage of the liquid stream may be so supplied to this separation.

The invention will be further described in connection with the accompanying drawing which illustrates, diagrammatically and conventionally, in elevation and partly in section with parts broken away, one form of apparatus appropriate for practice of the invention.

The illustrated apparatus comprises heating furnaces 1, 2 and 3, a pressure separator 4, separating towers 5 and 6, fractionating towers 7 and 8, condensers 9 and 10 and receivers 11 and 12. The separating towers 5 and 6, and the pressure separator 4, are provided with tar legs to facilitate the maintenance within these receptacles of that minimum volume of separated liquid necessary to maintain liquid discharge through connections 13, 14 and 15, respectively. Fractionating towers 7 and 8 are provided with reflux condensers 16 and 17. The operation of these fractionating towers, to separate as overhead products gasoline fractions of desired boiling range, is controlled either by the circulation of a cooling medium through these reflux condensers or by the direct introduction of a refluxing medium, part of the condensed overhead product for example, or by both of these means jointly. A part of the condensed overhead product separated in either or both of receivers 11 and 12 may be so introduced into either or both of the fractionating towers 7 and 8 through connections 18 and 19, or corresponding fractions supplied through either or both of connections 20 and 21 may be so introduced into either or both of the fractionating towers 7 and 8 through connections 18 and 19. Coolers 22 and 23 are provided for cooling any part of the higher boiling fractions separated in towers 7 and 8 discharged through connections 24 and 25.

In carrying out the invention in the apparatus illustrated, for example: High boiling petroleum oil, gas oil supplied from an extraneous source through connection 26 or condensate separated in fractionating tower 8 or a mixture of the two for

example, is forced through the heating coil 27 arranged in the heating furnace 1 by means of pump 28 and is heated, in the heating coil 27, to a temperature, for example of 820°-890° F., under a superatmospheric pressure sufficient to maintain discharge of the hot oil products of this heating operation into the pressure separator 4 while the latter is maintained under a pressure, for example, of 600-700 lbs. per square inch. A cooling medium is introduced through either or both of connections 29 and 30 at a rate sufficient to maintain a temperature in the lower part of the pressure separator 4 approximating, for example, 750°-800° F. For maximum accuracy of separation, it is usually advantageous to introduce a sufficient part of this cooling medium through connection 30 to maintain some refluxing within the pressure separator 4 and to introduce the balance through connection 29. The vapor fraction separated in the pressure separator 4 is forced, by means of the pressure maintained in the pressure separator 4, through the heating coil 31 arranged in the heating furnace 2 and is heated therein to a temperature, for example, of 950°-1050° F. under a pressure, for example, of 200-400 lbs. per square inch as discharged from this heating coil. A liquid level is maintained in the lower part of the pressure separator 4, advantageously within the tar leg 32, to maintain liquid discharge through connection 15 by appropriate regulation of valve 33. The liquid fraction separated in the pressure separator 4 and discharged through connection 15 is forced, by means of the pressure maintained in the pressure separator 4, through the heating coil 34 arranged in the heating furnace 3 and is heated therein to a temperature for example of 920°-980° F. under a pressure for example of 200-400 lbs. per square inch as discharged therefrom. The pressure on the hot oil product discharged from the heating coil 31 is controlled and reduced by means of valve 35 and that on the hot oil products discharged from the heating coil 34 is controlled and reduced by means of valve 36. The expanded hot oil products from the heating coils 31 and 34 are discharged, respectively, into the separating towers 5 and 6 in which they are separated into tar fractions and vapor fractions, the tar fractions being discharged through connections 13 and 14 and the vapor fractions being discharged through connections 37 and 38. The expanded hot oil products discharged into the separating towers 5 and 6 are cooled therein, in connection with separation into vapor fractions and liquid fractions, by the introduction of a cooling medium, into tower 5 through either or both of connections 39 and 40 and into tower 6 through either or both of connections 41 and 42, to maintain temperatures approximating, for example, 650°-775° F. in the lower parts of these separating towers. The fractionating towers 7 and 8 are controlled to separate, as overhead products, gasoline fractions condensed in the condensers 9 and 10 and collected in the receivers 11 and 12. These gasoline fractions are discharged through connections 43 and 44 and uncondensed vapors and gases are discharged through connections 45 and 46. After passing through the cooler 22, part of the higher boiling condensate separated in the fractionating tower 7 is introduced into the separating tower 5 by means of pump 47, and another part of this condensate may be introduced into the separating tower 6, through connections 48 and 49, by means of pump 50, the balance being either, in whole or in part, discharged through connection 51, or in-

duced into the pressure separator 4 through connections 48 and 52 by means of pump 53. The higher boiling condensate separated in the fractionating tower 8 may be either, in whole or in part, supplied to the heating coil 27 by means of pump 28 or, in whole or in part, after passing through the cooler 23, discharged through connection 54. After passing through the cooler 23 part of the higher boiling condensate separated in the fractionating tower 8 may be introduced into the separating tower 6 by means of pump 55. Part of this higher boiling condensate may also be introduced into the pressure separator 4, through connection 56 by means of pump 57. Other stocks may also be introduced into the separating tower 6, through connection 58 by means of pump 59. Reduced crudes or similar stocks including residual components, for example, may be so supplied to the operation, that part of such stock appropriate to be supplied to the heating coil 27 being vaporized in the tower 6 to be condensed in the tower 8 and thus supplied to the heating coil 27 by means of pump 28. The higher boiling condensate separated in the fractionating tower 8 is, with advantage, used as a cooling medium in both pressure separator 4 and separating tower 6. Gasoline fractions to be re-cracked, to improve their anti-knock value, are with advantage used as a cooling medium in the pressure separator 4. They may constitute the only cooling medium used in the pressure separator or they may be used in conjunction with other cooling media therein. For example, part of the gasoline fraction separated in the receiver 12 may be introduced into the pressure separator 4, through connections 60 and 61 by means of pump 62. Similarly, a gasoline fraction from an extraneous source to be re-cracked may be introduced into the pressure separator 4, through connections 63 and 61, by means of pump 62.

In the apparatus illustrated, the first stage of the combined operation is carried out in the heating coil 27 and the divided second stage is carried out in the heating coils 31 and 34. The use of a pressure separator intermediate the two stages of the combined operation has several advantages, it makes possible effective separation of the fractions appropriate to be supplied to the second stage at temperatures high enough to avoid excessive heat loss. In operations in which a gasoline fraction to be re-cracked is introduced into the pressure separator as a cooling medium, the heat loss involved may be recovered substantially completely in the vaporization and superheating of such gasoline fractions. It also eliminates any need for pumps or compressors to force the separated vapor and liquid streams through the second stage.

I claim:

1. In the manufacture of motor fuel gasoline, the improvement which comprises heating a stream of higher boiling petroleum oil to a moderate cracking temperature under a substantial superatmospheric pressure and subjecting said higher boiling oil to said moderate cracking temperature for a period of time sufficient to effect moderate cracking of said higher boiling oil, separating the composite hot oil products of this heating operation into a vapor stream and a liquid stream and separately heating each of said separated streams to high cracking temperatures under maintained superatmospheric pressure, reducing the pressure on the composite hot oil products of each of these heating operations and simultaneously cooling them to temperatures at

which substantial cracking ceases, separating the expanded and cooled products into tar fractions and vapor fractions and recovering gasoline fractions from these vapor fractions.

2. In the manufacture of motor fuel gasoline, the improvement which comprises heating a stream of higher boiling petroleum oil to a moderate cracking temperature under a substantial superatmospheric pressure and subjecting said higher boiling oil to said moderate cracking temperature for a period of time sufficient to effect moderate cracking of said higher boiling oil, separating the composite hot oil products of this heating operation into a vapor stream and a liquid stream and separately heating each of said separated streams to high cracking temperatures, the vapor stream to a higher cracking temperature than the liquid stream, under maintained superatmospheric pressure, reducing the pressure on the composite hot oil products of each of these heating operations and simultaneously cooling them to temperatures at which substantial cracking ceases, separating the expanded and cooled products into tar fractions and vapor fractions and recovering gasoline fractions from these vapor fractions.

3. In the manufacture of motor fuel gasoline, the improvement which comprises heating a stream of higher boiling petroleum oil to a moderate cracking temperature under a substantial superatmospheric pressure and subjecting said higher boiling oil to said moderate cracking temperature for a period of time sufficient to effect moderate cracking of said higher boiling oil, separating the composite hot oil products of this heating operation into a vapor stream and a liquid stream and separately heating each of said separated streams to high cracking temperatures under maintained superatmospheric pressure, reducing the pressure on the composite hot oil products of each of these heating operations and simultaneously cooling them, by direct heat exchange with a distillate fraction higher boiling than gasoline separated from the hereinafter mentioned vapor fraction produced by the heating of the vapor stream, to temperatures at which substantial cracking ceases, separating the expanded and cooled products into tar fractions

and vapor fractions and recovering gasoline fractions from these vapor fractions.

4. In the manufacture of motor fuel gasoline, the improvement which comprises heating a stream of higher boiling petroleum oil to a moderate cracking temperature under a substantial superatmospheric pressure and subjecting said higher boiling oil to said moderate cracking temperature for a period of time sufficient to effect moderate cracking of said higher boiling oil, introducing a gasoline fraction into the hot oil products of this heating operation and separating the composite mixture into a vapor stream and a liquid stream and separately heating each of said separated streams to high cracking temperatures under maintained superatmospheric pressure, reducing the pressure on the composite hot oil products of each of these heating operations and simultaneously cooling them to temperatures at which substantial cracking ceases, separating the expanded and cooled products into tar fractions and vapor fractions and recovering gasoline fractions from these vapor fractions.

5. In the manufacture of motor fuel gasoline, the improvement which comprises heating a stream of higher boiling petroleum oil to a moderate cracking temperature under a substantial superatmospheric pressure and subjecting said higher boiling oil to said moderate cracking temperature for a period of time sufficient to effect moderate cracking of said higher boiling oil, introducing a gasoline fraction recovered from the hereinafter mentioned vapor fraction produced by the heating of the liquid stream into the hot oil products of the first mentioned heating operation and separating the composite mixture into a vapor stream and a liquid stream and separately heating each of said separated streams to high cracking temperatures under maintained superatmospheric pressure, reducing the pressure on the composite hot oil products of each of these heating operations and simultaneously cooling them to temperatures at which substantial cracking ceases, separating the expanded and cooled products into tar fractions and vapor fractions and recovering gasoline fractions from these vapor fractions.

EUGENE C. HERTHEL.