

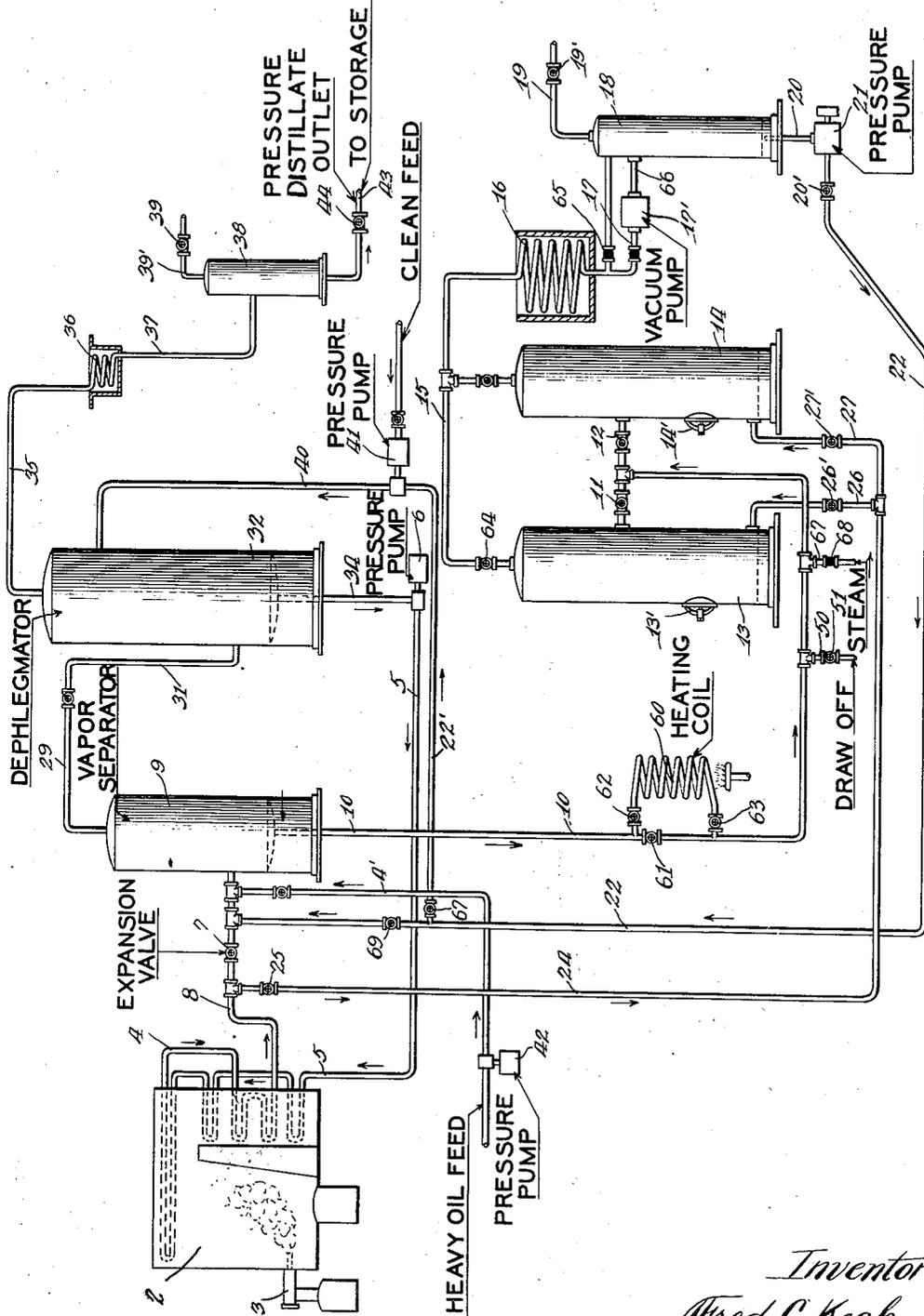
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CONVERTING RESIDUUM INTO CHARGING STOCK AND COKE

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CONVERTING RESIDUUM INTO CHARGING STOCK AND COKE

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The present invention relates to a process and apparatus for converting petroleum products, containing a preponderance of heavy ends, into coke, with the concomitant production of a clean distillate suitable for use as a cracking stock.

One of the objects of the invention is to convert residuum from oil cracking operations into merchantable petroleum coke and into a distillate which may be used as a clean charging stock for an oil cracking system.

A further object of the invention is to treat heavy residuum in a suitable container with a very highly heated cracked petroleum product whereby the heat of said cracked petroleum product will be imparted to the residuum with the result that the residuum is highly heated so as to cause the volatilization therefrom of all of the lighter ends therein contained, the heat being sufficiently high to convert the residuum into petroleum coke.

A further object of the invention is to inject highly heated cracked petroleum products into a body of oily residuum so as to heat the residuum to a coking temperature while maintaining above the body of said residuum a pressure low enough to cause substantially complete volatilization of all volatile matter therein contained, as well as to insure the volatilization of all volatile products introduced into the residuum by the heated cracked petroleum products.

A still further object of the invention is to heat heavy residuum by the introduction thereinto of very highly heated petroleum products drawn from the discharge end of an oil cracking still, under such conditions that the volatile material in said petroleum products as well as the residuum treated thereby may freely volatilize, whereby a final residue of petroleum coke is obtained and a distillate produced which may be introduced as a clean charging stock into the oil cracking system.

Other objects of the invention will appear from the following detailed description and the accompanying drawing which illustrates a preferred form of the invention. The invention, however, is not limited to said preferred embodiment but is capable of many variations, the scope of the invention being set forth in the appended claims.

The accompanying drawing is an illustrative and diagrammatic representation, only, of a complete oil cracking system showing the apparatus and connections by means of which the present invention is carried into effect and the relation of said apparatus to an entire operative oil crack-

ing system. Obviously the invention is not limited to the particular cracking system illustrated and described but is applicable to any system in which a residuum is produced that may be converted into lighter ends adaptable for charging stock and in which the heavier ends can be converted into coke.

The present invention comprises essentially the treatment of residuum in one or more unheated stills by means of highly heated cracked products drawn directly from the discharge end of an oil cracking still, which products are introduced into a body of said residuum. The volatile products resulting from the heating of said residuum by said petroleum products are discharged from the upper portions of said other-wise unheated stills and are condensed to form a distillate suitable for use as a clean charging stock for introduction into oil cracking systems.

In the operation of an oil cracking system, a quantity of a heavy oil generally known as residuum is produced. This residuum is usually discharged from the system without further treatment and frequently is sold as fuel oil.

The price of said fuel oil varies from time to time and it often occurs that the price of said fuel oil is so low that its profitable sale is precluded. Under such conditions, it becomes more economical to treat the residuum to obtain therefrom lighter ends, which can be used as charging stock for the cracking unit, and reducing the heavier ends to coke which can be sold as such on the market.

It has been customary to convert such residuum into coke by charging the same into an ordinary shell still, heated directly by the combustion of a suitable fuel whereby the residuum in said shell still is highly heated so as to distill the volatile parts thereof leaving a final residue of petroleum carbon. The shell still was then allowed to cool down and the carbon or coke removed therefrom, after which a fresh charge of residuum is charged to the still and the operation repeated.

The present invention avoids the use of a separately heated still in that the residuum is heated by using a portion of the hot cracked material as it emerges from the cracking still which is introduced into a container into which the residuum is discharged.

The residuum-treating stills or containers are so coordinated with the balance of the cracking equipment, that the operation may be so conducted that the residuum may either be drawn off as such or may be converted into coke and clean-charging stock at the option of the operator

by the simple expedient of the setting of certain valves and the operation of various pumps and condensers.

In order that the invention may be properly understood, and, with reference to the aforementioned drawing illustrating a preferred form of the invention, the operation of an oil cracking unit of the type to which the present invention is applicable, will now be given:

The illustrative oil cracking unit consists of a pipe still 2 heated by any suitable source of heat, such as a burner 3 and contains a continuous cracking coil 4 through which the oil to be cracked is forced under pressure, this pressure being controlled by the valve 7. The oil enters the cracking still through the pipe 5, being forced into said pipe by means of the pressure pump 6 and flows in the direction illustrated by the arrows on the drawing. The temperature of the oil increases as it flows through the cracking coil 4 in which it will very soon reach the cracking temperature, and this cracking will continue from there on through the coil, the temperature of the oil and/or vapors as they leave the coil preferably being somewhere around 900° F. The cracked oil is discharged from the cracking coil 4 through a transfer line 8 provided with the expansion valve 7, at which point pressure in said oil is materially reduced, as, for example, from 600 pounds to 200 pounds or from 60 pounds to 30 pounds, depending upon the desired operation of the system.

This reduction in pressure, at the given temperature, will result in the complete volatilization of all the volatilizable products in the oil being treated provided such complete volatilization has not already occurred in the cracking coil. Just beyond the expansion valve 7 is a branch pipe 4' through which heavy oil is introduced into the recently expanded cracked products. This heavy oil is heated by the cracked products and a considerable portion thereof is volatilized, the mixed products being discharged into the vapor separator 9. The vapors in the vapor separator are fed through pipe 29 into the lower part of a suitable dephlegmator well known to those skilled in the art, and from the upper end of this dephlegmator the desired vapor ends are conducted through pipe 35 to a suitable condenser 36, and thence through pipe 37 through a separator 38. From the separator 38 the uncondensable gases are drawn off through the pipe 39' under the control of the valve 39 and the pressure distillate is withdrawn through the pipe 43 under the control of the valve 44. All of the heavy vapors which are not desirable for conversion into pressure distillate are knocked down in the dephlegmator 32, as well known to those skilled in the art, and this reflux accumulating in the dephlegmator is withdrawn through the pipe 34 and is charged into the pipe 5 through the pressure pump 6 and fed to the cracking coil as heretofore described.

It will be evident from the foregoing description that intermingling of the heavy oil feed with the heated cracked products just beyond the expansion valve 7 results in a stripping action of said heavy oil feed whereby the desired portion of said heavy feed suitable as clean charging stock will be vaporized and carried with the vaporized cracked products through the line 29 into the dephlegmator 32, and that those constituents of these vapors not suitable for pressure distillate will be knocked down in the dephlegmator as reflux and charged to the cracking still as hereinbefore described.

If the clean charging stock thus produced is

not sufficient to adequately supply the cracking unit, then additional clean stock is supplied to the dephlegmator from a storage (not shown) by way of pressure pump 41 and pipe 40 which discharge this stock into the upper portion of the dephlegmator 32, where this charging stock is heated by the rising vapors and also acts as a refluxing medium to strip these vapors of their heavier ends. This clean charging stock thus introduced into the dephlegmator, together with the reflux, is charged through the cracking still as hereinbefore outlined.

The mixture of cracked products and heavy oil feed entering the vapor separator are therein separated into the vapors which are carried over into the dephlegmator, as hereinbefore described, and into a liquid which collects at the bottom of the vapor separator, and which is ordinarily referred to as residuum. This residuum collecting at the bottom of the vapor separator 9 is continuously withdrawn through the pipe 10 and, if desired, can be withdrawn from the pipe 10 through the pipe 50 and valve 51, through a suitable cooler (not shown) and disposed of as a commercial product known as fuel oil. In the event that the market for fuel oil is inadequate, or if the operation of the system is so conducted that the residuum contains a large proportion of ends which might be used as charging stock, then it may be desirable not to dispose of said residuum as commercial fuel oil, but to retreat said residuum and convert it into a charging stock and coke, the charging stock being returned to the system and the coke being sold as a commercial product.

This invention is directed in part to an improved and novel process for converting this residuum into coke and charging stock. If it is not desired to withdraw the residuum as such from the vapor separator, then it is conducted through the pipe 10 to either one of the tanks or stills 13 or 14 by way of the valves 11 and 12, respectively. These tanks 13 and 14 are alike and are supplied in duplicate so that the process may be conducted in one of said tanks while the other tank is being cleaned, that is, having the coke formed therein removed therefrom. The tanks are provided with suitable manhole openings 13' and 14' for the removal of the coke. Since the operation in either one of these tanks would be identical, the description in the following will be confined to the tank 13, under which circumstances valve 11 will be opened and valve 12 closed.

The residuum from the vapor separator under these conditions will flow through line 10, valve 61 being open, and valves 51, 62 and 63 being closed, through valve 11, which is open, into the tank 13. At the same time valve 25 will be opened to permit a desired portion of the cracked product to flow through pipe 24, and thence through pipe 26 and valve 26', which is open, into the bottom of tank 13. This hot, cracked product, having a temperature somewhere around 900° F., will mix with the residuum fed to the tank 13, and since the pressure in the tank 13 is substantially at atmospheric, excessive volatilization will occur in said tank. The vapors in said tank will flow through valve 64, which is open, and line 15 into the condenser 16, and thence by way of valve 65, which is open, into the separator 18, the valve 17 being closed.

In the separator 18 the uncondensable gases will flow through pipe 19 and valve 19' to a suitable storage, whereas the condensed products will flow from said separator 18 through pipe 20 and pressure pump 21 through valve 20', which

is open, and line 22 and valve 69, which is open, into the transfer line 8, where it will come along with the cracked products after they have been expanded beyond valve 7 and with the heavy oil feed, which is introduced into the transfer line 8 just beyond. The mixture of these products will flow into the vapor separator 9 where the vapors will leave by way of the pipe 29, as hereinbefore described, and the residuum will be drawn off through the pipe 10 to be again treated as hereinbefore described.

When the treatment of the residuum in tank 13 has continued for a sufficient period, so that considerable coke has collected in the tank 13, then the valve 11 is closed and valve 12 is opened and the residuum will then be drawn into the tank 14. Under these circumstances the valve 26' will be closed and the valve 27' opened and the hot cracked products will flow from line 24 through line 27 and valve 27' into the tank 14. The treatment of the residuum by the hot cracked products will then take place in the tank 14 in the same manner as hereinbefore described in connection with tank 13.

During the period that the residuum is being treated in tank 14 the operators will remove the coke from tank 13 and when sufficient coke has collected in tank 14, tank 13 will again be ready for operation and the valves will be operated so as to carry the residuum and cracked products into tank 13 in place of tank 14. This operation will be alternated between tanks 13 and 14, so as to have a continuous operation of the treatment of residuum by the cracked products, whereby the heat of the cracked products will volatilize the residuum, stripping it to coke, the stripped products being carried by way of the line 15 and condenser 16 to the separator 18, as hereinbefore described.

In the event that the temperature of the cracked products is not sufficiently high to reduce the residuum to coke in the tanks or stills 13 and 14, or if it is desired to reduce the amount of the cracked products which is utilized for this operation, it might be desirable to subject the residuum to a heating operation before it is conducted into the tank 13. For this purpose a heating coil 60 is illustrated which is connected into the pipe 10 by means of valves 62 and 63. If the residuum is to be heated before entering the tanks 13 or 14, the valve 61 is closed and the valves 62 and 63 are opened, under which circumstances the residuum will flow through pipe 10, through valve 62, the heating coil 60, valve 63, and then back into pipe 10, and thence to the tanks 13 or 14, depending upon the setting of the valves in the system.

The vaporization of the residuum may also be augmented by the introduction of steam into the pipe 10, and for this purpose the steam pipe 67 is shown connecting into the pipe 10, the introduction of steam being regulated by the valve 68. For increasing the vaporization of the residuum products either the heating coil 60, or the introduction of steam, or both, may be utilized. If steam is used provision must be made in receiver 18 to separate the stratified lighter oil produced from the lower layer of water which will form therein as is well known to those skilled in the art, no special provision for this purpose being shown in the drawing.

In order to assist and accelerate the coking action in the tanks 13 and 14, it might be desirable to operate the tanks 13 and 14 at a sub-atmospheric pressure. For this purpose the vacuum

pump 17' is provided which may be connected into the pipe line leading from the tanks 13 and 14 by opening the valve 17 and closing the valve 65. Under these conditions the pipe 15 will be connected through the condenser 16 and the valve 17 to the vacuum pump 17', said pump being connected to the separator 18 by the pipe 66.

As is well known to those skilled in the art a coking operation is accelerated by increased heating of the product being treated and also by reduction of pressure on the material that is being treated. Consequently, depending upon conditions and the results desired, the process and apparatus hereinbefore described is arranged so that the coking operation in the tanks or stills 13 and 14 can be conducted either by one of three methods. First, by treating the residuum merely with the cracked products withdrawn from the transfer line 8 at a pressure substantially at atmospheric; second, by treating the residuum with the hot cracked material withdrawn from the transfer line 8 under sub-atmospheric pressures, and, third, by treating the residuum with the hot cracked products withdrawn from the transfer line 8 at either substantial atmospheric or sub-atmospheric pressure and by preheating said residuum in the coil 60, or with steam, or both, before discharging it into the treating tank 13 or 14.

Which one of these methods would be most suitable will depend upon local conditions and can be readily determined by those skilled in the art, depending upon the manner in which the coking operation proceeds in the tanks 13 and 14.

It will be evident from the foregoing description that in the improved process described herein the residuum which is withdrawn from the vapor separator can be either sold as such, generally as fuel oil, if commercial conditions warrant such sale. However, if the demand for fuel oil is inadequate, or if the residuum contains a large percentage of material that may be charged to the cracking system for the production of pressure distillate, then said residuum can be economically treated in the tanks 13 and 14 by reducing the residuum to coke and recharging the volatilized constituents of said residuum produced as a result of the coking operation to the cracking system.

The product which is formed as a result of the coking operation in the tanks 13 and 14 will depend upon the nature of the residuum formed in the vapor separator and the manner in which the coking operation is performed in the tanks 13 and 14. If the residuum is of a suitable character and the coking operations in the tanks 13 and 14 are so performed that the product collected in the separator 18 for recharging to the system is a clean stock, then said stock may be pumped by the pressure pump 21 through the line 22 and the valve 67, valve 69 being closed, into the line 40, to be fed into the dephlegmator with the fresh clean stock which is pumped into the dephlegmator from storage, as hereinbefore described.

If, however, the product collecting in the separator 18 is not a clean stock but contains material which might tend to carbonize and coke in the cracking pipe 4, then the valve 67 should be closed and the valve 69 opened, and this material returned to the transfer line 8 to be intermingled with the cracked charging stock and the heavy oil feed, as hereinbefore described. Under these conditions the clean ends of the product charged into the transfer line coming from the separator

18 will be vaporized in the same manner as the heavy oil which is charged into the transfer line through line 4, and these volatilized ends will be carried from the vapor separator through the line 29 into the dephlegmator where they will be re-fluxed and returned to the cracking coil through the line 34, pressure pump 6 and line 5.

The essential and novel feature of this invention resides in the use of highly heated cracked products for effecting the coking of residuum in an otherwise unheated coking still with simultaneous condensation of the volatile matter thus produced and the introduction of the resultant condensate into the system either directly into the transfer line leading from the cracking unit to the vapor separator or, if the resulting condensate is sufficiently clean, into the upper portion of the dephlegmator.

One of the principal advantages of the present invention resides in the fact that no heat is applied to the outside of the coking stills 13 and 14, the coking operation being performed by an intermingling of the products of the system. Also, in the flexibility of the apparatus whereby, with the addition of very little equipment and the mere adjustment of a few valves, the residuum may either be withdrawn from the system to be sold as a commercial product, or it may be reduced to coke and the volatilized portions of the residuum returned to the system for further treatment.

These alternate operations can be performed with an apparatus of simple character requiring an initial minimum cost, as well as a minimum operating cost.

While this invention has been described in connection with an illustrative type of cracking systems, it is obvious that it is applicable to other types of cracking systems in which it is desirable to treat residuum with highly heated cracked products, so as to heat the same to the coking temperature and with the simultaneous removal of all volatile matter from the said cracked products and residuum for the formation of a condensate which can be recharged to the cracking system.

What is claimed and desired to be protected by Letters Patent is:

1. The process of treating petroleum products which consists in passing a clean feed oil through a pipe still heated to a cracking temperature and under superatmospheric pressure, passing the cracked products through an expansion valve, introducing a heavier feed oil into said products, and passing the resulting mixture into an enlarged zone wherein vapors separate from unvaporized residuum, removing said vapors from said enlarged zone, continuously transferring said residuum from said enlarged zone to a still wherein it is vaporized, withdrawing the vapors from said still and condensing them, and mixing the resulting condensate with the cracked products immediately after the latter have passed through the expansion valve.

2. The process of converting oils into gasoline and petroleum coke which comprises heating a continuously advancing oil stream in a heated pipe still to cracking temperature under pressure, passing the heated products through an expansion valve into an enlarged space, separating the resultant volatile products and non-volatile products in said space and conducting the volatile products to a dephlegmating tower and the non-volatile products to a tank still, returning the condensate from the dephlegmating tower to the

pipe still, diverting a portion of the highly heated cracked products from the outlet of said pipe still to said tank still and allowing said cracked products to pass into the non-volatile products therein whereby coke and condensable vapors are formed, condensing said vapors and transferring the resultant distillate directly to said enlarged space in admixture with freshly expanded highly heated cracked products.

3. The process of converting oils into gasoline and petroleum coke which comprises heating a continuously advancing oil stream in a heated pipe still to cracking temperature under pressure, passing the heated products through an expansion valve into an enlarged space, separating the resultant volatile products and non-volatile products in said space and conducting the volatile products to a dephlegmating tower and the non-volatile products to a tank still, returning the condensate from the dephlegmating tower to the pipe still, diverting a portion of the highly heated cracked products to said tank still and allowing said cracked products to pass into the non-volatile products contained therein whereby coke and condensable vapors are formed, condensing said vapors and transferring the resultant distillate to the said dephlegmating tower.

4. The process for converting petroleum products into gasoline and coke, which comprises heating the petroleum products in a pipe still to a cracking temperature under superatmospheric pressure, then reducing said pressure and introducing a heavier hydrocarbon oil into said cracked products, separating the resulting mixed product into a residuum and vapors, subjecting the said vapors to dephlegmation to separate the desired lighter end vapors from a liquid reflux, returning said reflux to said pipe still for further cracking and condensing said separated lighter end vapors, collecting said residuum in a suitable container or still, withdrawing a stream of said cracked petroleum products prior to their admixture with the heavier hydrocarbons from the main stream of such products leaving the pipe still and mixing the same with said residuum collected in said container or still, whereby the lighter ends of said residuum will be vaporized and the heavier ends reduced to coke by the contained heat of the said cracked petroleum products, condensing the said vaporized lighter ends of said residuum, and returning the said condensed lighter ends of said residuum into said cracked petroleum products.

5. The process for converting petroleum products into gasoline and coke, which comprises heating the petroleum products in a pipe still to a cracking temperature under superatmospheric pressure, then reducing said pressure and introducing a heavier hydrocarbon oil into said products, separating the resulting mixed product into a residuum and vapors, subjecting the said vapors to dephlegmation to separate the desired lighter end vapors from a liquid reflux, returning said reflux to said pipe still for further cracking and condensing said separated lighter end vapors, collecting said residuum in a suitable container or still, withdrawing a stream of said cracked petroleum products prior to their admixture with the heavier hydrocarbons from the main stream of such products leaving the pipe still and mixing the same with said residuum collected in said container or still, whereby the lighter ends of said residuum will be vaporized and the heavier ends reduced to coke by the contained heat of the said cracked petroleum products, condensing the said vaporized lighter ends of said residuum, and re-

turning the said condensed lighter ends of said residuum into said cracked petroleum products before their admixture with the heavier hydrocarbon oils.

5 6. The process of producing gasoline and coke from petroleum which comprises feeding a petroleum product successively through a high pressure cracking zone, a separating zone and a dephlegmating zone and returning dephlegmated condensate to said cracking zone, withdrawing heavy products from said separating zone and passing them to a zone where coke and vapors are formed, condensing said vapors to a liquid and passing the latter directly to the separating zone, and diverting a portion of the products from said high pressure cracking zone to said coking zone.

10 7. The process of cracking petroleum to produce gasoline and coke which comprises the steps of passing petroleum products through a high pressure cracking zone, dividing the high pressure cracked products thus produced into two streams, one of which passes into an enlarged separating zone in which separation into lighter and heavier products is effected, the heavier products being transferred to a coking zone, the second high pressure stream being directed into said coking zone to aid in converting said heavier products into coke and a distillate, said distillate being admixed with said first high pressure stream passing into said separating zone.

15 8. The process of converting heavy petroleum into gasoline and coke which comprises the steps of heating the petroleum to cracking temperature while passing through a high pressure cracking zone, releasing said pressure and passing the resulting cracked products into an expansion zone where vapors and liquid residuum are separated, transferring said residuum to a tank still, diverting a portion of the cracked products passing from said high-pressure cracking zone into said tank still under reduced pressure to distill said residuum and to produce coke, condensing the resulting vapors and returning said condensate directly to said expansion zone.

20 9. The process of cracking petroleum to produce

gasoline and coke which comprises the steps of passing petroleum products through a high-pressure cracking zone, dividing the cracked products thus obtained into two streams, one of which passes into an enlarged separating zone in which separation into lighter and heavier products is effected, the heavier products being transferred to a coking zone and the lighter products to a dephlegmating zone, the second stream being directed into said coking zone to aid in converting said heavier products into coke and a distillate, and transferring said distillate to said dephlegmating zone.

25 10. A hydrocarbon oil cracking process which comprises passing the oil in a restricted stream through a heating zone and heating the same therein to cracking temperature under pressure, dividing the heated oil issuing from the heating zone into two portions, commingling a cool oil with one of said portions and discharging the resultant mixture into a vapor separating zone maintained under pressure and separating the same therein into vapors and unvaporized oil, separately removing the vapors and unvaporized oil and flash distilling the latter in a flashing zone by pressure reduction, and passing the other portion of said heated oil directly from the heating zone to the flashing zone without introduction to the separating zone.

30 11. The process of cracking petroleum to produce gasoline and coke which comprises the steps of passing petroleum products through a high pressure cracking zone, dividing the high pressure cracked products thus produced into two streams, one of which passes into an enlarged separating zone in which separation into lighter and heavier products is effected, the heavier products being transferred to a coking zone, the second high pressure stream being directed into said coking zone to aid in converting said heavier products into coke and vapors, a cooling oil being admixed with said first high pressure stream passing into said separating zone.

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