March 9, 1937. A. P. SACHS 2,073,456

METHOD FOR TREATING CRUDE OIL

Filed May 26, 1934 2 Sheets-Sheet 1

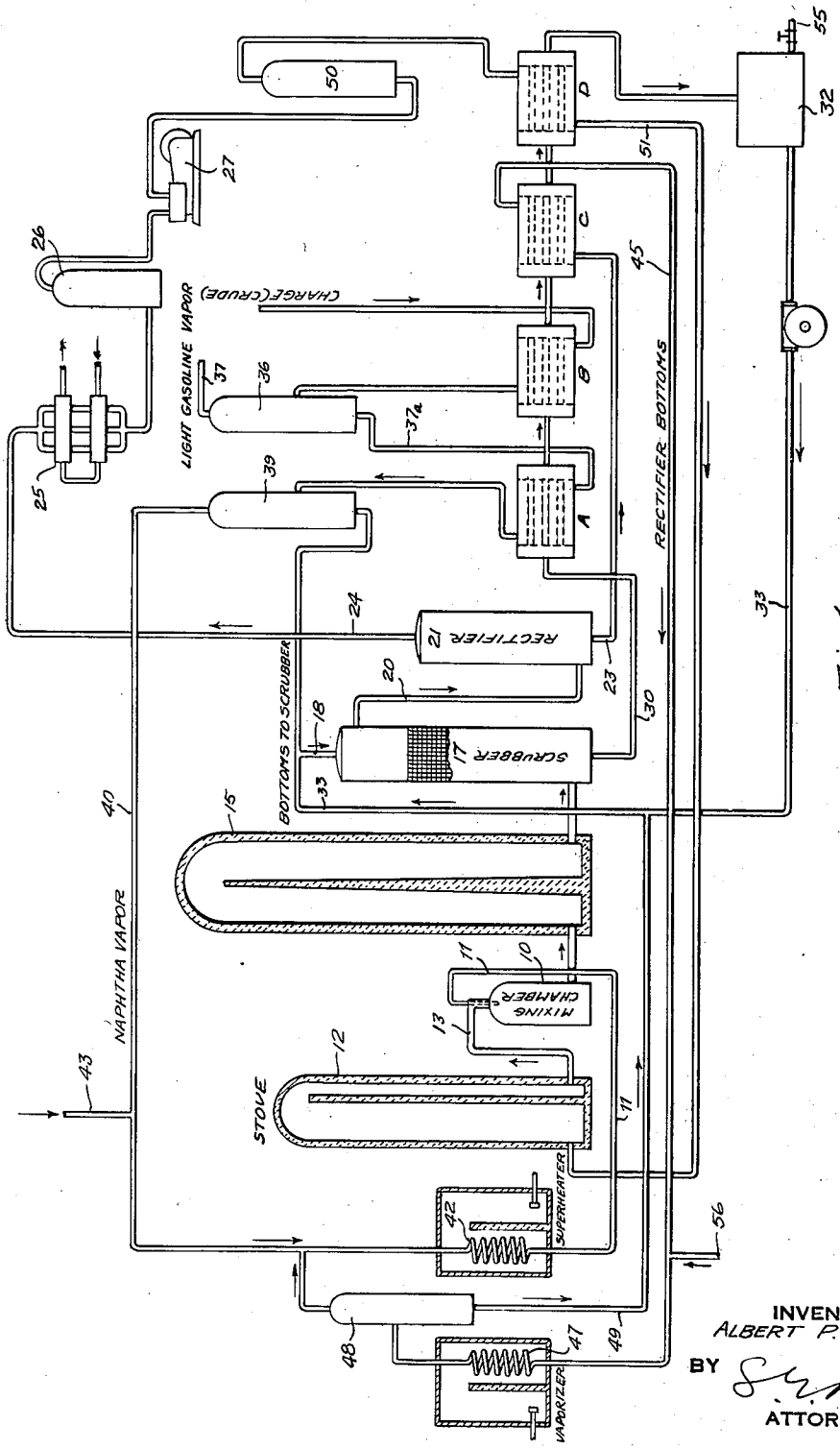


Fig. 1.

INVENTOR
ALBERT P. SACHS.
BY S. V. Berry
ATTORNEY

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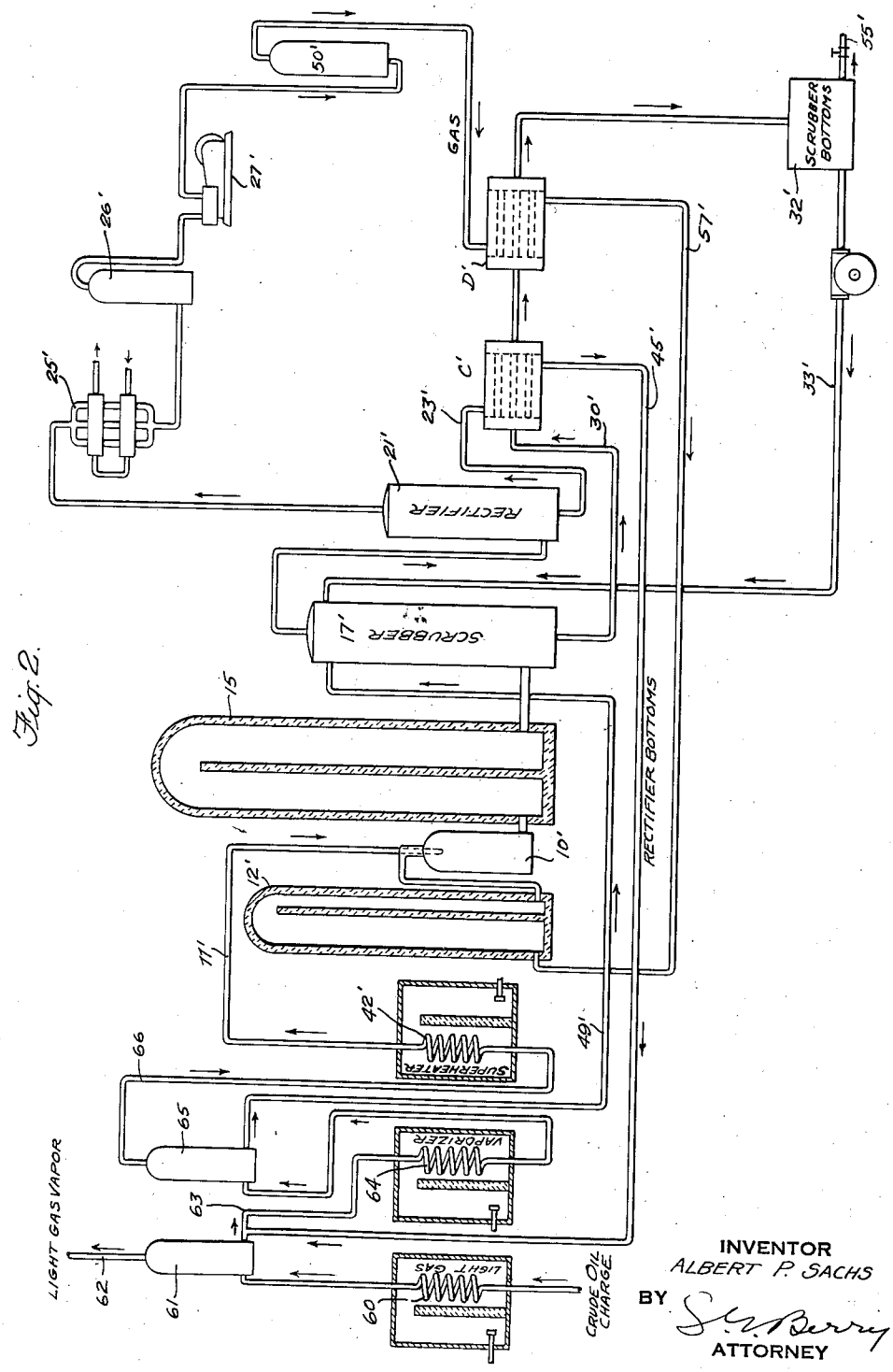


Fig. 2.

INVENTOR
ALBERT P. SACHS
BY S. W. Berry
ATTORNEY

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METHOD FOR TREATING CRUDE OIL

Albert P. Sachs, New York, N. Y., assignor to Petroleum Conversion Corporation, New York, N. Y., a corporation of Delaware

Application May 26, 1934, Serial No. 727,597

4 Claims. (Cl. 196—48)

The present invention relates to a method of and an apparatus for treating crude oil (or an oil containing light and heavy fractions) to produce therefrom a fuel of the gasoline type having a high anti-knock value. More particularly it relates to improvements in the process of vapor phase cracking exemplified by the Beardsley and Colony Patent No. 1,842,319. This process is characterized particularly by the superheating of the vapors to a temperature just below the active, rapid cracking range followed by cracking by the agency of a heat-carrier gas heated to the proper temperature. Since the amount of heat-carrier gas used may be of the order of equal weight of gas to vapor, the products of the reaction chamber constitute a source of considerable heat, and as set forth in the patent to Beardsley No. 1,883,744 this heat may be in large part recovered by utilizing it to vaporize those fractions of the charging stock which are to be cracked. In so doing, the volatilized fractions of the charging stock mingle, of course, with the vapors cracked in the reaction chamber. The vapor mixture is then subjected to a fractional condensation, in which the stock for the continuance of the cracking operation is first separated out, thus leaving in the vapor mixture the fractions in the gasoline range which may have been present in the original charging stock. If the latter be a crude, these natural gasoline fractions may be considerable in amount, thereby producing a blended gasoline. While satisfactory for most purposes, the anti-knock value of the product is limited by the fact that the straight run or natural gasoline has ordinarily, especially in the fractions of higher boiling range, a much lower anti-knock value than the cracked gasoline of the same boiling range from the same original charging stock.

It is therefore a principal object of my invention to provide, in a system of the foregoing type, for a greater output of unblended, anti-knock fuel when operating with a crude or other oil containing fractions within the gasoline range. Another object is to provide for a fractionation of the crude charge by using available heat in the products from the reaction chamber as by collecting such heat by means of a liquid menstruum and feeding the thus heated liquid in countercurrent heat exchange relationship with the crude oil charging stock in a manner so as to fractionate such stock. Still other objects of the invention and advantages thereof will be apparent as the description proceeds and the novel features will be pointed out in the appended claims.

In carrying out my invention, I propose to subject the charging stock, if it be a crude, to fractionation so as to yield first a light straight-run gasoline having an end point, say, of 300–325° F. (depending chiefly upon the octane number desired of this fraction) and a heavier naphtha fraction between, say, 325 and 460° F. I then add the naphtha fraction to the stock charged to the reaction chamber wherein it is cracked or reformed. As disclosed in my co-pending application Serial No. 695,408, which has matured into Patent No. 2,016,297, Oct. 8, 1935, substantial advantages result from this disposition of the naphtha, particularly when it is fed to the vaporizer as liquid as in the second herein described embodiment. Here the presence of the naphtha, by lowering the partial pressures and average boiling point in the vaporizer, greatly increases the vapor output thereof as compared with a heavier fraction such as gas oil, for example. A further reason is that the simultaneous reforming of the naphtha and the cracking of the heavier stock have been found to increase the yield of gasoline over that obtained when these operations are conducted separately.

The light straight-run fraction which is recovered directly is found to have a relatively high anti-knock value and moreover needs but simple refining treatment, as for example a mild treatment with acid or clay followed, if necessary, by doctor treatment. Such fractions thus treated may often be added to the cracked gasoline produced or other disposition may be made of them.

I may either fractionate the crude oil by utilizing heat from the scrubber or by using separate flash vaporizing apparatus. In the first mentioned case less heat within the system will be available for other uses to which it is commonly put, as for example the heating of the returned heat-carrier gas.

In the accompanying drawings I have shown two forms of apparatus:

Figure 1 being a diagram of apparatus for carrying out a preferred form of the invention in which heat for the fractionation of the crude is furnished from the scrubber, and Figure 2 a diagram of apparatus in which the heat for fractionation is supplied independently of the scrubber.

Referring to Figure 1, oil vapor from a source to be described hereinafter and superheated to an appropriate temperature is introduced into a mixing chamber 10 through pipe 11, to which chamber is also admitted hot heat-carrier gas from stove 12 through a pipe 13. The mingled

hot gas and vapor are then passed to a reaction chamber **15** through which the mixture travels and wherein the vapor is cracked to the desired degree. The mixture of cracked products and gas is then admitted to a scrubber **17** to which is admitted the scrubbing liquid consisting of an oil whose characteristics will be described hereinafter, such oil being admitted through pipe **18**. The scrubbed products then leave the scrubber **17** through a pipe **20** through which they are conducted to a rectifier **21**, the bottoms from which (constituting a part of the cracking stock) leave the rectifier through pipe **23** while the overhead portion constituting the cracked gasoline leaves through a vapor pipe **24** and is conducted to a condenser **25** which is in communication with accumulator **26**.

The scrubbing oil, after it has scrubbed out any free carbon present and tar and removed heavy ends from the reaction products and charged with much of the heat in the products from the reaction chamber, leaves the scrubber through pipe **30** by which it is conducted to a series of heat exchangers A, B, C, D, the function of which will be more fully explained, after which the cooled oil passes to a settling tank **32** and the oil pumped therefrom through pipe **33** back to the scrubber **17**.

The crude oil to be charged to the system, is admitted at heat exchanger B wherein it is heated by indirect heat exchange to a temperature, say, of 350° F., and while maintained under a pressure considerably above the system pressure, say a pressure of 100 pounds, when the system pressure is 50 pounds. The crude charge is then flashed in flash drum **36**, conditions being maintained so that fractions having an end boiling point, say from 300 to 325° F., are vaporized and led off through pipe **37** to a condenser, not shown. The topped crude then leaves the flash drum **36** through pipe **37***a* and is heated in heat exchanger A to a temperature say from 450 to 500° F. whereupon it is flashed in drum **39**. The vapor so produced, which is within the naphtha range say of 325 to 460° F., is now conducted through pipe **40** to superheater **42** after it has been previously dried as by the introduction of a stream of hot gas from a source **43**. The vapor superheated in the coil **42** then passes through the pipe **11** to the mixing chamber **13** as previously described. The charge to the reaction chamber is thus seen to consist of one component, the naphtha, the course of which has just been described, and a further component consisting of the bottoms from the rectifier **21** of the order of gas oil or heavier, which, as has been stated, leave the rectifier through pipe **23**, pass thence through heat exchanger C and then by means of pipe **45** to vaporizer **47** and flash drum **48**. Such bottoms as are left from the flashing operation in drum **48** are conducted through pipe **49** to the scrubber **17**, being added to the scrubbing liquid, as for example by being admitted to the pipe **33** returning the scrubbing fluid to the scrubber.

The residual heat-carrier gas after leaving the accumulator **26** passes by means of pump **27** through an absorber **50** to drop out light fractions held therein. The stripped gas or a portion of it is then led back to the hot blast stoves, passing on its way thereto through heat exchanger D to acquire such remaining heat in the scrubbing liquid as is available. As the temperature of the gas is fairly low in order to facilitate stripping in the absorption unit, it is thus possible to utilize low temperature heat contained in the scrubbing liquid. After being thus heated in the heat exchanger D, the gas passes to the stove through the pipe **51**.

It will thus be seen that by removing the fractions down to and including the naphtha fraction in the crude charge before the latter is fed to the scrubber, none of the straight-run naphtha is added to the cracked gasoline nor is there added thereto any of the light straight-run gasoline, at least before it is subjected to a purifying treatment which is simpler and more economical than that which it is necessary to give to the cracked gasoline.

In Figure 2 the crude charge is first heated in vaporizer **60** and then flashed in drum **61** so as to give a light gasoline vapor led off through pipe **62** to a suitable condenser, not shown, such vapor being of the same end point as mentioned in connection with the embodiment of Figure 1, i. e. of 300–325° F. The topped crude then passes through pipe **63** to vaporizer **64** and thence to flash drum **65**, wherein the naphtha component is flashed off and passes through pipe **66** to the superheater **42'** and thence by pipe **11'** to mixing chamber **10'**. The bottoms from the flash chamber **65** pass through pipe **49'** to the top of scrubber **17'**. The remaining steps in the process are the same as described in connection with the embodiment of Figure 1 except that heat exchangers A and B are omitted, the hot scrubbing liquid passing through pipe **30'** to heat exchanger C' and thence to heat exchanger D', residue chamber **32'** and thence by pipe **33'** to the scrubber again. The rectifier bottoms pass through pipe **23'** to heat exchanger C' wherein they are heated by the hot scrubbing fluid, passing thence through pipe **45'** to vaporizer **64**. The gas having passed to absorber **50'**, passes through heat exchanger D', pipe **57'**, to stove **12'**.

In lieu of the flash drums shown, distilling columns of equivalent size may be employed. In addition, various changes may be made as will occur to those skilled in the art. For example, in lieu of taking off the excess scrubbing liquid at the usual place (draw-off **55** from residue tank **32**) a proper quantity of the hot scrubbing liquid may be diverted from the pipe **30**, by means not shown, and led directly to a continuous vacuum still and reduced to a heavy residue, as for example asphalt, when dealing with an asphalt bearing crude or other oil. Here the heat in the oil may be sufficient for the distillation. It will be understood that in any event sufficient residual scrubbing liquid is removed so as to maintain a proper balance in the system. Also, if desired, naphtha from a separate source may be admitted through pipe **56** to pipe **45** and in this manner fed to the vaporizer **47**.

I claim:

1. In a method of converting hydrocarbon oil in the vapor phase into motor fuels of the gasoline type in which the method of the conversion reaction is brought about by the aid of a heated heat carrier gas in a reaction zone at a temperature in excess of 900 degrees F. and the products from the reaction zone are contacted directly with a hydrocarbon scrubbing medium to extract tar and carbon from said products and also a portion of the heat therein, the improvement which consists in subjecting a charging stock consisting of a crude to progressively more intense vaporizing conditions to separate it into (*a*) a light straight-run fraction, (*b*) a naphtha fraction, and (*c*) a fraction heavier than

said naphtha fraction, passing fraction (*a*) to a separate condenser, passing fraction (*b*) to said reaction zone where it undergoes conversion as stated at temperatures in excess of 900 degrees F. in contact with the heat carrier gas, and passing fraction (*c*) into said scrubbing zone wherein part is vaporized by heat contributed in part by the heat still remaining in said gaseous heat carrier, the vapor produced added to the stream of non-liquid fluid products passed from the scrubbing zone while the unvaporized part remains commingled with scrubbing medium, and subjecting said stream of non-liquid fluid products from said scrubbing zone to condensing conditions to condense a product suitable as charging cracking stock, vaporizing same and passing the vapor to the reaction zone.

2. In the method according to claim 1, vaporizing fractions (*a*) and (*b*) by bringing the crude charging stock into successive indirect heat exchanges with the heat charged scrubbing medium from said scrubbing zone, which medium is at a substantially higher temperature than said charging stock, and then passing the naphtha fraction to the reaction zone.

3. In the method according to claim 1, vaporizing fractions (*a*) and (*b*) by bringing the crude charging stock into successive countercurrent indirect heat exchanges with the heat charged scrubbing medium from such scrubbing zone, which medium is at a substantially higher temperature than said charging stock, then passing the naphtha fraction to the reaction zone.

4. The method according to claim 1 in which the straight-run fraction (*a*) has an end point from 300 to 325 degrees F. and in which the naphtha fraction (*b*) has an end point of from 325 to 460 degrees F.

ALBERT P. SACHS.