April 17, 1934. R. C. OSTERSTROM 1,955,596

METHOD OF PRODUCING AN AROMATIC LUBRICATING OIL

Filed Feb. 24, 1931 3 Sheets-Sheet 1

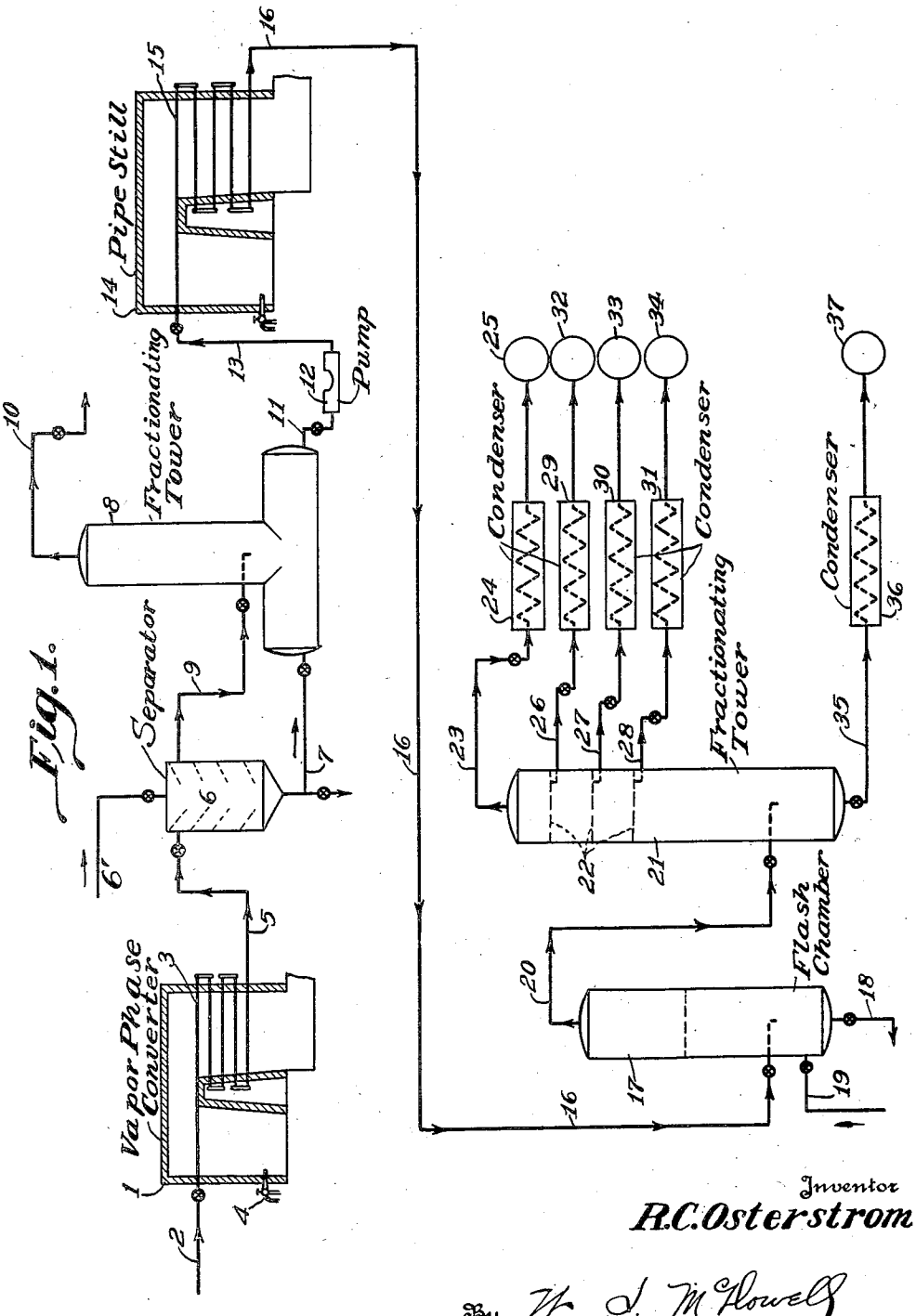


Fig. 1.

Inventor
R.C. Osterstrom

By W. J. McPowell

Attorney

April 17, 1934. R. C. OSTERSTROM 1,955,596

METHOD OF PRODUCING AN AROMATIC LUBRICATING OIL

Filed Feb. 24, 1931 3 Sheets-Sheet 2

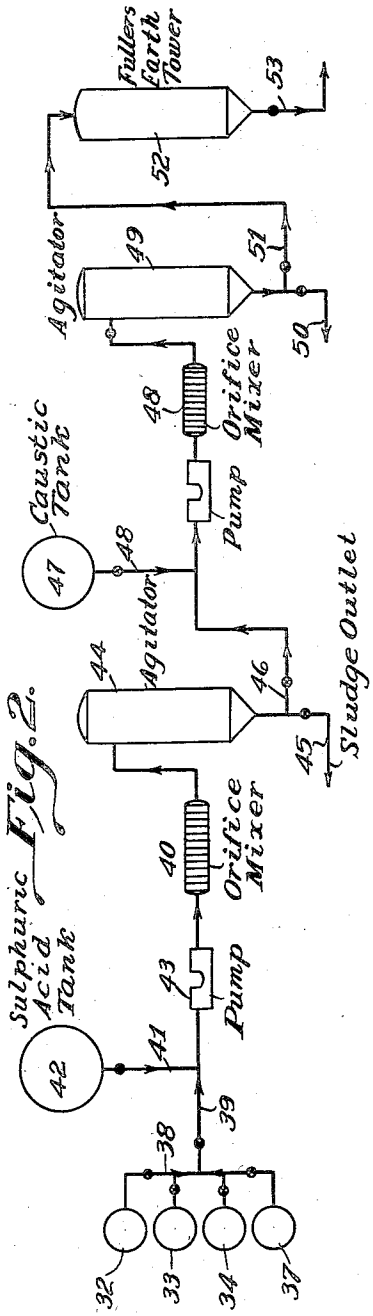


Fig. 2.

Inventor
R. C. Osterstrom

By W. S. McDowell

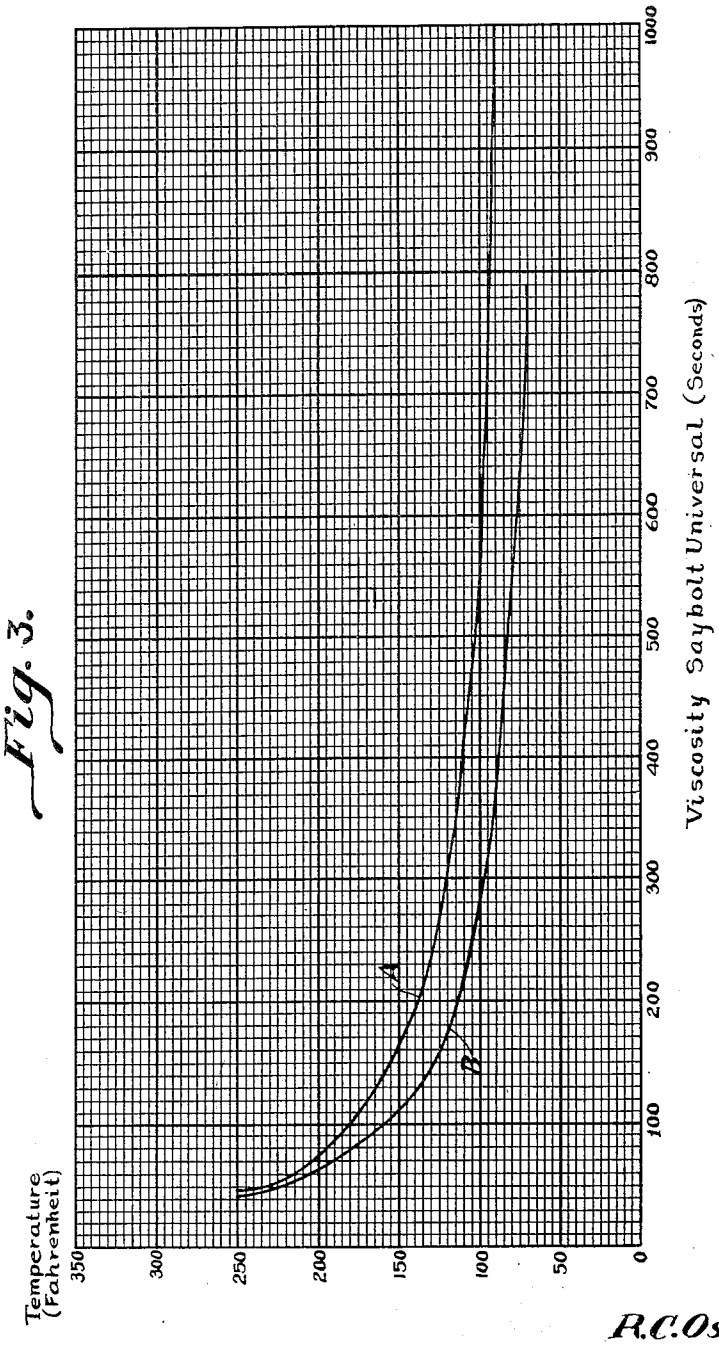
Attorney

April 17, 1934. R. C. OSTERSTROM 1,955,596

METHOD OF PRODUCING AN AROMATIC LUBRICATING OIL

Filed Feb. 24, 1931 3 Sheets-Sheet 3

Fig. 3.



Inventor
R. C. Osterstrom

By W. S. McFlowell

Attorney

Patented Apr. 17, 1934 1,955,596

UNITED STATES PATENT OFFICE

1,955,596

METHOD OF PRODUCING AN AROMATIC LUBRICATING OIL

Rudolph C. Osterstrom, Chicago, Ill., assignor to The Pure Oil Company, Chicago, Ill., a corporation of Ohio

Application February 24, 1931, Serial No. 517,897

5 Claims. (Cl. 196—75)

This invention relates to a method for producing an improved hydrocarbon lubricating oil, and an outstanding object thereof resides in the provision of what may be termed an aromatic lubricating oil wherein the compounds comprising the oil are such as to successfully withstand for extended periods of use without decomposition, the severe service and high temperatures which lubricating oil encounters especially when it is used in automotive engines.

In the lubricating of an internal combustion engine, one of the most important characteristics of a lubricating oil is its heat resisting property, that is, its ability to withstand temperatures which will decompose to some degree certain types of lubricating oil. At present it is generally recognized that the oils best adapted to withstand such lubricating conditions are those made up almost entirely of hydrocarbons of the paraffin series. It has been determined that when hydrocarbons of the type generally known as gas oil or topped crude, and even kerosene, are subjected to cracking temperatures in excess of substantially 1000° F., with or without pressures above atmospheric, such cracking reactions produce considerable polymerization of the hydrocarbons undergoing reaction. That is to say, cracking reactions are of the reversible type, i. e., while certain hydrocarbons are being split or decomposed into hydrocarbons of lower molecular weights, other molecular rearrangements are taking place wherein hydrocarbons of higher molecular weights are formed and this polymerization process can be made sufficiently extensive to produce very heavy viscous hydrocarbon oils of relatively high boiling range, up to and including products generally known as asphalt and tar. I have found that if these heavy hydrocarbons, which are the polymerization products of vapor phase cracking reactions, are redistilled and subjected to proper fractionation, very high grade lubricating oils are obtained. The physical properties and characteristics of the lubricating oils thus produced can be controlled by altering the temperature and pressure conditions in the original cracking reaction, as well as by selecting the charging stocks and regulating their throughput through the cracking reaction zone. These lubricating oil fractions, may as a result of redistillation of the heavy polymerized fraction, ordinarily contain small amounts of highly unsaturated hydrocarbons which are readily susceptible to oxidation. When desired, such highly unsaturated hydrocarbons can be removed in any suitable manner such as by acid treating, neutralizing and filtering, or by treatment with liquid sulphur dioxide. In general, these new lubricating oils which I have discovered have a lower A. P. I. gravity than an oil of the same viscosity of customary manufacture. Instead of being highly paraffinic, my new lubricating oils more nearly approach the aromatic series in being cyclic hydrocarbons, hence I use the expression aromatic in distinguishing the same from ordinary lubricating oils which approach the saturated cyclic or naphthenic compounds and contain paraffinic or iso-paraffinic side chains.

I am aware of the fact that it has been proposed to employ as lubricating oil stock residual oils obtained from liquid phase cracking operations, but such latter lubricating oils are readily distinguished from the oils comprising the present invention by the fact that they also are highly paraffinic and contain saturated cyclic hydrocarbons instead of being composed of hydrocarbons containing unsaturated compounds of substantially the aromatic series.

For a further understanding of the invention, reference is to be had to the following description and to the accompanying drawings:—

Fig 1 is a diagrammatic view showing the grouping and flow arrangement of apparatus which may be used in the production of the lubricating oils comprising the present invention;

Fig. 2 is a similar view disclosing apparatus for use in treating the lubricating oils comprising the present invention to remove certain undesirable compounds therefrom;

Fig. 3 is a view setting forth a graph, disclosing temperature-viscosity curves.

Referring more particularly to the accompanying drawings and especially to the apparatus disclosed in Fig. 1, the charging stock enters a cracking still indicated at 1 through a pipe line 2. This charging stock may be in a vaporous state when introduced into the heated zone of the still 1 by way of the pipe line 2. This charging stock may consist of such mineral oils or fractions thereof which are ordinarily referred to as gas oil, top crude or kerosene and any other type of oil found suitable in the operation of the system. The oil vapor passes through a coil 3 located in the highly heated zone of the still, and a burner or burners 4 may be utilized in heating the interior of the still to desired temperatures, whereby the oil or oil vapor, passing through the coil 3, attains a cracking temperature in excess of substantially 1000° F. It will be appreciated that the oil vapor undergoing cracking reactions in the coil 3 may be maintained under widely

different pressures and the invention is therefore applicable to either high or low pressure types of vapor phase converters. Often in the operation of such converters, it is found desirable to carry on the conversion reactions in the presence of a catalyst and with or without the addition of steam to the vapors in the coil, and I contemplate the application of my invention to all of such systems and methods of cracking oil in the vapor phase and especially to those systems where the oil vapor attains cracking temperatures varying between 1000° F. to 1300° F.

The cracked vapors are discharged from the still and led by way of a vapor line 5 into a separator 6. In this separator, a separation of a portion of the polymerized hydrocarbons from the lighter hydrocarbons takes place, the heavy polymerized hydrocarbons collect in the bottom of said separator and may be removed therefrom by means of a valved pipe line 7, which extends to the bottom of a fractionating tower 8. The lighter hydrocarbons in vaporous form also pass from the separator 6 by way of a valve pipe line 9 to the fractionating tower 8 and enter said fractionating tower in the vapor space thereof at a point above the heavy oil reservoir formed in the bottom of said tower. A steam line 6' may be employed for introducing superheated steam in the top of the separator. Likewise, the latter may be provided with the customary staggered baffles or plates. Within the tower, which may be of any suitable construction for fractionating purposes, the lighter hydrocarbons, substantially in the vaporous state, and containing some polymerized hydrocarbons, are subjected to fractionation to remove therefrom entrained liquids, the latter passing downwardly through the tower and collecting in the oil reservoir formed in the base thereof. The lighter vaporous hydrocarbons are released from the top of the fractionating tower and pass by way of a valve pipe line 10 to suitable condensing and collecting apparatus (not shown), as end point motor fuel distillate.

The polymerized residual oil is removed from the bottom of the tower 8 through a line 11, being picked up by a hot oil pump 12 and forced through a valved pipe line 13 into a pipe still 14. Within this still, the polymerized residual oil passes through a coil 15 and therein subjected to the heat of the pipe still to attain desired distillation temperatures. The oil is then discharged at such temperatures from the coil 15 by way of a valved outlet line 16 and enters a flash chamber 17 wherein a lower pressure is maintained on the oil than that which exists in the coil 15. Within the flash chamber, the separation of the heavier residues of the nature of tar or asphalt takes place, the latter being removed from the bottom of the flash chamber by way of a valved outlet line 18. Superheated steam may be introduced into the flash chamber through the valved line 19 to facilitate the fractionation of the oils and vapors contained therein, the intermingled oil and steam vapors leaving the flash chamber through an overhead line 20 and pass to the lower portion of a fractionating tower 21.

Arranged within the fractionating tower 21 are a plurality of vertically superposed trays 22 which function to receive the condensate formed by the operation of the tower and provide for the collection and separation of condensates composed of oils of different boiling ranges. The unvaporized fraction, comprising the lighter oils, passes overhead from the fractionating tower 21 by way of the line 23 and hence through a condenser 24 to a storage tank 25. This fraction generally comprises a distillate having the characteristics of a gas oil. The other fractions, which are collected on the trays 22, are removed from the tower 21 by way of lines 26, 27 and 28 and pass respectively through condensers 29, 30 and 31 and from these condensers the several cuts or fractions are delivered to storage tanks 32, 33 and 34 respectively. It will be appreciated that the fractionating tower 21 may be provided with as many trays 22 as required in order to secure any desired number of cuts of relatively differing boiling range, lubricating values and other characteristics. Obviously, the fraction collected in the tank 32 would be the lightest and the fraction collected in the tank 34, the heaviest of these intermediate fractions. The heaviest fraction, however, which may be even composed of resinous matter, is removed from the bottom of the tower 21 through a line 35, passing through a condenser 36 and thence to a storage tank 37. It will therefore be seen that the tank 25 will contain the lightest fraction and the tank 37 the heaviest fraction, due to the operation of the fractionating tower 21 and the placement of the trays 22 therein. As specified, any desired number of these trays may be used according to the number of lubricating oil fractions desired to be withdrawn from the tower. The coil 15, the flash chamber 17 and the fractionating tower 21 may, if desired, be operated under sub-atmospheric pressures and I use such sub-atmospheric pressures in the preferred form of my invention, although in steam distillation I may employ ordinary pressures or in certain instances pressures above atmospheric.

These lubricating oil fractions, which due to the high temperature vapor phase cracking operation in the coil 3 comprise hydrocarbons closely approximating the aromatic series, may be treated to produce finished lubricating oils by any one of several desirable methods. In the apparatus illustrated in Fig. 2, the tanks 32, 33, 34 and 37 are connected with valved outlet lines 38 which lead to a common pipe line 39 extending to an orifice mixer 40, and entering the line 39, ahead of the mixer 40, is a valved pipe line 41 which leads from a sulphuric acid tank 42, the line 39 being provided with a pump 43. In the orifice mixer, the sulphuric acid is intimately mixed with the particular lubricating oil fraction undergoing treatment, and after leaving the mixer, the acid-oil mixture enters an agitator 44. Acid sludge is withdrawn from the bottom of the agitator through the valve outlet line 45 and the acid treated oil is withdrawn through the line 46 where it meets a caustic solution discharged from a tank 47 through a line 48. The caustic-oil mixture enters a second orifice mixer 48' wherein the caustic is brought into proper neutralizing reaction with the acid treated oil. From the mixer 48' the oil caustic mixture is passed into a second agitator 49. Caustic sludge is withdrawn through the line 50 from the agitator 49 and the caustic-oil solution passes through a pipe line 51 into a filter 52, which contains a filtering agent such as fuller's earth or its equivalent. The finished lubricating oil fraction leaves the filter 52 by way of the outlet line 53 as a treated commercial product.

In view of the foregoing, it is seen that the present invention provides for the production of wax free, viscous lubricating oils which conform approximately to the molecular structure of aromatic cyclic hydrocarbons rather than the

ordinary saturated cyclic or naphthenic compounds found in ordinary lubricating oils and which contain paraffinic or iso-paraffinic side chains. Further, my new aromatic lubricating oils comprise the viscous fractions of the residual oils obtained as polymerization products following the cracking of substantially any kind of charging stock by the vapor phase method. Also, these oils differ radically from the commonly accepted lubricating oils in that the viscosity-temperature curve, shown at A in Fig. 4 is considerably flatter than the corresponding curve, indicated at B, of such ordinary lubricating oils, the curve A representing my improved lubricating oil and the curve B, a lubricating oil of the so-called Pennsylvania type. My improved lubricating oils, having been made as a result of extremely high temperatures, are very much more resistant to breaking down under high temperature lubricating conditions than general lubricating oils of the so-called Pennsylvania or Mid-Continent types.

What is claimed is:

1. The method of producing wax-free heat resistant lubricating oils of aromatic cyclic hydrocarbon base and having viscosity-temperature characteristics defined by approximately 200 to 600 seconds viscosity Saybolt universal at 140° F. to 100° F. which consist in subjecting mineral petroleum hydrocarbon oils to a vapor phase cracking operation wherein said oils attain a cracking temperature in excess of 1000° F. and not substantially in excess of 1300° F., separating the products of such a cracking reaction to obtain the viscous residual oils produced by the polymerization of hydrocarbons in the cracking operation, redistilling such residual oils, and recovering as a condensate of such redistillation a viscous lubricating oil fraction.

2. The method of producing a wax-free heat resistant hydrocarbon lubricating oil of aromatic cyclic hydrocarbon base and having viscosity-temperature characteristics defined by approximately 200 to 600 seconds viscosity Saybolt universal at 140° F. to 100° F., which comprises subjecting a mineral petroleum oil to a vapor phase cracking operation wherein said oil while in the vapor phase attains a temperature in excess of 1000° F., passing the products released from said cracking operation into a separating zone, removing from said separating zone as vapors low boiling compounds, separately removing from said zone high boiling residual oils containing polymerized hydrocarbons, subjecting said residual oils to redistillation, and fractionating the redistilled residual oils to remove therefrom a plurality of separately collected fractions constituting lubricating oils of different boiling range.

3. The method of producing wax-free heat resistant lubricating oils of aromatic cyclic hydrocarbon base and having viscosity-temperature characteristics defined by approximately 200 to 600 seconds viscosity Saybolt universal at 140° F. to 100° F. which comprises passing a mineral petroleum oil fraction through a heated converting zone wherein said oil while entirely in a vaporous state attains a cracking temperature in excess of 1000° F., passing the products of such conversion into a separating zone, removing from said zone as vapors oils of low boiling range, separately removing from said zone residual oils composed of viscous polymerized hydrocarbons of high boiling range, passing said residual oils through a second heating zone, subjecting the oils removed from the second heating zone while in a vaporous state to fractionation in a confined zone, and removing from said confined zone a plurality of lubricating oil fractions.

4. The method of producing wax-free heat-resistant lubricating oils of aromatic cyclic hydrocarbon base and having viscosity-temperature characteristics defined by approximately 200 to 600 seconds viscosity Saybolt universal at 140° F. to 100° F. which comprises passing a mineral petroleum oil fraction through a heated converting zone wherein said oil while entirely in a vaporous state attains a cracking temperature in excess of 1000° F., passing the products of such conversion into a separating zone, removing from said zone as vapors oils of low boiling range, separately removing from said zone residual oils composed of viscous polymerized hydrocarbons of high boiling range, passing said residual oils through a second heating zone, subjecting the oils removed from the second heating zone while in a vaporous state to fractionation in a confined zone, introducing superheated steam into said confined zone, and removing from said confined zone a plurality of lubricating oil fractions.

5. The method of producing wax-free heat-resistant lubricating oils of aromatic cyclic hydrocarbon base and having viscosity-temperature characteristics defined by approximately 200 to 600 seconds viscosity Saybolt universal at 140° F. to 100° F. which comprises passing a mineral petroleum oil fraction through a heated converting zone wherein said oil while entirely in a vaporous state attains a cracking temperature in excess of 1000° F., passing the products of such conversion into a separating zone, removing from said zone as vapors oils of low boiling range, separately removing from said zone residual oils composed of viscous polymerized hydrocarbons of high boiling range, passing said residual oils through a second heating zone, subjecting the oils removed from the second heating zone while in a vaporous state to fractionation in a confined zone, maintaining said second heating zone and said confined zone under sub-atmospheric pressures, and removing from said confined zone a plurality of lubricating oil fractions.

RUDOLPH C. OSTERSTROM.