W. C. KOEHLER & L. LINK.

DISTILLING PETROLEUM.

APPLICATION FILED JULY 5, 1910. RENEWED JUNE 26, 1913.

1,084,016. Patented Jan. 13, 1914.

Fig. 1.

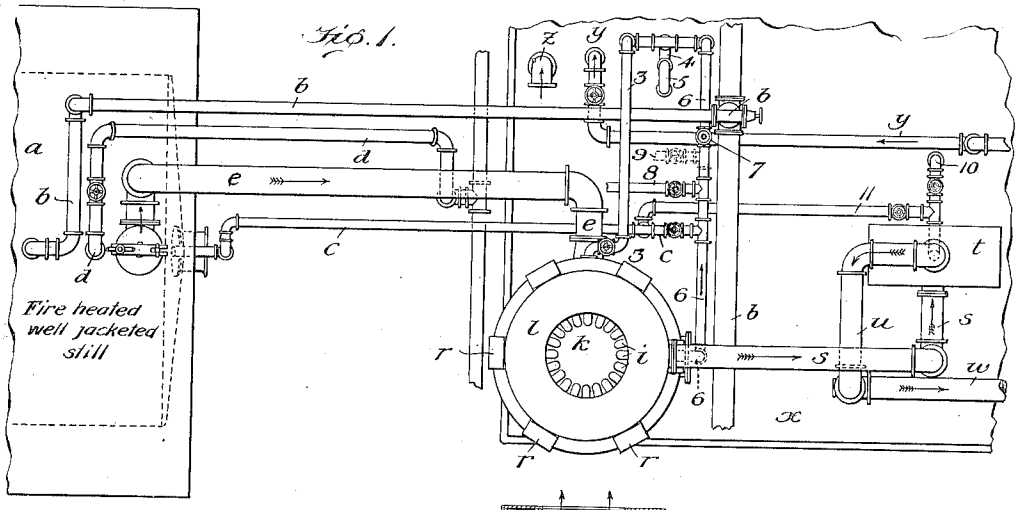


Fig. 2.

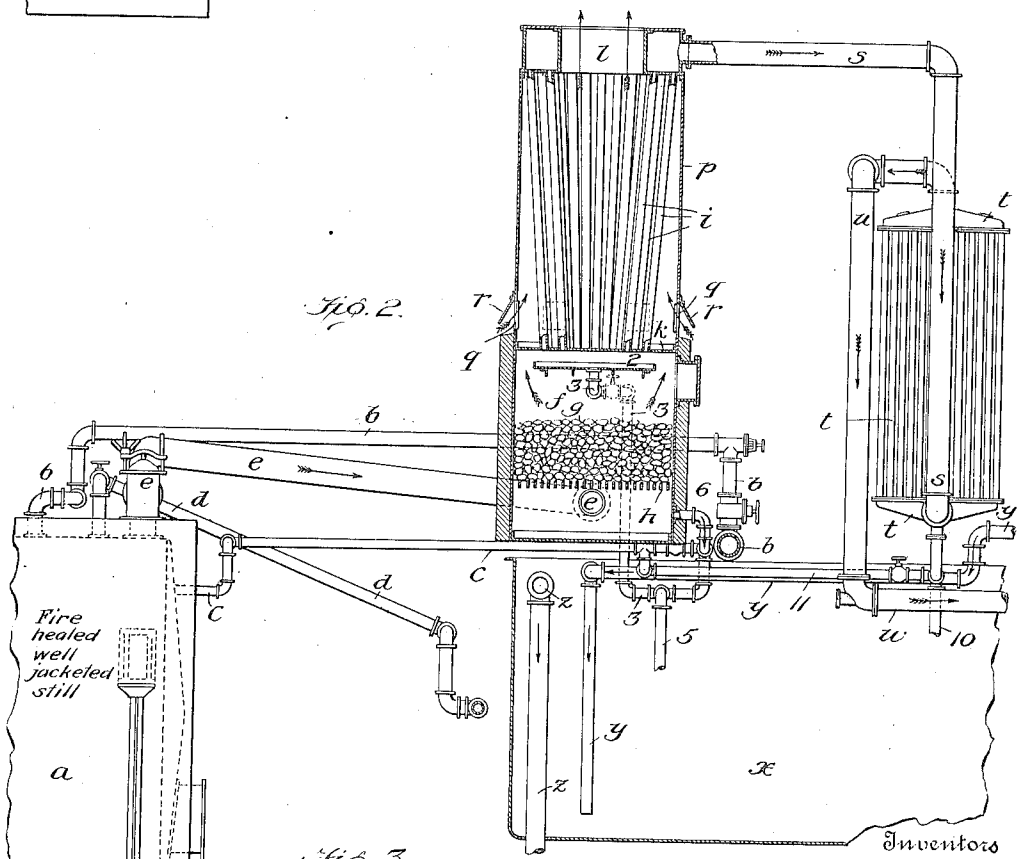
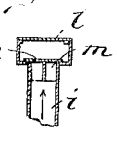


Fig. 3.



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UNITED STATES PATENT OFFICE.

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DISTILLING PETROLEUM.

1,084,016. Specification of Letters Patent. Patented Jan. 13, 1914.

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To all whom it may concern:

Be it known that we, WILLIAM C. KOEHLER and LUDWIG LINK, both citizens of the United States, residing at Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Distilling Petroleum, of which the following is a specification.

This invention relates more particularly to the distillation of the lubricant or lubricant and wax yielding fraction of crude petroleum at temperatures above 650° F. and with protection of the vapors against undue cooling before they pass over to be condensed as distillate, so as thereby to obtain distillate which shall contain the decomposable but undecomposed (or only slightly decomposed) hydrocarbons of said fraction and shall consequently be well suited for use as a lubricant and wax yielding material where the crude petroleum yields paraffin wax, or as a lubricant stock simply where it does not; for it is well known that the suitability of distillate as such material or stock is impaired when its decomposable hydrocarbons are cracked (decomposed) to more than a slight extent (if at all) and that undue cooling of the vapors before they pass over to be condensed as distillate results in objectionable cracking. But each of the improvements composing the invention is intended to be secured for all the uses to which it can be applied with or without modification. Heretofore in thus distilling said fraction much of the distillate has had to be rerun before it could be satisfactorily pressed for paraffin wax in the case of distillate from wax yielding petroleum or be given the customary sulfuric acid and alkali treatment in the case of distillate from petroleum having an asphaltic base. In the former case gummy matters have been present which clog the filter press and so prevent the pressing of the distillate at least with facility; and in the latter case asphaltic matters have been present which in the customary treatment with sulfuric acid and alkali unite with the alkali in the form of an emulsion that will not separate on standing. In distilling, for example, the petroleum from the Illinois and Kansas fields (a petroleum which yields paraffin wax) the best results in our experience have heretofore been the production in the crude oil run (along with lighter distillate) of about twenty per cent. of distillate available as lubricant and wax yielding material without further distillation and about eight and a half per cent. of distillate (termed slop) which must first be rerun. In rerunning nearly a fourth as much slop is again produced, making the total amount of distillate to be rerun constantly about ten and a half per cent. of this kind of crude oil.

We have discovered that it is possible materially to reduce the percentage of slop produced in the crude oil run in distilling the lubricant or lubricant and wax yielding fraction of petroleum as aforesaid; and we thus are able to effect a substantial saving in expense of working as compared with any previous process for performing such distillation with which we are acquainted; while the loss by decomposition may even be less than heretofore, when the decomposition in rerunning is taken into account. We have found (first, as we believe) that much of the vapors of lubricant or lubricant and wax yielding character which are accompanied by gummy or asphaltic matters in their passage from the still can be freed from such matters before said vapors are condensed as distillate by a suitably extended travel of the suitably cooled vapors in contact with oppositely flowing condensate in connection with a return of said condensate to the oil in distillation, without countervailing loss by decomposition of hydrocarbons or otherwise.

Conditions of cooling and travel which we have found efficient will be hereinafter set forth by way of example. It is only essential, first, that the cooling should be sufficient to effect the condensation of the gummy or asphaltic matters and not so far below the contemporaneous temperatures of the oil in distillation that the advantage otherwise of the new or improved process over the prior state of the art would be more than offset by the detrimental effects of increased decomposition and evaporation in the still which would result from excessive cooling of the vapors; and, second, that the travel of the suitably cooled vapors in contact with oppositely flowing condensate on its way back to the oil in distillation should be sufficient to free said vapors practically from said gummy or asphaltic matters. After the vapors have passed over to be condensed as distillate, they are subjected to fractional condensation with flow of vapors and condensate in opposite directions in contact with

each other in order to obtain distillate of lubricant or lubricant and wax yielding character as free as may be from more volatile hydrocarbons; and the facility or difficulty with which the so obtained distillate can be pressed for wax so that pressing without rerunning would or would not be preferable to rerunning and subsequent pressing (in the case of wax yielding petroleum) and the ability or inability of the distillate to separate on standing from the alkali of the customary sulfuric acid and alkali treatment when it is subjected thereto (in case of other petroleum) will indicate whether it has or has not been made practically free from gummy or asphaltic matters. If not thus free therefrom the vapors may be made to travel longer in contact with the oppositely flowing condensate with or without additional cooling as may be considered necessary or expedient. It is considered best to reduce the volume of this condensate as much as is consistent with the practical freedom of the vapors from said gummy or asphaltic matters when they pass over to be condensed as distillate. The distillation of the said fraction as a whole is best performed as hereinafter described; and the apparatus, which is hereinafter described, is best employed for the purpose.

Figure 1 of the accompanying drawings is a plan view of said apparatus; Fig. 2 is an elevation of the same, partly in vertical longitudinal section; and Fig. 3 is a detail view of one of a number of small relief valves forming part of said apparatus.

The fire heated still *a*, say in the form of a horizontal cylinder and of about a thousand barrels capacity, more or less, suitably jacketed to prevent undue cooling of the vapors before they leave the vapor space, is provided with a valved charging line *b*, a valved run back *c*, and a valved steaming out line *d*. It is connected by a vapor pipe *e* (say twelve inches in internal diameter and about twenty five feet long) with the lower part of chamber *f* provided with a heat retaining jacket and being, say, about seven feet in internal diameter and about eight feet high. The vapor pipe *e* has a short upright portion at its inlet end; and it thence descends toward its outlet end. Within chamber *f* are baffles in the form of cobble stones *g* (say from about four to about eight inches in diameter) loosely piled together to a depth, say, of about four feet and resting upon the grating *h* above the outlet end of the vapor pipe *e*.

Above the chamber *f* is an air cooled tubular condenser composed of, say, sixty pipes *i*, each about eleven feet in length and about four inches in external diameter, set in an inclined position between the tube sheet *k* at top of chamber *f* and the annular header *l*. As shown in Fig. 3 at the upper end of each pipe *i* is a light valve *m* (say about thirty three ounces in weight) with an opening *n* therein of smaller diameter than the inside of the pipe *i* (say an opening of about an inch and a quarter in diameter). The restricted openings *n* tend to equalize the currents in the several pipes *i;* and one or more of the valves *m* would rise and release the pressure in said pipes *i* if it should at any time become excessive.

The pipes *i* are inclosed in a casing *p* which at the top fits around the header *l* and which has inlet openings *q* at the bottom for inflow of air from the surrounding atmosphere. Each inlet is provided with a valve *r;* which can be opened to the extent desired, or can be closed. The casing is open on top through the annular header *l*, but closed at bottom except for the valved inlets *q*.

From the interior of header *l* a vapor pipe *s* leads to the bottom of an air cooled tubular condenser *t*. From the top of this latter a vapor pipe *u* connects with the water cooled condenser *w* formed of a single pipe which is immersed in the water of tank *x* and whose upper end only is represented, the rest of it being broken away for simplicity of illustration. The pipes 5, 8, 9 and 10 are similarly represented. The tank *x* is supplied with water by pipe *y* and provided with an overflow *z*.

Between the chamber *f* and the pipes *i* are means (in the form as shown of a saucer 2 and a valved outlet 3 from said saucer) for enabling (at the will of the operator) the condensate from pipes *i* to be supplied to chamber *f* or to be otherwise disposed of. As shown, the saucer outlet 3 connects through a trap 4 with a distillate draw off 5, which is immersed in the water of tank *x* for cooling.

The chamber *f* has a liquid outlet 6, which is connected with said trap 4 and distillate draw off 5, also with the run back *c*, also with a second valved distillate draw off 8 which is not immersed in the water of tank *x* and is consequently of higher temperature than pipe 5, and (if so desired) also with a valved draw off 9 (indicated in dotted lines) which is suitably trapped and immersed in the water of tank *x*. In outlet 6 between the trap and the draw offs 8 and 9 is a valve 7.

The condenser *t* has its liquid outlet connected with a trapped and valved draw off 10 immersed in the water of tank *x*. As shown, said outlet is also connected with the run back *c*, namely, by a valved branch pipe 11.

The vapors from still *a*, after cooling to a certain extent in vapor pipe *e*, enter the lower part of chamber *f* and, after passing up between the stones *g*, proceed thence through pipes *i*, header *l*, vapor pipe *s*, air

cooled condenser *t*, vapor pipe *u* and water cooled condenser *w*. In this last all but the non-condensable gases (and very lightest liquid hydrocarbons) are reduced to the liquid state, the uncondensed gases (and vapors) passing off in the known way, to be disposed of as may be desired.

By opening and closing proper valves, the condensate formed in the vapor pipe *e* and chamber *f* can be delivered (as may be preferred) either to the run back *c* or to the draw off 5, to the draw off 8 of higher temperature, or to the draw off 9, should this last be provided.

By opening and closing the proper valves the condensate from the pipes *i* can be allowed to fall into the chamber *f*, thence to flow away through one of the pipes connected with pipe 6; or it can be diverted by saucer outlet 3 direct to the distillate draw off 5.

The condensate from condenser *t* is drawn off through pipe 10; or, if desired (by changing the valves), it can be delivered through the branch pipe 11 to the run back *c*.

The condensate from condenser *w* is drawn off from the outlet thereof in ordinarily at least a sufficiently cool state.

In distilling the lubricant and wax yielding fraction of crude petroleum, say from the Illinois and Kansas fields, such petroleum can be deprived in any known or suitable way of its more volatile fractions, representing about 58 per cent. of the crude oil by volume; and the so obtained residual oil (representing about 42 per cent. of the crude oil) can then be charged into the still *a;* but it is more advantageous to supply the still *a* with the crude oil itself, or with an undistilled residual oil therefrom containing more or less of said more volatile fractions in addition to the lubricant and wax yielding fraction. In the latter cases there is no interruption to the distillation when said more volatile fractions have been removed; but whereas in removing them the run back *c* is open and the saucer outlet 3 closed (draw offs 8 and 9 and valve 7 also closed) when they have been removed the run back *c* is closed and the valve 7 is opened (saucer outlet 3 and draw offs 8 and 9 remaining closed). In the former case the still for distillation of the lubricant and wax yielding fraction may be brought in either with the run back *c* open and valve 7 closed or conversely (saucer outlet 3 and draw offs 8 and 9 being closed). In any case distillation of the lubricant and wax yielding fraction is in due course carried on with the oil in distillation above 650° F. in temperature and with the run back *c* closed, valve 7 being open and saucer outlet 3 and draw-offs 8 and 9 being closed; so that all the condensate formed after the vapors leave the ordinary vapor space of the still and before they leave the header *l*, except the small amount formed in the upright part of a vapor pipe *e*, is collected as distillate through the pipe 6 and draw off 5; while the well rectified vapors pass on by pipe *s* to the condenser *t*. In this latter further condensation takes place; and the condensate therefrom is collected as distillate through the draw off 10. The uncondensed vapors pass by pipe *u* to condenser *w;* from which the condensate is collected as distillate; while the gases and any uncondensed vapors pass off to be burnt under the still or to be otherwise disposed of.

Satisfactory lubricant and wax yielding distillate should be received from draw off 5 while the gravities of samples taken from the stream at its outlet end are changing from about 31 4/10° B. at 60° F. (which is about the gravity of the first distillate so received which belongs to this fraction of the crude oil under consideration) to about 26° B. The viscosities of these samples should range from about 65 seconds to about 108 seconds measured at 100° F. by Saybolt's Universal Viscosimeter. They should first exhibit cloudiness, due to solidification of the paraffin wax therein, at temperatures ranging from 56° F. to 78° F., when the samples are gradually reduced to sufficiently low temperatures. The oil in distillation should range in temperature from about 698° F. to about 745° F. The vapors pass over to be condensed as distillate almost as soon as they leave the ordinary vapor space of the still (which ends at the junction of the vapor pipe *e* with the still); and said vapors when they thus pass over should range in temperature from 620° F. to about 690° F., or from about 85° F. to about 55° F. below the oil in distillation. The distillation during this period may well occupy about 12 hours, and the total distillate collected equal about 27 per cent. by volume of the crude oil, about 20 per cent. being received by the draw off 5 and the remainder from the draw off 10 and condenser *w*.

When the distillate from draw off 5 exhibits a gravity of about 26° B. it would become unsatisfactory (according to our experience with said Illinois and Kansas oil) if the distillation were continued in the same manner and would have to be rerun before it could be pressed, at least with equal advantage. To avoid the formation of this unsatisfactory distillate (or slop) as soon as it makes its appearance (or just before the worker's experience may lead him to expect it) the saucer outlet 3 is opened; so that only condensate from the pipes *i* is collected as distillate through draw off 5; and the run back *c* is also opened, the pipe 6 being closed at valve 7 (and draw offs 8 and 9 remaining closed); so that the condensate

from chamber *f* is returned to the still for reëvaporation.

Satisfactory lubricant and wax yielding distillate should be received through the saucer outlet 3 and draw off 5 while the gravities of samples taken from the stream at the outlet end of the draw off are changing from about 26° B. to about 24° B. Said samples should have viscosities between about 74 seconds and about 86 seconds; and they should exhibit cloudiness between about 68° F. and about 76° F. The oil in distillation should range in temperature from about 745° F. to about 795° F. The vapors pass over to be condensed as distillate only when they have reached the upper part of chamber *f;* so that subsequently formed condensate can be received in the saucer 2; and when they thus pass over they should range in temperature from about 674° F. to about 685° F. or from about 71° F. to about 115° F. below the oil in distillation. The distillation with saucer outlet 3 and run back *c* open may well occupy about 6 hours, and the total distillate collected equal about 9 per cent. by volume of the crude oil, about 7½ per cent. being received through saucer outlet 3 and draw off 5 and about 1½ per cent. by draw off 10 and condenser *w*.

When the distillate from draw off 5 exhibits a gravity of about 24° B., in order to enable the still's contents to be dried out or coked, the run back *c* and the saucer outlet 3 are both of them closed; and the valve 7 in pipe 6 is opened, so that the vapors pass over to be condensed as distillate just after they leave the ordinary vapor space of the still. When the distillate becomes too thick at the temperature of the draw off 5, the valve 7 is closed and the draw off 8 is opened for the passage through it of the distillate. The distillation after closure of saucer outlet 3 and run back *c* may occupy about three hours and yield a total distillate equal to about 2 per cent. of the crude oil. About half of it would be received through the draw offs 5 and 8 (in succession) and about half from the draw off 10 and condenser *w* (concurrently until the flow from one of them ceases). The distillate which at this period would be received through the draw off 5 would (in our experience) be unsatisfactory without rerunning. That which would be received through the draw off 8 would be wax tailings.

The coke and loss during an uninterrupted distillation of all fractions of a charge of crude oil may represent about four per cent. by volume of the crude oil.

In distilling the lubricant or lubricant and wax yielding fraction the vapors which are cooled in pipes *i* should have a temperature between 400° F. and 600° F. when they leave the header *l*. By setting the valves *r* this cooling in pipes *i* can be regulated in accordance with the indications furnished by the distillate from the draw offs 5 and 10, so as to obtain distillate of lubricant and wax yielding character suitably free from more volatile hydrocarbons. These latter pass on to the condensers *t w* and are collected as distillate as long as condensate runs therefrom.

The particular figures which have been given are by way of example, in order the better to enable those skilled in the art to practise the invention, and not as restricting the invention thereto; and modifications in process, apparatus or both can be made indefinitely so long as the substance is taken of any one or more of the hereinafter written claims.

In drying out or coking the contents of the still, the run back *c* can be closed and the valve 7 opened and the saucer outlet 3 be left open, if preferred; or, if desired, the valve 7 could be left closed in that case, the draw offs 9 and 8 being used in succession, as required for condensate from chamber *f*.

The oil to be distilled as aforesaid need not contain all the lubricant or lubricant and wax yielding fraction. It suffices that it contain any substantial and appropriate part thereof. So, too, it is not necessary that all the lighter and all the heavy end of said fraction should be distilled as herein above described therefor, respectively; but any substantial and appropriate part of either of them may be so distilled. In fact, as mentioned, by reason of the difficulty (or practical impossibility) of drying out or coking the still's contents with run back *c* open, it is desirable to stop the return of condensate from chamber *f* before all the heavy end of the oil is received. All or any substantial and appropriate part of the condensate formed in the descending part of vapor pipe *e* and in chamber *f* in the distillation of said heavy end when the saucer outlet 3 is open can be returned to the liquid oil in distillation; although it is designed that all of it should be so returned. It is also designed that after the condensation of vapors as distillate in pipes *i* (or in vapor pipe *e*, chamber *f* and pipes *i*, according to the case) all the remaining vapors should, as far as possible, be condensed in condensers *t* and *w;* but, if desired, part only of them may be so condensed.

In the hereinafter written claims, therefore, the respective recitals are to be construed to apply to all, or to any substantial and appropriate part, of the therein specified fluid or fluids.

It is believed that the general designation of lubricant or lubricant and wax yielding fraction of crude petroleum designates the part intended sufficiently for all the purposes of this specification; but, should greater precision be desired, said fraction of

any given kind of crude petroleum may be taken to be the percentage of it by volume which remains in the still when, in distilling a charge of the same under atmospheric pressure with gradual rise of temperature and introduction into the liquid oil of free steam in sufficient volume to prevent cracking, samples of distillate taken in succession at the outlet of the customary water cooled condenser exhibit either a viscosity as high as 65 seconds at 100° F. by Saybolt's Universal Viscosimeter or a cloud at a temperature as high at 50° F. (whichever characteristic first appears). When another charge of crude petroleum of the same kind is distilled in any known or suitable way until the undistilled residue represents this percentage of the crude oil, such residual oil can be taken to contain substantially the entire lubricant or lubricant and wax yielding fraction of the crude oil without any portion of another fraction.

In order to secure concordant results, the assays must always be performed under identical conditions; and they may well be performed by using such a laboratory apparatus as is shown in cut No. 1286 in the catalogue for 1908 of E. H. Sargent & Company, of 145 Lake Street, Chicago, Illinois. Said apparatus has a copper still of cheese box form heated by a gas flame underneath; and it is provided with means for introducing free steam into the liquid oil in the still. A still with a charging capacity of about ten liters would be large enough; and it should receive a charge about equal to its capacity. In the distillation the heat may be so regulated that hydrocarbon distillate is received from the condenser at the uniform rate of about fifteen per cent. by volume per hour of the charge of crude oil; and the free steam supply may be so regulated that the stream from the condenser contains water of condensation equal in volume to from a third to a half of the hydrocarbon distillate. The steam may be dry and saturated; or it may be slightly superheated. The samples of distillate may be two per cent. by volume of the original charge of crude petroleum.

Some petroleum may be of such peculiar character that all of its lubricant or lubricant and wax yielding fraction would be distilled with the separation herein above described as applied to the heavy end of said fraction; and in such case, of course, the heavy end (no less than the lighter end) of its said fraction would be distilled with such separation. The recital that vapors of the heavy end of said fraction are subjected to certain operations does not of itself require that the vapors of said heavy end only should be subjected thereto.

Advantage over the prior state of the art is effected by a suitably extended travel of the suitably cooled vapors of said heavy end in contact successively with two lots of oppositely flowing condensate, separately collected as distillate, without the described return of condensate to the oil in distillation. The conditions of cooling and travel in vapor pipe *e* and chamber *f* as described are considered best for the first of the two separations. It is only essential thereto that said cooling should be sufficient to effect the condensation of the gummy or asphaltic matters and not as much as to condense practically all of the lubricant or lubricant and wax yielding hydrocarbons, and that the extent of the travel should suffice for the vapors passing on to be practically free from said gummy or asphaltic matters. The conditions of cooling and travel in pipes *i* as described are considered best for the second condensation. It is only essential in this condensation that the distillate of lubricant or lubricant and wax yielding character should be suitably free from more volatile hydrocarbons.

If it should be desired to work in this way with the apparatus shown, after distilling the lighter end of said fraction as herein above described, the saucer outlet 3 and the draw off 9 would be opened; the valve 7 would be closed, the run back *c* and the draw off 8 remaining closed; and distillation would be continued until the distillate received by draw off 9 should become too thick to flow properly at the temperature of the latter. The draw off 8 would then be opened; the draw off 9 would be closed, saucer outlet 3 remaining open and the run back *c* remaining closed; and distillation would be continued until the contents of the still should become dried out or coked to the desired extent. While, however, to work in this way would be an advance over the prior state of the art and is, therefore, included in the invention, it is inferior to the working with the described return of condensate, which latter working more particularly constitutes the invention. For example, without such return, the lubricant and wax yielding fraction of Illinois and Kansas petroleum has been distilled by us with the production in the crude oil run of slop equal to about three and a half per cent. by volume of the crude oil as against about eight and a half per cent. by the best prior practice known to us and about one per cent. by our working with the described return of condensate. In the hereinafter written claims the word "withdrawing" as applied to a condensate includes a collection as distillate or a return to the oil in distillation, whichever disposition of the condensate may be adopted, said collection and said return being considered each of them a mode of withdrawal of the condensate.

In the foregoing description and the ac-

companying drawings we have exhibited our invention in connection with matters which were originally, first and jointly invented as we are informed and believe by John W. Van Dyke and William M. Irish, both of Philadelphia, Pennsylvania, and which are described and claimed by them in their application of October 4, 1909, No. 520,937 and in divisions thereof. The invention of said Van Dyke and Irish is, of course, not claimed in whole or in part by us.

We claim as our invention or discovery:

1. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to such cooling after said vapors leave said vapor space and to such contact of the so cooled vapors with retrograding condensate that practically all of the gummy or asphaltic content of said vapors is condensed and that there is left a residue of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, withdrawing the gummy or asphaltic condensate, cooling said residual vapors to effect a condensation of them, drawing off as distillate so formed condensate practically free from gummy or asphaltic matters and having a lubricant (or lubricant and wax yielding) character, and so continuing until a quantity of heavy end distillate equal to about half of the distillable portion of said heavy end as a minimum has been collected, substantially as described.

2. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to such cooling after said vapors leave said vapor space and to such contact of the so cooled vapors with retrograding condensate that practically all of the gummy or asphaltic content of said vapors is condensed and that there is left a residue of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, withdrawing the gummy or asphaltic condensate, cooling said residual vapors to effect a condensation of them first at higher and then at lower temperatures and thus to form condensates of respectively heavier and lighter gravities, drawing off as distinct distillates so formed condensates which are practically free from gummy or asphaltic matters and include at least one condensate of lubricant (or lubricant and wax yielding) character, and so continuing until quantities of heavy end distillates together equal to about half of the distillable portion of said heavy end as a minimum have been collected, substantially as described.

3. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to such cooling after said vapors leave said vapor space and to such contact of the so cooled vapors with retrograding condensate that practically all of the gummy or asphaltic content of said vapors is condensed and that there is left a residue of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, returning said gummy or asphaltic condensate to the oil in distillation, cooling said residual vapors to effect a condensation of them, drawing off as distillate so formed condensate practically free from gummy or asphaltic matters and having a lubricant (or lubricant and wax yielding) character, and so continuing until a quantity of heavy end distillate equal to about half of the distillable portion of said heavy end as a minimum has been collected, substantially as described.

4. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to such cooling after said vapors leave said vapor space and to such contact of the so cooled vapors with retrograding condensate that practically all of the gummy or asphaltic content of said vapors is condensed and that there is left a residue of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, withdrawing the gummy or asphaltic condensate, cooling said

residual vapors to effect a condensation of them, drawing off as distillate so formed condensate practically free from gummy or asphaltic matters and having a lubricant (or lubricant and wax yielding) character, and so continuing until a quantity of heavy end distillate equal to about half of the distillable portion of said heavy end as a minimum has been collected, the distillation of said heavy end being carried on at least eventually with collection as distillate of gummy or asphaltic condensate, substantially as described.

5. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to such cooling after said vapors leave said vapor space and to such contact of the so cooled vapors with retrograding condensate that practically all of the gummy or asphaltic content of said vapors is condensed and that there is left a residue of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, withdrawing the gummy or asphaltic condensate, cooling said residual vapors to effect a condensation of them, drawing off as distillate so formed condensate practically free from gummy or asphaltic matters and having a lubricant (or lubricant and wax yielding) character, and so continuing until a quantity of heavy end distillate equal to about half of the distillable portion of said heavy end as a minimum has been collected, the distillation of said heavy end being carried on at least eventually with collection as distillate of gummy or asphaltic condensate through draw offs respectively of lower and of higher temperatures, substantially as described.

6. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil first the lighter end and afterward the heavy end of said fraction, subjecting the vapors evolved from said lighter end and protected against undue cooling within the ordinary vapor space of the still to such cooling after they leave said vapor space as to effect a condensation of said vapors, drawing off so formed condensate as distillate, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to such cooling after said vapors leave said vapor space and to such contact of the so cooled vapors with retrograding condensate that practically all of the gummy or asphaltic content of said vapors is condensed and that there is left a residue of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, returning the gummy or asphaltic condensate to the oil in distillation, cooling said residual vapors to effect a condensation of them, drawing off as distillate so formed condensate practically free from gummy or asphaltic matters and having a lubricant (or lubricant and wax yielding) character, and so continuing until a quantity of heavy end distillate equal to about half of the distillable portion of said heavy end as a minimum has been collected, the lighter end condensate which is drawn off as distillate being formed from vapors which pass over to be so condensed before they have been cooled even approximately to the extent to which said heavy end vapors are cooled in order to form the gummy or asphaltic condensate which is returned to the oil in distillation, substantially as described.

7. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil first the lighter end and afterward the heavy end of said fraction, subjecting the vapors evolved from said lighter end and protected against undue cooling within the ordinary vapor space of the still to cooling by means of three successive sets of cooling devices after said vapors leave said vapor space and to contact with the united retrograding condensates from the first two of said coolings, drawing off said united condensates as a distillate and condensate from the third of said coolings as a distinct distillate, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to cooling by means of the same successive sets of cooling devices to which said lighter end vapors were subjected and to contact with retrograding condensate from the first of said coolings, withdrawing the three heavy end condensates separately, those from the second and third coolings being drawn off as distinct distillates, and so continuing until quantities of heavy end distillates equal together to about half of the distillable portion of said heavy end as a minimum have been collected, the first of said coolings of the heavy end vapors and the contact of the so cooled vapors with retrograding condensate being

such that practically all of the gummy or asphaltic contact of said vapors is condensed and that a residue is left of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, substantially as described.

8. The process of distilling petroleum in a form which contains the defined lubricant (or lubricant and wax yielding) fraction of the crude petroleum, by heating such undistilled petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil first the lighter end and afterward the heavy end of said fraction, subjecting the vapors evolved from said lighter end and protected against undue cooling within the ordinary vapor space of the still first to cooling after they leave said vapor space and to contact of the so cooled vapors with retrograding condensate in passing over baffles in a chamber and then to further cooling by passage in subdivided streams between closely approached heat removing surfaces and, thirdly, to cooling to yet lower temperatures, uniting the condensate from the second mentioned cooling to that from the first mentioned cooling so that the united condensates flow over said baffles in contact with said vapors, drawing off said united condensates as a distillate and the condensate from the third of said coolings as a distinct distillate, subjecting the vapors evolved from said heavy end and protected against undue cooling within the ordinary vapor space of the still to cooling by means of the same successive sets of cooling devices to which said lighter end vapors were subjected and to contact with retrograding condensate from the first of said coolings in passing over said baffles, withdrawing the three heavy end condensates separately, those from the second and third coolings being drawn off as distinct distillates, and so continuing until quantities of heavy end distillates equal together to about half of the distillable portion of said heavy end as a minimum have been collected, the first of said coolings of the heavy end vapors and the contact of the so cooled vapors with retrograding condensate being such that practically all of the gummy or asphaltic content of said vapors is condensed and that a residue is left of uncondensed vapors practically free from gummy or asphaltic matters and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, substantially as described.

9. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, additional condensing means, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned condensing means and from the latter to said additional condensing means, appliances for withdrawing condensate formed by the first mentioned condensing means, and a distillate draw off leading from said additional condensing means and arranged to keep the distillate conveyed thereby distinct from the condensate withdrawn by said appliances from the first mentioned condensing means, substantially as described.

10. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, additional condensing means arranged to effect a condensation of vapors first at higher and then at lower temperatures and thus to form condensates of respectively heavier and lighter gravities, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned condensing means and from the latter to said additional condensing means, appliances for withdrawing condensate formed by the first mentioned condensing means, and distillate draw offs leading from different parts of said additional condensing means and arranged to keep the respective distillates conveyed thereby distinct from each other and from the condensate

withdrawn by said appliances from the first mentioned condensing means, substantially as described.

11. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, additional condensing means, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned condensing means and from the latter to said additional condensing means, appliances for returning condensate formed by the first mentioned condensing means to the oil in distillation, and a distillate draw off leading from said additional condensing means, substantially as described.

12. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, additional condensing means, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned condensing means and from the latter to said additional condensing means, appliances for withdrawing condensate formed by the first mentioned condensing means, and a distillate draw off leading from said additional condensing means and arranged to keep the distillate conveyed thereby distinct from the condensate withdrawn by said appliances from the first mentioned condensing means, said apparatus including a distillate draw off leading from the first mentioned condensing means, substantially as described.

13. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, additional condensing means, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned condensing means and from the latter to said additional condensing means, appliances for withdrawing condensate formed by the first mentioned condensing means, and a distillate draw off leading from said additional condensing means and arranged to keep the distillate conveyed distinct from the condensate withdrawn by said appliances from the first mentioned condensing means, said apparatus including distillate draw offs leading from the first mentioned condensing means and arranged to be maintained at higher and at lower temperatures respectively, substantially as described.

14. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude pertoleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, ad-

ditional condensing means, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned condensing means and from the latter to said additional condensing means, appliances for returning condensate formed by the first mentioned condensing means to the oil in distillation, a distillate draw off leading from the first mentioned condensing means, and a distillate draw off leading from said additional condensing means, substantially as described.

15. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means which include three successive sets of cooling devices connected in series for passage of the residual vapors from each preceding to the following set of cooling devices and adapted the first set for bringing the passing vapors into contact with retrograding condensate and the second set for delivery of condensate therefrom to the upper part of the first set, connections for conveying vapors from the ordinary vapor space of the still to the first of said sets, separate distillate draw offs leading from the second and third of said sets respectively, and appliances for withdrawing condensate from the first of said sets, which appliances include a distillate draw off leading from the first of said sets, the first of said sets being arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, substantially as described.

16. Apparatus for distilling petroleum, consisting of a still which is designed for heating petroleum in a form that contains the defined lubricant (or lubricant and wax yielding) fraction of crude petroleum (eventually at least) to the high temperatures (above 650° F.) necessary to distil the heavy end of said fraction and which is arranged to protect the evolved vapors against undue cooling within the ordinary vapor space of said still, condensing means which include (first) a set of cooling devices whereof a chamber with baffles therein for bringing the passing vapors into contact with retrograding condensate forms part, and (second) a set of cooling devices whereby the vapors are passed in subdivided streams between closely approached heat removing surfaces, and (third) another set of cooling devices, the three sets of cooling devices being connected in series for the passage of the residual vapors from each preceding to the following set of cooling devices and the second mentioned set of said cooling devices being adapted for delivery of condensate therefrom to the upper part of said chamber, connections for conveying vapors from the ordinary vapor space of the still to the first mentioned set of cooling devices, separate distillate draw offs leading from the second and third of said sets respectively, and appliances for withdrawing condensate from the first of said sets, which appliances include a distillate draw off leading from the first of said sets, the first of said sets being arranged to subject the passing vapors to such cooling and to such contact with retrograding condensate that in the distillation of said heavy end practically all of the accompanying gummy or asphaltic matters can be separated thereby from uncondensed vapors representing about half of the distillable portion of said heavy end as a minimum and consisting mainly of lubricant (or lubricant and wax yielding) hydrocarbons, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

WILLIAM C. KOEHLER.
LUDWIG LINK.

Witnesses:
CHARLES G. BLACK,
GEO. W. GORDON.