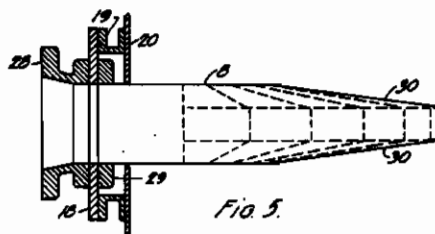
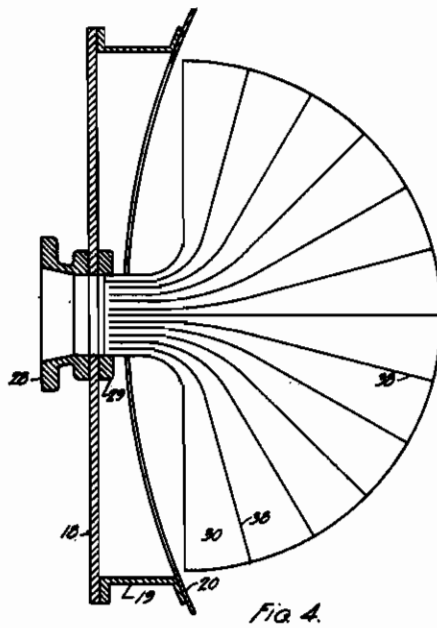
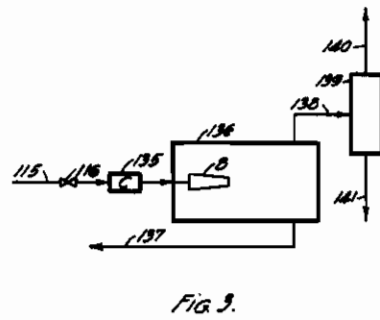
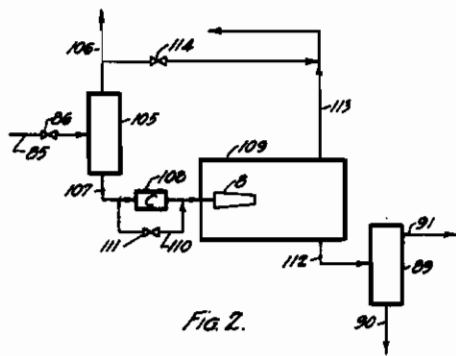




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By his Attorney: *[Signature]*

# ALIEN PROPERTY CUSTODIAN

## EXTRACTION PROCESS

Willem J. D. van Dijk, The Hague, Netherlands;  
vested in the Alien Property Custodian

Application filed October 26, 1935

This application is a continuation-in-part of my copending applications Serial No. 455,959, filed May 26, 1930, Serial No. 694,280, filed October 19, 1933, and Serial No. 669,580, filed May 5, 1933. This invention relates to an improved process for the separation of multi-component liquid mixtures, and particularly hydrocarbon mixtures, into more than two portions having different compositions by extracting the mixtures with selective solvents. The invention may be applied to the extraction of any multi-component mixture, but is especially useful in the extraction of petroleum fractions, such as gasoline, kerosene, Diesel fuel, gas oil, fuel oil, and various lubricating oils.

Such hydrocarbon mixtures are highly complex in character, and contain numerous hydrocarbons having widely different chemical structure and characteristics, such as anti-knock properties, burning qualities, stability against oxidation or sludge formation, viscosity index, specific gravity, refractive index, and the like. Such mixtures may, for example, contain hydrocarbons belonging to some or all of the following classes: Saturated straight chain or branched chain hydrocarbons, cyclo-paraffins or naphthenes with aliphatic side chains, unsaturated straight chain or branched chain hydrocarbons, aromatic hydrocarbons with aliphatic side chains, partially or wholly hydrogenated mono- or poly-cyclic aromatic hydrocarbons, and mono- or poly-cyclic aromatic hydrocarbons. These various hydrocarbons are polarizable to different degrees, and have different solubilities in polar liquids, such as sulfur dioxide, furfural, quinoline BB' dichloroethyl ether, etc.

At the present time such multi-component mixtures are separated into two portions by extracting them with a polar liquid as a selective solvent. The simplest form of extraction process involves merely the contacting of the liquid mixture with a selective solvent, in which the components of the mixture have different solubilities, followed by the separation of the phases by settling and decantation or by centrifuging. The solvent-poor phase, which contains the relatively less soluble components is known as the raffinate phase, while the solvent-rich phase, which contains the relatively more soluble components, is known as the extract phase. In the case of hydrocarbon mixtures the selective solvent, being a polar substance, dissolves the more highly aromatic or non-paraffinic hydrocarbons (i. e., the more polarizable hydrocarbons), while the more paraffinic hydrocarbons are obtained

in the raffinate phase. The separation of the phases is generally effected by utilizing the difference in their specific gravities. The solvent or solvents may then be removed from either or both of the separated phases by any suitable method, such as distillation, or by washing them with suitable extracting agents, for example, as described in the application of Sijbren Tijmstra, Serial No. 20163, filed May 7, 1935, or by absorption, or by precipitation with chemical reagents, etc., to produce pure raffinate and extract.

When a more complete removal of the relatively more soluble components is desired, the mixture is contacted with the selective solvent in multiple extractions or in countercurrent. It now becomes possible to remove the more soluble component from the raffinate to any desired extent, provided that a sufficient number or stages or length of contacting zone is provided and/or a sufficient quantity of selective solvent is employed. To this removal of the more soluble component from the raffinate I have applied the term "elutrication." The degree of elutrication may often be further increased by employing non-selective diluents with the selective solvents. Processes of this type are described in the U. S. Patent No. 1,945,516, and in the application of Lindeke and Greensfelder, Serial No. 740,286, filed August 17, 1934. These diluents are of the nature of the components preferably soluble in the selective solvents employed, and must be capable of being separated from the mixture being treated outside of the extraction zone, as by distillation or washing, etc. As an improvement on this process, the diluent may be removed at one or more points in the course of the extraction, as described in my copending application Serial No. 11,647, filed March 18, 1935. Although the countercurrent treatment of such mixtures will permit a mixture to be elutricated to any desired extent, it will not produce an extract which is entirely free from the raffinate.

A pure or purer extract may be produced by "deraffinating" the extract or the extract phase. By this term I mean any process which is effective in removing the relatively less soluble component from a liquid composition. Deraffination of the extract phase may be effected by washing the extract phase, preferably in countercurrent, with a second solvent which, in the presence of the extract phase, is not entirely miscible with the main selective solvent, as described, for example, in my copending application Serial No. 455,959, filed May 26, 1930; or with a backwash, as described in my copending applications Se-

rial Nos. 669,580 and 27,390, filed May 5, 1933, and June 19, 1935, respectively; or the extract phase may be passed through a chilling zone to lower the solvent power of the selective solvent, as described in my copending application Serial No. 694,280, filed October 19, 1933; or by removing a portion of the solvent from the extract phase and separating from it raffinate contained therein, as described in the application of Frank Cutting, Serial No. 22,541, filed May 21, 1935; or by combinations of these steps.

The separation of multi-component mixtures into more than two portions by selective solvents has heretofore been effected either by further extracting one of the products of an extraction process or by chilling the extract phase in a series of consecutive stages and withdrawing a separated phase at each step. The former expedient involves the running of several extraction operations; while the latter is incapable of producing sharply cut intermediate products because the withdrawn portions are in equilibrium with the liquid in the extraction apparatus, and contain undesirable quantities of components which it is desired to remove in another product of the process.

It is an object of my invention to provide a process for producing a number of closely fractionated intermediate products in a single extraction process, thereby improving the quality of the raffinate and/or the extract. It is another object of my invention to provide a process for separating complex mixtures into a number of products containing substances of different chemical constitution and/or physical properties. Other objects of my invention will be apparent from a reading of the following specification and from the accompanying drawings, it being understood that although I have described certain specific embodiments thereof, and have shown certain forms of apparatus suitable for carrying out the process, my invention is not restricted either to the particular embodiments described or to the apparatus illustrated, but may be practiced in many other forms without departing from the scope and spirit of the invention.

In accordance with my invention I extract a multi-component mixture in a countercurrent manner, employing either an elutriation zone, or a deraffinating zone, or both, preferably in a continuous countercurrent treater, such as a system of series of agitators or mixers and settling chambers, or a tower provided with perforated partitions or packing, or any other means for effecting the countercurrent contact of liquids, although my process may be carried out in a discontinuous manner. At one or more points in the process I separate out a portion of the counterflowing liquids as side streams and either withdraw such streams as a whole or subject the side streams either to an elutriation or deraffination treatment, withdraw the elutriated or deraffinated side streams as intermediate products, and return the residual portion of the side streams to the extraction process, preferably near the point or points at which they were separated from the process.

In accordance with the invention it is possible to withdraw either a solvent-rich or a solvent-poor phase, or a combination of the two as a side stream, thereby permitting a wide choice of side stream compositions. In the case of a packed tower, the side stream will often consist of a mixture of both phases present in the process at the point at which the side stream is separated.

In this situation it is preferable to run the separated stream through a settling zone or centrifuge to separate it into two phases, and to treat and/or withdraw from the process only one of these phases as the side stream, the other phase being returned to the extraction process; a portion of the latter phase may be treated together with the first phase. Alternatively, the latter phase may also be treated separately as an additional side stream.

Although either phase may be separated from the extraction and any phase may be treated either to elutriate it or to deraffinate it, depending upon the nature of the intermediate product desired, preferably I withdraw a portion of the solvent-rich or extract phase as a side stream from the elutriation zone of the process, and deraffinate this side stream to produce the intermediate product. In extraction processes employing a deraffination zone, I withdraw a portion of the solvent-poor or raffinate phase as a side stream from the deraffination zone of the main process, and preferably elutriate it to produce the intermediate product. In extraction processes having both elutriation and deraffination zones, I may withdraw side streams from either or both of these zones.

The process of my invention is more fully described below, with reference to the drawings, in which Figure 1 is a diagrammatic elevation view, partly in section, showing one form of apparatus suitable for carrying out my invention; Figures 2 and 3 are similar diagrams, showing two modified forms of apparatus for treating the side streams; Figure 4 is a plan view taken through the horizontal midsection of the distributing nozzle; and Figure 5 is a side elevation, partly in section, of the distributing nozzle.

Referring to Figure 1, A and B are tanks having circular cylindrical walls or tank shells and horizontal partitions dividing said tanks into sections, hereinafter referred to as settling chambers 1 to 7 and 11 to 17, each provided with an inlet, such as distributing nozzle 8, preferably located so that their center lines all lie in the same vertical plane, but alternately situated on opposite sides, and spaced approximately midway between the partitions. Each settling chamber is provided with two outlet conduits 9 and 10 placed near the top and the bottom of each chamber, respectively. The outlets in each chamber are placed diametrically or substantially diametrically opposite the feed inlet or distributing nozzle. Each distributing nozzle is connected with an agitator or mixer, designated on the drawing by reference numerals 21 to 27 and 31 to 37, preferably placed at a short distance from the outer wall of the settling chamber, and in which the liquids employed in the process are intimately contacted.

The distributing nozzles 8 are shown in detail in Figures 4 and 5. Each nozzle is connected to a flat, rectangular plate 18, which is affixed to a support 19 carried by the circular tank shell 20. The support 19 is preferably shaped to have an elongated rectangular opening through which the distributing nozzle can be inserted and withdrawn. The outer side of the plate 18 is provided with a flanged nipple 28 for connecting the nozzle with a feed conduit. A flange 29 on the inside of the plate 18 has an elongated rectangular cross-section and carries two substantially horizontal fan-shaped plates 30, which are interconnected by a number of vertical, diverging partitions 32. The distance between the two substan-

tially horizontal plates 30 decreases gradually, so that the vertical distance at the outer edge is about one-half of the vertical distance at the flange 29.

The channels formed between the fan-shaped plates and the partitions have a rectangular cross-section, the width of which gradually increases, and the height of which gradually decreases in the direction of flow. The purpose of this construction of the nozzle is to distribute the feed liquid evenly in a horizontal plane. The small vertical dimension of the nozzle at its orifice as compared to the height of the settling chamber insures a proper distribution of the feed into the settling chamber, and aids in the stratification of the feed mixture therein.

Another feature of the construction shown is that, it effectively reduces the turbulence within the settling chambers and permits rapid separation of liquid phases. As a further means for avoiding turbulence within the settling chamber, guide partitions, such as vertical baffles, may be installed therein.

When all of the settling chambers are filled with the liquids being contacted, the pressures on the opposite sides of the horizontal partitions are nearly equal and the partitions are but lightly stressed. Therefore, these partitions may be constructed of relatively thin plates.

One of the intakes of each of the mixers 21 to 26 and 31 to 36 is connected to the upper outlet 9 of the next lower settling chamber by a conduit 39 and one of the intakes of each of the mixers 22 to 27 and 32 to 37 is connected to the lower outlet 10 of the next higher settling chamber by a conduit 40 and valve 41. If desired, any or all of the mixers 22 to 27 and 31 to 37 may be provided with chilling apparatus 42 to 47 and 51 to 57, respectively, and all or a portion of the liquid passed through them by closing the valves 41. The mixer 31 is connected to the outlet 10 of the settling chamber 7 by a conduit 48, and the mixer 21 is connected by a conduit 49 to a source of a selective solvent 50.

The upper settling chambers in each tank are provided with overflow control devices 58 and control valves 59 for regulating the withdrawal of liquids from the respective chambers I and II. The outlet 9 in the zone II is connected through its overflow device 58, a valve 60 and conduit 61 to the mixer 27. This mixer is also connected by conduit 62 to the supply of liquid to be extracted. Suitable pumps, control valves, and auxiliary equipment, not shown, may be provided to cause the circulation of the liquids in the manner described below. In the following description it has been assumed that the extract phase is heavier than the raffinate phase with which it is in equilibrium. However, the particular apparatus and the method of this invention are just as effective where the raffinate phase is the heavier of the two, the required alterations in flowing liquids through the extraction system to be obvious to those skilled in the art.

The extraction apparatus shown, is adapted to effect both the elutriation of the raffinate phase and the deraffination of the extract phase, it being understood that my invention may be practiced although either of these operations is omitted from the process.

In operation, the liquid mixture to be extracted is continuously supplied through conduit 62 to the mixer 27, mixed with the extract phase from the upper adjacent chamber; the resulting mixture separates in the settling chamber 7 into two

liquid phases, the raffinate phase being withdrawn through the upper outlet 9, and the extract phase through the lower outlet 10. The raffinate phase thus produced is elutriated by being extracted in counterflow with the selective solvent supplied through conduit 49, as shown in the drawing, the completely elutriated raffinate phase being withdrawn from the chamber I through overflow device 58 and conduit 63 and introduced into a separating apparatus 64 where it is separated into a solvent portion and a raffinate portion, which portions are withdrawn at 65 and 68, respectively. The apparatus 64 may be a distilling apparatus, or any other type of washing, adsorption, or precipitation apparatus adapted to remove the solvent from the raffinate. In this operation, the extract phase from each settling chamber may be fed directly into the mixer of the next lower settling chamber through the valves 41, so that the temperature is substantially the same throughout the several stages of the elutriation zone. I have, however, found that a more efficient elutriation can be effected by maintaining progressively decreasing temperatures in the several stages or chambers in the direction of flow of the solvent. This may be effected by closing or throttling the valves 41 and chilling the extract phases flowing between settling zones. For example, in extracting lubricating oil with furfural as the selective solvent, I may employ a temperature of 140° C. in the top chamber I and a temperature of 94° in the bottom chamber 7, the temperatures in the intermediate chamber being at a uniform gradient.

If elutriation is not desired, as when the raffinate formed in the settling bottom chamber 7 is of the desired composition, this raffinate phase may be introduced directly into the solvent separator 64 by a conduit not shown, and the selective solvent from the tank 50 may be fed directly into the mixer 27.

The extract phase withdrawn at 49 may be deraffinated by treatment in accordance with any of the methods already mentioned in this specification. I have indicated certain of these modes of treatment in the drawing in connection with the tank B, it being understood that my invention may be practiced with any one of them, or with combinations of any or all of them.

According to one method of deraffinating, the extract phase from 48 is contacted, preferably in a countercurrent manner, with a second solvent for the portion or component of the feed mixture which is not preferentially soluble in the first solvent, and which is not completely miscible with the selective solvent at the temperature of treatment and in the presence of the feed mixture. To this purpose the second solvent may be supplied through conduit 67 to tank B and passed therethrough and through the corresponding mixers in countercurrent to the extract phase from the conduit 48. The secondary raffinate phase produced in this treatment is withdrawn from the top of the chamber II and may be returned to the mixer 27 of tank A through conduit 81. If the valve 60 is open, the second solvent will likewise be returned to the tank A, and may then be recovered from the final raffinate phase by treatment in the apparatus 64, the second solvent being withdrawn at 68. It is, however, often desirable to remove all or at least a portion of the second solvent from the secondary raffinate phase before returning it to the tank A. This may be effected by closing or throttling the valve 60, opening the valve 69, and passing the

secondary raffinate phase through solvent separator 70, from which the second solvent may be withdrawn at 71. The deraffinated extract phase is withdrawn from the bottom chamber of tank B through a valve 72 and a conduit 73 and introduced into solvent separator 74, which may be similar to the apparatus 64. The two solvents are withdrawn separately at 75 and 78, respectively, and may be recycled for the treatment of additional quantities of the feed mixture. The extract is withdrawn at 77, and is a product of the process.

According to another mode of deraffinating the extract phase from tank A, not employing a second selective solvent, the extract phase from the conduit 48 is passed through tank B and corresponding mixers countercurrently to a portion of the final extract phase withdrawn through 73 and from which all or a portion of the selective solvent has been removed. This may be effected by opening a valve 78 in conduit 79. If desired, this may be diluted with selective solvent by admitting a portion of the extract phase from the conduit 73 through a valve 80. This treatment, known as the "backwash" process, is more fully described in my application Serial No. 669,580.

If desired, the above described backwash treatment may be combined with the previously described treatment with an auxiliary solvent, this combination being more fully described in the copending application of Sijbren Tijmstra, Serial No. 759,185, filed December 26, 1934, it being understood that the various features there described may be applied to my process.

In either of the above operations the settling chambers 11 to 17 may be operated at the same temperature. I have, however, found it advantageous to make use of the chillers 51 to 57 and to maintain a negative temperature gradient in the direction of flow of the extract phase, as described in connection with the tank A. For example, in a furfural extraction of lubricating oil, using a backwash, I may employ a temperature of 86° C. in the chamber 11 and a temperature of 40° C. in the chamber 17, with a uniform gradient in the intermediate chambers.

It is, moreover, possible to deraffinate the extract phase in the tank B without employing either an auxiliary or second solvent or a backwash, but by gradual cooling of the liquids flowing through tank B at an effective rate, often greater than the one indicated in the preceding paragraph, whereby the extract phase entering tank B from the conduit 48 is caused to separate into secondary raffinate and secondary extract phases.

Still another mode of deraffination comprises the removal of a portion of the selective solvent from the extract phase flowing between the settling chamber 11 to 17 and between 7 and 11, the residual portions of the extract phases being chilled before being introduced into the settling chambers if the solvent separation involved the addition of heat. If desired, a temperature gradient may also be employed with this mode of operation.

If the deraffination of the extract phase is not required, as when the extract phase from the bottom of tank A is of the desired purity or composition, the extract phase from the conduit 48 may be introduced directly into the apparatus 74.

To produce the intermediate product according to my invention, I withdraw a portion of one of the phases flowing between the several stages or settling chambers of my process as a side

stream, either deraffinate or elutriate the side stream, withdraw the deraffinated or elutriated side stream as the intermediate product, and return the residual portion of the side stream to the process. As already mentioned, although I may withdraw either a raffinate or an extract phase from any part of the extraction process, I prefer to withdraw an extract phase from the elutriation zone, i. e., from either of the settling chambers of the tank A, and/or to withdraw a raffinate phase from the deraffination zone, i. e., from the settling chambers of the tank B. One or more of such side streams may be removed from either or both of these zones, at different points of the process, but I have for convenience shown only the withdrawal of a single side stream from each of these zones. The residual portions of the side streams are preferably returned to the extraction process at a point at which the composition of the phases most nearly approaches the composition of the returned portion of side streams. The exact point at which this composition occurs depends upon the nature and intensity of the treatment to which the side stream is subjected, and it is understood that while I have indicated certain preferred points for the return of these residual portions of the side streams, my invention is not limited to the specific arrangements shown, since these portions may be returned either to the same stage or to a higher stage or to a lower stage than the stage from which the side stream was withdrawn.

Referring again to Figure 1, a portion of the extract phase which is withdrawn from the lower outlet 10 of one of the settling chambers in tank A, such as chamber 3, is fed through a conduit 85 and a valve 86 and introduced as a side stream into a deraffinating apparatus 87. If desired, the side stream may be passed through the chillers before treatment in the apparatus 87. The deraffinated side stream may be withdrawn at 88 and introduced into a solvent separator 89, from which the intermediate product may be withdrawn at 90 and the solvent at 91. The complementary raffinate phase is withdrawn from 87 at 92 and may be returned to the next higher chamber through a conduit 93 and a valve 94.

The apparatus 87 may be of any desired type, and may, for example, be similar to the tank B, provided with suitable settling chambers, and may be operated in accordance with any of the modes of operations described for the tank B. I may also employ a packed tower, as shown in Figure 1 of the drawing. This packed tower may be provided with suitable chilling means, such as cooling coils located within the tower, or cooling elements 95, as shown. Moreover, a single settling zone may be employed instead of the plurality of stages shown in connection with the tank B or the packed tower as shown. If an auxiliary solvent is to be employed, it may be introduced through an inlet 96. This auxiliary solvent may be the same as or different from the second solvent which is employed in the tank B. In either case, this auxiliary solvent is preferably separated from the complementary raffinate phase before returning the latter to the tank A, as by closing the valve 94, opening a valve 97, and passing the raffinate phase through a separator 98, the complementary raffinate being withdrawn at 99 and the auxiliary and selective solvents at 100 and 101, respectively. If desired, a portion of the selective solvent may be returned with the complementary raffinate by operating the apparatus 98 to produce at 99 a liquid which contains

both the raffinate and the selective solvent, or by reintroducing the separated selective solvent into the complementary raffinate phase by means of a conduit 102 and a valve 103. When an auxiliary solvent is employed, the apparatus 89 may be operated to cause the removal of the latter at 104. In the apparatus shown in Figure 1 the complementary raffinate or raffinate phase (i. e., the residual portion of the side stream) is preferably returned to a mixer connected with a settling chamber higher than chamber 3, as, for example, the mixer 22, as shown, but may be returned to the mixer 23 or to any other mixer of the process.

In Figure 2 I have illustrated an alternative form of deraffinating apparatus. In this apparatus, the side stream in the conduit 85 is first passed through a solvent separator 105, wherein a portion, but not all, of the selective solvent is removed from the side stream at 106; the resulting solvent-poor side stream is withdrawn at 107, passed if desired, through chiller 108, and then into settling chamber or centrifugal separator 109, where it is allowed to stratify or is separated into extract and raffinate phases; chiller 108 may be by-passed by means of conduit 110 provided with valve 111. The temperature of the solvent-poor side stream, which is introduced into the chamber 109 may be the same as or slightly higher than that of the original side stream in the conduit 85, but is preferably somewhat lower. The extract phase from the chamber 109 is withdrawn at 112, and may be further freed of selective solvent and further treated in the manner described above, or may be introduced directly into the apparatus 99, similar to the apparatus 89 in Figure 1. The raffinate phase from the chamber 109 is withdrawn at 113 and returned to the process, either directly, or after admixture with all or a portion of the solvent from 106, the valve 114 being employed to control the admixing. This raffinate or raffinate phase is preferably returned to the mixer 23 or to a mixer connected with a chamber lower than the chamber 3, although it may be returned to any other mixer, preferably to the mixer containing liquids having a composition most nearly resembling that of the returned raffinate.

The method of operation illustrated by Figure 2 is particularly suitable when extraction in the tank A is carried out in the presence of a non-selective diluent, such as an aromatic hydrocarbon employed in mineral oil extractions, flowing concurrently with the selective solvent. In this case, the solvent separator 105 is used to remove from the side stream either a part or whole of the said diluent, thereby causing the separation of the residual mixture in the phase separator 109 into two liquid layers which are withdrawn through conduits 112 and 113 and treated, if desired, in the manner already described.

Considering next the treatment of a side stream from the deraffinating zone, i. e., from the tank B, and referring again to Figure 1, a portion of the raffinate phase which is withdrawn from the outlet 9 of the settling chamber 15 may be fed through a conduit 115 and a valve 116 and introduced into an elutriating apparatus 117. A selective solvent, which may be the same as that contained in the tank 50, or which may have different solvent characteristics, is introduced into the apparatus 117 from a tank 133 through a conduit 134, and removes the more soluble components from the side stream. The selective solvent is preferably contacted with the side stream

in a countercurrent manner. The elutriated side stream may be withdrawn at 118 and introduced into a separating apparatus 119, from which the intermediate product may be withdrawn at 120 and the solvent at 121. The complementary extract phase is withdrawn at 122 and may be returned to the process through a conduit 123 and a valve 124.

The apparatus 117 may be of any desired type, and may, for example, be similar to the tank A, and provided with suitable settling chambers, and may be operated in accordance with any of the modes of operation described for the tank A. I may also employ a packed tower, as shown in Figure 1 of the drawing. The packed tower may, if desired, be provided with suitable chilling means, such as cooling coils or jackets, not shown. Moreover, a single elutriating stage may be employed. It may, however, be provided with a deraffinating zone 125. If an auxiliary solvent is employed in this deraffinating zone, it may be introduced through an inlet 126. This auxiliary solvent may be the same as, or different from that which is introduced at 67. If desired, this auxiliary solvent may be separated from the complementary extract phase before returning it to the tank B by closing the valve 124 and opening a valve 127, and passing the extract phase through a separating apparatus 128, the complementary extract phase being withdrawn at 129, and the auxiliary solvent and selective solvent at 130 and 131, respectively. When an auxiliary solvent is employed, the apparatus 119 may be operated to cause the removal of the latter at 132.

The complementary extract or extract phase produced at 117 is preferably returned either to the mixer 35 as shown, or to the mixer 36 or to a mixer connected with a settling chamber higher than chamber 15, depending upon the quantity and nature of the solvent used in the apparatus 117, and the compositions of the complementary extract phase and the liquids in the various mixers. This phase may, however, also be returned to a mixer lower than the mixer 36.

In Figure 3 I have illustrated an alternative form of deraffinating apparatus. In this apparatus, the side stream from the conduit 115 is passed through a chilling device 135 and fed into a settling chamber or centrifugal separator 136, where the chilled side stream is allowed to stratify, or is separated into extract and raffinate phases. The extract phase is withdrawn at 137 and may be returned to the process, either directly, or after being freed of a portion of its solvent in a manner not shown. This extract phase is preferably returned also to the mixer 35 or 36, or to a mixer connected with a settling chamber lower than the chamber 16, although it may in certain cases be desirable to return it to a higher settling chamber, as determined by the composition of the extract phase. The raffinate phase may be withdrawn at 138 and passed through a solvent separator 139, from which the solvent is withdrawn at 140 and the intermediate produce is withdrawn at 141.

When treating hydrocarbon oils, such as lubricating oils, kerosenes, gasolines, naphthas, etc., my invention may be used with any suitable solvent or solvent mixtures, such as: sulfur dioxide, phenol, nitrobenzol, ethanol amines, furfural, BB' dichloroethyl ether, quinoline, isoquinoline, nitrogen bases, ether alone or together with other solvents, such as alcohols, ketones, etc. These can be used in conjunction with auxiliary sol-

vents which possess a solvent power for the more paraffinic hydrocarbons, such as propane, pentane, light naphthas, etc., although my invention is not restricted to the use of any particular solvent or solvents.

The present invention may, moreover, be applied to the treatment of all kinds of hydrocarbon oils, either natural or synthetic, e. g., those obtained by polymerization, hydrogenation, or cracking. Apart from carbon and hydrogen they may contain other elements, such as sulfur, nitrogen, oxygen and/or metals, which may be termed foreign elements. The hydrocarbon oils may contain sulphonic acids, naphthenic acids, phenols, or metal compounds of these substances. As a rule, the more polarizable hydrocarbons, and the hydrocarbon derivatives containing the foreign elements in their molecule will pass into the phase rich in the first solvent used, i. e., the selective or polar solvent. In those cases the solvent rich or extract phase, when deraffinated, will contain naphthenic and/or aromatic constituents and compounds containing the foreign elements, e. g., sulfur compounds. In such cases the intermediate products obtained from the side streams from the tank B can be substantially freed from the compounds containing these foreign elements.

The invention also is not limited to extraction of hydrocarbons, but can be applied in extracting any solution of a plurality of substances, which can be separated from each other by solvent extraction, the selection of suitable sol-

vents and diluents being within the skill of those skilled in the art. Thus, refining of vegetable oils by solvent extraction to produce several products of different grades, or the concentration of lower aliphatic acids by extraction with various solvents, such as some ethers or esters, particularly amyl acetate, and the production of several products containing different acids, and many other solvent extraction treatments are subject to the process of this invention.

As used in the present specification, the term "extraction zone" or "extraction apparatus" is used to designate the aggregate of all zones or stages, or the aggregate of all units of an apparatus adapted to effect the separation of a liquid mixture into several portions of different compositions with the aid of a selective solvent. Such a zone may include either an elutriating zone, or a deraffinating zone, or both, these terms having been defined in the foregoing specification. Thus, in referring to Figure 1 of the drawing, the term "extraction zone" includes both tanks A and B. The term "component" is not limited to pure substances but includes groups of substances having generally similar solubility characteristics with respect to a particular solvent. A component is said to be pure if it does not contain any portion of a substance which should be present only in another component. In the present specification there is no difference in meaning between the words "solution," "liquid mixture" and "liquid solution."

WILLEM J. D. VAN DIJCK.