May 3, 1938. M. R. FENSKE 2,116,428

PROCESS AND APPARATUS FOR TREATING MINERAL OILS

Filed June 29, 1935 2 Sheets-Sheet 1

Fig. 1.

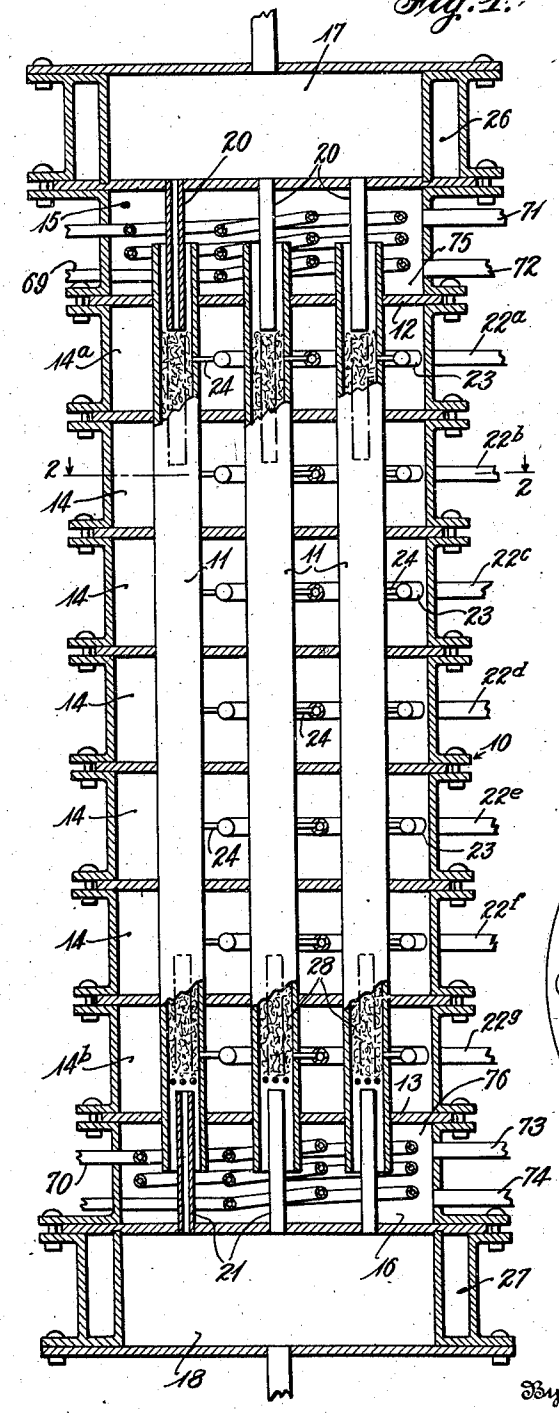


Fig. 2.

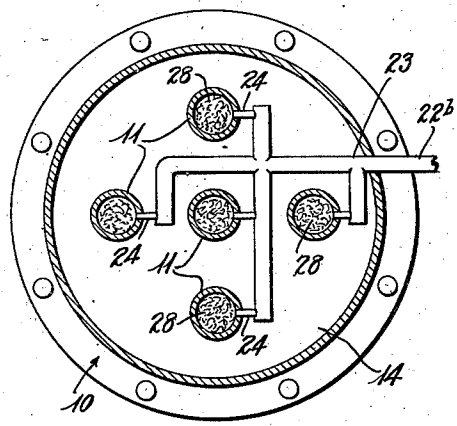
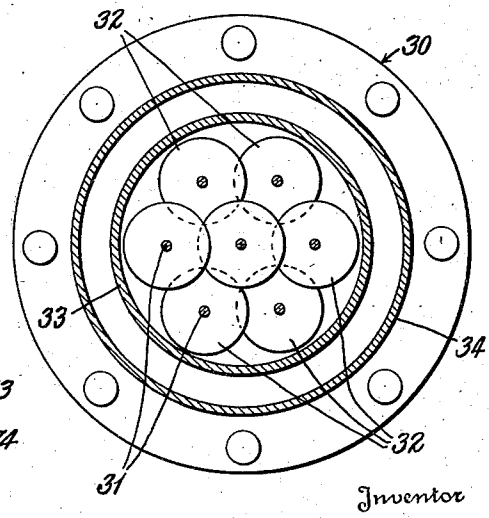


Fig. 4.



Inventor
Merrell R. Fenske

By Hugo A. Kemman
Attorney

May 3, 1938. M. R. FENSKE 2,116,428

PROCESS AND APPARATUS FOR TREATING MINERAL OILS

Filed June 29, 1935 2 Sheets-Sheet 2

Fig. 3a

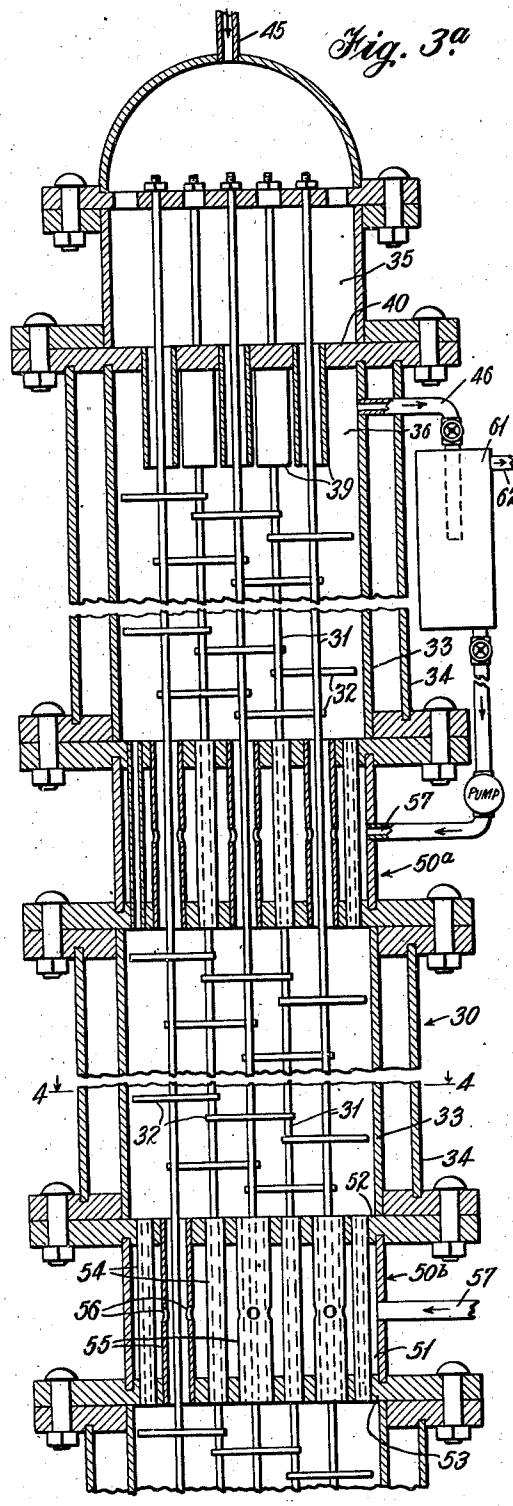
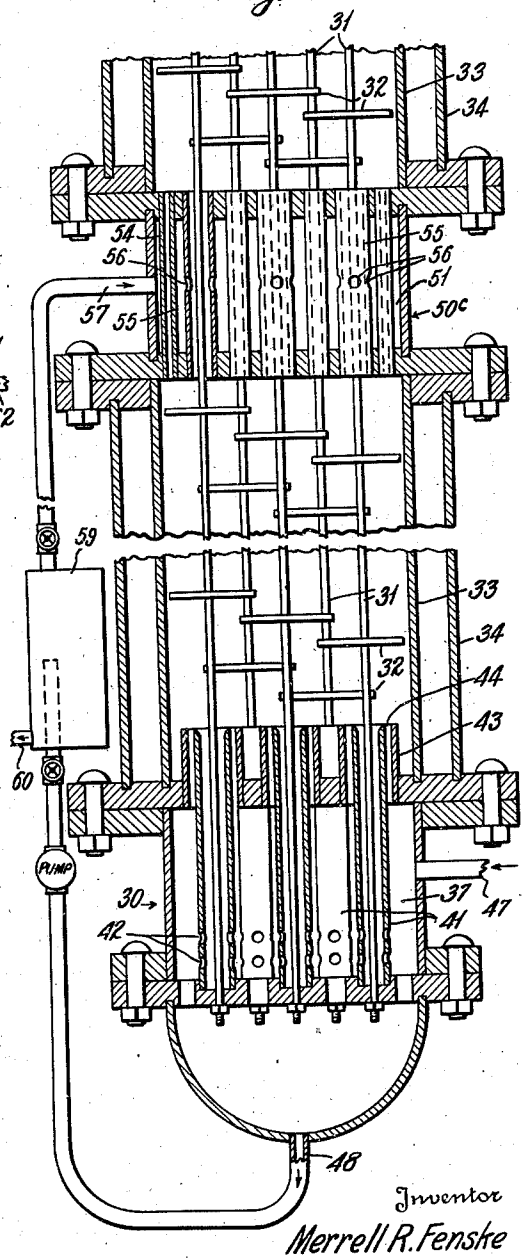


Fig. 3b



Inventor
Merrell R. Fenske

By Hugo A. Kemman
Attorney

Patented May 3, 1938 2,116,428

UNITED STATES PATENT OFFICE

2,116,428

PROCESS AND APPARATUS FOR TREATING MINERAL OILS

Merrell R. Fenske, State College, Pa., assignor to Pennsylvania Petroleum Research Corporation, a corporation of Pennsylvania

Application June 29, 1935, Serial No. 29,161

9 Claims. (Cl. 196—13)

This invention pertains generally to a method and apparatus for contacting liquid phases.

In copending application, Serial No. 10,932 by Merrell R. Fenske and Wilbert B. McCluer filed March 13, 1935 there is described and claimed a method and apparatus of the foregoing character wherein high efficiencies are obtained by effectively contacting the liquid phases without serious channeling. This is accomplished generally speaking by causing the liquids to flow through the zone of contact over one or more attenuated packing members.

This invention relates to an improvement over a certain species of said above-mentioned application.

While in the following description reference will be made to the contacting of lubricating oil with solvents it is to be understood that the process and apparatus may be employed for contacting other liquids.

In accordance with this invention two or more immiscible or only partially miscible solvents are counterflowed by virtue of a difference in their densities, the liquid under treatment such as lubricating oil, is introduced intermediate the counterflow and selectively dissolved in the two solvents, and the less soluble portions of the material dissolved in each solvent are thrown out of solution and fed back into the zone of contact.

When a plurality of packing members are employed they may or may not be separately enclosed.

When they are not separately enclosed and are of the same dimensions, said packing members are usually substantially uniformly distributed laterally of the counterflow, and substantially the same amount of liquid is caused to flow over each. Thus substantially the same conditions are caused to exist throughout any lateral cross section of the counterflow when the process is in operation. Should the packing members be of different dimensions, the necessary adjustments as to distribution of packing members and/or of liquid flow may be made to accomplish the same results.

When the packing members are separately enclosed, for instance by tubes having relatively small cross sections of any desired geometrical shape, the countercurrently flowing liquids are brought into efficient contact in a plurality of separate groups of countercurrently flowing streams or in other words in a plurality of separate phase contacting units. In this case each liquid is preferably metered into each unit in a manner so that at least substantially the same results are produced by each unit.

It has been observed that wetting of the packing member or members by one and perhaps in some cases more than one phase plays an important part in the efficiency of contact and the prevention of channeling. This is particularly true of longitudinally arranged attenuated packing members which appear to act as guiding elements for at least one phase (and possibly more) as it flows through the tower keeping said phase distributed laterally of its flow. The attenuations are preferably of sufficiently small cross section to avoid presenting a path of least resistance of any practicable consequence upon (which term includes through) itself.

The wetting feature makes it possible to disperse the wetting phase (or phases) by virtue of its spreading out into films on the surfaces of the packing member or members. In some cases these films collect in drops at points on the packing and become detached only to recontact the packing and spread out into films again. This kneading action, when present, assists in bringing the phase particles to the surface for contact purposes.

While the capacity of a tower having longitudinally arranged attenuated packing members may be increased somewhat by increasing the cross sections of the packing members, to avoid serious channeling due to too large a cross section, the capacity preferably will be increased and decreased by increasing and decreasing the number of packing members. The periphery of the tower is then adjusted to conform thereto.

When tubes are not employed, the individual longitudinally arranged packing members may be of any suitable character. For instance, they may comprise rods of any geometrical cross section, strips of jack chain etc. Such members may carry spaced laterally extending protuberances such as discs, spheres, frustums of cones, frustums of double cones, rain drop shapes, or any other surface of revolution to increase the surface. The protuberances on each attenuated packing member may overlap the protuberances on adjacent attenuated packing members so that any drops leaving any protuberance will at once contact another protuberance further downstream to re-form into a film. This arrangement of the protuberances also causes the liquids to flow in a circuitous course through the tower.

When tubes enclose individual longitudinally arranged packing members, these members may be constructed as set forth in the preceding paragraph or they may be made up of a large number of separate elements such as raschig rings

or similar packing. The separate elements may or may not be connected together since the packing may acquire its shape by virtue of the tube wall.

By making the tube walls perforated or reticular, for instance by forming the tube walls of wire cloth, the constructions of the two previous paragraphs might be combined, that is the reticular tubes may be packed as suggested in the first preceding paragraph and may carry on their outer surfaces protuberances of the character and arrangement as set forth in the second preceding paragraph. It should be noted that the rods and protuberances of said second preceding paragraph need not be solid but may be perforated or reticular or of other like construction.

Other features of the invention reside in the construction, arrangement and combination of parts and in the steps, combinations of steps and sequences of steps, all of which, together with other features, will become more apparent to persons skilled in the art as the specification proceeds and upon reference to the drawings in which:

Figure 1 is a sectional elevation of a tower illustrating one form of the invention;

Figure 2 is a section on line 2—2 of Figure 1;

Figures 3*a* and 3*b* comprise a broken sectional elevation illustrating another form of the invention; and

Figure 4 is a section on line 4—4 of Figure 3*a*.

Referring now more particularly to Figures 1 and 2, at 10 is shown a tower comprising a plurality of tubes 11 joined at their ends by tube sheets 12 and 13 and surrounded by a plurality of superimposed heat exchange chambers 14. Tower 10 also includes segregating chambers 15 and 16 respectively at opposite ends of tubes 11 as well as feeding chambers 17 and 18 also respectively at said opposite ends.

Chamber 17 communicates with the upper ends of tubes 11 through metering tubes 20 and chamber 18 communicates with the lower ends of tubes 11 through metering tubes 21.

Tubes 11 preferably contain suitable phase contacting means illustrated at 28, for instance, any of the packing materials referred to in said copending application. However, when tubes 11 are of small inner diameter, packing materials may not be required.

Communication is had with tubes 11 at any intermediate point through any suitable means, for instance, by means of a member 22 which is illustrated as comprising a conduit 23 and a plurality of metering orifices 24.

Chamber 17 is illustrated as being surrounded by heat exchange jacket 26 and chamber 18 is illustrated as being surrounded by a heat exchange jacket 27.

Chamber 15 is illustrated as containing a heat exchange coil 69 and chamber 16 is illustrated as containing a heat exchange coil 70.

Any suitable means (not shown) may be employed for circulating heat exchange fluid through any of the chambers 14, 26 and/or 27 and through coils 69 and/or 70.

Chamber 15 has an outlet pipe 71 at its upper end and an outlet pipe 72 at its lower end and chamber 16 has an outlet pipe 73 at its upper end and an outlet pipe 74 at its lower end.

Tubes 11 are illustrated as extending up into chamber 15 to form a well 75 with which outlet 72 communicates.

Tubes 11 are illustrated as also extending down into chamber 16 to form a well 76 with which outlet 73 communicates.

Tubes 11 may have a cross section of any desired geometrical configuration and, within certain preferred limits, any desired area. The cross section of tubes 11 is preferably limited to an area sufficiently small to prevent serious channeling after the contacting means, for instance packing 28, has been arranged therein.

The preferred limiting cross sectional area for tubes 11 will be not only a function of the type of packing employed since certain types of packing will as a rule permit the use of a larger cross section without an inordinate falling off of efficiency than other types, but also of the degree of uniformity of distribution of packing in the tubes. Since the tubes 11 may have sides which are straight or indented or of other surface configuration, the departure of a tube from a straight or continuous form will have its influence. For this reason a definite limit in cross sectional area which, if exceeded in size, will no longer demonstrate the substantial increase in efficiency which results from a constriction of cross sectional area cannot be given but may be readily determined, for instance, by testing the efficiency of single tubes of different sizes when packed with the packing which is to be employed.

It may be stated as a general rule that one should proceed with caution after exceeding a cross sectional area equivalent to that of a circular tube in the neighborhood of three inches in diameter although, with the proper selection of packing and a careful distribution in each tube, it is possible that larger cross sectional areas may be employed while in other cases smaller cross sections may be required.

Therefore, the term "relatively small cross sectional area" when employed in this specification and in the claims is intended to mean a cross section which when taken in conjunction with the contacting means (if any) therein is sufficiently small to materially increase the contacting efficiency because of the constriction of its area.

In those cases in which it is desired to cause heat transfer through the tube walls, consideration should be given to the effect of cross sectional area upon efficient heat transfer.

In the operation of tower 10 the heavier solvent is introduced into tubes 11 through chamber 17 and metering tubes 20, and the lighter solvent is introduced into tubes 11 through chamber 18 and metering tubes 21. Due to the difference in density these solvents flow countercurrently to each other through the tubes and, since they are immiscible or only partially miscible, two liquid phases are present.

The oil may be introduced into the tubes 11 through a member 22, for instance member 22*d* which is illustrated midway of the length of tubes 11.

If one of the solvents is selective as to nonparaffinic constituents and the other selective as to paraffinic constituents, the oil components will divide between the two phases more or less according to this selectivity.

The lighter phase flows into chamber 15 wherein its temperature is reduced by means of a cooling fluid in coil 69 causing separation of the less soluble constituents which collect in well 75 and the rest of this phase leaves the tower through pipe 71.

The separated components as they collect in well 75 are withdrawn through pipe 72 and are fed back into the tubes 11, for instance at 22*a*, 22*b*, or 22*c* and preferably at a point at which the

materials in process are of the same composition. Thus the precipitated components are refluxed.

The heavier phase flows into chamber 16 wherein its temperature is reduced by cooling fluid in coil 70 thereby separating less soluble components which collect in well 76 and the rest of this phase flows out through 74.

The separated components as they collect in well 76 are withdrawn through pipe 73 and are fed back into the tubes 11, for instance at 22*g*, 22*f*, or 22*e* and preferably at a point at which the materials in process are of the same composition. Thus the precipitated components are refluxed.

The result of setting up reflux conditions in tower 10 is a much sharper separation between paraffinic and non-paraffinic material.

Should the material separated in chamber 15 prove to be lighter than the phase from which it is separated, it will comprise the upper layer and can be withdrawn through pipe 71 instead of 72, the phase from which this material is separated being then withdrawn through pipe 72.

Likewise, should the material separated in chamber 16 be heavier than the phase from which it is separated so as to form the lower layer it might be withdrawn through pipe 74 and the phase from which it is separated withdrawn at 73.

Separation of less soluble materials from the two phases might be effected by other means, for instance by extending metering tubes 20 and 21 as indicated in dotted lines and employing heat exchange chambers 14*a* and 14*b* for cooling purposes. In this case tubes 11 can be made flush with headers 12 and 13 and pipes 72 and 73 might be omitted, particularly when the material separated is of a density such as to flow countercurrently to the phase from which it is separated.

If the opposite is true separation might take place in chambers 15 and 16 and the separated material fed back through members 22 as before.

It is, of course, understood that heat exchange chambers 14 may be of any number, that is one or more. The same applies to members 22 and tubes 11. Tubes 11 may be of any desired length.

Separation might be effected by other means, for instance, by the use of a third solvent which is capable of forming a solvent mixture of lower solvent capacity for the oil with the solvent or solvents of the phase; or by reducing the solvent concentration in the phase; or by reducing the temperature by any other means; or by a combination of any two or more of the foregoing or otherwise.

The desiderata in the operation of tower 10 are (1) that the lighter phase leaving any individual contacting unit shall be of the same composition as the lighter phase leaving any other contacting unit; (2) that the same shall apply with respect to the heavier phase; and (3) that the phases shall be mixed at any cross section in any contacting unit.

In substantially approaching the foregoing it is simpler to make tubes 11 of the same cross section and length; to provide the same character of contacting means in each tube; to feed the oil under treatment at substantially the same rate into each tube; to divide each solvent substantially equally between the tubes; and to divide each separated material substantially equally between the tubes.

However, the individual contacting units may differ without departing from the spirit of the invention. Such differences may be as to construction, for instance as to size, length, contacting means or otherwise.

For instance, the individual contacting units may vary as to construction but may be matched so that each will deliver lighter phase of substantially the same composition, and heavier phase of substantially the same composition when oil is fed at substantially the same rate to each, and each solvent is substantially equally divided between the tubes.

On the other hand, the individual contacting units may be of the same and/or of different construction but may differ as to capacity. In this case adjustments of oil feed and/or of solvent feed may be made to cause the respective phases from any unit to be of substantially the same composition as the respective phases from any other unit.

The use of metering tubes 20 makes it possible to adjust the feeding rate of the heavier solvent to any contacting unit by employing a metering tube for that unit of the desired capacity. Likewise, the use of metering tubes 21 makes it possible to adjust the feeding rate of the lighter solvent to any contacting unit by employing a metering tube for that unit of the desired capacity. In a similar manner the use of metering orifices 24 makes it possible to adjust the feeding rate of oil to any contacting unit.

Thus the desired balance may be obtained. The precision of this balance will, of course, depend upon the results desired and, therefore, may be rough or close according to requirements.

Any other means may be adopted for feeding the various liquids into the tubes 11.

While the invention has been described in connection with one or more tubes of "relatively small cross sectional area" in its broad phases it extends to setting up reflux conditions at the opposite ends of a tower of any diameter even though the high efficiencies resulting from the use of one or more tubes of the character described may not be obtained.

A construction in which the attenuated packing members are not enclosed in tubes is illustrated in Figures 3 and 4 in which tower 30 is shown as comprising a plurality of rods 31 carrying spaced protuberances 32, a plurality of shells 33 having jackets 34, a feeding chamber 35, a segregating chamber 36, a combined feeding and segregating chamber 37, and a plurality of intermediate feeding sections 50. Rods 31 may be supported in tower 30 in any suitable manner, for instance as illustrated.

Extending downwardly from feeding chamber 35 about each rod 31 is a metering tube 39 which is arranged so that the metered liquid will be deposited on the rod.

Tubes 39 are of sufficient length to form with their supporting plate 40 and the upper end of the uppermost shell 33 a segregating chamber 36.

The lower end of each rod 31 is illustrated as being surrounded by a segregating tube 41 which forms with the rod an annular space for the downward flow of liquid adhering to the rod. The lower end of each tube 40 is provided with a plurality of apertures 42 to permit said liquid to flow into chamber 37.

Each tube 41 is illustrated as extending beyond the upper end of chamber 37 and with its upper end surrounded by a tube 43 in such a manner as to afford an annular space 44 between the tubes for metering purposes.

The discs 32 on each rod 31 are illustrated as overlapping the discs 32 on adjacent rods 31.

Feeding chamber 35 has an inlet pipe 45, segregating chamber 36 has an outlet pipe 46, and com-

bined feeding and segregating chamber 37 has an inlet pipe 47 and an outlet pipe 48.

Each feeding section 50 comprises a chamber 51 formed by tube sheets 52 and 53 between which extend a plurality of imperforate tubes 54 and a plurality of perforate tubes 55.

Imperforate tubes 54 are free from any obstructions whereas a rod 31 passes through each perforate tube 55. Perforations 56 in tubes 55 comprise metering orifices through which liquid from chamber 51 may be metered onto rods 31. This may be preferred when the liquid fed into the tower at the intermediate point preferentially wets the attenuated packing members.

However, rods 31 may pass through tubes 54 if desired and orifices 56 may be employed for distributing said liquid from chamber 51 laterally of the tower, for instance in case said liquid does not preferentially wet the attenuated packing members.

Each feeding section 50 has an inlet pipe 57.

In describing the operation of tower 30 it will be assumed that the heavier solvent phase preferentially wets the rods 31 and discs 32 in preference to the lighter solvent phase. If the reverse is true, tower 30 might be constructed up-side-down.

The heavier liquid flows from feeding chamber 35 down through metering tubes 39 onto the respective rods 31, continues on down through the tower, collects in tubes 41, drains out through apertures 42 to form a layer in chamber 37 and is withdrawn through pipe 48.

The lighter liquid enters chamber 37 through pipe 47 and occupies the upper part of chamber 37. This liquid is metered up through annular spaces 44 and thus is distributed laterally of tower 30.

As the lighter phase flows up through the tower it intimately contacts the descending heavier phase.

The lighter phase collects in segregating chamber 36 and is withdrawn through 46.

The liquid under treatment, for instance petroleum oil dissolved or not in a solvent, is fed into tower 30 through feeding sections 50, fresh oil being fed in at feeding section 50*b* and partially treated oil at feeding section 50*a* and/or feeding section 50*b*.

The fresh oil fed into the tower through feeding section 50*b* is selectively dissolved in the two counter-flowing solvents, one part of the oil being carried down into feeding and segregating chamber 37, dissolved in the heavier solvent and the other part being carried up into segregating chamber 36 in solution in the lighter solvent.

The heavier solvent with oil in solution is pumped into separating chamber 59 wherein a part of the dissolved oil is separated from the solvent, for instance by cooling, and is fed back into the tower through feeding section 50*c*. The rest of the oil dissolved in the heavier solvent is withdrawn from separating chamber 59 at 60.

The lighter solvent with oil in solution flows into separating chamber 61 wherein a part of the oil is separated from solvent, for instance by cooling. The separated oil is fed back into tower 30 through feeding section 50*a*. The rest of the oil dissolved in solvent is removed from separating chamber 61 through pipe 62.

In the foregoing description, it has been assumed that the oil separated from the heavier solvent is lighter than the solvent and that the oil separated from the lighter solvent is heavier than the lighter solvent. If the reverse is true in the case of either or both solvents, it is merely necessary to turn separating chambers 59 and/or 61 up-side-down as required.

Any other means for separating a part of the oil from solution may be employed.

Any other suitable means may be provided for metering the liquids into the tower and/or for separating the phases. For instance, tubes 41 and 43 might be eliminated. The separation of lighter solvent from the heavier solvent (with oil in solution) would then be by simple layer formation, and the lighter solvent would be distributed laterally of the tower by virtue of its layer. This arrangement might be preferred in certain cases particularly if the differential in wetting ability is small between the heavier solvent (with oil in solution) and the lighter solvent.

For the purpose of clearness, a limited number of attenuated packing members has been shown in the drawings with the volume of free space fairly large compared to the surface area of the packing. It is to be understood, however, that the attenuated packing members may be as densely grouped as desired and may be provided with any desired number of protuberances.

If one or more of the liquids should find a path of least resistance along the inner walls of shells 33, baffles might be attached to these walls to cause such liquid or liquids to flow back toward the attenuated packing members and to become re-distributed.

While the metering onto the individual packing members of the liquid which preferentially wets the packing may be preferred, it is not an indispensable feature and other constructions may be employed, for instance in case there should be no clearly defined differential between wetting ability of the various phases.

While heat exchange jackets 34 have not been illustrated as being divided into a number of sections, such construction may be adopted.

Principles set forth in connection with the description of tower 10 are applicable to tower 30.

While in the description of the attenuated packing members, it has been inferred that they have uniform wetting features throughout, it is to be understood that the packing members may have surfaces of at least two different types, said surfaces differing from each other in that they are preferentially wetted by different phases as described and claimed in copending application, Serial No. 29,159, filed June 29, 1935.

These different types of surfaces may be distributed over the packing members in any desired way, for instance (1) alternately in circumferential bands, (2) longitudinal bands, (3) spiral bands, (4) mottling, (5) checker work and/or (6) in any other suitable manner particularly when applied to longitudinally arranged attenuated packing members of solid or similar design. However, when said packing member or members are made up in the form of a net-work, such as by the use of raschig rings, jack chain or other packing materials, the same arrangement of surfaces may be adopted when practical, or any other suitable arrangement may be adopted.

With such an arrangement any phase may be positively conducted through any portion of the zone of contact by virtue of the preferential wetting feature, or the phases may be caused to intermittently displace each other for the purpose of contact and spontaneous molecular mixing.

Many other modifications are possible.

Having particularly described the invention, it is to be understood that changes, omissions, ad-

ditions, substitutions, and/or modifications might be made within the scope of the claims without departing from the spirit thereof.

I claim:

1. In a process for contacting a mineral oil and two solvents capable of forming two liquid phases wherein said solvents are caused to flow countercurrently to each other by virtue of a difference in density and said oil is introduced intermediate the ends of the counterflow for solution in said solvents, the steps of dividing each of said solvents into a plurality of relatively small streams, contacting said streams so that each stream of each solvent contacts one stream of the other solvent in a separate phase contacting path of relatively small cross sectional area and of substantial length, feeding said oil into said separate phase contacting paths intermediate the ends of the counterflow of solvents, precipitating components from the final phases thus produced, flowing a separate stream of each of said precipitates through each of said phase contacting paths for re-solution in said solvents, uniting the streams of the lighter of the resultant phases at the tops of said phase contacting paths, and uniting the streams of the heavier of said resultant phases at the bottoms of said phase contacting paths.

2. In a process involving the contacting of a mineral oil and at least two solvents in a common path wherein said solvents are caused to flow countercurrently to each other by virtue of a difference in their densities and wherein said oil is fed into said path at an intermediate point, the steps of causing at least one of said liquids to flow through said common path in a widely distributed form by conducting said liquid through said common path over a plurality of vertically arranged packing mediums each of which has a relatively long and narrow shape, said packing mediums being wetted by said liquid, separating dissolved oil from the lighter solvent, feeding said separated oil back into said common path at a point above the feeding point of fresh oil, separating dissolved oil from the heavier solvent, and feeding said last-mentioned separated oil back into said common path at a point below the feeding point of fresh oil.

3. In a process involving the contacting of a mineral oil and at least two solvents in a common path wherein said solvents are caused to flow countercurrently to each other by virtue of a difference in their densities and wherein said oil is fed into said path at an intermediate point, the steps of causing at least one of said liquids to flow through said common path in a widely distributed form by conducting said liquid through said common path over a plurality of vertically arranged packing mediums each of which has a relatively long and narrow shape, said packing mediums being wetted by said liquid, separating dissolved oil from the lighter solvent, feeding said separated oil back into said common path at a point above the feeding point of fresh oil, separating dissolved oil from the heavier solvent, feeding said last-mentioned separated oil back into said common path at a point below the feeding point of fresh oil, and separately encasing each of said packing mediums to confine said counterflow to said packing mediums.

4. A process for treating liquid phases of incomplete and partial miscibility such as in the solvent treatment of petroleum oil fractions with two solvents comprising countercurrently flowing said solvents by means of a difference in their densities through a plurality of phase contacting paths of relatively small cross sectional area and of substantial length, introducing said petroleum oil fractions into said paths at an intermediate point, separating dissolved oil from the lighter solvent at the upper portion of said paths, setting up reflux conditions in the upper portion of said paths with said separated oil by subjecting said separated oil to contact with said solvents, separating dissolved oil from the heavier solvent at the lower portion of said paths, setting up reflux conditions in the lower portion of said paths with said last-mentioned separated oil by subjecting said last-mentioned separated oil to contact with said solvents, maintaining the proportions of said phases at least substantially identical in said phase contacting paths, uniting the streams of the lighter of the resultant phases at the tops of said phase contacting paths, and uniting the streams of the heavier of the resultant phases at the bottoms of said phase contacting paths.

5. A process for treating a mineral oil with two solvents which are capable of forming two solvent phases with said oil in solution and in which said phases are caused to move countercurrently to each other through a phase contacting zone by virtue of a difference in density, comprising introducing said solvents and oil into said phase contacting zone at vertically spaced points to form said two solvent phases with said oil in solution, maintaining at least one phase in a widely distributed form by causing said relative movement between said phases to take place in the presence of a group of attenuated packing members arranged in the zone of contact side by side and longitudinally of the flow of said phases with each packing member of sufficient length to extend throughout at least a substantial portion of said zone of contact, spacing the points of entry of said solvents from each other and from the point of entry of said oil with the points of entry of said solvents on opposite sides of the point of entry of said oil, choosing said solvents as to density so that said phases will flow through said phase contacting zone in opposite directions, precipitating oil from the lighter phase, bringing said precipitated oil into contact with the two phases in said phase contacting zone above the point of entry of said oil, precipitating oil from the heavier phase, and bringing said last mentioned precipitated oil into contact with the two phases in said phase contacting zone below the point of entry of said oil.

6. A process for treating a mineral oil with two solvents which are capable of forming two solvent phases with said oil in solution and in which said phases are caused to move countercurrently to each other through a phase contacting zone by virtue of a difference in density, comprising introducing said solvents and oil into said phase contacting zone at vertically spaced points to form said two solvent phases with said oil in solution, maintaining at least one phase for at least the most part in a plurality of separate relatively small streams, spacing the points of entry of said solvents from each other and from the point of entry of said oil with the points of entry of said solvents on opposite sides of the point of entry of said oil, choosing said solvents as to density so that said phases will flow through said phase contacting zone in opposite directions, precipitating oil from the lighter phase, bringing said precipitated oil into contact with the two phases in said phase contacting zone above the point of

entry of said oil, precipitating oil from the heavier phase and bringing said last mentioned precipitated oil into contact with the two phases in said phase contacting zone below the point of entry of said oil.

7. Apparatus comprising a column, means for introducing liquids into said column at at least three vertically spaced points to cause at least two of said liquids to flow countercurrently to each other through said column by virtue of a difference in density such as in the treatment of mineral oils, means at each of said points for dividing the fed liquid into a plurality of separate streams, means for contacting each separate stream of each liquid in a segregated phase contacting course of substantial length with a separate stream of each of the other liquids, and means for maintaining the temperature at opposite ends of said phase contacting courses lower than the temperature of the main portions of said phase contacting courses.

8. Apparatus comprising a column, means for introducing liquids into said column at at least three vertically spaced points, to cause at least two of said liquids to flow countercurrently to each other through said column by virtue of a difference in density such as in the treatment of mineral oils, means at each of said points for dividing the fed liquid into a plurality of separate streams, means for contacting each separate stream of each liquid in a segregated phase contacting course of substantial length with a separate stream of each of the other liquids, means for maintaining the temperature at opposite ends of said phase contacting courses lower than the temperature of the main portions of said phase contacting courses, means at said opposite ends for separating liquid phases produced by said reduction in temperature, and means for feeding one of the phases separated at each end back into said column.

9. Apparatus comprising a column, a group of attenuated packing members vertically arranged in the zone of contact of said column side by side, said packing members being of sufficient length to extend throughout at least a substantial portion of said zone of contact and to provide segregated phase contact paths, means for feeding liquids into said column at at least three vertically spaced points to cause at least two of said liquids to flow countercurrently to each other by virtue of a difference in density such as in the solvent treatment of mineral oils, means for removing solutions of said liquids, means for separating solute from said solutions, and means for feeding said separated solute back into said column.

MERRELL R. FENSKE.