

Aug. 31, 1937.

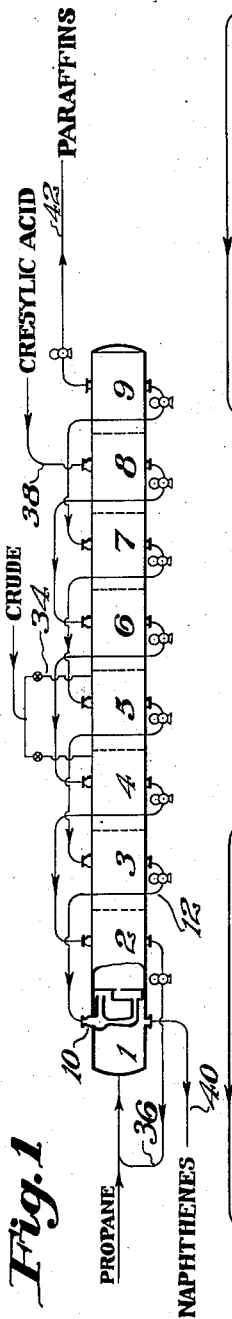
A. C. HAMPTON

2,091,709

COUNTERCURRENT CONTACT APPARATUS

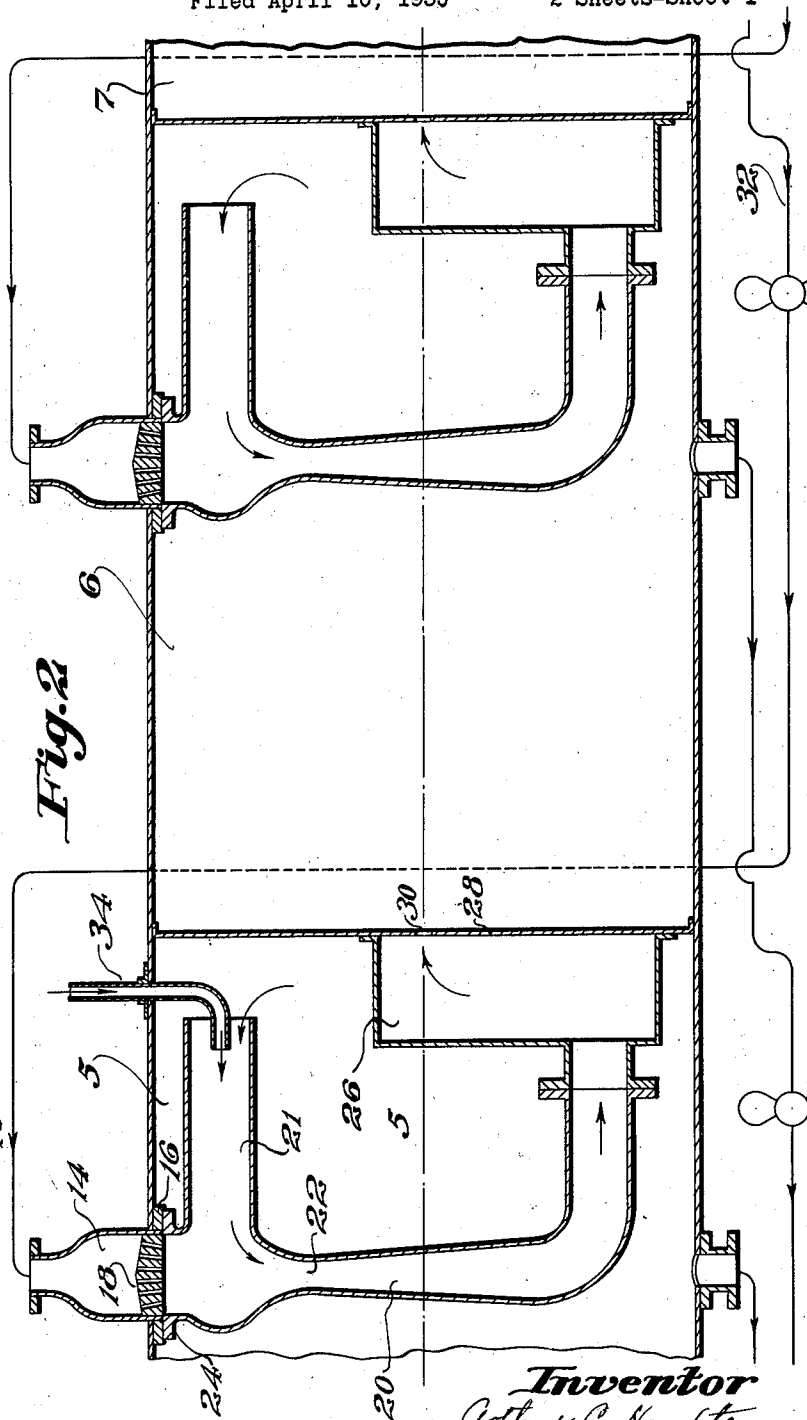
Filed April 10, 1935

2 Sheets-Sheet 1



Witness

Paul F. Bryant



Inventor

*Arthur C. Hampton
by his attorney
Fish, Widdroth, Cary & Fenney*

Aug. 31, 1937.

A. C. HAMPTON

2,091,709

COUNTERCURRENT CONTACT APPARATUS

Filed April 10, 1935

2 Sheets-Sheet 2

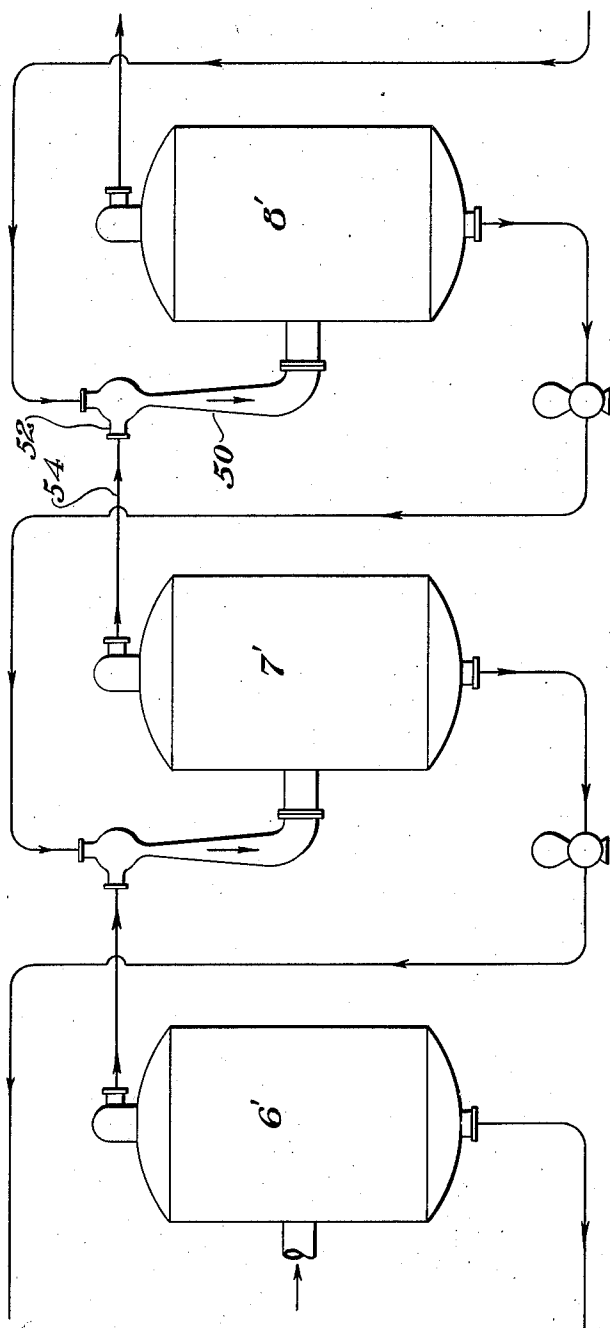


Fig. 3

Witness

Paul F. Bryant

Inventor

Arthur C. Hampton
by his attorney
Frank Hildreth, Esq., Denver

UNITED STATES PATENT OFFICE

2,091,709

COUNTERCURRENT CONTACT APPARATUS

Arthur C. Hampton, Belleville, N. J., assignor to
The Lummus Company, New York, N. Y., a corporation of Delaware

Application April 10, 1935, Serial No. 15,729

9 Claims. (Cl. 23—270)

The present invention relates to countercurrent liquid contact apparatus and more particularly to mixing devices for promoting liquid contact.

5 The liquid contact apparatus of the type described herein is of value, for example, in the solvent extraction of lubricating oils for separation of the naphthenic and paraffinic constituents. The apparatus comprises a series of extraction chambers, each of which contains two practically immiscible liquid layers of different densities and provision is made for progressing the materials of the two layers in opposite directions through the series of chambers. Existing apparatus has frequently been unsatisfactory either because of its failure to permit proper segregation of the liquid layers or because of variations in operation which tend to prevent differentiation of the liquids from chamber to chamber.

20 The principal object of the present invention is to provide countercurrent extraction apparatus which is dependable in continuous operation and which acts to promote proper contact and segregation of the liquids in the different chambers.

25 With this and other objects in view, as will hereinafter appear, the present invention comprises the apparatus hereinafter described and particularly defined in the claims.

30 In the accompanying drawings, Fig. 1 is a diagram of the preferred form of apparatus for solvent extraction of lubricating oils; Fig. 2 is a section, on an enlarged scale, showing the details of the mixing apparatus; and Fig. 3 is a diagram of a modified form of apparatus.

35 The apparatus is herein illustrated as applied to the two-solvent method of separating a reduced crude into its paraffinic and naphthenic constituents. To this end, two immiscible solvents are employed, one a light solvent, such as propane, for extracting the paraffins and the other a relatively heavy solvent as cresylic acid for extracting the naphthenes. The reduced crude to be treated is introduced at an intermediate point of a countercurrent path along which the propane courses in one direction and the cresylic acid in the other.

40 The illustrated apparatus comprises a horizontal extraction cylinder having a series of extraction chambers numbered consecutively from 1 to 9. Propane is continuously introduced into the left-hand chamber 1 and cresylic acid into the right-hand chamber 9, while the crude oil to be treated is introduced into one or more of the

intermediate chambers. The liquids in each chamber settle into two layers, namely, a heavy layer comprising primarily cresylic acid with dissolved oils and a light layer comprising largely propane with dissolved oils. The proportions of materials vary from chamber to chamber and in general, the heavy layer has increasing proportions of naphthenes progressing from right to left, while the light layer has increasing proportions of paraffins progressing from left to right. In the chamber 1, the heavy layer comprises mainly cresylic acid with naphthenes in solution while in chamber No. 9, the light layer comprises mainly propane with paraffins in solution.

45 Included in each chamber, except the last, is a mixing device indicated generally at 10. To produce the general countercurrent flow of liquids, material is continuously pumped from the heavy layer of each of the chambers from 3 to 9 inclusive into the mixer of a preceding chamber. Thus, for example, a pipe 12 is connected from the bottom of chamber 3 leading to the mixer in chamber 1.

50 As shown in Fig. 2, each mixer comprises a nozzle 14 external to the cylinder and having a flange 16 secured to the shell. At the bottom of the nozzle 14, there may be placed a spray head 18 for introducing the liquid in a plurality of jets into the tube 20. Branching from the tube 20 is an injector pipe 21 having an open end in the light layer. At the point of connection of the tube 20 and the pipe 21, the former is flared and immediately below the connection, the tube 20 is contracted, as indicated at 22, whereby the liquid is drawn from the upper layer through the pipe 21 by injector action. The purpose of the spray head 18 is to introduce the liquid entering at 14 in a plurality of high velocity jets which converge in the restriction 22, thereby promoting the injector action and preventing back flow through the pipe 21.

55 The tube 20 is suitably supported at its upper end by a flange 24. At the lower end, the pipe 22 leads into a plenum chamber 26 which extends completely across the extraction chamber and lies against the end wall 28 thereof. At the top of the plenum chamber and approximately at the interface of the light and heavy layers, there is a slot 30 extending across the chamber and opening into the next succeeding chamber.

As shown in Figs. 1 and 2, material from the bottom of chamber 7 is conducted by a pipe 32 to enter the mixer in chamber 5. The flow of heavy material through the mixer acts to

withdraw material from the upper layer of chamber 5 and to introduce a mixture of both materials into chamber 6. The action is therefore to introduce material from the heavy layer of chamber 7 and from the light layer of chamber 5 into chamber 6. The apparatus gives high velocity with turbulence and consequent effective contact between the liquid particles in the region 20. In the settling tank itself, however, turbulence is undesirable because it would mix the previously settled layers. The plenum chamber forms a transition space of large volume wherein the velocity is lowered and the liquid is brought to a relatively quiescent condition prior to its introduction into the settling chamber. The introduction of the mixture into chamber 6 results in some agitation of the liquids at the interface, thereby promoting the effective surface contact of the particles of the liquids. This turbulence is, however, largely confined to a small region immediately above and below the interface, so that the previously settled layers of liquid are not unduly disturbed.

Although the mixer by which liquid is introduced into chamber 6, for example, is, for reasons of convenience, physically placed within chamber 5, the invention does not require such disposition of the mixer. The mixer may be disposed anywhere so long as it operates to promote the countercurrent passage of light and heavy liquids.

The same action occurs for all of the chambers. There is therefore a continuous progression of heavy material toward the left and of light material toward the right. The heavy layer becomes enriched in naphthenes as it progresses toward chamber 1 and the light layer becomes enriched in paraffins as it progresses in the opposite direction.

The introduction of the crude oil to be treated is by pipe 34, the open end of which points directly into the open end of the injector pipe 21. The crude may be introduced into one or more of the chambers, as shown in Fig. 1. For those mixers into which the crude oil is introduced, the injector handles a portion of the crude as well as a part of the material of the light layer.

In the arrangement shown in Fig. 1, propane is pumped continuously into chamber 1 in mixture with heavy material pumped from chamber 2 through a pipe 36. Cresylic acid is introduced by the pipe 38 into the mixer in chamber 8, and enters the final chamber 9 in mixture with material obtained from the upper layer of chamber 8. The naphthenes dissolved in cresylic acid and possibly mixed with a small quantity of propane, are continuously withdrawn from the lower layer of chamber 1 by a pipe 40, and the paraffins dissolved in propane and possibly mixed with a small quantity of cresylic acid are continuously withdrawn from the upper layer of chamber 9 by a pipe 42. The pipes 40 and 42 lead to suitable solvent recovery apparatus, by which the extracted oils are separated from the solvents.

The apparatus affords maximum reliability and efficiency of contact. Since the injector pipe 21 of each chamber is disposed at all times entirely in the upper layer, and since the heavy material is withdrawn from the bottom of each chamber, the operation is not materially affected by fluctuations in the height of the interface. Furthermore, the rate of withdrawal of light material from any chamber is dependent

upon the rate of flow of heavy material through the mixer, so that proper proportions in the mixture are always maintained.

The modified apparatus shown in Fig. 3 comprises a series of individual extraction chambers or vessels, each with an external mixing device. Only three vessels are shown, designated as 6', 7' and 8', corresponding to the chambers 6, 7 and 8 of the apparatus of Fig. 1. Each chamber is provided with a mixer 50, of the same general form as those shown in Fig. 2, having an injector pipe 52 connected by a pipe 54 with the upper layer of the preceding chamber. Material from the lower layer of the succeeding chamber is pumped into the top of the mixing device, and the mixture of materials is introduced into the corresponding extraction vessel approximately at the interface of the two layers. The operation is identical with that taking place in the apparatus of Figs. 1 and 2.

Although the invention has been described as embodied in a method and apparatus for extracting the paraffinic and naphthenic portions of petroleum oils, it will be understood that the invention is not limited to such use but may be employed for other purposes involving the countercurrent flow of liquids.

Having thus described the invention, what is claimed is:

1. In countercurrent extraction apparatus having a succession of chambers to maintain an upper layer and a lower layer of liquid, a mixer having an outlet leading into one of the chambers, and having two inlets, one of said inlets being connected with one layer of one adjacent chamber, means for forcing liquid from the other layer of the other adjacent chamber into the second inlet, the mixer being constructed to take liquid by injector action through the first inlet, and a plenum chamber into which the liquids flow between the inlets and the outlet.

2. In countercurrent extraction apparatus having a succession of chambers to maintain an upper layer and a lower layer of liquid, a mixer having an outlet leading into one of the chambers, and having two inlets, one of said inlets being an injector pipe disposed in the upper layer of one adjacent chamber, a connection from the lower layer of the other adjacent chamber to the other inlet, and a plenum chamber into which the liquids flow between the inlets and the outlet.

3. In countercurrent extraction apparatus having a succession of chambers to maintain an upper layer and a lower layer of liquid, a mixer having an outlet leading into one of the chambers, and having two inlets, one of said inlets being disposed in one layer of one adjacent chamber, means for forcing liquid from the other layer of the other adjacent chamber into the second inlet, the mixer being constructed to take liquid by injector action through the first inlet, and a plenum chamber into which the liquids flow between the inlets and the outlet, said outlet being disposed approximately at the interface of the liquid layers in the chamber.

4. In countercurrent extraction apparatus having a succession of chambers to maintain an upper layer and a lower layer of liquid, a mixer having an outlet leading into one of the chambers, and having two inlets, one of said inlets being an injector pipe disposed in the upper layer of one adjacent chamber, a connection from the lower layer of the other adjacent chamber to the other inlet, and a plenum chamber into which

the liquids flow between the inlets and the outlet, said outlet being disposed approximately at the interface of the liquid layers in the chamber.

5 5. In countercurrent extraction apparatus having a succession of extraction chambers, each maintaining an upper layer and a lower layer of liquid, a mixer having an outlet to discharge into one of the chambers, inlets for the mixer connected with the upper layer of a chamber at one side and the lower layer of a chamber at the other side of the chamber into which the mixer discharges, the mixer having provision for turbulently mixing the liquids entering the inlets, and a plenum chamber between the inlets and the outlet.

10 6. In countercurrent extraction apparatus having a succession of extraction chambers, each maintaining an upper layer and a lower layer of liquid, a mixer having an outlet to discharge into one of the chambers, inlets for the mixer connected with the upper layer of a chamber at one side and the lower layer of a chamber at the other side of the chamber into which the mixer discharges, the mixer having provision for turbulently mixing the liquids entering the inlets, and means providing a substantial enlargement of the passage through which the mixed liquid flows to lower the velocity of the mixed liquid prior to its discharge through the outlet of the mixer into the corresponding chamber.

15 7. In countercurrent extraction apparatus having a succession of extraction chambers, each maintaining an upper layer and a lower layer of liquid, a mixer having an outlet to discharge into one of the chambers, inlets for the mixer connected with the upper layer of one adjacent chamber and the lower layer of the other adjacent chamber, the mixer having provision for turbulently mixing the liquids entering the in-

lets, and means providing a substantial enlargement of the passage through which the mixed liquid flows to lower the velocity of the mixed liquid prior to its discharge through the outlet of the mixer into the corresponding chamber.

5 8. In countercurrent extraction apparatus having a succession of extraction chambers, each maintaining an upper layer and a lower layer of liquid, a mixer having an outlet to discharge into one of the chambers, inlets for the mixer connected with the upper layer of a chamber at one side and the lower layer of a chamber at the other side of the chamber into which the mixer discharges, means for pumping liquid into one of the inlets, means for injecting liquid into the other inlet by the flow of the first liquid to produce a turbulent mixing of the liquids, and means providing a substantial enlargement of the passage through which the mixed liquid flows to lower the velocity of the mixed liquid prior to its discharge through the outlet of the mixer into the corresponding chamber.

10 9. In countercurrent extraction apparatus having a succession of extraction chambers, each maintaining an upper layer and a lower layer of liquid, a plurality of mixtures, one for each of several of the chambers and having an outlet to discharge into its corresponding chamber, two inlets for each mixer connected respectively with the upper and lower layers of adjacent chambers, means for turbulently mixing the liquids introduced into the inlets, and means providing a substantial enlargement of the passage through which the mixed liquid flows to lower the velocity of the mixed liquid prior to its discharge through the outlet of the mixer into the corresponding chamber.

ARTHUR C. HAMPTON.

CERTIFICATE OF CORRECTION.

Patent No. 2,091,709.

August 31, 1937.

ARTHUR C. HAMPTON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 26, claim 9, for the word "mixtures" read mixers; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office. Signed and sealed this 12th day of October, A. D. 1937.

Henry Van Arsdale.
Acting Commissioner of Patents.

(Seal)