Nov. 18, 1941. B. G. ALDRIDGE 2,263,534

METHOD AND APPARATUS FOR MIXING FLUIDS

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Fig. 1.

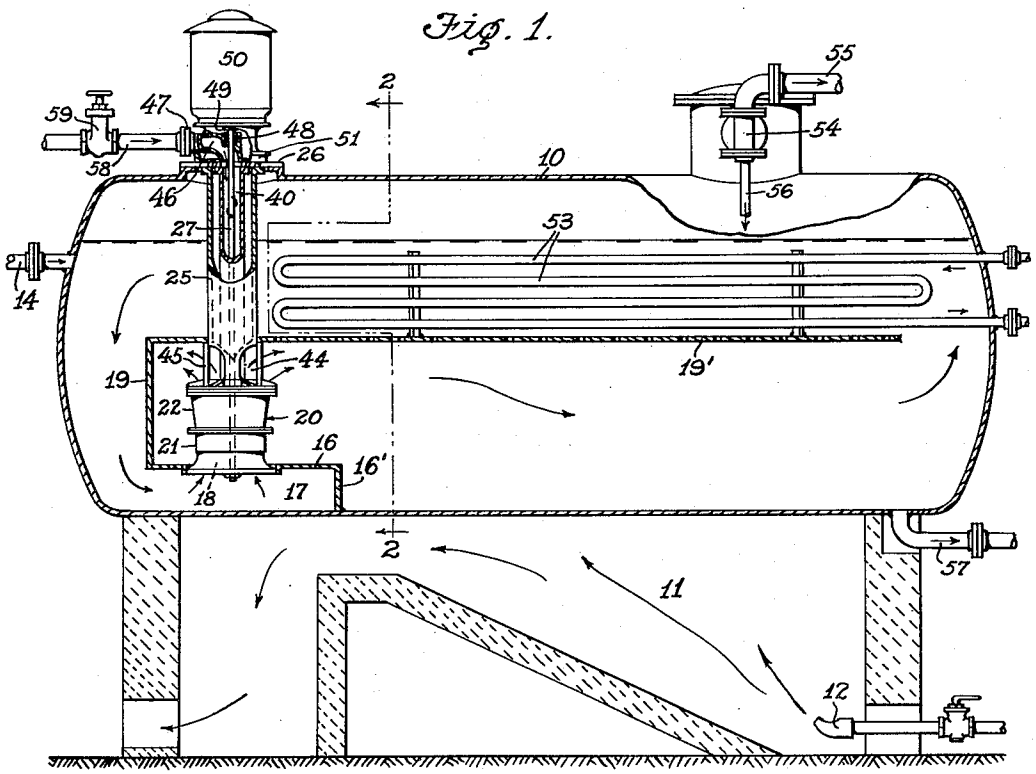


Fig. 3.

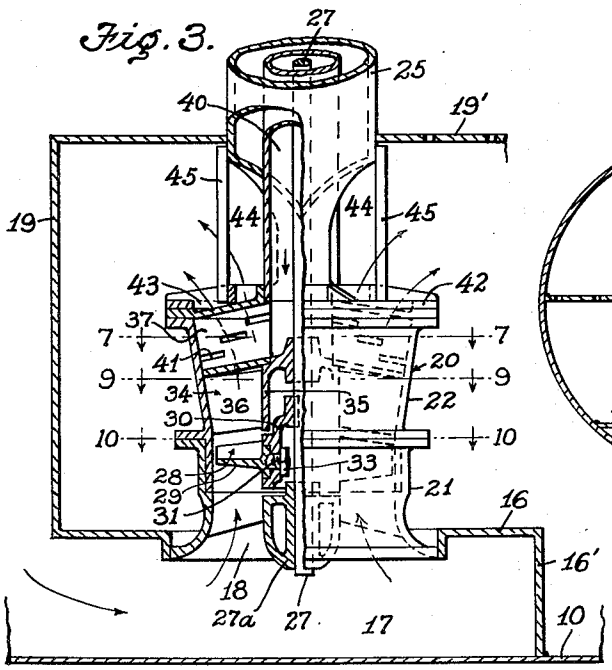
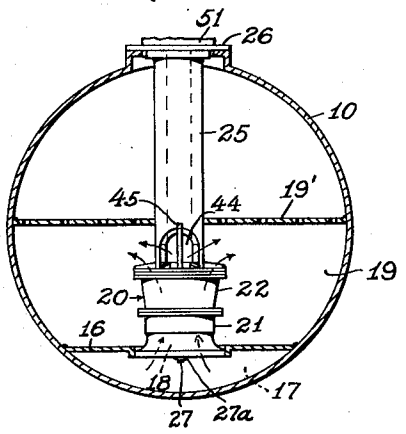


Fig. 2.



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Fig. 4.

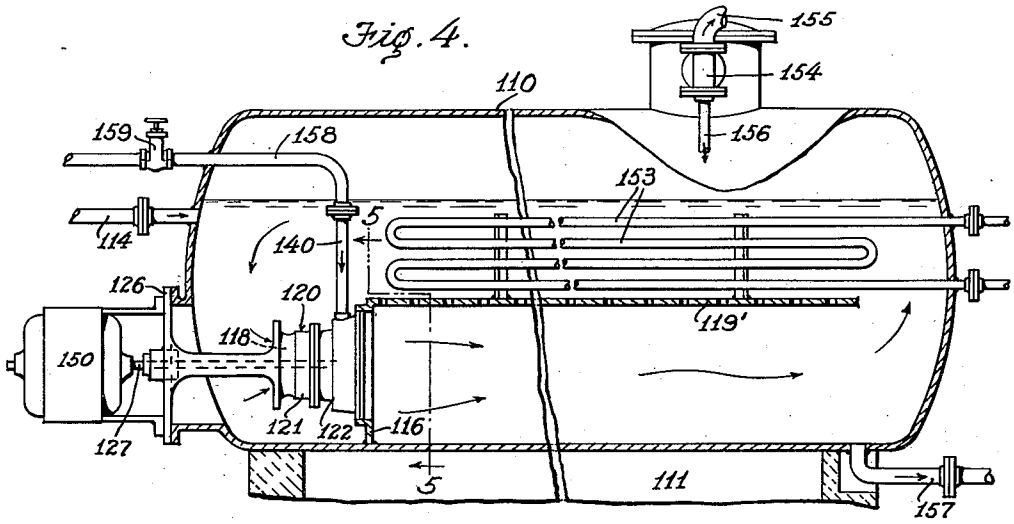


Fig. 5.

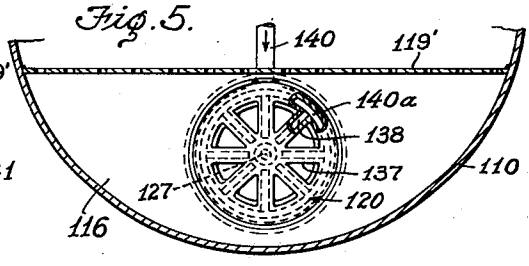


Fig. 6.

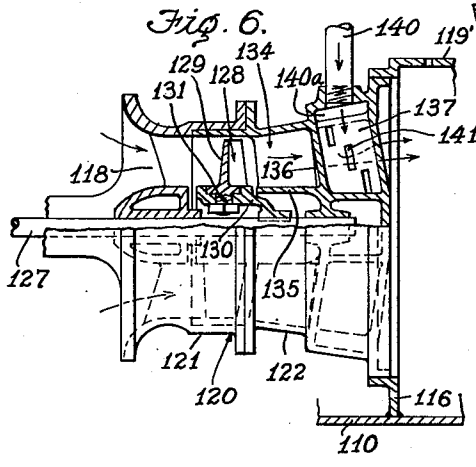


Fig. 9.

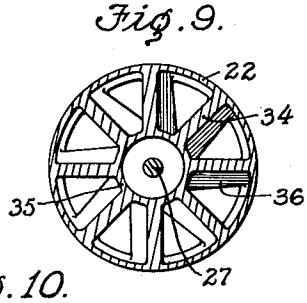


Fig. 8.

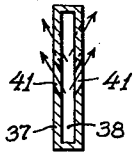


Fig. 7.

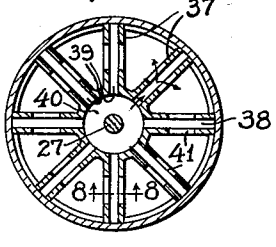
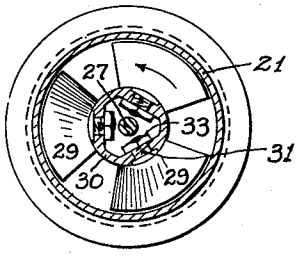


Fig. 10.



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UNITED STATES PATENT OFFICE

2,263,534

METHOD AND APPARATUS FOR MIXING FLUIDS

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Application December 17, 1938, Serial No. 246,413

8 Claims. (Cl. 196—74)

The present invention relates to the treatment of petroleum oils and, in particular, relates to a process and apparatus for the production of oxidized or air-blown asphalt.

The use of air and other oxygen-containing gases is well known in the art of producing oxidized asphalt. However, in the past, it has been impossible to produce oxidized asphalts of desired melting points, penetrations and ductilities which have high solubility in such solvents as carbon bisulfide, carbon tetrachloride and 86° gasoline. In these older methods, the penetration, melting point and ductility are not independently variable. If the melting point is increased, the penetration is decreased and the ductility is also decreased. This is due to the fact that the methods used cause some of the asphalt to become over-oxidized and part to be under-oxidized. Also, there is a considerable amount of distillation during the oxidation period. The air passes through the oil in large globules and is not intimately mixed with all of the oil. In such methods, the rate of oxidation must be fairly low, otherwise the temperature of the oil will rise too high, with the resultant low yield and poor quality of asphalt.

Also, in the manufacture of oxidized asphalt in the conventional spider and shell still, it has been found that the oxygen utilization is very poor and that the spent gases from the still will contain as high as 17% to 19% of oxygen showing only a 2% to 4% reduction in the oxygen content of the air employed. This high oxygen content in the spent gases allows the vapors in the vapor space of the still and the vapor lines to undergo oxidation and since the oxidation reaction is exothermic, this results in a rapid increase in temperature to as high as 700° F. in the vapor space of the still. This often leads to vapor explosions and consequent rupture of the still or explosion diaphragms built into the still. Also the oxidation in the vapor space of the still results in the formation and deposition of large quantities of carbonaceous materials in the still and in the vapor lines.

The use of vertical stills is also known in the art of air-blowing oils to produce asphalt. In this method of oxidation, a vertical still containing a column of oil is air-blown by introducing the air through an air distributing spider positioned at the bottom of the still. The air thus travels upwardly through the oil in the column oxidizing it as the air passes to the vapor space at the top of the column. By providing a column of oil of sufficient height and by regulating the rate of air introduction, fairly good utilization of oxygen is obtained. However, in this method of operation, it is difficult to obtain an even distribution of the air or an intimate admixture of the oil with the air with the result that even though a better oxygen utilization is obtained, part of the oil will be over-oxidized and part will be under-oxidized. Also, it has been found that upon completion of a run, the spiders are usually coated with carbonaceous and coke-like materials, particularly at the nozzle ends of the spiders.

It is one of the objects of my invention to provide a simple, efficient and economical process by which petroleum oils may be converted into asphaltic products of desired penetration, melting point, ductility and solubility in carbon bisulfide, carbon tetrachloride and 86° gasoline.

It is a further object of my invention to provide a process and apparatus whereby the various characteristics of penetration, melting point, ductility and solubility of asphalt may be controlled and varied independently and at will.

It is an important object of my invention to control the oxidation of oil to produce air-blown asphalt so as to obtain a uniformly oxidized asphalt.

It is another important object of my invention to control the oxidation of the oil so as to partially oxidize the oil by contacting it with oxygen-containing gas, to accomplish substantially complete use of the oxygen under controlled conditions to remove undesirable gaseous and vaporous products of reaction, to prevent oxidation of vapors in the vapor space of the oxidizing still and to prevent formation of carbonaceous and coke-like materials in the still.

It is a further important object of my invention to reduce the time necessary to air-blow asphalt to the desired grade.

Another important object of my invention is to permit the oil to remain in contact with the air for a longer period of time than is now possible in the conventional shell still.

Another object of my invention is to effect the oxidation reaction in a cyclic and continuous manner with a minimum power consumption.

Other objects of my invention will appear from the included description of preferred embodiments of my process appearing below.

I have found that it is possible to convert the ordinary shell still for oxidizing oils to produce air-blown asphalts into a unit which will permit a more uniform oxidation of the oil and a longer contact of the oil with the air. I have found it

to be possible to obtain some of the advantages of operations in a column still, such as a longer contact of the oil with the air so that more complete utilization of the oxygen in the air is obtained but I avoid the disadvantages of column still operation in that I effect a more intimate contact of the oil with the air and prevent the air from channeling in its upward passage through the oil. I also prevent the formation of carbonaceous and coke-like materials in the still, particularly at the air-mixing devices. According to my invention, the oil is initially intimately mixed with air or oxygen-containing gas and is allowed to remain in contact with the air for a period of time somewhat equivalent to the column still operation except that the oxidation is carried out in a horizontal shell still. At the same time, the oil is continuously circulated in the still in a cyclic manner, being returned to the mixing device where it is mixed with further quantities of air.

Briefly stated, therefore, my invention resides in intimately mixing the oil with air in a mixing device which also is adapted to circulate the oil and allowing the air to remain in contact with the oil, after it issues from the mixing device, for sufficient period of time to enable substantially complete utilization of the oxygen in the air, then allowing the air to separate from the oil and returning the oil to the mixing device for admixture with further quantities of air.

The admixture of oil with air and circulation of the oil may be accomplished by providing a pumping and mixing device at one end within a shell still and a baffle plate extending across the greater portion of the still, the discharge of the pumping device being located below the baffle plate so that the oil and air discharged from the pump must necessarily travel the length of the still before passing into the section of the still above the baffle plate. The suction of the pump is so arranged that the oil must travel back across the still above the baffle plate before being readmitted into the pump. Air is continuously admitted into the pump during the circulation of the oil across the still below the baffle plate and back across the still above the baffle plate to the pump. The body of oil in the still is maintained substantially above the baffle plate.

Thus with the circulation of the body of oil in the shell still in this manner, the rate of air introduction into the mixing device or pump may be regulated so that the ratio of oil to air passing through the pump may be accurately controlled to obtain substantially complete utilization of the oxygen before the air is liberated from the oil during its circulation in the still. In this respect, I have found that in order to reduce the oxygen content of the air to a value below about 12% by contact of the oil with air in a mixing device, it is necessary to circulate the oil through the mixing device at such a rate that the ratio of oil to air in the mixing device is approximately 10 to 50 gallons of oil per minute per cubic foot of air per minute. With this rate of circulation, it has been found that approximately 30% to 80% or more of the oxygen in the air is consumed by its admixture with the oil with an average of about 60% to 70% when the oil is circulated at a rate of about 30 gallons per cubic foot of air. In other words, with a circulation ratio of approximately 10 gallons of oil per minute to 1 cubic foot of air per minute, the oxygen content of the spent gases will be in the neighborhood of about 15% while at an oil circulation ratio of about 45 gallons per cubic foot of air per minute, the oxygen content of the spent gases will fall to as low a figure as 3% to 5% and even as low as 1% of oxygen.

With the present improvements, it is possible to reduce the circulation ratio somewhat and yet obtain substantially complete oxygen utilization during the oxidation reaction since part of the reaction occurs by the intimate admixture of the oil with the air in the mixing device and the remainder occurs during the travel of the oil across the still while in intimate admixture with the air.

By providing the baffle plate with perforations, any air liberating from the oil-air mixture issuing from the pump and mixing device may be allowed to pass upwardly through the perforations during the travel of the oil-air mixture across the still below the baffle plate. This liberated air will then contact the oil traveling back across the still above the baffle plate and then will provide for further contact with the oil before separating from the oil and passing into the vapor space of the still.

Various other objects, features and advantages of my invention will be better understood by those skilled in the art from the following description of my invention taken from the drawings in which:

Fig. 1 represents a diagrammatic view, partly in elevation and partly in longitudinal section through a still equipped with a vertically disposed pumping and mixing structure;

Fig. 2 is a section taken along line 2—2 of Fig. 1;

Fig. 3 represents a vertical sectional view, partly in elevation, of the circulating and mixing structure shown in the still of Fig. 1;

Fig. 4 represents a diagrammatic view, partly in elevation and partly in longitudinal section through a still equipped with a horizontally disposed pumping and mixing structure;

Fig. 5 is a section taken along line 5—5 of Fig. 4;

Fig. 6 represents a vertical sectional view, partly in elevation, of the circulating and mixing structure shown in the still of Fig. 4;

Fig. 7 is a section taken along line 7—7 of Fig. 1;

Fig. 8 is a section taken along line 8—8 of Fig. 7;

Fig. 9 is a section taken along line 9—9 of Fig. 1, and

Fig. 10 is a section taken along line 10—10 of Fig. 1.

In the drawings, 10 is a cylindrical shell still for containing the bulk supply of oil to be treated. Still 10 is positioned on a fire-box or furnace 11. Burner 12 is for the purpose of supplying heat to the fire-box 11. Line 14 serves to introduce the oil to be oxidized into the still 10. The lower interior of the still is provided with a horizontal baffle plate 16 which extends across a portion of the bottom of the still to form a passageway 17 for the oil to the section of the pump to be described. The baffle plate 16 is joined to a vertical plate 16' at one end adjacent the pump so that all oil entering the passageway must be drawn into the pump. The baffle plate 16 is joined at its other end with a vertical plate 19, the upper end of which in turn is joined with a horizontally disposed perforater plate 19'.

The passageway 17 leads to the section 18 of

a circulating and commingling pump which in the modification of my invention shown in Fig. 1, is preferably of the vertical type. The moving parts of the pump are enclosed in a housing 20 which consists of two sections 21 and 22 connected together by bolts or other suitable means. These sections are generally annular in shape. The housing 20 is suspended from a supporting pipe 25, the upper end of which is attached to a plate 26, bolted or otherwise united to the upper end of the still 10 in which the assembly is disposed.

A shaft 27 extends vertically through the diametric center of the supporting pipe 25 and of the housing 20. The lower end of the shaft is supported at the lower end of section 21 by means of a bearing 27a. Section 21 is also provided with the annular opening 18 comprising the suction opening of the pump. Within section 21 and substantially in its upper portion, shaft 27 is provided with a pumping device 28 which, as shown in Figs. 3 and 10, may be of the impeller type consisting of a plurality of blades 29 attached to a hub 30 which is actuated by the rotation of shaft 27. For the purpose of attachment of the blades 29, as well as to provide an impeller pump of a variable pitch type, the inner edges of the blades are equipped with bolts 31, these bolts passing through a hub 30 and being rigidly attached thereto as by means of nuts 33. It is thus clear that blades 29 may be rotated about the axis of their respective bolts to regulate the pitch of the impeller pump 28.

The lower portion of section 22, immediately above the pumping device 28 in section 21 comprises a stator section more particularly shown in Fig. 9, and adapted to force the upwardly moving liquid to flow in a direction substantially parallel to the axis of the pump. For this purpose, this lower portion of section 22 is provided with a plurality of radially disposed ribs 34 which extend between and are connected or otherwise attached to the inner walls of the section 22 and to a stationary hub 35 arranged substantially adjacent to the shaft 27. A plurality of vanes 36 are attached to the ribs 34. As stated, the purpose of vanes 36 is to deflect the stream of liquid pumped upwardly by impeller blades 29 and to cause the liquid to pass substantially vertically and axially with respect to the axis of the structure. For this purpose, vanes 36 are curved or arcuated as shown more specifically in Fig. 9, the upper portions or ends of said vanes 36, near their junction with ribs 34, being substantially vertical in configuration.

The upper part of section 22 is also provided with a plurality of ribs 37. These ribs also extend radially, as this is shown in Fig. 7, and they align with the upper edges of the aforementioned ribs 34. Ribs 37 are, however, hollowed, providing a space 38 therein. This space 38 communicates at 39 with an air-introducing pipe 40 extending axially within supporting pipe 25 and around shaft 27. Ribs 37 are also provided with a plurality of slots 41 communicating the interior 38 of said ribs with the space surrounding each of said ribs. Preferably, as shown more particularly in Fig. 8, these openings or slots 41 are drilled at an angle so that the air or other oxygen-containing gases, passing from space 38 outwardly, is ejected in an upwardly direction.

The upper end of section 22 is enclosed by a webbed plate 42, webs 43 of which are connected to the supporting pipe 25. To facilitate the discharge of the air-liquid mixture, the lower portion of pipe 25 is provided with ports or openings 44. Optionally, and only for the purpose of strengthening the structure, supporting elements 45 connect the webs 43 to pipe 25 on the two sides wherein pipe 25 is provided with the aforementioned ports 44.

As indicated in Fig. 1, the upper end of air-pipe 40 passes through plate 26 and communicates with a curved pipe or elbow 46 which terminates in a flange 47 to which is connected air and steam lines 58 controlled by valve 59. Shaft 27 passes through said curved pipe 46 and through a packing gland 48, the upper end of shaft 27 being attached directly or otherwise to shaft 49 of an actuating motor 50 supported by means 51 to the plate 26.

As shown in the drawings, the pumping, circulating and commingling structure is disposed in the still 10 preferably suspending from the top of the still, the lower end of the structure slidably fitting in an opening provided in the baffle plate 16. The still 10 is also provided with a cooling coil 53 through which may be circulated oil, water or other cooling fluid. The top of the still is provided with a reflux condenser 54 in the vapor outlet 55 which permits condensation of the heavier oils contained in the vapors and gases, the condensate returning to the still for oxidation via drain 56. The oxidized charge may be withdrawn from the still via line 57.

In operation, shaft 27 is rotated by motor 50 in the direction shown by the arrow (see Fig. 1). The pumping device of impeller 28 actuated by the rotation of shaft 27 causes the upward flow of the oil or other liquid entering section 21 through opening 18. By varying the pitch or angle of blades 29, it is possible to regulate the rate of inflow of the liquid into housing 20. The liquid thus pumped upwardly by the impeller 28 enters the lower portion of section 22, wherein it is forced to pass along the arcuated surfaces of blades or vanes 36. Due to the curvature of these vanes 36, the upwardly moving liquid is gradually forced to move in a path which is parallel to the axis of the pumping structure. Therefore, when the structure is disposed vertically, the liquid being lifted by the pump or impeller 28, will be flowing in a substantially vertical direction when it enters the upper part of section 22. During the passage through said upper part of section 22, the oil moves upwardly between the hollow ribs 37. Simultaneously, air or a similar oxygen-containing gas is conveyed downwardly through pipe 40, this air passing through the openings 39 into the interior 38 of the hollow ribs 37. This air then passes from 38 through ports 41 into the space between the ribs 37, thus coming into contact and commingling with the upwardly moving stream of liquid. Because of the slanting or angular position of ports 41, the air is caused to move upwardly and substantially in the direction of the flow of the liquid, thus aiding in the lifting of said liquid. The liquid-air mixture thus formed then passes through the webbed plate 42 (between the webs 43) and, after passing through openings or ports 44 in the lower portion of pipe 25, passes into the still below the horizontal plate 19' and passes horizontally across the still below the horizontal plate 19' and then back across the still above the plate 19' where it is cooled by contact with the cooling coils 53, and returns to the passageway 17, where it is drawn into the pump as afore-

mentioned. Thus, the oil discharged from the pump must necessarily travel approximately twice the length of the still into passageway 17 before it may be readmitted into the pump. During its travel from the pump under the perforated plate 19', the unused air, gases and vapors formed in the oxidation reaction passes upwardly through the perforations in the horizontal plate 19' into the space above the horizontal plate further contacting and oxidizing the oil above the perforated plate. The bulk of the air, however, being intimately mixed with the oil by the pumping structure, travels with the oil during its passage below the perforated plate and thus permits a longer contact with the oil before the air is liberated from the oil in the upper part of the still. The vapors and gases thus pass into the vapor space of the still and then pass to condenser 54 when the heavier oxidizable oils are condensed and returned to the still via drain 56. The remaining vapors and gases containing light oils and water may be passed via line 55 to a condenser (not shown) for the purpose of recovering the light oils.

It is thus seen that the liquid, such as, for example, an asphaltic oil to be oxidized, may be continuously recirculated or recycled through the above described structure, each particle of the oil coming into contact with air introduced through ports 41, and the mixture thus formed overflowing back into the still wherein the oil separates from the air. The provision of the straightening vanes and the introduction of the air through the ports 41 in ribs 37 eliminates a considerable amount of agitation. It has been found, however, that there is sufficient commingling of the oil with air to cause the necessary interaction or oxidation if an asphaltic oil is to be oxidized. Since no excessive agitation is necessary and because of the relatively short lift to which the oil is to be subjected, there is a considerable saving in energy, the impeller pump imparting to the oil entering through the suction of the pump only sufficient energy and/or velocity to cause its upward movement through the structure 20 and to a point above the webbed plate. Another advantage resides in the fact that the air may be introduced at a very low pressure. Thus, the angular arrangement or disposition of ports 41 in ribs 37 permits the upwardly moving stream of oil to create a partial vacuum within the hollow ribs 37, thus aiding in the injection of the air into the oil to be oxidized. Obviously, the velocity and pitch of the impeller blades 29 may thus be regulated for each individual case, the liquid receiving only enough energy for its travel through the structure.

It is also seen that I have in effect converted a horizontal shell still into one having the advantages of a vertical still in that the oil is permitted to be contacted with air for a sufficient period of time necessary to obtain substantially complete stabilization of the oxygen in the air before the air is liberated from the oil. By providing a travel of the oil-air mixture of about 25 feet below the perforated plate, that is, by making the perforated plate approximately 25 feet long from the discharge of the pump, complete stabilization of the oxygen in the air is assured in the space below the perforated plate and with the air which liberates from the oil-air mixture passing through the perforated plate further contacting the oil above the perforated plate, even the oxygen in this portion of the air is substantially completely utilized before passing into the vapor space of the still. Yet the process and apparatus corrects many of the disadvantages of the ordinary vertical still oxidation operations in that a more uniform oxidation is obtained and less coke is formed.

In operation, a hydrocarbon oil, preferably a residuum obtained by distilling off the lighter oils, such as kerosene and perhaps gas oils from an asphaltic crude oil, is introduced into the still 10 via line 14. When a certain amount of the charge is in the still, the pump 28 driven by shaft 27 and motor 50 is started and the oil in the still 10 is drawn from the passageway 17 through opening 18 in the suction side of the pump by impeller 29 which causes the oil to be whirled upwardly past the impeller. The oil then passes through the straightening vanes into the main body of oil in the still. The fire under the still is lighted and the oil is heated to an oxidation temperature, the temperature being controlled by burner 12. The oil is circulated until the required amount of oil has been introduced into the still through line 14 and until the required oxidation temperature has been reached.

As soon as the required amount of oil is charged into the still, the introduction is discontinued and air at an appropriate rate is admitted through line 58 controlled by valve 59 and pipe 40. The two fluids commingle (as described above) in section 22 of the structure 20, the mixture returning back into the still through the aforementioned openings. Cooling medium, such as steam, air, water or oil is circulated through cooling coil 53 in order to maintain the temperature of the contents in the still at about 425° F. to 475° F. preferably not over 475° F.

In still 10, the vapor and gases are separated from the oil as described previously and pass to condenser 54 where the heavier oxidizable oils are condensed and returned to the still via drain 56. The remaining vapors and gases containing light oils and water may be passed via line 55 to condensers for the purpose of recovering the light oils.

When the charge has been oxidized to the desired degree, the air introduction via pipes 58 and 40 is discontinued. The pump continues to circulate the charge in the still. Steam is then introduced through the lines 58 and 40 and the temperature of the charge is raised to about 490° F. to 500° F. The circulation at about 490° F. to 500° F. through the pump and mixing section above the impeller and back to the still is continued until the charge is brought to proper specifications. When the charge has been brought to proper specification, it may be withdrawn from still 10 via the drain 57 and passed to suitable storage.

In the modification shown in Figs. 4, 5 and 6, the pump assembly is disposed in a horizontal instead of a vertical position as previously described. The pump, however, is similar in construction to the vertical pumps of Figs. 1 to 3 and 7 to 10; in fact, the same reference characters are given to the similarly constructed and operated parts shown in Figs. 4, 5 and 6 as for those in Figs. 1 to 3 and 7 to 10 except that 100 has been added to the reference characters of Figs. 1 to 3 and 7 to 10. The positioning of the pump structure in a horizontal position necessitates a change in the air introduction into the pump. Instead of passing the air via a pipe 40 through openings 39 into the interior 38 of the hollow ribs 37 and then through ports 41 into the space between the ribs 37 where it contacts

with the stream of oil, the air now passes via a pipe 140 into the air annular chamber 140a, shown in Fig. 5, where the air distributes and passes through the interior 138 of the hollow ribs 137 and then through the ports 141 into the space between the ribs 137 where the air contacts with the oil.

A horizontally disposed perforated plate 119' is provided as in still 10 of Fig. 1 and is connected to a vertical plate 116 which is provided with air opening so that the lower end of the pump assembly may slidably fit into the plate 116.

In operation, shaft 127 is rotated by motor 150 which rotates the impeller 128 causing a horizontal flow of the oil entering section 121 through the opening 118. The liquid thus pumped enters the forward portion of section 122 wherein it is freed to pass along the arcuated surfaces of blades or vanes 136. Due to the curvature of the vanes, the liquid is gradually forced to move in a path which is parallel to the axis of the pumping structure. Therefore, with the structure disposed horizontally, the liquid being pumped by the impeller 128 will flow in a substantially horizontal direction when it enters the rearward portion of section 122. During the passage of the oil through section 122, the oil moves horizontally between the hollow ribs 137. Simultaneously, air or a similar oxygen-containing gas is conveyed downwardly through the pipe 140, this air passing into the annular chamber 140 and thence into the interior 138 of the radial hollow ribs 137. The air then passes through the ports 141 into the space between the ribs 137, thus coming into contact and commingling with the horizontally moving stream of liquid. The liquid-air mixture thus formed then passes into the still in the space below the horizontal plate 119' flowing across the still to the outer end of the plate 119'. The oil then flows upwardly and back across the still in the space above the horizontal plate 119' and is returned to the pump.

Any air and vapor liberating from the oil during its passage below the horizontal plate passes upwardly through the perforations in the plate and contacts the oil above the plate and then passes into the vapor space of the still from which it is removed.

The above description of my invention is not to be considered as limiting but only as illustrative of the invention since many changes and modifications thereof will be apparent to those skilled in the art within the scope of the following claims.

I claim:

1. An apparatus for mixing liquids with gases which comprises a horizontal chamber, a horizontally disposed baffle plate within said chamber, a pumping and liquid-gas mixing means positioned at one end of said chamber below said baffle plate and adapted to circulate an oil-air mixture across said chamber below said baffle plate and across said chamber above said baffle plate back to said pumping and mixing means and means for introducing gas into said pumping and mixing means.

2. An apparatus for mixing liquids with gases which comprises a horizontal chamber, a horizontally disposed baffle plate within said chamber, a pump within said chamber having its suction and discharge sides below said baffle plate, said pump being positioned at one end of said chamber and adapted to circulate liquid in said chamber horizontally across said chamber below said baffle plate, upwardly into the space above said baffle plate, then horizontally back across said chamber above said baffle plate and downwardly into the space below said baffle plate to the suction of said pump and means for introducing a gas into said pump for admixture with the liquid circulated by said pump.

3. An apparatus for mixing liquids with gases which comprises a horizontal chamber, a horizontally disposed perforated baffle plate within said chamber, a pump within said chamber having its suction and discharge sides below said baffle plate, said pump being positioned at one end of said chamber and adapted to circulate liquid in said chamber horizontally across said chamber below said baffle plate, upwardly into the space above said baffle plate, then horizontally back across said chamber above said baffle plate and downwardly into the space below said baffle plate to the suction of said pump and means for introducing a gas into said pump for admixture with the liquid circulated by said pump.

4. A method for oxidizing oil which comprises providing a body of oil in a horizontal chamber provided with a horizontal baffle plate in the body of said oil, initially commingling an oxygen-containing gas with the oil at one end of said chamber and below said baffle plate and thereby subjecting said oil to oxidation with said oxygen-containing gas, passing said mixture of oil and oxygen-containing gas horizontally to the opposite end of said chamber and below said baffle plate, separating gases and vapors from said oil in the space above said baffle plate and returning said oil for commingling with additional quantities of oxygen containing gas.

5. A method for oxidizing oil which comprises providing a body of oil in a horizontal chamber provided with a horizontal baffle plate in the body of said oil, circulating said oil substantially horizontally from one end of said chamber below said baffle plate to the opposite end of said chamber below said baffle plate, then upwardly into the space above said baffle plate at said opposite end of said chamber, then substantially horizontally above said baffle plate in the direction opposite to said circulation below said baffle plate and then downwardly to said initial point of circulation, commingling an oxygen-containing gas with said oil at said initial point of circulation for contact with said oil during said circulation below said baffle plate and separating gases and vapors from said oil in the space above said baffle plate.

6. A method for oxidizing oil which comprises providing a body of oil in a horizontal chamber provided with a horizontal baffle plate in the body of said oil, circulating said oil substantially horizontally from one end of said chamber below said baffle plate to the opposite end of said chamber below said baffle plate, then upwardly into the space above said baffle plate at said opposite end of said chamber, then substantially horizontally above said baffle plate in the direction opposite to said circulation below said baffle plate and then downwardly to said initial point of circulation, commingling an oxygen-containing gas with said oil at said initial point of circulation for contact with said oil during said circulation below said baffle plate, separating gases and vapors from said oil in the space above said baffle plate and cooling said oil during its circulation above said baffle plate.

7. A method for oxidizing oil which comprises

providing a body of oil in a horizontal chamber provided with a horizontal perforated baffle plate in the body of said oil, circulating said oil substantially horizontally from one end of said chamber below said baffle plate to the opposite end of said chamber below said baffle plate, then upwardly into the space above said baffle plate at said opposite end of said chamber, then substantially horizontally above said baffle plate in the direction opposite to said circulation below said baffle plate and then downwardly to said initial point of circulation, commingling an oxygen-containing gas with said oil at said initial point of circulation for contact with said oil during said circulation below said baffle plate, separating a portion of said oxygen-containing gas during said circulation below said baffle plate and passing said separated gas through the perforations in said baffle plate into the body of oil circulated above said baffle plate and separating gases and vapors from the oil in the space above said baffle plate.

8. A method for oxidizing oil which comprises providing a body of oil in a horizontal chamber provided with a horizontal perforated baffle plate in the body of said oil, circulating said oil substantially horizontally from one end of said chamber below said baffle plate to the opposite end of said chamber below said baffle plate, then upwardly into the space above said baffle plate at said opposite end of said chamber, then substantially horizontally above said baffle plate in the direction opposite to said circulation below said baffle plate and then downwardly to said initial point of circulation, commingling an oxygen-containing gas with said oil at said initial point of circulation for contact with said oil during said circulation below said baffle plate, separating a portion of said oxygen-containing gas during said circulation below said baffle plate and passing said separated gas through the perforations in said baffle plate into the body of oil circulated above said baffle plate, separating gases and vapors from the oil in the space above said baffle plate and cooling said oil during its circulation above said baffle plate.

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