June 18, 1940. E. W. GARD ET AL 2,205,090

APPARATUS FOR MIXING FLUIDS

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Fig. 1.

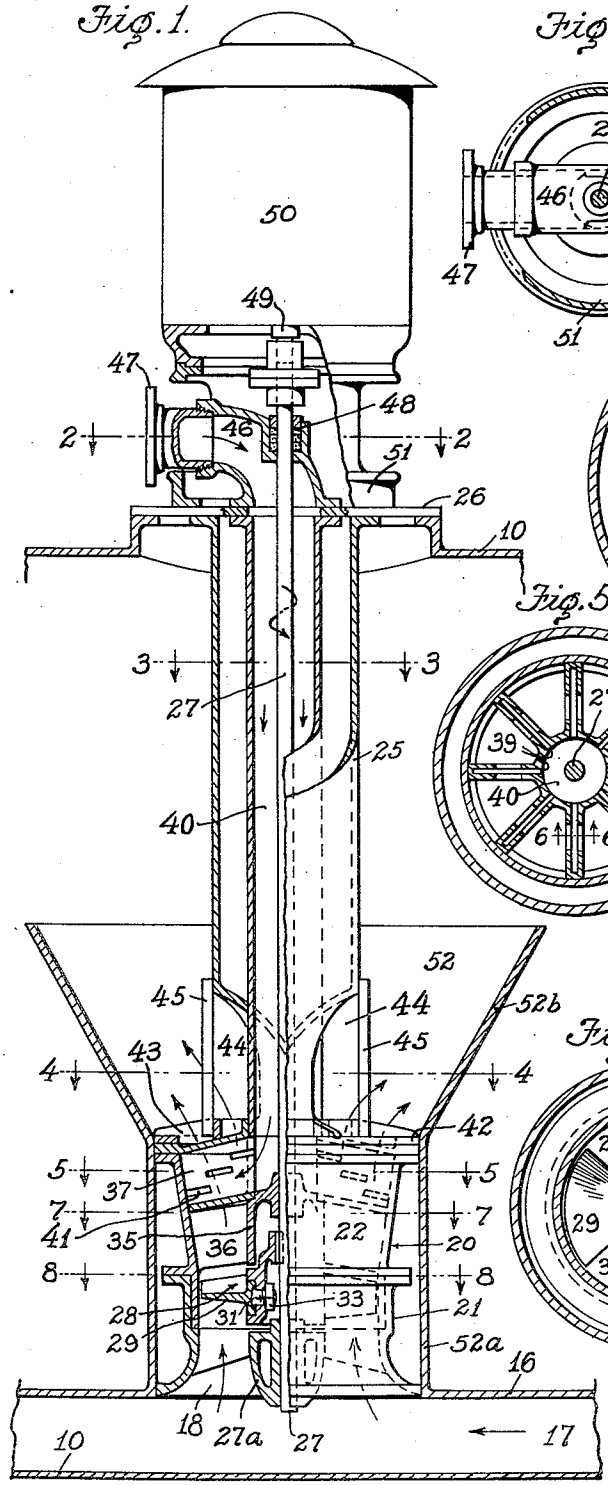


Fig. 2.

Fig. 3.

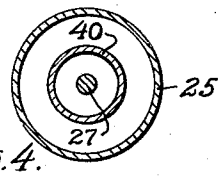


Fig. 4.

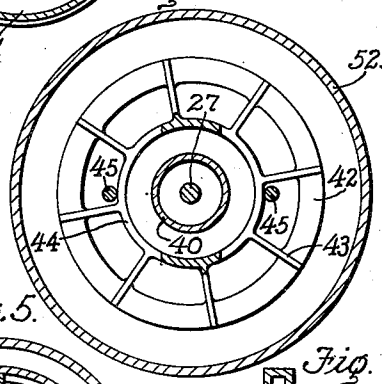


Fig. 5.

Fig. 6.

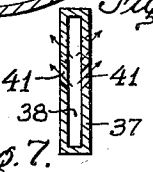


Fig. 7.

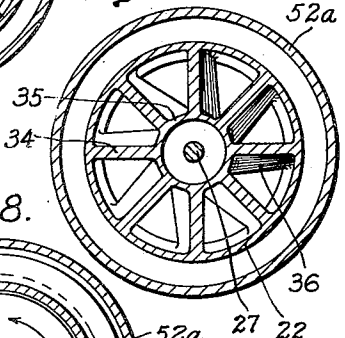
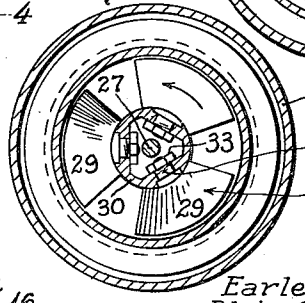


Fig. 8.



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Fig. 9.

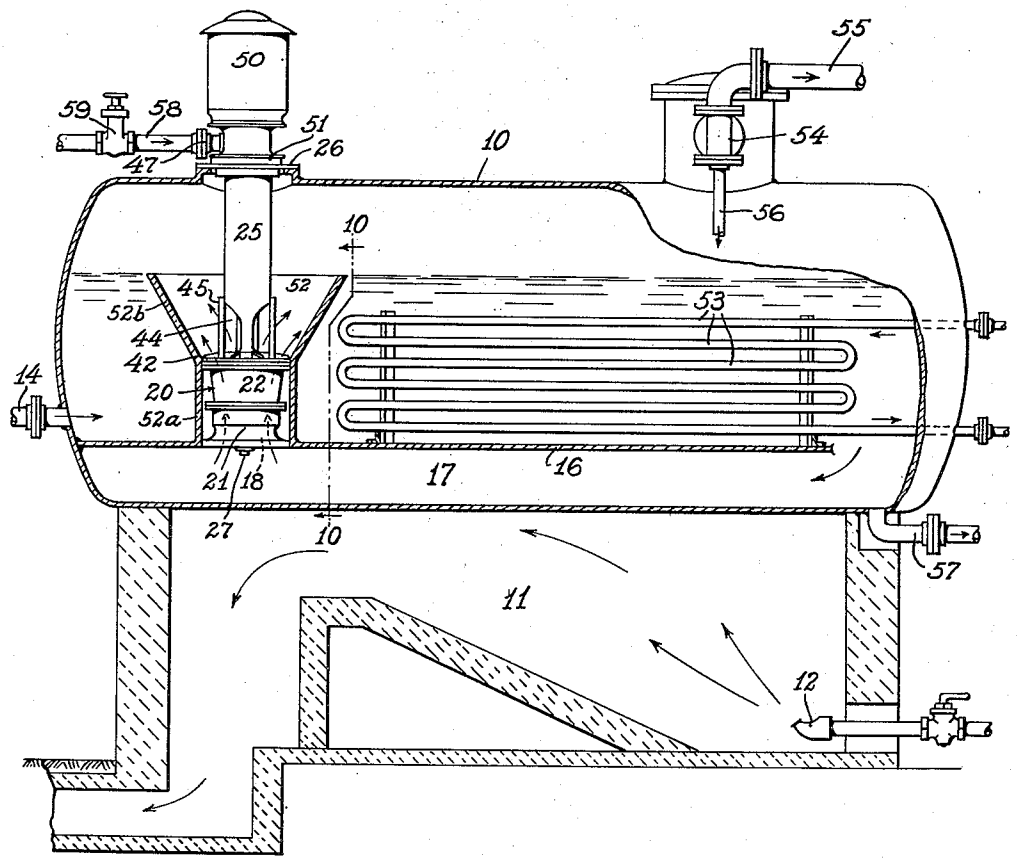
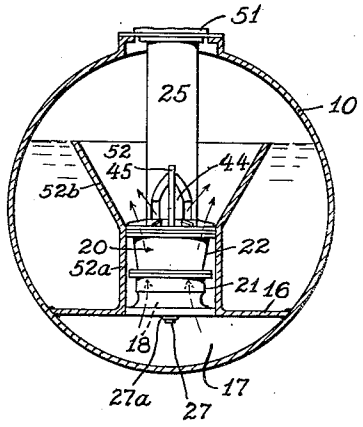


Fig. 10.



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APPARATUS FOR MIXING FLUIDS

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Application December 17, 1938, Serial No. 246,412

4 Claims. (Cl. 261—93)

The present invention relates to apparatus for the treatment of petroleum oils and in particular, relates to the production of oxidized or air-blown asphalt. This invention also relates to efficient apparatus for carrying out processes of oxidation. This application is a continuation in part of our copending application, Serial No. 217,452, filed July 5, 1938.

The use of air and other oxygen-containing gases are well known in the art of producing oxidized asphalt. However, in the past it has been impossible to produce oxidized asphalts of desired melting point, penetration and ductilities which have high solubility in such solvents as carbon bisulfide, carbon tetrachloride and 80° 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 at 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.

We have found by circulating the oil to be oxidized in the still at a fairly high rate that the oxygen utilization is more complete with the result that the oxidation in the vapor space of the still and the deposition of carbon materials are greatly minimized.

In our copending application, Serial No. 154,606, filed July 20, 1937, we have described such a method of circulation of the oil in the still. In this application, we have provided a vertical impeller pump within the still and at one end thereof, which draws oil from the bottom of the still and circulates it to the top in a continuous manner. Simultaneously with the circulation of the oil, air or other oxygen containing gas is introduced into a spider provided within the pump. The air thus intimately commingles with the oil in the pump and then the oil passes into the main body of oil in the still where the air is separated and the oil maintained at a controlled temperature by cooling coils provided in the bulk of the oil in the still.

This system of oxidation is a vast improvement over the older methods of oxidation. However, the provision of the pump within the still and particularly, at one end of the still appears to vibrate the still when the pump is in operation. Apparently, the force of the oil and air as it is discharged from the pump, usually below the level of the main body of the oil in the still, causes the oil to surge back and forth in the still. This surging of the oil is perhaps the main cause for the vibration of the unit. In other words, there is an unbalanced condition in the still.

Also, when the air and oil is discharged from the pump, the force resulting thereby causes the oil to splatter in all directions, a considerable amount of the oil adhering to the portion of the inner surfaces of the still above the oil level. These oil droplets soon carbonize and coke due to the high temperatures maintained in the still and it is not unusual to find upon completion of a run, large amounts of coke deposited in the still. Some of these coke-like materials drop into the main body of the oil either by the vibration of the still, as aforementioned, or by the further splashing of oil or both with the result that a poorer quality of air-blown asphalt is produced.

It is, therefore, one of the main objects of our invention to correct the aforementioned unbalanced condition set up in the still resulting in the vibration of the still and to provide a balanced vibration in the unit during the operation of the pump employed to circulate the oil.

It is another important object of our invention to eliminate the formation and deposition of carbonaceous material in the still resulting from the coking of oil droplets splatter on the unexposed surfaces in the still. It is our object to confine the splashing of the oil in the still so

that the surface upon which the splashing takes place is continuously washed free of the oil droplets before they are coked into insoluble products.

Another object of our invention is to provide a simple, efficient and economical apparatus by which petroleum oils may be converted into asphaltic products of desired penetration, melting point, ductility and solubility and to control these various characteristics and to vary them independently and at will.

Another object is to control the oxidation of oil to produce a uniformly oxidized asphalt.

Another object is to control the oxidation of the oil and to accomplish substantially complete use of the oxygen and to prevent oxidation in the vapor space of the oxidizing still.

The above and other objects of our invention may be obtained by providing a pump of the vertical impeller type within the still so that the oil is caused to travel from the bottom of the still through the pump in a vertical upward direction. The pump is provided with a line for introducing air or other oxygen containing gas into the pump at a point above the impeller blades of the pump. A discharge means is also provided in the pump so that the air and oil after commingling in the pump are discharged from the pump preferably below the oil level in the still. The still and pump is provided with a structure which is adapted to prevent the surging of the oil in the still when the air and oil is discharged from the pump. Specifically, this structure comprises a funnel-shaped element which encloses the lower end of the pump so that the oil and air discharged from the pump must pass into the truncated portion of the funnel-like element before passing into the main body of oil in the still. The upper edge of the funnel element is preferably maintained at or below the oil level in the still so that the funnel is maintained full of oil during the discharge of oil-air mixture from the pump. The funnel element is attached to the still preferably to a baffle plate which in turn is attached to the lower part of the still. The pump assembly is preferably suspended from the top of the still and slidably fits in the cylindrical portion of the funnel-like member.

By thus isolating the pump from the bulk of the oil in the still, the oil and air is caused to travel upwardly in the conical section of the funnel-like member without exerting forces on the main body of oil which ordinarily cause the oil to surge back and forth in the still resulting in setting up of vibrations.

Also, any splashing occurring by the discharge of the oil and air from the pump into the still is confined to a smaller area at the top of the still so that this area will be continuously washed free of the oil by subsequent splashings before the droplets are given any opportunity to carbonize into coke-like materials.

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

Fig. 1 represents a vertical sectional view, partly in elevation, of a circulating and mixing structure and includes a vertical section of the funnel-shaped structure;

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

Fig. 3 is a section taken along line 3—3 of Fig. 1;

Fig. 4 is a section taken along line 4—4 of Fig. 1;

Fig. 5 is a section taken along line 5—5 of Fig. 1;

Fig. 6 is a section taken along line 6—6 of Fig. 1;

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. 1;

Fig. 9 represents a diagrammatic view, partly in elevation and partly in longitudinal section through a still equipped with a vertically disposed pumping and mixing structure of the type shown in Fig. 1; and

Fig. 10 is a cross-sectional view taken along line 10—10 of Fig. 9.

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 the bottom of the still and forms a passageway 17 for the oil to the suction of the pump to be described.

The passageway 17 leads to the suction 18 of a circulating and commingling pump which 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 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. 1 and 8, 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. 7 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 26 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. 7, 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. 5, 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. 6, 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.

The pumping, circulating and commingling structure is provided with a funnel-shaped element 52, the lower portion of which is a cylindrical tube 52*a* which slidably fits over the lower section 21 of housing 20. The upper section 52*b* of the element 52 is shaped similar to a truncated cone. The point where the upper end of the cylindrical tube joins with the smaller end of the truncated cone is preferably disposed near the upper end of section 22 of housing 20. The lower end of the element 52 is fastened as by welding to the baffle plate 16. The funnel-shaped element is welded to the baffle plate before the pumping structure is surrounded in the still. The height of the truncated section of the element should preferably be above the discharge of the pump so that the oil discharged from the pump will travel upwardly some distance in the cone before being passed into the main body of oil in the still. The funnel-shaped element thus separates the pump from the bulk of oil in the still and confines the products discharged from the pump to only a small portion of the contents in the still. By the provision of the funnel-shaped member, the forces set up by the discharge of air and oil from the pump are also confined in the funnel with the result that agitation of the main body of oil with consequent surging back and forth in the still is entirely eliminated. Also, any splashing of oil resulting from the discharge of oil and air from the pump is confined to only the surfaces immediately above the funnel-like member with the result that sufficient liquid is provided by subsequent splashings to wash the oil adhering to the surfaces free from oil before opportunity is had for carbonization into insoluble coke-like substances.

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 the lower portion of the funnel at the point where the lower edge of the funnel joins with 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, overflows into conical portion of the funnel-shaped element 52 and then into the still from which the liquid was originally withdrawn from passageway 17 through opening or suction 18. The oil discharged from the pump must necessarily travel the length of the still into passageway 17 before it may be readmitted into the pump.

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 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 the 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 and the funnel-shaped element. 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. A further advantage of the present structure resides in the fact that the air inlet line is constructed and arranged so that it is not necessary to work within the still when it is desired to remove the structure, as, for example, for repairing the structure. The axial disposition of the air conduit **40**, as well as the provision of the bent pipe or elbow **46** and of flange **47** permits the withdrawal of the structure by a simple disconnecting of the air-pipe at flange **47**. Obviously, plate **26**, supporting the structure must also be released from still **10** when such removal is contemplated.

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 **36** and into the funnel overflowing 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. The level of oil in the still is preferably maintained substantially at or above the upper edge of the funnel.

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 425–475° F., preferably not over 475° F.

In still **10**, the vapors and gases are separated from the oil 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 (not shown) 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 490–500° F. The circulation at about 490–500° 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.

The foregoing description of our 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.

We claim:

1. A fluid mixing apparatus including a motor, a rotary shaft driven by said motor, a casing around said shaft, a rotary fluid propeller mounted on the end of said shaft and within said casing and adapted to receive a fluid and to discharge it into said casing at a relatively low velocity head, arcuated vanes within said casing and adjacent the discharge side of said propeller adapted to cause the fluid to flow in a direction substantially parallel to the axis of said shaft and casing, a plurality of hollow ribs disposed radially with respect to the axis of the shaft, said ribs being provided with openings communicating the interior of said hollow ribs with the exterior thereof, discharge means and a funnel shaped element having its smaller opening in communication with said discharge means.

2. A fluid mixing apparatus including a motor, a rotary shaft driven by said motor, a casing around said shaft, a rotary fluid propeller mounted on the end of said shaft and within said casing and adapted to receive a fluid and to discharge it into said casing at a relatively low velocity head, arcuated vanes within said casing and adjacent the discharge side of said propeller adapted to cause the fluid to flow in a direction substantially parallel to the axis of said shaft and casing, and a plurality of hollow ribs disposed radially with respect to the axis of the shaft, openings in the sides of said ribs communicating the interior of said hollow ribs with the exterior thereof, said openings being disposed at an angle with respect to the sides of said ribs, whereby the second fluid is introduced from the interior of said ribs through said openings and into the first fluid substantially parallel to the axis of the shaft, thereby aiding in the moving of the first fluid and also causing said fluids to be intimately commingled, discharge means and a funnel shaped element having its smaller opening in communication with said discharge means.

3. A fluid mixing apparatus including a tank adapted to receive a mixture of fluids, a motor mounted on said tank, a rotary shaft driven by said motor and extending into said tank, a rotary fluid propeller mounted on said shaft near the lower end thereof and adapted to receive a fluid and to discharge it at a relatively low velocity head, a stationary casing adapted to receive said fluid, arcuated vanes within said casing and disposed radially with respect to the pump shaft and adapted to receive said fluid and to cause it to move substantially vertically and parallel to the axis of said shaft, a fluid inlet pipe axially disposed around the pump shaft, a plu-

rality of radially arranged hollow ribs communicating with said pipe, and openings in the sides of said ribs communicating the interior of said hollow ribs with the exterior thereof, said openings being disposed at an angle with respect to the sides of said ribs whereby the second fluid is introduced from said pipe and the interior of said ribs through said openings and into the first fluid substantially parallel to the axis of the shaft, discharge means adapted to discharge the mixed fluids into said tank for recirculation and a funnel shaped element having its smaller opening in communication with said discharge means.

4. A fluid mixing apparatus including a tank adapted to receive a mixture of fluids, a motor mounted on said tank, a rotary shaft driven by said motor and extending into said tank, a rotary fluid propeller mounted on said shaft near the lower end thereof and adapted to receive a fluid and to discharge it at a relatively low velocity head, a stationary casing adapted to receive said fluid, arcuated vanes within said casing and disposed radially with respect to the pump shaft and adapted to receive said fluid and to cause it to move substantially vertically and parallel to the axis of said shaft, a fluid inlet pipe axially disposed around the pump shaft, a plurality of radially arranged hollow ribs communicating with said pipe, and openings in the sides of said ribs communicating the interior of said hollow ribs with the exterior thereof, said openings being disposed at an angle with respect to the sides of said ribs whereby the second fluid is introduced from said pipe and the interior of said ribs through said openings and into the first fluid substantially parallel to the axis of the shaft, and wherein the discharge openings communicates with an arcuated baffle within the tank, said baffle being adapted to receive the discharged fluids and to return said fluids into the tank without substantial vibration of the mixing apparatus, discharge means adapted to discharge the mixed fluids into said tank for recirculation and a funnel shaped element having its smaller opening in communication with said discharge means.

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