

June 24, 1930.

C. D. MILLER

1,768,209

METHOD AND APPARATUS FOR RECLAIMING LUBRICATING OIL

Filed Dec. 17, 1927

4 Sheets-Sheet 1

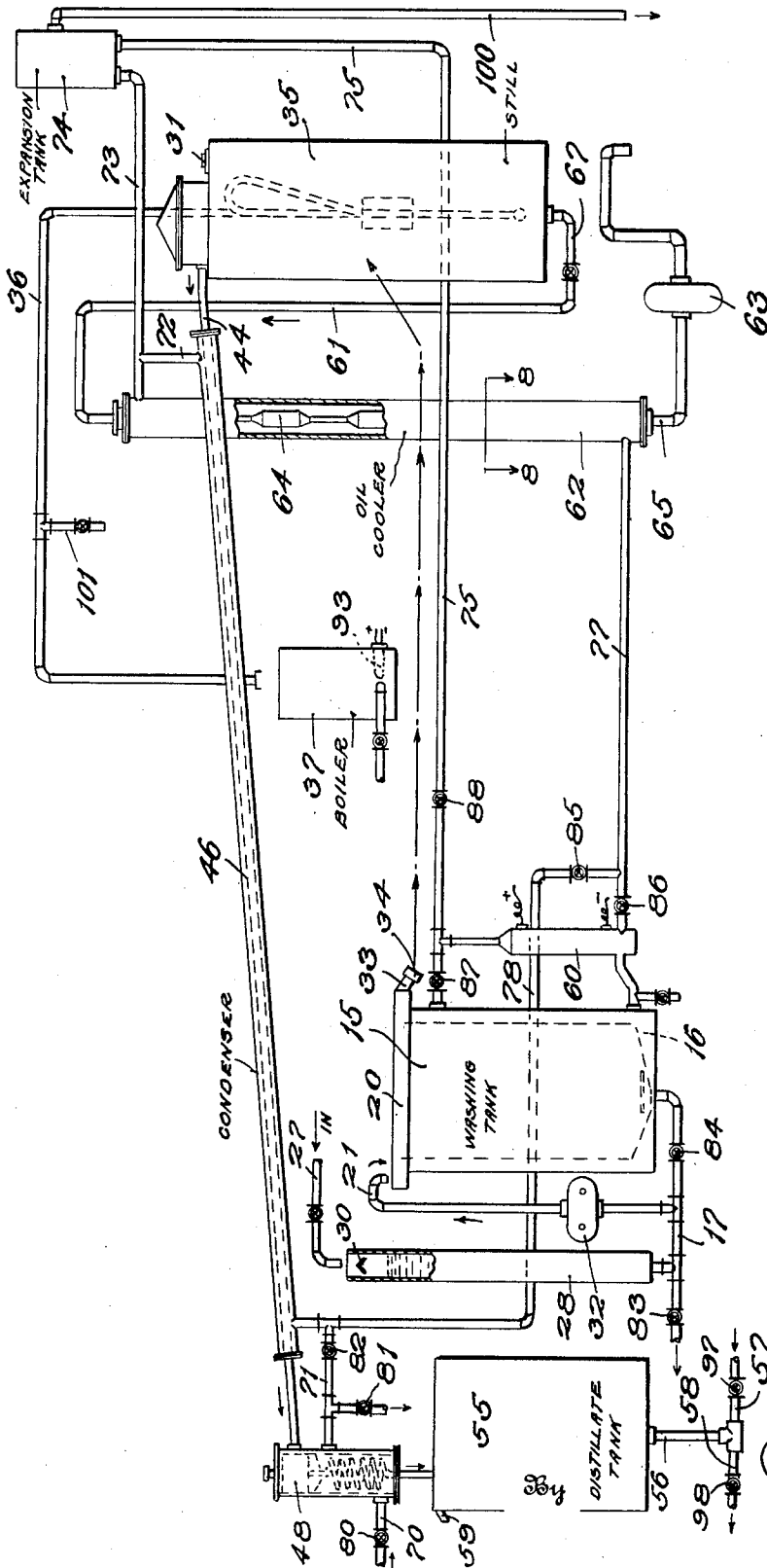


Fig. 1.

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June 24, 1930.

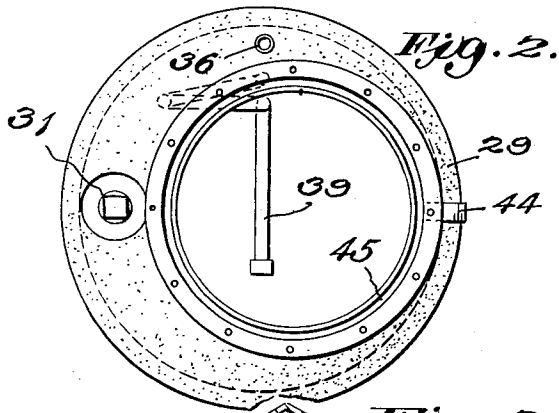
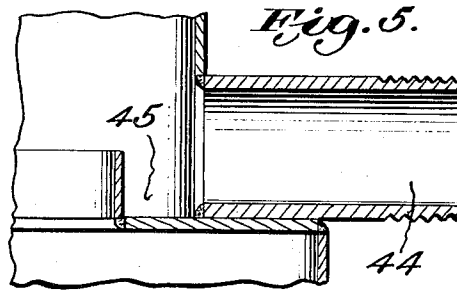
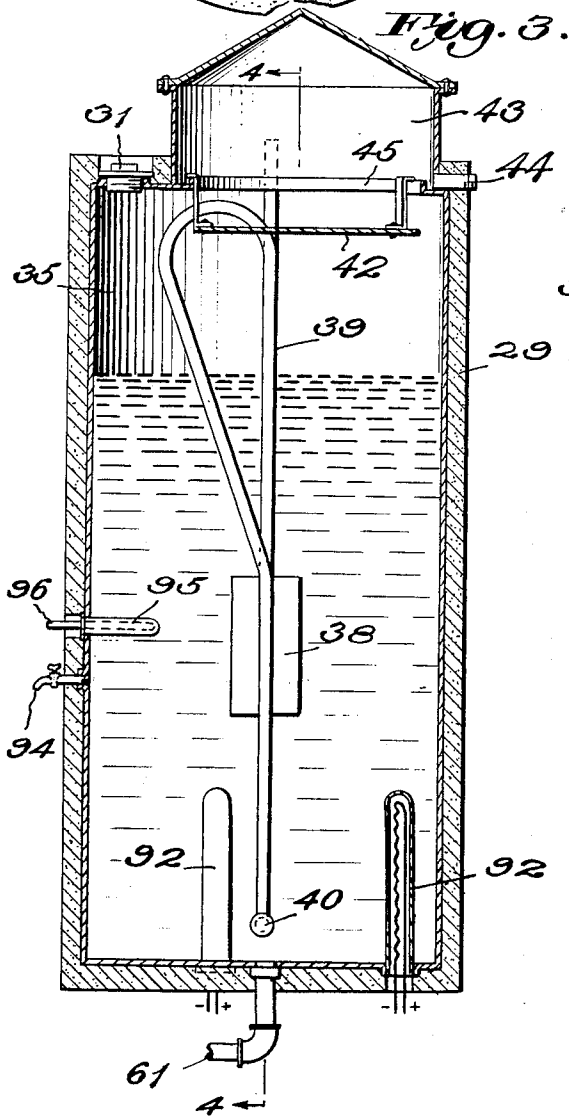
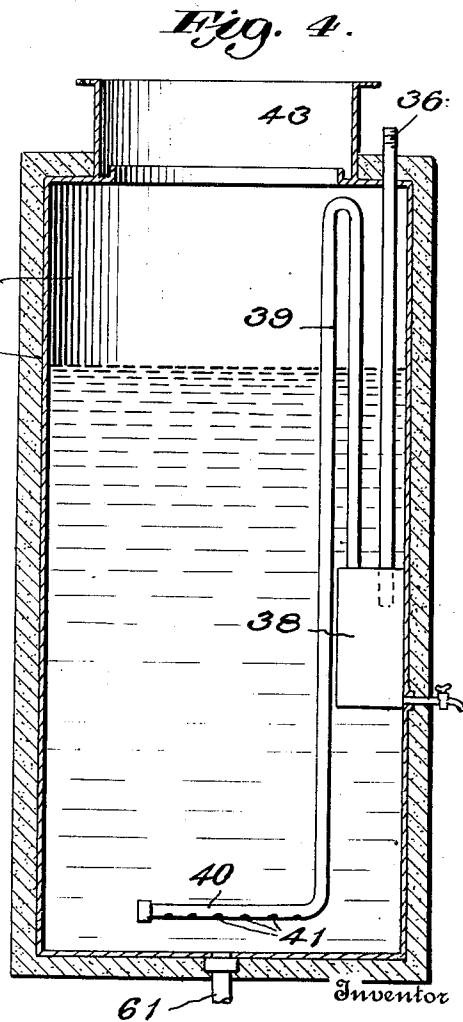
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METHOD AND APPARATUS FOR RECLAIMING LUBRICATING OIL

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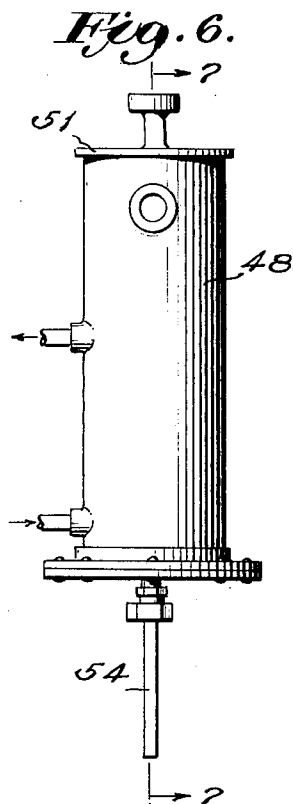
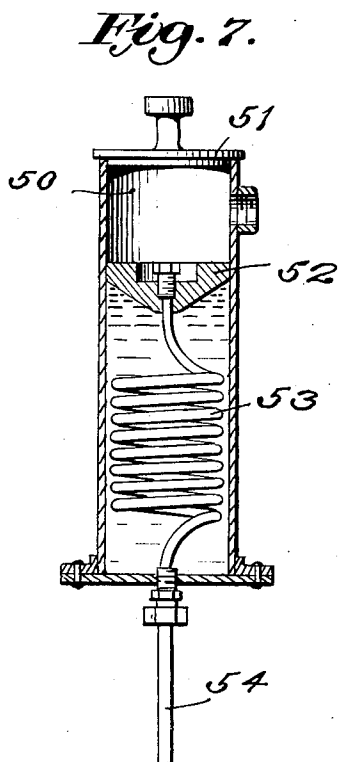
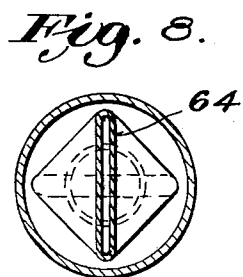
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METHOD AND APPARATUS FOR RECLAIMING LUBRICATING OIL

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4 Sheets-Sheet 3



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Fig. 9.

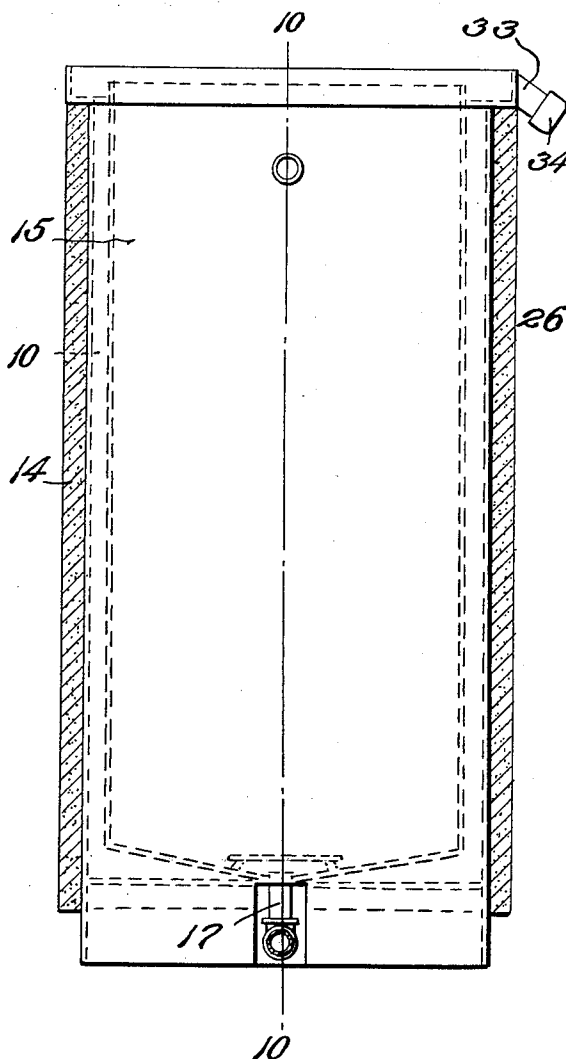
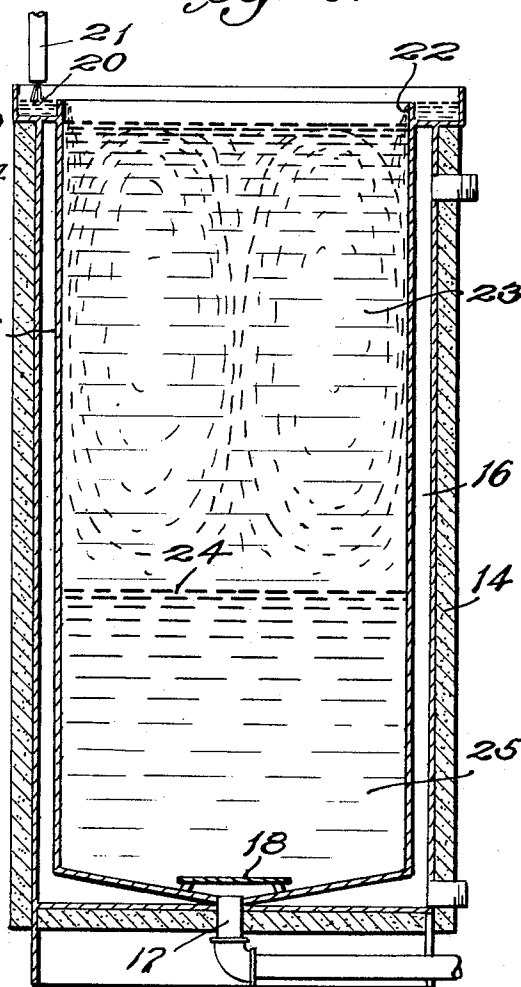


Fig. 10.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR RECLAIMING LUBRICATING OIL

Application filed December 17, 1927. Serial No. 240,842.

The present invention relates to the reclaiming of used lubricating oil drained from automobile crankcases and similar engines, and aims to provide an improved method and apparatus whereby such oil may be put in condition for further use.

It is now fairly well established that such oil is largely lubricating oil of unimpaired quality. Such chemical breakdown of the oil as occurs in service is a breakdown of the weaker constituents, rather than of the stronger, and is so complete that the resulting products are not oil at all, and can be separated from the remaining oil along with other foreign matter, solid and liquid, that is taken up by the oil during service. The problem of reclaiming this oil is therefore simply one of effecting a physical separation of the foreign matter from the oil.

Various methods have been proposed for effecting this separation, such methods generally comprising a step wherein the solid matter is removed from the oil by washing, and a second step wherein liquid impurities are removed by distillation.

This general procedure is followed in the present invention, but certain differences occur in the manner of executing the steps thereof. In the washing step, it has been customary to mix a solution of soap or washing powder with the oil to be cleaned, agitating the mixture in order to expose all of the oil to the action of the washing solution. When this is done, however, the difficulty occurs that the oil and wash water form an emulsion which is practically impossible to break down, so that the oil itself is largely lost in the emulsion. In the present invention, the oil and washing solution are brought into thorough contact with each other without, however, forming an emulsion, with the result that all the solid matter can be separated from the oil in an open tank without difficulty, the method being effective to remove all the solid matter, from the finest carbon or metal particles to nails, bolts and pieces of cloth and waste.

As to the theory of the washing process, the following may be said: The solid particles, such as carbon particles, apparently

adsorb the oil and are thereby held to an extent in suspension, so that allowing the oil to stand will not result in settling out these particles satisfactorily. The film of adsorbed oil may, however, be replaced by the washing solution, even though these liquids themselves do not mix. That is, the washing solution will, under suitable conditions, force its way to the surface of the solid particle and displace the film of oil adhering thereto, the carbon particle being thereby loaded down by a coating of washing solution and caused to sink faster than it would by its own weight alone. Most important, however, the carbon particles when impregnated with the washing solution will stick together when they come in contact, forming comparatively large agglomerations that sink much more rapidly than the particles will sink separately. These agglomerations settle through the oil, forming a layer of black sludge at the bottom thereof, the oil above this layer being thereby entirely freed of solid matter. Below this layer of sludge is normally a layer of washing solution, since the particles in the sludge mostly do not sink through the wash water, apparently because a sufficient amount of oil is entangled with the particles to make the sludge lighter than the washing solution itself.

In order to enable the washing solution to reach all of the suspended particles, it is necessary that the two liquids be brought into intimate contact with each other. As above explained, previous methods for effecting such contact have frequently resulted in the formation of an emulsion which was virtually impossible to break down. The present method avoids this difficulty in that the mechanical action between the wash water and the oil takes place without substantial violence, such violence being altogether unnecessary in accomplishing the theoretical effect above discussed. For the action on the particles, contact is all that is needed, a fact which can be appreciated by considering the enormous molecular forces exerted between the surface of the solid particle and the adsorbed film of

liquid, in comparison to which any outside force is entirely unappreciable.

A practical embodiment of an apparatus for carrying out the process of the present invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a diagrammatic layout of the apparatus;

Fig. 2 is a plan view of the still with the cover removed;

Fig. 3 is a vertical section of the still;

Fig. 4 is a section taken on line 4—4 of Fig. 3;

Fig. 5 is an enlarged detail of the vapor outlet of the still;

Fig. 6 is an elevation of the distillate cooler;

Fig. 7 is a sectional view of the same taken on the line 7—7 of Fig. 6;

Fig. 8 is an enlarged sectional view taken on the line 8—8 of Fig. 1;

Fig. 9 is an elevation of the washing tank; and

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 9.

Referring more particularly to the drawings, 15 represents the washing tank which is surrounded by a jacket 16 whereby the contents of the tank may be heated, the jacket being further surrounded by heat insulating material 14, as shown in Figs. 9 and 10. At the bottom of tank 15 is provided an inlet and outlet pipe 17, and a baffle 18 is positioned over the mouth of the pipe so that when liquid enters through pipe 17 it will be deflected outwardly rather than passing directly upward. At the top of tank 15 is formed a trough 20 which is fed by a wash water conduit 21 and has an overflow pipe 33 leading therefrom, said pipe being normally closed by a cap 34. The inner edge 22 of trough 20 is at a lower level than the outer edge, with the result that the wash water leaving pipe 21 will fill trough 20 and then overflow into the tank 15. During the washing operation, the tank will normally contain a layer 23 of the oil being cleaned, a layer 24 of sludge which has been removed from the oil, and a layer 25 of wash water beneath the sludge. The wash water overflowing from trough 20 will tend to cling to the inner wall 26 of the tank, and will flow downwardly thereover for some distance in a substantially unbroken sheet, imparting a minimum of agitation to the oil 23. The passage of this sheet of wash water, however, tends to set up a circulation within the oil layer, with the result that the oil is sufficiently stirred to eventually bring it all into contact with the descending sheet of wash water. An electric heater 60 of any usual design is connected to jacket 16 in the usual manner to provide for heating the heating medium, preferably water, used

therein. While the washing operation is going on the tank and its contents are heated by means of the jacket 16. Heating tends to set up a circulation in the oil, and this tendency is partly counterbalanced by, or partly counterbalances, the circulating tendency of the descending wash water.

The water which is to be used for washing is introduced through an inlet pipe 27 discharging into a standpipe 28 which is provided with a baffle 30 which is provided to facilitate the escape of air or other gases contained in the water as it comes from the mains. The standpipe connects with pipe 17, which is in turn connected to the interior of the washing tank and with wash water conduit 21. A pump 32 is positioned in conduit 21 to provide circulation of the wash water by withdrawing it from the bottom of tank 15 and discharging it into the trough 20.

As seen in Figs. 2, 3, 4 and 5, still 35 is provided with an insulating layer 29, and has an inlet opening adjacent its top which is normally closed by a plug 31. A steam pipe 36 leads from a steam boiler 37 and connects, through a trap 38, with a pipe 39 which has a horizontal arm 40 provided with a series of apertures 41 for admitting steam into the bottom of the still. The steam enters through pipe 36, any water contained therein being caught in trap 38, where the high temperature of the oil converts it into steam. Pipe 39 is bent into a goose neck as shown, and the effect of the hot oil is to superheat the steam passing through the pipe, with the result that when the steam emerges from the openings 41 and comes into direct contact with the oil, it is superheated. No water is allowed to come into direct contact with the oil, as this is objectionable in the explosive suddenness with which water is converted into steam in the case of such contact when the oil is hot. The goose neck is provided to prevent the oil from running into the water trap 38 before the steam is turned on. A further precaution is to avoid the formation of a vacuum in boiler 37 when it is turned off, as this will draw the oil out into the trap 38 and into the boiler. This is prevented by providing a cock 101 in pipe 36, which cock is always kept slightly open.

The steam issuing from apertures 41 passes outwardly through the hot oil and greatly facilitates the evolution of its more volatile constituents. These more volatile constituents pass upwardly around a splash plate 42 into a dome 43 which, unlike the body of the still, is not insulated. A trough 45 is provided to catch the condensate of such vapors as are condensed in the dome, such condensate passing out through an outlet pipe 44. Pipe 44 connects with a condenser 46 which may be simply in the

form of an inclined pipe surrounded by a cooling water jacket.

The still 35 is heated by any suitable means, preferably the electric heating elements 92 shown in Fig 3, which project upwardly from the bottom of the still. Boiler 37 is also preferably heated by means of an electric heating element 93, a steady, constant supply of steam being required which is best furnished by electric heat.

As a guide to the stage to which the distillation has progressed, a cock 94 is provided in the still, whereby test samples of the oil may be withdrawn from time to time. A sheath 95 also projects inwardly from the wall of the still, and is adapted to receive a chemical thermometer 96.

The vapors and condensate issuing from condenser 46 pass into a cooler 48 which comprises a receiving chamber 50 having a cover 51 loosely mounted thereon so as to be raised if the pressure in chamber 50 exceeds a certain limit. A partition 52 forms the bottom of chamber 50, and a worm 53 has one of its ends extending through the partition to communicate with chamber 50, and its other end 54 extending through the base of the cooler into a distillate tank 55. A pipe 56 is connected at the bottom of the tank 55, and connects with an inlet pipe 57 and an outlet pipe 58, and an overflow 59 is provided adjacent the top of the tank. The mixed hydrocarbons and water coming from cooler 48 separate by gravity in tank 55, and the hydrocarbons may then be removed by admitting water from the mains through inlet pipe 57 until the hydrocarbons have flowed out through overflow 59. Valve 97 is then closed and valve 98 opened, allowing the residue, consisting chiefly of water, to flow out of the tank.

The means for cooling the residue from still 35 is as follows. A pipe 61, having a valve 67, leads from the bottom of the still to a cooler 62 which is preferably vertically disposed adjacent the still. The oil pipe 64 within the cooler is preferably pinched or deformed as shown, so that the oil does not flow therethrough in a smooth stream, but is broken up by the deformations of the pipe. Pipe 64 terminates in an outlet pipe 65 which is shaped to deliver the cooled oil to a suitable container. A pump 63 is provided in pipe 65 to draw the oil from the still through the cooler 62. The water piping of the system is so arranged that heat yielded either by the cooling of oil in cooler 62 or by the condensing of vapors in condenser 46 can be utilized in heating the contents of the washing tank 15. The cooling water from the mains enters at 70, passes through cooler 48 and pipe 71 until the system is filled with water. Thereupon, valve 82 is closed and valve 81 opened, so that the water flowing from cooler 48 is dis-

charged, while the water in the rest of the system circulates without any addition to or subtraction from its volume. The water jacket of condenser 46 is connected, by pipes 72 and 73, to the oil cooler 62 and to an expansion tank 74, having an overflow pipe 100. A return pipe 75 leads from tank 74 to jacket 16. A pipe 77 connects the lower portion of jacket 16 to the lower portion of cooler 62, and a pipe 78 connects pipe 77 with the water jacket of condenser 46. Valves 80, 81, 82, 85, 86, 87 and 88 are provided in the cooling system as shown in Fig. 1, and permit several alternative arrangements as to cooling.

Assuming that a batch of oil is being cooled in cooler 62, and that a cold batch of oil has been placed in tank 15, valve 82 will be closed, the remainder of the valves being open. The heated water will then pass upwardly out of cooler 62, through pipe 73, tank 74 and pipe 75 to jacket 16, where it gives up its heat to the cold oil. It then returns through pipe 77 to the cooler 62. The water from cooler 62 may also pass through pipe 72, condenser 46, pipe 78 and pipe 77 to the bottom of the cooler without passing through jacket 16, but this is ordinarily not objectionable because more than enough heat is generated by cooler 62 to bring the oil in tank 15 up to the desired washing temperature, the heater 60 being necessary only when there is no hot oil to be cooled in cooler 62. Valve 85 is provided, however, so that condenser 46 may be cut out of the system if desired. It will be readily understood that the heat generated in condenser 46 may be used instead of that from cooler 62 to heat the water if desired. Valve 87 may be closed, to prevent further heating of the washing tank by waste heat from the still, and if desired valve 82 may be opened and valve 81 closed, so that cold water entering by pipe 70 passes through the system and out from the tank 74 through pipe 100.

The operation is as follows. A batch of oil to be cleaned is poured into tank 15, filling it to within 10 or 12 inches of the top. Valves 83 and 84 are kept closed while the oil is being poured in. Valve 84 is then opened, allowing water to run into the bottom of tank 15, the incoming water being deflected horizontally by the baffle 18 so that it does not unduly disturb the body of oil above it. The admission of water is continued until the oil above it is within about 2 inches of the top of the tank. The oil is then heated by means of the water entering through pipe 75, as above described, or by means of heater 60 if necessary, until the oil is raised to a temperature of 180° to 200° F., at which temperature the oil boils slightly. As soon as the oil has become noticeably hot, the pump 32 is started, taking the wash water from the bottom of

the tank to the trough 20, filling the trough and causing the water to flow over the rim 22 and down the inner surface of the tank. The tank is carefully leveled, so that the water passes over in a thin uniform sheet all around. The descending sheet of wash water acquires only a very low velocity, so that it passes through the oil gently, continuing in large measure on down the tank still as a continuous sheet between the wall and the oil. After the pump has been started, about 5 pounds of washing powder of any of the usual brands is put into the tank and stirred down. This is dissolved by the water, which is continued in circulation for three or four hours. The washing powder has an immediately noticeable effect on the water as it runs down the exposed surface between the oil and the rim 22, in causing the water to adhere to the metal in a substantially uniform sheet, whereas the pure water flows over this surface in irregular rivulets.

The effect of the washing on the carbon particles in the oil soon becomes apparent. Before the washing has begun, the carbon will be diffused rather uniformly through the oil in very fine particles, giving the oil an inky appearance. When the oil is heated, the particles acquire a noticeable tendency to gather together in groups, and after the washing has been under way for a time, they will be seen to have gathered in masses which appear as black specks of considerable size, leaving the oil between them apparently clear. This agglomeration or coagulation naturally increases enormously the speed with which the carbon will settle when the oil is left at rest, and the weight of the wash water adsorbed by the carbon accentuates this tendency. After three or four hours of this washing, all of the carbon throughout the oil is acted on by the wash water and coagulated. The mechanical effect of the downward stream of wash water and of the heat applied to the tank is to set up convection currents, producing various eddying and swirling motions, not of a violent nature, but serving to bring the oil and carbon particles into contact with the wash water and to bring the carbon particles into contact with each other to form the larger agglomerations. The effect of heating is to increase the fluidity of the oil thereby increasing the eddying and swirling motions which bring the water and carbon particles into contact. Heat also hastens the action of the wash water on a particle when the contact is made. Also, by decreasing the surface tension, it decreases the tendency of the oil and the wash water to emulsify.

When the washing operation is complete, the tank is covered to keep the oil from cooling at the top and producing convection

currents. Cap 34 is removed and trough 20 emptied of wash water and cleaned. The oil is allowed to settle overnight or longer if convenient, the insulation 14 serving to prevent loss of heat, so that the fluidity of the oil is maintained during the settling.

When settling is complete, the clean oil is forced out of the tank by running water in through pipe 17 from standpipe 28. The admission of water is regulated by valve 84, the oil being slowly pushed up from below by the water so as to cause it to flow over the rim 22 into the trough 20, out the spout 33 and into the receiving vessel. When the layer of sludge approaches the top of the tank, the stream of oil is diverted to another container, so that no sludge gets into the clean oil previously run off. The sludge forms a sharply defined layer below the oil, and the oil immediately above the sludge is entirely clean if the sludge has not been disturbed during the operation. The final layer of oil is run off until only a very thin layer remains above the sludge, after which any oil remaining in the trough is pushed out by means of a paint brush. In some cases, under the best conditions, the oil will drain completely from the sludge, as from a solid surface, without bringing any sludge over into the trough. The sludge may then be dipped out and the water run out by opening the drain valve 83. If any sludge is found adhering to the sides of the tank, it can be washed or brushed down, leaving the tank ready for another batch of oil. Metallic impurities such as filings or nails will be found at the bottom of the tank.

The distillation is next performed, the clean oil being transferred to the still 35, where it is heated electrically to a temperature ranging from 400° to 600° F. depending upon the nature of the diluents and the desired viscosity of the residue.

In distilling, the steam should not be started through the oil until the oil has reached a temperature well above the boiling point of water, and yet sufficiently low that the vapors will not be evolved too rapidly or violently, which would cause oil to be carried along with the vapors. Usually, the steam is admitted when the oil reaches a temperature of about 300° F. keeping all the heaters on in the oil until the temperature reaches 600°, and then turning off all except one of the heaters, which maintains the temperature at approximately 600°, at which temperature the distillation is continued for some time.

When steam is introduced into the still through the pipe 40, it passes up through the oil in the still from the bottom. This greatly facilitates the distillation, as is well known. The evolved vapors, consisting of substances resembling kerosene mixed with steam, pass into the dome 43 and out the

outlet 44 into the condenser 46. If the temperature of the still is kept constant, the volume of hydrocarbons evolved will naturally decrease as distillation progresses, and when this volume has become equal to the volume of the water condensed from the steam, it will generally be found that distillation cannot be profitably prolonged. Where a temperature of 600° F. is used, the last run will be a light lubricant.

The vapors evolved in still 35 are chiefly condensed in condenser 46; but any remaining vapors are passed, along with the condensate, through cooler 48, where they meet the cold incoming water from the mains, which completes the condensation. The distillate then passes into container 55, where the water and hydrocarbons separate by gravity and the latter are removed as described above.

Various changes may be made in the specific embodiment above described. Thus, while only one washing tank is shown in the drawings, a plurality of such tanks may be used where found desirable, the heating jackets of the tanks being connected in parallel to the water cooling system, so that heat may be transferred from oil cooler 62 to several washing tanks.

Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A method for washing oil, comprising passing a washing solution through the oil in a substantially continuous sheet without such agitation as will cause an emulsion.

2. A method for washing lubricating oil, comprising heating a body of oil, passing a soap solution downward therethrough in a substantially continuous sheet, allowing the impurities to separate as sludge, and mechanically separating said sludge from the oil.

3. A process for washing a contaminated liquid which consists in passing a layer of a second liquid immiscible therewith and having the property of removing the contaminating substances therefrom in contact with a layer of the contaminated liquid, and changing the contacting surfaces without forming an emulsion.

4. A process for washing a contaminated liquid which consists in contacting a layer of the contaminated liquid with a second liquid immiscible therewith and having the property of removing the contaminating substances therefrom without substantially intermingling said liquids, whereby an emulsion is avoided, and changing the contacting layer of contaminated liquid, whereby all parts of said contaminated liquid are contacted with the washing liquid.

5. A process for washing contaminated oil which consists in contacting a layer of the contaminated oil with a layer of wash-

ing solution without intermingling the liquids, whereby an emulsion is avoided, and producing a relative movement between the liquids, whereby all parts of the contaminated oil are contacted with the washing solution.

6. A process for washing contaminated oil which consists in heating a quantity of the oil, passing a layer of washing solution in substantially sheet form from the top of the oil to the bottom thereof without intermingling the liquids, thereby avoiding an emulsion, the movement of the washing solution past the oil being adapted to produce contacting currents in the oil, stopping the flow of washing solution, and allowing the suspended impurities to settle out of the oil.

In testimony whereof, I have hereunto set my signature.

CARL D. MILLER.