Feb. 26, 1929. 1,703,644

C. VAN BRUNT ET AL

OIL RECLAIMER

Filed July 3, 1922 2 Sheets-Sheet 1

Fig. 3.

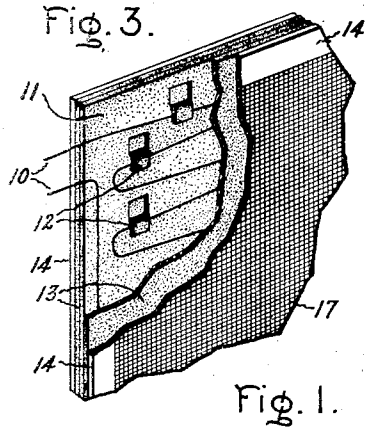


Fig. 2.

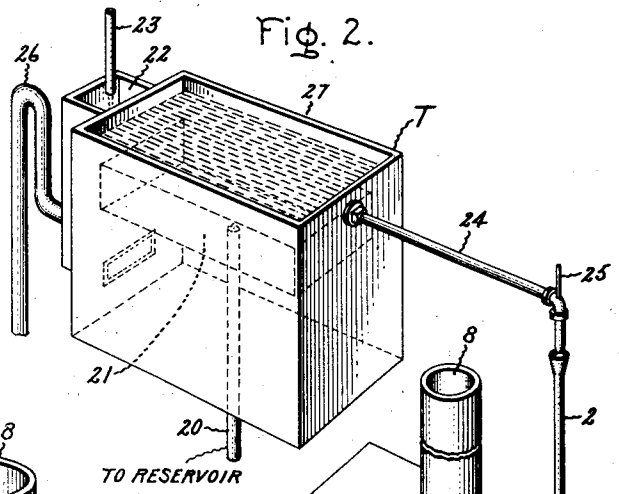
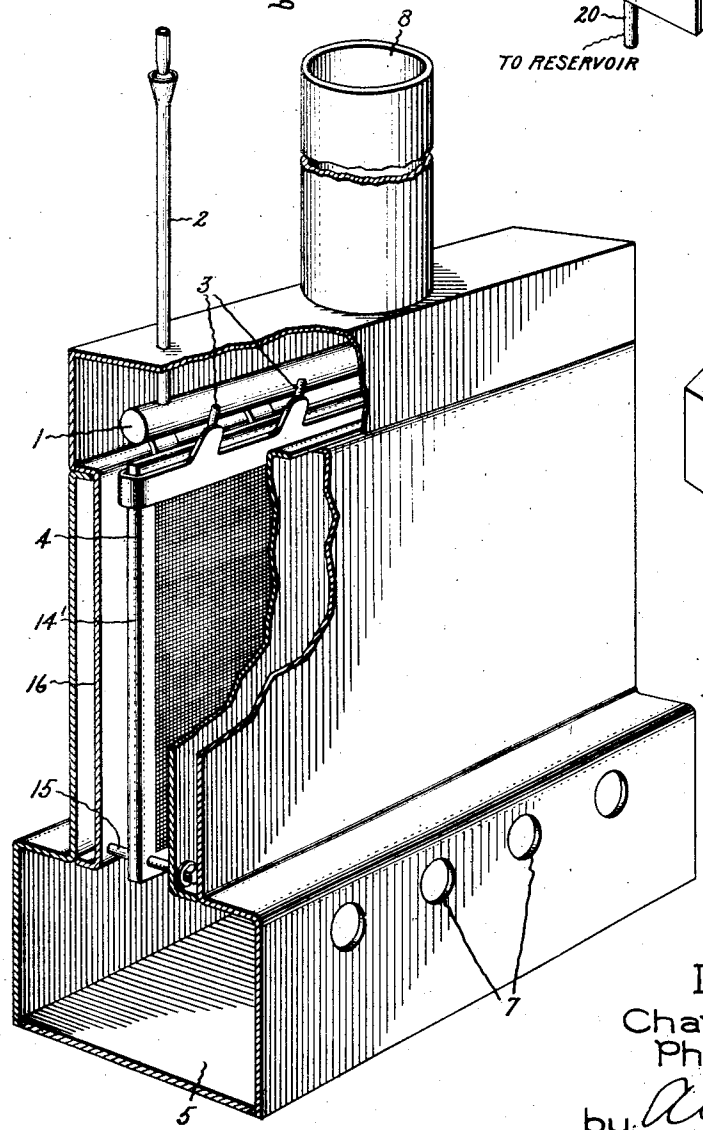


Fig. 1.



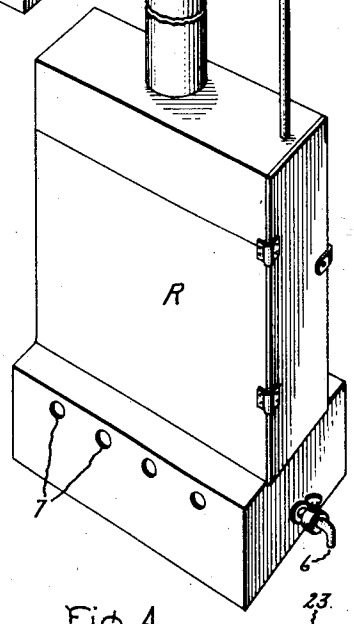


Fig. 4.

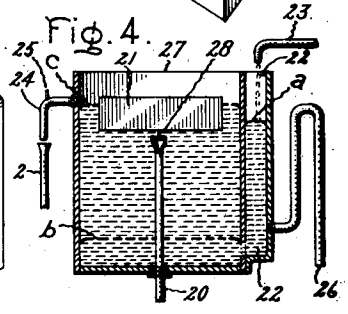


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Fig. 5.

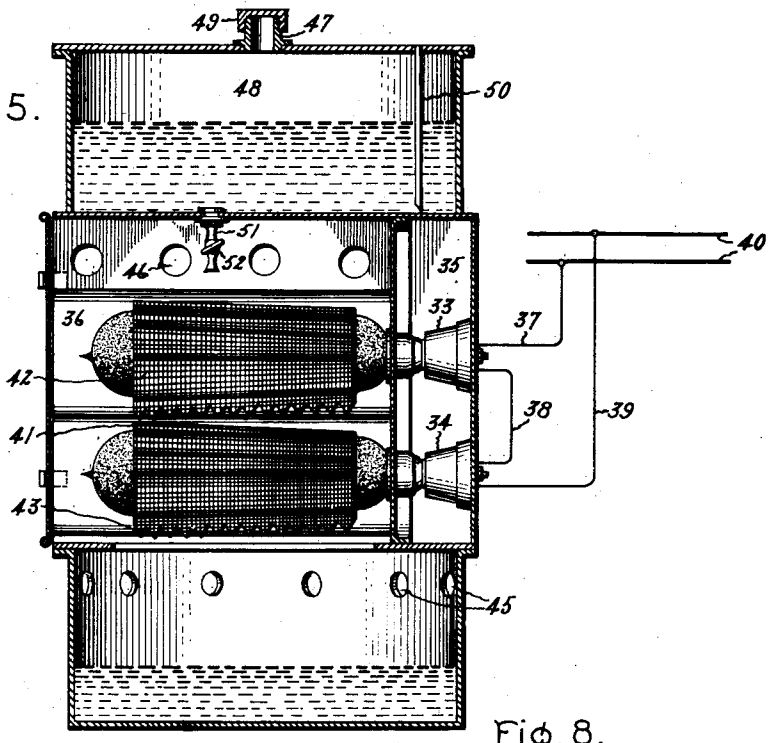


Fig. 8.

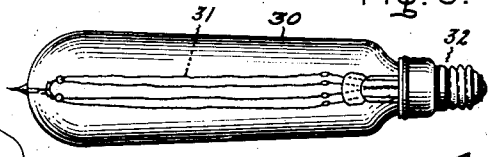


Fig. 6.

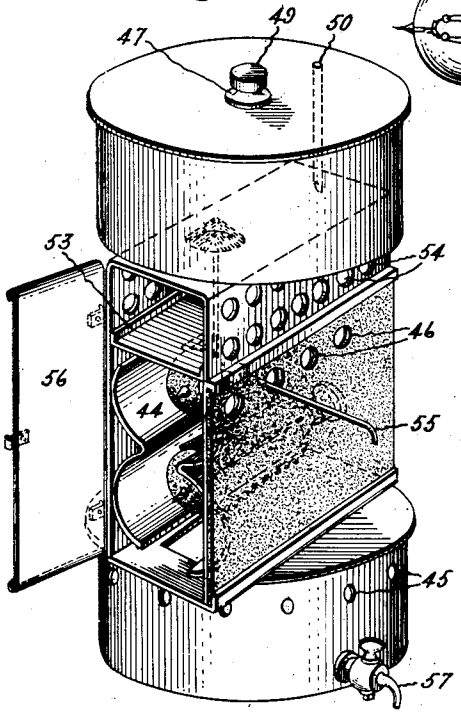
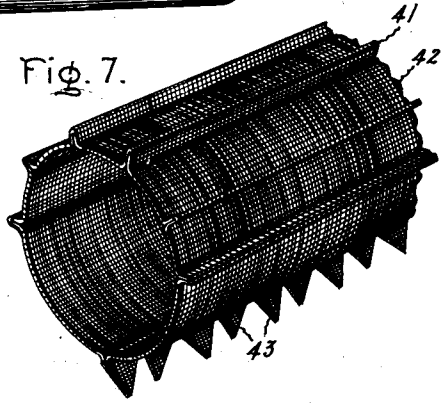


Fig. 7.



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Patented Feb. 26, 1929. 1,703,644

UNITED STATES PATENT OFFICE.

CHARLES VAN BRUNT AND PHILIP S. MILLER, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

OIL RECLAIMER.

Application filed July 3, 1922. Serial No. 572,601.

This application is a continuation in part of our prior application, Serial No. 484,202, filed July 12, 1921.

The present invention relates to the purification of liquids and particularly to the reclamation of lubricating oil which has been used in the crank case of an internal combustion engine, or under any other conditions which reduce its viscosity and impair its lubricating qualities. Our invention makes it possible to remove volatilizable impurities from oil, and in a single and expeditious way to restore the viscosity or body of used oil to substantially its original condition so that it will be equal or even superior in serviceability to unused oil. The apparatus for practicing our invention is automatic in operation, is free from fire hazard, and is simple in construction so that it may be readily operated even by unskilled labor.

In the crank case of internal combustion engines, particularly under the conditions encountered by automobile engines, the lubricant becomes contaminated both with solid matter and diluted by unburnt fuel constituents. This dilution of the oil lowers its lubricating and piston sealing value. Our present invention relates to the removal of the diluents in the oil. These diluents are completely miscible with the heavier lubricating oil, and therefore could be removed by ordinary heating of the oil in bulk only at a dangerously high temperature and an uneconomical expenditure of time and energy.

In accordance with one feature of our invention, we have provided a rectification apparatus whereby the rate of evaporation is so greatly accelerated that only a moderate temperature is required for a commercially useful rate of reclamation.

In accordance with another feature of our invention the oil to be purified in the form of a thin turbulent film, is subjected to a draft or current of air, or other gas, which carries away the vapor from the surface of the film.

In accordance with another feature of our invention we have provided an evaporator which subjects the oil to a progressively higher temperature as its content of diluents becomes reduced, and the boiling point becomes higher, thereby accelerating the evaporation of the diluents as their removal becomes more difficult.

In accordance with still another feature of our invention, we have provided means for feeding the oil into the reclaimer at a substantially constant rate even in spite of variations in viscosity of different samples and we also may and preferably do arrange to feed the oil in such a manner that the rate of feed also will be independent of variations of the head of the oil in the storage tank and feed pipe.

Our invention will be better understood from the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Referring to the accompanying drawings, Fig. 1 is a perspective view of a preferred form of apparatus for practising our invention, a part of the housing being shown broken away; Fig. 2 shows in perspective a complete outfit including a feed device; Fig. 3 is a fragmental view showing the preferred construction of an evaporator for use in our oil recovery device; Fig. 4 is a vertical section of our feed device; Fig. 5 is a vertical section of another form of apparatus for practising our invention; Fig. 6 is a perspective view of the apparatus shown in Fig. 5; Figs. 7 and 8 constitute respectively perspective views of the spreader and heater used in the apparatus shown in Figs. 5 and 6.

Referring to the drawing, the apparatus shown in Fig. 1 comprises a distributing device 1, into which oil to be reclaimed is fed by a tube 2. The oil is discharged and distributed upon each side of an evaporator 4 by ducts 3 which preferably are of capillary dimensions. The construction of the evaporator will be hereinafter more fully described, particularly in connection with Fig. 3. After passing over the surface of the evaporator, where it is substantially freed from diluents, the oil is discharged into a receiving storage tank 5 from which it may be withdrawn by a cock 6, as shown in Fig. 2. The volatilized constituents from the oil are carried away by a current of air or other gas which enters the apertures 7, becomes heated in contact with the evaporator, and therefore

rises and escapes through a vent pipe 8. The function of the draft, produced in this way (or in any other way that circumstances may indicate), and flowing counter to the oil flow is of prime importance in that it greatly expedites evaporation by keeping the partial pressure of the vapors of the diluents down, and thus renders this operation practical at a comparatively low temperature. The dilution of the vapors attendant upon this feature has also the important effect of rendering the gaseous diluent non-inflammable.

As shown in Fig. 1, the evaporator is plate-shaped and therefore adapted to be used in apparatus of large capacity in any desired number of units placed side by side. There is described in detail hereinafter a particular form of evaporator adapted to be used in the practice of our invention, but we wish it to be understood that various other constructions may be employed to accomplish the desired result, the essential feature being the provision of means whereby the oil to be reclaimed shall be spread in a moving film of minute thickness over a heated surface, the film being subjected as it moves along to sufficient heat to volatilize the diluents in the oil, or whatever liquid is to be purified.

The evaporator as best shown in Fig. 3 comprises an electric resistance heater 10 supported on a sheet of insulating material 11, for example, by securing the resistance wire under ears 12 cut out of the insulating sheet material and bent back upon the same.

Upon each side of the heater wire thus mounted are placed sheets of insulating material 13 so as to secure the resistor between sheets of insulation. Upon each side of the insulated resistor are placed in turn plates 14, of suitable sheet metal. These plates may be secured in place by the marginal stiffening strips 14′ soldered at the edges and secured by bolts 15 to the side walls 16 of the reclaiming chamber. The sidewalls 16 of the reclaiming chamber preferably are double to provide heat insulation. Upon the surface of these sheet metal plates is secured some means for guiding the oil received from the distributing device 1 over the entire surface of the heated metal plates 14, as a continuously moving film. We prefer to use for this purpose a reticulated material, such as a wire gauze 17, which is secured to the surface of the sheet metal by welding or riveting so as to provide a plurality of interlacing ducts of capillary dimensions into which the oil will run and therefore spread uniformly over the heated surface as a fine network of tiny streams with a film of varying thickness between them instead of following certain limited paths which would otherwise be the case.

In order to secure the greatest efficiency, the wire gauze 17 should be so attached to the heated plate, that no bulging of the gauze away from the plate occurs. Good results are obtainable by sweating fine mesh brass gauze to tin-plated sheet metal to which the heat is applied. The gauze may consist of wire about 10 mils in diameter with 40 meshes to the inch.

The heater which may be of any desired form is shown in Fig. 3 as a wire bent back and forth upon itself, the turns of the zig-zag being placed more closely adjacent at the bottom than at the top so as to heat the lower part of the plates 14 to a higher temperature than the upper part. This affords a very compact construction in which the film of oil is brought into very close contact with the heated surface over a relatively large area so that the heat is applied uniformly to all parts of the oil film, the oil with the above described construction, being subjected to a gradually and uniformly increasing temperature. Preferably, we provide for a steady increase of temperature from about 120° C. at the top of the plates to about 150° C. at the bottom of the plates. As the diluted oil flows over the heated surface the rate of evaporation of the diluents becomes less, as a result both of their decreasing concentration and of the increasing boiling point of the residual constituents. To counteract this the temperature encountered becomes increasingly higher as the oil flows downward. In other words, the rising temperature gradient from the top of the evaporator downwardly, counteracts a tendency for the evaporation of diluents to slow down, as the oil film passes over the evaporator.

Although the dimensions of the evaporator may be varied to some extent, an increase of the length of path over which the oil may flow is of little advantage beyond a limit determined by the nature of the oil and its content of diluents. When using a plate-shaped evaporator, as shown in Fig. 1, for the reclamation of oil taken from the crank case of an automobile, we prefer to use units having a height of about 12 inches, the width being determined by convenience. The oil flow preferably occurs at a rate of about 3½ gallons per square foot of evaporator surface per day of 24 hours. This rate is illustrative only, because, while, as explained below, it is not designed to be adjustable at will by the operator, but to remain fixed, at least over long periods, it will depend upon certain factors which practice and demand may impose; for example, the well known seasonal variations and requirements in crank case lubrication.

With a fixed orifice, the head and the rate of oil flow will vary rapidly with the degree of dilution of the oil. This is a variation in the wrong direction and would correspondingly diminish the completeness of the reclamation. In accordance with our invention, we provide a feed device which will supply oil at a rate which is entirely independent of the viscosity or other characteristics of the

impure oil. The fact that the time required to evaporate a volatile diluent from a liquid which is not readily volatile from a concentration A to a concentration B, is proportional to log. A minus log. B, is in favor of an approximate independence of the rate of rectification and the degree of dilution.

In accordance with this mathematical function, the rate of evaporation increases enormously with the concentration of the diluent above a certain point, and conversely, decreases to a similar extent with the diminution of the concentration below a certain point so that a considerable increase in the dilution of the oil will not greatly affect the total time of its substantial removal.

A further consideration of a device of the present character which is intended to be operated by unskilled labor, or at least, by labor having by training and inclination little interest in the operation of an oil reclaimer, is that the operation of the device should be wholly automatic and should require no adjustment of feed valves for oils of different viscosity. Still another consideration in favor of an automatic rate of feed, which cannot be readily changed by the operator, is the fact that it removes the possibility of increasing the rate of operation at the expense of the character of the product. We have therefore provided, as illustrated in Fig. 2, an apparatus whereby the feed takes place in a fixed and definite manner, which is obtained by providing for a fixed low head of oil and a feed of oil by displacement with water supplied through a capillary orifice.

Fig. 2 shows in perspective the oil reclaimer, designated by R, receiving oil from an intermediate storage tank T, which in turn receives the impure oil through a pipe 20 leading to a reservoir (not shown) into which the impure oil may be dumped at any time and accumulated. The intermediate tank T may be of small capacity, say, from a quart upward. It contains a float 21, Fig. 4, connected to a valve in the receiving pipe 20. When the float 21 is in the position shown and a quantity of oil is contained in the tank T, the oil is displaced by water received from an adjoining tank 22 communicating with the main tank, and receiving water at a constant rate through an opening of capillary dimensions, for example, a pipe 23. The water causes the oil to float off the oil at the same rate through a pipe 24 into the receiving pipe 2 of the oil reclaimer. A vent 25 is provided to prevent the pipe 24 acting as a siphon. In order to avoid the water following the oil and flowing off through the pipe 24 into the oil reclaimer, a siphon 26 has been provided through which the water will escape when it has reached a certain level.

The operation of the feed device will best be understood by reference to Fig. 4. Suppose the tank 22 to be filled with water up to the level *a* and the communicating tank 27 to contain water up to the level *b* and oil from level *b* to the level *c*. As the oil is lighter than water the upper level *a* of the water in the tank 22 will be below the level *c*. Water is admitted to the tank 22 at a constant rate through the capillary tube 23 in which throttling is obtained by length rather than by constriction, and which therefore, is less likely to plug up than a cock or needle valve. As the flow of water is constant, the oil displacement is constant, regardless of changing viscosity of the oil and of changing head. As the oil and water interface at *b* rises, the level *a* also rises until finally the level of water becomes high enough to start the siphon 26. The siphon 26 empties the tank 22 at a greater rate than oil can be supplied by the supply pipe 20, so that the siphon breaks before oil can follow the water through the same. The tank 27 then fills with oil until the supply is shut off by the float operated valve 28. The oil feed by displacement with water then is repeated. Since the capillary distributing ducts 3, (Fig. 1) are of fixed dimensions, a standpipe is provided to permit oil of varying viscosities fed at a constant primary rate, as above indicated, to automatically find a level at which their discharge through the ducts 3 equals this rate, regardless of their viscosities.

Figs. 5 and 6 illustrate somewhat simpler embodiments of our invention in which the standard heater lamps are used in place of the plate heater shown in Figs. 1 and 3. These heaters, as illustrated in Fig. 8, comprises a bulb 30 containing the usual incandescent filament 31 connected to wires leading to the standard screw socket 32. The exterior surface of the heater lamp may be roughened or frosted, as indicated in Figs. 5 or 6. The heater lamps are arranged to be inserted into standard sockets 33, 34, which are fixed to the side wall of a chamber 35, adjoining the main chamber 36 in which the oil reclamation takes place. We prefer to provide a plurality of lamps located one above the other, the resistance and wattage of the heaters being so chosen that the lower heater operates at a somewhat higher temperature than the upper heater. For example, the upper heater may operate at a temperature of 110 to 125° C. and the lower heater may operate at a temperature of 135° to 150° C. The heaters conveniently are connected electrically in series by the conductors 37, 38, and 39, to supply mains 40. Surrounding the heaters are oil distributors 42 consisting of wire gauze, or other suitable reticulated material whereby a network of passages of capillary dimensions may be obtained.

As illustrated in Fig. 7, the cylinders of wire gauze conveniently are crimped so as to provide longitudinally extending flanges 41, the lowermost flange being cut to provide

a set of downwardly extending teeth in order to assist in the distribution of the oil. The side walls of the rectifying chamber are provided with air deflectors 44, as shown in Fig. 6. These deflectors are spaced away from the heaters and are so shaped as to conform with the general surface configuration of the heaters, thereby directing the air currents entering through the lower draft holes 45 over the surface of the oil film in order to carry away the vapors arising from the surface of the oil. The vapor laden air escapes through the upper draft holes 46. The supply tube 47 of the storage tank 48 is provided with a tightly fitting cap 49. Air can be admitted to the space above the oil only by a tube 50 which terminates near the bottom of the tank. By this means the oil flow from tank 48 through the feed pipe 51 may be regulated to proceed at a substantially constant rate as the oil level in the tank falls. This regulation is also assisted by a stopcock 52 in the pipe 51.

The device shown in Fig. 6, corresponds very closely to the device shown in Fig. 5, except that a chamber 53 is provided intermediate the oil tank 48 and the evaporating chamber 36 to prevent undue heating of the oil in the chamber 48. A double row of ventilating holes 54 is provided in the walls of this intermediate chamber 53. Fig. 6 also shows the stop cock 52 provided with an external handle 55.

When the flow of oil has been adjusted to a suitable rate the door 56 of the draft chamber 36 is closed and the apparatus is then ready to operate without supervision. The oil trickling over the wire gauze distributors 42 is freed from volatilizable constituents and accumulates in the lower reservoir 45 where it may be drawn off by a tap 57.

We mean by the appended claims to cover modifications and equivalents coming within the scope and spirit of our invention. For example, when in the claims we have specifically referred to currents of air, we mean also to cover gases other than air used for the same purpose.

What we claim as new and desire to secure by Letters Patent of the United States, is,—

1. A rectification apparatus, comprising a storage tank, an evaporator having an exposed surface provided with an area of superficial, capillary passages, heating means enclosed within said evaporator, a housing therefor having walls closely adjacent said evaporator having inlet and outlet openings for providing a draft of air over said area, means for feeding a liquid over said evaporator from said storage tank at a substantially constant rate, and means for collecting said liquid.

2. A rectification apparatus, comprising an evaporator constructed to provide for the downward flow of a liquid thereon and being provided with a surface area of interlacing, capillary passages, means for maintaining said evaporator at a higher temperature than its environment, means for distributively feeding a liquid to be rectified over said area, and means for collecting said liquid after passage over said heater.

3. An oil reclaimer comprising an oil delivery means, a heater associated therewith having an exposed surface over which oil may be caused to flow, electrical means for providing an increasingly higher temperature in the path of oil flowing by gravity over the surface of said heater, the surface of said heater being provided with reticulate, capillary passages whereby oil delivered to said heater is caused to spread over said surface and means for collecting oil discharged from said heater.

4. An oil reclaimer comprising a storage reservoir, an evaporator having a broad surface having a configuration providing a plurality of interlacing capillary ducts, means within said evaporator for heating the same, means for delivering oil from said reservoir to said evaporator at a substantially constant rate and a housing having walls closely surrounding said evaporator and having openings providing for the passage of air over the surface of said evaporator.

5. A device for reclaiming oil comprising a storage reservoir, a heater having a recticulate surface configuration providing capillary ducts, means for delivering oil from said reservoir to the surface of said heater, and means for automatically maintaining the rate of oil flow substantially constant, means for distributing oil from said reservoir to the surface of said heater, means for collecting said oil, and means for passing air over said film of oil to carry away from said film vapors of volatilized diluents in the oil.

6. A device for reclaiming oil containing diluents in variable proportions, comprising a plate-shaped evaporator having a reticulate surface, means for automatically regulating the delivery of said oil to said evaporator to maintain a substantially constant rate of flow, and means for collecting the reclaimed oil.

7. In an oil reclaimer the combination of an evaporator positioned to permit the flow of oil over its surface by gravity and having a reticulate surface with passages of capillary dimensions, heating means enclosed within said evaporator, means for supplying oil, from which vaporizable constituents are to be removed, to the upper part of said evaporator at a plurality of supply points spaced apart, means for heating said evaporator to a temperature which increases progressively from the top to the bottom of said evaporator, and means for collecting oil which has been passed over the surface of said evaporator.

8. A rectification device which consists in a plate-shaped heater supported in an upright position and having a reticulate surface providing a network of interlacing ducts of such small dimension that a liquid supplied thereto is distributed throughout said ducts by capillary force, means for supplying the liquid to be treated at distributed regions at the top of said heater and means for collecting said liquid after having traversed the surface of said heater.

In witness whereof we have hereunto set our hands this first day of July, 1922.

CHARLES VAN BRUNT.
PHILIP S. MILLER.