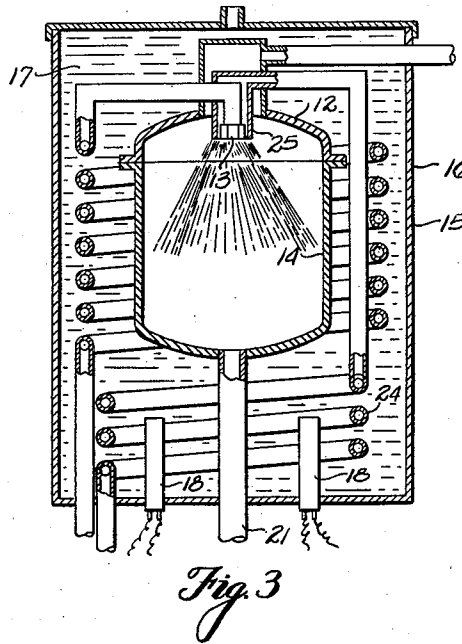
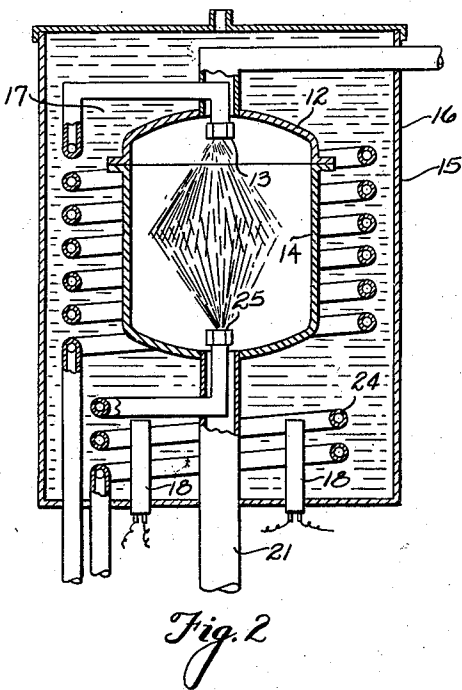
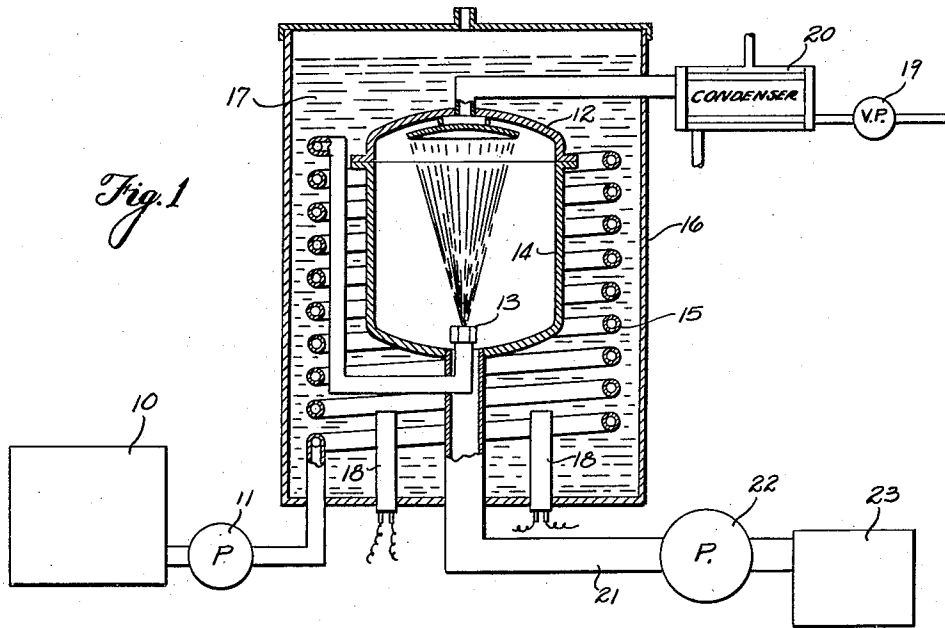


Oct. 19, 1948.

C. J. EGGER ET AL
PROCESS AND APPARATUS FOR RECONDITIONING
CONTAMINATED OIL
Filed March 17, 1943

2,451,668



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UNITED STATES PATENT OFFICE

2,451,668

PROCESS AND APPARATUS FOR RECONDITIONING CONTAMINATED OIL

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Application March 17, 1943, Serial No. 479,462

11 Claims. (Cl. 196-16)

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Our invention relates to reconditioning equipment for oil and process for treating oil.

It is a well known fact that when lubricating oils of predominantly petroleum character are used in internal combustion engines, their life of service is dependent on the rate at which contaminants increase relative to the quantity of oil used. These contaminants may be introduced extraneously or may occur as products of decomposition or of chemical change in the oil itself. Petroleum oils are generally comparatively stable, as means of refining have improved this property, but severe operating conditions may cause oxidation, or thermal decomposition, or both, to occur. The products of such deterioration include carboxylic acids, alcohols, ketones, esters, and even aldehydes, of varying molecular weights and degrees of chemical activity. Thermal decomposition alone will cause the formation of hydrocarbons foreign to the original oil, some of which are volatile while others may be of sufficiently high molecular weight as to be waxes or solids; in addition there may be ultimate destruction of some constituents to produce carbon, which persists as a solid in the lubricant, and hydrogen.

Impurities which frequently are introduced extraneously include water, either from the atmosphere or from the combustion of the fuel used, fuel which is not consumed in the normal operation of the engine or is introduced otherwise, and solid particles such as road dust, metallic particles, metallic oxides, carbonaceous matter and the like.

It will thus be seen that the volatile impurities include the oxidation and thermal decomposition products of comparatively low molecular weight, unused fuel, and water. Adverse effects have been shown to be attributable to each type. Water forms the nuclei around which sludges accumulate, the oxidation products are much more active chemically than the hydrocarbons in that they cause loss of metal in the critical mechanism by corrosion, and the volatile contaminants of hydrocarbon structure, that is, the fuel and some thermal decomposition products reduce the viscosity and other physical properties of the oil, thus affecting the film characteristics and other factors.

In the case of petroleum oils which are used in the electrical and power industries, the effects of deterioration in service have long been known to cause seriously adverse results in the operation of the equipment and apparatus in which such oils are utilized. The efficiency of hydrocarbon oils for such purposes is dependent almost completely upon the dielectric properties

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of these oils, and these qualities are greatly diminished by factors such as the introduction, formation, or incidence of water and of oxidation products. It has been found that the rate of formation of oxidation products is greatly influenced by the presence of water and of atmospheric oxygen and carbon dioxide, and that when the presence of these agents can be eliminated or held to an exceedingly low proportion, the useful life of these oils can be prolonged for a very considerable period of time, and that corrosion effects in the equipment become practically non-existent.

In a wide range of industrial applications, the useful life of oils is frequently found to be dependent upon the rate at which extraneous impurities are introduced, and consequently upon a critical concentration of these impurities. In quenching oils, the rate of heat transfer will be greatly affected by the presence of a small amount of water; in vacuum pump oils, air compressor oils, and adsorption oils, the incidence of gases and volatile contaminants, either in solution or present as separate phases is unavoidable from the nature of the applications and mechanisms in which the oils are employed, and removal or reduction in the amounts of these contaminants will obviously extend the length of service of such oils.

Some lubricating oils are subjected to the action of gases and volatile liquids even in applications which are totally divorced from the introduction of volatile liquids as fuels, as in internal combustion engines. For example, in the operation of steam turbines, it has been found impossible in practice to prevent the introduction into the lubricating oil of considerable amounts of condensate and gases. Removal of such contaminants will decelerate the rate of formation of oxidation products generally recognized to be undesirable.

Solid impurities can be removed from an oil by filtration, and the higher molecular weight contaminants have not been generally proven to be so greatly deleterious to the functioning of the lubricant, but in treating contaminated oils it is recognized that the total and efficient removal of the volatile contaminants has not been yet satisfactorily achieved.

An object of our invention is to remove volatile contaminants from an oil by heating the oil, introducing it into a chamber in finely dispersed globular particles, the chamber being kept at sub-atmospheric pressures, and being heated while the oil is in a finely dispersed form to as-

sure complete vaporization and removal of diluents and other low-boiling contaminants from the oil being treated.

Another object of our invention is to remove volatile contaminants from an oil by distilling the volatile contaminants at sub-atmospheric pressures while the oil is maintained in the form of finely dispersed particles in a vessel, the walls of which are heated to prevent condensation of the vaporized volatile contaminants within the vessel.

Another object is to supply sufficient additional heat to a previously heated contaminated oil while being distilled at sub-atmospheric pressures and while in a finely dispersed state to obtain complete vaporization of all volatile contaminants and to prevent condensation of the vaporized volatile contaminants within the distillation chamber.

Another object is to supply sufficient additional heat to a contaminated oil which has been heated immediately previous to introduction to a distillation chamber in a finely dispersed state, the chamber being maintained at sub-atmospheric pressures to remove volatile contaminants in a vaporized form and to prevent condensation of the volatile contaminants within the chamber.

Another object of our invention is to remove light volatile contaminants from an oil by subjecting the contaminated oil in a finely dispersed form to a sub-atmospheric pressure at a temperature substantially below the flash point of the original oil before contamination.

Another object is to remove volatile contaminants from a contaminated oil by subjecting the contaminated oil in a finely dispersed form to the action of a sweeping agent at a sub-atmospheric pressure and at relatively low temperatures, that is, temperatures substantially below the normal boiling point of the highest boiling volatile contaminant.

A further object is to provide means for removing volatile contaminants from a contaminated oil by introducing a sweeping agent into the contaminated oil and subjecting the mixture of contaminated oil and sweeping agent to a sub-atmospheric pressure and at a relatively low temperature while the contaminated oil is in a finely dispersed form.

Another object is to remove volatile contaminants from a contaminated oil by introducing a sweeping agent into the oil, and spraying the mixture of contaminated oil and sweeping agent into a vessel maintained at a sub-atmospheric pressure to remove the volatile contaminants and the sweeping agent in the vapor phase, to recover the oil freed from its volatile contaminants.

Another object is to remove volatile contaminants from a contaminated oil by exposing the oil in a finely dispersed form at a temperature substantially lower than the flash point of the original oil before contamination to a sub-atmospheric pressure in a vessel, the walls of which are maintained at a temperature substantially at least as high as the temperature of the oil being treated in it.

Still another object is to provide means for removing volatile contaminants from a contaminated oil by exposing it to the combined action of a sweeping agent and a sub-atmospheric pressure while the contaminated oil is in a finely dispersed form in a vessel, the walls of which are maintained at a temperature substantially at least as high as the temperature of the oil being introduced into it.

Other objects and a fuller understanding of our

invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

Figure 1 is a cross-sectional view of an apparatus embodying the features of our invention and capable of carrying out our process;

Figure 2 is a modification of Figure 1, in that an arrangement for adding a sweeping agent is added to the equipment; and

Figure 3 is a further modification wherein the spray means for the sweeping agent surrounds the spray means for the oil.

To achieve separation of volatile contaminants from a petroleum oil, it is necessary to use some convenient form of distillation, and all known methods of re-refining oils contemplate the use of this type of physical action. Many means have been devised to accomplish this separation rapidly, completely, and efficiently, but all have comprehended the separation being done by distillation of considerable quantities of the contaminated oil. Consequently, an appreciable time interval elapses between the introduction of heat and pressure change and completion of the removal of the volatile contaminants, and to accomplish final removal of the last traces of volatile contaminant from a quantity of oil, thermal energy is applied at an increasing rate. While this is being done, conditions exist in the oil frequently favorable to breakdown of some of the normal constituents, with formation of additional products of lower molecular weight, and consequently of lower boiling point, usually sufficient in degree and amount to cause them also to be classified as volatile contaminants, and contaminants which should therefore also be removed. Before a completely desirable result is achieved it is frequently found that the final yield of oil freed from its volatile contaminants has been unsatisfactory from an economical standpoint. If the distillation be not carried on with this degree of thoroughness, the presence of constant boiling mixtures will frequently cause the final product to be considered not totally satisfactory in regard to flash point, the characteristic most usually employed in evaluating the freedom or otherwise of an oil from low boiling components. This in turn is considered to be indicative qualitatively of increased consumption in service.

If, however, a comparatively small amount of oil be subjected to a distillation process as described at sub-atmospheric pressure, and if this quantity be extended to present the greatest possible surface to this action, it is found that the removal of undesirable low boiling contaminants is achieved with a degree of completeness not previously possible, and in a period of time which does not permit any observable degradation of the normal constituents of the oil. In order to present maximum surface, it is necessary either to present a continuous film of negligible thickness, or to disperse the oil in exceedingly fine globules. The existence of either of these forms must persist for a period of time sufficient to assure the removal in vapor form of the low boiling point impurities. From the standpoint of control of operating conditions, it has been found to be more satisfactory to present discrete globular particles to the combined action of heat and reduced pressure than to extend a continuous film, only one surface of which can be presented to the sub-atmospheric pressures and spaces.

One of the features of our invention is the provision of heat for the walls of the chamber independently of the heating of the contaminated

oil to be treated. We have found by experiment that when a heated contaminated oil is sprayed into a chamber at a sub-atmospheric pressure the walls of which are free to the atmosphere, and consequently maintained at substantially atmospheric temperature, vaporization of the volatile contaminants of the oil will occur to a very appreciable extent, and if the oil is first raised to a temperature sufficiently high to assure enough heat energy for expansion of the oil and latent heat of vaporization of the volatile contaminants, it is entirely possible that removal of the contaminants by distillation will be practically complete. If, however, the vaporized constituents have occasion to come in contact with the walls of the vessel, which are at a much lower temperature, condensation occurs on the walls to an appreciable extent, and the condensed volatile contaminants will flow down the sides of the vessel and combine with the oil which has been freed from the volatile contaminants by the fractional distillation which has already occurred. The final result is therefore that the volatile contaminants are removed from the oil being treated and subsequently re-incorporated to some degree.

We have found that by maintaining all of the walls of the vessel at an elevated temperature which is determined relative to the temperature of the contaminated oil at the point of introduction into the vessel we have contributed substantially to the efficiency of the process. In the first place, there can be no flow of heat from the oil or from the vaporized volatile contaminants or the sweeping agent to the walls, and consequently condensation of vaporized constituents can not occur; secondly, since the contaminated oil has to supply energy for expansion in the vessel maintained at sub-atmospheric pressure and to supply latent heat of vaporization for the removal of the volatile contaminants, additional heat will flow from the walls of the vessel to the oil at the time it may be required.

Our invention comprehends the application of the principles explained in a manner which is efficient and economical. The apparatus employed is shown in the Figures 1, 2 and 3, and the process will be understood when reference is made to it while the operation is explained.

As will be seen, the requisites for carrying out our process consists of a means of supplying contaminated oil from a supply vessel 10 by a pump 11 to a chamber 12 in which the oil, by reason of passage through a spray nozzle 13, is dispersed into exceedingly fine globular particles projected into the space enclosed by the walls 14 of the chamber. The contaminated oil in passing from the pump 11 flows through a series of coils 15 which are immersed in a heat transfer liquid 17 within a container 16. The heat transfer liquid 17 may be heated in any suitable manner and as illustrated we provide for heating the liquid by means of electric heaters 18 suitably energized from a source of electrical energy. The chamber 12 is maintained at sub-atmospheric pressure by means of a vacuum pump 19. As illustrated, a condenser 20 is connected between the chamber 12 and the vacuum pump 19 in order to condense the volatile contaminants which are carried off by the action of the vacuum pump 19.

The contaminated oil in passing through the series of coils 15 is heated by the heat transfer liquid before being introduced into the chamber 12. The heat transfer liquid 17 also heats the walls 14 of the chamber 12 at a temperature substantially at least as high as the temperature of

the oil which is introduced into the chamber 12 in order to prevent condensation of the vaporized volatile contaminants within the chamber 12. The treated oil is removed from the chamber 12 through a conduit 21 under the action of a pump 22 which delivers the treated oil to a storage vessel 23. The treated oil is immediately removed through the conduit 21 from the chamber 12 so that no accumulation of oil is present at any time in the chamber 12 to decrease its effective space or capacity. The process may be carried out continuously without interruption and tests show that the process and equipment restore the oil substantially to its original constituency.

Provision is made in Figure 2 for the introduction of a gaseous or vaporized sweeping agent into the treating chamber through a nozzle 25, so that in the oil being treated advantage may be taken of the well known principle by which such a gas or vapor creates a system of partial pressures of the vapors of distillation and of the gas or vapor inducing or assisting volatilization at temperatures lower than the true boiling point at the given pressure of the hydrocarbons or other volatile contaminating liquids from which the vapors are being produced and have to be removed from the oil undergoing treatment.

In Figure 2 the oil spray nozzle 13 is located at the top of the chamber 14 and the sweeping agent nozzle 23 is at the bottom. The sweeping agent is heated by passing through a series coil 24.

Steam is one of the most common agents used, since it is usually readily available or it may be produced at a source adjacent or contiguous to the chamber in which the distillation is effected. Since the steam must be introduced at a pressure equal to or greater than the pressure of the stream of oil being supplied, it is not necessary to apply any degree of heat to the steam, since manifestly condensation of water can not occur in the distillation chamber.

In some specific applications, such as for example some hydrocarbon oils used as dielectrics or in various uses in the electric power industry, a special degree of care must be taken to insure that the conditions under which the volatile contaminants are removed are such that no oxidation of the product can occur during treatment. This is true of some special cases in industrial applications in which the types of contamination which are critical may be very specific in character. Oxidation mechanisms leading to the production of low molecular acids, alcohols or aldehydes, and thermal or chemical decomposition producing hydrocarbons of substantially lower molecular weights than those of the normal constituents of the oil may occur. We have employed inert gases, such as for example nitrogen, as sweeping agents in the treatment of contaminated oils to remove the volatile contaminants in several cases in which, either by reason of the composition of the oil or of the contaminants, the product was found to exhibit a degree of sensitivity towards the use of steam, or where it was desired to prevent access of atmospheric air to the product after the volatile contaminants had been removed. In Figure 3, the sweeping agent nozzle 25 surrounds the oil nozzle 13 so that the oil and the sweeping agent are brought into intimate contact as illustrated.

We have also found that by employing the process herein described, a product is obtained which is equivalent to the original oil in all physical respects, showing complete removal of all volatile contaminants, and this result is obtained

at temperatures very substantially lower than those which are necessary when batch vacuum distillation is used and which are below the critical temperatures for thermal decomposition. Thus, we have found that diluents which had been introduced into aircraft engine oils in service to the extent of approximately six per cent of the total volume, and which consisted of volatile hydrocarbons, such as are present in gasoline, together with some low molecular weight oxidation products and water were apparently totally removed by spraying the contaminated oil which had previously been heated to 300° F. into the distillation chamber, which was maintained at a vacuum of approximately 29.6 inches of mercury as referred to a 30-inch barometer, the walls of the chamber also being maintained at 300° F.

The flash point of the aircraft engine oil was 480° F. when new and the contaminated oil contained a sufficiently high proportion of very volatile hydrocarbons that the flash point was approximately 115° F., and sustained combustion occurred at 155° F. After subjecting the contaminated oil to the process described above, the product had a flash point of 495° F. Similarly, the viscosity of the contaminated oil was very much less than that of the new oil, while the viscosity of the product after treatment was substantially identical with that of the new oil.

Determination of the value for the physical properties usually accepted for evaluation of an oil showed that after the contaminated oil had been fractionally distilled by the process which we have discovered, the product met the requirements outlined in the specifications for new aircraft oil.

A series of experiments was made with the same aircraft engine oil in which sweeping agents were used, and in which the direction in which the oil was caused to travel after introduction into the distillation chamber was changed, to determine if changes in the path of travel of the finely dispersed particles in relation to the liquid outlet and the vapor outlet were significant. We have discovered that no appreciable differences were obtained, the final product in every case possessing physical properties closely paralleling those demanded for new oil.

While these results show that the limiting conditions for removal of volatile contaminants had been met in every case, to extend the results in the general field of oil contamination, particularly petroleum oil contamination, series of tests were made with an electrical oil, specifically a transformer oil, and with an oil used in the heat treatment of steel.

In the case of the contaminated transformer oil, it was found that the oil before treatment was dark in color, possessed a neutralization value of 0.53 milligram KOH per gram of oil, and a dielectric strength of 7 kilovolts when tested by the standard method of test described by the A. S. T. M. Some sludge was present, and the moisture content was found to be 0.27% by distillation from xylene.

This contaminated oil was subjected to vacuum fractional distillation by the method we have disclosed above, at a temperature of 200° F. and without the use of a sweeping agent. Preliminary to spraying the contaminated oil into the distillation chamber, it was strained to remove solid impurities and aggregations of sludge which would clog the spray nozzle.

The oil collected after subjection to this treat-

ment was then analyzed and the neutralization value was found to be 0.21 mg. KOH per gram of oil, the moisture content was nil by the same method of distillation from xylene, and the dielectric strength was 24 kilovolts. In addition, the product was substantially lighter in color than the contaminated oil before treatment.

The utilization of the process had therefore resulted in the elimination of water and in reduction of the neutralization value of the oil, which can only be ascribed to removal of volatile oxidation products such as carboxylic acids and esters, compounds which are sufficiently active, in a chemical sense, to cause deterioration of the equipment in which they may come in contact. The increase in dielectric strength is likewise ascribed to removal of these volatile contaminants, since it is well known that mechanical dispersions of water and the presence in solution of substances relatively rich in oxygen will materially decrease the efficiency of transformer oils and of hydrocarbon dielectrics in general.

With regard to the oil which was used for the heat treatment of steel, it had been discovered in the commercial application for industrial production, that after a certain degree of contamination had occurred, the rate of heat dissipation had been accelerated to the point where surface hardening or "brinelling" was prevalent, and persisted to an extent which either militated against subsequent machine finishing operations, or resulted in the rejection of the steel, because of failure to meet manufacturing specifications.

The rate of heat transfer is analogous to the rate of transfer of electrical energy in that the same contaminants, and degree of concentration of these contaminants, will affect these properties in like manner, although there may be a difference in the final permissible limits.

The heat transfer oil, or quenching oil, which was used for the experiments herein described, had been rejected as unfit for further use in industry. On analysis, it was found to contain a small amount of free water, and the neutralization value was very much higher than that of the oil originally.

This contaminated oil was heated to a temperature of approximately 250° F., and sprayed into the evacuated distillation chamber, the walls of which were maintained at substantially the same temperature as the oil being treated, and the volatile contaminants vaporized and removed in the vapor form. In some of the experiments, steam was used as a sweeping agent, and it was found that by the use of this sweeping agent, the rate of treatment could be increased to some extent without deleteriously affecting the quality of the treated oil. In all cases, it was possible to produce an oil which possessed physical properties equal to or approximating those demanded in purchase specifications for new oil for the designed application. More significantly, when oil which had been contaminated in service and subsequently subjected to our process as described above was replaced into commercial use, it was found to function in a completely satisfactory manner. While the scientific study of service contamination of quenching oils is not nearly as complete or thorough as similar studies made for electrical and lubricating oil deterioration, a broad survey of the results so far available shows that the progressive formation or incidence of volatile oxidation products and of water, and of extraneously introduced contaminants or catalysts for the

production of contaminating products result in a parallel deterioration affecting the quality of the metal products treated therein, and that a limit of usefulness is reached in a comparatively short period of time. Interruption of production and cost of replacement therefore contribute a substantial portion of production costs for the metal products which have to be subjected to this treatment. When means for treating such oils by our process are provided in conjunction with the heat treating bath, the life of the heat transfer medium has been prolonged to a period exceeding several times that of mediums used in identical applications but where the treatment has not been made available.

It may therefore be stated that in commercial applications of hydrocarbon oils of predominantly petroleum origin, the usual life of such oils varies directly with the rate of accumulation of service contaminants, and that a serious proportion of these contaminants are products of oxidation or thermal decomposition which are substantially more volatile than the hydrocarbon from which they are derived, together with water formed as a product of decomposition or otherwise introduced. If these volatile contaminants are removed totally or are kept below a predetermined critical concentration, dependent upon the application, the useful life of these oils may be prolonged to an extent which will greatly affect the economic operation of the equipment in which they are employed, and in addition will reduce substantially the degree to which deterioration products may adversely affect the materials of which the equipment is compounded. The process and apparatus we have disclosed provide a convenient and efficient means for accomplishing the removal of such volatile deleterious agents and are capable of incorporation in a wide variety of useful commercial applications.

Although we have described our invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

We claim as our invention:

1. Apparatus for treating oil comprising, a vessel, means for evacuating the vessel, spray means for spraying the oil in the vessel, a container having a heat transfer liquid, means for heating the said liquid, conduit means for conveying the oil to the spray means, said conduit means and said vessel being immersed in the said heat transfer liquid.

2. Apparatus for treating oil comprising, a vessel, means for evacuating the vessel, spray means for spraying the oil in the vessel, a container having a heat transfer liquid, means for heating the said liquid, conduit means for conveying the oil to the spray means, said conduit means and said vessel being immersed in the said heat transfer liquid, and second conduit means including a nozzle for introducing a sweeping agent in the vessel, and means for heating the second conduit means by the heat transfer liquid.

3. Apparatus for treating oil comprising, a vessel, means for evacuating the vessel, spray means for spraying the oil in the vessel, a container having a heat transfer liquid, means for heating

the said liquid, conduit means for conveying the oil to the spray means, said conduit means and said vessel being immersed in the said heat transfer liquid, and second conduit means including a nozzle for introducing a sweeping agent in the vessel, and means for heating the second conduit means by the heat transfer liquid, said sweeping agent nozzle surrounding said spray means and introducing the sweeping agent in the oil spray.

4. The process for treating oil comprising the steps of heating and spraying same into an evacuated chamber while the said chamber is substantially completely surrounded in a body of heat transfer fluid which heats and maintains the chamber to at least the boiling point temperature of the impurity to be removed having the highest boiling point temperature at the pressure of the evacuated vessel, and removing the volatilized impurities, and drawing the treated oil from the chamber.

5. Apparatus for treating oil, comprising a first closed vessel, a second closed vessel positioned within the first vessel to provide space between the interior surface of the first vessel and the exterior surface of the second vessel, and having a heat transfer medium between said surfaces, spray means for spraying the oil in the second closed vessel, first conduit means for conveying the oil to the spray means through said heat transfer medium, said conduit means being positioned between the first closed vessel and the second closed vessel, second conduit means being positioned between the first and second closed vessels, means for heating the heat transfer medium to supply heat to the walls of the second closed vessel and to the said first and second conduit means, means for evacuating the second closed vessel and conduit means for removing the treated oil from the second closed vessel.

6. Apparatus for treating oil, comprising a first closed vessel, a second closed vessel positioned within the first vessel to provide space between the interior surface of the first vessel and the exterior surface of the second vessel, and having a heat transfer medium between said surfaces, spray means for spraying the oil in the second closed vessel, first conduit means for conveying the oil to the spray means through said heat transfer medium, said conduit means being positioned between the first closed vessel and the second closed vessel, second conduit means including a nozzle for introducing a sweeping agent, said second conduit being positioned between the first and second closed vessels, said sweeping agent nozzle surrounding said spray means and introducing the sweeping agent in the oil spray, means for heating the heat transfer medium to supply heat to the walls of the second closed vessel and to the said first and second conduit means, means for evacuating the second closed vessel and conduit means for removing the treated oil from the second vessel.

7. The process of treating oil having volatile constituents therein, comprising the steps of heating the oil, thereafter atomizing the oil to produce a mist atmosphere of the oil and volatile constituents by spraying the oil in an evacuated chamber, said chamber having chamber wall surfaces toward which the spray is directed, and supplying heat energy to substantially all of the wall surfaces of the chamber independently of the heating of the oil to be treated to substantially maintain said chamber wall surfaces at a temperature at least as high as the boiling point,

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at the reduced pressure of the evacuated vessel, of the highest boiling point constituent to be removed, and removing the volatilized constituents and the treated oil through different outlets.

8. The process of treating oil having volatile constituents therein, comprising the steps of heating the oil, thereafter atomizing the oil to produce a mist atmosphere of the oil and volatile constituents by putting the heated oil under pressure and spraying the oil in an evacuated chamber, said chamber having chamber wall surfaces toward which the spray is directed, and supplying heat energy to substantially all of the wall surfaces of the chamber independently of the heating of the oil to be treated to substantially maintain said chamber wall surfaces at a temperature at least as high as the boiling point, at the reduced pressure of the evacuated vessel, of the highest boiling point constituent to be removed, and removing the volatilized constituents and the treated oil through different outlets.

9. The process of treating oil to remove volatile constituents contained therein, comprising the steps of putting the oil under a pressure of more than at least one atmosphere, thereafter spraying said oil into a chamber maintained at a pressure of at least less than one atmosphere, said chamber having chamber wall surfaces toward which the spray is directed, said at least less than one atmosphere of pressure being a composite pressure of the partial pressures of at least one other gas besides the volatilized constituents of the said oil, and supplying heat energy to substantially all of the chamber wall surfaces to substantially maintain said chamber wall surfaces at a temperature at least as high as the volatilizing temperature of the constituent to be removed from the oil having the highest boiling point in the partial pressure credited to said constituent.

10. The process of treating oil having volatile constituents therein, comprising the steps of heating the oil, thereafter spray atomizing the oil in an evacuated chamber to produce a mist atmosphere of the oil and volatile constituents, and supplying thermal energy to substantially all of the wall surfaces of the chamber independently of the heating of the oil to be treated to substantially

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maintain said chamber wall surfaces at a temperature at least as high as the boiling point, at the reduced pressure of the evacuated vessel, of the highest boiling point constituent to be removed, and removing the volatilized constituent and treated oil through different outlets.

11. Apparatus for treating oil, comprising a first closed vessel, a second closed vessel positioned within the first vessel to provide space between the interior surface of the first vessel and the exterior surface of the second vessel, and means to provide heat between said surfaces, spray means for spraying the oil in the second closed vessel, conduit means for conveying the oil to the spray means, said conduit means being positioned between the first closed vessel and the second closed vessel, said means for providing heat between said surfaces serving to supply heat both to the walls of the second closed vessel and to the said conduit means, means for evacuating the second closed vessel and conduit means for removing the treated oil from the second closed vessel.

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