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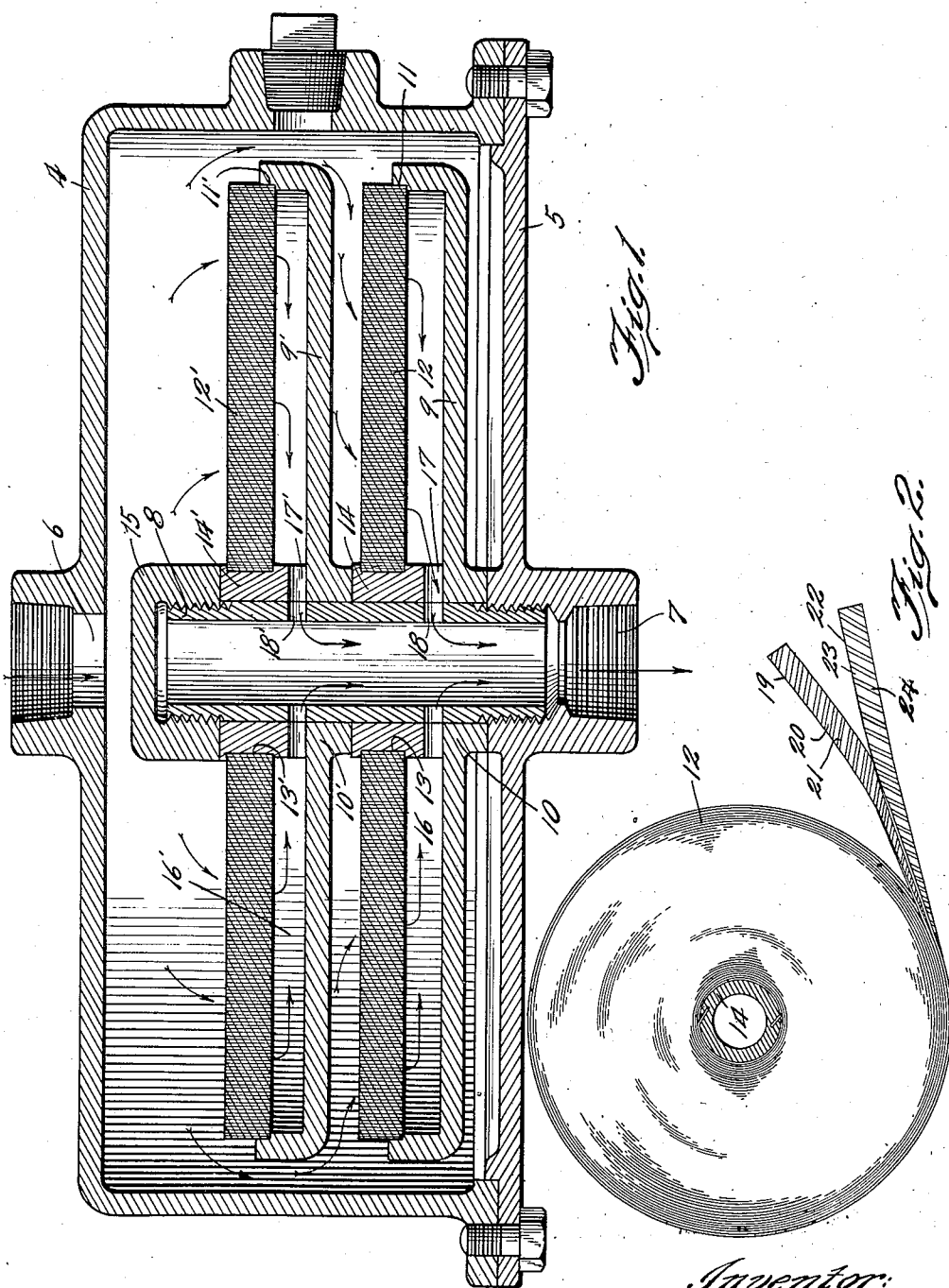
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METHOD AND APPARATUS FOR PURIFYING LIQUIDS

Filed Oct. 14, 1932

2 Sheets-Sheet 1



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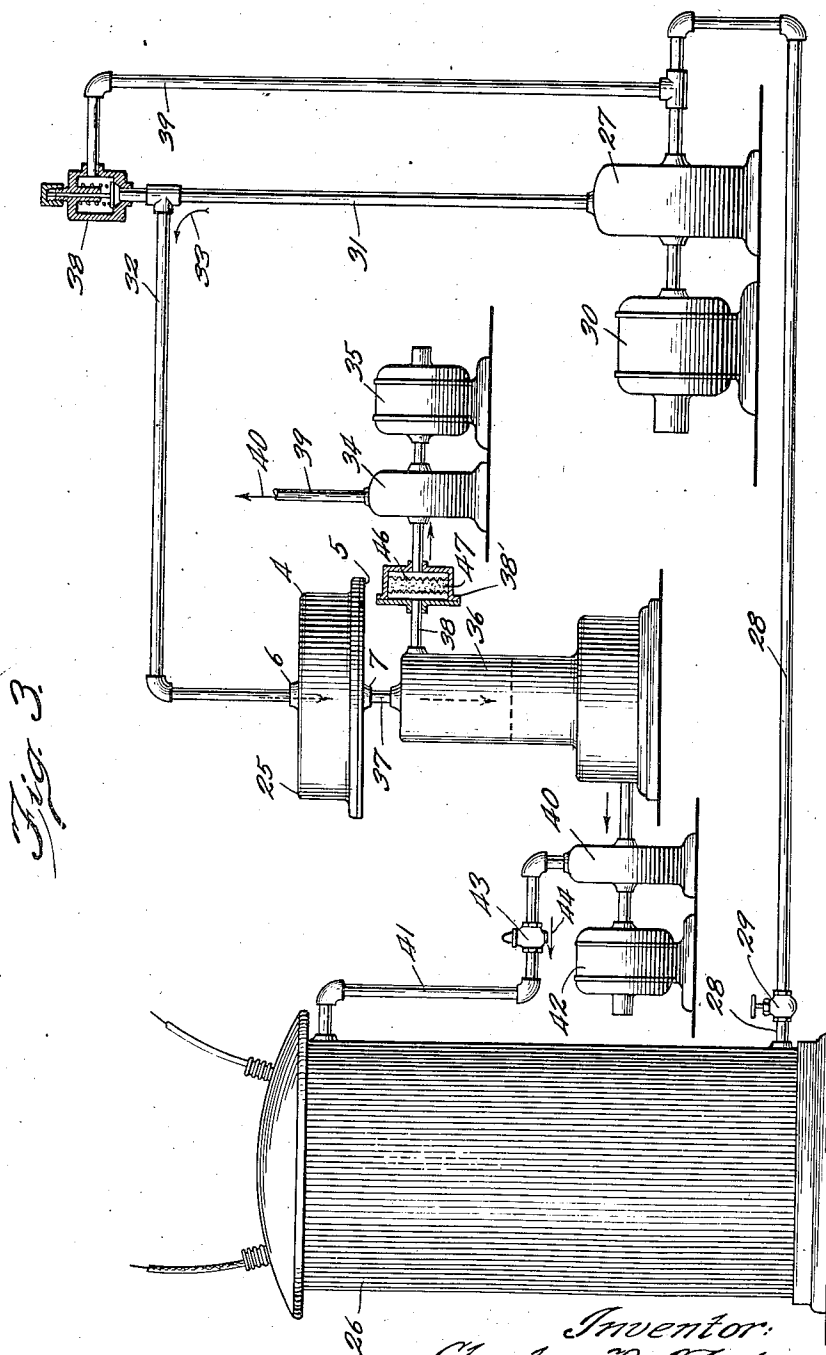
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,095,470

METHOD AND APPARATUS FOR PURIFYING LIQUIDS

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6 Claims. (Cl. 196—16)

This invention relates to a method and apparatus for purifying liquids, and more particularly to the method and apparatus of purifying mineral hydrocarbon oils to increase their insulating value in electrical apparatus.

According to the present invention, the non-aqueous liquids, such as mineral hydrocarbon oils, are treated to render them anhydrous and free from dissolved gases, moisture and volatile hydrocarbons which result from oxidation of the oil when in use. In the purification of such mineral hydrocarbon oils, my present invention is applicable both to the conditioning of new oils and to the reconditioning of electrical oils after use.

Mineral hydrocarbon oils are refined for and find a wide application as an insulating medium in oil submerged electrical apparatus because of the dielectric strength characteristics of the oil. The oils are used both as a cooling and insulating medium in transformers, voltage regulators and as an insulating medium in cable joints and the like. When hydrocarbon oils are used for these purposes, they are subjected to oxidation reactions resulting from the combined action of heat absorbed from the electrical apparatus, and the oxygen in the atmosphere which has ready access to the oil. Complex hydrocarbons are chemically altered by such oxidation reactions resulting in the formation of organic acids, volatile hydrocarbons, soap and deposits termed "sludge". When hydrocarbon mineral oils are used in electrical apparatus such as circuit breakers, the arcing action which takes place results in decomposition of the complex hydrocarbons forming elemental carbon, hydrogen, carbon monoxide, carbon dioxide, methane, and hydrocarbon vapors, all of which reduce the dielectric strength of the insulating medium. Concurrently with the decomposition of a portion of the oil, water may be formed due to the combination of hydrogen evolved in the zone of the arc with oxygen dissolved in the oil. These traces of water may be in true solution in the oil and together with the evolved carbon particles of colloidal or suspensoid size contribute to the deterioration of the insulating value of the oil.

In accordance with the present invention, I introduce the oils under pressure, and in a very finely divided condition, into a vacuum chamber from which the air and other gases are excluded, and which is maintained under a relatively high degree of vacuum. The oil introduced into the vacuum chamber is preferably heated and its pressure is raised preferably to above 60 pounds per square inch prior to and for the purpose of introducing the oil into the vacuum chamber. The vacuum within the chamber is maintained at as high a vacuum as is prac-

tical, preferably from 28 to 30 inches of mercury as referred to a 30 inch barometer. When the liquid is thus forced into the highly rarified atmosphere in a finely divided form, as for instance, by introducing the oil into the vacuum in a multiplicity of minute, preferably microscopic streams of flowing oil, the dissolved water and gases in the oil are caused to burst into vapor while the oil is maintained in a liquid state even though it be in very finely divided or film-like condition. The oil in filmed, or finely divided condition, is then caused to flow in a more or less tortuous pathway while subjected to the highly rarified atmosphere, whereby completely to remove the water and objectionable gases therefrom. In carrying out the broad principles of my process and apparatus, any desired type of means may be used for the purpose of finely dividing the oil while subjecting it to a high degree of vacuum, and while I have illustrated in my present invention, one type of apparatus, I wish it to be understood that such showing is merely by way of illustration and not by way of limitation.

In my present invention I have provided an apparatus which will not only remove the water and undesirable gases, but will also simultaneously filter out solid impurities in the oil, and while this is a desirable feature of my improved process and apparatus, I wish it to be understood that my invention is not limited to the simultaneous removal of the gases, air and solid impurities, but comprehends a process and apparatus which will remove the gases and water without necessarily filtering.

One of the objects of my present invention is the provision of an improved method and apparatus for removing the volatile liquid impurities from less volatile liquids, or, in other words, a method and apparatus for selectively removing volatile liquid impurities from liquids having relatively lower vapor tensions as in the case of removing water from oils used for electrical insulating purposes in transformers and oil break switches, and in creating, restoring or controlling the desirable high dielectric properties in such oils.

Yet another object of my invention is the provision of a process and apparatus in connection with the purification of electrical oils whereby the electrical oil is converted or formed into a porous liquid film to which a high degree of vacuum is applied, whereby to cause the undesirable water and gases to vaporize while maintaining the liquid state of the oil.

Yet another object of my invention resides in the process and apparatus for the formation of electrical oils into a liquid film of porous structure by subjecting the liquid to be purified to a relatively high vacuum at the point of film

formation, and in such a manner that the more volatile impurities will change to their vapor phase before being removed, and by so doing will convert a liquid film during formation into a froth-like, or porous structure of greatly increased area of exposure and surface contact, all of which is carried out under a high degree of vacuum and with the exclusion of air.

Another object of my invention resides in the provision of a method and apparatus for the breaking up of electrical oils preferably while in a heated condition into a multitude of very fine streams of flowing liquid oil while subjecting the same to a relatively high degree of vacuum, and also in causing said streams of flowing liquid oil to be transformed into a film-like condition while still subjected to the high degree of vacuum whereby to cause the vaporization of substantially all of the moisture and objectionable gases therefrom.

Yet another object of my invention is the provision of a portable apparatus and process for sufficiently removing impurities from transformer and other electrical oils, and which apparatus may be easily transported from place to place and attached to transformers already installed and in use and whereby the oil in the transformer may be treated locally to remove the impurities therefrom.

When completely refined oils are placed in use in various industries certain forms of deterioration sometimes takes place, such as the accumulation of water in steam turbine lubricating oil. Minute particles of water condensed from atmospheric water vapor, will collect in transformer oil used to cool and insulate electric windings of high voltage transformers. In the last named instance, even when the water particles are of microscopic size and less than one part in fifty thousand by volume, the dielectric strength of the transformer oil will be so reduced that the apparatus will be in constant danger of being destroyed should any unusual electrical surges occur on the high tension lines or in the high tension system connected to or embodying such transformer. In transformer practice, it seldom happens that transformers may be shut down and disconnected from the high tension system while the oil is being treated to restore its dielectric strength and seldom is a reserve amount of transformer oil carried on hand so that the used or dirty oil may be removed.

One of the objects of my invention therefore, is the provision of means for removing impurities from transformer oil in a continuously circulating system without interfering with the operation of the transformer and while the transformer remains in operation in a high tension transmission system.

Other objects of the invention will appear hereinafter, the novel features, processes and combinations being set forth in the appended claims.

In the accompanying drawings,

Fig. 1 shows the preferred form of multiple unit for use in my film forming apparatus;

Fig. 2 illustrates one of the active elements of the multiple unit shown in Fig. 1; and

Fig. 3 illustrates more or less diagrammatically the application of my improved method of film forming apparatus, to the restoration of the dielectric strength of transformer oil in a continuous circulating system while the transformer is in operation and without interfering with its function.

Referring now to the drawings which disclose one form of apparatus for carrying out my process for removing the moisture and undesirable gases from electrical oils such, for instance, as transformer oil, Fig. 1 shows a casing 4 having a removable cover plate 5 and provided with a liquid inlet 6 and a liquid discharge 7. The casing 4 may take any size or shape convenient. Internally it is provided with means for changing or converting the liquid, such as the electrical oil into a finely divided condition. I prefer to finely subdivide the oil by forcing it to flow in a multitude of very fine liquid streams while at the same time subjecting it to a high degree of vacuum. I also prefer to cause this multitude of flowing streams of oil of very minute cross-section to take on a film-like formation while subjecting it to the relatively high vacuum whereby to cause the moisture and undesirable gases in the liquid oil to vaporize and also to burst through the oil film so that such undesirable constituents can be removed, preferably by suction, so as to leave the oil in a purified condition. In this condition I prefer to cause the oil during its purification, and while subjected to the high degree of vacuum, to travel in an extended path of more or less tortuous nature so as to extend the time to which the oil in liquid, and preferably in filmed condition, is subjected to this high degree of vacuum, whereby substantially completely to eliminate the moisture and other undesirable constituents.

In the form illustrated, I have provided the casing 4 at the center of the bottom plate 5 and threading into a portion of the outlet port 7, with a pipe 8 which is preferably screw-threaded to that part of the pipe 7 forming a part of the plate 5. In addition, I have mounted one or more shallow cups, two of the same being shown as 9-9' and each provided with a hub 10-10' fitting on the pipe 8. The vertical, cylindrical portion of the cups 9-9' are provided with annular seats 11-11' into which may be soldered or otherwise secured means for dividing the liquid oil in a multitude of liquid flowing streams of very fine cross section and preferably almost microscopic cross section. In the form illustrated I have shown a plurality of metallic discs 12-12' which are mounted in grooves 13-13' in the hubs 14-14'. When the hubs 10-10' and hubs 14-14' are assembled on the pipe 8, they may be clamped in adjusted position by the screw-threaded cap 15 which is screw-threaded into the upper end of the pipe 8. The disc 12-12', with those secured in the annular seats 11-11' and to the grooves 13-13' are positioned at a sufficient space above the bottoms of the cups 9-9' to provide intervening chambers 16-16'. These chambers are in communication with the passageways 17-17' in the hubs 14-14' with passageways or ports 18-18' in the tubular member 8.

These metallic discs 12-12' are preferably constructed to provide a multitude of openings, holes or passages of very small cross section. I prefer to form the disc 12 in the manner illustrated in Fig. 2 wherein it is shown as preferably composed of two metal ribbon tapes wound tightly on the hub 14 and each being provided with preferably diagonally arranged transverse grooves. The metal ribbon 19 is provided with spaced apart transverse grooves 20 and spaced-apart raised cross bars 21 which are integral with the tape. In the present instance two of such tapes are used. The tape 22 is likewise provided with diag-

onal transverse grooves 23 and spaced apart, raised cross bars 24 integral with the tape. These diagonally arranged cross bars extend in opposite directions so that when the pair of tapes is wound tightly into the form of a flat disc, the cross bars will be in criss-crossed relation with respect to adjacent laminations.

Although the sectional area and shape of the passageways extending from one face of the disc to the other, i. e., from top to bottom are preferably of the construction as shown in Fig. 1, such passageways may be varied in accordance with the nature—such as viscosity, et cetera, of the insulating oil, or insulating liquid to be filtered, and with the nature of the impurities of the liquid to be removed by filtering, and while I have shown these passageways of some length, it will be understood that any construction may be utilized for the purpose intended, of causing the liquid to flow in liquid streams of very fine cross section, and for the purpose intended.

In the construction shown in Fig. 3 of the drawings, which relates to an apparatus and process for restoring the insulating properties of transformer and other electrical oils to its high dielectric strength, the amount of solid impurities in the oil, such as carbon, dust, et cetera, is very small, and the main purpose of the device shown in Fig. 1 is to sub-divide the liquid into a multitude of flowing streams of very fine cross section and to cause these flowing streams to form a liquid film of relatively great surface exposure while at the same time applying a relatively high degree of vacuum thereto for the purpose of removing water or other volatile impurities from the flowing streams of liquid and the film of liquid.

With reference to the device shown in Fig. 1 of the drawings, the device will also act as a filtering unit to remove solid impurities from the oil after the oil has been used in the transformer, but as hereinbefore stated, the concurrent removal or filtering off of these impurities is not necessary to the manner of removing the moisture and other volatile impurities.

The ribbon or tape 19 and 22 shown in Fig. 2 of the drawings may be formed of copper and in some instances, as when removing impurities from transformer and switch oils, it is desirable to form the ribbons approximately .004 of an inch thick by $\frac{1}{4}$ inch in width with the depressions or grooves formed approximately $\frac{1}{8}$ of an inch wide and from .0003 to .0005 of an inch in depth. These dimensions are purely illustrative of one form of construction which may be used and are not to be considered as limitative to the invention.

Referring now more particularly to Fig. 3 of the drawings which show a complete type of apparatus for removing moisture and other undesirable volatile impurities from electrical oils, I have shown the manner in which one form of my invention—and in the present instance that form as shown in Fig. 1 of the drawings—may be utilized in a continuous circulating system connected to a device having electrical oil to be purified, as, for instance, to an electrical transformer.

In Fig. 3, the device shown in Fig. 1, or a device made in accordance with the teachings of my invention, is illustrated, as at 25. A rotary pump 27 is connected by means of a pipe 28 and by means of a valve 29 to the oil-containing chamber in the transformer 26. An electric motor 30 is shown connected to the rotary pump 27 to

operate the latter whereby to pump the dirty or used transformer oil from the transformer 26 when the valve 29 has been opened. The pump 27 functions to force the oil under pressure upwardly along the pipe 31 to pipe 32 as indicated by the arrow 33. In this manner the oil is pumped under pressure into the inlet pipe 6 of the casing 4. By referring to Fig. 1, it will be seen that the oil under pressure will flow into this casing and will be forced into the openings formed between the tapes 19 and 22 at the tops of upper surfaces of the device, providing a multitude of oil openings or passages.

A vacuum pump 34 operated by an electric motor 35 is connected to the upper portion of an enclosed oil reservoir 36 which, in turn, is in communication through pipe 37 and port 7 with the pipe 8 as shown in Fig. 1. It will therefore be seen that by means of the vacuum pump 34 a high vacuum may be produced in the upper portion of the oil reservoir 36 and through the center of pipe 8, the passages 17, and into the intermediate chamber 16—16', so as to be effective on the under surfaces of the openings or passages formed in the tapes 19 and 22.

In this manner, the oil is forced under pressure through a multitude of passages of minute cross section, and as the oil thus flows in liquid condition, it will be subjected to the action of the high degree of vacuum in the chamber 16—16'. The high degree of pressure acting at one end of these openings or passages will tend to force the liquid oil therethrough and the high degree of vacuum acting on the other end of these openings or passages will tend to pull the liquid oil therethrough or cut down the frictional resistance of the walls to the passage of the oil therethrough. In effect, the vacuum will penetrate a considerable distance along the passage formed in the tape and will operate as a means for volatilizing or vaporizing the moisture and the volatile impurities. As these minute flowing streams of liquid arrive at the outer surface of the disc and while under the influence of the high degree of vacuum, and to the exclusion of air, the streams of oil will form continuously in film-like formation on the lower surfaces of these porous elements 12—12' in such a manner that the water, moisture and other undesirable volatile impurities will be extracted from the liquid oil. The water and volatile impurities are removed by means of the vacuum pump 34 directly through pipe 38 and are discharged to atmosphere through the pipe 39 as indicated by the arrow 40. If desirable, I may place in the pipe 38, a water absorbing device 38' comprising a casing having therein two spaced apart screens 45 and 46 with the water-absorbing chemical 47, such as granular calcium chloride between them. When the device 38' is employed, the vacuum pump 34 must act through the calcium chloride.

It will be understood that the porous, pervious, or reticulated elements 12—12' constitute means for forming the liquid oil into spaced-apart flowing streams of liquid oil of very fine cross section, and also constitute means for forming even, reticulated, and regular films of liquid oil for the purpose of subjecting oil in such state to the action of the relatively high degree of vacuum.

As above described, the porous body of each element 12—12' embodies a multiplicity or multitude of minute, almost microscopic passages distributed throughout so that when oil is applied to the upper surfaces or faces of the discs 12—12', the oil is forced on one hand by the force pump

27 and pulled on the other hand by the vacuum pump 34, and the oil appears on the inner sides of the discs as a very evenly formed thin film of liquid oil.

It will thus be seen that the oil to be treated in passing through the various fine or small openings in the metallic devices 12 and 12' is converted into a multitude of very fine liquid streams, or in other words, the oil to be treated is very finely divided or broken up so as to subject it to the maximum effect of the highly rarified atmosphere while still maintaining the oil in liquid condition. The conversion of the oil into finely divided condition in the manner herein described is accomplished by a substantial differential in pressure at the entrance and exit sides of these relatively small openings. For instance, on the exit side I maintain a relatively high degree of vacuum and at the entrance side the oil is subjected to varying degrees of pressure up to a pressure substantially above atmospheric pressure. For instance, I preferably arrange the force pump 27 whereby it forces the oil through the openings at a maintained constant pressure of approximately 100 pounds per square inch more or less, it being understood, of course, that such pressures may vary in accordance with the types of oil under treatment and the conditions connected therewith. I prefer, however, to use pressure substantially above atmospheric pressure so that the oil first has its pressure raised substantially above atmospheric pressure and is finely subdivided and is then subjected to a high degree of vacuum so that the moisture and gases are automatically liberated from the liquid oil.

The pressure on the oil exerted by the pump 27 may be regulated by the check valve 38 in the by-pass pipe 39. The check valve 38 may be set to open when the pressure per square inch on the upper surfaces of the filter discs, 12—12' exceeds a predetermined limit. When such limit is reached the oil will be circulated back to the pump 27 through the pipe 39.

In the case of oils containing emulsions of volatile liquids or very small particles of water, et cetera, accompanied by dirt particles which tend to clog the passages through the elements 12—12', the high vacuum produced in the chambers 16—16' is useful because such volatile liquids boil while within the passages at temperatures greatly reduced and far below those of the normal boiling points of such volatile liquids, and form steam or vapours at a very rapid rate, which steam or vapors will cause the dirt particles to be blown out of the passages, the whole action effecting continuous or intermittent cleaning of the passages of the film forming means.

In other words, in addition to the elimination of the more volatile ingredient of the mixture of liquids, such as water in oil, the application of the vacuum to the lower surfaces of the discs 12—12', also has the effect of forming at reduced temperatures vapor volumes in the passages in the elements 12 and 12', which when emerging from the passages burst through the thin oil film covering the lower surfaces of the porous elements 12 and 12' in the form of minute bubbles, thereby causing the film to become very porous with the result that the surface area of the oil film exposed to the action of vacuum is greatly increased. That is to say, the application of the high vacuum has the effect of continually cleaning the passages of dirt particles and greatly increasing the film surface.

In this manner the more volatile constituent

such as water in oil may be removed at a much greater rate and much more thoroughly than could be accomplished where vacuum is applied to the surface of oil in a reservoir. The vacuum producing means shown in Fig. 3 causes the volatile vapors to accumulate in the upper portion of the reservoir 36 and to be expelled through the pipes 38 and 39 to the atmosphere. If desired, the volatile vapors may be drawn by the vacuum pump 34 through a suitable absorbent 47 such as calcium chloride between the screens 45 and 46 in the container 38', thereby preventing such vapors from re-entering the oil or recondensing and re-entering the oil, or lowering the vacuum.

The limits of temperature within which my improved process is adapted to operate is between the freezing point of the water in the oils and such high temperatures as would tend to injure the oil. Preferably the temperature of the oils being treated should be sufficiently high to decrease the viscosity of the liquid so as to cause it to flow freely. I also find that when the oils to be thus treated are heated below such high temperature as would tend to injure the same, the process is more satisfactory. For instance, in the treatment of transformer oil, the temperature of 150 degrees Fahrenheit to 180 degrees Fahrenheit has been found to be satisfactory. Such temperatures are often found in the transformers while in use by reason of the electrical heat produced in the transformer windings. Furthermore, when the vacuum is applied to the liquid oil film at the lower surfaces of the discs 12—12', the boiling point of the moisture in the oil is greatly reduced. It will thus be seen that when the oil to be treated has been heated, i. e., when the temperature of the incoming oil has been raised, the boiling point of the water in the oil will be reached sooner when the high degree of vacuum is applied, and such boiling begins to take place in the form of minute explosions while the oil is still in the passageways, with the result of forcing back dirt particles which may tend to enter these passageways.

With further reference to Fig. 3 of the drawings, the purified or cleaned oil, after passing into the bottom of the reservoir 36 may be pumped therefrom by means of the rotary pump 40 through the pipe 41, back into the upper portion of the transformer 26. The pump 40 may be operated by an electric motor 42. A check valve 43 opening toward the left, as indicated by the arrow 44 is preferably placed in the pipe 41 so as to prevent back-flow. Motors 30, 35 and 42 may each be controlled by the usual and well known starting and regulating electrical devices. All three of the pumps 27, 34 and 40 may be operated at the same time so that the system may be operated for as long a period as may be desired with little or no attention from the engineer or attendant. Each motor may be regulated as to speed, depending upon the desired operation of the pumps to which the motors are connected.

While, for the sake of clearness, the pumping units and reservoir 36 with filter and film forming unit 25 on top of the same are shown mounted at different locations, the whole system may be mounted on a truck platform so as to be portable and adapted to be connected by means of the pipes 28 and 41 to the lower portion and upper portion respectively of a transformer, the oil of which is to be cleaned to restore its dielectric strength.

In the application of the filter and film forming means shown in the drawings, to transformer oils, the film produced on the lower surfaces of the

discs 12-12' are very porous and cellular; the films are of a porous or honeycomb structure having a very great surface in contact with a partial vacuum maintained in the upper portion of the reservoir 36 and in the chambers 16-16' below the discs 12-12'. The vacuum acts upon the film of transformer oil appearing on the lower or discharge sides of the film forming means thereby causing the removal of water therefrom. By maintaining a desirable high degree of vacuum such as 20 millimeters or less of mercury when the barometer is standing at 760 millimeters absolute pressure, the lowered atmospheric pressure on the discharge sides of the discs penetrates deeply into the pores of the filter body. This desirable high degree of vacuum is preferably from 28 to 30 inches of mercury as referred to a 30 inch barometer.

It should also be understood that the filtering and film forming operations above described are not intended for the refining of petroleum. It is also obvious that operations used in the refining of petroleum are not adapted to the restoration of dielectric properties of electrically insulating oils such as oils used in or while in use in transformers.

The system shown in the accompanying drawings includes improved film producing means which, with the aid of vacuum, quickly restores the dielectric properties of transformer oils to a very high degree. For instance, transformer oil used in practice may deteriorate and break down below seven thousand five hundred volts strain when using a one tenth inch jump gap as found in a standard General Electric Company dielectric testing machine, whereas after receiving treatment for a period of but one second of time with the system and apparatus above described the oil may be cleaned sufficiently to withstand a dielectric strain without breakdown of approximately thirty five thousand volts. That this is more than ample is evident from the fact that the United States Government specifications for transformer oils of this type require the application of twenty three thousand volts without breakdown when using a one-tenth inch gap.

Such penetration causes the approaching water particles to change to their vapor phase and as this vapor passes out from the porous body it bubbles through the film of oil on the lower or discharge surface causing it to froth and thereby expose a very large surface of liquid oil to the action of vacuum in the container for the final rapid removal of very minute traces of water.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I wish therefore not to be restricted to the precise construction herein disclosed. This application is a continuation in part of application, Serial No. 302,415, filed August 27, 1928.

What I claim as new and desire to obtain by Letters Patent of the United States is:

1. In apparatus for removing from a mixture of liquids a volatile ingredient comprising a multiplicity of closely adjacent capillary passageways, means for forcing liquid therethrough, and means for forming the liquid into a multitude of liquid films, means for applying a vacuum to

effect volatilization of the volatile ingredient while preventing evaporation of the liquid, and means for directing the remaining liquid from said film forming means.

2. In apparatus for removing a volatile constituent from a liquid, the combination with a porous metal device having a multiplicity of substantially microscopic passages therethrough with a film forming surface on the discharge side, of means for directing the liquid to the top of the device, and means for applying a vacuum to the bottom of the device to remove the volatile constituent while in the film and before the liquid drips from such film-forming surface.

3. The method of dehydrating viscous liquid, which consists in forming a multiplicity of minute elongated streams of liquid each of microscopic cross-sectional area and causing said streams to exude to a liquid film-forming discharge surface to form a film thereon, applying a vacuum to the film formed on such surface to vaporize the water in the oil without vaporization of the oil, and continually removing the dehydrated liquid while supplying additional hydrated liquid to the film on said surface by exuding the same from said minute streams to said surface.

4. The method of dehydrating viscous liquid, which consists in separating liquid not directly affected by vacuum but containing traces of water into a multiplicity of minute elongated streams each of microscopic dimensions in cross-sectional area, and exuding the liquid therefrom to spread the same into a thin liquid film, applying a vacuum to such film to effect vaporization of the water therein and causing frothing thereof to increase the surface of the oil exposed to the vacuum without vaporization of the oil, and continually removing the liquid after it has been dehydrated and supplying dehydrated liquid continuously to said film by causing the same to exude from said streams into said film to maintain the liquid film to be dehydrated.

5. In apparatus for removing from mixtures of liquids a volatile ingredient, the combination with a body of relatively hard material having a multiplicity of closely adjacent straight capillary passageways extending therethrough with the spaces surrounding said passageways entirely closed by the solid material of said body, the surface of said body where the oil exudes from said passageways serving as a means for forming a thin film of liquid, means for applying a vacuum to such thin film of liquid to effect volatilization of the volatile ingredient, and means for directing the liquids to and from said passageways from which the liquid exudes to said film.

6. The process of removing entrapped matter from a viscous fluid which comprises subjecting said contaminated fluid under pressure to a degree of heat which will render it fluent without deterioration, passing said contaminated fluid through filtering means, forming a film of the filtered fluid, subjecting said film to the action of a high vacuum to facilitate the escape of entrapped gases, vapors and vaporizable matter, and continuously feeding filtered fluid under pressure to said film as the vacuum treated fluid is drawn off.

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