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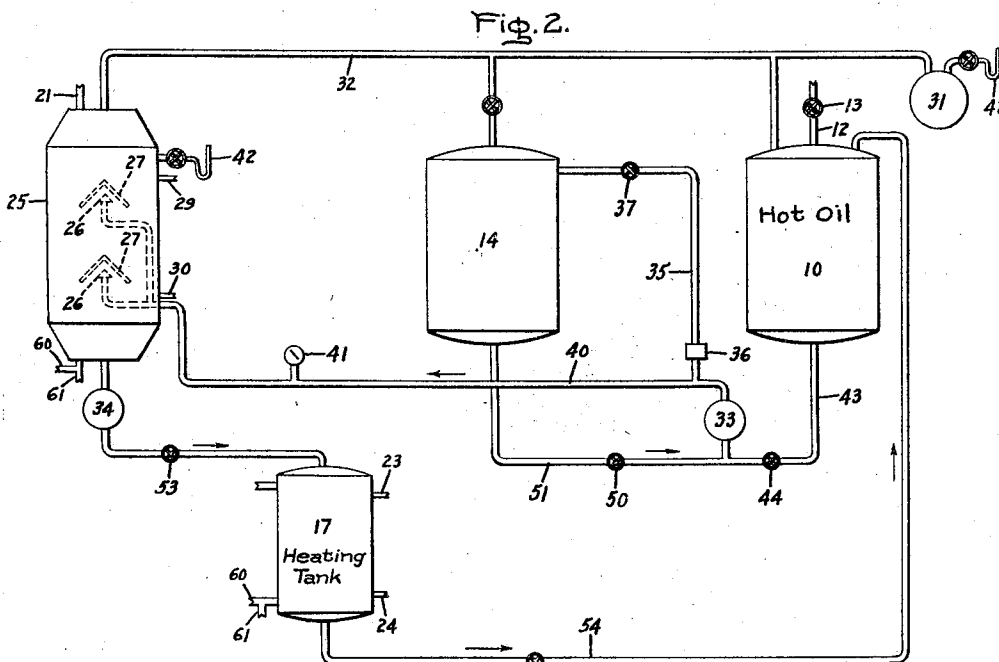
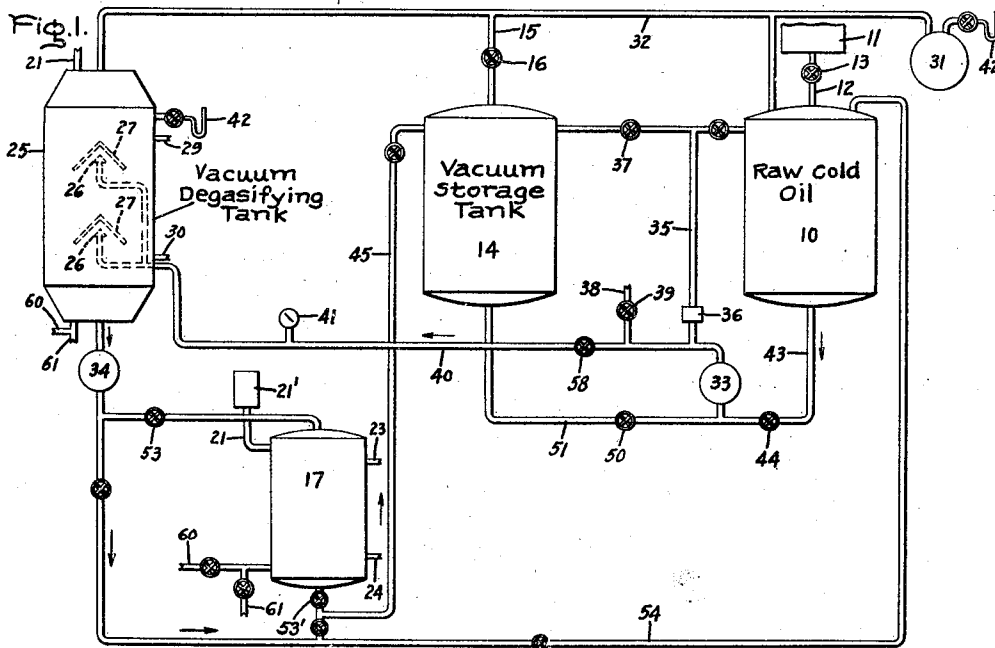
C. A. PIERCY ET AL

2,201,870

METHOD OF DEGASIFYING LIQUID FOR ELECTRICAL INSULATING PURPOSES

Filed Feb. 1, 1939

2 Sheets-Sheet 1



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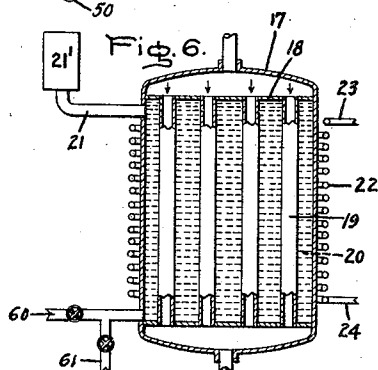
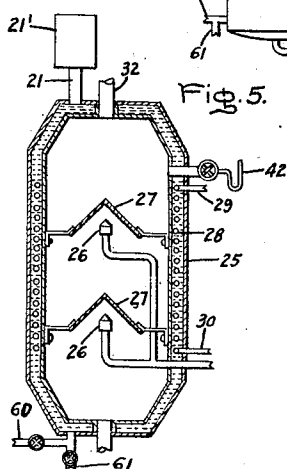
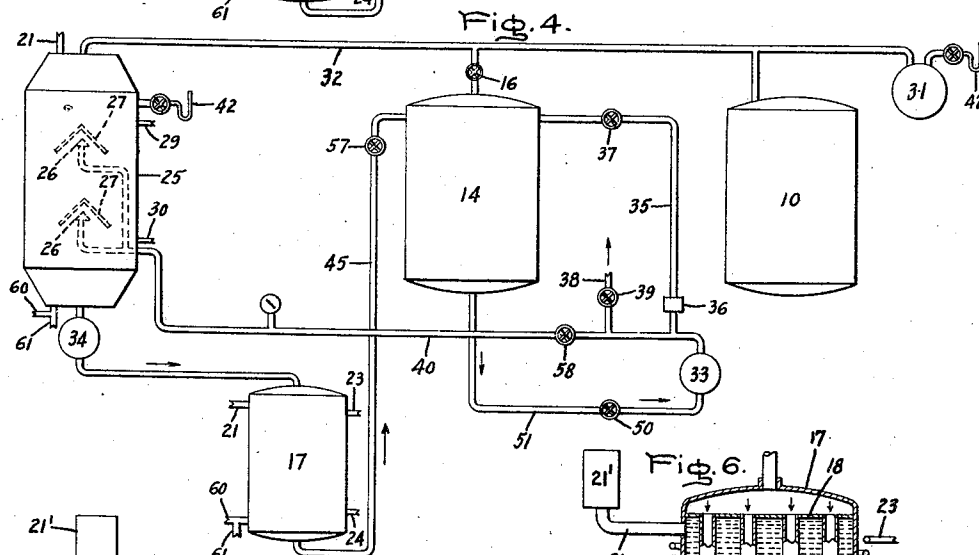
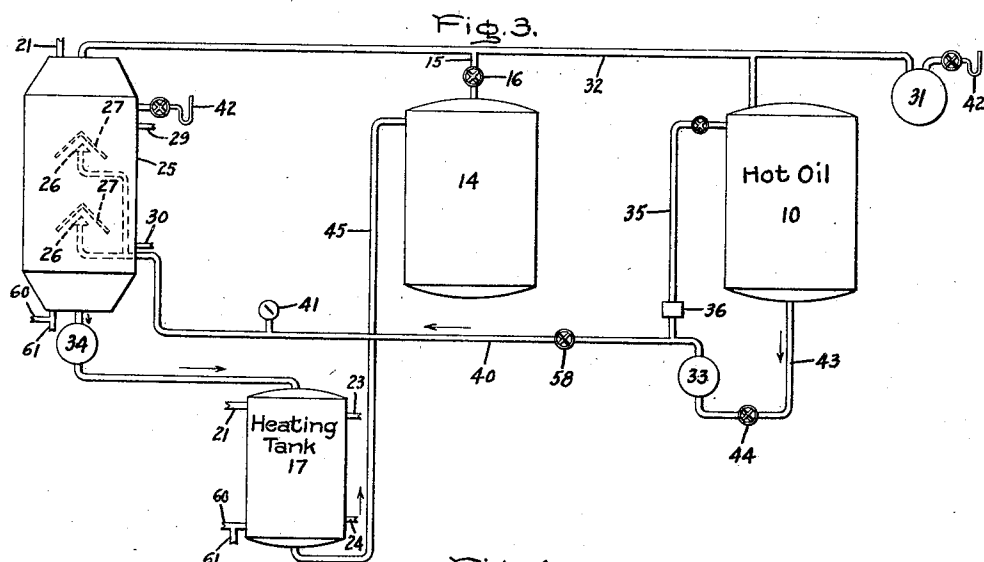
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METHOD OF DEGASIFYING LIQUID FOR ELECTRICAL INSULATING PURPOSES

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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METHOD OF DEGASIFYING LIQUID FOR
ELECTRICAL INSULATING PURPOSESCarl A. Piercy, Ballston Lake, and Eugene L.
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4 Claims. (Cl. 183—2.5)

Raw oil is very largely used as an impregnating medium to improve the dielectric strength of insulating material, such as paper for example. Such oil, after being carefully refined by existing methods to remove impurities, contains approximately 12% by volume of air and other gases, and is satisfactory for many electrical purposes but not for cable intended to carry high tension current, for example of the order of 132,000 volts and upwards. As a result, it has been the practice to degasify the oil to remove the contained gases, and to maintain it in such condition during its introduction and utilization as an impregnant.

For degasification, the prior practice has been to initially and continuously heat the raw oil to a substantial degree and while so heated to subject it to the effects of vacuum to facilitate the liberation of the contained gases. We have determined that the initial and continued application of heat in this manner throughout the process results in reducing the resistivity of the oil to the passage of electric currents; in increasing its power factor as an insulating medium and in increasing its acid value. These changes in the oil are accompanied by a change of color.

A serious objection to the initial and continuous use of heat throughout the entire cycle, as in the past, is that it is liable to cause burning of the oil to a greater or less extent, particularly at the beginning of the cycle, thereby resulting in serious damage to the electrical apparatus in which it is used. This is due largely or wholly to the fact that cold oil is introduced into an empty tank which because it is empty may have a higher temperature than it should have. The damage due to improper heating is not readily ascertained because the operations are necessarily carried out in a closed system and the degasified oil taken from such system is delivered to the apparatus in which it is used without being subject to suitable or visual inspection.

In brief, the changes in the oil brought about by initially and continuously heating it during degasification decreases its insulating value, the amount of such decrease depending upon various factors including the kind of apparatus used and the skill of the operators performing the work.

It has also been the prior practice to recirculate the oil within the same tank in which it is heated, as for example by taking oil from the bottom of the tank and discharging it into the top thereof, meanwhile maintaining the tank

under vacuum. Such procedure is open to the serious objection that oil which has only been partially degasified is being continuously discharged into a larger body of oil which has a higher gas content. This means that the circulation must be continued for a long time, such as 28 hours for example, in order to reduce the gas content of the entire body of oil to the desired extent. Tanks for this purpose are relatively large and expensive and may contain an amount of oil of the order of 500 gallons.

Our invention has for its object an improved method of degasifying oil or other liquid for use as an insulating material in electrical apparatus.

In carrying out our improved method, the major part of the contained gases are removed from the oil while it is in a cold state, i. e., at approximately room temperature whereby objectionable changes in the character of the oil are obviated. This is done by subjecting the cold oil in a cold degasifying tank or container to a vacuum and continuously removing the oil as it is degasified and conveying it to another vacuum tank where it is temporarily retained. This last mentioned tank for convenience may be termed a storage tank. To more effectively remove the gases during the vacuum treatment, which may be termed the cold stage of the process, the oil is caused to pass into the tank through suitable devices which discharge it in the form of a spray or sprays, thereby greatly increasing the surface of area of the oil exposed to the vacuum. Subsequently in what may be termed the hot stage of the process, the relatively small remnants of such gases are within practical limits removed by subjecting the oil to heat as by heating the tank or container and spraying the oil into the heated vacuum tank. The oil is continuously removed from the last mentioned tank and conveyed to a suitable vacuum storage tank. Heat may be imparted to the oil after it has had the greater portion of its contained air removed with practically no danger of injury because of the absence of any substantial amount of oxygen therein. This is particularly true where the process as in the present case separates what may be termed the "cold stage" of the cycle of operation from the "hot stage."

Stated more specifically, the cold oil is continuously delivered as through suitable spray means into what for convenience may be termed a degasifying tank. Now instead of circulating the oil over and over again on itself in the degasifying tank, the largely degasified oil is continuous-

ly removed from the degasifying tank and conveyed to another evacuated storage tank from which oil is withdrawn for the hot stage of the process. In the event that degasification of the cold oil by a single pass through the degasifier tank is not sufficient for a particular use, the operation may be repeated one or more times. By this arrangement of immediately separating degasified oil from that which contains a greater amount of gas, the length of time required for the process may be reduced as much as three-quarters over the prior procedure. If the degasification of the hot oil by a single pass is not sufficient, the operation may be repeated one or more times.

For a consideration of what we believe to be novel and our invention, attention is directed to the accompanying description and the claims appended thereto.

In the accompanying drawings is illustrated apparatus suitable for carrying out our invention in which Fig. 1 is a diagrammatic view of such apparatus; Fig. 2 illustrates the portion of the apparatus which is active during the second pass of cold oil through the degasifying tank; Fig. 3 illustrates the portion of the apparatus which is in active use during the first hot cycle or stage of operation; Fig. 4 illustrates the portion of the apparatus which is in use during the second hot or final stage of degasification; Fig. 5 is a detail view of the degasifying tank containing the spraying apparatus, and Fig. 6 is a detail view of the tank in which heat is imparted to the oil.

10 indicates a vacuum tank to which raw or untreated oil is admitted from a suitable source of supply, such as tank 11, by the pipe 12, subject to the control of a valve 13. 14 indicates a sealed storage tank of suitable size to receive and retain the charge of degasified oil ultimately received from tank 10. Tank 14 is maintained under vacuum by a pump as will appear later, through the pipe 15 having a controlling valve 16. 17 indicates a tank in which the oil is heated during the second or hot stage of operation of the method. The construction of this tank is shown more in detail in Fig. 6. The tank is sealed and contains top and bottom headers or tube sheets 18 in which the tubes 19 are secured at their respective ends. The space between the several tubes and the wall of the tank contains a body of oil 20 constituting an oil bath, said oil being separate from that undergoing treatment. Connected to the oil bath by a pipe 21 is an expansion tank 21' to take care of expansion of the oil when heated. The oil bath is suitably heated, as for example, by a coil of pipe 22 to which steam is admitted by the inlet pipe 23 and withdrawn by the outlet pipe 24. When it is desired to cool the tank, the supply of steam is shut off from the coil 22 and cooling water caused to flow therethrough. The temperature of the oil bath may readily be controlled by regulating the pressure and temperature of the heating steam. Other forms of controllable heat for the tank may be employed. Because in the first stage of operation the parts should be cold, meaning thereby that they should be at or about room temperature, the coil 22 after the steam is shut off by suitable valves is supplied with properly circulated cooling water. This arrangement avoids the use of a separate cooling coil although such a coil may be employed if desired. The main consideration is that the oil to be treated should be cold in the first stage of operation and

hot at the later stage. Care should be exercised to reduce the temperature of the heating tank before the succeeding charge of raw oil is admitted to the apparatus.

25 indicates a sealed tank, for convenience termed the degasifying tank, containing as shown in Fig. 5 one or more spray nozzles 26 and baffle 27 for each nozzle. The oil contained in the tank 25 when undergoing treatment during the second stage of operation is heated by the steam coil 28, steam being admitted by a suitable inlet pipe 29 and discharged by a suitable outlet pipe 30. In order to cool the tank for the first stage operation or operations, cold water is circulated through the coil after the steam is shut off for the same reasons indicated in connection with tank 17 and by similar means. The tank 25 has an expansion tank similar to tank 21' of Fig. 6 and for the same purpose.

31 indicates a vacuum pump which is connected to the tanks 10, 14 and 25 by the main pipe 32 and suitable branch pipes, some or all of the latter having shut off valves. The oil being treated is circulated by separately driven pumps 33 and 34 which may be of any suitable construction provided they do not admit air to the system. In order to prevent excess pressure in the system due to the circulating pump 33, a by-pass 35 is provided between the discharge side of the pump and the supply tank 10 containing cold raw oil. In this by-pass is located a loaded relief valve 36 of any suitable construction which opens toward the tank 10 when the predetermined pressure is exceeded. A valve 37 permits shutting off the passage of oil from the by-pass to the tank 14. As will appear later on, the pump 33 first circulates raw oil and then degasified oil. The same is true of the circulating pump 34. The completely degasified oil is removed from the apparatus by the outlet pipe 38 subjected to a control valve 39. In the delivery pipe 40 of the circulating pump 33 is a suitable pressure gauge 41. The vacuum pump 31 and the degasifying or spraying tank 25 are both provided with vacuum gauges 42 which may be of the U-tube or other type.

Assuming the tank 10 is to be filled or substantially filled with oil or other liquid and valve 37 closed, it is fed to the pump 33 by the pipe 43 subject to the control of the valve 44, the valve 50 being closed. From the pump, oil flows through pipe 40 to the sprays 26 in the tank 25. At this stage in the process, the tank 25 is kept cool by circulating water through the coil 28, Fig. 5, and evacuated by pump 31. From the tank 25, the oil from which the major part of the gases has been removed is fed to the vacuum storage tank 14 by pump 34 and pipe 45, the heating tank 17 being shut off by valves 53 and 53'. The tanks 14 and 25 are both connected by the pipe 32 to the vacuum pump 31 which is continuously operated. The pumps utilized are desirably operated by electric motors in the usual way subject to necessary controlling means. The capacity of storage tank 14 is desirably great enough to receive and retain the amount of oil originally contained in tank 10. During this stage or part of the process or method, the amount of gas contained in the raw oil is advantageously reduced to a small value, say 1% by volume as contrasted with approximately 12% contained at the start. The figure of 1% is not a definite one but is given by way of illustration, a limited variation being permissible. Should it be desired, cold oil may be caused to flow or pass a second time

through the cooled vacuum tank 25 for the purpose of further removing its contained gases. This is not always necessary but is desirable in some cases. Assuming that the oil after the first pass is contained in storage tank 14, for a second pass it flows therefrom by pipe 51, Fig. 2, through open valve 50 to the pump 33, the valve 44 being closed to shut off tank 10. Oil from the pump flows through pipe 40 to the degasifying tank 25 which at this stage is cold or at room temperature. The oil after having been sprayed by the nozzles 26 collects in the bottom of the tank and is fed by the pump 34 through shut-off valve 53 into the tank 17. The cold stage of the treatment ends when the oil leaves the tank 25. The tank 17 is heated and at this point the hot stage of the process begins. As the oil flows through the tank, it is heated by the steam coil 22 of Fig. 6 and flows through pipe 54 into tank 10 which initially contained raw oil, the valve 44 in its outlet pipe 43 being closed.

In Fig. 3 is indicated the portions of the apparatus in active use during what may be termed for convenience a "hot stage" of the process. During this stage, a suitable temperature for the oil being treated is between 90 and 100° C. due to the action of heating tank 17. Desirably in no part of the method at any time is the temperature of the oil permitted to exceed 105° C., and the nearer it is maintained within the limits of 90 to 100° C., the better will be the final results. In this figure, the tanks 17 and 25 are both heated, as by passing steam at the desired controlled temperature through their respective heating coils, as before explained. All three of the pumps 31, 33 and 34 are active and at this stage or step in the process, the oil after it is heated in tanks 25 and 17 flows into the storage tank 14 which as previously indicated is continuously under a vacuum and which previously contained partially degasified cold oil. The arrows indicate the passage of oil from the tanks 10, 25 and 17 into the tank 14. As above stated at this stage of the process, the oil is hot whereas in the earlier stage, it was cold.

In Fig. 4 is illustrated the active parts during the final stage of the process in which the degasified hot oil is contained in storage tank 14. Assuming the tank 14 to have been filled by the preceding step, the valve 57 in the inlet pipe discharging into the tank is closed as is also the valve 58 in the pipe 40 leading to degasifying tank 25. The valve 50 in the pipe 51 leading from the tank 14 to the suction side of the pump 33 is opened. A suitable connection is made from the discharge pipe 38 to the container designed to receive the degasified oil and valve 39 is opened. In making the connection between pipe 38 and the container to receive the oil, it is desirable to permit a limited amount of oil to escape to free the pipe beyond the valve of any contained air or moisture. The circulating pump 33 which had been temporarily stopped while the various valves were being manipulated is now in operation and degasified oil is pumped thereby from the storage tank 14 and delivered to the discharge pipe 38. At or shortly before the tank 14 is filled in the preceding step of the process, the heat should be shut off from tanks 17 and 25 and the cooling medium circulated through the coils so as to reduce the temperature of the tanks to approximately room temperature preparatory to receiving a new charge of raw oil. By this means the degasified oil entering the storage tank 14 may have its tempera-

ture reduced. No attempt has been made in the drawings to show the relative sizes of the tanks or their respective positions since the drawings are of a diagrammatic nature in order to more clearly illustrate the steps in the process. The sizes of the tanks and their respective positions, the pumps, valves, etc. should, of course, follow good engineering practice.

From the foregoing, it will be seen that in the cold stage of the process, raw oil is taken from the cold tank 10 and conveyed to the cold degasifying tank 25 where a major portion of the gases are removed by vacuum, and that instead of being recirculated on itself, as was the prior practice, the oil is pumped into the vacuum storage tank 14 from which it may again be conveyed through the cold degasifying tank 25 if a second pass is considered desirable; that in the first step of the hot stage of the process oil from which the gases have largely been removed is taken from tank 10 and delivered to degasifying tank 25 which is now heated. Thereafter the degasified oil is conveyed to the heated tank 17 and from it to the vacuum storage tank 14. This step in the operation removes all or practically all of the hot degasified oil from the tank 10 which initially contained raw oil, and delivers it to vacuum tank 14. Prior to delivering the fully degasified oil to the tank 14 in the last stage of the process, it may be cooled by circulating water about the tank 17. Having filled tank 14, the oil is removed for use by the particular parts shown in Fig. 4. It is to be particularly noted that at no time is the raw oil subjected to an amount of heat sufficient to injure it because of its contained air. It is recognized, of course, that even with the cooling coils, there may be a small amount of heat retained by the parts of the tanks. It is only after the major part of the gases, particularly air, have been removed from the oil that it is subjected to an appreciable amount of heat.

The tanks 17 and 25 are each provided with an inlet pipe 60 and valve for controlling admission of oil to the oil bath, and a valve controlled drain pipe 61. We have illustrated tanks 17 and 25 as imparting heat to the liquid by steam coils which surround them but other means may be employed for the purpose. We have also illustrated means for cooling the tanks. The main consideration is to provide controllable means for heating or cooling the oil as desired during the steps of the process.

The following data table shows the results obtained by the prior process wherein the oil was initially and continuously heated throughout the entire process, in comparison with the results obtained by our improved process where the oil is initially treated in a cold state to remove the major part of the gases, and then heated to permit removal of the remanent gases.

Method of degasifying	Dielectric strength kv. at 40° C.	Resistivity ohms per cm. ² X 10 ¹¹	A. S. T. M. color
Old process:			
Before degas.....	30	50	1.3
After degas.....	32	14	1.75
		27	1.60
		17	1.70
Our process:			
Before degas.....	30	41.7	1.4
After degas.....	35	41.7	1.4

The gas content as measured in the oil degasified according to the present process averages

0.2% by volume. The color numbers are those of the American Society of Testing Materials, National Paint Association.

Reference has been made to the degasification of oil because of its extensive use as an insulating fluid but other liquids used for the same purpose may be degasified in the same manner.

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

1. The method of degasifying liquid to improve its insulating properties which comprises supplying cold raw liquid to a supply tank, continuously removing the liquid from the supply tank and spraying it when in a cold state into a cold tank where it is partially degasified, continuously removing the partially degasified cold liquid from the degasifying tank and temporarily delivering it to a storage tank, maintaining a vacuum in both of said tanks, continuously removing the partially degasified liquid from the storage tank and passing it into and through a heating tank for heating the liquid, continuously removing the liquid from the heating tank and returning it in its heated condition to the original supply tank, continuously removing heated liquid from the supply tank and delivering it for a second time to the degasifying tank, heating the degasifying tank to assist in liberating gas from the liquid, removing the heated degasified liquid from the degasifying tank and delivering it for a second time to the storage tank from which it is withdrawn for use and subsequently cooling the degasifying tank and the heating tank preparatory to admitting a second charge of raw liquid thereto.

2. The method of degasifying liquid to improve its insulating properties which comprises supplying cold liquid to a supply tank, removing the liquid from the supply tank and spraying it in a cold state into a cold degasifying tank where its contained gases are largely removed by vacuum, removing the largely degasified liquid therefrom and delivering it to a cold storage tank where it is temporarily retained, maintaining a vacuum in both of said tanks, removing the largely degasified cold liquid from the storage tank and passing it into and through a heating tank where the liquid is heated, removing the heated liquid from the heating tank and returning it to the original supply tank, removing the heated liquid from the supply tank and delivering it for a second time to the degasifying tank where it is subjected to the effects of vacuum, supplying heat to the degasifying tank to facilitate removal of gas from the liquid, removing the heated degasified liquid from said tank and delivering it for a second time to the cold storage tank, removing the liquid for use from the storage tank without exposing it to the effects of the atmosphere, and subsequently cooling both the degasifying tank

and the heating tank preparatory to admitting a second charge of liquid to said tanks and to the supply tank.

3. The method of degasifying liquid to improve its insulating properties which comprises supplying cold raw liquid to a supply tank, continuously removing the liquid from the supply tank and spraying it when in a cold state into a cold degasifying tank where it is largely degasified, continuously removing the largely degasified cold liquid from the degasifying tank and temporarily delivering it to a storage tank, maintaining a vacuum in both of said tanks, continuously removing the largely degasified liquid from the storage tank and passing it into and through a heating tank for heating the liquid, continuously removing the liquid from the heating tank and returning it in its heated condition to the original supply tank, continuously removing heated liquid from the supply tank and delivering it for a second time to the degasifying tank, heating the degasifying tank to assist in liberating gas from the liquid, removing the heated degasified liquid from the degasifying tank and passing the hot liquid from the degasifying tank through a cooling tank for reducing its temperature, delivering the liquid for a second time into the storage tank from which it is removed for use, and subsequently cooling the degasifying tank preparatory to admitting a second charge of raw liquid thereto.

4. The method of degasifying insulating liquid to improve its insulating properties which comprises supplying cold raw liquid to a supply tank, continuously removing liquid from the supply tank and by a first pump spraying it in a cold state into a cold degasifying tank wherein it is largely degasified, continuously removing the so degasified liquid from the tank and by a second pump delivering it to a storage tank where it is temporarily retained, maintaining both tanks under vacuum, continuously removing the largely degasified liquid from the storage tank and by the first pump returning it to the degasifying tank for a second pass therethrough, continuously removing liquid from the degasifying tank by the second pump and causing it to pass through a heating tank and thence into the original supply tank, continuously removing hot oil from the supply tank and by the first pump returning it to the degasifying tank, heating the degasifying tank, continuously removing hot degasified liquid from the tank by the second pump and delivering it to the storage tank, and withdrawing degasified liquid from the storage tank by the first pump and delivering it to an outlet pipe for subsequent use.

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