July 25, 1933. C. J. RODMAN ET AL 1,919,669

HYDROCARBON MINERAL OIL

Filed April 30, 1929 2 Sheets-Sheet 1

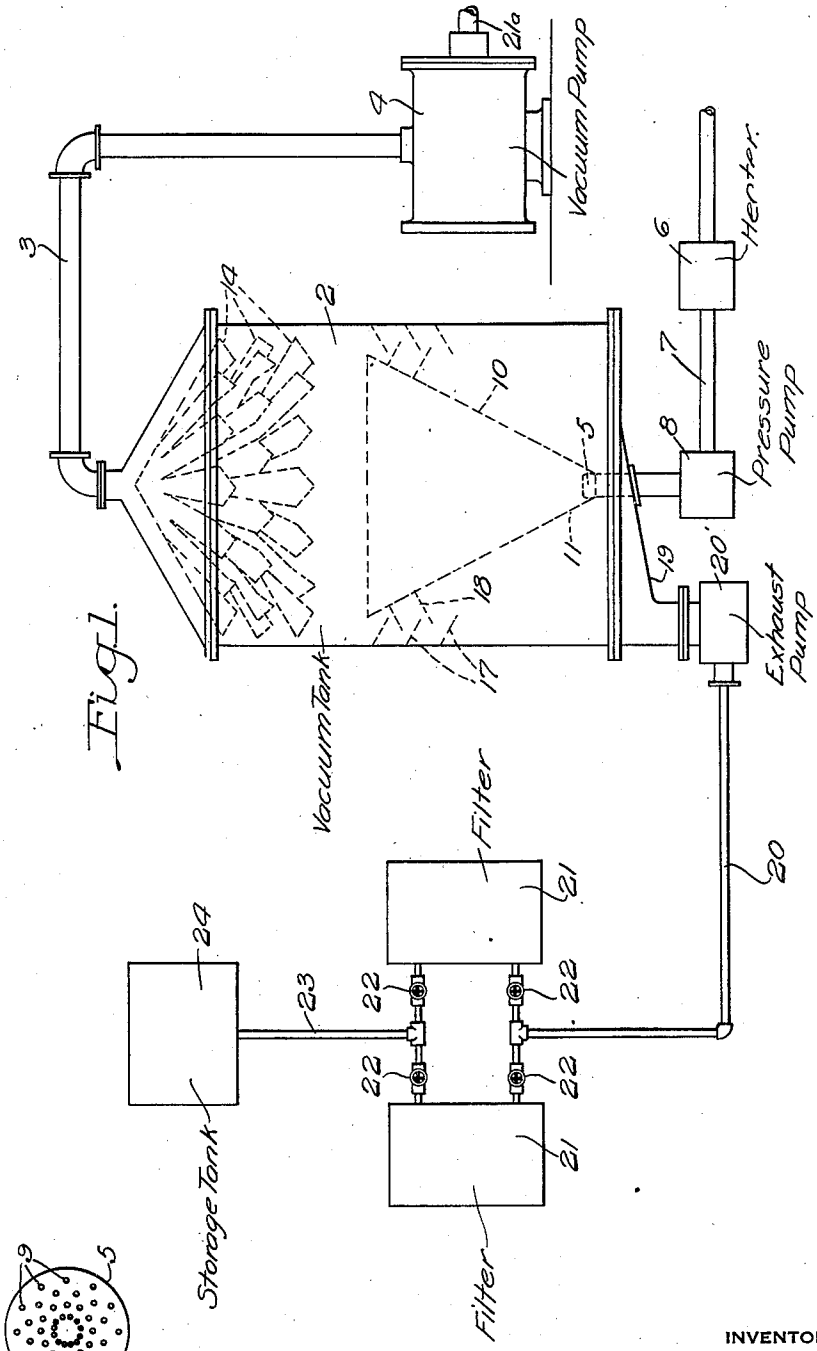


Fig. 1.

Fig. 5.

INVENTORS

Clarence J. Rodman
Russell P. Mennire
by Byrnes, Stebbins & Parmelee
Attys

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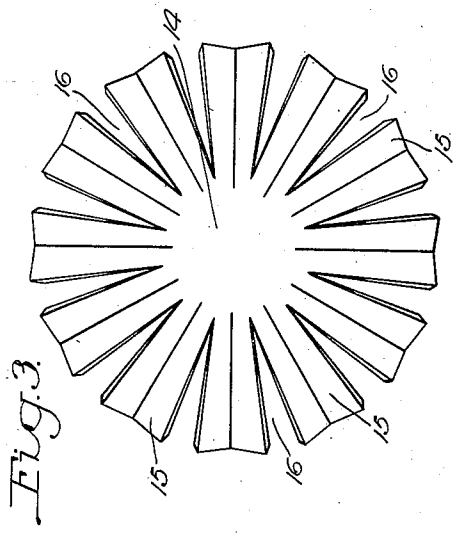


Fig. 3.

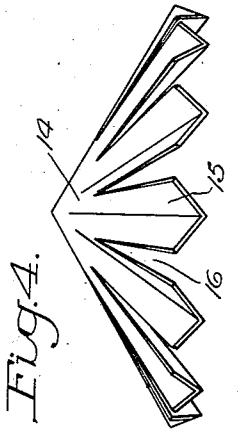


Fig. 4.

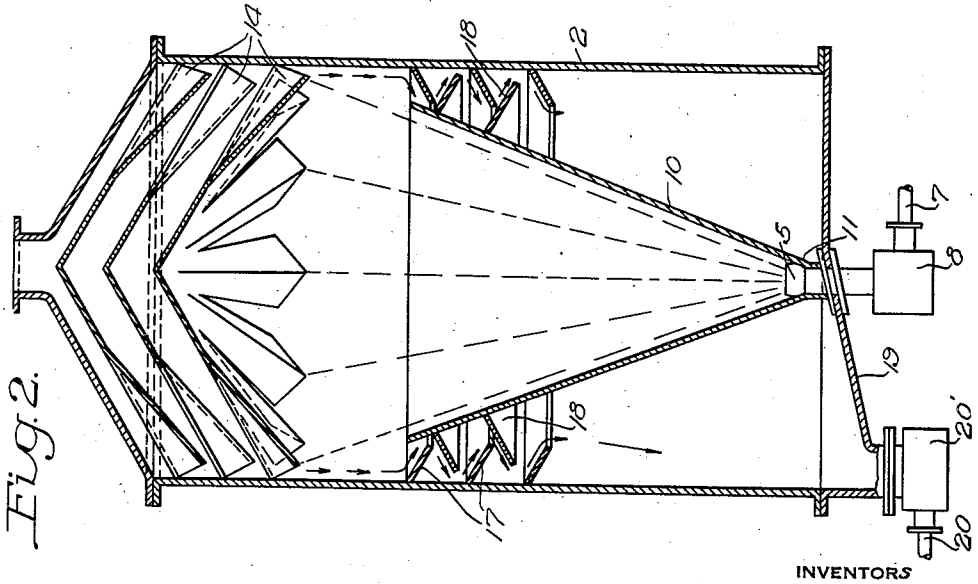


Fig. 2.

INVENTORS

Clarence J. Rodman

Russell P. Mennie

by Byrnes, Stebbins & Parmelee

Attys

Patented July 25, 1933 1,919,669

UNITED STATES PATENT OFFICE

CLARENCE J. RODMAN AND RUSSELL P. DUNMIRE, OF ALLIANCE, OHIO, ASSIGNORS TO THE BUCKEYE TWIST DRILL COMPANY, OF ALLIANCE, OHIO, A CORPORATION OF OHIO

HYDROCARBON MINERAL OIL

Application filed April 30, 1929. Serial No. 359,301.

This invention relates to mineral hydrocarbon oils, particularly oil of the type adapted for use as an insulating and cooling medium in electrical apparatus. Oil produced according to the process herein described has a high dielectric strength and also the unusual property of increasing in dielectric strength upon standing in contact with the atmosphere, even though the atmosphere contains considerable moisture. Our process is adapted for the purification of new oils, that is, oils which have not been used previously in electrical apparatus or to the reconditioning of oils which have been used previously in electrical apparatus, in order to render them anhydrous, free from dissolved gases, moisture and volatile hydrocarbons.

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 already 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 size contribute to the deterioration of the insulating value of the oil.

Heretofore it has been attempted to remove water and suspensions by gravity, by centrifugal force, and by filtering. These processes, however, have been only partially successful because they failed to remove water of true solution, volatile hydrocarbons and dissolved gases such as oxygen.

In accordance with the present invention we spray the oil to be purified into a vacuum. The oil introduced into the vacuum chamber is preferably under a pressure of from 50 to 100 pounds per square inch, and the vacuum within the vacuum chamber is maintained at as low a pressure as is practicable. We prefer to maintain the vacuum in the vacuum chamber at a pressure of less than one-half pound per square inch. When the oil under pressure is introduced into the vacuum chamber it is subjected to a sudden pressure drop or shock which causes the water and gases to escape therefrom. The oil after having water and gases removed therefrom is pumped through suitable filters and delivered to a storage tank.

In the accompanying drawings which illustrate the present preferred embodiment of apparatus suitable for carrying out our process,

Figure 1 shows in a diagrammatic manner the arrangement of the purifying apparatus,

Figure 2 is a vertical section of the vacuum tank,

Figure 3 is a plan view of one of the baffles for collecting and deflecting the liquid,

Figure 4 is an elevation of the baffle shown in Fig. 3, and

Figure 5 is a front elevation of the spray nozzle, showing the arrangement of spray openings.

Referring to the drawings, there is shown a vacuum tank 2 connected by a pipe 3 to a vacuum pump 4 which maintains the vacuum chamber under reduced pressure. The tank 2 has a nozzle 5 arranged in its bottom for spraying the oil which is to be purified. The oil is heated in a heater 6 to about 90–160° F., preferably to about 140° F. and is

supplied to the nozzle 5 through a pipe 7 and a pressure pump 8. The pressure pump raises the pressure of the oil supplied to the nozzle so that as it is sprayed into the vacuum tank it is subjected to a sudden shock which releases dissolved gases and water therefrom. The nozzle 5 is formed with a series of concentric openings 9 which spray the oil upwardly in the vacuum tank in a series of concentric cones. The spray is guided in its travel upwardly through the vacuum tank by a conical baffle 10 having its apex 11 extending downwardly and surrounding the nozzle. A series of conical baffles 14 are arranged in the tank above the baffle 10. These baffles are shown in detail in Figs. 3 and 4. They are formed from a circular piece of metal which is slit to form segments 15. Each of these segments is then bent into a trough shape as indicated in Fig. 4. After the segments have been bent to form the troughs, the baffle consists of trough-like segments 15 separated by spaces 16. As shown, three of these conical baffles are arranged one above the other in the vacuum tank. They are arranged so that the segments of the middle baffle are in alinement with the spaces 16 between the segments of the upper and lower baffles. The oil sprayed from the nozzle 5 impinges upon the series of baffles 14.

Due to the arrangement of the baffles as described, a tortuous path is formed between the segments of adjacent baffles. The oil impinges upon the segments of the baffles and drops down into and is collected by the segments of the next lower baffle. It flows in the downwardly and outwardly extending troughs and is collected by annular baffles 17 secured to the inside of the vacuum tank. Other baffles 18 connected to the conical baffle 10 cooperate with the baffles 17 to cause the oil to follow the tortuous path indicated by the arrows in Fig. 2, after which it flows to the bottom of the tank. The bottom 19 of the tank slopes downwardly so as to cause the oil to collect and be delivered to the pipe 20 by means of an exhaust pump 20′.

As the oil sprayed from the nozzle 5 impinges against the baffles 14 and is collected thereby as above described, the gases and moisture removed therefrom the liquid by the vacuum flow out of the top of the tank through the pipe 3 and vacuum pump 4 and are exhausted through a pipe 21*a*.

The purified oil from which the moisture and gases have been removed flows from the vacuum tank through the pump 20′ and pipe 20 to one of the filters 21. The filters remove any suspended particles which may have been present in the liquid. In the drawings two filters 21 are shown and the system is provided with valves 22 so that one of the filters may be used while the other is being cleaned. The filtered oil flows through a pipe 23 to a storage tank 24.

We have found that by raising the pressure of the oil before it enters the vacuum tank, and then introducing it into the tank which is maintained at a very low pressure, we accomplish the removal of water and gases more efficiently than if it were introduced into the vacuum under atmospheric pressure. We find that the sudden drop in pressure gives a jarring or cracking action which causes the water and dissolved gases to be expelled therefrom. The apparatus hereinabove described causes the oil sprayed from the nozzle 5, after having impinged against the conical baffles 14, to follow a tortuous path before it leaves the vacuum tank. In this manner the liquid is subjected to the action of the vacuum for a relatively long time, so that the dissolved gases and water have an opportunity to escape from the oil. The apparatus causes the efficient removal of moisture and gases from oils so as to increase their dielectric properties. The apparatus is of simple construction involving the use of no revolving parts.

We have found that oil purified in accordance with our invention has certain desirable properties which are not present in oil produced by other methods. For example, we have found that oil treated in accordance with our process, after having been allowed to stand in contact with the atmosphere, has an increased insulating value or dielectric strength. It would ordinarily be expected that if oil were allowed to stand in contact with the atmosphere, particularly moist atmosphere, the dielectric strength of the oil would be decreased. We have found further that an oil treated in the above described apparatus has a greater dielectric strength after having stood in contact with the atmosphere, even if the atmosphere is moist, than it had when it was first delivered from the purifying apparatus. A sample of oil was tested soon after it had come from the apparatus. This sample was found to have a dielectric strength of 35 kilovolts measured at the standard one-tenth inch gap using parallel electrodes one inch in diameter. The oil was allowed to stand in contact with the atmosphere for about three weeks and a second sample was tested under the same conditions. The second sample had a dielectric strength of considerably over 40 kilovolts.

The exact theory which causes oil purified in accordance with our invention to increase in dielectric strength has not yet been definitely determined. We believe, however, that it is due to the fact that in our purification process certain impurities in the oil which tend to absorb water from the atmosphere are substantially entirely removed from the oil. After oil has been so purified it will not absorb moisture from the atmosphere so as to

decrease in dielectric strength, but will, on the contrary, actually increase in dielectric strength upon exposure to the atmosphere. The reason for the increase in insulating value may be accounted for by the oil absorbing certain gases without, however, absorbing moisture.

Whether or not our theories are correct, we have found that there is an actual increase in the insulating value of oil purified in accordance with our invention, after the oil has been allowed to stand for some time, and we do not limit ourselves to the theories which we have advanced to account for the increase in insulating value of the oil.

We have illustrated and described the present preferred embodiment of an apparatus suitable for carrying out our process. We also have described in detail the manner of practicing the process and have advanced certain theories which we now believe account for certain unlooked for phenomena. It is to be understood, however, that the invention may be otherwise embodied or practiced within the scope of the following claims.

We claim:—

1. Mineral hydrocarbon oil produced by heating the oil to a temperature of 90–160° F. and spraying it under superatmospheric pressure into a rarified atmosphere maintained under a high vacuum to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having the property of increasing in dielectric strength upon exposure to moist atmosphere.

2. Mineral hydrocarbon oil produced by heating the oil to a temperature of 90–160° F. and spraying it under superatmospheric pressure into a rarified atmosphere maintained under a high vacuum to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having a dielectric strength of more than 35 kilovolts when tested under standard conditions using a $\frac{1}{10}$ inch gap and parallel electrodes 1 inch in diameter.

3. Mineral hydrocarbon oil produced by heating the oil to a temperature of 90–160° F. and spraying it under a pressure of 50–100 pounds per square inch into a rarified atmosphere maintained under a high vacuum to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having the property of increasing in dielectric strength upon exposure to moist atmosphere.

4. Mineral hydrocarbon oil produced by heating the oil to a temperature of 90–160° F. and spraying it under a pressure of 50–100 pounds per square inch into a rarified atmosphere maintained under a high vacuum to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having a dielectric strength of more than 35 kilovolts when tested under standard conditions using a $\frac{1}{10}$ inch gap and parallel electrodes 1 inch in diameter.

5. Mineral hydrocarbon oil produced by heating the oil to a temperature of 90–160° F. and spraying it under a pressure of 50–100 pounds per square inch into a rarified atmosphere maintained under a pressure of less than ½ pound per square inch to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having the property of increasing in dielectric strength upon exposure to moist atmosphere.

6. Mineral hydrocarbon oil produced by heating the oil to a temperature of 90–160° F. and spraying it under a pressure of 50–100 pounds per square inch into a rarified atmosphere maintained under a pressure of less than ½ pound per square inch to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having a dielectric strength of more than 35 kilovolts when tested under standard conditions using a $\frac{1}{10}$ inch gap and parallel electrodes 1 inch in diameter.

7. Mineral hydrocarbon oil produced by heating the oil to a temperature below 120° F. and spraying it under superatmospheric pressure into a rarified atmosphere maintained under a high vacuum to release moisture and gases from the oil, and separating the moisture and gases from the oil, the oil having the property of increasing in dielectric strength upon exposure to moist atmosphere.

CLARENCE J. RODMAN.
RUSSELL P. DUNMIRE.

CERTIFICATE OF CORRECTION.

Patent No. 1,919,669. July 25, 1933.

CLARENCE J. RODMAN, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 52, strike out the words "the liquid"; page 3, lines 5 and 10, respectively, after "value" insert "or dielectric strength"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of August, A. D. 1933.

M. J. Moore.

(Seal) Acting Commissioner of Patents.