

June 2, 1936.

H. F. FISHER ET AL

2,042,887

PROCESS AND APPARATUS FOR DEWAXING OILS

Filed Oct. 9, 1933

Fig. 1.

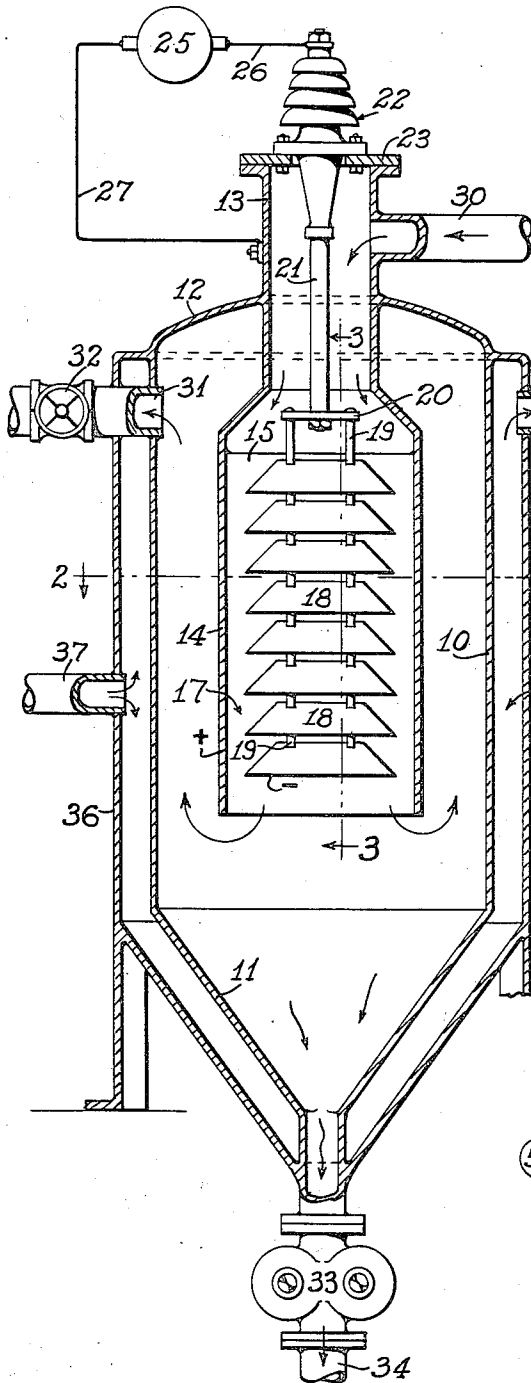


Fig. 2.

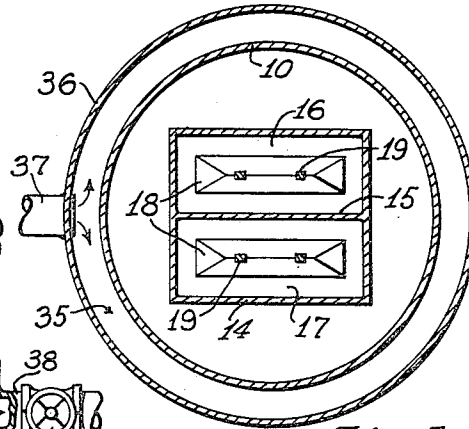


Fig. 3.

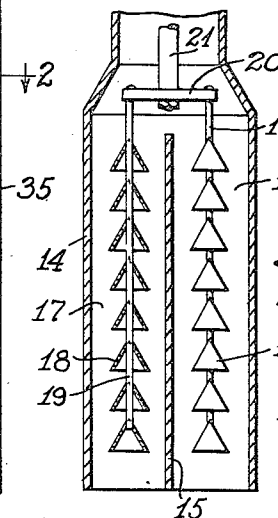


Fig. 5.

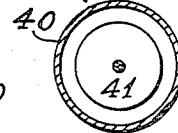


Fig. 4.

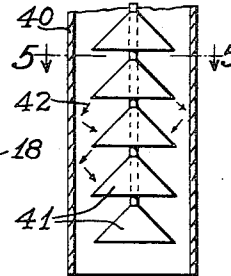


Fig. 6.

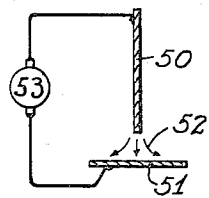
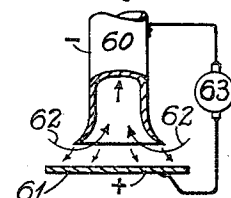


Fig. 7.



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UNITED STATES PATENT OFFICE

2,042,887

PROCESS AND APPARATUS FOR
DEWAXING OILS

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Application October 9, 1933, Serial No. 692,724

2 Claims. (Cl. 204—24)

This invention relates to the separation of wax from wax-bearing oil. The invention relates more particularly to the electrical separation of suspensions of precipitated wax from oil.

Many crude oils from which lubricating oil is produced contain paraffin or wax which is carried over and remains in the lubricating oil fractions derived therefrom. As the temperature of these lubricating oil fractions containing wax or paraffin is sufficiently lowered, wax or paraffin is found to begin to be precipitated from solution therein in the form of a colloidal suspension, and as the temperature is further lowered more wax is precipitated until the resulting oil and wax mixture finally congeals to a semi-plastic or solid mass. Lubricating oil fractions containing relatively large quantities of wax will have relatively high congealing temperatures, while oils containing small quantities of wax will have correspondingly lower congealing temperatures. Thus, it is apparent that the presence of wax limits the minimum temperature at which lubricating oils containing it can be used. The pour point of lubricating oil is that temperature 5° F. above the temperature at which the oil, under certain specified test conditions, congeals or ceases to flow, and it is apparent, as stated hereinbefore that the presence of wax or paraffin in lubricating oil largely governs this characteristic of the oil. Therefore, in the production of lubricating oil it is necessary to remove a large proportion of the wax or paraffin in order to lower its pour point, and thereby extend the lower range of temperatures at which it retains its lubricating qualities.

The separation of wax or paraffin from lubricating oil may be accomplished by a number of well known processes, three of which are the "cold settling process", the "cold pressing process", and the recently developed "electric process". In the separation of wax from wax-bearing oils by the "electric process", the wax-bearing oils may be mixed with suitable diluents, the solution of oil and diluent chilled to a temperature at which wax precipitates from solution, and the resulting mixture of wax-bearing oil, diluent, and precipitated-wax suspension subjected to an electric field between electrodes in contact with said solution. A major portion of the chilled precipitated-wax suspension under the influence of the electric field is removed in the form of a deposit or plate upon the electrodes between which the said treating field is maintained. The oil diluent solution thus freed from wax is then distilled to recover the diluent and the wax-free oil.

After a short period of electric treating to remove precipitated wax from the chilled wax-bearing oil according to the hereinbefore described electric process, the electrodes upon which the wax is deposited become thickly coated, and it is necessary that this wax coat be continuously removed in order to maintain the apparatus in operative condition. If the wax is allowed to accumulate on the electrodes to a very great thickness it impairs the electric precipitating and depositing action and reduces the cross sectional area of the passageway between the electrodes through which the oil undergoing treatment flows. This reduction of cross sectional area of treating space results in either a decrease in the thoroughness of the treating, or a substantial reduction in the capacity of the treater. Furthermore, the wax may in time accumulate to the extent that the entire treating space between the electrodes is filled with it and the wax-bearing oil either forced to channel its way through the wax or be stopped entirely from flowing. The means heretofore employed for removing deposited wax from the electrodes have been in the form of scrapers which return the wax accumulations to the oil diluent solution from which they were formerly deposited. Subsequent separation of the thus removed wax from the treated oil was accomplished by settling.

Apparatus for the electric deposition of wax from oil may be constructed so as to operate over long periods of time without attention, by providing said apparatus with a large area of electrode surface and suitable means for maintaining this surface reasonably free from deposited wax.

Objects of this invention, therefore, are to provide apparatus for dewaxing oil which will be efficient, of high capacity, and capable of operating for long periods of time without attention.

Other objects are to provide an electric treater for dewaxing oil in which the completeness of the separation of precipitated wax from the wax-bearing oil will be a maximum, in which the electric treating zone will be continuously maintained in operative condition by continuous removal therefrom of accumulated wax, and in which the said removal of accumulated wax is accomplished by impingement of electric windage convection currents of the liquid undergoing treatment against the surfaces of the electrodes, and where said removal of deposited wax is continuously accomplished in the aforesaid manner without employment of mechanical means therefor.

It is another object of this invention to subject the wax-precipitate particles to a repellant field in a direction either concurrent or counter-current to the liquid flow in the treater to aid separation and settling.

In general, these objects are attained according to the invention by providing an electric treater incorporating an electrode structure wherein one electrode takes the form of a flat surface of extensive area, and the opposite electrode takes the form of a plurality of thin points or edges of relatively small effective area positioned in electrostatic relationship with respect to the first mentioned electrode, and wherein, according to the well known phenomenon of electric windage a rapidly moving current of a fluid or liquid is caused to flow from the electrode of smallest area toward the electrode of largest area, and wherein the electrode system is constructed so as to bring this phenomenon into play with sufficient intensity to dislodge wax accumulations forming in or on said electrodes.

These objects are also attained by producing an electric field in the treater which has in effect a downward component, and which acts to repel the wax precipitate downward to aid separation and settling.

The invention broadly stated includes a process and apparatus for electrically removing wax from wax-bearing oil wherein the electrodes included in the apparatus, when operated according to the process, are maintained free from wax deposit and in operative condition by means of local convection currents in the oil undergoing treatment between electrodes, of sufficient velocity and intensity to continuously dislodge and/or prevent deposit and accumulation of said wax, said local currents being caused by the electric phenomenon known as electric windage.

The invention more specifically resides in a process and apparatus adapted to carry on the process, wherein the electrode surfaces are maintained in contact with the oil to be dewaxed, and are constructed so as to be self-cleaning, and wherein the wax precipitated in the oil is caused to agglomerate and/or be momentarily deposited on an electrode and immediately dislodged after deposition by currents set up in the liquid, said currents being caused by the effect of the electric potential between the electrodes, known as the "electric windage effect", and wherein the wax deposit thus removed from the electrode is in the form of agglomerations large enough to be readily settled, and wherein the field is directional in effect, tending to repel the wax particles of the wax precipitate downward through the liquid to aid settling and separation.

The invention also resides in apparatus adapted to utilize the effect of electric windage comprising one or a plurality of electrode systems, each system comprising a pair of electrodes of opposite polarity and of high area ratio, one with respect to the other. The invention also resides in apparatus and process wherein wax precipitate is separated from a stream of oil by counter-current repulsion of the wax-precipitate particles.

Other objects, advantages, and features of the invention will be evident hereinafter.

The accompanying drawing illustrates one embodiment of the invention in which Figure 1 is a sectional elevation through the vertical axis of the treater, Figure 2 is a plan section through the treater, taken at line 2—2 in Figure 1, Figure 3 is a section through the electrode system

taken on line 3—3 of Figure 1, Figure 4 is a section similar to that of Figure 3, taken through an optional electrode structure, Figure 5 is a plan section taken on line 5—5 of Figure 4, Figure 6 is an elevation of an elementary electrode system adapted to illustrate "electrical windage effect", and Figure 7 is a partial sectional elevation through an electrode system making use of the phenomenon illustrated in Figure 5, for separating colloidal particles from a fluid stream.

The treater unit illustrated in Figure 1 is provided with a vertical, cylindrical tank or enclosure 10 having an inverted conical bottom 11, and a spherical-shaped top 12. Centrally and axially supported by said top 12 is an electrode system comprising an upper cylindrical section 13 closed at the top by a flange 23, and a lower rectangular section 14 open at the bottom and suspended in turn by said cylindrical section 13. The rectangular portion 14 is provided with a centrally disposed vertical partition 15 to form two rectangular passageways 16 and 17. The inner surfaces of these two rectangular passageways 16 and 17 which are constructed of metal constitute the outer electrodes of the electrode system. Also included in the electrode system are inner electrodes comprising a series of roof-like pieces of sheet metal 18 equally spaced one above the other in vertical alignment and centrally supported within the rectangular spaces 16 and 17 by bars 19. Bars 19 are in turn spaced and supported by means of a yoke 20 and a rod 21. The inner electrode assembly including the roof-like electrode units 18, spacing bars 19, and rod 21 is supported through and electrically insulated from the treater body by a lead-in insulator bushing 22 which rests both upon flange 23 and the hereinbefore described cylindrical section 13.

Electrical connection is made to the inner electrode assembly from a high potential generator 25 through conductor 26, said lead-in insulator bushing 22 and rod 21. The circuit is completed to the generator 25 from the outer electrode 14 through the cylindrical support 13, the body of the treater and the return ground connection 27.

The feed to the treater is introduced through inlet connection 30 into the upper supporting cylindrical section 13 from where the incoming liquid flows downward between the electrodes 14 and 18. An outlet from the treater is provided through connection 31 near the top of the cylindrical enclosure 10. A wax pump 33 is provided at the apex of the inverted conical bottom for the ejection of the wax settlings through line 34. A jacket 36 surrounds the sides and bottom of the treater unit and is provided with an inlet 37 and an outlet 38 through which refrigerants may be circulated for the purpose of cooling or maintaining the temperature of the treater contents constant.

Figure 4 illustrates an optional electrode system structure in which the outer electrode takes the form of a cylinder 40 and a series of vertically and centrally spaced conical electrodes 41 suitably supported therein. In operation the electrical treating potential is imposed between the said cylindrical electrode 40 and the conical electrodes 41.

Figure 6 illustrates an electrode arrangement wherein a bar electrode 50 is perpendicularly positioned endwise or edgewise with respect to a flat plate electrode 51. Electrodes 50 and 51 are adapted to be immersed in a fluid similar to that which is to be treated in the treater and this figure is presented here to illustrate and explain

the electric windage effect obtainable in such a liquid where an electrode of small area is placed in spaced relationship to an electrode surface of large area. An electric potential is impressed across the electrodes 50 and 51 by means of a suitable generator 53.

Figure 7 illustrates an electrode system with an arrangement similar to that of Figure 6 in which the principle explained in connection with Figure 6 is employed to effect a countercurrent repulsion of a wax precipitate through a fluid stream. The electrodes in this case take the form of an outlet pipe 60 positioned opposite a flat electrode surface 61. Pipe 60 and electrode 61 are adapted to be immersed in the liquids undergoing treatment and said liquid caused to flow from the outside through the spaces between the end of the pipe 60 and the electrode 61 and out through pipe 60. An electric potential is impressed across the electrodes 60 and 61 by means of a suitable generator 63.

The operation is as follows:

The wax-containing oil which has been pre-cooled to a temperature at which wax is precipitated from solution therein enters the treater through inlet connection 30, flows downward through cylindrical electrode supporting section 13 and into and through the spaces 16 and 17 between the electrode surfaces of electrodes 14 and 18. It has been found that the wax particles of a majority of wax precipitates in oil are negatively charged. Therefore, by maintaining the outer electrode surface positively charged, wax tends to deposit thereon, and unless constantly removed, continues to accumulate there in a layer or coating during treatment. The prevention of this accumulation is accomplished by causing localized convection currents of fluid to impinge upon the active surface of electrode 14 with sufficient intensity to wash or break away the wax deposit tending to form thereon, before any substantial accumulation can take place. These localized convection currents of fluid are induced by an electrical effect known as electric windage. When two electrodes are placed one with respect to the other, as shown in Figure 5, wherein an electrode surface of small area is positioned opposite to an electrode surface of large area, a stream of the fluid therebetween is set into motion in a direction from the electrode of small area toward the electrode of large area, as indicated by the arrows 52. This principle is incorporated in the electrode system in the treater. The electrode 14 on which the wax tends to deposit is of a large continuous surface, while the opposite electrode 18 is of relatively small area and provided with a plurality of projections or edges of small area. Thus windage convection currents are induced in the oil between the electrodes, flowing from the inner electrode 18 outward and impinging upon the outer electrode 14. By constructing the inner electrode of a series of superimposed vertically spaced roof-like pieces of sheet metal with edges directed obliquely downward, the electrically induced fluid currents are combined to result in a downward component along the outer electrode surface. By proper spacing of these electrodes the combined windage currents may be made sufficiently intense, for a given potential, to dislodge the wax being deposited.

The distribution of areas of the elements 18 of the central electrode is such as to cause, in effect, a downwardly and outwardly directed electric field. The wax particles being charged to the

same polarity as the inner electrode are thus repelled in a downward direction parallel with said downwardly directed field. Thus, the tendency is to cause these wax precipitate particles to move downward through the liquid and out from the electrode system enclosure toward the bottom of the container 11, where further settling and separation can take place. During operation a unidirectional electric potential gradient in the region of 45,000 to 60,000 volts per inch is maintained between the electrodes and this high potential is supplied from a high tension generator 25 through conductor 26, lead-in insulator bushing 22 and rod 21 to the inner electrodes 18. The return circuit is completed from the outer electrode 14 through the treater body and conductor 27 to the generator 25.

The oil, after passing between the electrodes and being treated as described above, passes into the settling space inside of the container 10 below and surrounding the electrode assembly where the wax agglomerations are allowed to separate and settle to the bottom 11 of the treater. The accumulated wax settlings are withdrawn from the bottom 11 of the treater unit container 10 by means of the wax pump 33 and disposed of through line 34. The oil from which the wax is being removed by settling after electrical treating, slowly rises through the settling zone inside the container 10 as freshly treated oil enters through the treating zone between the electrodes, and the thus dewaxed oil as it reaches the top is continuously withdrawn through outlet pipe 31.

The oil withdrawn from outlet 31 may in some cases be subjected to an additional final stage of settling in a separate settling tank, to remove the last traces of precipitated wax.

When it is desired to dissolve the wax-bearing oil in a suitable diluent before treating to maintain the desired fluidity at the low temperature at which the process is carried on, this dilution may be effected before introduction of the resulting solution into the treater through line 49. Under some conditions of operation it is desirable to employ a normally gaseous hydrocarbon diluent, such as liquid propane, in solution with the oil in the treater to accomplish either partial or complete refrigeration. As described hereinabove, this diluent may be added under pressure to the flowing stream of wax-bearing oil prior to its introduction into the treater and evaporation of the thus added diluent may be allowed to take place at reduced pressure either inside the treater or preferably outside the treater in a separate expansion chamber prior to its introduction into said treater.

When the wax-bearing oil-diluent solution is introduced into the treater under pressure through inlet 30, the pressure on the thus introduced solution may be regulated by means of valve 32 on the outlet line 31. In operation it is preferred to precool the solution prior to its introduction into the treater and to maintain a pressure upon the precooled treater contents sufficient to prevent evaporation of the volatile solvent therein in sufficient quantity to cause ebullition and agitation which is detrimental to successful settling and separation of the agglomerated wax.

Instead of employing normally gaseous diluents in the wax-bearing oil for refrigeration, it is sometimes desirable to cool the oil prior to introduction into the treater, by indirect heat exchange with a refrigerant. This is desirable where the oils undergoing treatment are sufficiently fluid at the low temperatures, to be treated without dilu-

ents or where heavy non-volatile diluents are employed.

A careful regulation of the temperature of the liquid contents in the treater is necessary under all conditions of operation and this is accomplished by means of circulating or introducing a refrigerant into the jacketed space 35 between the treater unit 10 and the jacket 36. A refrigerant such as a normally gaseous hydrocarbon may also be used here and regulation of temperature accomplished by evaporation thereof in the jacket 36 at a regulated pressure. In this case the normally gaseous hydrocarbon enters the jacket 36 through inlet connection 37 under pressure and the vapors withdrawn through outlet 38 and released through pressure regulator valve 39. The temperature in the treater is ordinarily maintained between -20° and -40° F. Obviously any suitable refrigerant or cooling medium can be employed in the jacket 36 to accomplish the desired refrigeration and/or temperature control.

Figure 4 illustrates a modified electrode system comprising an outer cylindrical electrode 40, with a series of centrally positioned inner conical electrodes 41. When electrically charged at high potential electric windage convection currents are electrically induced in the fluid between the electrode 40 and the oppositely positioned edges of the conical electrodes 41, according to the principle described hereinbefore in connection with the rectangular roof-shaped electrodes of Figures 1, 2, and 3. Since the inner and outer surfaces of the cones 41 are downwardly sloping, windage currents from the edges thereof are guided and caused to follow a course parallel therewith between the edges of the said cones and the said cylindrical electrode 40 in a direction as shown by arrows 42. The result of the thus induced convection currents in freeing the electrode 40 from deposited wax is identical to that which takes place in the electrode arrangement shown in the said Figures 1, 2, and 3. The electrode arrangement shown in Figures 1, 2, and 3 may be preferable over that shown in Figure 4 only where economy of space is essential.

Since the particles of precipitated wax in oil are negatively charged, a selective separation of precipitate and oil may be accomplished by an electrically charged electrode system arranged as illustrated in Figure 7. Pipe 60 forms one of the electrodes and at the same time the oil outlet from the treater. The negatively charged wax particles in the oil which is flowing between the electrodes 60 and 61 in a direction as shown by arrows 62, are repelled downwardly and outwardly from the negatively charged electrode 60 toward the positively charged electrode 61 in a direction countercurrent to the said direction of oil flow. The oil flowing out through the electrode pipe 60 may thus be prevented from carrying the wax precipitate with it and in this manner be freed of a substantial proportion of the wax.

As stated hereinbefore, it has been found that the wax particles of a majority of suspensions of precipitated wax, resulting from chilling of wax-

bearing oils, are negatively charged. Therefore by providing for a positive polarity on the electrode 14 of large area, from which the wax is readily dislodged by the electric windage currents, the accumulation of wax thereon is prevented and it is unnecessary to provide any means to maintain the negative electrode free from wax. Where the charges on the precipitated wax particles are found to differ from this the polarity of the electrodes may, obviously, be reversed as required to cause the deposition of the wax to tend to take place on the electrode from which it is being continuously washed by the windage currents. The flow of wax-bearing oil to be treated may be reversed through the treater so that the wax-bearing oil enters through pipe 31 and is withdrawn through pipe 30. In some cases it has been found desirable to operate in this manner employing the principle hereinbefore described in connection with Figures 1 and 7, so that the flow of oil undergoing treatment will flow upward through the electrode system and so that the countercurrent movement of the wax under the influence of the downwardly directed repellant field of the electrode, aided by gravity settling, may be employed to accomplish a countercurrent separation of the wax precipitate from the oil stream.

The process and apparatus is not to be limited to the specific structure nor to the treatment of oils for the removal of wax but they are applicable to the treatment of similar substances for the removal of asphaltines, asphalt, petrolatum, sludges, finely divided solids, and other substances and impurities both solid and plastic.

The foregoing is merely illustrative of one apparatus and process and the invention is not limited thereby but may include any process and apparatus which accomplishes the same within the scope of the invention.

We claim:

1. A process for dewaxing oil which comprises establishing an electric field between a pair of oppositely charged electrodes, one of said electrodes terminating in an edge or point, said electric field being of sufficient potential to establish an electric windage between said electrodes, flowing a wax bearing oil between said electrodes to agglomerate wax therein and withdrawing oil in a direction countercurrent to the established electric windage.

2. A process for dewaxing oil which comprises establishing an electric field between a pair of oppositely charged electrodes, one of said electrodes consisting of a conduit, said electric field being of sufficient potential to establish an electric windage between said electrodes, flowing a wax bearing oil between said electrodes to agglomerate wax therein and withdrawing oil through said conduit in a direction countercurrent to the established electric windage.

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