June 6, 1944. J. F. THORNTON 2,350,944

DEWAXING APPARATUS

Filed May 2, 1941

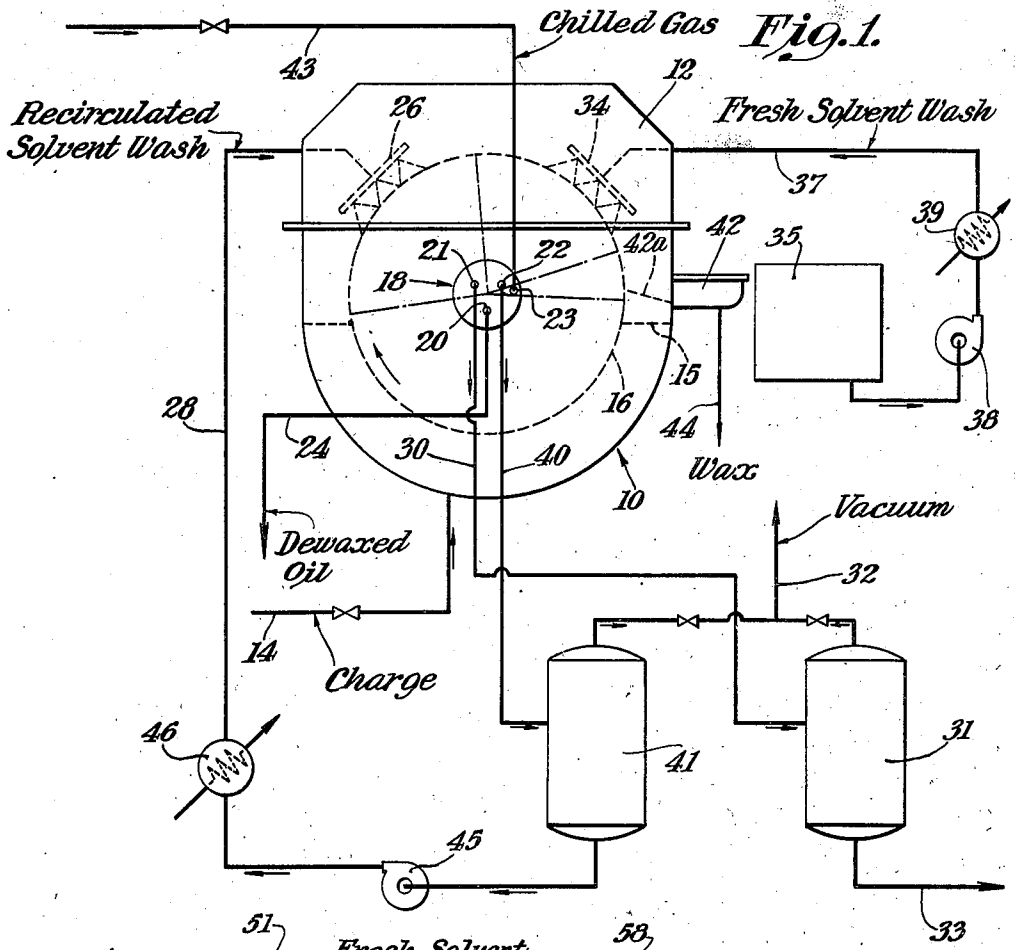

Fig. 1.

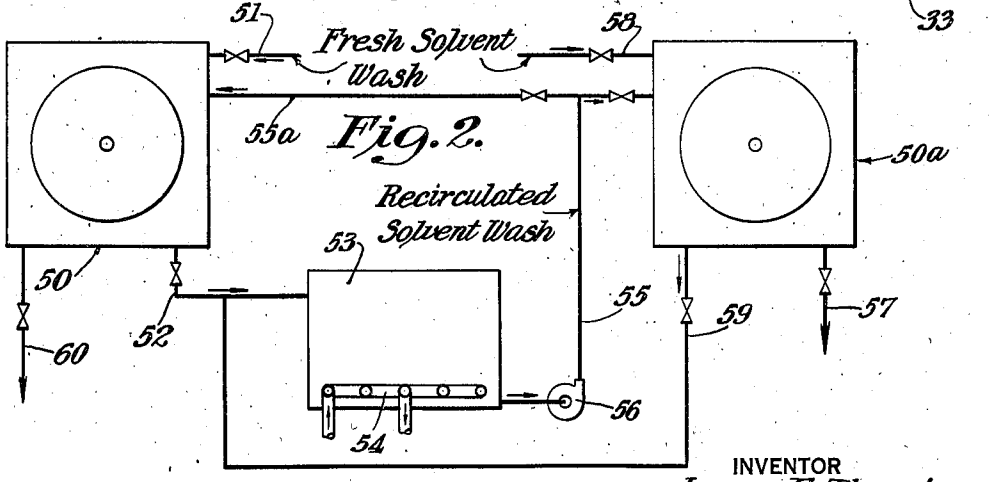

Fig. 2.

INVENTOR
James F. Thornton
BY
ATTORNEY

Patented June 6, 1944 2,350,944

UNITED STATES PATENT OFFICE

2,350,944

DEWAXING APPARATUS

James F. Thornton, Bronxville, N. Y., assignor to The Lummus Company, New York, N. Y., a corporation of Delaware

Application May 2, 1941, Serial No. 391,519

3 Claims. (Cl. 196—18)

This invention relates to improvements in the treatment of paraffin wax-containing hydrocarbon oils, more particularly distillate oils in the lubricating oil range, for the removal of the paraffin wax, the presence of which in the finished oil is undesirable. It more particularly relates to improvements in the filtration of the wax from the oil whereby the amount of utilities required can be materially reduced and whereby a greater yield of dewaxed oil may be obtained.

In the dewaxing of lubricating oil, the waxy oil is initially mixed with a solvent, and the resulting mixture is chilled to precipitate the wax; the waxeous mixture is then passed to a filter, which separates the wax as a waxeous cake. The operating temperature in a dewaxing process, normally below 0° F., requires the use of a substantial amount of refrigeration not only to chill the waxy oil but also to chill the solvent; in a large plant the cost of refrigeration may thus be very substantial.

During the filtration operation, it is necessary to apply a suitable wash solvent or wash liquid chilled to the dewaxing temperature to the waxeous cake in order to remove entrained or occluded oil therefrom. Although the quantity of occluded oil can be reduced to a minimum by repeated washing with fresh solvent, it has been found that there is a practical limit to the amount of fresh solvent which can thus be used. Such limit is based on a determination of the amount of occluded oil which can be economically removed by the application of fresh wash solvent and on the physical limitations and the expense of refrigerating and handling the additional solvent.

In the past it has been generally found that the amount of oil retained in the waxeous cake could be thus practically recovered to within several per cent of the theoretical yield. The final retained oil could not be profitably removed from the wax, however, although the loss thereof was objectionable and the presence thereof in the wax cake was not desirable in subsequent treatment of the wax.

The principal object of this invention is to provide an improved filtration operation in the solvent dewaxing of oil whereby the operating costs can be materially reduced and whereby the yield of wax-free oil may be increased.

A more specific object of the invention is to provide a method for decreasing the volume of wash solvent required for the removal of the oil retained in the waxeous filter cake obtained in a dewaxing operation whereby the cost of solvent refrigeration and recovery is considerably reduced.

A further specific object of the invention is to provide a simplified wash system for the washing of the waxeous filter cake obtained in a dewaxing operation, which system includes washing the cake first with partially contaminated wash solvent, the oil content of which is appreciable but has no objectionable effect on the waxeous cake, and thereafter washing the cake with fresh wash solvent, in order to reduce the amount of refrigeration required and in order to obtain a maximum yield of oil, the fresh wash solvent after use being available as the partially contaminated wash solvent in the initial washing step.

Further objects and advantages of the invention will appear from the following description of a preferred form of embodiment thereof taken in connection with the attached drawing, illustrative thereof, in which:

Fig. 1 is a flow diagram of a continuous filtration system more particularly adapted for the continuous filtration of a waxy oil-solvent mixture; and

Fig. 2 is a modified flow diagram more particularly adapted for batch filtration.

In accordance with the preferred form of embodiment of the invention, the filter 10, which may be continuous and suitably enclosed within a housing or tank 12, is adapted to receive a charge of waxy oil distillate and solvent through the line 14. As is well understood, the rate of feed of the waxy oil-solvent charge is sufficient to maintain the tank 12 partially full as indicated at 15 so that the filter leaves or drum, generally indicated by the dotted line 16, will always be partially covered by the waxy oil-solvent charge. Such a filter is normally equipped with a rotary multiport valve generally indicated at 18, which is provided with liquid outlet ports 20, 21, and 22 and a gas inlet port 23. Outlet port 20 serves to remove the dewaxed oil filtrate, and outlet ports 21 and 22 serve to remove the wash solvent as will hereinafter be more fully described; inlet port 23 admits chilled gas which serves to dislodge the waxeous cake from the filter at the point of wax discharge. These ports are automatically interconnected during rotation of the filter clockwise, as indicated, to successive portions of the filter area as is well known in the art.

Upon the application of a vacuum to port 20, the liquid portion of the waxy oil-solvent charge is drawn through the filter medium, and a waxeous cake is formed thereon. This dewaxed oil-

solvent filtrate is withdrawn through line 24 and is discharged into a receiver (not shown), to which a vacuum is preferably applied. This filtrate may then be treated in any well known manner for the recovery of the dewaxed oil and the solvent.

Under normal circumstances, the waxeous filter cake that is formed on the filter medium occludes some oil, which in the past it has not proved profitable to entirely remove although a suitable wash liquid is applied to the filter. The wash liquid is normally applied as through the spray head 26 from a suitable source; in such case the wash liquid usually consists of fresh wash solvent that has been chilled to the temperature of dewaxing in order not to disturb the liquid-solid equilibrium conditions already set up. In normal dewaxing operations this temperature is required to be in the neighborhood of —15° F., for example.

Although it was known that the use of additional wash solvent to increase the ratio of wash solvent to waxy oil charge from 1:1 to about 2:1 would materially increase the yield of dewaxed oil, the greater initial equipment cost and the higher refrigeration and operating costs more than offset the value of the additional yield of oil. Such practice, therefore, has not been followed.

In accordance with the invention, a wash solvent is initially applied to the waxeous cake through the spray head 26 from the line 28; such wash solvent, however, already contains a small proportion of oil, which may be, for example, in the range of 2 to 4% and is preferably below 5%. Although this wash solvent may be considered as contaminated, the small amount of oil therein as compared to the relatively larger amount of oil retained in the waxeous cake is such that a substantial portion of the oil can be efficiently washed from the cake thereby. The waxeous cake, after it passes the region of the initial spray head 26, will thus contain only a relatively small amount of oil. The mixture of wash solvent and oil is drawn through the filter medium upon the application of a vacuum to port 21 and is withdrawn from the filter through line 30 into receiver 31, to which a vacuum is applied through line 32. The resulting wash solvent-oil filtrate may be conveniently removed through line 33 either for recovery of the oil and the solvent or for use as the secondary diluent in further dewaxing operations.

Fresh cold wash solvent is then applied through spray head 34 to the waxeous cake as it is rotated in a clockwise direction by the filter. This fresh wash solvent is supplied from tank 35 and is passed to spray head 34 through line 37 by means of pump 38. Cooler 39 is inserted in line 37 to reduce the temperature of the wash solvent to the dewaxing temperature. This wash solvent serves to remove substantially all of the remaining occluded oil from the waxeous cake. Upon application of a vacuum to port 22, the wash solvent and occluded oil are drawn through the filter, and the resulting wash solvent-oil filtrate is withdrawn from the filter through line 40 to the filtrate tank 41, to which a vacuum is also applied through line 32.

The wax cake, from which the occluded oil has been removed, is discharged from the filter medium into receiver 42 by the application of chilled flue gas or the like under pressure through line 43 and port 23. Deflector 42a is preferably provided to aid in removing the wax cake from the filter medium. The discharged wax cake may be conveniently removed through line 44.

The wash solvent-oil filtrate discharged into tank 41 may be conveniently utilized as the first or recirculated wash solvent in that it contains a relatively low percentage of oil; this amount of oil, however, is not objectionable in the partial removal of the occluded oil from the waxeous filter cake in the initial washing step. This wash solvent-oil filtrate is recycled by pump 45 through line 28; if necessary, added refrigeration may be supplied as by the cooling coil 46. It will be appreciated that, even though this wash solvent filtrate contains a small amount of contaminating oil, it has the advantage that it is at a relatively low temperature because of the refrigerated condition of the fresh wash solvent supplied from tank 35. Any temperature rise in this wash solvent filtrate is occasioned only by heat leakage during its passage through the filter into receiver 41; therefore, the amount of refrigeration required to be supplied at 46 is relatively insignificant as compared to the refrigeration necessary to lower the temperature of the initial wash solvent to operating conditions as is accomplished by cooler 39.

In operation it is found that, without the use of additional wash solvent and with only additional refrigeration in the amount of a few per cent of the total refrigeration required, it is possible to reduce the final retained oil content of the wax cake to considerably less than what it would normally be. Thus, without increasing the ratio of wash solvent to waxy oil charge, an improved yield of dewaxed oil is obtained. This greater oil yield requires the addition only of another pump, another receiver or tank, and another cooling coil. Under normal conditions it may be expected that the entire cost of the added equipment required can be paid off in additional oil yield in a period of a few months' operation.

Where reduction in operating costs is primarily desired, the same dewaxed oil yield may be obtained with the use of a lower wash solvent-waxy oil charge ratio. In such case, a material reduction in the cost of wash solvent refrigeration and recovery is effected; and the initial cost of the equipment for these purposes is less; for a smaller amount of wash solvent is applied to the waxeous filter cake. As in the case where an increased yield of dewaxed oil is desired, the only additional equipment required includes a pump, a receiver, and a cooling coil. The cost of this equipment, however, will be quickly paid off by the savings effected in the amount of utilities used.

It will be appreciated that this improved washing system may be so employed as to accomplish simultaneously a reduction in operating costs and an improvement in dewaxed oil yield.

The following example will illustrate the operating advantages of the invention as applied to a plant capable of dewaxing 3000 bbls./day of waxy oil. When a wash solvent-waxy oil charge ratio of 1.5:1 is employed according to customary practice, the total amount of refrigeration required is 479 tons/day. The total amount of steam required for the recovery of the solvent in such case is 18,500 lbs./hr. When, however, the improved washing system is used, the ratio of wash solvent to waxy oil charge may be lowered to 0.75:1 without a decrease in the yield of dewaxed oil. In this case, the total amount of refrigeration required is 409 tons/day; this represents a saving of 14.6%. Likewise, the total

amount of steam required for the recovery of the solvent is only 14,550 lbs./hr.; this represents a saving of 21.5%.

The invention is also applicable to a batch dewaxing system. As illustrated in Fig. 2, this system (diagrammatically shown) may consist of two filter units generally indicated at **50** and **50***a*, respectively. In such case it will be appreciated that the operations on one unit are staggered with respect to those on the other unit; e. g., while the wax cake in unit **50** is being washed with recirculated wash solvent, the wax cake in unit **50***a* is being washed with fresh wash solvent.

In the course of operations, fresh wash solvent may be applied to the wax cake in unit **50** through line **51** from a suitably chilled supply tank (not shown). The resulting wash solvent-oil filtrate is withdrawn from unit **50** through line **52** into tank **53**, which is preferably provided with a refrigerating coil **54** to maintain the contaminated wash solvent at the appropriate low temperature. The wax cake is then removed from unit **50**, and a new batch of waxy oil-solvent mixture is charged thereto.

Meanwhile, contaminated or recirculated wash solvent is applied to wax cake in unit **50***a*; this wash solvent is pumped from tank **53** through line **55** by pump **56**. The wash solvent-oil filtrate resulting from this washing step is withdrawn from unit **50***a* through line **57** for suitable recovery of the solvent and the oil. The wax cake is then ready for washing with fresh wash solvent, which may be supplied from a suitable source (not shown) through line **58**. The resulting wash solvent-oil filtrate is withdrawn through line **59** and is passed to the recirculated wash solvent tank **53**.

Recirculated wash solvent may be supplied to unit **50** for the first washing step through lines **55** and **55***a*. The resulting wash solvent-oil filtrate is withdrawn through line **60** to a suitable recovery system. Appropriate valves are shown in the various lines for regulation of the flow of the wash solvent.

It will be apparent that the added equipment in this batch system also includes only a tank, a pump, and a suitable refrigerating coil to maintain the recirculated wash solvent at a low temperature. In either case, there are always two sources of wash solvent, the initially refrigerated fresh wash solvent and the recirculated wash solvent, the temperature of which needs merely be maintained at the requisite low degree.

This invention is equally applicable to a dewaxing process in which a normally liquid solvent such as a mixture of methyl ethyl ketone and benzol is used and to one in which a liquefied normally gaseous solvent such as propane is used. Likewise, the invention is equally applicable to a process in which the pressure side of the filter is maintained at atmospheric pressure and to one in which the pressure side is maintained at an elevated pressure. It will also be realized by those skilled in the art that the wash solvent is conveniently and preferably the same as that used to dewax the waxy oil charge.

The invention is also not necessarily limited to the use of two banks of wash sprays or similar devices for the application of the wash solvent to the wax cake. If it is found practicable and desirable to do so, the wash solvent-oil filtrate removed through line **30** may be separately recirculated for use in another washing step. In this way, the wax cake may be subjected to a plurality of separate washings whereby it comes into contact with wash solvent containing less and less oil as it is moved towards the point of discharge.

Furthermore, the invention may be so modified that the temperature of the fresh wash solvent may be maintained several degrees below the dewaxing temperature. In this manner, additional cooling coil **46** may be dispensed with inasmuch as any rise in temperature of the fresh wash solvent during passage through the filter, which temperature rise is normally small, will raise the temperature of the fresh wash solvent-oil filtrate up to the dewaxing temperature.

Although several embodiments of the invention have been described, it will be appreciated that other modifications may be made thereto; therefore, only such limitations as appear in the claims appended hereinafter should be imposed.

I claim:

1. In combination with a continuous separator for separating precipitated wax from a chilled oil-wax slurry and forming a wax cake with some occluded oil, said separator being constructed and arranged to continuously pass said cake along a fixed path to a discharge point, wash spray means at one point along said path to apply wash solvent to said cake to remove a substantial portion of the occluded oil therefrom, a second wash spray means spaced along said path from the first spray means, means to continuously supply said second spray means with fresh wash solvent chilled to the dewaxing temperature to remove more of the occluded oil from the cake, a conduit arranged and connected to conduct wash solvent and the oil removed thereby from said second washing to said first spray means, and means to continuously force said solvent and contained oil through said conduit for continuous discharge by said first spray means simultaneously with the discharge by the second spray means.

2. In combination with a continuous differential pressure filter for separating precipitated wax from a chilled oil-wax slurry and forming a wax cake with some occluded oil, said filter being constructed and arranged to pass said cake continuously along a fixed path to a discharge point, wash spray means at one point along said path to apply wash solvent to the cake to remove a substantial portion of the occluded oil therefrom, a second wash spray means spaced along said path in advance of said first spray means to apply wash solvent to the cake for further removal of the occluded oil, means to supply said second spray means continuously with fresh wash solvent, cooling means connected to said spray supply means to chill said fresh solvent to the dewaxing temperature, a conduit arranged and connected to conduct wash solvent and the oil removed thereby by the second washing to said first spray means, means to continuously force the solvent and contained oil through said conduit for continuous discharge by said first spray means simultaneously with the discharge by said second spray means, and cooling means connected to said conduit to chill the solvent as it is passed therethrough.

3. In combination with separating apparatus for separating precipitated wax from a chilled oil-wax slurry and forming a wax cake with some occluded oil, wash spray means associated with said apparatus and disposed to apply wash solvent to said cake to remove a substantial portion of the occluded oil therefrom, a second wash spray means spaced from said first spray means to apply wash solvent to wax cake which has

previously been solvent-washed to remove a substantial portion of the occluded oil therefrom, means to supply said second spray means with fresh wash solvent to remove more of the occluded oil from the cake, conduit means arranged and connected to conduct wash solvent and the oil removed thereby from said second washing to said first spray means, means to force said solvent and contained oil through said conduit for discharge by said first spray means simultaneously with the discharge by the second spray means, and cooling means associated with said conduit means to cool the solvent in the course of its passage from said second washing to said first spray means.

JAMES F. THORNTON.