

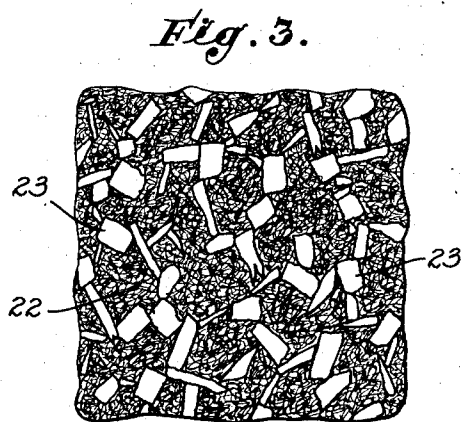
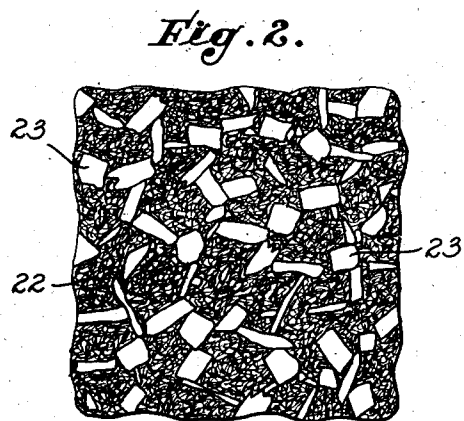
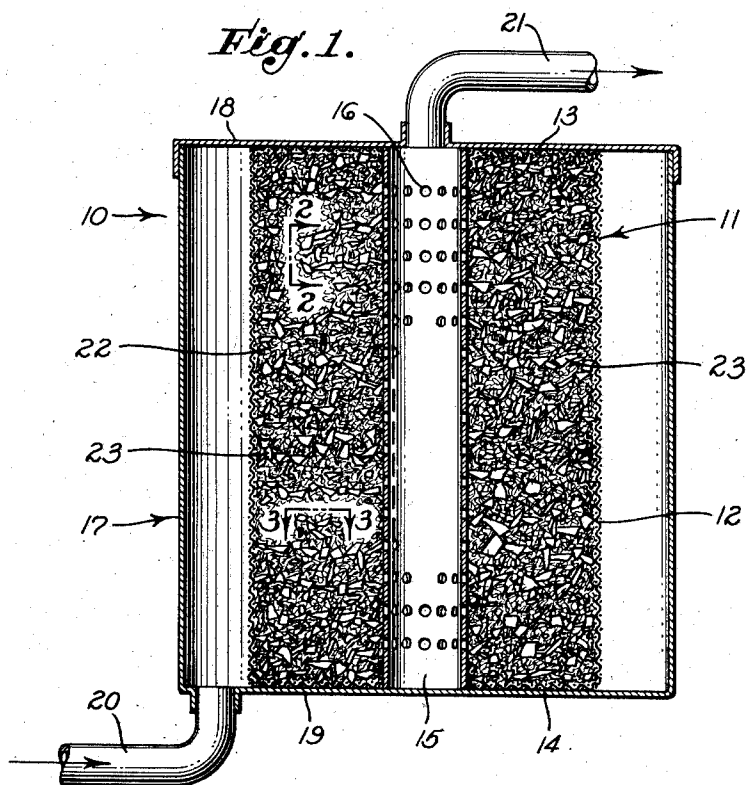
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U. B. BRAY ET AL

2,435,707

METHOD OF AND APPARATUS FOR TREATING OIL

Filed May 31, 1941



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METHOD OF AND APPARATUS FOR
TREATING OILUlric B. Bray, Palos Verdes Estates, and John K.
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Application May 31, 1941, Serial No. 396,144

30 Claims. (Cl. 252—326)

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Our invention relates to a method and apparatus for the refining of lubricating oil in the oil circulating systems of internal combustion engines, such as Diesel engines, gasoline engines employed in passenger vehicles, and the like. Certain subject matter herein disclosed but not claimed is covered in our co-pending application Serial No. 396,145.

Many of the commercial lubricating oils employed in the lubricating systems of Diesel and other engines are compounded so that they are initially alkaline and remain so during their effective lives, or are compounded with oxidation-inhibiting agents so that they remain substantially non-acidic during their effective lives, and for the purpose of illustrating the advantages of our invention we hereinafter describe its use in connection with the oil circulating system of a Diesel engine employing such oils.

Lubricating oils employed in the oil circulating systems of such engines become contaminated during the use of the engines with solid impurities including particles of carbon, metal, and foreign matter, such as silica or the like, taken up from the air, which particles are of sufficient size to permit their removal at substantially the rate of their supply to the oil circulating system by a filter interposed therein containing canton flannel or cotton waste. Likewise, the oil in such a system becomes contaminated during use of the engine by particles too small to be removed from the oil by such a filter, including particles of soot from the oxidation of the fuel, particles of carbon from the breakdown of the lubricating oil, and particles of inorganic abrasives, such as silica, from the air, and these minute particles of impurities, referred to herein as suspended or colloidal impurities, during their accumulation in the lubricating oil form deposits, varnish-like and gummy in nature, upon the bearing surfaces, cylinder and piston walls, and the piston rings of the engine, greatly increasing friction and impairing the efficiency of the engine.

In some commercial lubricating oils supplied for the lubricating systems of Diesel and other engines, there is provided a minute proportion of a detergent having the property of washing and cleansing from the bearing and other such surfaces upon which such suspended or colloidal impurities are deposited, the impurities of such nature and the products which, unless removed, they combine to form. Such detergents include calcium phenylstearate, calcium dichlorostearate, calcium soap of oxidized petroleum acids such as calcium Alox, calcium salts of phenolic bodies,

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and calcium salts of alkylated phosphoric acid, and by the term "detergent" herein is meant the foregoing and such other substances as may be carried by the oil in the circulating system of an engine and which possess the property of removing impurities from and preventing their accumulation upon the bearing surfaces of the engine.

In the use of a filter made of canton flannel, cotton waste, or the like in such an oil circulating system containing detergent-bearing oil, we have found that the detergent exercises its property not only in washing from the bearing surfaces the accumulated deposits of impurities, but also in washing from and cleansing the filter medium of the impurities deposited and entrapped therein, with the result that the intended function of the filter medium is impaired, the accumulation of the impurities in the oil circulating system is rapid, and the effective life of the oil is short.

One of the objects of our invention is to prevent or to reduce to the point where it is negligible the tendency of the detergent in the lubricating oil to remove from a filter and refining unit interposed in the circulating system the deposited and entrapped impurities.

During the use of such a detergent-bearing oil, it is found that the detergent is consumed until the quantity in the system may reach such a low value as to be ineffective before the lubricating qualities of the oil are exhausted. It is possible that the detergent is consumed by its formation of a container or envelope around each of the particles of suspended or colloidal impurities which it washes from the bearing surfaces or contacts in the oil stream.

It is an object of our invention to prevent such consumption of the detergent or reduce its consumption to the point where it is negligible so that a minute quantity in the oil stream remains effective for the life of the oil. This we accomplish by supplying to the oil stream an agglomerating material which causes the suspended or colloidal impurities to coalesce, combine, or agglomerate. The words "agglomerating material" as used herein mean any material having a tendency to cause suspended materials, usually present in the lubricating oil of an internal combustion engine after some use, to coalesce, combine, or agglomerate into masses large enough to be readily filtered out. It is possible that the great reduction in the consumption of the detergent resulting from such a supply to the oil stream of such agglomerating material is caused by the freeing of the detergent

on or around the suspended or colloidal impurities by the agglomerating action of such material, with the result that the detergent is returned to the oil stream with its cleansing or washing property substantially undiminished. The coalescing or agglomeration of the suspended or colloidal impurities is continued by the agglomerating material until there are formed masses of such impurities of such dimensions as to cause their entrapment and retention by the filter medium in the circulating system and the prevention of washing therefrom by the action of the detergent in the oil.

In such a process it is desirable that an intimate and frequent contact of the agglomerating material and the suspended or colloidal impurities be provided, both in the engine and oil circulating system and within the refining unit interposed in the system. In accordance with our invention, such contact in the engine and circulating system is accomplished by utilizing an agglomerating material of sufficient solubility in the oil to exert an agglomerating action upon the impurities within the engine and circulating system, and such contact is accomplished within the refining unit by providing therein the agglomerating material with a very large surface area.

Since the agglomerating material is consumed in the process herein described, it is necessary to continuously replenish it, and our invention contemplates such a continuous replenishment of the agglomerating material in the refining unit in the circulating system by a supply which is not coated or choked or rendered ineffective by the deposit of impurities within the unit so that such supply continually replenishes the agglomerating material consumed for the full life of the filter medium in the refining unit.

When a filter of conventional construction containing only cotton flannel, cotton waste, or the like is used in such a circulating system, we have found that the filter medium first contacted by the oil stream entering it and carrying solid and agglomerated impurities is rapidly coated with a slime bed of such impurities, so increasing the resistance to the passage of oil through the refining unit as to render it ineffective in a short period of use and before the filtering properties of the filtering medium in the remainder of the unit have been exhausted. Coupled with the object last stated, therefore, is our object of so combining in a refining unit a supply of agglomerating material and a filter medium as not only to prevent the coating of the agglomerating material with impurities, rendering such material ineffective, but also to insure that the filtering property of the entire mass of filtering material within the unit will be exhausted before the resistance to passage of oil through the unit has increased to an extent to render the unit ineffective.

During the passage of the oil bearing the suspended and colloidal impurities through the refining unit, it is desirable to contact such impurities with the agglomerating material and thereafter immediately pass the oil bearing such agglomerated masses through a filter medium capable of removing and entrapping them so that the agglomerating agent next contacting the oil stream may better agglomerate the colloidal or suspended impurities, and it is desirable that such alternate contacts of the oil stream bearing such impurities with the agglomerating material and passages of the oil stream through a filter

medium should be very numerous within the refining unit in order that the suspended and colloidal impurities may be removed substantially at the rate at which they are formed and their accumulation in the oil stream prevented, and it is an object of our invention to provide such a process and apparatus for its practice.

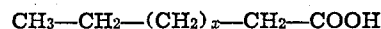
Still another object of our invention is to provide a refining apparatus for use in the circulating system of an internal combustion engine which is compact in form and inexpensive in manufacture.

An embodiment of such apparatus of our invention adapted for use in a circulating system containing a compounded detergent-bearing oil and connected to a Diesel engine is illustrated in the accompanying drawing, in which

Fig. 1 is a vertical sectional view of the refining apparatus; and

Figs. 2 and 3 are enlarged fragmentary sectional views taken as indicated by the lines 2-2 and 3-3, respectively, of Fig. 1.

As agglomerating material, we have found that soaps of alkylolamines such as triethanolamine and tri-isopropanolamine are admirably suited for the purpose. The soaps of alkylamines or arylamines which are sufficiently alkaline to form a soap with an organic acid can be employed. While a soap of any alkylolamine may be employed, we prefer to employ a soap of triethanolamine. The soap is formed by mixing the tri-ethanolamine, for example, with a fatty acid having the formula



in which x is more than 10, coconut oil fatty acid, or hydroxylated fatty acids, such as castor oil fatty acid, or synthetic acids produced by catalytic oxidation of paraffins, forming a neutral soap so that the mixture does not react alkaline to phenolphthalein.

Soaps, of which the foregoing are examples and which are referred to herein as agglomerating materials or soaps of limited solubility, are heated to liquefaction and then sprayed or sprinkled upon a carrier or supporting medium so as to present an extremely large surface.

We prefer to form the purifying cartridge or unit of a mixture of a material in granule or particle form and a filtering material of a fibrous nature. The material in particle form may be porous cellulosic material, such as pressed walnut hulls, ground coconut shells, sawdust, or ground wood, or material of a substantially non-porous nature, such as sand, silica, or the like. We prefer when employing ground wood or sawdust that the particle size be such as to pass a six-mesh per inch screen and be retained on a twenty-four-mesh per inch screen. The filtering material is initially formed in one mass or a plurality of masses so that its fibres are loose, distended, and separated from each other. Of the materials capable of use as a filtering medium, such as cotton waste or the like, we prefer to employ beaten or ground paper. The paper, ground or beaten into one mass or a plurality of masses so that the fibres thereof are distended and separated from each other, may be employed as the supporting vehicle for the agglomerating soap of limited solubility, the soap being sprayed or sprinkled thereon after being heated to liquefaction. While results of commercial value may be achieved utilizing a mixture of particles such as above described, and fibrous material, with the latter bearing the agglomerating soap

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of limited solubility, such a mixture has the disadvantage that the effectiveness of the layer of soap upon the fibres of paper is impaired by the filtering or straining action of the paper, causing a deposition of impurities upon the soap coating and diminishing the area of such coating available for contact with the suspended or colloidal impurities in the oil stream. We prefer, therefore, to apply the agglomerating soap of limited solubility to material which is in particle form. Employing the particles as the supporting vehicle for the agglomerating soap permits a more uniform distribution of the soap throughout the refining unit, since the very small quantity of such soap required for each unit may be better or more uniformly sprayed, sprinkled, or mixed with the lesser volume of particles than with the greater volume of filtering material. When employing particles of wood or other granular material having some acids therein or thereon, the soap is formed with a sufficient excess of triethanolamine to neutralize such acids, such acids being employed to form all or part of the soap.

The particles of wood coated with the agglomerating soap, which may be referred to as a granular oil refining medium or finely divided particles or refining medium, are then mixed with the mass or plurality of masses of the beaten or ground paper so that the particles are distributed throughout the mass or masses. While the proportions of the granular refining medium and the filtering material will vary with the conditions of use and the pressure within the oil circulating system, we have found that for use in a refining unit interposed in the circulating system of a Diesel engine a mixture of from 15 to 45% by weight of the granular refining material with the filtering material accomplishes excellent results. After the materials are mixed as above described, the mixture is subjected to pressure, rendering it sufficiently compact to bring adjacent coated particles into contact or proximity with each other throughout the mixture in all directions. The mixture while thus compressed has a porosity such as to permit the ready flow of oil therethrough at pressures customary in the oil circulating system of an internal combustion engine. We have found, for example, that, if there be mixed 840 grams or 30 ounces of ground or beaten paper and 260 grams or 9 ounces of ground spruce or spruce sawdust, so that the mixture before compression has a volume of about 5,100 cubic inches, and this mixture is compressed to form a cartridge or cylinder with a diameter of $6\frac{1}{16}$ inches and a length of $8\frac{1}{16}$ inches and a volume of about 300 cubic inches, there is provided both the requisite porosity of the mass and the desired contact and proximity of the wood particles. The quantity of agglomerating soap of limited solubility contained in the mixture also varies somewhat with the conditions of use. In the example above referred to, such soap in the quantity of .1% to .3% by weight of the oil employed in the crank case charge is ample.

As illustrated in Fig. 1 of the drawing, wherein the numeral 10 indicates the refining unit, the mixture may be formed into a cylindrical cartridge 11 confined within a porous layer of cloth or metal 12 covering the exterior cylindrical wall and the end walls 13 and 14, the cylindrical cartridge being provided with a central cylindrical pipe 15 extending therethrough and with a plurality of openings 16 therein. When such a cylindrical cartridge is placed within a container 17 of a diameter larger than that of the cartridge

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with its ends 13 and 14 in engagement with the container end walls 18 and 19, respectively, it will be seen that oil may be conveyed from the circulating system through an inlet pipe 20 to the space within the container 17 around the cylindrical cartridge 11, and through the cartridge 11 to the central cylindrical pipe 15. The treated and refined oil is led from the central pipe 15 through an outlet pipe 21 back to the oil circulating system of the engine. As is illustrated in Figs. 2 and 3, the relative proportions of the filtering material indicated by the numeral 22 and the particles 23 of wood or the like, and the degree to which the mixture is compressed are so related that adjacent particles 23 are in contact with or in close proximity to each other. There being an extremely large number of the particles 23 distributed throughout the mixture, there is thus established a labyrinth of an enormous number of paths in all directions on the surface of the particles 23 along which oil may travel through the mixture.

The agglomerating soap, such as hereinbefore described, has very limited solubility in the oil, being of the order of 0.001 per cent to a few hundredths of one per cent. During the passage of the oil through the mixture within the container 17, some of the agglomerating soap enters into solution in the oil and is carried with the oil stream through the circulating system and engine. During this travel, the agglomerating soap in solution contacts colloidal and suspended impurities, agglomerating them and thus conditioning the oil for removal of the agglomerated masses of such impurities by the filter material 22 which it contacts upon its entry into the container 17. As the oil passes through the mixture, contacting the agglomerating soap upon the surfaces of the particles 23, it is repeatedly conditioned for further filtration by the filtering medium 22. After each such conditioning step or a limited number of conditioning steps, the oil containing suspended and colloidal impurities agglomerated to masses of strainable or filterable dimensions is subjected to a step of filtration by passage through some of the adjacent filtering medium 22. By such a mixture, therefore, the filtering medium 22 first contacted by the entering oil stream is enabled to remove some of the agglomerated masses, and the filtering material throughout the mixture likewise removes such masses agglomerated by the soap within the mixture. In this manner an extremely large number of alternate agglomerating and filtering steps are performed within the refining mass of relatively small volume.

We believe that, as each agglomerating step is performed, the detergent enveloping the colloidal and suspended particles is released and returned to the oil stream, available for continuing its washing and cleansing action to remove the deposited impurities from the bearing surfaces. Our tests demonstrate that when employing a mixture such as described, the amount of detergent in the oil stream is not substantially diminished, although the colloidal and suspended impurities are agglomerated and entrapped within the refining medium most efficiently.

Any tendency for the agglomerated impurities to deposit upon the first portions of the filtering medium contacted by the oil stream after entry into the container 17 and to form thereon an impervious slime bed before the filtering properties of the remainder of the filtering medium 22 are exhausted is greatly diminished by the fact that only a very small part of the agglomerating soap

is in solution in the oil within the circulating system and engine, so that the proportion of the suspended and colloidal impurities agglomerated to filterable dimensions before the oil stream reaches such first portions of the filtering medium 22 is only a very small fraction of the colloidal or suspended impurities present in the oil stream. Further, such tendency is counteracted by variations in pressure upon the mixture within the container 17 caused by the stopping and starting of the engine and variations in the engine speed. This variation in pressure upon the mixture causes a relative movement of the particles 23 and adjacent filtering material 22, particularly near the outer surface of the cylindrical cartridge 11 where the slime bed forms in ordinary filters. The relative movement of the particles 23 and filtering medium 22 with the resilience possessed by the compressed fibres of the filtering medium 22 operates to dislodge any excess of deposited impurities from the filtering medium adjacent the exterior of the cylindrical cartridge 11, the dislodged impurities being carried by the oil stream into the mixture and trapped and retained by the filtering medium further within the cartridge.

Furthermore, if there are deposited upon the filtering material 22 adjacent the exterior of the cylindrical cartridge 11 impurities in slight excess of such impurities within the interior of the cartridge 11, tending to impede the flow of oil there-through, the presence of a large number of particles 23 in contact or proximity with each other permits the oil to flow readily through the mixture. The fibres of filtering medium 22 are not bonded to or intertwined with the particles 23 so intimately as to exert a straining or filtering or flow-impeding action upon the stream of oil, as is the case with the relation of the fibres to each other when a bed of impurities is deposited therein. Thus the oil is permitted to flow in an almost infinite number of paths in thin streams or films along the surfaces of the particles in contact or close proximity with each other, with little resistance thereto, although the filtering medium thereadjacent, due to the entrapped impurities therein, may offer considerable resistance to the flow of oil therethrough. The presence and relationship of the particles 23, therefore, insures that the oil will readily flow through the mixture at a pressure customary in the oil circulating systems of internal combustion engines until the filtering property of all of the filtering medium 22 throughout the mixture is exhausted. At the same time the enormous number and the relation to each other of the particles 23 insure a most intimate contact of the coating of agglomerating soap thereon with the suspended and colloidal impurities in the extremely thin streams or films of oil flowing in contact therewith.

Results of commercial value may be secured by substituting for the agglomerating soap of limited solubility one of the alkylolamines, such as triethanolamine. However, we have found that the practical results in employing an agglomerating soap such as herein described are vastly superior, and we believe this to be due both to the fact that the soap has a greater solubility in the oil stream than the triethanolamine, the solubilities being of the order of 3 to 1, so that the soap better preconditions the oil in the circulating system and engine for refining by the mixture, and to the fact that the soap, having a very considerably greater volume than an equivalent amount of triethanolamine, may be more uniformly distributed throughout the refining mixture, afford-

ing an enormously greater surface for contact with the colloidal and suspended impurities.

While those embodiments of our invention hereinbefore illustrated and described are fully capable of performing the objects and providing the advantages primarily stated, and while that use of our invention specifically described herein demonstrates the accomplishment of such objects and the importance of such advantages, our invention, it is understood, is not restricted to the specific embodiment or uses herein set forth.

We claim as our invention:

1. The method of facilitating the removal from a lubricating oil of the colloidal impurities produced therein during the operation of an internal combustion engine, which comprises: adding a non-aqueous slightly oil-soluble agglomerating amino soap to an oil so contaminated; and thereafter filtering out the agglomerated masses produced by such addition, said addition and removal being rendered continuous during the use of the oil by circulating the contaminated oil through a supply of said agglomerating agent and a medium capable of producing such filtration.

2. The method of facilitating the removal from a lubricating oil of the colloidal impurities produced therein during the operation of an internal combustion engine, which comprises: adding to an oil so contaminated an agglomerating amino soap of a saponifiable organic acid; and thereafter filtering out the agglomerated masses produced by such addition.

3. A method for removing minute impurities from mineral lubricating oil comprising the steps of: alternately agglomerating said impurities to bodies of larger size by contacting such impurities while suspended in the oil with saponifiable organic acid amino soap disposed upon the surfaces of particles of porous material disposed in proximate relationship with bodies of fibrous filtering material; and removing said agglomerated bodies from the oil by entrapment within said fibrous material.

4. A method of treating a flowing stream of used lubricating oil containing suspended colloidal impurities produced in use and of insufficient size for filtration, which method comprises: alternately agglomerating such impurities to bodies of dimensions sufficient for removal by filtration by contacting the oil with slightly oil-soluble agglomerating alkylolamine fatty acid soap disposed upon particles of relatively inert material; and removing such agglomerated bodies from the oil by passing oil bearing such agglomerated bodies through a filter medium adjacent said particles.

5. Means for treating used mineral lubricating oil and for removal of colloidal particles therefrom, comprising: a filtering medium incapable of removing substantial proportions of said colloidal particles; and carrier particles of relatively inert material carried adjacent said filtering medium and carrying thereon slightly oil-soluble saponifiable organic acid amino soaps adapted to agglomerate said colloidal particles to bodies of sufficient size for removal by said filtering medium.

6. Means according to claim 5 wherein the agglomerating soap is alkylolamine soap of coconut oil fatty acids.

7. Means according to claim 5 wherein the agglomerating soap is alkylolamine soap of saponifiable fatty acids.

8. Means according to claim 5 wherein the carrier particles are particles of wood and the ag-

glomerating soaps are amino soaps of acids naturally occurring in the wood.

9. Means for treating contaminated mineral lubricating oil and for removal of colloidal particles therefrom, comprising: a filtering medium incapable of removing substantial proportions of said colloidal particles; and slightly oil-soluble amino soaps of saponifiable organic acids associated with said filtering medium and adapted to agglomerate said colloidal particles to bodies of sufficient sizes for removal by said filtering medium.

10. Means according to claim 9 wherein the agglomerating soap is an amino soap of synthetic acids from the oxidation of paraffins.

11. An oil filter comprising a porous filtering medium having intimately admixed therewith prior to use an alkylolamine soap of a fatty acid.

12. Means according to claim 9 in which the soaps are soaps of coconut oil fatty acid.

13. Means according to claim 9 wherein the soaps are amino soaps of acids naturally occurring in wood.

14. Means as in claim 9 wherein the filtering medium comprises wood sawdust.

15. Means according to claim 9 wherein the filtering medium comprises fibrous materials.

16. A filter adapted for treating an oil during contamination by particles of solid impurities and colloidal impurities of smaller size than said particles, comprising: a filter mass of such porosity as to allow the oil and colloidal impurities to pass therethrough and to filter the solid particles therefrom; and an agglomerating amino soap of saponifiable fatty acid and having a slight solubility in oil, the soap being carried by said filter mass in a quantity sufficient to agglomerate said colloidal impurities to bodies of dimensions filtered from the oil by said filter mass at substantially the rate of contamination of the oil by said colloidal impurities during the effective life of said filter mass.

17. A filter as in claim 16 wherein the soap has oil solubility in the order of 0.001 per cent to a few hundredths of 1 per cent.

18. A filter adapted for treating an oil during contamination by particles of solid impurities and colloidal impurities of smaller size than said particles, comprising: a filter mass of such porosity as to allow the oil and colloidal impurities to pass therethrough and to filter the solid particles therefrom; and an agglomerating soap of an alkylolamine carried by said filter mass in a quantity sufficient to agglomerate said colloidal impurities to bodies of dimensions filtered from the oil by said filter mass at substantially the rate of contamination of the oil by said colloidal impurities during the effective life of said filter mass.

19. A filter as in claim 18 wherein the soap is an alkylolamine soap of saponifiable fatty acid.

20. A filter as in claim 18 wherein the soap is an alkylolamine soap of acids naturally occurring in wood.

21. A filter as in claim 18 wherein the soap is a triethanolamine soap of saponifiable organic acid.

22. A filter as in claim 18 wherein the soap is a triethanolamine soap of acids naturally occurring in wood.

23. A filter adapted for treating an oil during contamination by particles of solid impurities and colloidal impurities of smaller size than said particles, comprising: a filter mass of such porosity as to allow the oil and colloidal impurities to pass

therethrough and to filter the solid particles therefrom; and an agglomerating coconut oil fatty acid soap of triethanolamine carried by said filter mass in a quantity sufficient to agglomerate said colloidal impurities to bodies of dimensions filtered from the oil by said filter mass at substantially the rate of contamination of the oil by said colloidal impurities during the effective life of said filter mass.

24. A process for treating mineral lubricating oil as it is used, said oil containing a detergent material, said process comprising: circulating said used oil; and passing said oil through filter means containing an amino soap capable of causing removal of colloidal impurities from the oil, the filter being incapable of removing substantial proportions of said detergent.

25. A process for treating mineral lubricating oil as it is used, said oil containing a detergent material, the process comprising: circulating said used oil; dissolving in said oil a slightly oil-soluble agglomerating amino soap of saponifiable organic acid, said soap being capable of agglomerating to filterable particle size colloidal impurities formed in said oil during use; and passing said oil and contained agglomerated particles through filtering means capable of removing said agglomerated particles and incapable of removing substantial proportions of said detergent.

26. A process as in claim 25 wherein said organic acid is a fatty acid.

27. A process as in claim 25 wherein said soap is an alkylolamine soap of saponifiable fatty acid.

28. The method of treating a flowing stream of non-acidic lubricating oil during contamination by colloidal impurities, which includes the steps of: agglomerating the colloidal impurities in the oil flowing in the stream at substantially the rate at which they are formed to bodies of filterable dimensions with a coconut oil fatty acid soap of an alkylolamine in solution in said oil; filtering said agglomerated bodies from the oil at one locus in the stream; and maintaining said soap in solution in the oil at a concentration sufficient to agglomerate the colloidal impurities in the oil at substantially the rate at which they are formed.

29. The method of treating a flowing stream of lubricating oil during contamination by colloidal impurities, which includes the steps of: agglomerating in the oil along the stream such impurities of a particle size too small for removal by filtration to bodies of sufficient size for removal by filtration with an alkylolamine soap of coconut oil fatty acids in solution in said oil; simultaneously filtering such agglomerated bodies from the oil by passing the oil through a filter mass interposed in the stream; and subjecting such oil to further agglomerating action by contact with said soap supported within said filter mass.

30. A process as in claim 25 wherein the amino soap is a triethanolamine soap.

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