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LUBRICANT

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This invention relates, as indicated, to lubricating compositions and more particularly to lubricating compositions which are predominantly hydrocarbon oil, the properties of which affecting its use for particular purposes are improved by the addition of materials which are particularly effective in rendering the lubricants suitable for use under conditions of extreme stress as imposed by high temperatures, high loads, etc.

In my co-pending applications, Ser. No. 737,070, filed July 26, 1934, 216,153, filed June 27, 1938 and 245,226, filed December 12, 1938, I have disclosed a broad class of lubricating compositions of general utility, particularly in the field of use where extreme pressures are encountered.

My present invention relates to the discovery that a certain class of such materials is particularly suitable for use in lubricants subjected to conditions of extreme stress such as those involved in the lubrication of heavily loaded gears, and in the lubrication of internal combustion engines operating under severe service conditions; for example, those encountered by internal combustion engines particularly of the aviation and Diesel types.

It is the principal object of my invention, therefore, to provide a lubricating composition which is especially suited for the purposes described.

Other objects of my invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the following description setting forth in detail certain approved combination of ingredients embodying my invention, such disclosed combinations of ingredients embodying my invention, such disclosed means constituting, however, but one of various forms in which the principle of the invention may be used.

Broadly stated, this invention comprises the provision of a lubricating composition for the purposes specified, characterized by the fact that the same contains a lubricating oil, preferably of the hydrocarbon type, as a major constituent with the properties of such composition affecting its use as a lubricant, especially under the conditions specified, by the incorporation therein of a minor amount, based on the amount of lubricating oil present, of a stable, oil-soluble salt of an aromatic acid.

More especially, my invention comprises the discovery that salts of aromatic acids, of the type which contain a substituent selected from the class consisting of aliphatic and cyclo-aliphatic radicles, are particularly suited for use.

The oil base

The oil base of my lubricating compositions is a lubricating oil of the type best suited for the particular use for which the ultimate composition is designed. When the lubricating compositions of my invention are designed for the lubrication of automobiles, the oil base will of course preferably consist of a refined mineral lubricating oil of lubricating viscosity for the particular point of application. In other words, a conventional gear oil may be used for the lubrication of the gears and generally a lighter, more highly refined, oil will be used in the crank case.

This invention is applicable to lubricating compositions in which the base may consist either entirely or in part of synthetic oils, hydrogenated oils, and volatilized oils.

The oil base may also desirably contain other well known constituents such as those which improve the oiliness, film strength, pour point, cold test, corrosiveness, and oxidation properties, etc., of the oil. In general, compositions of my invention may be employed with any commercially available addition agents for the above defined purposes since they are generally compatible with the same in the amounts usually used.

The addition agents

As above indicated, the addition agents may be generally defined as salts of aromatic acids. The term salts as used herein is intended to include the salts formed by organic bases with aromatic acids as well as the salts formed by inorganic bases with aromatic acids. The inorganic base salts such as the metallic salts of aromatic acids will generally be found to give best results, and of these, those salts in which the metal is present in polyvalent and especially in divalent form, will usually be preferred.

The halogen bearing salts of aromatic acids generally are a broad class of addition agents which have been found to be notably effective.

For certain uses, the salts of aromatic acids of the type which contain a substituent selected from the class consisting of aliphatic radicles and cyclo-aliphatic radicles have been found very useful. This latter class of salts may optionally also contain a halogen such as chlorine.

Due to the nature of the addition agents contemplated for use, they may be conveniently identified by first having reference to the various aromatic acids from which the salts may be prepared and by then giving a list of the various radicles or bases which may be combined with such acids in producing the salts.

TABLE I.—AROMATIC ACIDS

A. Aromatic acids with carboxyl group attached to ring

Benzoic acid	5
Benzoic acid derivatives:	
Hydroxybenzoic acids	
p-Hydroxybenzoic acid	
Salicylic acid	
Polyhydroxybenzoic acids	
Protocatechuic acid	
Pyrocatechuic acid	
Resorcylic acids	10
Gallic acid	
Amino-benzoic acids	
p-Aminobenzoic acid	
Anthranilic acid	
Azobenzoic acids	
Thiobenzoic acids	15
Monothio-benzoic acid	
Dithio-benzoic acid	
Mercapto benzoic acids (Sulphydryl benzoic acids)	
Thio-salicylic acid (o-mercapto-benzoic acid)	
p-Mercapto-benzoic acid	
Alkylated benzoic acids	
Methyl benzoic acids	20
Toluic acids	
Xylic acids	
Trimethyl benzoic acids	
Ethyl benzoic acids	
Lauryl benzoic acids	
Cetyl benzoic acids	
Carnaubyl benzoic acids	
Ceryl benzoic acids	25
Montanyl benzoic acids	
Myricyl benzoic acids	
Cyclo-aliphatic substituted benzoic acids	
Cyclohexyl-benzoic acid	
Methyl-cyclohexyl benzoic acids	
Amyl-cyclohexyl benzoic acids	
Naphthenyl-benzoic acids	
Naphthenoyl benzoic acids	
Ether-substituted benzoic acids	
Methoxy-benzoic acids	
Ethoxy-benzoic acids	
Lauroxy-benzoic acids	
Phenoxy-benzoic acids	
Veratric acid	
Piperonylic acid	
Keto-substituted benzoic acids	
Acetyl benzoic acids	
Lauryl benzoic acids	
Stearoyl benzoic acids	
Naphthenoyl benzoic acids	
Benzoyl benzoic acids	
Ester-substituted benzoic acids	
Mono-esters of phthalic acid, isophthalic acid and terephthalic acid	($\text{ROOC}-\text{C}_6\text{H}_4-\text{COOH}$)
Mono-methyl phthalate	
Mono-amyl phthalate	
Mono-lauryl phthalate	
Mono-benzyl phthalate	
Mono-cyclohexyl phthalate	
Amide-substituted benzoic acids	
Mono-amides of phthalic acid, isophthalic acid, and terephthalic acid	$\left. \begin{array}{l} \text{NH}_2\text{CO}-\text{C}_6\text{H}_4-\text{COOH} \\ \text{RNHCO}-\text{C}_6\text{H}_4-\text{COOH} \\ \text{and} \\ \text{R} \diagdown \text{NCO}-\text{C}_6\text{H}_4\text{COOH} \\ \text{R}' \diagup \end{array} \right\}$
N-Methyl phthalic acid mono-amide	
N-Amyl phthalic acid mono-amide	
N-Lauryl phthalic acid mono-amide	
N-Cyclohexyl phthalic acid mono-amide	
N-Methyl cyclohexyl acid mono-amide	
Thio-amide substituted benzoic acids	
Mono thio-amides of phthalic acid, isophthalic acid, and terephthalic acid	$\left. \begin{array}{l} \text{NH}_2\text{CS}-\text{C}_6\text{H}_4-\text{COOH} \\ \text{RNHCS}-\text{C}_6\text{H}_4-\text{COOH} \\ \text{and} \\ \text{R} \diagdown \text{NCS}-\text{C}_6\text{H}_4\text{COOH} \\ \text{R}' \diagup \end{array} \right\}$
e. g. where R and R' are:	
Methyl, amyl, lauryl, cyclohexyl, methyl cyclohexyl, etc.	
Salicylic acid derivatives:	
Alkylated salicylic acids	65
Ethyl salicylic acids	
Lauryl salicylic acids	
Cyclohexyl salicylic acids	
Naphthenyl salicylic acids	
Stearoyl salicylic acids	
Anthranilic acid derivatives:	
(1) With substituent in ring e. g.	
Alkylated anthranilic acids	70
Propyl anthranilic acids	
Amyl anthranilic acids	
Lauryl anthranilic acids	
Phenyl anthranilic acids	
Benzoyl anthranilic acids	
Stearoyl anthranilic acids	
Hydroxy-phenyl anthranilic acids	75

(2) With substituent attached to nitrogen atom, e. g.

N-alkylated anthranilic acids	
N-methyl anthranilic acids	
N-dimethyl anthranilic acids	
N-amyl anthranilic acids	
N-lauryl anthranilic acids	
N-dilauryl anthranilic acids	
N-ceryl anthranilic acids	
N-acetyl anthranilic acids	
N-stearoyl anthranilic acids	
N-naphthenoyl anthranilic acids	
N-phenyl anthranilic acid	
N-diphenyl anthranilic acid	
N-benzoyl anthranilic acid	
N-naphthyl anthranilic acid	
Benzene polycarboxylic acids	
Phthalic acid	
Isophthalic acid	
Terephthalic acid	
Benzene tricarboxylic acids	
Benzene tetracarboxylic acids	
Diphenyl carboxylic acids	15
Phenyl benzoic acids	
Diphenic acid	
Diphenylmethane carboxylic acids	
o-Benzyl benzoic acid	
Benzyl phthalic acids	
Benzophenone carboxylic acids	20
o-Benzoyl benzoic acid	
Benzoyl phthalic acids	
Naphthalene carboxylic acids	
Alpha-naphthoic acid	
Beta-naphthoic acid	
Naphthalene polycarboxylic acids	25
Naphthalic acid	
Anthracene carboxylic acids	
Anthraquinone carboxylic acids	
Phenanthrene carboxylic acids	
Heterocyclic acids	
Furan carboxylic acids	30
Furoic acid (pyromucic acid)	
Pyrrole carboxylic acids	
Pyrrole alpha-carboxylic acid	
Thiophene carboxylic acids	
Thiophene alpha-carboxylic acid	
Thiophene beta-carboxylic acid	
Pyridine carboxylic acids	35
Picolinic acid	
Nicotinic acid	
Pyridine polycarboxylic acids	
Pyridine dicarboxylic acids	
Quinolinic acid	
Lutidinic acid	
Dinicotinic acid	
Dipicolinic acid	
Cinchomeronic acid	
Isocinchomeronic acid	
Pyridine 2,3,6, tricarboxylic acid	40
Quinoline carboxylic acids	
Quinadlinic acid	
Cinchoninic acid	
Quinlinic acid	45
Acridinic acid	

B. Aromatic acids containing fatty-acid radicles having a plurality of carbon atoms

Aromatic-acetic acids	
Phenyl acetic acid	
Diphenyl acetic acid	
Benzoyl acetic acid	
Xenyl acetic acid	
Naphthyl acetic acid	
Salicyl acetic acid	
Aromatic propionic acids	
Phenyl propionic acids	
Hydratropic acid	
Hydrocinnamic acid	
Benzoyl propionic acid	
Diphenyl propionic acid	
Xenyl propionic acid	
Naphthyl propionic acid	
Furyl propionic acid	
Hydroxyphenyl propionic acids	
Hydrocoumaric acids	
Aromatic caproic acids	
Phenyl caproic acid	
Diphenyl caproic acid	
Xenyl caproic acid	
Naphthyl caproic acid	
Tolyl caproic acid	
Xylyl caproic acid	
Aromatic caprylic acids	
Phenyl caprylic acid	
Naphthyl caprylic acid	
Xylyl caprylic acid	
Aromatic capric acids	70
Phenyl capric acid	
Naphthyl capric acid	
Xylyl capric acid	
Aromatic lauric acids	
Phenyl lauric acid	
Lauryl-phenyl lauric acids	
Naphthyl lauric acid	75

B. Aromatic acids containing fatty-acid radicals having a plurality of carbon atoms—Cont.

Aromatic myristic acids
 Phenyl myristic acid
 Naphthyl myristic acid
 Aromatic palmitic acids
 Phenyl palmitic acid
 Naphthyl palmitic acid
 Xenyl palmitic acid
 Tollyl palmitic acid
 Xylol palmitic acid
 o-Hydroxyphenyl palmitic acid
 o-Benzoylphenyl palmitic acid
 Stearoyl-phenyl palmitic acid
 Aromatic stearic acids
 Phenyl stearic acid
 Diphenyl stearic acid
 Triphenyl stearic acid
 Xenyl stearic acid
 Naphthyl stearic acid
 o-Cyclohexyl-phenyl stearic acid
 Tollyl stearic acid
 Xylol stearic acid
 Ethyl-phenyl stearic acid
 Lauryl-phenyl stearic acid
 Benzyl stearic acid
 Benzoyl stearic acid
 o-Hydroxy-phenyl stearic acid
 p-Hydroxy-phenyl stearic acid
 Hydroxy-xenyl stearic acids
 Dihydroxy-phenyl stearic acids
 Amino-phenyl stearic acids
 N-lauryl-amino-phenyl stearic acids
 N-cyclohexyl-amino-phenyl stearic acids
 N-dilauryl-amino-phenyl stearic acids
 Salicyl stearic acids
 Benzoyl-phenyl stearic acids
 Stearoyl-phenyl stearic acids
 Phenoxy-phenyl stearic acids
 Methoxy-phenyl stearic acids
 Lauroxy-phenyl stearic acids
 Furyl stearic acid
 Pyridyl stearic acid
 Phenyl hydroxystearic acid
 Phenyl glyoxylic acid
 Benzoyl glycolic acid
 Hippuric acid
 Phenyl glycine
 Phenyl glycine o-carboxylic acid
 Phenyl alanine
 Benzilic acid
 Phthalonic acid
 N-phenyl succinamic acid
 N-diphenyl succinamic acid
 Benzyl tartronic acid
 Aromatic unsaturated acids
 Atropic acid
 Cinnamic acid
 Coumaric acid
 Phenyl angelic acid
 Phenyl cinnamic acid
 Phenyl crotonic acid
 Phenyl-amino crotonic acid
 Phenyl propiolic acid
 Benzoyl acrylic acid
 Phenyl oleic acids
 Phenyl ricinoleic acid
 Benzal lactic acid
 Benzal malonic acid
 Fural malonic acid
 Benzal propionic acid

C. Aromatic cyclo-aliphatic acids

Aromatic derivatives of naphthene acids
 Phenyl naphthene acids
 Hydroxy-phenyl naphthene acids
 Benzyl naphthene acids
 Benzoyl naphthene acids
 Naphthyl naphthene acids
 Xenyl naphthene acids
 Aromatic derivatives of cyclopropane carboxylic acids
 Phenyl-ethylene acetic acid
 Phenyl vinaconic acid
 Phenyl caronic acid
 Aromatic derivatives of cyclobutane carboxylic acids
 Truxillic acids
 Truxinic acids
 Phenyl norpinic acid
 Phenyl pinic acid
 Aromatic derivatives of cyclopentane carboxylic acids
 Phenyl camphoric acid
 Phenyl camphenic acid
 Phenyl 2,3,4-trimethyl cyclopentane-3 carboxylic acid
 Aromatic derivatives of cyclohexane carboxylic acids
 Phenyl hexa-hydrobenzoic acids
 Hydroxy-phenyl hexahydrobenzoic acids
 Benzyl hexahydrobenzoic acids
 Benzoyl hexahydrobenzoic acids
 Naphthyl hexahydrobenzoic acids
 Phenyl hexahydrophthalic acids
 Benzoyl hexahydrophthalic acids
 Hydroxy-phenyl hexahydrophthalic acids
 Phenyl quinic acid

D. Aromatic acids other than carboxylic

Hydroxyl-containing derivatives of benzene
 Pyrogallol acid
 Pyrogallol acid derivatives
 Alkylated pyrogallol acid
 Lauryl pyrogallol acid
 Esters of gallic acid
 Methyl gallate
 Amyl gallate
 Lauryl gallate
 Phenyl gallate
 Benzyl gallate
 Cyclohexyl gallate
 Methyl-cyclohexyl-gallate
 Amides of gallic acid
 Gallic acid amide
 Gallic acid anilide
 N-lauryl gallic acid amide

Hydroxyl-containing derivatives of triphenyl methane
 Pararosanolic acid
 Rosolic acid
 Mercapto-rosolic acid
 Thio-rosolic acids

Any of the acids listed above under A, B, C, and D in which one or more oxygen atoms have been replaced with sulphur. Any of the foregoing which have been halogenated or in which one or more hydrogen atoms have been replaced with a halogen.

20 In the preparation of those salts of aromatic acids of the type in which the aromatic acid is of the class which contains a substituent selected from the class consisting of aliphatic radicles and cyclo-aliphatic radicles, such acids may be conveniently prepared either by:

- (1) Condensing an aromatic compound with
 - (a) An aliphatic unsaturated acid, or
 - (b) A halogenated aliphatic acid, or
 - (c) A cyclo-aliphatic unsaturated acid, or
 - (d) A halogenated cyclo-aliphatic acid; or by
- 30 (2) Condensing an aromatic acid with
 - (a) An unsaturated aliphatic compound, or
 - (b) A halogenated aliphatic compound, or
 - (c) An unsaturated cyclo-aliphatic compound, or
 - (d) A halogenated cyclo-aliphatic compound.

Aromatic compounds which may be used in any of the condensation reactions identified under (1) above in the preparation of aromatic acids from which appropriate salts may be prepared are as follows:

TABLE II.—AROMATIC COMPOUNDS

- 40 I. Hydrocarbons
 - (A) Benzene and its homologs such as toluene, xylene, cymene, ethyl-benzene, mesitylene.
 - (B) Polyphenyls such as diphenyl, diphenyl benzene, and homologs of them such as o-phenyl toluene, poly-ethyl diphenyls, propyl diphenyl.
 - 45 (C) Condensed ring hydrocarbons
 - (1) Naphthalene and its homologs, such as the methyl naphthalenes, ethyl naphthalenes, propyl naphthalenes.
 - (2) Phenanthrene and anthracene and their homologs such as the mono- and di-methyl, and propyl and iso-propyl, substitution products, e. g. retene.
 - 50 (3) Chrysene and plicene and their homologs.
 - (D) Compounds resulting from substitution of aryl groups in compounds of classes (A), (B) and (C), e. g., di-benzyl, di-naphthyl, phenyl naphthalenes, the polyphenylmethanes, etc.
 - (E) Bridged ring hydrocarbons such as certain of the terpenes and related compounds including pinene, camphene and limonene.
- 55 II. Heterocyclic compounds of the aromatic or allied type such as: pyridine, quinoline, etc. and their derivatives.
- III. Substitution products (other than hydrocarbon homologs) of compounds of classes I and II, including:
 - (A) Oxygen-bearing substitution products. (See Table No. II(a) below, for further classification.)
 - 60 (B) Halogen-bearing substitution products.
 - (C) Other substitution products, such as those resulting from substitution of the following groups:

Amino, and substituted amino groups	Mercapto
Imino	Sulphide
Azo	Polysulphide
Hydrazo	Thiocyanate
Hydrazine	Isothiocyanate
Nitrile	Dithiocarboxylic acids (also ester and salt groups derived therefrom)
Isonitrile	
- 65 IV. Derivatives of the compounds included in classes I, II, and III resulting from addition reactions, such as hydrogenation, halogenation, etc. Examples of such compounds are the hydro-naphthalenes, phenyl cyclohexane, phenyl cyclohexanol, cyclohexyl phenol, naphthalene tetrachloride.
- 70
- 75

Attention is called to the fact that certain of the compounds may belong to more than one class; as, for example, the halogenated phenols which belong in class III(A) and III(B), or the

halogenated amino phenols, class III(A), (B) and (C).

The oxygen-bearing aromatic compounds (class III(A)) of Table No. I are of particular importance, and are, therefore, classified in further detail according to the nature of the attachment of the oxygen to the molecule, viz:

TABLE II(a)

- I'. Directly attached to one or more carbon atoms, as in the case of:
- (1') Ethers and analogous compounds
 - (2') Compounds containing the



radicle, such as alcohols and other derivatives of carbinol (including phenols, cresols, naphthols, etc.)

- (3') Compounds containing the carbonyl



radicle, such as amides, aldehydes, ketones, organic acids, esters and salts of organic acids (including such salts of both inorganic and organic bases), thio-acids and esters and salts of thio-acids.

- (4') Compounds in which oxygen forms a part of the ring structure, e. g. furan and its derivatives, etc.
- (5') Compounds with an inorganic radicle where the oxygen is directly attached to a carbon atom, e. g.

Arsenites
Hypochlorites
Phosphites
Thiophosphates

Thiophosphites
 β -Hydroxylamines
Borates

- II'. Indirectly attached through the means of some other atom, i. e., in the form of an inorganic radicle, e. g.

Arsenate
Chlorate
Chlorite
Cyanate
 α -Hydroxylamine
Nitrate
Nitrite
Nitro
Nitroso
Oxime
Perchlorate

Phosphate
Sulphate
Sulphite
Sulphinic acid
Sulphone
Sulphonic acid
Sulphoxide
Thiophosphate
Thiophosphite
Thiosulphate

(Note.—This class includes salts of organic bases with inorganic oxy-acids.)

For specific examples of oxygen-bearing aromatic compounds, reference may be had to the table beginning on page 6 of my co-pending application Ser. No. 737,070, filed July 26, 1934. These examples include both the unhalogenated compounds listed and the halogenation products of them.

The following is a list of aliphatic unsaturated acids which may be used as one of the components of the condensation reactions identified under (1) (a) above in the preparation of aromatic acids from which salts may be accordingly prepared.

TABLE III.—ALIPHATIC UNSATURATED ACIDS

Vinyl acetic acid	Elaeostearic acid
Vinyl acrylic acid	Propiolic acid
Vinyl glycolic acid	Stearolic acid
Acrylic acid	Methyl acrylic
Crotonic acid	Beta pentanoic acid
Oleic acid	Undecylenic
Linolenic acid	Myristolenic
Maleic acid	Palmitolenic
Hydroxymaleic acid	Acetylene dicarboxylic acid
Fumaric acid	Hydrosorbic acid
Glutaconic acid	Sorbic acid
Linoleic acid	Ricinoleic acid

In the following table are given a number of representative examples of halogenated aliphatic acids which may be used in the condensation reactions identified under I above.

TABLE IV.—HALOGENATED ALIPHATIC ACIDS

Chloracetic acid	Chlorlactic acid
Chlorbutyric acid	Chlorsuccinic acid
Chlorlauric acid	Chloradipic acid
Chlormyristic acid	Chlorsuberic acid
Chlorpalmitic acid	Chlorsebacic acid
Chlorstearic acid	Chlormalic acid
Dichloroleic acid	Chlortartaric acid
Chlor-ricinoleic acid	Chlorcitric acid

In the following table are given representative examples of cyclo-aliphatic unsaturated acids which may be used as one component of the condensation reaction identified under (1) (b) above.

TABLE V.—CYCLO-ALIPHATIC UNSATURATED ACIDS

Lauroleonic acid	Methyl cyclohexylidene acetic acid
Chaulmoogric acid	Fural acrylic acid
Hydrocarpic acid	Fural malonic acid
Tetrahydrobenzoic acid	Benzal malonic acid
Tetrahydrophthalic acid	Benzal propionic acid
Dihydrophthalic acids	Benzal lactic acid
Tetrahydrotoluic acids	Abietic acid
Tetrahydro-xylic acids	

In the following table are given certain representative examples of halogenated cyclo-aliphatic acids which may be used as one of the components of the condensation reaction referred to under (1) (c) above.

TABLE VI.—HALOGENATED CYCLO-ALIPHATIC ACIDS

Chlor-naphthenic acids	Chlor-hexahydrobenzoic acid
Chlor-ethylene-acetic acid	Chlor-hexahydrobenzoic phthalic acid
Chlorvinacetic acid	Chlor-quinic acid
Chlor-caronic acid	Chlor-decahydronaphthoic acids
Chlor-norpinic acid	Chlor-camphenonic acid
Chlor-pinic acid	Chlor-cholanolic acid
Chlor-pinonic acid	Chlor-cholic acid
Chlor-truxillic acid	Chlor-choleic acids
Chlor-camphoric acid	
Chlor-camphenic acid	

As well as the chlor derivatives of all of the acids given in Table V;

When the second type of condensation reaction is employed, i. e. that identified under (2) above, where an aromatic acid is condensed with an aliphatic compound, the aromatic acid may be any of the acids given in Table I above.

When the condensation reaction of the type identified under (2) (a) above is employed, the unsaturated aliphatic compounds, which may be used in such condensation reaction, may be any of those listed in the following table.

TABLE VII.—UNSATURATED ALIPHATIC COMPOUNDS

Hydrocarbons	Decene
Ethylene	Acetylene
Propylene	Butadiene
Butylene	Allene
Isobutylene	Amylene
Di-isobutylene	

As well as those unsaturated products derived from petroleum and petroleum fractions and derivatives such as paraffin wax as by cracking or for example removal of HCl by NaOH from monochlor paraffins. The unsaturated products derived from cracked gasoline, gas oil etc. will be found particularly useful.

Unsaturated organic compounds other than hydrocarbons may also be used and may, for some purposes, give improved results. Included among such unsaturated compounds are the following classes:

Table No. 1

- (A) Oxygen-bearing substitution products (for further classification and examples see Tables Nos. 2 and 3 below).
- (B) Halogen-bearing substitution products.
- (C) Other substitution products such as those containing the following substituent groups:

Amino, and substituted amino groups	Mercapto
Imino	Sulphide
Azo	Polysulphide
Hydrazo	Thiocyanate
Hydrazine	Isothiocyanate
Nitrile	Dithiocarboxylic acids (also ester and salt groups derived therefrom).
Isonitrile	

Note.—This invention contemplates the use of compounds containing more than one substituent group. In such cases the compound may belong in two or more of the above classes.

Examples of the oxygen-bearing compounds are as follows:

Table No. 2

- (1) Unsaturated alcohols, e. g.
 Vinyl ethyl alcohol
 Allyl alcohol
 Crotonyl alcohol
 Oleyl alcohol
 Propargyl alcohol
- (2) Unsaturated aldehydes, e. g.
 Acrolein
 Crotonaldehyde
 Hexadienal
 Octatrienal
 Citral
 Propargyl aldehyde
- (3) Unsaturated ketones, e. g.
 Allyl acetone
 Di-allyl ketone
 Mesityl oxide
 Phorone
 Vinyl lauryl ketone
 Acetylenic ketones (e. g. $R-C\equiv C-CO-R'$), such as:
 Allylene methyl ketone
 Allylene lauryl ketone
- (3a) Ketenes
 Ketene
 Acetyl ketene
- (4) Unsaturated ethers, e. g.
 Di-vinyl ether
 Di-allyl ether
 Allyl ethyl ether
 Vinyl ethyl ether
 Allyl iso-amyl ether
 Allyl lauryl ether
 Propargyl ethyl ether
- (5) Unsaturated acids, e. g.
 Vinyl acetic acid
 Vinyl acrylic acid
 Vinyl glycolic acid
 Acrylic acid
 Crotonic acid
 Oleic acid
 Linoleic acid
 Maleic acid
 Hydroxymaleic acid
 Fumaric acid
 Glutaconic acid
 Linolenic acid
 Elaeostearic acid
 Propiolic acid
 Stearolic acid
 Acetylene dicarboxylic acid
- (5') Unsaturated anhydrides
 Maleic anhydride
 Itaconic anhydride
 Citraconic anhydride
 Pyrocinchoninic anhydride
 Xeronic anhydride
 Glutaconic anhydride
 Methyl glutaconic anhydride
 Dimethyl anhydride
- (6) Unsaturated esters, e. g.
 (a) Esters of unsaturated acids (e. g. those listed under (5) above as well as unsaturated aromatic acids such as cinnamic and coumaric) with mono- and poly-hydric alcohols, or other hydroxy compounds (including phenols). Examples of such alcohols and hydroxy compounds are:
 Methyl alcohol
 Ethyl alcohol
 Propyl alcohol
 Butyl alcohols
 Amyl alcohols
 Lauryl alcohols
 Cetyl alcohols
 Cyclohexanol
 Alkylated cyclohexanols, e. g. methyl cyclohexanol
 Benzyl alcohol
 Furfuryl alcohol
 Tetrahydrofurfuryl alcohol
 Ethylene glycol
 Propylene glycol
 Di-ethylene glycol
 Glycerol
 Erythritol
 Phenol
 Polyhydroxy-benzenes
 Alkylated phenols
 Naphthols
 Unsaturated alcohols (e. g. those listed under (1) above)
- (b) Esters of unsaturated alcohols (e. g. those listed under (1) above) with organic acids, either aliphatic or aromatic, or with inorganic acids. Examples of such acids are:
 Aliphatic acids, including:
 Saturated acids, such as:
 Acetic acid
 Propionic acids
 Butyric acids
 Lauric acids
 Palmitic acid
 Stearic acid
 Oxalic acid
 Citric acid
 Lactic acid
 Glycolic acid
 Malonic acid
 Tartaric acid
 Unsaturated acids, such as those listed under (5) above.
 Aromatic acids, including:
 Benzoic acid
 Phthalic acids
 Salicylic acid
 Anthranilic acid
 Cinnamic acid
 Cyclo-aliphatic acids, including:
 Naphthenic acids
 Hexahydrobenzoic acid

Heterocyclic acids including:

Furoic acid
 Pyrrol carboxylic acids
 Pyridine carboxylic acids

Inorganic acids, including:

Hydro-halogen acids
 Oxy-halogen acids
 Sulphurous acid
 Sulphuric acid
 Thiosulphuric acid
 Carbonic acid
 Thiocarbonic acids
 Hydrogen sulphide
 Phosphorous acid
 Thiophosphorous acids
 Phosphoric acid
 Thiophosphoric acids
 Cyanic acid
 Thiocyanic acid
 Hydrocyanic acid
 Boric acid

(7) Salts of unsaturated acids, including the ammonium and substituted ammonium

Sodium
 Calcium
 Barium
 Cobalt
 Aluminum
 Magnesium
 Zinc
 Lead

Salts of unsaturated acids generally, and more specifically of such acids as those listed under (5) above and of unsaturated aromatic acids.

In addition to the compounds listed above, commercial products comprising complex mixtures of unsaturated oxygen-bearing organic compounds may be used as the "unsaturated" reactant. Examples of such materials are the fatty oils of unsaturated character, e. g.

Castor oil
 Chinawood oil
 Corn oil
 Cottonseed oil
 Croton oil
 Lard oil
 Linseed oil
 Menhaden fish oil
 Rape seed oil
 Soya bean oil
 Sperm oil

Additional material, for use as the "unsaturated" reactant in the condensation, may be derived from any of the above fatty oils, e. g.

- (1) Acids, extracted from the oils by direct hydrolysis, or by saponification and subsequent hydrolysis, or otherwise.
 (2) Esters, produced by esterifying the acids of (1) e. g. to form esters analogous to any of those listed under (6) in Table No. 2.
 (3) Soaps, produced by saponifying the oils directly or by neutralizing the acids of (1) with alkalis, e. g. to form salts analogous to those listed under (7) in Table No. 2.

The unsaturated oxygen compounds are of particular importance and may, therefore, be classified in further detail according to the nature of the attachment of the oxygen atom to the molecule, viz:

Table No. 3

- I. Directly attached to one or more carbon atoms, as in the case of:
 (1') Ethers and analogous compounds
 (2') Compounds containing the



radicle, such as alcohols and other derivatives of carbinol (including phenols, cresols, naphthols, etc.)

- (3') Compounds containing the carbonyl



radicle, such as amides, aldehydes, ketones, organic acids, esters and salts of organic acids (including such salts of both inorganic and organic bases), thio-acids and esters and salts of thio-acids.

- (4') Compounds in which oxygen forms a part of a ring structure, e. g. compounds containing the furyl or hydro-furyl groups.
 (5') Compounds with an inorganic radicle where the oxygen is directly attached to a carbon atom, e. g.

Arsenites
 Hypochlorites
 Phosphites
 Thiophosphates
 Thiophosphites
 β -Hydroxylamines
 Borates

- II'. Indirectly attached through the means of some other atom, i. e., in the form of an inorganic radicle, e. g.,

Arsenate
 Chlorate
 Chlorite
 Cyanate
 α -Hydroxylamine
 Nitrate
 Nitrite
 Nitro
 Nitroso
 Oxime
 Perchlorate
 Phosphate
 Sulphate
 Sulphite
 Sulphinic acid
 Sulphone
 Sulphonic acid
 Sulphoxide
 Thiophosphate
 Thiophosphite
 Thio-sulphate

(Note.—This class includes salts of organic bases with inorganic oxy-acids.)

In the following table are listed a number of representative halogenated aliphatic compounds which may be used as one of the components of the condensation reaction identified under (2) (b) above.

TABLE VIII.—HALOGENATED ALIPHATIC COMPOUNDS

Ethyl chloride	Benzyl chloride
Butyl chloride	Ethylene dichloride
Amyl chloride	Carbon tetrachloride
Lauryl chloride	Chlorparaffin wax
Cetyl chloride	Chlor naphtha
Ceryl chloride	Chlor decane
Melissyl chloride	Amyl dichloride

Chlorinated aliphatic paraffin derivatives as well as the chlorinated derivatives of the various materials and compounds listed in Table VII above.

In the following table are listed a number of specific examples of unsaturated cyclo-aliphatic compounds which may be employed as components of the condensation reaction identified under (2) (c) above.

TABLE IX.—UNSATURATED CYCLO-ALIPHATIC COMPOUNDS

Examples of such unsaturated cyclic compounds are:

Hydrocarbons:
Cyclobutene
Methyl cyclobutene
Methylene cyclobutane
Cyclopentene
Methyl cyclopentenenes
Laurolene
Cyclopentadiene
Fulvenes
Di-cyclopentadiene
Cyclohexene
Methyl cyclohexenes
Cyclohexadienes
Methyl cyclohexadienes
P-menthenes
P-menthadienes
Terpinenes
Limonene
Di-cyclohexadiene
Dihydronaphthalene
Dihydrodiphenyl
Tetrahydrodiphenyl
Pinene
Camphene
Oxygen-containing compounds
Alcohols
Terpineol
Isopulegol
Dihydrocarveol
Pinocarveol
Aldehydes
Ketones
Pulegone
Elperitone
Carvone
Eucarvone
Ionone
Pinocarvone
Verbenone
Carvenone
Ethers
Pinol
Tetrahydro-anisole
Tetrahydro-phenetole
Acids
Laurolenic acid
Chaulmoogric acid
Hydrocarpic acid
Tetrahydrobenzoic acid
Tetrahydrophthalic acid
Tetrahydrotoluic acids
Dihydrophthalic acids
Tetrahydro-xylic acids
Methyl cyclohexylidene acetic acid
Fural acrylic acid
Fural malonic acid
Benzal malonic acid
Benzal propionic acid
Benzal lactic acid
Abietic acid

Commercial products comprising complex mixtures of unsaturated cyclic organic compounds may also be used, e. g.

Turpentine
Pine oil

In the following table are listed a number of representative examples of halogenated cyclo-aliphatic compounds which may be employed as

one of the components of the condensation reaction identified under (2) (d) above.

TABLE X.—HALOGENATED CYCLO-ALIPHATIC COMPOUNDS

5	Halogenated cyclo-aliphatic hydrocarbons
	Chlorcyclobutane
	Chlorcyclopentane
	Chlorethylcyclobutane
	Chlorcyclohexane
10	Chlormethylcyclohexane
	Dichlorcyclohexane
	Chlorcycloparaffin
	Dichlorcyclopentane
	Halogenated cyclo-aliphatic alcohols
	Chlorcyclopentanol
	Chlorcyclohexanol
	Chlormethylcyclohexanol
15	Chloramylcyclohexanol
	Chlorquinitol
	Chlormenthol
	Chlor-terpins
	Chlor-terpineols
	Chlor-borneol
	Halogenated cyclo-aliphatic ketones
	Chlorcyclobutanone
20	Chlorcyclobutyl methyl ketone
	Chlorcyclopentanone
	Chlor-cyclohexanone
	Chlormenthone
	Chlor-camphor
	Brom-camphor
	Halogenated cyclo-aliphatic esters
25	Chlormethyl-naphthenates
	Chlorcyclohexyl-acetate
	Chlorcyclohexyl-stearate
	Chlormethyl-hexahydrobenzoate
	Chlor di-methyl-hexahydrophthalate

The various aromatic acids, either those specifically identified in Table I above or those prepared by the various condensation reactions above identified, may, as previously indicated, be combined with either an organic radicle or base in the preparation of organic salts or with inorganic bases in the preparation of the inorganic salts.

In the following table will be found listed a number of organic radicles or bases which may thus be employed in the preparation of organic salts of aromatic acids.

TABLE XI.—ORGANIC RADICLES OR BASES

Amino compounds such as:	Quinazoline
45	Monoethanolamine
	Pyrolline
	Diethanolamine
	Pyridazine
	Triethanolamine
	Picoline
	Aniline
	Pyrazole
	Benzylamine
	Pyridine
	Laurylamine
	Quinoline
	Diphenylamine
	Pyrrole
	Triphenylamine
50	Piperidene
	Diethylamine
	Thiazole
	Triethylamine
	Carbazole
	Putrescine
	Phenoxazine
	Nitrogen ring compounds, such as:
	Pyrimidine
	Phenthiazine
	Pyrazine
	Indole
	Phenazine
	Indoxyl
	Thiodiazole
	Oxygen-bearing ring compounds, such as:
55	γ -Pyrone

Among the specific organic salts of aromatic acids which may thus be prepared for use, may be listed the following as illustrative examples.

TABLE XII.—ORGANIC SALTS

60	Aniline phenyl stearate
	Benzylamine chlorphenylstearate
	Laurylamine naphthylstearate
	Diphenylamine chlornaphthylstearate
	Diethylamine phenylmercaptostearate
65	Ethanolamine phenylpalmitate
	Triethanolamine piperidyl laurate
	Pyridine phenyl stearate
	Quinoline naphthyl palmitate
	Piperidene chlor nap thyl laurate
	Thiazole phenyl palmitate
	γ -Pyrone phenyl stearate

In the following table are listed a number of inorganic radicles which may be combined with any of the aromatic acids given above in the production of inorganic salts of aromatic acids which may be used as addition agents in the lubricating compositions of my invention.

TABLE XIII.—INORGANIC RADICLES

Sodium	Aluminum
Potassium	Chromium
Ammonium	Stannous
Lithium	Lead
Beryllium	Copper
Magnesium	Cadmium
Calcium	Bismuth
Strontium	Silver
Barium	Mercury
Cobalt	Vanadyl (VO—)
Zinc	
Nickel	
Manganese	

In the following table are given a list of representative inorganic salts which may be produced by the combination of certain of the aromatic acids above identified with certain of the inorganic radicles of Table XIII above.

TABLE XIV.—INORGANIC SALTS

Calcium diphenyl acetate
Magnesium diphenyl acetate
Nickel diphenyl acetate
Cobalt diphenyl acetate
Stannous diphenyl acetate
Potassium phenyl stearate
Ammonium phenyl stearate
Lithium phenyl stearate
Magnesium phenyl stearate
Calcium phenyl stearate
Strontium phenyl stearate
Barium phenyl stearate
Cobalt phenyl stearate
Zinc phenyl stearate
Nickel phenyl stearate
Manganese phenyl stearate
Aluminum phenyl stearate
Chromium phenyl stearate
Stannous phenyl stearate
Copper phenyl stearate
Cadmium phenyl stearate
Silver phenyl stearate
Vanadyl phenyl stearate
Calcium phenyl mercapto stearate
Magnesium phenyl mercapto stearate
Nickel phenyl mercapto stearate
Cobalt phenyl mercapto stearate
Stannous phenyl mercapto stearate
Calcium xenyl stearate
Magnesium xenyl stearate
Nickel xenyl stearate
Cobalt xenyl stearate
Stannous xenyl stearate
Calcium naphthyl stearate
Magnesium naphthyl stearate
Nickel naphthyl stearate
Cobalt naphthyl stearate
Stannous naphthyl stearate
Calcium tolyl stearate
Magnesium tolyl stearate
Nickel tolyl stearate
Cobalt tolyl stearate
Stannous tolyl stearate
Magnesium butyl phthalate (salt-ester)
Calcium butyl phthalate (salt-ester)
Nickel butyl phthalate (salt-ester)
Cobalt butyl phthalate (salt-ester)
Aluminum butyl phthalate (salt-ester)
Calcium decyl phthalate (salt-ester)
Cobalt decyl phthalate (salt-ester)
Nickel decyl phthalate (salt-ester)
Stannous decyl phthalate (salt-ester)
Calcium lauryl phthalate (salt-ester)
Cobalt lauryl phthalate (salt-ester)
Nickel lauryl phthalate (salt-ester)
Stannous lauryl phthalate (salt-ester)
Magnesium mercapto rosolate
Calcium mercapto rosolate
Nickel mercapto rosolate
Cobalt mercapto rosolate
Aluminum mercapto rosolate
Calcium lauryl rosolate

The halogen-bearing salts corresponding to the foregoing halogen-free salts will be found of utility and the following are particularly useful:

Calcium chlor phenyl stearate
Magnesium chlor phenyl stearate
Calcium chlor naphthyl palmitate
Stannous chlor phenyl palmitate
Calcium chlor phenyl laurate
Nickel chlor phenyl laurate
Cobalt chlor phenyl laurate
Stannous chlor phenyl laurate
Calcium chlor phenyl palmitate
Nickel chlor phenyl palmitate
Cobalt chlor phenyl palmitate
Stannous chlor phenyl palmitate
Calcium chlor phenyl myristate
Nickel chlor phenyl myristate
Cobalt chlor phenyl myristate
Stannous chlor phenyl myristate
Calcium chlor naphthyl laurate
Nickel chlor naphthyl laurate
Cobalt chlor naphthyl laurate

Stannous chlor naphthyl laurate
Calcium chlor naphthyl palmitate
Nickel chlor naphthyl palmitate
Cobalt chlor naphthyl palmitate
Stannous chlor naphthyl palmitate
Calcium chlor naphthyl myristate
Sodium chlor naphthyl myristate
Nickel chlor naphthyl myristate
Cobalt chlor naphthyl myristate
Stannous chlor naphthyl myristate
Calcium chlor xenyl laurate
Sodium chlor xenyl laurate
Nickel chlor xenyl laurate
Cobalt chlor xenyl laurate
Stannous chlor xenyl laurate
Calcium chlor xenyl palmitate
Sodium chlor xenyl palmitate
Nickel chlor xenyl palmitate
Cobalt chlor xenyl palmitate
Stannous chlor xenyl palmitate
Calcium chlor xenyl myristate
Sodium chlor xenyl myristate
Nickel chlor xenyl myristate
Cobalt chlor xenyl myristate
Stannous chlor xenyl myristate
Calcium chlor tolyl laurate
Nickel chlor tolyl laurate
Cobalt chlor tolyl laurate
Stannous chlor tolyl laurate
Calcium chlor tolyl palmitate
Nickel chlor tolyl palmitate
Cobalt chlor tolyl palmitate
Stannous chlor tolyl palmitate
Calcium chlor tolyl myristate
Nickel chlor tolyl myristate
Cobalt chlor tolyl myristate
Stannous chlor tolyl myristate

Salts of any of the metals of Table XIII with an aromatic acid produced by condensing paraffin wax hydrocarbons with benzoic acid. The salts produced by combining the metals of Table XIII with an aromatic acid such as with benzoic acid, toluic acid or salicylic acid having one or more long aliphatic groups condensed onto the ring structure.

35 Calcium lauryl toluate	Nickel lauryl toluate
Cobalt lauryl toluate	Stannous lauryl toluate

Instead of preparing the salts designed for use as the addition agents of the present invention by treating any of the acids, of the type above identified, with an alkali for example such as sodium hydroxide in the preparation of the corresponding sodium salt of the acid, it is also possible to prepare corresponding salts by first preparing an ester of the acid, and then reacting such ester with an alkali such as sodium hydroxide to prepare, for example, the sodium soap of the acid, and then treating such soap with another salt in the preparation of a salt of a different inorganic radicle. Thus, for example, the methyl ester of chlorphenylstearic acid may be reacted with sodium hydroxide in the production of sodium chlorphenylstearate which is in turn reacted with calcium chloride in the production of calcium chlorphenyl stearate.

It may be preferable to prepare the ester, employed in the foregoing preparation of the salt, where such ester is one of an aromatic acid on page 2 above, by condensing an ester of an aromatic acid with an unsaturated compound or halogenated organic compound instead of condensing the aromatic acid itself with such compound. For example, in the preparation of salts of stearoyl benzoic acid, methyl benzoate may be condensed with stearoyl chloride to form methyl stearoyl benzoate, this ester saponified with sodium hydroxide, and the resulting sodium salt reacted with magnesium chloride in aqueous solution to form magnesium stearoyl benzoate.

An example of the preparation of magnesium stearoyl benzoate in detail is as follows:

A mixture of 1 mole each of methyl benzoate and stearoyl chloride is dissolved in an equal weight of carbon bisulphide. One mole of anhydrous aluminum chloride is added slowly with

the temperature at 45° C. and the mixture held at that temperature for one hour longer. The materials are then poured into a mixture of cracked ice and concentrated hydrochloric acid, and the carbon bisulphide layer removed and washed with warm water. Carbon bisulphide and moisture are then removed by distilling under vacuum leaving the condensation product, namely methyl stearoyl benzoate. The latter is saponified by adding 1 mole of sodium hydroxide in the form of a 10% aqueous solution, the mixture being refluxed until the aqueous solution is approximately neutral. One-half mole of magnesium chloride is added in the form of an aqueous solution which causes the precipitation of magnesium stearoyl benzoate. The water layer is decanted from the precipitate which is then dissolved in benzol and dried by removing the benzol and water by distilling under vacuum. The resulting product was dissolved in a naphthenic type oil in a concentration of 1% and found to materially improve the oil when used in an internal combustion engine, particularly in preventing the formation of harmful deposits on the piston and piston rings.

Included among the compounds contemplated for use by this invention are stable oil soluble salt-esters of polybasic aromatic acids. These may be formed for example by neutralizing an acid ester of a polybasic aromatic acid with a base, or by partially saponifying a neutral ester of a polybasic aromatic acid with a base so that each molecule of the saponified material retains at least one ester group in addition to at least one basic group.

Examples of such compounds are the salt-esters of the following:

1. Benzene polycarboxylic acids, e. g.
Phthalic acids
Trimesic acid
Trimellitic acid
Hemimellitic acid
Pyromellitic acid
Mellaphanic acid
Prenthitic acid
2. Benzene pentacarboxylic acid
2. Naphthalene polycarboxylic acids, e. g.
Naphthalic acids
3. Pyridine polycarboxylic acids, e. g.
Lutidinic acid
Dipicolinic acid
Cinchomeronic acid
Isocinchomeronic acid
Dinitrocinic acid
Alpha-carbocinchomeronic acid
Beta-carbocinchomeronic acid
Berberonic acid
Trimesitinic acid
Pyridine tetracarboxylic acids
Pyridine pentacarboxylic acid
4. Pyrrole polycarboxylic acids
5. Quinoline polycarboxylic acids
6. Thiophene polycarboxylic acids
7. Thiazole polycarboxylic acids
8. Diphenyl polycarboxylic acids, e. g.
Diphenic acid
9. Dibenzylic polycarboxylic acids
10. Anthracene polycarboxylic acids
11. Phenanthrene polycarboxylic acids
12. Thianthrene polycarboxylic acids

Where such salt-esters are employed, it will generally be found advantageous to have at least one of the ester groups consist of an aliphatic or cyclo-aliphatic group and preferably one containing four or more carbon atoms. For example, salts of the acid butyl or amyl esters of phthalic acid have been found suitable.

Specific examples of these salt-esters have been so labeled in the principal list of specific examples given above.

In view of the particular uses for which my compounded lubricants are intended, it is apparent that of the salts included in the foregoing enumeration of the addition agents which may be employed, those which are readily oil-

soluble are the ones preferred for use. When these compounded oils are designed for use under conditions where high temperatures are usually encountered, the addition agents should be stable at elevated temperatures. For use in crankcase lubricants for internal combustion engines, they should preferably be stable to the extent where there will be substantially no decomposition, when the lubricating composition is exposed to temperatures up to 250° F.

The addition agents which are to be selected from the class described should be such that they are relatively non-corrosive with respect to the metallic surfaces with which they come in contact during use. Certain of the named addition agents may be found to be detrimentally corrosive to certain sensitive bearing metals, in which case an appropriate corrosion inhibitor may be employed in conjunction therewith in the composition.

A lubricating composition prepared in accordance with my invention and which is predominantly hydrocarbon oil may contain from an effective amount to 20% of the salt addition agent above identified. In general, it will be found that an amount as low as .1% will often be quite effective and that amounts in excess of 10% are seldom necessary. A preferred range of concentrations for the salt in the oil is from .25% to about 2%.

The principal use for which the lubricants of this invention are designed is in the crankcase of internal combustion engines. The oil base is therefore preferably a liquid highly refined mineral oil with the addition agent present therein in such amounts as not to detrimentally change the viscosity of the composition. The viscosity of the blended lubricant used for this purpose may vary from an S. A. E. 10 grade to an S. A. E. 50. Generally the blended lubricant in the viscosity range of S. A. E. 10, 20 and 30 will be found of most general utility.

It is also within the contemplation of this invention to provide the addition agents in the form of a concentrate in a suitable oil, said oil containing rather high percentages of the addition agents. Such concentrates may be employed for further blending with a lubricating oil in the proportions desired for the particular conditions of use.

While mineral oil, generally, is the principal ingredient of the lubricant, it is not essential that it be the only ingredient other than the addition agents, provided that there be no additional ingredient which is incompatible with such addition agent. It is within the contemplation of this invention to include, if necessary or desirable, such other addition agents as are commonly added to improve the viscosity index or cold test of the lubricants; addition agents which function as corrosion inhibitors; as well as addition agents whose property is to reduce the tendency of the composition toward oxidation; and a lubricating composition according to this invention which also has a separate film-strength or oiliness increasing agent has been found to be especially effective.

When used in conjunction with a hydrocarbon lubricating oil, it is obvious that, generally, only such amounts of the addition agent may be included as are soluble in the specified amount of oil. By the term "soluble," as herein used, it is intended to indicate the ability to form not only true solutions but also any form

of substantially permanently homogeneous

composition when incorporated in mineral oil. With most of the compounds there is usually little difficulty, especially if the incorporation is effected in the manner described in Cornell Patent No. 2,042,880, and since quite small percentages often give remarkably improved results, it is seldom of extreme importance that the addition agents be oil-soluble in all proportions.

The addition agents above enumerated for use in my compounded lubricants include certain ones which may be found to at least partially decompose under conditions of extreme stress such as the very high temperature encountered in certain classes of use, while others are quite stable even under such extreme conditions.

The use for which the lubricant is designed therefore determines the particular type of addition agent to be selected. A certain amount of decomposition, which proceeds at a relatively slow rate, is usually not harmful. Care should be exercised, however, to select for a particular set of operating conditions, an addition agent which in the oil base used, will not decompose under such operating conditions except at a low rate.

By the term "stable" as used herein in describing the addition agents is meant the characteristic of the addition agents which enables them to resist decomposition in the oil under the condition of use for which the lubricating composition is designed.

The lubricating compositions of this invention may be prepared by first preparing the salt and then dissolving the salt in the oil base, or they may be prepared by reacting the acid in solution in all or a portion of the oil with a suitable basic compound in order to form the desired salt directly in solution in oil. In the latter case, it is frequently desirable to remove the water formed by the reaction, or which may have been added with the basic compound, by some means such as by heating at atmospheric or sub-atmospheric pressure.

In case the salt to be used is water-insoluble, an alternative procedure is as follows:

An aqueous solution of a water-soluble salt of the acid is first prepared, for example by dissolving the acid in an aqueous solution of caustic soda or caustic potash. The aqueous salt solution is then emulsified with oil and a water soluble salt containing the cation of the desired salt is added to the mixture. The desired salt is thus precipitated from the aqueous medium and subsequently or simultaneously dissolved by the oil medium. Separation of the aqueous and oil layers is then effected for example by settling or centrifuging. Subsequent water-washing of the oil solution to remove traces of inorganic salts may be desirable, and removal of moisture may also be required.

A preferred class of addition agents for use in improved lubricating compositions of my invention may be defined as salts of aromatic acids, which salts contain the radicle $-C-X-M$ in which X is an element of the class consisting of oxygen and sulphur and M is a member of the class consisting of metals and basic radicles.

This application is a continuation-in-part of my aforesaid co-pending applications Serial Numbers 737,070, 245,226 now Patent No. 2,223,127, 332,782 now Patent No. 2,223,129, 332,781 now Patent No. 2,223,128, 334,082 now Patent No. 2,223,130, and 216,153, the latter being in turn

a continuation-in-part of Serial No. 760,038 now Patent No. 2,121,825.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. A liquid lubricating composition comprising a major proportion of mineral lubricating oil and an oil-soluble salt of an aromatic acid in an effective amount insufficient, however, to substantially change the viscosity of the composition.

2. A liquid lubricating composition comprising a major proportion of mineral lubricating oil and an oil-soluble salt of an aromatic acid in an amount from .10% to less than that which would substantially change the viscosity of the composition.

3. A liquid lubricating composition suitable for use as the lubricant for the crankcase of internal combustion engines comprising a major proportion of highly refined mineral lubricating oil to which has been added an effective minor amount of an oil-soluble salt of an aromatic acid without any substantial change in the viscosity of the refined mineral lubricating oil.

4. The method of reducing the rate of deposit in internal combustion engines of those materials usually resulting from the use of highly refined mineral lubricating oil as the primary lubricant which consists in incorporating in such lubricant a minor amount of an oil-soluble salt of an aromatic acid.

5. The method of reducing the rate of deposit on the pistons in internal combustion engines of those materials usually resulting from the use under high temperatures of highly refined mineral lubricating oils as the primary lubricants, which consists in introducing to the area where such deposits tend to occur, a minor amount of an oil-soluble salt of an aromatic acid.

6. A liquid lubricating composition comprising a major proportion of mineral lubricating oil and a minor amount of an oil-soluble polyvalent metallic salt of an aromatic acid.

7. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid of the class having a carboxyl group attached to the ring.

8. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of a substituted benzoic acid.

9. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of a substituted salicylic acid.

10. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic substituted carboxylic acid.

11. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid of the class consisting of sulphur-containing aromatic-substituted aliphatic acids.

12. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid of the class consisting of hydroxyl-containing derivatives of triphenyl methane.

13. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid having a molecular composition like that produced by condensing an aromatic heterocyclic compound with an aliphatic acid.

14. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid having a molecular composition like that produced by condensing an oxygen bearing aromatic compound with an aliphatic acid.

15. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid having a molecular composition like that produced by condensing an aromatic acid with an unsaturated aliphatic oxygen compound.

16. A lubricating composition comprising a major proportion of mineral lubricating oil and a minor proportion of an oil-soluble salt of an aromatic acid having a molecular composition like that produced by condensing an aromatic acid with an unsaturated halogen bearing aliphatic compound.

17. A lubricating composition comprising a major proportion of mineral lubricating oil and a

minor proportion of an oil-soluble salt of an aliphatic substituted aromatic acid in which the aliphatic substituent contains oxygen.

18. A lubricating composition comprising a major proportion of mineral lubricating oil, and a minor proportion of an oil-soluble salt of an aromatic acid having a molecular structure like that produced by condensing a salicyclic acid with oleyl alcohol.

19. A lubricating composition comprising a major proportion of mineral lubricating oil, and a minor proportion of an oil-soluble polyvalent metallic salt of an aromatic acid having a molecular structure like that produced by condensing salicyclic acid with oleyl alcohol.

20. A lubricating composition comprising a major proportion of mineral lubricating oil, and a minor proportion of an oil-soluble salt of an aromatic acid having a molecular structure like that produced by condensing an oxygen bearing aromatic derivative of furan with an aliphatic acid.

21. A liquid lubricating composition comprising a major proportion of mineral lubricating oil, and a minor amount of an oil-soluble metallic salt of an aromatic acid.

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