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## MINERAL LUBRICATING OIL COMPOSITION

Richard E. Baus, Philadelphia, and Earl E. Fisher, Glenside, Pa., and Paul R. Pendell, Pennsauken, N.J., assignors to Gulf Oil Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

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This invention relates to mineral oil compositions and more particularly to mineral lubricating oil compositions adapted to prevent rusting and corrosion of metal surfaces which are exposed to moisture.

Mineral oil films afford only limited protection to metal surfaces against rusting and other types of corrosion and, in general, can not be relied upon to provide sufficient protection against rust formation in the presence of moisture. Various lubricating compositions have, heretofore, been disclosed for protecting metal surfaces against rusting and corrosion but the prior compositions have not been entirely satisfactory. It has become common practice to employ corrosion inhibitors or anti-corrosion agents as additives in oil compositions for the purpose of providing additional protection against rusting and corrosion. Such additives have been used in various types of lubricating compositions such as machine oils, internal combustion engine and diesel lubricating oils, turbine oils, greases, oils for small arms, fuse mechanisms, etc., as well as in slushing oils and fuel oils. Some of the prior compositions have exhibited good resistance to oxidation, but they have not given complete protection against rusting and corrosion of metal parts which are exposed to moisture. Other compositions, while being satisfactory for use in the presence of water or water vapor, do not provide adequate protection against corrosion if the composition is contaminated with water prior to its use. Still other compositions, while being satisfactory if applied to metal surfaces which are dry, are ineffective if applied to surfaces which are not free from moisture.

Although gasoline, oil and other hydrocarbons derived from petroleum are substantially free from moisture when produced, traces of water may later be found in these products. Liquid petroleum products are frequently removed from storage tanks by water displacement, thus giving rise to the possibility of water contamination. In other instances, water can be introduced into petroleum products through faulty tank or container closures. Water contamination is particularly a problem in humid atmospheres such as those encountered in the tropics and on the seaboard as well as on board ships. When lubricating oils which have become contaminated with water are subsequently used, substantial corrosion of metal surfaces with which the contaminated lubricant comes in contact may be encountered. It is desirable, therefore, to provide a lubricating composition which will protect metal surfaces from corrosion even though the composition may have been contaminated with water, or the metal surfaces upon which the composition is applied may contain a film of water.

In accordance with the present invention, a lubricating composition is provided which gives prolonged protection against corrosion and rusting normally resulting when metals are exposed to the lubricating composition containing water as a contaminant. The composition of the invention also gives prolonged protection against corrosion and rusting even though it is applied to moist metal surfaces. The composition of the present invention has fur-

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ther desirable properties in that it is a particularly effective lubricant and has good oxidation stability.

The improved lubricating composition of this invention comprises a major proportion of a mineral lubricating oil and minor proportions of each of an alkali metal salt of an oil-soluble sulfonic acid, a metal alkyl thiophosphate, a partial ester of a fatty acid containing at least 8 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule and an ethylene glycol  $C_6$  branched-chain alkyl ether. An improved lubricating composition can be prepared by incorporating in an oil an alkali metal salt of an oil-soluble sulfonic acid, a metal alkyl thiophosphate and a partial ester of a fatty acid containing at least 8 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule. While the composition thus obtained has good corrosion and rust-inhibiting characteristics, the composition has a disadvantage in that it does not give adequate protection to metal surfaces if the composition is contaminated with water prior to its ultimate use or if the metal surfaces contain a film of water at the time the protective film is applied.

We have found that an oil to which has been added an alkali metal salt of an oil-soluble sulfonic acid, a metal alkyl thiophosphate and a partial ester of a fatty acid containing at least 8 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule can be improved with respect to its rust-inhibiting characteristics even though contaminated with water or applied to surfaces which contain water by incorporating in the composition a small amount of an ethylene glycol  $C_6$  branched-chain alkyl ether.

The mineral oil base to which the other constituents are added may be any of the hydrocarbon oils of lubricating grade. The oil may be a refined or semi-refined paraffinic-, naphthenic-, or asphalt-base oil having a viscosity of about 50 to 4000 SUS at 100° F. If desired a blend of oils of suitable viscosity may be employed instead of a single oil, by means of which any desired viscosity within the range of 50 to 4000 SUS at 100° F. may be secured. The particular oil employed will depend upon the ultimate use of the final composition.

The alkali metal salt of an oil-soluble sulfonic acid which we employ can be prepared in known fashion by neutralizing the oil-soluble sulfonic acid with alkali. The sulfonates can be prepared from the oil-soluble sulfonic acids obtained in the sulfonation of mineral oil. The oil-soluble sulfonic acids obtained by sulfonating certain mineral oil fractions are known as mahogany acids as distinguished from the green acids or water-soluble sulfonic acids. Other oil-soluble sulfonic acids can be obtained in sulfonating an alkyl aryl compound, such as didodecyl benzene, or by sulfonating certain organic acids including the naphthenic acids and fatty acids occurring in animal and vegetable oil. In some instances it may be desirable to employ a mixture of sulfonates such as a mixture of petroleum sulfonate with one or more of the other named sulfonates. It is essential, of course, that the alkali metal sulfonate or mixture of sulfonates be soluble in mineral oil. In general, we prefer to employ the sulfonic acid derived from the sulfuric acid treatment of petroleum fractions. Of these, the sulfonic acids having an average molecular weight of about 400 to about 475 are particularly advantageous.

The sulfonate can be employed, per se, or it can be added to the lubricating oil in the form of a mineral oil concentrate. We prefer to employ the sulfonate in the form of a mineral oil concentrate because homogeneous mixtures are more readily obtained when the sulfonate is added in this form. Also, commercially available sul-

fonates are generally supplied in the form of mineral oil concentrates.

The amount of the sulfonate which we employ is between about 1 and about 5 percent by weight based on the weight of the total composition. While we can use more than about 5 percent of the sulfonate, we prefer to use the least amount required to give good detergent properties for obvious economic reasons. An amount less than about 1 percent can be used in instances where detergency is unimportant but if the oil is used as a lubricant in a modern engine higher concentrations are generally required. Preferred compositions comprise about 2 to about 4 percent by weight of sulfonate. When the sulfonate is employed in the form of a mineral oil concentrate, the concentrate is employed in an amount sufficient to incorporate between about 1 and 5 percent by weight of the sulfonate in the final composition. Thus a concentrate containing 60 percent of sulfonate in a light mineral oil diluent can be employed in amounts between about 1.7 and about 8.3 percent by weight.

Typical characteristics of a sodium petroleum sulfonate (65% by weight) in a light mineral oil which was used in preparing compositions A, B and C shown in Table 1 are as follows:

Gravity, ° API	5.1
Specific gravity, 60°/60° F.	1.036
Pounds per gallon, 60° F.	8.63
Molecular combining weight	465
Viscosity, Furol, sec., @ 210° F.	201
Flash point, OC, ° F.	410
Fire point, OC, ° F.	450
Pour point, ° F.	+60
Color, ASTM union	5.5
Water by distillation, percent	5.4
Neutralization value, ASTM D 974 total acid No.	0.11
Sulfated residue, ASTM D 874, percent	10.2

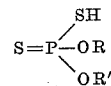
The metal alkyl thiophosphates which can be used in accordance with the invention are advantageously those whose metal component is a metal of Group II of Mendeleeff's periodic arrangement of the elements. Included within this group are magnesium, calcium, zinc, strontium, cadmium and barium. However, other metals including aluminum, copper, lead, tin, iron and manganese can also be employed. The alkyl substituents are preferably those containing between 3 and 12 carbon atoms. Examples of the alkyl groups which can be used are butyl, particularly tertiary butyl, amyl, isoamyl, tertiary amyl, hexyl, cyclohexyl, heptyl, octyl, nonyl, decyl, dodecyl, and the like. While the mono-alkyl esters can be used, the di-alkyl esters are particularly suitable for the purposes of the invention. Exemplary of particularly effective compounds which can be used are zinc octyl hexyl dithiophosphate and zinc dioctyl dithiophosphate. When either zinc octyl hexyl dithiophosphate or zinc dioctyl dithiophosphate is used, it is preferably used in an amount between about 0.1 and about 1.5 percent by weight based on the weight of the total composition.

The metal salts of the thiophosphoric acid esters can be prepared by reacting a basic divalent metal compound with acidic thiophosphoric acid esters that, in turn, are prepared by reacting a monohydric alcohol or mixtures of such alcohols with phosphorus pentasulfide. The monohydric alcohol can be either an open chain or cyclic aliphatic alcohol. Excellent additives for the purpose of our invention can be obtained with alcohols containing an average of 6 to 8 carbon atoms. However, we can also use the aliphatic monohydric alcohols containing 3 to 12 carbon atoms. Hexanol, cyclohexanol, methylcyclohexanol and the Oxo octyl alcohols are exemplary of the alcohols which have given excellent additives for the purpose of our invention. Examples of other alcohols which can be used are heptanol, 2-ethylhexyl alcohol, lauryl alcohol and propyl cyclohexanol. Unsaturated, or olefinic, alcohols including octenol and dodecenol are

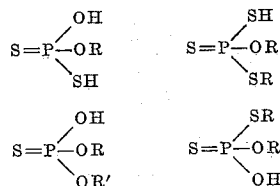
also contemplated. It is not essential that the alcohol component consist entirely of a single alcohol since mixed alcohols, i.e., Oxo octyl alcohols, propyl and octyl alcohols, hexyl and octyl alcohols, can also be used in preparing useful compositions.

The acidic thiophosphoric esters are prepared with relative ease at moderately elevated temperatures and most conveniently at atmospheric pressure. Suitable temperatures for this reaction are generally between about 130° and about 350° F. In the early stages of the reaction, temperatures in the lower part of the range are suitable, but when the reaction nears completion as evidenced by a reduced rate of evolution of hydrogen sulfide, the temperature is preferably raised to at least about 200° F., preferably about 300° F., in order to insure essentially complete reaction of the phosphorus pentasulfide. The reaction of alcohol with phosphorus pentasulfide may be carried out in a solvent which does not interfere with the reaction, such as a mineral lubricating oil, naphtha or benzene, if desired. The reaction will normally be complete within 6 hours, the usual time being about 30 minutes to two hours.

The principal product of the reaction of alcohol with phosphorus pentasulfide in a mol ratio of 4:1, respectively, is ordinarily considered to be a diester of dithiophosphoric acid having the formula



where R and R' are like or unlike ester-forming radicals derived from alcohols of the kind disclosed above. The phosphorus:sulfur mol ratio of such a product is obviously about 1:2. Also possible, but in lesser amounts, are other thiophosphoric acid esters such as those having the following formulae:



where R and R' are as indicated above.

The metal salts of the thiophosphoric acid esters can be prepared by reacting the thiophosphoric acid ester with an excess of the corresponding metal or a basic metal compound. This reaction can be conducted at a temperature between room temperature, i.e., 60° to 70° F. and 300° F., the reaction generally requiring about 1 to 8 hours or more to effect substantial completion thereof. The exact amount of time required for this reaction to take place will vary principally according to the reaction temperature, lower temperatures generally requiring a longer time. The time is also somewhat dependent upon the quantity of reactants employed and the effectiveness of the contacting means.

The metal salts of the thiophosphoric acid esters can be employed per se or they can be added to the lubricating oil in the form of a mineral oil concentrate. Formation of the thiophosphate is frequently facilitated by employing a solvent such as a light mineral oil, naphtha or benzene. When such a mineral oil solvent is used, the thiophosphate is readily recovered in the form of a mineral oil concentrate. This concentrate can then be added directly to the oil to be improved or it can be admixed with one or more of the other additive constituents. Regardless of whether the thiophosphate is employed per se or in the form of an oil concentrate, an amount is used sufficient to incorporate about 0.1 to about 1.5 percent by weight of the thiophosphate in the final lubricating composition. Thus, a concentrate containing 50 percent of the thiophosphate and 50 percent of light mineral oil can be employed in amounts of about

0.2 to about 3.0 percent by weight. The ratio of thiophosphate to sulfonate is preferably in the order of about 1:1 to 1:10.

Typical characteristics of zinc octyl hexyl dithiophosphate which was used in preparing compositions A, B and C shown in Table 1 are as follows:

Gravity, ° API	9.5
Specific gravity, 60°/60° F.	1.004
Pounds per gallon, 60° F.	8.36
Viscosity, SUS:	
100° F.	238
210° F.	43.9
Flash point, OC, ° F.	360
Pour point, ° F.	+20
Color, ASTM union	2.75
Sulfur, B, percent	9.76
Phosphorus, percent	4.68
Zinc, percent	5.26
Carbon residue, Conradson, percent	17.4
Neutralization value, ASTM D 974 total acid No.	68.5
Ash, percent	7.10
Sulfated residue, ASTM D 874, percent	14.7

The ester of a polyol and a fatty acid is prepared by esterifying the polyol with the fatty acid under known reaction conditions. In general, we prefer to employ partial esters, i.e., those wherein at least one and preferably two hydroxyl radicals remain in the molecule. The polyol can contain from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule. Examples of the polyols suitable for the purposes of this invention are glycerol; erythritol; erythritan; penitols, such as arabitol, xylitol and adonitol; arabitan; hexitols, such as mannitol, dulcitol and sorbitol; and sorbitan. Esters suitable for the purposes of this invention include esters of long-chain fatty acids that contain at least 8, and preferably 12 to 24, carbon atoms per molecule. Esters of fatty acids that contain on the average about 18 carbon atoms per molecule are considered particularly effective. Examples of fatty acids that form suitable esters for the purposes of this invention are caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, arachidic acid, behenic acid and lignoceric acid. Specific examples of the esters that can be used in the compositions of this invention are glycerol monolaurate, glycerol monopalmitate, glycerol monostearate, glycerol monooleate, erythritol monooleate, erythritol monopalmitate, erythritol monostearate, erythritol monooleate, erythritol dioleate, erythritan monolaurate, erythritan monooleate, arabitol monolaurate, arabitol monooleate, arabitan monolaurate, arabitan monooleate, sorbitol monolaurate, sorbitol dilaurate, sorbitol monooleate, sorbitol trioleate, sorbitol tetraoleate, sorbitan monolaurate, sorbitan monopalmitate, sorbitan monostearate, sorbitan monooleate, sorbitan dilaurate, sorbitan trioleate and commercially available mixtures of such esters. A useful concentration range for these esters is from about 0.1 to about 5.0 percent by weight.

Typical characteristics of sorbitan monooleate which was used in preparing compositions A and C shown in Table 1 are as follows:

Gravity, ° API	10.1
Specific gravity, 60°/60° F.	0.999
Pounds per gallon, 60° F.	8.32
Viscosity, SUS:	
100° F.	1827
210° F.	108.3
Flash point, OC, ° F.	450
Fire point, OC, ° F.	545
Pour point, ° F.	+10
Color, ASTM union	4.5
Water by distillation	Nil
Carbon residue, Conradson, percent	2.94

Neutralization value, ASTM D 974 total acid No.	6.15
Saponification No., ASTM D 94	149.4
Ash, percent	0.212

The ethylene glycol C<sub>6</sub> branched-chain alkyl ether component of the composition of our invention is critical in that we have found that closely related compounds, i.e., ethylene glycol straight-chain alkyl ethers, do not produce compositions having the desired water displacement and water stability characteristics. The compounds of this type which we can use are selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether. The ethylene glycol C<sub>6</sub> branched-chain alkyl ether is used in amounts between about 1 and about 3 percent by weight based on the weight of the final composition. If less than about 1 percent is used the composition does not have the desired water stability characteristics and if more than about 3 percent is used the composition does not possess the desired high temperature, i.e., 250° F. corrosiveness and oxidation stability. The concentration of the ethylene glycol C<sub>6</sub> branched-chain alkyl ether component is therefore critical in the composition of this invention.

The lubricating oil compositions of this invention can contain other additive agents, if desired, to improve other specific properties without deleteriously affecting the beneficial properties of the compositions. For example, pour point depressors, viscosity and viscosity index improvers, dyes, sludge inhibitors and the like can be used. Also, if desired, the oil can contain a foam inhibitor such as organo-silicon oxide condensation products, organo-silicol condensation products, and the like.

The individual constituents of compositions of this invention may be added to the lubricating oil base in any order or simultaneously, either per se, or in the form of a mineral oil concentrate. The latter practice is sometimes desirable in order to facilitate compounding of the composition. The components can be admixed at room temperature or at an elevated temperature. Blending is more readily accomplished at an elevated temperature below the boiling point of the lowest boiling component. According to a preferred embodiment a temperature of 120° F. is employed when blending mineral oil with sodium petroleum sulfonate, zinc octyl hexyl dithiophosphate, glycerol monooleate, and diethylene glycol ethylbutyl ether.

To illustrate the improved properties of the compositions of the invention, a base oil containing sodium petroleum sulfonate, zinc octyl hexyl dithiophosphate and sorbitan monooleate was compared with an otherwise identical composition containing ethylene glycol ethylbutyl ether. An additional comparison was made with a composition containing glycerol monooleate instead of sorbitan monooleate and diethylene glycol ethylbutyl ether instead of ethylene glycol ethylbutyl ether. The base oil used in the comparative tests was a naphthenic oil having an API gravity between about 29.0 and 30.0° and a viscosity of about 58 at 100° F. In each instance the base oil also contained 1.0 percent of a polymerized methacrylic acid ester as a pour point depressant and a viscosity index improver. The polymerized methacrylic acid ester has the following typical characteristics:

Gravity, ° API	27.0
Specific gravity, 60°/60° F.	0.893
Viscosity, Furol, seconds, 210° F.	395
Flash point, OC, ° F.	280
Fire point, OC, ° F.	375
Pour point, ° F.	+20
Color, ASTM union	1.25
Water by distillation, percent	Trace
Carbon residue, Conradson, percent	0.02
Neutralization value, ASTM D 974 total acid No.	0.13

Ash, percent -----	0.003
Sulfated residue, ASTM D 874, percent -----	0.003

#### WATER DISPLACEMENT TEST

Three sandblasted steel panels are dipped into distilled water momentarily and drained in a vertical position for not more than five seconds. The panels are then immersed horizontally for fifteen seconds in a petri dish containing fifty cubic centimeters of the composition to be tested. After draining momentarily, the panels are placed in a closed vessel containing distilled water which is out of direct contact with the panels. The vessel is kept at 77° F. and the panels are held therein for one hour after which the panels are removed. The composition is then removed from the panels and the panels are visually examined. In order for a composition to be given a pass rating, there must be no evidence of rust, pitting or other abnormal stains or defects on the surface of the panels.

#### WATER STABILITY TEST

Fifty cubic centimeters of the test composition are placed in an Erlenmeyer flask containing five cubic centimeters of distilled water. The contents of the flask are thoroughly mixed and maintained in a stoppered flask overnight at 130° F. The oil-water mixture is then cooled to 77° F. The cooled oil-water mixture is then utilized in the water displacement test outlined above.

#### CORROSIVENESS AND OXIDATION STABILITY TEST

This test is carried out in accordance with Federal Standard Method No. 5308.4. One hundred cubic centimeters of the test composition are placed in a Pyrex test tube fitted with a water cooled reflux condenser. Prepared and weighed strips of copper, steel, aluminum, magnesium and cadmium plated steel are then lowered into the test tube. The metallic test specimens which are each about one inch square are fastened together so the magnesium and copper do not touch each other. The test tube and its contents are then placed in an oil bath maintained at 250° F. The temperature of the water in the reflux condenser is not permitted to exceed 59° F. A glass tube is introduced through the condenser to a point near the bottom of the test tube. Dry air is then introduced through the glass tube at a rate of about five liters per hour for 168 hours. At the end of this period the metal test specimens are removed and reweighed to determine the loss due to corrosion. In order for the composition to be given a pass rating, the change in weight for the specimens must not be greater than 0.2 milligram per square centimeter of surface.

The make-up of the compositions tested together with their properties and test results are tabulated in Table 1 as follows:

Table 1

Composition, percent by weight	A	B	C
Base Oil	95.25	93.25	92.75
Sodium petroleum sulfonate (65% active ingredient)	3.00	3.00	3.00
Zinc octyl hexyl dithiophosphate	0.75	0.75	0.75
Glycerol monooleate	1.00	1.00	1.00
Sorbitan monooleate	1.00	2.00	2.50
Ethylene glycol ethylbutyl ether		2.00	
Diethylene glycol ethylbutyl ether		2.00	
Inspection:			
Gravity, ° API	28.6	29.0	29.1
Viscosity, Kinematic, C, 100° F	12.3	12.14	12.14
Flash Point, O, ° F	295	300	280
Pour Point, ° F	below -70	below -70	below -70
Water Displacement Test	fails	passes	passes
Water Stability Test	fails	passes	passes
Corrosiveness and Oxidation Stability Test	passes	passes	passes

As can be noted from the data in the above table, the base oil containing sodium petroleum sulfonate, zinc octyl hexyl dithiophosphate and sorbitan monooleate

passed the corrosiveness and oxidation stability test but failed the water displacement and water stability tests. However, when 2.5 percent by weight of ethylene glycol ethylbutyl ether was added to the composition, the improved composition (composition C) passed all three tests. A similar composition (composition B) within the scope of the invention containing glycerol monooleate and diethylene glycol ethylbutyl ether instead of the sorbitan monooleate and ethylene glycol ethylbutyl ether, respectively, also passed all three tests. Another satisfactory composition contains 1.5 percent by weight of ethylene glycol methylpentyl ether. When other closely related ethylene glycol alkyl ethers were added to composition A, the composition failed one or more of the three tests. For example, composition A containing diethylene glycol diethyl ether, diethylene glycol dibutyl ether, or ethylene glycol dibutyl ether failed the water displacement test. And, composition A containing diethylene glycol n-hexyl ether, ethylene glycol n-hexyl ether, or ethylene glycol monobutyl ether failed the corrosiveness and oxidation stability test.

While the invention has been described above with reference to certain specific embodiments thereof by way of illustration, it is to be understood that the invention is not limited to such embodiments except as hereinafter defined in the appended claims.

We claim:

1. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of an alkali metal salt of an oil-soluble sulfonic acid; about 0.1 to about 1.5 percent by weight of a metal alkyl thiophosphate, said metal being a metal of group II of the periodic system and said alkyl thiophosphate containing at least one alkyl group containing between 3 and 12 carbon atoms; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing between 12 and 24 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

2. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of a metal alkyl thiophosphate, said metal being a metal of group II of the periodic system and said alkyl thiophosphate containing at least one alkyl group containing between 3 and 12 carbon atoms; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing between 12 and 24 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

3. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of a metal alkyl thiophosphate, said metal being a metal of group II of the periodic system and said alkyl thiophosphate containing at least one alkyl group containing between 3 and 12 carbon atoms; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing 18 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals

per molecule; and about 1 to about 3 per cent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

4. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of a metal di-alkyl dithiophosphate, said metal being a metal of group II of the periodic system and said di-alkyl dithiophosphate containing at least one alkyl group containing between 3 and 12 carbon atoms, the weight ratio of said thiophosphate to said salt of an oil-soluble petroleum sulfonic acid being between about 1:1 and about 1:10; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing 18 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

5. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of a metal alkyl thiophosphate, said metal being a metal of group II of the periodic system and said alkyl thiophosphate containing at least one alkyl group containing between 3 and 12 carbon atoms; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing 18 carbon atoms and glycerol; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

6. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of a metal alkyl thiophosphate, said metal being a metal of group II of the periodic system and said alkyl thiophosphate containing at least one alkyl group containing between 3 and 12 carbon atoms; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing 18 carbon atoms and sorbitan; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

7. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of zinc octyl hexyl dithiophosphate; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing 18 carbon atoms and a polyol containing from 3

to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

8. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of zinc octyl hexyl dithiophosphate; about 0.1 to about 5.0 percent by weight of glycerol monooleate; and about 1 to about 3 percent by weight of diethylene glycol ethylbutyl ether.

9. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of zinc octyl hexyl dithiophosphate; about 0.1 to about 5.0 percent by weight of sorbitan monooleate; and about 1 to about 3 percent by weight of ethylene glycol ethylbutyl ether.

10. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of zinc octyl hexyl dithiophosphate; about 0.1 to about 5.0 percent by weight of sorbitan monooleate; and about 1 to about 3 percent by weight of ethylene glycol methylpentyl ether.

11. An improved lubricating composition comprising a major proportion of a mineral lubricating oil and minor proportions consisting of about 1 to about 5 percent by weight of a sodium salt of an oil-soluble petroleum sulfonic acid; about 0.1 to about 1.5 percent by weight of a zinc dialkyl dithiophosphate wherein the alkyl groups contain an average of 6 to 8 carbon atoms; about 0.1 to about 5.0 percent by weight of a partial ester of a fatty acid containing an average of about 18 carbon atoms and a polyol containing from 3 to 6 carbon atoms and from 3 to 6 hydroxyl radicals per molecule; and about 1 to about 3 percent by weight of an ethylene glycol C<sub>6</sub> branched-chain alkyl ether selected from the group consisting of ethylene glycol ethylbutyl ether, diethylene glycol ethylbutyl ether, ethylene glycol methylpentyl ether and diethylene glycol methylpentyl ether.

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