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LUBRICATING OIL

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1 Claim. (Cl. 252—44)

This invention relates to lubricating oils and more particularly to improved lubricating oils of high film strength, high resistance to oxidation, and markedly reduced formation of corrosive products during use.

This is a continuation in part of my co-pending application, Serial No. 70163, filed March 21, 1936.

Present-day mechanical devices require lubricating oils of high film strength, of high oiliness characteristics, and of low tendency to oxidize during use. It has been found that the present-day hydrocarbon lubricants of the very highest quality are deficient in these very important characteristics. These three properties are of vital importance under conditions of thin film lubrication where the lubricant has been squeezed from between the friction surfaces because of high pressure, slow speeds, and other causes. In modern engines, large surfaces of oil are exposed to the action of atmospheric oxygen, promoting rapid oxidation. It is readily seen that the viscosity or the body of the lubricant plays no part in thin film lubrication and that the remaining film of oil must have a very high film strength and be of high oiliness value to prevent rupture of the film of the lubricant, which would cause seizure. The oil film must tend to keep the coefficient of friction as low as possible. The oil must resist oxidation when these thin films are heated in the presence of atmospheric oxygen as they are in use.

Mechanical devices are being designed for higher pressure operation, and the film strength of the best quality straight hydrocarbon lubricant has been found to be too low for satisfactory service. It will be obvious that an invention which provides a means of improving the film strength of these lubricants is of great importance to the art of lubricant manufacture and to the designer and fabricator of mechanical devices.

Substantially all machines operate in part or at times totally under conditions of boundary or thin film lubrication, under which conditions the oiliness or unctuousity of the lubricant is the first and primary requisite of efficient operation. Those skilled in the art of lubricant manufacture or machine manufacture will readily appreciate the value of an invention that will improve the oiliness of these otherwise high-quality lubricants. Furthermore, sludge and acid are especially deleterious under conditions of thin film lubrication. The sludge is not a lubricant in any sense of the word, and the soluble acid is par-

ticularly corrosive to bearing metals such as cadmium-silver, copper-lead, and the like.

In starting idle mechanical equipment which is lubricated from a sump by pumping or circulating the lubricant, there is always a short period of time in which the rubbing surfaces must operate under conditions of dry friction if ordinary hydrocarbon lubricants are used. With dry friction, the wear on friction surfaces is extreme; and during cold weather when the lubricant is sluggish or during periods when the lubricating system is not functioning properly for one reason or another, rubbing surfaces may not only suffer considerable wear but may be damaged to the point where they must be replaced. The product of this invention has a very important property of reacting with the metal surfaces, penetrating or adsorbing on the metal surfaces, and leaving a film of lubricant with high oiliness character, which remains on the metal surface irrespective of the length of time the machine has been idle.

This high oiliness film gives very even and smooth operation, which may be easily discerned by the experienced operator or lubricating engineer.

When the hydrocarbon lubricants are diluted with unburned fuel or with other light hydrocarbons, the small degree of oiliness of the original hydrocarbon lubricant is greatly decreased. It has been found that the addition of the products of this invention to hydrocarbon lubricants more than compensates for the loss in oiliness and load-carrying ability from dilution.

It is well known that, in order to obtain lubricants which are preeminently satisfactory from the standpoint of oxidation in use, it is necessary to refine the oil thoroughly and then to add an inhibitor of oxidation. The thorough refining may consist of more and heavier acid treatments or solvent treating so as to remove a considerable part of the oil and leave only the most stable portion. Such drastic refining is necessary in order to obtain stability with respect to sludge formation, but the oil is then subject to easy oxidation to form soluble acids and other corrosive materials. This can be prevented by the addition to the refined oil of small amounts of materials which either prevent the formation of these corrosive products or by some action render them inert. Furthermore, such well-refined oils are susceptible to the formation during use of lacquer-like materials which tend to stick rings. This results in blow-by and hence loss of power, failure of lubrication, scratching, scoring, overheating, and eventually replacement of parts.

It is practically impossible to refine a lubricant in such a manner as to avoid all three of these difficulties, namely, sludge, soluble corrosive products, and lacquer. It is considerably more advantageous to add the materials of this invention and avoid these difficulties by this method.

Certain compounds are adsorbed or absorbed by metals forming tenacious films at the surface of metals which are able to stand high pressures. X-ray diffraction methods have shown that compounds containing highly polar molecules, that is, molecules of unsymmetrical electrical character containing an atom or group of atoms exhibiting a secondary or residual valence, tend to produce regimentation of the molecules of hydrocarbon oil when added thereto. A metal immersed in a strongly polar compound will show a film of the compound in which there is a regimentation of molecules oriented with respect to the surface of the metal by which they are adsorbed or absorbed.

Many of these additive materials are effective when added to poorly refined or even wholly unrefined lubricants. The addends may thus be substituted in whole or in part for the usual refining processes.

In the prior art of applying these principles to the manufacture of lubricants, many diverse types of materials have been suggested to be added to obtain improvement in various characteristics. It has been found that the addition of various compounds frequently improves film strength, oxidation resistance, noncorrosiveness, and other characteristics.

One object of this invention is to provide improved inhibitors of oxidation and corrosion for addition to lubricants.

Another object of this invention is to provide film strength improving addition agents suitable for use in lubricants and especially in crankcase lubricants.

Other and further objects of this invention will appear in the course of the following description.

In general, this invention contemplates an oil of lubricating viscosity having added thereto a small amount of an organo-metallic salt. The organo-metallic salt may be an organo-metallic salt of an organic, inorganic or organo-metallic acid. Organic or inorganic salts of organo-metallic acids or organo-metallic substituted acids may be used. The organic parts of these molecules may be radicals of the aliphatic, carbocyclic, or heterocyclic series. The metallic element may be any one of a number of which the following are representative. For convenience these are listed in accordance with their occurrence in the Periodic Table.

Group II:

Beryllium
Magnesium
Zinc
Cadmium
Mercury

Group III:

Aluminum
Thallium

Group IV:

Germanium
Tin
Lead

Group V:

Arsenic
Bismuth
Antimony

Group VI:

Tellurium
Selenium

The compound may contain in the organic radical or attached to the metal an additional element or combination of elements including the halogens, phosphorus, sulfur, nitrogen or oxygen.

The organo-metallic salts of this invention have a dual action in a lubricant. One action involves increased load-carrying ability and/or oiliness, while another action is directed to the stability of the lubricant. For load-carrying capacity, quantities ranging from 0.1 per cent to about 10 per cent may be added. As an anti-corrosive agent and/or an anti-sludging agent, much smaller amounts may be required ranging from approximately 0.001 to 0.1 per cent. The action of the organo-metallic salts is specific but difficult to understand. These compounds may be added to any type of hydrocarbon lubricants but show an unusual value in highly refined and solvent treated lubricants. By oil having lubricating viscosity in the appended claim, it is meant to include the so-called mineral oils and various hydrogenated, polymerized and otherwise synthetically treated oils such as voltolized oils, aluminum chloride treated oils, and the like. Furthermore the lubricating oil may consist in whole or in part of shale oil, animal or vegetable oils such as castor oil, lard oil, corn oil, cottonseed oil, and the like.

In practice, it is better to employ compounds whose boiling point is above 225° F. in order that the addition compound will not be evaporated or distilled in use. The selection of a particular compound or compounds to be used as an addition agent to the hydrocarbon or other oil is to be made considering the physical and chemical properties of the various compounds and the use to which the blend is put. Thus, if water is likely to be present during use, a salt or combination of salts is selected which is not affected by water. If a particular added compound proves too volatile for its application, a higher boiling material should be used and the more volatile compound used for blending in an oil intended for duty at lower temperatures. In general, for automotive crankcase lubricants, it is preferred to use compounds having vapor pressures of less than atmospheric at 250° F.

The following compounds may be used in accordance with this invention. All and each of these are to be considered as examples of this invention when blended in an oil of lubricating viscosity.

I. Organo-metallic salts of inorganic acids

A. Salts of acids of nitrogen

1. Salts of nitrous acid

Triamyltin nitrite $(C_5H_{11})_3SnNO_2$

Tribenzyltin nitrite

$(C_6H_5CH_2)_3SnNO_2$

Tripyridyl germanium nitrite

$(C_5H_4N)_3GeNO_2$

Trithienyltin nitrite $(C_6H_5S)_3SnNO_2$

Furfurylmercuric nitrite

$(C_4H_3O)HgNO_2$

Di-isoamylaluminum nitrite

$(C_5H_{11})_2AlNO_2$

- Di-phenylbismuth nitrite
(C₆H₅)₂BiNO₂
- o-Tolyltellurium nitrite
(CH₃C₆H₄)₂TeNO₂
- Tri-omega-chloroamyltin nitrite 5
(ClC₅H₁₀)₃SnNO₂
- n-Butylberyllium nitrite C₄H₉BeNO₂
2. Salts of nitric acid
- Diethylthallium nitrate
(C₂H₅)₂TlNO₃ 10
- Trilauryl tin nitrate (C₁₂H₂₅)₃SnNO₃
- Di-p-tolyl lead dinitrate
(CH₃C₆H₄)₂Pb(NO₃)₂
- Benzyl cadmium nitrate
C₆H₅CH₂CdNO₃ 15
- p-tert.-Butylphenylarsenic nitrate
C₄H₉C₆H₄AsNO₃
- p-Aminobenzylselenium nitrate
H₂NC₆H₄CH₂SeNO₃
- Pyridyl cyclohexyl germanium dinitrate (C₅H₄N)(C₆H₁₁)Ge(NO₃)₂ 20
- Diamyl tin dinitrate
(C₅H₁₁)₂Sn(NO₃)₂
- Tri-omega-chloroamyltin nitrate
(ClC₅H₁₀)₃SnNO₃ 25
- n-Butylberyllium nitrate C₄H₉BeNO₃
- B. Salts of acids of phosphorus
1. Salts of phosphorous acid
- Tribenzyltin phosphite
[(C₆H₅CH₂)₃Sn]₃PO₃ 30
- Triamyltin phosphite
[(C₅H₁₁)₃Sn]₃PO₃
- Tripyridyltin phosphite
[(C₅H₄N)₃Sn]₃PO₃
- Di-omega-chloroamyltin phosphite 35
[(ClC₅H₁₀)₂Sn]₃(PO₃)₂
- o-Tolylzinc phosphite
(CH₃C₆H₄Zn)₃PO₃
- beta-Thioethylthallium phosphite
(HSC₂H₄Tl)₃(PO₃)₂ 40
- Tribenzyltin dicresylphosphite
[(C₆H₅CH₂)₃Sn](CH₃C₆H₄)₂PO₃
- Tribenzyltin monohydrogen phosphite [(C₆H₅CH₂)₃Sn]₂HPO₃
- Tribenzyltin dihydrogen phosphite 45
[(C₆H₅CH₂)₃Sn]₂H₂PO₃
2. Salts of Thiophosphorous acids
- Tribenzyltin monothiophosphite
[(C₆H₅CH₂)₃Sn]₃PO₂S
- Diamyltin dithiophosphite 50
[(C₅H₁₁)₂Sn]₃(PO₂S)₂
- Trilauryltin trithiophosphite
[(C₁₂H₂₅)₃Sn]₃PS₃
- Allyl dicyclohexyltin monothiophosphite [(C₆H₅)(C₆H₁₁)₂Sn]₃PO₂S 55
- p-Amyloxyphenylthallium trithiophosphite (C₅H₁₁O.C₆H₄Tl)₃(PS₃)₂
- Thienylmercuric dithiophosphite
(C₄H₅S.Hg)₃POS₂
- omega-Chloroamylselenium monothiophosphite (ClC₅H₁₀Se)₃PO₂S 60
- p-Dimethylaminophenylbismuth trithiophosphite
[(CH₃)₂NC₆H₄Bi]₃(PS₃)₂
- Tribenzyltin monohydrogen monothiophosphite [(C₆H₅CH₂)₃Sn]₂HPO₂S 65
- n-Butylberyllium monothiophosphite (C₄H₉Be)₃PO₂S
3. Salts of phosphoric acid 70
- Tribenzyltin phosphate
[(C₆H₅CH₂)₃Sn]₃PO₄
- Pyridyl cyclohexylthallium phosphate [(C₅H₄N)(C₆H₁₁)Tl]₃PO₄ 75
- Chloronaphthylmercuric phosphate
(ClC₁₀H₆Hg)₃PO₄
- Dibenzothienylantimony phosphate
(C₁₂H₇S.Sb)₃(PO₄)₂
- Allyl diamyltin diallyltin phosphate
[(C₃H₅)(C₅H₁₁)₂Sn]₃PO₄
- Tribenzyltin dicresylphosphate
[(C₆H₅CH₂)₃Sn](CH₃C₆H₄)₂PO₄
- Di-p-nitrophenyltin phosphate
[(O₂NC₆H₄)₂Sn]₃(PO₄)₂
- Tri (4-benzoylphenyl) lead phosphate [(C₆H₅CO C₆H₄)₃Pb]₃PO₄
- 2-Ethylhexylzinc phosphate
[C₄H₉CH(C₂H₅)CH₂Zn]₃PO₄
- n-Butylberyllium phosphate
(C₄H₉Be)₃PO₄
- Diphenyllead phosphate
[(C₆H₅)₂Pb]₃(PO₄)₂
- Tribenzyltin monohydrogen phosphate [(C₆H₅CH₂)₃Sn]₂HPO₄
- Tribenzyltin dihydrogen phosphate
[(C₆H₅CH₂)₃Sn]₂H₂PO₄
- Diethylthallium phosphate
[(C₂H₅)₂Tl]₃PO₄
4. Salts of thiophosphoric acids
- Triamyltin monothiophosphate
[(C₅H₁₁)₃Sn]₃PO₃S
- Tribenzyltin monothiophosphate
[(C₆H₅CH₂)₃Sn]₃PO₃S
- Tribenzyltin dithiophosphate
[(C₆H₅CH₂)₃Sn]₃PO₂S₂
- Tribenzyltin trithiophosphate
[(C₆H₅CH₂)₃Sn]₃POS₃
- Tribenzyltin tetrathiophosphate
[(C₆H₅CH₂)₃Sn]₃PS₄
- Di-beta-ethoxyethylthallium monothiophosphate
[(C₂H₅O C₂H₄)₂Tl]₃PO₃S
- beta-Hydroxyethylmercury tetrathiophosphate (HOC₂H₄Hg)₃PS₄
- omega-Chloroamylantimony dithiophosphate (ClC₅H₁₀Sb)₃(PO₂S₂)₂
- p-Aminophenylselenium trithiophosphate (H₂NC₆H₄Se)₃POS₃
- beta-Mercapto-alpha-naphthylbismuth monothiophosphate
(HS.C₁₀H₆Bi)₃(PO₃S)₂
- Pyridyl cyclohexyltin dipyridyl cyclohexyltin monothiophosphate
[(C₅H₄N)(C₆H₁₁)Sn]₃PO₃S
- Tribenzyltin monohydrogen dithiophosphate
[(C₆H₅CH₂)₃Sn]₂HPO₂S₂
- n-Butylberyllium tetrathiophosphate (C₄H₉Be)₃PS₄
5. Salts of pyrophosphoric acid
- Trilauryltin pyrophosphate
[(C₁₂H₂₅)₃Sn]₄P₂O₇
- Tribenzyltin pyrophosphate
[(C₆H₅CH₂)₃Sn]₄P₂O₇
- Tribenzyltin dicyclohexyltin monohydrogen pyrophosphate
[(C₆H₅CH₂)₃Sn]₃HP₂O₇
- Furfurylmercuric pyrophosphate
(C₄H₃O.Hg)₄P₂O₇
- Di (4-trichloronaphthoynaphthyl) thallium pyrophosphate
[(Cl₃C₁₀H₄COC₁₀H₆)₂Tl]₄P₂O₇
- Allylthallium dihydrogen pyrophosphate C₃H₅TlH₂P₂O₇

- Dicetylarsenic pyrophosphate
 $[(C_6H_5)_2As]_2P_2O_7$
 Tritylselenium dihydrogen pyrophosphate $[(C_6H_5)_3CSe]_2H_2P_2O_7$
 p-Nitrobenzenazophenylzinc pyrophosphate 5
 $(O_2N.C_6H_4N=N.C_6H_4Zn)_4P_2O_7$
 n-Butylberyllium pyrophosphate
 $(C_4H_9Be)_4P_2O_7$
6. Salts of metaphosphoric acid and its 10 polymers
 Triamyltin monometaphosphate
 $(C_5H_{11})_3SnPO_3$
 Tribenzyltin monometaphosphate 15
 $(C_6H_5CH_2)_3SnPO_3$
 Dicinnamyltin monometaphosphate
 $[(C_6H_5CH=CHCH_2)_2Sn](PO_3)_2$
 Tri (4-methylcyclohexyl) tin monometaphosphate
 $(CH_3C_6H_{10})_3SnPO_3$ 20
 Dibenzofurylmercuric monometaphosphate $C_{12}H_7OHgPO_3$
 Di (p-mercaptobenzenyl) aluminum monometaphosphate 25
 $(HSC_6H_4C_6H_4)_2AlPO_3$
 Pentacosylphenylantimony monometaphosphate
 $C_{25}H_{51}C_6H_4Sb(PO_3)_2$
 Trityltellurium monometaphosphate
 $(C_6H_5)_3C.TePO_3$ 30
 Tribenzyltin dimetaphosphate
 $[(C_6H_5CH_2)_3Sn]_2P_2O_6$
 Tribenzyltin trimetaphosphate
 $[(C_6H_5CH_2)_3Sn]_3P_3O_9$
 Tribenzyltin tetrametaphosphate 35
 $[(C_6H_5CH_2)_3Sn]_4P_4O_{12}$
 Tribenzyltin pentametaphosphate
 $[(C_6H_5CH_2)_3Sn]_5P_5O_{15}$
 Tribenzyltin hexametaphosphate
 $[(C_6H_5CH_2)_3Sn]_6P_6O_{18}$ 40
 n-Butylberyllium dimetaphosphate
 $(C_4H_9Be)_2P_2O_6$
7. Salts of hypophosphorous acid
 Tribenzyltin hypophosphite 45
 $[(C_6H_5CH_2)_3Sn]_3PO_2$
 Tribenzyltin monohydrogen hypophosphite $[(C_6H_5CH_2)_3Sn]_2HPO_2$
 Tribenzyltin dihydrogen hypophosphite $(C_6H_5CH_2)_3SnH_2PO_2$
 Crotonylmagnesium hypophosphite 50
 $(CH_3CH=CHCH_2Mg)_3PO_2$
 Cycloamyl amylium hypophosphite $[(C_5H_9)(C_5H_{11})In]_3PO_2$
 Cycloamylindium hypophosphite
 $(C_5H_9In)_3PO_2$ 55
 omega-Chloroamyl ethyltin hypophosphite
 $[(C_6H_5)(C_2H_5)Sn]_3(PO_2)_2$
 Tri (triethylstannyl) tin hypophosphite $[(C_2H_5)_3Sn]_3Sn_3PO_2$ 60
 Tripyridyltin hypophosphite
 $[(C_5H_4N)_3Sn]_3PO_2$
 Trilauryltin hypophosphite
 $[(C_{12}H_{25})_3Sn]_3PO_2$
 omega-Diethylbismuthylamylbismuthyl hypophosphite 65
 $[(C_2H_5)_2Bi(CH_2)_5Bi]_3(PO_2)_2$
 Amylselenium hypophosphite
 $(C_5H_{11}Se)_3PO_2$
 n-Butylberyllium hypophosphite 70
 $(C_4H_9Be)_3PO_2$
8. Salts of hypophosphoric acid
 Tribenzyltin hypophosphate
 $[(C_6H_5CH_2)_3Sn]_2PO_3$ 75
- Tribenzyltin hydrogen hypophosphate $(C_6H_5CH_2)_3SnHPO_3$
 Trilauryltin hypophosphate
 $[(C_{12}H_{25})_3Sn]_2PO_3$
 Dithienyllead hypophosphate
 $(C_4H_3S)_2PbPO_3$
 Divinylthallium hypophosphate
 $[(CH_2=CH-)_2Tl]_2PO_3$
 Oleylphenylmercuric hypophosphate $(C_{18}H_{35}C_6H_4Hg)_2PO_3$
 Lauroylphenylarsenic hypophosphate $C_{11}H_{23}COC_6H_4AsPO_3$
 2-ethylhexyltellurium hydrogen hypophosphate
 $C_4H_9CH(C_2H_5)CH_2TeHPO_3$
 omega-Chloroamylbismuth hypophosphate $ClC_5H_{10}BiPO_3$
 Di (thiobenzoylphenyl) indium hypophosphate
 $[(C_6H_5CS.C_6H_4)_2In]_2PO_3$
 n-Butylberyllium hypophosphate
 $(C_4H_9Be)_2PO_3$
- C. Salts of acids of sulfur
1. Salts of hydrogen sulfide
 Tribenzyltin sulfide
 $[(C_6H_5CH_2)_3Sn]_2S$
 Tribenzyltin hydrosulfide
 $(C_6H_5CH_2)_3SnSH$
 Tribenzyltin benzyl sulfide
 $(C_6H_5CH_2)_3SnSCH_2C_6H_5$
 Trilauryltin sulfide $[(C_{12}H_{25})_3Sn]_2S$
 Dilauryltin sulfide $[(C_{12}H_{25})_2Sn]S$
 Lauryltin sulfide $(C_{12}H_{25}Sn)_2S_3$
 Lauryltin hydrosulfide
 $C_{12}H_{25}Sn(SH)_3$
 Di(ethylcyclohexyl) thallium sulfide
 $[(C_2H_5C_6H_{10})_2Tl]_2S$
 Octadecyllead sulfide $(C_{18}H_{37}Pb)_2S$
 Tri-octadecyllead sulfide
 $[(C_{18}H_{37})_3Pb]_2S$
 Tripentacosyllead sulfide
 $[(C_{25}H_{51})_3Pb]_2S$
 Triquinolytin trilauryltin sulfide
 $[(C_9H_{17})_3Sn]_2[(C_{12}H_{25})_3Sn]S$
 Methacrylylselenium sulfide
 $(CH_2=C(CH_3)CH_2Se)_2S$
 Diamylantimony sulfide
 $[(C_5H_{11})_2Sb]_2S$
 Diphenyllead sulfide $(C_6H_5)_2PbS$
 n-Butylberyllium sulfide
 $(C_4H_9Be)_2S$
2. Salts of sulfurous acid
 Tribenzyltin sulfite
 $[(C_6H_5CH_2)_3Sn]_2SO_3$
 Tribenzyltin hydrosulfite
 $(C_6H_5CH_2)_3SnSO_3H$
 Tribenzyltin dibenzylthallium sulfite
 $[(C_6H_5CH_2)_3Sn]_2[(C_6H_5CH_2)_2Tl]SO_3$
 Thienylzinc sulfite $(C_4H_3SZn)_2SO_3$
 omega-Chloroamylarsenic sulfite
 $ClC_5H_{10}AsSO_3$
 n-Butylberyllium sulfite
 $(C_4H_9Be)_2SO_3$
 Allsylvanum sulfite $(C_3H_5Se)_2SO_3$
 Tribenzyltin amyl sulfite
 $(C_6H_5CH_2)_3SnSO_3C_5H_{11}$
3. Salts of sulfuric acid
 Tribenzyltin sulfate
 $[(C_6H_5CH_2)_3Sn]_2SO_4$
 Dibenzyltin sulfate
 $(C_6H_5CH_2)_2SnSO_4$
 Tribenzyltin tri-p-tolyllead sulfate
 $[(C_6H_5CH_2)_3Sn]_2[(CH_3C_6H_4)_3Pb]SO_4$

Benzyl cadmium sulfate
 $(C_6H_5CH_2Cd)_2SO_4$
 Tri-omega-chloroamyllead sulfate
 $[(ClC_5H_{10})_3Pb]_2SO_4$
 Tribenzyltin hydrogen sulfate 5
 $(C_6H_5CH_2)_3SnHSO_4$
 Tribenzyltin amyl sulfate
 $[(C_6H_5CH_2)_3Sn]C_5H_{11}SO_4$
 p-tert.-Butylphenylindium (III) sul-
 fate $C_4H_9C_6H_4InSO_4$ 10
 p-tert.-Butylphenylindium (II) sul-
 fate $(C_4H_9C_6H_4In)_2SO_4$
 Di-p-aminobenzylbismuth sulfate
 $[(H_2NC_6H_4CH_2)_2Bi]_2SO_4$
 Pyridyl dicyclohexyltin sulfate 15
 $[(C_5H_4N)(C_6H_{11})_2Sn]_2SO_4$
 Tri(mercapto-tolyl) lead sulfate
 $[(HSC_6H_3CH_3)_3Pb]_2SO_4$
 n-Butylberyllium sulfate
 $(C_4H_9Be)_2SO_4$ 20

4. Thiosulfates

Tribenzyltin thiosulfate
 $[(C_6H_5CH_2)_3Sn]_2S_2O_3$
 Tribenzyltin diallylthallium thiosul-
 fate 25
 $[(C_6H_5CH_2)_3Sn][(C_3H_5)_2Tl]_2S_2O_3$
 Pyridyltellurium thiosulfate
 $(C_5H_4NTe)_2S_2O_3$
 Dicyclohexylgeranium thiosulfate
 $(C_6H_{11})_2GeS_2O_3$ 30
 omega-Chloroamylzinc thiosulfate
 $(ClC_5H_{10}Zn)_2S_2O_3$
 Nitroxenylarsenic thiosulfate
 $O_2N.C_6H_4C_6H_4AsS_2O_3$
 beta-Ethoxyethylselenium thiosul- 35
 fate $(C_2H_5OC_2H_4Se)_2S_2O_3$
 Mercaptophenylaluminum thiosul-
 fate $HSC_6H_4AlS_2O_3$
 n-Butylberyllium thiosulfate
 $(C_4H_9Be)_2S_2O_3$ 40

II. Organo-metallic salts of organic acids

A. Salts of acyclic acids

Diethylthallium acetate
 $(C_2H_5)_2Tl.O.CO.CH_3$
 Diethylthallium trichloroacetate 45
 $(C_2H_5)_2Tl.O.CO.CCl_3$
 Diphenylthallium acetate
 $(C_6H_5)_2Tl.O.CO.CH_3$
 Tribenzyltin acetate
 $(C_6H_5CH_2)_3Sn.O.CO.CH_3$ 50
 Tribenzyltin dicetylacetate
 $(C_6H_5CH_2)_3SnO.CO.CH(C_{16}H_{33})_2$
 Tribenzyltin ethyl succinate
 $(C_6H_5CH_2)_3$
 $SnO.CO.CH_2CH_2CO_2C_2H_5$ 55
 Tribenzyltin acetoacetate
 $(C_6H_5CH_2)_3SnO.CO.CH_2CO.CH_3$
 Tribenzyltin oleate
 $(C_6H_5CH_2)_3SnO.CO.C_{17}H_{33}$
 Tribenzyltin tartrate 60
 $[—CHOHCO_2Sn(CH_2C_6H_5)_3]_2$
 Tribenzyltin dichlorostearate
 $C_{17}H_{33}Cl_2CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin alpha-amino-n-valer- 65
 ate $C_3H_7CHNH_2CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin mercapto-stearate
 $C_{17}H_{34}(SH)CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin salt of the half-alde-
 hyde of succinic acid 70
 $H.CO.CH_2CH_2CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin hydrogen succinate
 $HO_2C.CH_2CH_2CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin diethoxystearate
 $C_{17}H_{33}(OC_2H_5)_2CO_2Sn(CH_2C_6H_5)_3$ 75

Tribenzyltin carbonate
 $CO[OSn(CH_2C_6H_5)_3]_2$
 Dilauryltin oleate
 $(C_{17}H_{33}CO_2)_2Sn(C_{12}H_{25})_2$
 Lauryltin oleate
 $(C_{17}H_{33}CO_2)_3SnC_{12}H_{25}$
 Dicyclohexylarsenic oleate
 $C_{17}H_{33}CO_2As(C_6H_{11})_2$
 Allylselenium oleate
 $C_{17}H_{33}CO_2SeC_3H_5$
 n-Butylberyllium oleate
 $C_4H_9BeO.CO.C_{17}H_{33}$
 Dilauryltin oleate ethyl succinate
 $(C_{17}H_{33}CO_2)(C_2H_5O.CO.$
 $CH_2CH_2CO_2)Sn(C_{12}H_{25})_2$
 Pyridyl diethyllead oleate
 $C_{17}H_{33}CO_2[Pb(C_2H_5)_2(C_5H_4N)]$
 p-tert.-Butylphenylzinc oleate
 $C_{17}H_{33}CO_2ZnC_6H_4C_4H_9$
 Di-alpha-amino-beta-naphthylindi-
 um oleate
 $C_{17}H_{33}CO_2In(C_{10}H_6NH_2)_2$
 iso-Propylmercuric stearate
 $C_{17}H_{35}CO_2HgCH(C_6H_5)_2$
 Phenylmercuric myristate
 $C_{13}H_{27}CO_2HgC_6H_5$
 p-Amylphenylmercuric laurate
 $C_{11}H_{23}CO_2HgC_6H_5C_5H_{11}$
 Benzylmercuric palmitate
 $C_{15}H_{31}CO_2HgCH_2C_6H_5$
 Tetrahydronaphthylmercuric mon-
 tanate $C_{20}H_{39}CO_2HgC_{10}H_{11}$
 Diethylthallium caprylate
 $C_7H_{15}CO_2Tl(C_2H_5)_2$
 Diphenylthallium succinate
 $[—CH_2CO_2Tl(C_6H_5)_2]_2$
 p-Amyloxyphenylthallium didodec-
 anoate
 $C_{11}H_{23}CO_2)_2TlC_6H_4OC_5H_{11}$
 Triethyltin adipate
 $[—CH_2CH_2CO_2Sn(C_2H_5)_3]_2$
 Diamyltin divalate
 $(C_4H_9CO_2)_2Sn(C_5H_{11})_2$
 p-Aminobenzyltin tributyrat
 $(C_3H_7CO_2)_3SnCH_2C_6H_4NH_2$
 Diphenyllead acid propionate
 $(C_6H_5)_2Pb(O.CO.C_2H_5)_2.C_2H_5CO_2H$
 Diphenyllead trichloroacetate
 $(C_6H_5)_2Pb(OCOCCL_3)_2$
 Tribenzyltin methyl xanthate
 $CH_3O.CSS.Sn(CH_2C_6H_5)_3$
 n-Propylmercuric ethyl xanthate
 $C_2H_5O.CSS.HgC_3H_7$
 Diethylthallium amyl xanthate
 $C_5H_{11}O.CSS.Tl(C_2H_5)_2$

B. Salts of carbocyclic acids

Tribenzyltin cyclohexylcarboxylate
 $C_6H_{11}CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin phenylacetate
 $C_6H_5CH_2CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin octadecylbenzoate
 $C_{18}H_{37}C_6H_4CO_2Sn(CH_2C_6H_5)_3$
 Tripropyllead p-ethoxybenzoate
 $C_2H_5OC_6H_4CO_2Pb(C_3H_7)_3$
 Triethylgermanium p-nitrobenzoate
 $O_2N.C_6H_4CO_2Ge(C_2H_5)_3$
 Tribenzyltin p-ethoxybenzoate
 $C_2H_5OC_6H_4CO_2Sn(CH_2C_6H_5)_3$
 Triamyltin tributylphenylacetate
 $(C_4H_9)_3C_6H_2CO_2Sn(C_5H_{11})_3$
 Diethylthallium phenylstearate
 $C_{17}H_{34}(C_6H_5)CO_2Tl(C_2H_5)_2$
 Pyridylmercuric o-nitrobenzoate
 $O_2N.C_6H_4CO_2HgC_5H_4N$

Tribenzyltin cetyl phthalate	
$C_{16}H_{33}O.CO.C_6H_4CO_2Sn(CH_2C_6H_5)_3$	
n-Butylberyllium hydrocinnamate	
$C_6H_5CH_2CH_2CO_2BeC_4H_9$	
Tribenzyltin cetyl 3-isopropyl-6-methyl-3,6 - endoethylene - Δ^4 - tetrahydrophthalate	5
$C_{16}H_{33}O.CO.C_2H_5CO_2Sn(CH_2C_6H_5)_3$	
Tribenzyltin 3-isopropyl-6-methyl-3, 6-endoethylene- Δ^4 -tetrahydrophthalate	10
$C_{12}H_{18}[CO_2Sn(CH_2C_6H_5)_3]_2$	
Tribenzyltin hydrogen 3 - isopropyl-6-methyl - 3, 6-endoethylene- Δ^4 -tetrahydrophthalate	
$C_{12}H_{18}(CO_2H)CO_2Sn(CH_2C_6H_5)_3$	
beta-Chloroethylarsenic phenylstearate	15
$[C_{17}H_{34}(C_6H_5)CO_2]_2AsC_2H_4Cl$	
beta-Chloroethyltellurium phenylstearate	
$C_{17}H_{34}(C_6H_5)CO_2TeC_2H_4Cl$	
Trichloronaphthylmercuric terephthalate	20
$C_6H_4(CO_2HgC_{10}H_4Cl_3)_2$	
2-ethylhexylthallium p-nitrobenzeneazop-toluenesulfonate	
$[O_2N.C_6H_4N=N.C_6H_3(CH_3)SO_3]_2$	
Diethyl Δ^4 -amlytin triamylhydrocinnamate	25
$[C_5H_{11}]_3C_6H_2CH_2CH_2CO_2$	
$[Sn(C_2H_5)_2CH_2CH_2CH_2CH=CH_2]$	
Tribenzyltin cinnamate	30
$C_6H_5CH=CHCO_2Sn(CH_2C_6H_5)_3$	
Furfurylmercuric phenylstearate	
$C_{17}H_{34}(C_6H_5)CO_2Hg.C_4H_3O$	
C. Salts of heterocyclic acids	
Tribenzyltin furoate	35
$C_4H_3O.CO_2Sn(CH_2C_6H_5)_3$	
Furfurylmercuric terpenylate	
$C_7H_{11}O_2.CO_2HgC_4H_3O$	
Dilaurylthallium furfuracrylate	40
$C_4H_3O.CH=CHCO_2Tl(C_{12}H_{25})_2$	
omega-Chloroamyl arsenic thiophene-alpha-carboxylate	
$ClC_5H_{10}As(O.CO.C_4H_3S)_2$	
p-Amyloxyphenylselenium beta-indoleacetate	45
$C_8H_6N.CO_2SeC_6H_4OC_5H_{11}$	
Tribenzyltin tetrahydrofuroate	
$C_4H_7O.CO_2Sn(CH_2C_6H_5)_3$	
Tribenzyltin nicotinate	
$C_8H_4N.CO_2Sn(CH_2C_6H_5)_3$	
n-Butylberyllium nicotinate	50
$C_8H_4N.CO_2BeC_4H_9$	
III. Salts of organo-metallic acids	
A. Inorganic salts of organo-metallic acids	
Calcium laurylstannionate	55
$(C_{12}H_{25}SnO_2)_2Ca$	
Sodium laurylstannionate	
$C_{12}H_{25}SnO_2Na$	
Aluminum laurylstannionate	
$(C_{12}H_{25}SnO_2)_3Al$	
Lead laurylstannionate	60
$(C_{12}H_{25}SnO_2)_2Pb$	
Manganese laurylstannionate	
$(C_{12}H_{25}SnO_2)_2Mn$	
Cobalt laurylstannionate	
$(C_{12}H_{25}SnO_2)_2Co$	
Nickel laurylstannionate	65
$(C_{12}H_{25}SnO_2)_2Ni$	
Ferrous laurylstannionate	
$(C_{12}H_{25}SnO_2)_2Fe$	
Ferric laurylstannionate	
$(C_{12}H_{25}SnO_2)_3Fe$	
Stannous laurylstannionate	70
$(C_{12}H_{25}SnO_2)_2Sn$	
Stannic laurylstannionate	
$(C_{12}H_{25}SnO_2)_4Sn$	
Mercurous laurylstannionate	
$C_{12}H_{25}SnO_2Hg$	
Mercuric laurylstannionate	
$(C_{12}H_{25}SnO_2)_2Hg$	
Calcium p-tolylstannionate	
$(CH_3C_6H_4SnO_2)_2Ca$	
Aluminum p-tolylstannionate	
$(CH_3C_6H_4SnO_2)_3Al$	
Sodium p-tolylstannionate	
$CH_3C_6H_4SnO_2Na$	
Calcium cetylphenylarsenite	
$C_{16}H_{33}C_6H_4AsO_2Ca$	
Calcium p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2Ca$	
Aluminum p-tert.-amylphenylarsenite	
$(C_5H_{11}C_6H_4AsO_2)_3Al_2$	
Sodium p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2Na_2$	
Calcium dipropylarsenate	
$[(C_3H_7)_2AsO_2]_2Ca$	
Aluminum dipropylarsenate	
$[(C_3H_7)_2AsO_2]_3Al$	
Sodium dipropylarsenate	
$(C_3H_7)_2AsO_2Na$	
Ammonium laurylstannionate	
$C_{12}H_{25}SnO_2NH_4$	
Ammonium p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2(NH_4)_2$	
Ammonium dipropylarsenate	
$(C_3H_7)_2AsO_2NH_4$	
B. Organic salts of organo-metallic acids	
Tetramethylammonium laurylstannionate	
$C_{12}H_{25}SnO_2N(CH_3)_4$	
Tetramethylammonium p-tolylstannionate	
$CH_3C_6H_4SnO_2N(CH_3)_4$	
Tetramethylammonium cetylphenylarsenite	
$C_{16}H_{33}C_6H_4AsO_2[N(CH_3)_4]_2$	
Tetramethylammonium p-tert.-amylphenyl arsenite	
$C_5H_{11}C_6H_4AsO_2[N(CH_3)_4]_2$	
Tetramethylammonium dipropylarsenate	
$(C_3H_7)_2AsO_2N(CH_3)_4$	
Triamylammonium laurylstannionate	
$C_{12}H_{25}SnO_2NH(C_5H_{11})_3$	
Triamylammonium p-tolylstannionate	
$CH_3C_6H_4SnO_2NH(C_5H_{11})_3$	
Triamylammonium p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2[NH(C_5H_{11})]_3$	
Triamylammonium dipropylarsenate	
$(C_3H_7)_2AsO_2NH(C_5H_{11})_3$	
Diethylammonium laurylstannionate	
$C_{12}H_{25}SnO_2NH_2(C_2H_5)_2$	
Diethylammonium p-tolylstannionate	
$CH_3C_6H_4SnO_2NH_2(C_2H_5)_2$	
Diethylammonium p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2[NH_2(C_2H_5)]_2$	
Diethylammonium dipropylarsenate	
$(C_3H_7)_2AsO_2NH_2(C_2H_5)_2$	
Phenylammonium laurylstannionate	
$C_{12}H_{25}SnO_2NH_3C_6H_5$	
Phenylammonium p-tolylstannionate	
$CH_3C_6H_4SnO_2NH_3C_6H_5$	
Phenylammonium p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2(NH_3C_6H_5)_2$	
Phenylammonium dipropylarsenate	
$(C_3H_7)_2AsO_2NH_3C_6H_5$	
Phenylammonium ethyl-p-tert.-amylphenylarsenite	
$C_5H_{11}C_6H_4AsO_2(C_2H_5)NH_3C_6H_5$	
C. Organo-metallic salts of organo-metallic acids	
Tribenzyltin laurylstannionate	
$C_{12}H_{25}SnO_2Sn(CH_2C_6H_5)_3$	
Tribenzyltin p-tolylstannionate	
$CH_3C_6H_4SnO_2Sn(CH_2C_6H_5)_3$	

Tribenzyltin p-tert.-amylphenylarsenite
 $C_5H_{11}C_6H_4AsO_2[Sn(CH_2C_6H_5)_3]_2$
 Tribenzyltin dipropylarsenate
 $(C_3H_7)_2AsO_2Sn(CH_2C_6H_5)_3$
 Di-omega-chloroamylthallium p-tolyl-
 stannionate $CH_3C_6H_4SnO_2Ti(C_5H_{10}Cl)_2$
 p-tert.-Amylphenylzinc p-tert.-amyl-
 phenylarsenite
 $C_5H_{11}C_6H_4AsO_2(ZnC_6H_4C_5H_{11})_2$
 p-Aminophenylbismuth dipropylarsenate
 $[(C_3H_7)_2AsO_2]_2BiC_6H_4NH_2$
 Allylselenium laurylstannionate
 $C_{12}H_{25}SnO_2SeC_3H_5$
 Mercaptophenylaluminum p-tert.-amyl-
 phenylarsenite
 $C_5H_{11}C_6H_4AsO_2AlC_6H_4SH$
 n-Butylberyllium laurylstannionate
 $C_{12}H_{25}SnO_2BeC_4H_9$
 Tribenzyltin ethyl-p-tert.-amylphenyl-
 arsenite
 $C_5H_{11}C_6H_4AsO_2(C_2H_5)Sn(CH_2C_6H_5)_3$
 D. Salts of organo-metallic substituted acids
 Diamylthallium diacetoxymercuri-5-
 nitrosalicylate
 $(CH_3CO_2Hg)_2C_6H(OH)(NO_2)CO_2Ti$
 $(C_5H_{11})_2$
 Di-(tribenzyltin) mercuri-bis-anthrani-
 late
 $Hg[C_6H_3(NH_2)CO_2Sn(CH_2C_6H_5)_3]_2$
 Tribenzyltin o-chloromercuribenzoate
 $ClHgC_6H_4CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin o-sulfidomercuribenzoate
 $S[Hg.C_6H_4CO_2Sn(CH_2C_6H_5)_3]_2$
 Tribenzyltin beta-mercury-bis-pro-
 pionate
 $Hg[CH_2CH_2CO_2Sn(CH_2C_6H_5)_3]_2$
 Tribenzyltin alpha-tribenzyltinstearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2Sn$
 $(CH_2C_6H_5)_3$
 Tribenzyltin alpha-diethylthallium-
 laurate
 $C_{11}H_{22}[Ti(C_2H_5)_2]CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin p-n-butylberylliumben-
 zoate
 $C_4H_9BeC_6H_4CO_2Sn(CH_2C_6H_5)_3$
 Tribenzyltin omega-chloroamylarsenic-
 dibenzoate
 $ClC_5H_{10}As[C_6H_4CO_2Sn(CH_2C_6H_5)_3]_2$
 Tribenzyltin allylseleniumbenzoate
 $C_3H_5SeC_6H_4CO_2Sn(CH_2C_6H_5)_3$
 Aluminum diacetoxymercuri-5-nitro-
 salicylate
 $[(CH_3CO_2Hg)_2C_6H(OH)(NO_2)CO_2]_3Al$
 Calcium beta-mercury-bis-propionate
 $Hg(CH_2CH_2CO_2)_2Ca$
 Sodium alpha-tribenzyltinstearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2Na$
 Ammonium alpha-tribenzyltinstearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2NH_4$
 Tetramethylammonium alpha-triben-
 zyltinstearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2N(CH_3)_4$
 Triamylammonium alpha-tribenzyltin-
 stearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2NH(C_5H_{11})_3$
 Diethylammonium alpha-tribenzyltin-
 stearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2NH_2(C_2H_5)_2$
 Phenylammonium alpha-tribenzyltin-
 stearate
 $C_{17}H_{34}[Sn(CH_2C_6H_5)_3]CO_2NH_3C_6H_5$
 Tribenzyltin tribenzyltinsuccinate
 $(C_6H_5CH_2)_3SnCHCH_2CO_2Sn(CH_2C_6H_5)_3$
 $O_2Sn(CH_2C_6H_5)_3$

Any of these compounds or other members of the classes represented may be used within the scope of my invention.

The organo-metallic salts have varying degrees of solubility in hydrocarbon and other oils. In some cases it is necessary to use a solvent for the compound or to form colloidal suspensions of the compound in oil. While some of these compounds have only limited solubility in hydrocarbon oils, it is to be remembered that because of their great efficiency extremely small amounts are often effective. Thus I may use as little as 0.001 per cent of some of these compounds, and it will be seen that a fairly insoluble material may dissolve to a sufficient extent to be satisfactory for my purpose. In general, more than 0.001 per cent of my addition agents are used, and I may add one, two, or even five per cent or more.

Furthermore, it is well known that different types of oils have different capabilities of dissolving a given material. For some purposes therefore, I prefer paraffinic, for other purposes, asphaltic, and for still other purposes, naphthenic or mixed base lubricants. Another method of obtaining a satisfactory mixture of addition agent with the hydrocarbon oil is the use of a mutual solvent to bring the addend into solution. Alternatively, peptizing agents may be added to maintain the organo-metallic salt in permanent suspension.

Many of the more difficult soluble materials are rendered more soluble by the introduction of alkyl groups, particularly those containing four or more carbon atoms. The isoamyl, octyl, lauryl, and octadecyl radicals and radicals from paraffin wax greatly increase the solubility of organic compounds in oil. One or more of such groups may be introduced as required. For example, triphenyltin phosphate is not very soluble in hydrocarbon lubricating oils but tri (cetylphenyltin) phosphate is much more soluble.

It will be obvious from these considerations that all the organo-metallic salts are not equivalent and that some are more suitable than others in special cases. Of the examples listed above, for example, the organo-metallic sulfides are likely to be difficultly soluble in petroleum hydrocarbons and fatty oils. Hence, of these, I prefer the purely aliphatic sulfides such as trilauryltin sulfide or triamyltin sulfide. If it is particularly desired, however, to use an aromatic organo-metallic sulfide it may best be accomplished by using a compound in which there are at least as many aliphatic carbon atoms as there are aromatic carbon atoms, or more. Thus I prefer to use triquinolytin trilauryltin sulfide or 2-ethylhexylphenylzinc sulfide.

In the case of the organo-metallic salts of organic acids, I prefer to use salts of acids having boiling points over 120° C. The salts of the unsubstituted aliphatic acids such as acetic, are less likely to be sufficiently soluble than the trichloroacetates, butyrates, stearates and the like. An exception here, however, are the salts of carbonic acid which may be considered an inorganic acid.

It is sometimes advantageous to combine more than one of these compounds in a blend to obtain particular properties. I accomplish this by mixing two or more of these compounds together and blending the mixture with the hydrocarbon oil or by blending one in the hydrocarbon oil, blending the second into this mixture, and so on until the composition is complete.

The various organo-metallic salts usually improve both the film strength and oxidation characteristics of the hydrocarbon oil. For example, the sludging tendencies may be decreased by as little as 0.001 per cent of my organo-metallic salts compounds. The oxidation characteristics of lubricants are very important, and these are markedly improved by our compounds. The ability to reduce friction is another feature contributed to lubricants by some of our tin compounds.

It may be desirable to include in one and the same blend, in addition to the addends here described, other addends for specific purposes. Thus, I may add a pour point depressor such as a naphthalenechlor wax condensation product, a viscosity index improver such as certain resins or polymerized hydrocarbons, and sulfur or phosphorus containing inhibitors, in addition to my organo-metallic salts. Furthermore, various other metallic compounds may be added to the blend without interfering with the action of my ingredients. Indeed, in some cases it is advantageous to combine with my organo-metallic salts in a hydrocarbon oil blend such materials as calcium dichlorostearate, chromium oleate, aluminum stearate, and other metallic soaps. Various halogenated oxygen bearing ring or aliphatic compounds may be added.

My addends are admirably adapted for use in lubricating oils of all types including those designed for use in automotive crankcases, Diesel oils, and any other oils of lubricating viscosity. Furthermore, my addends are advantageously blended in gasoline and other petroleum fuels either directly or after being blended first in a lubricating oil and then added to the fuel. Soap-thickened mineral oils of all types ranging from those showing only a slight increase in viscosity over that of the mineral oil alone to the semi-solid and solid greases containing fifty per cent or more of soap are amenable to treatment according to my invention. In making these greases, the usual soaps such as sodium stearate, aluminum stearate, calcium soaps of beta fat, and the like may be used to form the large part of the necessary soap. Various other thickening ingredients or materials for other purposes may be added. These include yarn, hair, graphite, glycerol, water, lamp black, mica, zinc, dust, litharge and the like.

Some of these organo-metallic salts are more suitable than others for some purposes. Thus iron and lead compounds, in general, are found to be accelerators of oxidation in crankcase lubricants. On the other hand, these same lead compounds, for example, are quite desirable in the manufacture of mild and violent types of hypoid lubricants. Here the value of the extreme pressure characteristics far overshadows the oxidation accelerating ability.

The following examples of blends of my addition agents are given as illustrations and not as limitations:

Example 1

	Per cent
Mid-Continent paraffin base SAE 30	99.0
Tribenzyltin phosphite	1.0

Example 2

	Per cent
California naphthenic base SAE 30	98.7
omega Chloroamyl diethyltin monothio-phosphate	1.3

Example 3

	Per cent
Pennsylvania paraffin base SAE 10	99.40
Diethylthallium trichloroacetate	0.05
Naphthalene-chlorwax condensation product	0.50
Triamylammonium alpha - tribenzyltin-stearate	0.05

Example 4

	Per cent
Paraffin base bright stock	58.0
Paraffin base neutral oil	40.0
Sulfurized methyl esters of corn oil fatty acids	0.1
Tribenzyltin stearoylsalicylate	0.2
Calcium dichlorostearate	1.3
Diphenyl-chlorwax condensation product	0.4

Example 5

	Per cent
Mid-Continent paraffin base SAE 20	98.0
Tribenzyltin p-tolylstannionate	2.0

Example 6

	Percent
Mid-Continent mixed base SAE 50	98.4
Aluminum naphthenate	1.3
Tribenzyltin 3-isopropyl-6 methyl-3, 6-endoethylene-Δ4-tetrahydrophthalate	0.3

Example 7

	Percent
Mid-Continent paraffin base SAE 40	93.8
Volatilized corn oil	5.0
Chlorodiphenylene oxide	1.0
Trilauryl tin phenylstearate	0.2

Example 8

	Percent
Naphthenic base SAE 30	98.0
Diphenyllead dichlorostearate	1.3
Methyl dichlorostearate	0.7

Example 9

	Percent
Castor oil	98.3
Sulfurized soy bean oil	0.2
Dicyclohexylarsenic oleate	1.0
Chlorodiphenyl	0.5

Example 10

In making a grease containing my addends I may use:

	Percent
Oleic acid	8.1
Lime	1.2
Water	0.3
Dichlorostearic acid	1.1
Bright stock	13.1
Distillate (440 seconds at 100° F.)	76.0
Diamyltin divalerate	0.2

Example 11

In making a lubricating gasoline, I blend 0.5 per cent of the product of Example 1 with gasoline. The product has the composition:

	Percent
Gasoline	99.5
Oil	0.495
Tribenzyltin phosphite	0.005

It will be understood that certain features and sub-combinations may be employed without reference to other species or combinations. This is contemplated by and is within the scope of my claim. It is further obvious that various changes may be made in details within the scope of my claim without departing from the spirit of my invention. It is therefore to be under-

stood that my invention is not to be limited to the details described.

Having thus described my invention, I claim:

A lubricant comprising in combination a major proportion of an oil of lubricating viscosity and a minor proportion of diethylarsenic phenylstearate.

BERT H. LINCOLN.