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3,048,542

LUBRICATING COMPOSITIONS

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This invention relates to a lubricating composition which is particularly designed for lubrication of turbine engines which operate over a wide temperature range and under severe operating conditions. More particularly, this invention concerns a synthetic lubricating composition having very superior non-corrosive, extreme pressure properties. This application is a continuation-in-part of copending application Serial No. 593,381, filed June 25, 1956, now abandoned.

In many instances mineral oil base lubricants are not satisfactory for the lubrication of modern turbines which are operated under severe conditions. Turbine engines used to power jet aircraft in particular require lubricants which will withstand the stress to which they are submitted. Synthetic base lubricants of the ester-base type have been found to be extremely useful in meeting the particular requirements for lubrication of jet turbine engines. However, even these superior base components need to be "tailored" to meet certain engine requirements set forth by the military and commercial aircraft engine manufacturers. It is particularly difficult to achieve a synthetic oil composition having properties enabling it to withstand extreme stress without becoming corrosive due to excessive oxidation of the components.

The lubricant composition of this invention broadly comprises a polyester-type base fluid and a fatty material consisting essentially of a compound selected from the group consisting of dimers and trimers of ethylenic fatty acids, and mixtures thereof, said fatty acids having from 12 to 22 carbon atoms and said material being present in an amount sufficient to lend extreme pressure properties to the composition. The effective amounts of the E.P. additives in the base oil range from 0.01 to 1 percent by weight, however, the preferred amounts range from 0.05 to 0.15 weight percent. An increase in additive amounts over the prescribed broad range does not increase the load-carrying ability of the lubricant composition appreciably and tends to increase lead corrosion tendencies thereof. The preferred dimer and trimer acids are prepared using linoleic acid as a polyethylenic component.

Although the dimer and trimer acid material contain none of the elements usually associated with E.P. activity, such as chlorine, phosphorus, or sulfur, they have been found to give significant increases in the load carrying levels of synthetic lubricants without imparting corrosive tendencies to the composition.

Dimerized fatty acids are well known in the art as anti-corrosive additives in both lubricant and non-lubricant mineral oils and as intermediates in the preparation of other mineral oil additives. Their preparation and physical properties are set forth in varying degrees in such U.S. patents as 2,482,761 to Goebel, 2,631,979 to McDermott, and 2,632,695 to Landis et al. It has been shown that material consisting primarily of the dimer acid can be prepared by subjecting unsaturated fatty acids to moderate steam pressures of from 80 to 300 pounds per square inch, at temperatures of from 260 to 360° C. for a period of from about 3 to 8 hours.

Another method for preparing the dimer acids broadly comprises heating a short chain aliphatic alcohol ester of an ethylenic fatty acid at about 300° C. for several

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hours in an inert atmosphere. The resulting dimerized ester is then separated by distillation and hydrolyzed with hydrochloric acid or its equivalent. Fatty oils have also been heat polymerized and thereafter hydrolyzed to produce dimer acids. The first mentioned method is preferred, however, owing to the fact that a larger percentage of dimer acids are produced from the starting materials by the utilization of that method of production.

The trimer acid material is quite easily obtained. It can be separated as it forms along with monomers and higher polymer acids during the preparation of dimer acids by the methods just described. In the case of the trimer acids, however, conventional methods for preparing polymer acids are preferred over the method of Goebel 2,482,761, wherein unsaturated acids are subjected to moderate steam pressure, at moderate temperature for a few hours, since these other methods produce higher percentages of trimer acid material.

The mixture of dimer and trimer acids formed in these processes are at times, for commercial reasons, separated from monomeric and higher polymeric material present as well as from each other. However, the dimer and trimer acids of the invention can be used as E.P. additives for the synthetic base fluids described either separately, mixed or with minor non-degrading amounts of monomer and higher polymer acids.

The dimer and trimer acids of the present invention, although preferably conjugation products of two and three of the same molecules which are di- or polyethylenic, are also products of the combination of monoethylenic compounds and polyethylenic compounds. For instance, linoleic acid and oleic acid dimerized to become the dimer of linoleic and oleic acids. It is, however, necessary to have at least one polyethylenic compound present to form the dimer and trimer.

The fatty acids useful in accordance with this invention include ethylenic monocarboxylic acids having from 12 to 22 carbon atoms examples of which are as follows: 4-dodecenoic, 5,9-dimethyl-2,8-decadienoic, myristoleic, palmitoleic, oleic, linoleic (9,11-octadecadienoic, 10,12-octadecadienoic and 11,13-octadecadienoic) linolenic, erucic and 13,15-docosadienoic. The preferred acid is linoleic acid on the basis of availability and cost. Good source materials from which these fatty acids can be obtained by hydrolysis are vegetable oils, such as soybean oil, linseed oil, cotton seed oil, corn oil, castor oil, mustard seed oil, and peanut oil.

Examples of the percentage composition of some fatty materials consisting essentially of a dimer acid, trimer acid or mixtures thereof which are useful in accordance with the invention are as follows:

	Wt. percent
(1) Dimer acid -----	78
Trimer and higher polymer acids -----	22
(2) Dimer acid -----	72
Trimer and higher polymer acids -----	20
Monomer acid -----	8
(3) Dimer acid -----	85
Trimer and higher polymer acids -----	12
Monomer acid -----	3
(4) Dimer acid -----	92
Trimer and higher polymer acids -----	6
Monomer acids -----	1.5
Fatty residue material -----	0.5
(5) Dimer acid -----	99.5
Fatty residue material -----	0.5
(6) Trimer acid -----	53
Dimer acid -----	35
Monomer acid -----	6
Higher polymer acid and fatty residue -----	6

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	Wt. percent
(7) Trimer acid -----	85
Dimer acid -----	6
Higher polymer acid -----	5
Monomer acid -----	4
(8) Trimer acid -----	65
Dimer acid -----	35
(9) Trimer acid -----	98
Fatty residue -----	2

The most commonly used ester base lubricant is an aliphatic diester of an organic dicarboxylic acid. The dicarboxylic acid component is usually an aliphatic dicarboxylic acid containing 6 to 12 carbon atoms but glutaric acid esters and succinic acid esters may also be used. From the standpoint of cost and availability, the preferred dibasic acids are adipic acid, sebacic acid and azelaic acid. The aliphatic alcohols used to form the diesters usually contain at least 4 carbon atoms and may contain 20 or more carbon atoms. C_6 to C_{18} alcohols are most commonly used. Ether alcohols, such as Cellosolve and Carbitol may also be used in the formation of the aliphatic diesters of organic dicarboxylic acids used as the lubricating base in the compositions of this invention.

Specific examples of the dialkyl esters of aliphatic dicarboxylic acids, which are the preferred base fluids for use in the lubricant composition of the invention, are as follows di-isooctyl azelate, di-2-ethylhexyl sebacate, di-2-ethylhexyl azelate, di-2-ethylhexyl adipate, dilauryl azelate, di-sec-amyl sebacate, di-2-ethylhexyl alkenylsuccinate, di-2-ethoxyethyl sebacate, di-2-(2'-methoxyethoxy) ethyl sebacate, di-2-(2'-ethylbutoxy) ethyl sebacate, di-2-butoxyethyl azelate, di-2-(2'-butoxyethoxy) ethyl alkenylsuccinate, etc.

In addition to the aliphatic dicarboxylic acid esters described above, polyester lubricants formed by a reaction of an aliphatic dicarboxylic acid, a glycol and a monofunctional compound, which is either an aliphatic monohydroxy alcohol or an aliphatic monocarboxylic acid, in specified mol ratios are also employed as the synthetic lubricating base in the compositions of this invention; polyesters of this type are described in U.S. 2,628,974 to Robert T. Sanderson, issued February 17, 1953. Complex esters formed by reaction of a mixture containing specified amounts of 2-ethyl-1,3-hexanediol, sebacic acid and 2-ethylhexanol and by reaction of a mixture containing adipic acid, diethylene glycol and 2-ethylhexanoic acid illustrate this class of synthetic polyester lubricating bases.

Polyesters formed by reaction of a monocarboxylic acid and a glycol may also be used as the ester component. The acid component is usually an aliphatic acid containing at least 6 carbon atoms. The glycol component is advantageously a straight glycol such as 1,6-hexanediol, but ether glycol, such as tetraethylene glycol, may also be used.

Specific examples of the diesters of glycols are the following: di-n-decanoate of 1,4-butanediol, di-2-ethylhexanoate of 1,6-hexanediol, dilaurate of 1,4-hexanediol, dioctanoate of 1,5-pentanediol, dilaurate of tetraethylene glycol, dilaurate of triethylene glycol, dioctoate of pentaethylene glycol.

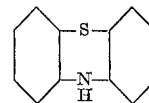
Complex esters formed by reacting trimethylol alkanes with various mol ratios of dibasic acids and monobasic acids or alcohols is another example of polyesters useful for the base fluid of the lubricants of this invention.

The sulfur analogs of the above-described esters are also used in the formulation of the lubricating compositions of this invention. Dithioesters are exemplified by di-2-ethylhexylthiosebacate, di-n-octyl thioadipate and the dilaurate of 1,5-pentanedithiol; sulfur analogs of polyesters are exemplified by the reaction product of adipic acid, thioglycol and 2-ethylhexyl mercaptan.

The finished lubricant composition of this invention normally contains other well known additives which act as

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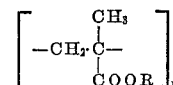
V.I. improvers and anti-oxidants. For example, phenothiazine, which acts as an anti-oxidant and a methacrylate polymer, which acts as a V.I. improver, thickener, and detergent, are usually included in the finished lubricants and are often necessary in order to meet rigid military requirements. Phenothiazine, which has the formula:



is a particularly effective anti-oxidant and anti-corrosive agent. It inhibits corrosion by preventing oxidation of the components of the lubricating composition to acidic bodies which are inherently corrosive. Phenothiazine is usually present in a concentration of 0.1 to 1.5 weight percent of the lubricant composition.

Various aromatic amines either alone or in combination are also known to have anti-oxidant properties and may at times be used in the present composition. For example, naphthylamines, diphenylamines and phenylene diamines in amounts up to about 2 percent by weight are very effective.

Methacrylate polymers are well known V.I. improvers and pour point depressors. Polyester base lubricants, although they, per se, possess excellent V.I. and pour, usually require the presence of small concentrations of methacrylate polymers to meet the requirements of military specifications. These methacrylate polymers are usually copolymers of two or more esters of methacrylic acid and usually have a molecular weight between 5000 and 20,000. The methacrylate esters have the following general formula:



wherein R is an aliphatic radical preferably ranging from butyl to stearyl.

Copolymers which find particular use as V.I. improvers and pour point depressants are the following: a copolymer wherein R in the above formula comprises 20% lauryl, 40% octyl and 40% cetyl; a copolymer wherein R in the above formula is 50% stearyl and 50% lauryl; a copolymer wherein R in the above formula comprises 50% lauryl and 50% octyl.

Methacrylate polymers are usually sold in the form of a concentrate comprising approximately 60 to 40% polymer in a carrier oil. For the lubricant compositions of this invention, it has been found advisable to use an ester-type carrier oil rather than the usual mineral base lubricating oil. The use of a methacrylate ester in an ester-type carrier oil has proven particularly effective in meeting the low temperature requirements of military specifications.

Methacrylate polymers can constitute 1 to 20 weight percent of the composition but ordinarily are used in a concentration between 1.5 and 10 weight percent.

A Schiff's base reaction product of 1 mole of an aliphatic polyamine having two primary amino groups with 2 moles of an aromatic aldehyde having the general formula $\text{A}-\text{CH}=\text{N}-\text{R}-\text{N}=\text{CH}-\text{A}$, where A represents an aromatic nucleus and R is an aliphatic radical having two nitrogen atoms attached directly to different carbon atoms of the same open chain, are also sometimes incorporated in the finished lubricant. Compounds of this type which generally constitute 0.05 to 1 weight percent of the composition act as metal deactivators as disclosed in the Downing et al. No. 2,282,513, issued May 12, 1942. A preferred compound of this class, which is commercially available, is disalicylal propylenediamine which is

also known as disalicylidene-1,2-diaminopropane. This compound is sold under the trade name "DMD" by E. I. du Pont de Nemours and Company and as "Tenamene 60" by Tennessee Eastman. Examples of other compounds of this type are the following:

Di-(2-hydroxy-3-methoxybenzal) ethylenediamine
 Di-(2-hydroxybenzal) ethylenediamine
 Di-(2-hydroxybenzal) decamethylenediamine
 Di-(2-hydroxybenzal) triethylenetetramine
 Di-(2-hydroxybenzal) hexamethylenediamine
 Di-(2-hydroxybenzal) 1:3 propylenediamine
 Dibenzal ethylenediamine
 Dibenzal hexamethylenediamine
 Dibenzal diethylenetriamine
 Dibenzal triethylenetetramine
 Disalicylal ethylenediamine

Anti-wear agents have also been found extremely useful in synthetic lubricant preparations to be used under extreme stress such as in jet aircraft turbines. The anti-wear agents preferred in the composition of the invention are tricresyl phosphate and that compound set forth and described in U.S. Patent No. 2,866,755, issued December 30, 1958. That patent discloses di(o-chlorophenyl) phenyl phosphate in an amount sufficient to impart E.P. and anti-wear properties to a synthetic lubricant composition. These phosphate additives are generally incorporated in the lubricant in amounts up to 5 wt. percent and preferably from 1 to 3 percent. Although anti-wear compounds usually improve the E.P. properties of the base lubricant, the dimer acids of the present invention provide up to $\frac{1}{3}$ more extreme pressure withstanding ability for the synthetic lubricant composition over any previously known E.P. agent.

Still other additive compounds can be advantageously incorporated in the lubricant composition. Detergents, such as the metal salts of phenates and sulphonates, are now widely used in lubes as dispersants. Particularly the basic salts, although neutral salts are at times satisfactory, have been found useful since they will neutralize any acidic products formed during oil oxidation. Sulfonates may be petroleum derivatives having molecular weights from about 300 to 500, such as calcium petroleum sulfonate or sodium petroleum sulfonate. Synthetic sulfonate detergents, such as the barium salt of wax-substituted benzene sulfonate are also available. The sulfonates either neutral or basic are used alone or in various sulfonate combinations in detergent additions to the lubricant ranging from less than one to as high as twenty percent. However, amounts ranging from 1 to 6 percent by weight of the sulfonates in the lube oil are preferred.

The phenates or phenolates useful as detergents are metal alkyl phenols or metal alkyl phenol-sulfides, such as calcium phenyl stearate, zinc alkyl salicylate, wherein the alkyl group comprises olefin polymers having an average of from 12 to 30 carbon atoms, and the alkaline earth metal salts of wax-substituted phenol carboxylate sulfide. These detergents are also added to lube oils in an amount ranging from less than one up to twenty percent, however, from one to six percent by weight is preferred.

The testing of the dimer acids of this invention was performed using the test procedure and apparatus of the high speed gear scuff test. This test is intended for the evaluation of the scuff-limited load-carrying ability of those lubricants used in reduction and accessory drives of turbo-jet and turbo-prop engines. The method of test provides for the running of two spur gears in a Pratt and Whitney gear and lubricant tester (also termed the Ryder gear tester). The face width of the driven gear was 0.937 inch and the face width of the driving gear was 0.25 inch. The dynamometer speed of the gear tester was put up to 4600 r.p.m. and a loading pressure of 2.5

p.s.i. applied. After running for 15 minutes, the tester was shut down and the driving gear removed and an estimate of the percentage of tooth area scuffed on each tooth of that gear was made. The gear was replaced and the above procedure continuously repeated using a higher loading pressure at each repetition until 22.5 percent of the total tooth face area on the driving gear had been scuffed, the load corresponding to this point being considered the scuff load. The loading pressures used were as follows: 3.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 25, 30, 35, 40, 45, 50, 60 p.s.i. and higher, increasing the load by 10 p.s.i. until the load limit was reached. A tooth load conversion factor of 18.5 sq. in., which was a constant calculated from the product of the effective piston area of the test machine (4.52 sq. in.) and the cotangent of the helix angle of the helical gears ($\cot 13.7^\circ = 4.10$), was multiplied by the loading pressure at the scuff load and the product divided by the width of the driving gear (0.25 in.) to obtain the tooth load in pounds per inch. The composition of a base lubricant, designated base fluid #1, tested by the above procedure was as follows:

	Wt. percent
Di-2-ethylhexyl sebacate	79.4
Copolymer of 50% lauryl methacrylate and 50% stearyl methacrylate in a di-2-ethylhexyl sebacate base oil (50% conc.)	18.0
Di-(o-chlorophenyl) phenyl phosphate	2.0
Phenothiazine	0.5
Disalicylidene-1,2-diaminopropane	0.1

The dimer acid material used as an E.P. additive can be described as consisting of 78% of the dimer of linoleic acid and 22% of the trimer and higher polymers of linoleic acid. This dimer acid material is a light colored 36 carbon unsaturated dibasic acid sold by Emery Industries, Inc. under the trademark "Empol 1022" and has the following properties:

Acid value	185
Saponification value	190
Neut. equiv.	300
Color (Gardner)	9
Viscosity at 25° C. (Gardner-Holdt)	Z4
Flash point, ° F.	530

The results of tests upon the foregoing synthetic composition using the high speed gear test procedure are given in the following Table I.

TABLE I
High Speed Gear Test

	Tooth load, lb./in.
Base fluid #1	¹ 2390
Base fluid #1+0.1 wt. percent dimer acid material	3070; 2950

¹ Average of several runs.

Tests on this same composition with the same procedure by an independent research organization produced the following results:

TABLE II
High Speed Gear Test

	Tooth load, lb./in.
Base fluid #1+0.1 wt. percent dimer acid material	3180; 3220

The results of the oxidation and corrosion test, the procedure of which is set forth in the military specification designated MIL-L-7808B, on the composition of the invention tested in Tables I and II, are given in the following Table III and compared to the military requirements prescribed in MIL-L-7808B.

TABLE III

Oxid.-Corr. Test 347° F./72 hrs. mg./sq. cm.	MIL-L- 7808B Specification	Base Fluid #1 +0.1 wt. per- cent dimer acid material
Cu.....	±0.4	-0.4
Al.....	±0.2	0.0
Mg.....	±0.2	+0.1
Fe.....	±0.2	+0.1
Ag.....	±0.2	+0.1

These results clearly demonstrate the non-corrosive quality of a synthetic lubricant having the dimer acid material of this invention incorporated therein.

Another synthetic oil composition, designated base fluid #2, which was used in testing the dimer acid material, consisted of the following:

	Percent by vol.
Di-isooctyl azelate	96.4
Copolymer of 50% lauryl methacrylate and 50% octyl methacrylate (40% concentrate in the carrier di-2-ethylhexyl sebacate)	2.0
Di-(o-chlorophenyl) phenyl phosphate	1.4
Disalicylidene-1,2-diaminopropane	0.2
Phenothiazine	(1)

¹ 0.5% by weight of the total composition was added.

The results of the tests on this base fluid #2 with and without dimer acid material are given in the following Table IV. The dimer acid material was as previously described.

TABLE IV

High Speed Gear Test

	Tooth load, lb./in.
Base fluid #2	¹ 2065
Base fluid #2+0.05 wt. percent dimer acid material	3080; 2730

¹ Average of several runs.

The testing of the extreme pressure properties of the dimer acid material was continued still further on another synthetic oil blend, designated base fluid #3, which had the following composition:

	Percent by wt.
Di-isooctyl azelate	95.5
Copolymer of 50% lauryl methacrylate and 50% octyl methacrylate (40% concentrate in the carrier di-2-ethylhexyl sebacate)	2.0
Tricresyl phosphate	2.0
Phenothiazine	0.5

The results of the tests on this base fluid #3 with and without the dimer acid material are given in the following Table V. As shown in the table, the amount of tricresyl phosphate was increased when the dimer material was added with a corresponding decrease in percentage amount of the di-isooctyl azelate. The dimer acid material used was that previously described.

TABLE V

High Speed Gear Test

	Tooth load lb./in.
Base fluid #3	¹ 1740
Base fluid #3+an additional 0.5 wt. percent tricresyl phosphate and 0.05 wt. percent dimer acid material	2040

¹ Average of several runs.

In order to demonstrate the usefulness of trimer acid material in increasing the load-carrying ability of a synthetic fluid, a fatty material consisting of about 85 per-

cent trimer of linoleic acid was incorporated in the base fluid #4 which consisted of the following:

	Percent by wt.
Di-isooctyl azelate	97.50
Copolymer of 50% lauryl methacrylate and 50% stearyl methacrylate in di-2-ethylhexyl sebacate (50% conc.)	2.0
Phenothiazine	0.5

The above composition and other similar compositions were tested in the high speed gear test, the results of which are given in the following table.

TABLE VI

High Speed Gear Test

	Tooth load lb./in.
Base fluid #4	1670; 2110
Base fluid #4+0.05 wt. percent lineoleic acid	1700; 1670
Base fluid #4+0.05 wt. percent oleic acid	1910; 1910
Base fluid #4+0.05 wt. percent dimer of linoleic acid	2330; 2330
Base fluid #4+0.05 wt. percent trimer of linoleic acid	2140; 2500

The significant increases in load carrying ability which is given to synthetic lubricating oils by relatively small amounts of the non-corrosive, extreme pressure additive of this invention is amply demonstrated by the preceding tables.

Obviously, many modifications and variations of the invention as hereinabove set forth may be made without departing from the spirit and scope thereof, and therefore, only such limitations should be made as are indicated in the appended claims.

We claim:

1. A synthetic lubricant composition comprising a major portion of an aliphatic carboxylic acid ester having lubricating properties, selected from the group consisting of diesters and polyesters, and a minor amount sufficient to improve the extreme pressure property of the composition of a fatty material consisting essentially of a compound selected from the group consisting of dimers and trimers of linoleic acid and mixtures thereof.

2. A synthetic lubricant composition comprising a major portion of an aliphatic carboxylic acid ester having lubricating properties, selected from the group consisting of diesters and polyesters, and from 0.01 to 1 percent by weight of a fatty material consisting essentially of a compound selected from the group consisting of dimers and trimers of linoleic acid and mixtures thereof.

3. A synthetic lubricant composition as described in claim 2 wherein the ester consists of a dialkyl ester of an aliphatic dicarboxylic acid having an alkyl portion ranging from 6 to 18 carbon atoms and an aliphatic acid portion ranging from 6 to 12 carbon atoms.

4. A synthetic lubricant composition comprising a major portion of a dialkyl ester of an aliphatic dicarboxylic acid having an alkyl portion ranging from 6 to 18 carbon atoms and an aliphatic acid portion ranging from 6 to 12 carbon atoms, from 0.01 to 1 percent by weight of a fatty material consisting essentially of a compound selected from the group consisting of dimers and trimers of linoleic acid and mixtures thereof, a viscosity index improving amount of a methacrylate polymer, an oxidation inhibiting amount of phenothiazine, and di(o-chlorophenyl)phenyl phosphate in an amount sufficient to improve the anti-wear properties of the lubricant.

5. A synthetic lubricant composition comprising a major portion of a dialkyl ester of an aliphatic dicarboxylic acid having an alkyl portion ranging from 6 to 18 carbon atoms and an aliphatic acid portion ranging from 6 to 12 carbon atoms, from 0.05 to 0.15 weight percent of a fatty material consisting essentially of the dimer of linoleic acid, from about 1 to 20 percent by weight of a methacrylate polymer from 0 to 5 percent by weight of

di(o-chlorophenyl)phenyl phosphate, from 0 to 1 percent by weight of disalicylidene-1, 2-diaminopropane, and from 0 to 2 percent by weight of phenothiazine.

6. A synthetic lubricant composition as described in claim 5 wherein the dialkyl ester is dioctyl sebacate.

7. A synthetic lubricant composition as described in claim 5 wherein the dialkyl ester is dioctyl azelate.

8. A synthetic lubricant composition as described in claim 5 wherein the dialkyl ester is dioctyl adipate.

9. A synthetic lubricant composition comprising a major portion of dioctyl sebacate, from about 5 to 10 percent by weight of a methacrylate polymer, about 1 to 2 percent by weight of di(o-chlorophenyl)phenyl phosphate, about 0.5 percent by weight of phenothiazine, about 0.1 percent by weight of disalicylidene-1,2-diaminopropane, and from 0.05 to 0.15 percent by weight of a material consisting essentially of the dimer of linoleic acid.

10. A synthetic lubricant composition comprising a major proportion of a dialkyl ester of an aliphatic dicarboxylic acid having alkyl portions ranging from 6 to 18 carbon atoms and an aliphatic acid portion containing from 6 to 12 carbon atoms, from 0.05 to 0.5 weight percent of a fatty material consisting essentially of the dimer of linoleic acid, and from about 1 to 5 weight percent of tricresyl phosphate.

11. A synthetic lubricant composition comprising a major proportion of dioctyl sebacate, from about 5 to 10 weight percent of a methacrylate polymer, about 1 to 3 weight percent of tricresyl phosphate, about 0.1 to 1 weight percent phenothiazine and from 0.05 to 0.15 weight percent of a material consisting essentially of the dimer of linoleic acid.

12. The method of lubricating a jet turbine aircraft engine which comprises supplying to the lubricated metal parts thereof a lubricating composition comprising a major portion of an aliphatic carboxylic acid ester of lubricating characteristics, selected from the group consisting of di-

esters and polyesters, and about 0.01-1 percent by weight of a fatty material consisting essentially of a compound selected from the group consisting of dimers and trimers of linoleic acid and mixtures thereof.

13. The method of lubricating a jet turbine aircraft engine which comprises supplying to the lubricated metal parts thereof a lubricating composition comprising a major portion of an aliphatic dicarboxylic acid ester of lubricating characteristics, selected from the group consisting of diesters and polyesters, about 0.01-1 percent by weight of a fatty material consisting essentially of a compound selected from the group consisting of dimers and trimers of linoleic acid and mixtures thereof, a viscosity index improving amount of a methacrylate polymer, about 0.1-1.5 percent by weight of a phenothiazine and about 1-3 percent by weight of a phosphate ester of the class consisting of tricresyl phosphate and di(o-chlorophenyl)phenyl phosphate.

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