

1

2

3,790,478
**SYNTHETIC LUBRICANT FOR AERO GAS
TURBINES**

Stanley George Rudston, West Molesey, Surrey, Derek Clark Byford, Staines, and Peter Michael Blanchard, West Molesey, Surrey, England, assignors to The British Petroleum Company Limited, Moor Lane, London, England

No Drawing. Continuation of abandoned application Ser. No. 652,696, July 12, 1967. This application Apr. 30, 1971, Ser. No. 139,183

Int. Cl. C10m 1/34, 1/46

U.S. Cl. 252—34

12 Claims

ABSTRACT OF THE DISCLOSURE

An aero gas turbine lubricant having outstanding oxidation stability, corrosion resistance and load carrying ability and good low temperature fluidity is based on a hindered ester and contains an alkylated diphenylamine and an alkylated phenyl naphthylamine as antioxidants, a copper passivator, a dispersant polymer and a neutral organic phosphate as a load-carrying additive. A lead corrosion inhibitor and a hydrolytic stability improver may also be included in the lubricant.

This application is a continuation of our application Ser. No. 652,696, now abandoned.

This invention relates to synthetic lubricants suitable for use under the severe conditions that exist in the operation of modern aero gas turbine engines. More specifically, the invention is concerned with a lubricant of this type that is based on a thermally stable ester and which contains an additive package principally designed to impart good high temperature antioxidation, anti-corrosion and load carrying properties to the basestock.

The problem of thermal stability in aero gas turbine lubricants can be satisfactorily handled by the use of certain hindered ester basestocks which generally also have good low temperature properties, being fluid in many cases at temperatures of -40° or below. A more difficult problem that has to be faced however, is the problem of oxidation stability and resistance to corrosion which arises owing to the fact that the lubricants have to operate at high bulk oil temperatures (about 200° C.) in contact with air. These conditions have the effect of greatly accelerating the oxidative deterioration of the lubricant which generally results in an increase in its viscosity and acidity, and corrosion of, or formation of deposits on, metal surfaces. Excessive increase in viscosity can lead to a restricted flow of lubricant to the engine bearings resulting in inadequate lubrication on starting and/or inadequate cooling during engine running. Deterioration of engine component condition by excessive corrosion or deposition can lead to malfunctioning of the moving parts and excessive formation of oil insoluble materials can cause inadequate lubrication due to blockage of oil-ways. It is therefore very desirable that a lubricant of this type should show no more than a slight tendency to increase in viscosity and acidity during service.

The performance of a lubricant in these respects is frequently assessed by submitting it to an oxidation/corrosion test in which a sample of oil is maintained at a high temperature in contact with metal test pieces while a stream of air is bubbled through it for a prolonged period of time. Forms of this test are quoted in some Government and Engine Manufacturers' specifications for aero gas turbine lubricants. In one form of this test, used to assess oils for high temperature applications, the sample size is 90 grams, a temperature of 400° F. (204° C.), an air flow-rate of 5 litres/hour and a test period of 72

hours are adopted as the test conditions and one inch square plates of magnesium alloy, aluminium alloy, copper, silver and steel are used as the metal test pieces. A variation of this procedure uses a temperature of 425° F. (218° C.) and a test period of 48 hours. In these forms of the test, oils having poor resistance to oxidation at high temperatures give high viscosity and acidity increase and tend to corrode certain of the metals, especially copper and magnesium.

Lead alloy bearings are sometimes used in jet engines and lead corrosion presents a particular problem. Lead corrosion is usually measured by a separate test described later.

Another serious problem that has to be faced in lubricants of this type is the provision of adequate load-carrying ability. This problem arises owing to the fact that ester basestocks that are sufficiently mobile to meet the low temperature requirements of lubricants of this type (for example to permit easy starting of the engines in extremely cold conditions) are very thin and lack "body" under the high temperature operating conditions. Various methods are used for assessing the load carrying ability of such lubricants, for example the well known Ryder and IAE gear machines. Government and engine manufacturers specifications usually specify minimum load carrying characteristics.

Various additives are known for alleviating the above problems but in producing a final lubricant blend it is important that the particular combination of base oil and additives used should be clean in use and not give rise to unacceptable levels of deposits on the engine components. One method of assessing the cleanliness of an oil in this respect is a Panel-Coking Test described later. An indication of the cleanliness of an oil can also be obtained by measuring the amount of insoluble material formed in the oxidation/corrosion tests described above.

The principal object of the present invention is to provide a lubricating composition having outstanding oxidation stability and corrosion resistance and good load carrying ability and low temperature fluidity, whereby it is suitable in these respects for the lubrication of modern aero gas turbine engines and is clean in use.

According to the invention, there is provided a lubricating composition comprising an ester basestock consisting of a liquid neutral polyester that has been prepared by reacting together under esterification conditions and in one or more stages

- (i) an aliphatic mono- and/or polyhydric alcohol having 5-15, preferably 5-10, carbon atoms per molecule and having no hydrogen atoms attached to any carbon atom in a 2 position with respect to any —OH group and
- (ii) an aliphatic mono- and/or polycarboxylic acid having 2-14, preferably 3-12, carbon atoms per molecule,

the basestock having dissolved therein:

- (a) 0.5 to 5.0, preferably 1.5 to 4.0, percent wt. of an alkylated diphenylamine antioxidant, particularly one where the alkyl groups have up to 14 carbon atoms, e.g. a dioctyl or a dinonyldiphenylamine,
- (b) 0.5 to 4.5, preferably 0.5 to 3.5, percent wt. of an alkylated phenyl naphthylamine antioxidant, particularly one where the alkyl groups have up to 14 carbon atoms, e.g. a mono- or dioctyl, or a mono- or dinonyl, phenyl naphthylamine, the total concentration of (a) and (b) being between 1.0 and 8.0, preferably 2.0 and 6.0, percent wt., and the weight of (a) preferably being 1 to 10, especially 2 to 4, times the weight of (b),
- (c) 0.005 to 1.5, preferably 0.01 to 0.5, percent wt. of a copper passivator,

(d) 0.5 to 5.0, preferably 1.0 to 4.0, percent wt. of a neutral organic phosphate of the formula $(RO)_3PO$ where the groups R are tolyl groups, phenyl groups, xylyl groups, or alkyl or cycloalkyl groups having up to 10 carbon atoms and

(e) 0.01 to 5.0, preferably 0.01 to 1.0, percent wt. of a dispersant polymer.

The additive concentrations in this specification are based on the ester basestock. It is to be understood that the composition may contain more than one member of each of the classes of ingredients specified.

THE BASE OIL

The base oil is a hindered polyester of the type described above. By "polyester" is meant an ester having at least two ester linkages per molecule; it therefore includes diesters such as neopentyl glycol dipelargonate and di(2:2:4-trimethylpentyl) sebacate. The term neutral is used to mean a fully esterified product.

It is to be understood that in the esterification reaction described above there may be used more than one of any of the reactants mentioned e.g. a mixture of monocarboxylic acids, and, in any case, the neutral ester product of the esterification reaction will sometimes consist of a mixture of different ester molecules, so the expression "polyester" is to be construed in this light.

Examples of suitable acids and alcohols that may be used in the preparation of the polyester are caprylic acid, capric acid, caproic acid, enanthic acid, pelargonic acid, valeric acid, pivalic acid, propionic acid, butyric acid, 2-ethylhexanoic acid, adipic acid, sebacic acid, azelaic acid, 2:2:4-trimethylpentanol, neopentyl alcohol, neopentyl glycol, trimethylolethane, trimethylolpropane, trimethylolbutane, pentaerythritol and di-pentaerythritol.

The most suitable polyesters are the esters of trimethylolpropane, trimethylolbutane, trimethylolethane, pentaerythritol and/or di-pentaerythritol with one or more monocarboxylic acids having 3 to 10 carbon atoms, particularly one or more of those mentioned in the previous paragraph, and more complex esters, for example those prepared from trimethylolpropane, sebacic acid and/or azelaic acid, and one or more monocarboxylic acids having 3 to 10 carbon atoms, particularly one or more of those mentioned in the previous paragraph. Most suitably, the trimethylolpropane and dicarboxylic acid are reacted in the molar ratio of 1:0.05-0.75, preferably 1:0.075-0.4, the amount of monocarboxylic acid being sufficient to provide a carboxyl/hydroxyl balance in the reactants.

THE ANTIOXIDANTS

A two component antioxidant system is used in the compositions according to the invention. Many of the most efficient antioxidants for high temperature lubricants have been found to cause unacceptable deposit and sludge formation and corrosion of copper and magnesium in use. The alkylated diphenylamine is used because of its cleanliness in use and long-lasting quality. Mono- and di- C_{14} alkyl diphenylamines are preferred, especially p,p'-dioctyldiphenylamine. The efficiency of the antioxidant in accelerated oxidation tests is boosted by an alkylated phenyl naphthylamine, preferably a mono- or di- C_{14} alkyl phenyl naphthylamine, especially a mono-octyl phenyl naphthylamine. The combination has been found to be very satisfactory for the control of viscosity increase during the oxidation test and gives rise to negligible weights of sludge.

THE COPPER PASSIVATORS

Copper passivators are a well-known class of materials, the function of which is to reduce the extent to which copper is attacked by corrosive substances. The copper passivator used in the compositions according to the invention must, of course, be soluble in the basestock. The effect of this additive is to reduce the corrosion on engine component materials when exposed to the lubricant for long

periods of time and in the presence of air. The effectiveness of metal passivators can be measured by the oxidation/corrosion tests described previously. Copper is the most critical metal involved in such tests and it has been found that if this metal can be effectively passivated, then the corrosion of the other metals present is negligibly small, except for lead. Suitable classes of copper passivator include:

(1) Those of the azole type such as imidazole, pyrazole, triazole and their derivatives, e.g. benzotriazole, methylbenzotriazole, ethylbenzotriazole, butylbenzotriazole, dodecylbenzotriazole, methylene bis benzotriazole and naphthotriazole.

(2) Salicylaldehyde semicarbazone and its C_1 to C_{20} alkyl derivatives, e.g. methyl and isopropyl salicylaldehyde semicarbazone.

(3) Condensation products of salicylaldehyde and hydrazine derivatives, and fatty acid salts of such condensation products. A particularly suitable hydrazine derivative is aminoguanidine and suitable fatty acids are those having 2 to 24 carbon atoms.

Particularly effective copper passivators are methylene bis-benzotriazole and salts of 1-salicylalaminoguanidine and fatty acids having 13 to 18 carbon atoms, e.g. palmitic acid. Where the lubricant is intended for use in engines containing lead alloy components, it is desirable to include a lead corrosion inhibitor in the blend, usually at a concentration of 0.01 to 1.0, preferably 0.05 to 0.25, percent wt. Suitable lead corrosion inhibitors are C_1 to C_{20} alkyl gallates, neopentyl glycol dibsebacate, sebacic acid and quinizarin. Propyl gallate is preferred; it does not affect the other properties of the lubricant.

THE LOAD CARRYING ADDITIVE

Tritolyl phosphate is the preferred load-carrying additive but other effective ones are triphenyl phosphate, phenyl/tolyl phosphates, trixylyl phosphate, tributyl phosphate and tricyclohexyl phosphate.

THE DISPERSANT POLYMERS

The cleanliness of the lubricating compositions is improved by the inclusion of this well-known type of additive. Suitable polymers are acrylate and methacrylate polymers, co-polymers of N-vinyl pyrrolidone with acrylates and methacrylates and co-polymers of N-vinyl pyrrolidone with olefins as described in U.S. Pat. No. 3,523,931. The polymers or co-polymers must, of course, be soluble in the ester basestock. The most suitable ones usually have molecular weights within the range 1,000 to 1,000,000, especially 5,000 to 500,000. The acrylates and methacrylates referred to are preferably those derived from acrylic or methacrylic acid and monohydric alcohols having 1 to 24, especially 4 to 18, carbon atoms.

FURTHER OPTIONAL ADDITIVES

If desired, the hydrolytic stability of the compositions according to the invention may be improved by the addition of 0.005 to 0.5, preferably 0.02 to 0.1, percent wt. of a hydrolytic stability improver. Suitable ones are aliphatic or aliphatic/aromatic amines having up to 30 carbon atoms, or hydroxyl derivatives thereof, preferably tertiary amines. The most suitable amines for this purpose are those of the general formula $R^4(R^5)NR^6$ where R^4 and R^5 are alkyl groups having 1 to 4 carbon atoms and R^6 is an alkaryl, or hydroxy-substituted alkaryl, group having up to 20 carbon atoms. A preferred compound of this type is 2:6-ditertiarybutyl-4-dimethylaminomethyl phenol.

If desired a very small proportion (up to 25 parts per million) of an anti-foam agent may also be included in the composition, e.g. a silicone.

EXAMPLES

A number of examples of lubricating compositions according to the invention will now be described.

Three base oils were used in these compositions as follows.

Base Oil N: A complex ester made by esterifying caprylic acid, 1:1:1-trimethylolpropane (TMP) and sebacic acid in the molar ratio of 28:10:1 and in the absence of a catalyst.

Base Oil Q: A complex ester made by esterifying caprylic

that contains this oxidation/corrosion test. The specification is for a "Type 2" aero turbine oil, i.e. an advanced type of aero turbine oil. It will be seen that the results obtained for oils A, B and C compare favorably with those for oils P, Q, R and S and that oils A, B and C are cleaner than the approved oils as measured by the amount of insoluble material produced in the test.

TABLE 2

	Oil							Limits
	A	B	C	P	Q	R	S	
Viscosity increase at 100° F., percent....	37	39	45	47	31.5	24.5	35	Not more than 50.
Acidity increase, mg. KOH/g.....	3.5	3.6	1.5	2.5	1.5	2.0	2.2	Not more than 5.
Mg weight change, mg./cm. ²	-0.02	-0.01	-0.02	-7.1	Nil	+0.02	-0.02	+0.3 to -0.3.
Al weight change, mg./cm. ²	-0.02	-0.01	-0.02	-0.02	+0.03	-0.01	Nil	
Cu weight change, mg./cm. ²	-0.07	-0.15	-0.07	-1.9	-0.03	-0.26	-0.08	
Ag weight change, mg./cm. ²	-0.06	-0.03	-0.05	Nil	Nil	Nil	-0.01	
Fe weight change, mg./cm. ²	+0.02	+0.01	-0.02	-0.02	+0.02	+0.03	+0.02	
Insolubles, mg.....	Nil	Nil	Nil	1.0	5.0	2.3	(1)	

¹ Trace.

acid, TMP and sebacic acid in the molar ratio of 28:10:1 and using a catalyst.

Base Oil R: An ester made by esterifying pentaerythritol, enanthic acid, and 2-ethylhexanoic acid in the molar ratio of 1:3:1 and in the absence of a catalyst.

The additives used in the compositions were as follows:

DODPA=p,p'-Diocetylphenylamine

MOPBN=Mono-octyl phenyl beta naphthylamine

SAGP=Salt of 1-salicylaminoguanidine and a mixture of fatty acids having 13-18 carbon atoms

PG=Propyl gallate

TTP=Tritolyl phosphate

DISP=Dispersant co-polymer of N-vinylpyrrolidone and a methacrylate (molecular weight 60,000 to 70,000) sold commercially under the name Acryloid HF 866.

The proportions (in parts by weight) of the ingredients used in the compositions are shown in Table 1 which also gives the kinematic viscosity in centistokes of the compositions at 210° F. and -40° F., the ASTM slope, the pour point (° F.) and the flash point (° F.).

TABLE 1

	Composition		
	A	B	C
Base Oil:			
N.....	100		
Q.....		100	
R.....			100
DODPA.....	3.0	3.0	3.0
MOPBN.....	1.0	1.0	1.0
SAGP.....	0.1	0.1	0.1
PG.....	0.1	0.1	0.1
TTP.....	2.0	2.0	2.0
DISP.....	0.1	0.1	0.1
Viscosity at--			
210° F.....	5.41	5.40	5.26
-40° F.....	9,440	9,380	15,600
ASTM slope (210-100° F.).....	0.699	0.700	0.732
Pour point, ° F.....	-75	-75	<-70
Flash point (COC), ° F.....	495	495	515

The compositions were evaluated for oxidation stability, corrosion resistance, load carrying and cleanliness by using tests of the type specified in government and engine manufacturers specifications for lubricants for use in aero turbine engines suitable for modern jet aircraft.

Oxidation/corrosion test

This test was carried out as described previously using a temperature of 425° F. (218° C.), a test period of 48 hours and an air-rate of 5 litres/hour.

The results are given in Table 2 which also shows the desirable limits for oil of the type in question. Table 2 also gives results obtained on four commercially available aero gas turbine oils, P, Q, R and S that have been approved against an engine manufacturer's specification

Lead corrosion test

This was measured by maintaining a sample of the oil at 375° F. (190° C.) for five hours with air bubbling through it at a rate of 28 litres per hour and a copper plate immersed in it. A lead plate is rotated in the oil and the weight loss after the test is measured. Results are given in Table 3. A good oil of the type in question is considered to be one which gives a weight loss not exceeding 6.0 mg./sq. in.

TABLE 3

Oil:	Lead weight change, mg./in. ²
A.....	-0.20
B.....	-0.26

Load carrying tests

Lubricating composition A was assessed by the well-known Ryder gear machine test in which a set of gears is immersed in the oil being tested at 165° F. and the gears are run at 10,000 r.p.m. while a load is applied hydraulically in increments. The degree of scuffing on each tooth is measured and the failure point of the oil is considered to be reached when an average of 22.5 percent area of the total tooth face is scuffed.

The result is given in Table 4 which also gives the result on an oil (A¹) which has the same composition as oil A except that the load-carrying additive TTP was omitted, and on the commercial oil P.

TABLE 4

Oil:	Ryder rating, p.p.i.
A.....	2,870
A ¹	2,270
P.....	2,422

Further load carrying tests were carried out using the well-known IAE gear machine test in which a set of gears is sprayed with the oil being tested at certain elevated temperatures and the gears are run at certain speeds while a load is applied. The load when scuffing of the gears occurs is noted. Results are given in Table 5.

TABLE 5

Temperature, ° C.:	Gear speed, r.p.m.	Scuffing load, lb.	
		Oil A	Oil B
110.....	2,000	62	63
110.....	6,000	36	37
200.....	2,000	37	36

Panel coking test

The cleanliness of the lubricating compositions was further assessed by this test in which a sample of the oil is splashed on to a weighed aluminium panel heated at 600° F. (316° C.) for 8 hours and the nature and weight of deposit on the panel are noted.

Results are given in Table 6. An oil giving a deposit of not more than 10 mg. is considered to be an exceptionally good oil of the type in question. Results are also given on the four commercial oils P, Q, R and S referred to previously and it will be seen that oils A, B and C were much cleaner than the commercial oils.

TABLE 6

	Wt. of deposit, mg.	Nature of deposit
Oil:		
A-----	8.0	Yellow lacquer. Brown bands.
B-----	9.0	Very thin golden lacquer.
C-----	7.0	Do.
P-----	79	Thick hard black coke.
Q-----	82	Do.
R-----	74	Thick soft black deposit.
S-----	13	Light brown thin lacquer.

Bearing test

Both oils A and B were submitted to a 100 hour bearing test, conducted at a bulk oil temperature of 440° F. and a bearing temperature of 500° F. Both gave excellent results particularly as regards the cleanliness of the bearing parts after the test, demonstrating the very low deposition and sludging tendencies of these oils.

What we claim is:

1. A lubricating composition comprising an ester base-stock consisting of a liquid neutral polyester that has been prepared by reacting together under esterification conditions and in at least one stage

(i) an aliphatic alcohol selected from the group consisting of monohydric alcohols, polyhydric alcohols, and mixtures thereof, said alcohol having 5-10 carbon atoms per molecule and having no hydrogen atoms attached to any carbon atom in a 2 position with respect to any —OH group and

(ii) an aliphatic acid selected from the group consisting of monocarboxylic acid, polycarboxylic acid, and mixtures thereof, said acid having 3-12 carbon atoms per molecule,

the basestock having dissolved therein:

(a) 0.5 to 5.0% wt. of a di-alkylated diphenylamine antioxidant,

(b) 0.5 to 4.5% wt. of a monoalkylated phenyl naphthylamine antioxidant, the total concentration of (a) and (b) being between 1.0 and 8.0% wt.,

(c) 0.005 to 1.5% wt. of a copper passivator,

(d) 0.5 to 5.0% wt. of a neutral organic phosphate of the formula (RO)₃PO where the groups R are selected from the groups consisting of tolyl groups, phenyl groups, xylyl groups, alkyl groups having up to 10 carbon atoms, and cycloalkyl groups having up to 10 carbon atoms, and

(e) 0.01 to 5.0% wt. of a dispersant polymer.

2. A lubricating composition according to claim 1, in which the polyester is an ester of an alcohol selected from the group consisting of trimethylolpropane, trimethylol-ethane, trimethylolbutane, pentaerythritol, dipentaerythritol and mixtures thereof with one or more monocarboxylic acids having 3 to 10 carbon atoms.

3. A lubricating composition according to claim 1, in which the polyester is a complex ester prepared from (a) trimethylolpropane, (b) a dibasic acid selected from the group consisting of sebacic acid, azelaic acid and mixtures thereof and (c) one or more monocarboxylic acids having 3 to 10 carbon atoms.

4. A lubricating composition according to claim 1, in which component (a) is a di- C₁ to C₁₄ alkyl diphenylamine and component (b) is a mono- C₁ to C₁₄ alkyl phenyl naphthylamine, the amount of (a) being 1.5 to 4.0% wt. and of (b) 0.5 to 3.5% wt., and the total amount of (a) and (b) being 2.0 to 6.0% wt.

5. A lubricating composition according to claim 1, in which component (c) is one or more of the following: methylene bis-benzotriazole, benzotriazole, methyl benzotriazole, ethyl benzotriazole, butyl benzotriazole, dodecylbenzotriazole, naphthotriazole and salts of 1-salicylalamino guanidine and one or more fatty acids having 13 to 18 carbon atoms, the weight of (c) being 0.01 to 0.5%.

6. A lubricating composition according to claim 1, in which component (e) is an acrylate or methacrylate polymer, a co-polymer of N-vinyl pyrrolidone with an acrylate or methacrylate, or a co-polymer of an olefin with an acrylate or methacrylate, the polymer or co-polymer having a molecular weight of 1,000 to 1,000,000 and being present in an amount of 0.01 to 1.0% wt.

7. A lubricating composition according to claim 1, which also contains .01 to 1.0% wt. of a lead corrosion inhibitor.

8. A lubricating composition according to claim 7, in which the lead corrosion inhibitor is a C₁ to C₂₀ alkyl gallate, neopentyl glycol dibsebacate, sebacic acid or guinizarin.

9. A lubricating composition according to claim 1, which also contains 0.005 to 0.5% wt. of a hydrolytic stability improver.

10. A lubricating composition according to claim 9, in which the hydrolytic stability improver is an amine having the general formula R⁴(R⁵)NR⁶ where R⁴ and R⁵ are alkyl groups having 1 to 4 carbon atoms and R⁶ is an alkaryl, or hydroxy-substituted alkaryl, group having up to 20 carbon atoms.

11. A lubricating composition comprising an ester base-stock consisting of a liquid neutral polyester prepared by reacting (a) one molar proportion of trimethylolpropane with (b) 0.075 to 0.4 molar proportions of sebacic, azelaic acid or mixtures thereof, and (c) a sufficient amount of one or more monocarboxylic acids to provide a hydroxyl-carboxyl balance in the reactants, the said polyester having dissolved therein:

(a) 1.5 to 4.0% wt. of a dioctyl or dinonyl diphenylamine,

(b) 0.5 to 3.5% wt. of a mono-octyl or mono-nonyl phenyl naphthylamine, the total amount of (a) and (b) being 2.0 to 6.0% wt.,

(c) 0.01 to 0.5% wt. of a salt of 1-salicylalamino guanidine and one or more fatty acids having 13 to 18 carbon atoms,

(d) 1.0 to 4.0% wt. of tri-tolyl phosphate, and

(e) 0.01 to 1.0% wt. of an acrylate or methacrylate polymer or a co-polymer thereof with N-vinyl pyrrolidone, the polymer or co-polymer having a molecular weight of 5,000 to 500,000 and the acrylate or methacrylate being derived from acrylic or methacrylic acid and monohydric alcohols having 1 to 24 carbon atoms.

12. A lubricating composition comprising an ester basestock consisting of a liquid neutral polyester prepared by reacting one molar proportion of pentaerythritol with four molar proportions of one or more monocarboxylic acids having 3 to 10 carbon atoms, the said polyester having dissolved therein:

(a) 1.5 to 4.0% wt. of a dioctyl or dinonyl diphenylamine,

(b) 0.5 to 3.5% wt. of a mono-octyl or mono-nonyl phenyl naphthylamine, the total amount of (a) and (b) being 2.0 to 6.0% wt.,

(c) 0.1 to 0.5% wt. of a salt of 1-salicylalamino guanidine and one or more fatty acids having 13 to 18 carbon atoms,

(d) 1.0 to 4.0% wt. of tri-tolyl phosphate, and

(e) 0.01 to 1.0% wt. of an acrylate or methacrylate polymer or a co-polymer thereof with N-vinyl pyrrolidone, the polymer or co-polymer having a molecular weight of 5,000 to 500,000 and the acrylate or methacrylate being derived from acrylic or methacrylic acid and monohydric alcohols having 1 to 24 carbon atoms.

References Cited

UNITED STATES PATENTS

2,009,480	7/1930	Craig	252—50 X
3,247,111	4/1966	Oberright et al.	252—34.7
3,321,401	5/1967	Ford et al.	252—49.9
3,321,402	5/1967	Dadura et al.	252—56 S

FOREIGN PATENTS

986,068 3/1965 Great Britain.

OTHER REFERENCES

Gunderson et al.: "Synthetic Lubricants," Rheinhold Pub. Co., New York, 1962, p. 210.

DANIEL E. WYMAN, Primary Examiner

W. H. CANNON, Assistant Examiner

U.S. Cl. X.R.

252—49.8, 49.9, 51.5 R, 56 S

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,790,478 Dated February 5, 1974

Inventor(s) Stanley George Rudston, Derek Clark Byford,
Peter Michael Blanchard

It is certified that error appears in the above-identified patent
and that said Letters Patent are hereby corrected as shown below:

Claim 12, lines 17-18, change "pyrrolidone" to

- - pyrrolidone - -.

Signed and sealed this 25th day of June 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents