PATENT SPECIFICATION

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750402

Date of filing Complete Specification: Jan. 19, 1954.

Application Date: Jan 28, 1953. *No. 2500/53.*

Complete Specification Published: June 13, 1956.

Index at acceptance:—Class 91, F2.

COMPLETE SPECIFICATION

Improvements in or relating to Lubricating Compositions

We, C. C. WAKEFIELD & COMPANY LIMITED, a British Company, of 46, Grosvenor Street, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to lubricating compositions and in particular to lubricating compositions for internal combustion engines.

It is well known that castor oil possesses certain properties which render it outstanding as a lubricant. Thus its ability to carry relatively high loads without rupture of the lubricant film, coupled with its very low coefficient of friction under conditions of boundary lubrication, give it a unique place among lubricants.

Castor oil and blends of castor oil with mineral lubricating oil have been extensively used for the lubrication of internal combustion engines, especially those operating under high loads and at high speeds.

Up to the present time such lubricants have suffered from the disadvantage that they have only been available within a very restricted range of viscosities. Mineral lubricating oils, on the other hand, as is well known, can be made available over a very ride range of viscosities, and such oils have been used for lubricating internal combustion engines, having viscosities ranging from about 50 to about 400 seconds Redwood at 140° F., i.e., ranging from 5W. to 50 according to the Society of Automotive Engineers (S.A.E.) classification.

The viscosity of castor oil has in the past been modified to a certain extent by blending with mineral oils of different viscosities, but it has not been found possible to bring about more than minor alterations in viscosity by this means, owing to the limited solubility of mineral oil in castor oil (about 15% maximum).

Another disadvantage associated with the use of lubricants consisting wholly or mainly of castor oil has been their tendency to form gummy deposits in the engine and on external parts such as exhaust pipes, etc., necessitating frequent changing of the oil and cleaning of the gummed parts. Improved lubricants having greatly reduced tendency to gum formation have been described in our British Patent Specification No. 713,423.

It will be appreciated that the viscosity of an oil which is to be used for lubricating an internal combustion engine will depend on the design of the engine. Thus, certain engines designed to operate in conjunction with lubricating oils of relatively low viscosity, *e.g.*, in the S.A.E. 10W or 20 category, will not run so efficiently on oils having viscosities in the S.A.E. 40/50 range, and therefore cannot be lubricated so effectively by castor oil or by conventional blends of castor and mineral oil such as have heretofore been employed. On the other hand, some of these engines, *e.g.*, the engines of certain racing cars, cannot be lubricated so satisfactorily by mineral oils owing to the high piston speeds involved.

It is accordingly an object of the present invention to provide a lubricant, more especially a lubricant for internal combustion engines, which lubricant comprises a substantial proportion of castor oil, but which has a viscosity appreciably less than that of castor oil.

It is a further object of the present invention to provide a lubricant containing castor oil but which has a reduced tendency to gum formation.

According to the present invention, a lubricating composition comprises a mixture of castor oil and at least one aliphatic or cyclo-aliphatic alcohol ester of an organic dicarboxylic acid which ester is represented by

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the general formula

$$(CH_2)_n < \begin{matrix} COOR_1 \\ COOR_2 \end{matrix}$$

where n is a small integer from 2 to 8 inclusive and R_1 and R_2 are identical and are branched-chain alkyl radicals or alkyl-substituted cycloalkyl radicals having at least 5 carbon atoms.

The alcohols used in esterifying the dicarboxylic acids should be saturated aliphatic or cycloaliphatic alcohols such as 2-ethyl *n*-hexyl, 3:5:5-trimethyl-hexyl and capryl (1-methyl *n*-heptyl) alcohols, or a commercially available mixture of branched-chain C_7 to C_9 alcohols known as "Alphanol 79." ("Alphanol" is a Registered Trade Mark). Alternatively, cycloaliphatic alcohols such as methyl and dimethyl cyclohexanol may be used.

Examples of specific esters which may be used in accordance with the present invention include:—

di(methyl cyclohexyl) adipate, di(Alphanol 79) adipate, di(2-ethyl hexyl) azelate, di(2-ethyl hexyl) sebacate, di(3:5:5 trimethyl hexyl) sebacate, dicapryl sebacate or di(Alphanol 79) sebacate.

The relative proportions of castor oil and ester or esters which are to be employed will depend upon the desired viscosity of the final blend. Any blends may be employed preferably within the range 10% castor oil and 90% ester to 90% castor oil and 10% ester.

In one form of the invention a proportion of mineral oil, less than the proportion of castor oil, is also included in the blend. Both the amount of mineral oil used and its viscosity will depend upon the relative amounts of castor oil and ester present, and the desired viscosity of the final blend. The use of the esters of this invention, however, permits the incorporation of substantially more mineral oil than could normally be used in conjunction with castor oil, the ester acting as a mutual solvent for the two oils. The following table illustrates some typical examples of the compositions in accordance with the present invention with their physical properties:—

Example No.	Blend	Viscosity at 140° F.	Viscosity Index
1.	50% Castor oil 25% Di(3:5:5 trimethyl hexyl) sebacate 25% Mineral oil of viscosity about 70 seconds Redwood at 140° F.	120"	103
2.	55% Castor oil 10% Di(3:5:5 trimethyl hexyl) sebacate 35% Mineral oil of viscosity about 50 seconds Redwood at 140° F.	120"	80
3.	49% Castor oil 19% Di(2 - ethyl hexyl) sebacate 19% Di(3:5:5 trimethyl-hexyl) sebacate 13% Mineral oil of viscosity about 70 seconds Redwood at 140° F.	103"	113
4.	10% Castor oil 90% Di(2 - ethyl hexyl) azelate	47"	150

The lubricating compositions of the present invention, especially those containing a substantial proportion of the ester, will have less tendency to gum-formation in service than conventional blends of castor and mineral oil, and may therefore be employed without the addition of additives.

In a preferred form of the invention, however, the composition includes one or more additives to retard oxidation and gum formation. A preferred combination of additives is that disclosed in our British Patent Specification No. 713,423 in which an aromatic or heterocyclic secondary mono- or poly-amine containing at least three cyclic nuclei at least two of which nuclei are aromatic nuclei attached directly to the nitrogen atom, is used in conjunction with an organic compound of tin or antimony. Thus, for example, one may employ amines such as phenyl-α-naphthyl-

amine, phenyl-β-naphthylamine, β,β-dinaphthylamine, di(-β-naphthyl)-p-phenylene diamine, phenothiazine, benzonaphthothiazine or xylyl-β-naphthylamine in conjunction with tin laurate, tin oleate, the tin derivative of p-tertiary amyl phenol thioether, or preferably tin or antimony petroleum sulphonate.

Other additives which may be included with advantage are the triaryl phosphites and especially the phosphite esters of aromatic hydroxy-substituted thioethers and disulphides disclosed in our Patent Specification No. 574,445 which not only provide protection against corrosion of composite metal, *e.g.*, copper-lead bearings, but also serve to increase the load-carrying capacity of the composition.

Auxiliary additives which may be included in the composition are the reaction products of aldehydes or ketones with basic water-soluble primary or secondary amines, as more fully described in our British Patent Specification No. 588,864. An example of such a compound is dimorpholinyl phenyl methane.

If desired, other additives, *e.g.*, detergents and antioxidants operative at high temperatures, may also be present. Thus, for example, the composition may include detergents such as calcium petroleum sulphonate or basic barium petroleum sulphonate, or antioxidants such as oil-soluble metal salts of organic dithiophosphoric acids or metal derivatives of alkylated phenol thioethers or disulphides.

Specific examples of combinations of additives which may be incorporated in any of the foregoing blends are:—

1. 1.0% Phenyl-β-naphthylamine
   0.2% Tin petroleum sulphonate
2. 0.5% Phenyl-β-naphthylamine
   0.2% Tin petroleum sulphonate
   1.0% Di (3-carbomethoxy-4-hydroxyphenyl) thioether cresyl phosphite
   0.2% Di-morpholinyl phenyl methane
3. 0.25% Zinc di(α-methyl isoamyl) dithiophosphate
   0.1% Calcium petroleum sulphonate

Further examples illustrative of the present invention are given in the following table which indicates how lubricants may be prepared, falling into various categories of the S.A.E. classification.

Example No.	Blend	Viscosity at 140° F. (Redwood seconds).	Viscosity Index	S.A.E. Classification
5.	15% Castor oil 42.5% D.O.S. 42.5% D.N.S.	55"	153	5W 10W
6.	43% Castor oil 28.5% D.O.S. 28.5% D.N.S.	75"	126	10W 20W 20
7.	30% Castor oil 27.5% D.O.S. 27.5% D.O.A. 15% Oil A.	59"	125	5W 10W
8.	49% Castor oil 19% D.O.S. 19% D.N.S. 13% Oil B.	~~100~~ 103"	113	20 — 20W

In the foregoing table the following abbreviations have been used:—

D.O.S. = di(2-ethyl hexyl) sebacate.
D.N.S. = di(~~3+5~~ trimethyl hexyl) sebacate.
D.O.A. = di(2-ethyl hexyl) adipate.
Oil A. = Mineral oil of viscosity about 50 seconds Redwood, at 140° F.
Oil B. = " " " about 70 seconds Redwood, at 140° F.

In order to evaluate the performance of the lubricants of the present invention, the following engine tests were carried out:—

A. LAUSON ENGINE TEST.—Tests were carried out in a standard H-2 type Lauson engine, under the following conditions:—

Jacket temperature 210° F. ±2° F.
Oil sump temperature 280° F. ±2° F.
Test duration 60 hrs.
Speed 1840 r.p.m.

The following test results illustrate the behaviour of a typical lubricant blend (blend A) of the present invention as compared with a blend of much higher viscosity, as hitherto employed, (blend B).

Blend A consisted of:

49%	Firsts Castor oil
13%	Mineral oil B (as previously specified)
19%	Di(2-ethyl hexyl) sebacate
19%	Di(3:5:5 trimethyl hexyl) sebacate

+

1%	Di(3-carbomethoxy-4-hydroxy phenyl) thioether cresyl phosphite
0.5%	Phenyl-β-naphthylamine
0.2%	Tin petroleum sulphonate
0.2%	Dimorpholinyl phenyl methane

Blend B prepared in accordance with British Patent Specification No. 713,423, consisted of:

87.5%	Firsts castor oil
12.5%	Mineral oil of viscosity 44 seconds Redwood at 140° F.

+

2%	Di(3-carbomethoxy-4-hydroxy-phenyl) thioether cresyl phosphite
1%	Phenyl-β-naphthylamine
0.2%	Tin petroleum sulphonate
0.2%	Dimorpholinyl phenyl methane

This oil had a viscosity of 260" Redwood at 140° F., a viscosity index of 90, and fell within the S.A.E. 40 classification.

Lubricant	Piston Lacquer Rating (C.R.C. visual rating)	Bearing weight loss (mgs.)	Used oil analysis Percent viscosity increase
Blend A	9.2	193	145
Blend B	8.5	131	149

B. Lauson Engine Tests (High Jacket Temperature)

Speed	2400 r.p.m.
Load	4.0 B.H.P.
Jacket temperature	350° F.
Oil sump temperature	170/190° F.
Fuel	2.5/3 ml. TEL/Gall.
Time	10 hours

Blend	Oil consumption (gm. per hr.)	Bearing weight loss (mgs.)	Piston Rating	Comments
Blend B	13.6	20	8.2	1st and 2nd rings 50% stuck, soft gum on inlet underhead and exhaust valve stem.
Blend A	9.2	29	8.3	Top ring, lightly pinched, other rings free, soft gum on inlet underhead.
Blend A (after 20 hours)	—	38	7.8	Top ring 55% stuck, others free. No change in inlet valve condition Trace hard black deposit on exhaust valve neck.

C. Chevrolet Engine Tests. — Tests were carried out in a standard 216.5 cu. ins. 6-cylinder Chevrolet engine under the following conditions:

Jacket temperature, 200° F.
Oil sump temperature, 280° F.
Test duration, 36 hours.
Speed, 3150 r.p.m.
Brake horsepower, 30.

The following results were obtained:—

	Blend A.	Blend B.
Piston Rating	9.1	8.2
Total varnish	47.6	48.0
Total sludge	44.5	48.0
Total varnish and sludge	92.1	96.0
Bearing weight loss	584 mgs.	775 mgs.
Oil consumption, pints/hr.	0.116	0.112

D. Frictional Horse-Power (F.H.P.) and Oil Temperature Characteristics. — Tests were carried out in a 216.5 cu. ins. 6-cylinder Chevrolet engine, motored by an electric dynamometer under the following conditions:—

Speed, 3000 r.p.m.
Induction depression, 5" Hg.
Jacket outlet temperature, 200° F. (except where otherwise stated).

The sump oil was allowed to reach a steady maximum temperature and F.H.P. recorded, at least three constant readings at 5 minute intervals being obtained. The sump was then artificially cooled to 220° F. and 200° F., and similar readings taken. For the final readings jacket temperature was reduced to 170° F., and maximum sump cooling employed to obtain the lowest possible sump temperature with each oil. Results are tabulated below, a separate column showing, for interest, the viscosity of the oil at sump temperature.

	Blend B		Blend A	
Sump Temperature	F.H.P.	Viscosity (centistokes)	F.H.P.	Viscosity (centistokes)
260° F.	24.0	8.1	—	—
250° F.	—	—	22.1	5.4
220° F.	24.6	14.0	22.1	7.5
200° F.	25.3	19.0	22.3	9.6
190° F. (min. jacket 170° F.)	27.8	23.0	—	—
166° F. „	—	—	24.6	15.8

It will readily be seen from the foregoing tests that Blend A not only gave a performance equivalent to that of Blend B in the normal Lauson and Chevrolet tests, but also effected a significant reduction in frictional horsepower. In the high temperature Lauson tests it also showed a marked improvement in ring sticking.

In addition, Blend A has been subjected to trials in a variety of highly-stressed motor cycle and motor car engines used in racing and record-breaking, and has given highly satisfactory results, the engines stripping in a very clean condition after test. For one new type of racing engine it was the only lubricant tried which gave a satisfactory performance.

What we claim is:—

1. A lubricating composition, consisting of a mixture of castor oil and at least one aliphatic or cyclo-aliphatic alcohol ester of an organic dicarboxylic acid which ester is represented by the formula

$$(CH_2)_n < \begin{matrix} COOR_1 \\ COOR_2 \end{matrix}$$

where n is an integer from 2 to 8 inclusive and R_1 and R_2 are identical and are branched-chain alkyl radicals or alkyl-substituted cycloalkyl radicals having at least 5 carbon atoms.

2. A lubricating composition as claimed in Claim 1 wherein the ester or esters are derived from 2-ethyl *n*-hexyl, 3:5:5-trimethyl-hexyl or capryl (1-methyl *n*-heptyl) alcohols, a mixture of branched-chain C_7 to C_9 alcohols known as "Alphanol 79," methyl cyclohexanol or dimethyl cyclohexanol.

3. A lubricating composition as claimed in Claim 1 or Claim 2 wherein the ester is di(methyl cyclohexyl) adipate, di(Alphanol 79) adipate, di(2-ethyl hexyl) azelate, di(2-ethyl hexyl) sebacate, di(3:5:5-trimethyl hexyl) sebacate di-capryl sebacate or (di(Alphanol 79) sebacate.

4. A lubricating composition as claimed in any one of the preceding claims wherein the castor oil and organic ester or esters are employed within the range 10% castor oil and 90% ester to 90% castor oil and 10% ester.

5. A lubricating composition as claimed in any one of claims 1 to 3 wherein there is included a proportion, less than the proportion of castor oil, of mineral lubricating oil.

6. A lubricating composition as claimed in any one of the preceding claims in which there is included one or more additives to retard oxidation and gum formation.

7. A lubricating composition as claimed in any one of the preceding claims in which there is included an aromatic or heterocyclic secondary mono- or poly-amine containing at least three cyclic nuclei at least two of which nuclei are aromatic nuclei attached directly to the nitrogen atom in conjunction with an organic compound of tin or antimony.

8. A lubricating composition as claimed in any one of the preceding claims in which there is included a triaryl phosphite or a phosphite ester of an aromatic hydroxy-substituted thioether or disulphide.

9. A lubricating composition as claimed in any one of the preceding claims in which there is included the reaction product of an aldehyde or ketone with a basic water-soluble primary or secondary amine, for example, dimorpholinyl phenyl methane.

10. A lubricating composition as claimed in any one of the preceding claims in which there is included a neutral or basic alkaline earth metal petroleum sulphonate or the oil-soluble metal salts of organic dithiophosphoric acids or metal derivatives of alkylated phenol thioethers or disulphides.

11. A lubricating composition substantially as described in any one of the specific examples hereinbefore set forth.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.1,
Chartered Patent Agents.

PROVISIONAL SPECIFICATION

Improvements in or relating to Lubricating Compositions

We, C. C. WAKEFIELD & COMPANY LIMITED, a British Company, of 46, Grosvenor Street, London, W.1, do hereby declare this invention to be described in the following statement:—

This invention relates to lubricating compositions and in particular to lubricating compositions for internal combustion engines.

It is well known that castor oil possesses certain properties which render it outstanding as a lubricant. Thus its ability to carry relatively high loads without rupture of the lubricant film, coupled with its very low coefficient of friction under conditions of boundary lubrication, give it a unique place among lubricants.

Castor oil and blends of castor oil with mineral lubricating oil have been extensively used for the lubrication of internal combustion engines, especially those operating under high loads and at high speeds.

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$$(CH_2)_n < \begin{matrix} COOR_1 \\ COOR_2 \end{matrix}$$

where n is an integer from 2 to 8 inclusive and R_1 and R_2 are identical and are branched-chain alkyl radicals or alkyl-substituted cycloalkyl radicals having at least 5 carbon atoms.

2. A lubricating composition as claimed in Claim 1 wherein the ester or esters are derived from 2-ethyl *n*-hexyl, 3:5:5-trimethyl-hexyl or capryl (1-methyl *n*-heptyl) alcohols, a mixture of branched-chain C_7 to C_9 alcohols known as "Alphanol 79," methyl cyclohexanol or dimethyl cyclohexanol.

3. A lubricating composition as claimed in Claim 1 or Claim 2 wherein the ester is di(methyl cyclohexyl) adipate, di(Alphanol 79) adipate, di(2-ethyl hexyl) azelate, di(2-ethyl hexyl) sebacate, di(3:5:5-trimethyl hexyl) sebacate di-capryl sebacate or (di(Alphanol 79) sebacate.

4. A lubricating composition as claimed in any one of the preceding claims wherein the castor oil and organic ester or esters are employed within the range 10% castor oil and 90% ester to 90% castor oil and 10% ester.

5. A lubricating composition as claimed in any one of claims 1 to 3 wherein there is included a proportion, less than the proportion of castor oil, of mineral lubricating oil.

6. A lubricating composition as claimed in any one of the preceding claims in which there is included one or more additives to retard oxidation and gum formation.

7. A lubricating composition as claimed in any one of the preceding claims in which there is included an aromatic or heterocyclic secondary mono- or poly-amine containing at least three cyclic nuclei at least two of which nuclei are aromatic nuclei attached directly to the nitrogen atom in conjunction with an organic compound of tin or antimony.

8. A lubricating composition as claimed in any one of the preceding claims in which there is included a triaryl phosphite or a phosphite ester of an aromatic hydroxy-substituted thioether or disulphide.

9. A lubricating composition as claimed in any one of the preceding claims in which there is included the reaction product of an aldehyde or ketone with a basic water-soluble primary or secondary amine, for example, dimorpholinyl phenyl methane.

10. A lubricating composition as claimed in any one of the preceding claims in which there is included a neutral or basic alkaline earth metal petroleum sulphonate or the oil-soluble metal salts of organic dithiophosphoric acids or metal derivatives of alkylated phenol thioethers or disulphides.

11. A lubricating composition substantially as described in any one of the specific examples hereinbefore set forth.

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Castor oil and blends of castor oil with mineral lubricating oil have been extensively used for the lubrication of internal combustion engines, especially those operating under high loads and at high speeds.

Up to the present time such lubricants have suffered from the disadvantage that they have only been available within a very restricted

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range of viscosities. Mineral lubricating oils, on the other hand, as is well known, can be made available over a very wide range of viscosities, and such oils have been used for lubricating internal combustion engines, having viscosities ranging from about 50 to about 400 seconds Redwood at 140° F. *i.e.*, ranging from 5W. to 50 according to the Society of Automotive Engineers (S.A.E.) classification.

The viscosity of castor oil has in the past been modified to a certain extent by blending with mineral oils of different viscosities, but it has not been found possible to bring about more than minor alterations in viscosity by this means, owing to the limited solubility of mineral oil in castor oil (about 15% maximum).

Another disadvantage associated with the use of lubricants consisting wholly or mainly of castor oil has been their tendency to form gummy deposits in the engine and on external parts such as exhaust pipes, etc., necessitating frequent changing of the oil and cleaning of the gummed parts. Improved lubricants having greatly reduced tendency to gum formation have been described in our co-pending application No. 11960/50.

It will be appreciated that the viscosity of an oil which is to be used for lubricating an internal combustion engine will depend on the design of the engine. Thus, certain engines designed to operate in conjunction with lubricating oils of relatively low viscosity, *e.g.* in the S.A.E. 10W or 20 category, will not run so efficiently on oils having viscosities in the S.A.E. 40/50 range, and therefore cannot be lubricated so effectively by castor oil or by conventional blends of castor and mineral oil such as have heretofore been employed. On the other hand, some of these engines, *e.g.* the engines of certain racing cars, cannot be lubricated so satisfactorily by mineral oils owing to the high piston speeds involved.

It is accordingly an object of the present invention to provide a lubricant, more especially a lubricant for internal combustion engines, which lubricant comprises a substantial proportion of castor oil, but which has a viscosity appreciably less than that of castor oil.

It is a further object of the present invention to provide a lubricant containing castor oil but which has a reduced tendency to gum formation.

According to the present invention, a lubricating composition comprises a mixture of castor oil and a relatively non-volatile substantially neutral organic ester, with or without the further addition of a mineral lubricating oil.

The esters to be employed should be relatively non-voltaile, *i.e.*, should have a boiling point of at least 200° C. and they should be readily miscible with castor oil at normal operating temperatures. In a preferred form of the invention the esters employed are the aliphatic or cyclo-aliphatic alcohol esters of organic dicarboxylic acids and may be represented by the general formula

$$R\begin{<}COOR_1\\COOR_2\end{}$$

where R is an alkyl, aryl, alkaryl or cycloalkyl radical, and R_1 and R_2 are the same or different, and are alkyl or cycloalkyl radicals.

In a preferred sub-class of these esters R = $(CH_2)_n$ where n is a smaller integer from 2 to 8 and R_1 and R_2 are identical, and are branched-chain alkyl radicals having at least 5 carbon atoms.

Specific examples of organic dicarboxylic acids from which the esters may be derived are:—phthalic, succinic, maleic, malic, tartaric, pyrotartaric, glutaric, adipic, pimelic, suberic, azelaic, sebacic and pinic acids. It is preferred to use saturated acids.

The alcohols used in esterifying the dicarboxylic acids should be saturated aliphatic or cycloaliphatic alcohols such as methyl, ethyl, *n*-butyl and isobutyl alcohols or, preferably, the higher branched-chain alcohols such as 2-ethyl *n*-hexyl, 3:5:5-trimethylhexyl and capryl (1-methyl *n*-heptyl) alcohols, or a commercially available mixture of branched-chain C_7 to C_9 alcohols known as "Alphanol 79." Alternatively, cycloaliphatic alcohols such as methyl and dimethyl cyclohexanol may be used. If desired, there may be employed in place of ordinary alcohols, ethers or esters of polyhydric alcohols containing at least one free hydroxyl group *e.g.*, ethylene glycol monobutyl ether or diethylene glycol monobutyl ether.

Although, as has already been stated, it is preferred to employ esters of dicarboxylic acids, other esters having a boiling point above about 200° C may be used if desired. Thus it is possible to use simple esters such as [illegible] lactate or tricresyl phosphate, or the esters of polyhydric alcohols, especially dihydric alcohols, with monocarboxylic acids, especially those containing more than five carbon atoms. It is also within the scope of the present invention to use esters of polyalkylene glycols and glycol ethers such as the "Ucon" synthetic fluids. In selecting an ester it is preferred to avoid those containing unsaturated groupings, which are more prone to oxidation and decomposition, and those which are easily hydrolysed by water yielding corrosive acids of low molecular weight.

Examples of specific esters which may be used in accordance with the present invention include:—

diethyl phthalate, di-*n*-butyl phthalate, di-isoamyl succinate, di-*n*-butyl tartrate, di(2-ethyl hexyl) malate, triamyl citrate, di(methyl cyclohexyl) adipate, di(Alphanol 79) adipate,

di(2-ethyl hexyl) azelate, di(2-ethyl hexyl sebacate, di(3:5:5 trimethyl hexyl) sebacate, dicapryl sebacate, di(Alphanol 79) sebacate, dimethyl glycol phthalate, di(2-butoxyethyl) azelate, triethylene glycol di(2-ethyl hexanoate), amyl lactate, and tricresyl phosphate.

The relative proportions of castor oil and ester which are to be employed will depend upon the desired viscosity of the final blend. Any blends may be employed within the range 10% castor oil and 90% ester to 90% castor oil and 10% ester.

In one form of the invention a proportion of mineral oil is also included in the blend. Both the amount of mineral oil used and its viscosity will depend upon the relative amounts of castor oil and ester present, and the desired viscosity of the final blend. The use of the esters of this invention, however, permits the incorporation of substantially more mineral oil than could normally be used in conjunction with castor oil, the ester acting as a mutual solvent for the two oils. The following table illustrates some typical examples of the compositions in accordance with the present invention with their physical properties:—

Example No.	Blend	Viscosity at 140° F.	Viscosity Index
1.	90% Castor oil 10% Dibutyl phthalate	250"	89
2.	50% Castor oil 25% Di(3:5:5 trimethyl hexyl) sebacate 25% Mineral oil of viscosity about 70 seconds Redwood at 140° F.	120"	103
3.	55% Castor oil 10% Di(3:5:5 trimethyl hexyl) sebacate 35% Mineral oil of viscosity about 50 seconds Redwood at 140° F.	120"	80
4.	49% Castor oil 19% Di(2 - ethyl hexyl) sebacate 19% Di(3:5:5 trimethyl hexyl) sebacate 13% Mineral oil of viscosity about 70 seconds Redwood at 140° F.	103"	113
5.	10% Castor oil 90% Di(2 - ethyl hexyl) azelate	47"	150

The lubricating compositions of the present invention, especially those containing a substantial proportion of the ester, will have less tendency to gum-formation in service than conventional blends of castor and mineral oil, and may therefore be employed without the addition of additives.

In a preferred form of the invention, however, the composition includes one or more additives to retard oxidation and gum formation. A preferred combination of additives is that disclosed in our co-pending application No. 11960/50 in which an aromatic or heterocyclic secondary mono- or poly- amine containing at least three cyclic nuclei at least two of which nuclei are aromatic nuclei attached directly to the nitrogen atom, is used in conjunction with an organic compound of tin or antimony. Thus, for example, one may employ amines such as phenyl-α-naphthylamine, phenyl-β-naphthylamine, ββ-dinaphthylamine, di(-β-naphthyl)-p-phenylene diamine, phenothiazine, benzonaphthothiazine or xylyl - β - naphthylamine in conjunction with tin laurate, tin oleate, tin *p*-tertiary amyl phenol thioether, or preferably tin or antimony petroleum sulphonate.

Other additives which may be included with advantage are the triaryl phosphites and especially the phosphite esters of aromatic hydroxy-substituted thioethers and disulphides disclosed in our British Patent Specification No. 574,445 which not only provide protection against corrosion of composite metal, *e.g.*, copper-lead bearings, but also serve to increase the load-carrying capacity of the composition.

Auxiliary additives which may be included in the composition are the reaction products of aldehydes or ketones with basic water-soluble primary or secondary amines, as more fully described in our British Patent Specifi-

cation No. 588,864. An example of such a compound is dimorpholinyl phenyl methane.

If desired, other additives, *e.g.*, detergents and antioxidants operative at high temperatures, may also be present Thus, for example, the composition may include detergents such as calcium petroleum sulphonate or basic barium petroleum sulphonate, or antioxidants such as oil-soluble metal salts of organic dithiophosphoric acids or metal derivatives of alkylated phenol thioethers or disulphides.

Specific examples of combinations of additives which may be incorporated in any of the foregoing blends are:—

1.	1.0%	Phenyl-β-naphthylamine
	0.2%	Tin petroleum sulphonate
2.	0.5%	Phenyl-β-naphthylamine
	0.2%	Tin petroleum sulphonate
	1.0%	Di (3-carbomethoxy-4-hydroxyphenyl) thioether cresyl phosphite
	0.2%	Di-morpholinyl phenyl methane
3.	0.25%	Zinc di(α-methyl isoamyl) dithiophosphate
	0.1%	Calcium petroleum sulphonate

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ERRATA

SPECIFICATION No. 750,402

Page 3, line 31, *for* "oil-insoluble" *read* "oil-soluble"
Page 3, line 66, *for* "1003"" *read* "103""
Page 3, line 72, *for* "(3:5" *read* "(3:5:5"
Page 4, line 15, *for* "+{" *read* "{"
Page 4, line 17, *for* "{" *read* "+{"
Page 6, line 38, *for* "methyl" *read* "(methyl"
Page 7, line 76, *for* "smaller" *read* "small"
Page 8, line 76, *for* "xyly" *read* "xylyl"

THE PATENT OFFICE,
11*th July*, 1956.

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