This invention relates to novel synthetic ester based lubricating oil compositions. More specifically, the invention is concerned with lubricating oil compositions comprising a synthetic ester base oil of lubricating viscosity having incorporated therein an amide of a hydrogenated dimer acid. The amide is effective as an anti-suff and anti-fatigue agent.

The demand for synthetic lubricants is ever increasing in view of the need for lubricants of low pour point, high viscosity index and low volatility for a given viscosity. This is particularly due to the present and increasing widespread use of turbojet engines for military and commercial aircraft. Even though most synthetic ester lubricants have high viscosity index, low volatility and low pour point, the latter affording low oil temperature starting characteristics, these oils, including those derived from the standpoint of stability and cost, often have insufficient load carrying, anti-suff and anti-fatigue capacity.

One of the primary requirements of a high temperature synthetic lubricant is that it lubricates satisfactorily under high load for long periods of time. This property is measured by two critical tests. The Rydev gear scuff test for high temperature synthetic lubricants requires that the lubricants carry a minimum of 2400 pounds per inch. The gear fatigue test requires that the lubricant should protect the gears from fatigue for at least 100 hours.

Synthetic ester lubricants, for instance, consisting essentially of carbon, hydrogen and oxygen, are particularly desirable as they have many satisfactory characteristics and they are not beyond a feasible price range. On the other hand, the load carrying capacity of these base oils is not sufficient to meet turbo engine specifications. It is then desirable to increase the load carrying capacity of these and other synthetic lubricant bases to adapt them for use in turbine engines and in other applications where high temperature load carrying properties are required. These requirements have not been met without the use of suitable anti-suff and anti-fatigue additives. Furthermore, EP additives such as triresyl phosphate, titanium compounds and many sulfur compounds are unsatisfactory in improving the anti-suff and anti-fatigue properties of the high temperature synthetic ester lubricants.

This invention pertains to synthetic ester lubricants containing suitable additives which, when used in minor quantities, will improve the lubricity and load carrying properties of the ester base oil as measured by the gear scuff and gear fatigue tests. We have found that the amides of hydrogenated dimer acids when used in these lubricant compositions, substantially improve the load carrying ability of the compositions as measured by the Ryder gear scuff test and adequately protect against failure in gear fatigue tests. A minor, effective amount of amides of the hydrogenated dimer acid may be used. Normally, the amount of the amide is between about 0.01 and 1 weight percent of the lubricant with the preferred amount being between about 0.1 and 0.5 weight percent.

The amides of hydrogenated dimer acids of this invention are soluble in the ester base oil, at least to the extent used, and can be represented by the formula:

\[
\text{A} \quad \text{(CONH)}_{x} \quad \text{(CONR}_{y})_{z} \quad \text{R} \quad \text{(COOH)}_{n}
\]

wherein A is the hydrocarbon residue of a hydrogenated dimer acid and R and R' can be hydrogen or a hydrocarbon radical usually of up to about 20 or even more carbon atoms such as alkyl, including cycloalkyl, and aryl radicals, including mixed aryl-alkyl radicals. The hydrocarbon radicals may be substituted with non-deleterious substituents or unsubstituted. The letter x is a small number up to about 1.7, usually at least 0.1 and preferably between 0.5 and 1.5. All or a portion of the non-amidified carboxyl groups may, if desired, be in the ester form, for instance, a lower alkyl ester. Hydrogenated dimer acid can be derived from commercial dimer acid by hydrogenation. It differs from the commercial dimer acid in that it has a minimum of residual olefinic bonds, i.e., on the average less than \( \frac{1}{2} \) and preferably less than \( \frac{1}{3} \) olefinic bond in the A radical. Thus the dimer acid amides of this invention contain less than an average of \( \frac{1}{2} \) and preferably less than \( \frac{1}{3} \) carbon-carbon linkages per molecule which are less than 1.40 A. the interatomic distance of carbon atoms in a benzene ring. Essentially all of the carbon-carbon linkages are not less than 1.34 A. the interatomic distance of carbon atoms in an olefinic double bond. The hydrogenated dimer is therefore much more resistant to thermal and oxidative degradation than the conventional unsaturated dimer acids. The unhydrogenated dimer acids are not satisfactory in high temperature synthetic lubricants because of low resistance to thermal oxidation and degradation. However, because of the substantial absence of double bonds, our amides of hydrogenated dimer acid are extremely resistant to degradation under the conditions in which the synthetic lubricants are used.

The commercial dimer acids which can be used in forming the additive of our invention are biomolecular addition products of conjugated or non-conjugated olefinic fatty acids having from 16 to 22 or more carbon atoms before dimerization. Such dimerized fatty acids may be prepared by known methods, for example, the monomer of an olefinic fatty acid may be subjected to heat treatment above 300° C. under elevated pressure. The dimer acid is recovered from the reaction mixture by distillation. Another method of preparation involves heating the methyl ester of an olefinic fatty acid at about 300° C. for several hours in an inert atmosphere. The resulting dimerized ester is then separated by distillation, saponified and then acidified with a mineral acid.

In general, dimerized acids suitable for purposes of this invention are those prepared from olefinic alkanolic or monocarboxylic acids having the formula:

\[
\text{C}_{x}\text{H}_{2n-x}\text{COOH}
\]

wherein \( n \) is an integer of from 15 to 21 and \( x \) is an integer from 1 to 7, preferably 3 to 5. The resulting dimerized acids will thus contain 32 to 44 carbon atoms.
Representative of the class of dimerized acids suitable for the purposes of this invention are dimers of dienoic, trienoic or dienoic-acidic (octadecadienoic), homocarboxylic (nonadecadienoic) and eicosinic (eicosadienoic) acids. Dimers of trienoic acids, for example, such as linolenic and eleostearic (octadecatrienoic) acids may also be used. The dienoic and trienoic acids containing 18 carbon atoms, and especially those having conjugated olefinic linkages (i.e., dieneic (octadecadienoic), homocarboxylic (nonadecadienoic) and eicosinic (eicosadienoic) acids) may be used. The dienoic and trienoic acids containing 18 carbon atoms, and especially those having conjugated olefinic linkages (i.e., dieneic (octadecadienoic), homocarboxylic (nonadecadienoic) and eicosinic (eicosadienoic) acids) may also be used. The dienoic and trienoic acids containing 18 carbon atoms, and especially those having conjugated olefinic linkages (i.e., dieneic (octadecadienoic), homocarboxylic (nonadecadienoic) and eicosinic (eicosadienoic) acids) may also be used. The dienoic and trienoic acids containing 18 carbon atoms, and especially those having conjugated olefinic linkages (i.e., dieneic (octadecadienoic), homocarboxylic (nonadecadienoic) and eicosinic (eicosadienoic) acids) may also be used. The dienoic and trienoic acids containing 18 carbon atoms, and especially those having conjugated olefinic linkages (i.e., dieneic (octadecadienoic), homocarboxylic (nonadecadienoic) and eicosinic (eicosadienoic) acids) may also be used.

The dimerized acids disclosed above are hydrogenated to substantially eliminate carbon-carbon unsaturation. It is necessary that unsaturation be reduced in order that a product highly resistant to degradation be obtained. The hydrogenated dimer acids can be formed by catalytic hydrogenation of commercial dimeric acids. An example of a suitable commercial hydrogenated dimer acid is Emery 3389R which is a mixture of acids containing an average of 36 carbon atoms and having an average of less than 5% double bond per molecule. It has an acid number of 190-210 and an iodine number of 25-30.

Our dimer acide amides can be prepared from the hydrogenated dimer acids by treating with a calculated amount of ammonia or amine and heating the acid salts thus formed to remove the desired amount of water. The reaction can be carried out in the presence or absence of a solvent or a diluent and can be conducted either under atmospheric pressure or in an autoclave, although a pressure reaction is preferred when ammonia or a low boiling amine is used as the reactant. The preferred nitrogen compounds are ammonia and alkyl amines. The amines may be primary or secondary amines and generally have to at least 20 or more carbon atoms, often up to about 12 carbon atoms. Particularly suitable amines are methyamine, ethylamine, propylamine, n-butylamine, amylamine, n-hexylamine, 2-ethylhexylamine, dimethylamine, diethylamine, dipropyamine, dibutylamine, diisobutylamine, dicyclicamine, dihexylamine, di-2-ethylhexylamine, n-octadecylamine, cococaine, Primene JMT (a mixture of primary amines having an average of about 18-22 carbon atoms per molecule), diethylene and di(p-oxyphenyl) amine are also suitable. Cycloaliphatic amines such as cyclohexylamine and tetrahydrofurcular amine may also be used.

Our compositions contain sufficient amounts of the hydrogenated dimer acid to increase the load carrying capacity and lubricity of the base oil. Generally, the final compositions will contain from about 0.01 to 1 weight percent of the additive agent and we prefer about 0.1 to 0.5 percent. The actual amount of amide employed may be dependent upon the degree of improvement desired and upon factors such as the character of the base oil and the other materials which may be added to or be present in the lubricant composition. It is sometimes advantageous to ship and handle the additive as concentrate in the base oil and thus the dimer acid amide may be as high as about 75 or more percent of such a concentrate, but normally the concentrate would contain about 10 to 50 percent additive. Our additive amides can be blended with a base oil at room temperature. The composition can also contain additional agents such as anti-oxidants, anti-fouling additives, corrosion inhibitors, V.I. improvers, other extreme pressure agents, thickeners and other agents added to give desired properties.

The lubricant composition of this invention includes as the major component a base oil which is an ester of lubricating viscosity which may be, for instance, a simple ester or compounds having multiple ester groupings such as complex esters, di- or other polyesters, and polymer esters. The diesters are usually made from mono- and multifunctional aliphatic alcohols or alkanols, and aliphatic mono- or poly-carboxylic or alkanolic acids. Frequently, the alcohols and acids have about 4 to 12 carbon atoms. The reaction product of mono-functional alcohol and a mono-carboxylic acid is usually considered to be a simple ester. A diester is usually considered to be the reaction product of 1 mole of a dicarboxylic acid, say of 6 to 10 carbon atoms, with 2 moles of a mono-hydric alcohol or of 1 mole of a glycol, for instance, of 4 to 10 carbon atoms, with two moles of a mono-carboxylic acid, e.g. of 4 to 10 carbon atoms. The diesters frequently contain from 20 to 40 carbon atoms. A complex ester is usually considered to be of the type X—Y—Z—Y—X in which X represents a mono- or diester residue. Y represents a dicarboxylic acid residue and Z represents a glycol residue and the linkages are ester linkages. Those esters wherein X represents a monademic residue, Y represents a glycol residue and Z represents a dibasic acid residue are also considered to be complex esters. The complex esters often have 30 to 50 carbon atoms.

Polymer esters or “polyester bright stocks” can be prepared by direct esterification of dicarboxylic acids with glycols in about equimolar quantities. The polyesterification reaction is usually continued until the product has a kinematic viscosity from about 15 to 200 centistokes at 210°F, and preferably 40 to 100 centistokes at 210°F.

Although each of these products in itself is useful as a lubricant, they may be particularly useful when added or blended with each other in synthetic lubricant compositions. These esters and blends have been found to be especially adaptable to the conditions to which turbine engines are exposed, since they can be formulated to give a desirable combination of high flash point, low pour point, and high viscosity at elevated temperatures, and need contain no additives which might leave a residue upon volatilization. In addition, many complex esters have shown good stability to shear. Natural esters, such as castor oil may be employed and also be included in the blends, as may be small amounts of a polyol inhibitor such as a methyl silicone polymer, or other additives or lubricant components to provide a particular characteristic, for instance, extreme pressure or load-carrying agents, corrosion inhibitors, etc., can be added.

The monohydric alcohols employed in these esters usually contain about 4 to 20 carbon atoms and are generally aliphatic. Preferably the alcohol contains up to about 12 carbon atoms. Useful alkanol include butyl, hexyl, methyl, iso-octyl and dodecyl alcohols, C8-C10 alcohols and octadecyl alcohols. C8 to C18 branched chain primary alcohols are frequently used to improve the low temperature viscosity of the finished lubricant composition. Alcohols such as n-decanol, 2-ethyl-hexanol, “o xo” alcohols, prepared by the reaction of carbon monoxide and hydrogen upon the olefins obtainable from petroleum products such as diisobutylene and C6 olefins, ether alcohols such as butyl carbitol, tripropylene glycol mono-isopropyl ether, dipropylene glycol mono-isopropyl ether, and products such as “Terirol 3A5” which has the formula C6H12O(CH2CH2O)14 made from monoglycerides for use in fuel and for use in the desired lubricant. If the alcohol has no hydrogens on the beta carbon atoms, it is neo-structured; and esters of such alcohols are often preferred. In particular, the neo-C6 alcohol—2,4,trimethyl-penta- nol—I—gives lubricating diesters or complex esters suitable for blending with diesters to produce lubricants which meet stringent viscosity requirements. Iso-octanol and isodecanol are alcohol mixtures made by the o xo process from C8-C10 copolymer heptenes. The cut which makes
up iso-octanol usually contains about 17\% 3,4-dimethyl-hexanol; 29\% 3,5-dimethylo-hexanol; 25\% 4,5-dimethyl-hexanol; 1,4\% 5,5-dimethylo-hexanol; 16\% of a mixture of 3-n-decanoic acid, 5-ethyl-1,3-pentanoic, 2-butyl-1,3-pentanoic, 2,4- dipheryl-1,3-butanoldiyl, and 2,4-dimesityl-1,3-butano-andiol. In addition to these glycols, ether glycols may be used, for instance, where the alkylene radical contains 2 to 4 carbon atoms such as diethylene glycol, dipropylene glycol and ethylene glycol up to 1000 to 2000 molecular weight. The most popular glycols for the manufacture of ester lubricants appear to be polypropylene glycols having a molecular weight of about 100-300 and 2-ethyl hexanediol. The 2,2-dimethyl glycols, such as neopentyl glycol have been shown to impart heat stability to the final blends. Minor amounts of ether glycols or other materials can be present as long as the desired properties of the product are not unduly deleteriously affected.

One group of useful monocarboxylic acids includes those of 8 to 18 or even 24 carbon atoms such as stearic, lauric, etc. The carboxylic acids employed in making ester lubricants will often contain from about 4 to 12 carbon atoms. Suitable acids are described in U.S. Patent No. 2,575,195, and include the aliphatic dibasic acids of branched or straight chain structures which are saturated or unsaturated. The preferred acids are the saturated aliphatic carboxylic acids containing not more than about 12 carbon atoms, and mixtures of these acids. Suitable dibasic acids include succinic, adipic, suberic, azelaic, and sebacic acids and "isoestic" which is a mixture of α-ethyl suberic acid, α,ω-diethyl adipic acid and sebacic acid. This composite of acids is attractive from the viewpoint of economy and availability since it is made from petroleum hydrocarbon mixture than the natural oils and fats which are used in the manufacture of many diacylic acids, which natural oils and fats are frequently in short supply. The preferred dibasic acids are sebacic and azelaic or mixtures thereof. Minor amounts of adipic used with a major amount of sebacic may also be used with advantage.

The ester base oils to which incorporation of the amide additive of the invention is particularly advantageous and the oils commonly referred to as neopentyl polyol esters, i.e., having more than one ester group. These are the esters of aliphatic carboxylic acids, generally monoalkanoic acids, of about 4 to 12 carbon atoms, and a polyhydric alcohols free of beta hydrogen, i.e., containing no hydrogen on the beta carbon atoms, and including the di(polyhydric alcohol) ethers. The polyhydric alcohol generally contains about 2 to 6 hydroxy groups and about 5 to 20, preferably 5 to 12, carbon atoms. Illustrative of the alcohols are those having the general formula:

\[
\text{HOCH}_2\text{C}-\text{CH}_2 \left[ \overset{\text{R}}{\overset{\text{R}}{\text{O}}-\overset{\text{R}}{\overset{\text{R}}{\text{C}}\text{H}_2-\overset{\text{R}}{\overset{\text{R}}{\text{C}}\text{H}_2}\text{OH}}} \right] \text{OH}
\]

wherein \( n \) is 0 to 1 and \( R \) is a lower alkyl group, preferably about 1 to 4 carbon atoms, which can be straight or branched chain, or a hydroxy methyl group. These esters can be made by reacting a mole of the alcohol with about 2 moles up to the stoichiometric equivalent of the carboxylic acid.

Illustrative of polyhydric alcohols free of beta hydrogen are neopentyl glycol, trimethylolthene, trimethylolpropane, pentaerythritol, dipentaerythritol, 2-butyl-2-ethyl-1,3-propanediol, etc. Suitable aliphatic carboxylic acids with which the polyhydric alcohols free of beta hydrogen may be esterified are n-butyric acid, isobutyric acid, n-pentanoic acid, isopentanoic acid, n-heptanoic acid, isooctanoic acid, n-isooctanoic acid, n-octanoic acid, isooctanoic acid, pelargonic acid, n-decanoic acid, lauric acid, myristic acid, stearic acid, n-dodecanoic acid, valeric acid, n-hexabutyric acid, etc.

In order to retard oxidation in synthetic ester based lubricating oils antioxidants are often added. An effective antioxidant is a "monoalkaline" metal salt of a triester of an alkylenediamine-tetraacetic acid. The monoalkaline metal salts of the triester are soluble in the ester base fluid to the extent used and for convenience may be represented by the following structural formula:

\[
\text{CH}-\text{CH} \quad \text{CH}\quad \text{OM}
\]

wherein \( M \) is the stoichiometric equivalent of an alkaline metal, that is, an alkaline metal such as Na, K, Li, Cs and Rb or an alkaline earth metal such as Ca, Ba, Sr and Mg; \( Z \) is an alkylene radical including cycloalkyl straight or branched chain, preferably of about 4 to 8 carbons on the average or an aryl radical and can be substituted with non-interfering groups such as hydroxy and alkyl groups. The \( R \) groups can be the same or different and are of sufficient molecular weights to render the salt of the triester soluble in the base oil. Illustrative of alkylene radicals represented by \( Z \) are \((\text{CH}_2)_x\) wherein \( x = 1 \) to 20;

\[
\text{CH}_2\text{CH}_2\text{CH}_2\text{N}-\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \quad \text{CH}_2\text{CH}_2\text{N}-\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \quad \text{CH}_2\text{CH}_2\text{N}-\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}
\]

where \( R \) and \( M \) are as designated above.

The monoalkaline metal salts can readily be prepared by partial saponification with an alkaline metal base of the tetraesters of the alkylenediamine tetraacetic acid obtained, for instance, by the method described in U.S. Patent No. 2,482,353 to Frederick Bersworth, hereby incorporated by reference. Suitable bases include for example, the hydroxides, carbonates, etc. of the alkaline or alkaline earth metals. Alternatively, the salts can be obtained as by-products of the process of the aforementioned patent. Briefly, the esterification of the patent involves reacting a polyhydroxy amino acid with an alcohol in the presence of sufficiently strong mineral acid to form an amino acid-mineral acid addition product, the reaction being carried out so that the water resulting from the esterification reaction is driven off. Alternatively, the amino-acid mineral acid addition product is first prepared and separated as a crystalline product and esterified by heating with alcohol. On completion of the esterification reaction in either method, excess alcohol is removed by distillation which leaves the ester usually in the form of an addition product with the mineral acid. To neutralize and remove the mineral acid, the ester product is treated before or after the alcohol removal, with an alkaline solution and in so doing forms at least in part
the alkaline metal salts of the present invention which can be separated from the ester, if desired, by any suitable means such as solvent extraction. Generally the reaction product includes on the basis of the tetramer about 0.005 to 0.4 or even more equivalent weights of the alkaline metal, preferably about 0.02 to 0.1. The monoaalkaline metal salts per se can be employed in the composition of this invention but it is preferred to utilize the mixture of monoaalkaline metal salt, tetraester and other by-products, such as formed, by the neutralization step of the process described in the aforesaid title. Ordinarily, the resulting neutralized ester product mixture will contain anywhere from 3 to 40 weight percent of monoaalkaline metal salt. Although it is preferred to use this mixture as such, should the monosalt by itself be desired, it can be separated from the ester mixture. Alternatively, a substantially pure tetraester is first prepared as described by the Bersworth patent and the substantially pure ester obtained saponified as with an equimolar amount of the alkaline base in solution to give the monosalt on a calculated basis.

It has been observed that synthetic ester based lubricating oils containing a monoaalkaline metal salt of a triester of an alkaline diamine tetracetic acid and a dimer acid extreme pressure agent may develop a haze upon standing for long periods. Although this haze or cloudiness in the ester lubricant does not appear to have a detrimental effect upon lubricating properties, it may be considered undesirable. It has been found that this tendency of synthetic ester based lubricating oils containing a monoaalkaline metal salt of a triester of an alkaline diamine tetracetic acid and the dimer acid can be substantially reduced by using instead of the dimer acid, the minor amount of our amine of a hydrogenated dimer acid. Very small amounts of the amide are effective in reducing the haze. However, we prefer from about 0.05 to 1 part by weight of amide per part of monoaalkaline metal salt of a triester of an alkaline diamine tetracetic acid. Thus, the amide may serve as a dual function of reducing haze and improving load carrying properties.

The following examples illustrate the preparation of the amides of hydrogenated dimer acids.

EXAMPLE I

Preparation of half 2-ethylhexylamide of hydrogenated dimer acid

A solution of 112 g. (0.2 mole) of hydrogenated dimer acid (Emery 3389R) in 100 g. xylene was placed in a 500 ml, 4-necked flask. With constant stirring, a solution of 25.8 g. (0.2 mole) of 2-ethylhexylamine in 50 g. xylene was added slowly. The mixture was heated to reflux and refluxed for a period of 22.5 hours during which time 3.5 g. of water was collected in the azeotrope trap. The residue was vacuum tripped to a temperature of 140° C., leaving 135 g. of viscous brown liquid which showed the following analysis:

Acid No.: 81.06; percent N: 1.69. The theoretical values for a half amide are: Acid No.: 84.1; percent N: 2.10.

EXAMPLE II

Preparation of half amide of hydrogenated dimer acid

A solution of 280 g. (0.50 mole) of hydrogenated dimer acid (Emery 3389R) in 280 g. xylene was charged to a 1 liter Magnedrive autoclave. Ten grams (0.59 mole) of liquid ammonia was weighed into a stainless steel bomb and then forced into the autoclave by heating the bomb with an infrared lamp. A pressure of 135 p.s.i.g. was obtained at a temperature of 87° F. The mixture was heated to 367° F., at which point the NH₃ pressure dropped to 110 p.s.i.g. In another hour, the pressure dropped to 85 p.s.i.g. and temperature to 350° F. At this point the autoclave was bled into the atmosphere through a downward condenser. About 7 ml. of water was condensed, along with considerable xylene. The mixture was taken out and vacuum stripped to 150° C., yielding 278 g. of brownish viscous oil with the following analysis:

Acid No: 104.9; percent N: 2.16. The theoretical values for half amide of hydrogenated dimer acid are: Acid No: 101; percent N: 2.52.

Table I shows the amides prepared using the above defined hydrogenated dimer, method of preparation and the analytical data concerning the amides. The compounds are called half amide, three-quarters amide, nine-tenths amide, etc. as a matter of convenience, even though the analysis deviates somewhat from the calculated value corresponding to the names.

The tables presented below, several tests showing the advantages of our amide of hydrogenated dimer acids in high temperature synthetic lubricating oils are shown. Table II shows the effectiveness of the amides defined in Table I in increasing the load carrying properties of synthetic lubricants as determined by the standard Ryder gear scuff test. The scuffing load is the load in pounds per inch of gear width, at which average scuff on the gear of 22.5 percent takes place. It can be seen that the use of 0.1 to 0.5 percent of these various partial amides increased the load by 325 to 755 pounds per inch and improved the relative rating from 61 to 71-100 percent. It should be noted that with only 0.25 weight percent of the hydrogenated dimer acid amide present in Base Fluid I, the lubricant was able to meet the 2400 pound per inch Pratt and Whitney proposed specification (No. 5). Only 0.1 weight percent of the added partial amide was required in Base Fluid II in order to meet the specification (No. 9).

Table III shows the effectiveness of the % amide described in Table I in improving the gear fatigue char-

<p>| Table I: Partial Amides of Hydrogenated Dimer Acid Prepared |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Description of Amide</th>
<th>Analysis</th>
<th>Acid No.</th>
<th>Percent N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Half 2-ethylhexylamide</td>
<td>Calculated</td>
<td>84.1</td>
<td>2.10</td>
</tr>
<tr>
<td>2</td>
<td>Half Pristene JMT Amide</td>
<td>Calculated</td>
<td>80.06</td>
<td>1.69</td>
</tr>
<tr>
<td>3</td>
<td>Half Cocosamide</td>
<td>Calculated</td>
<td>79.0</td>
<td>1.20</td>
</tr>
<tr>
<td>4</td>
<td>Half Amide</td>
<td>Calculated</td>
<td>80.5</td>
<td>1.94</td>
</tr>
<tr>
<td>5</td>
<td>½ Amide</td>
<td>Calculated</td>
<td>84.3</td>
<td>1.86</td>
</tr>
<tr>
<td>6</td>
<td>¼ Amide</td>
<td>Calculated</td>
<td>84.9</td>
<td>2.25</td>
</tr>
<tr>
<td>7</td>
<td>½ Dimethylamide</td>
<td>Calculated</td>
<td>107.9</td>
<td>2.03</td>
</tr>
<tr>
<td>8</td>
<td>Half Amide</td>
<td>Calculated</td>
<td>105.8</td>
<td>2.07</td>
</tr>
</tbody>
</table>

In the tables presented below, several tests showing the advantages of our amide of hydrogenated dimer acids in high temperature synthetic lubricating oils are shown.
characteristics of the synthetic lubricant. Fatigue failure is signaled by the appearance of three size B pits (i.e., pits visible to the naked eye) on non-adjacent teeth. It can be seen that the use of 0.1 percent of a partial amide gives a candidate lubricant more than 110 hours, enough to meet the requirement of Pratt and Whitney. Without use of the amine the lubricant has failed the test in 80 hours.

### TABLE II—RYDER GEAR SCUFFING TEST RESULTS

<table>
<thead>
<tr>
<th>Run No.</th>
<th>Base Fluid</th>
<th>Antiscuff Additive</th>
<th>Wt. Percent</th>
<th>Setting Load, lbs./in.</th>
<th>Relative Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
<td>None</td>
<td>0.1</td>
<td>2,970 2,772 2,925</td>
<td>61</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>Hal 2-ethylhexylamide of hyd. dimer acid.</td>
<td>0.25</td>
<td>2,300 2,300 2,290</td>
<td>81</td>
</tr>
<tr>
<td>3</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.5</td>
<td>2,200 2,400 2,345</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.25</td>
<td>2,200 2,300 2,290</td>
<td>84</td>
</tr>
<tr>
<td>5</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.25</td>
<td>2,300 2,300 2,290</td>
<td>84</td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.5</td>
<td>2,300 2,400 2,400</td>
<td>94</td>
</tr>
<tr>
<td>7</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.25</td>
<td>2,300 2,300 2,290</td>
<td>84</td>
</tr>
<tr>
<td>8</td>
<td>I</td>
<td>None</td>
<td>0.1</td>
<td>2,300 2,300 2,300</td>
<td>80.9</td>
</tr>
<tr>
<td>9</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.25</td>
<td>2,245 2,300 2,300</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>I</td>
<td>None</td>
<td>0.2</td>
<td>2,710 2,800 2,765</td>
<td>100.5</td>
</tr>
<tr>
<td>11</td>
<td>I</td>
<td>Half amide of hyd. dimer acid.</td>
<td>0.8</td>
<td>2,700 2,700 2,700</td>
<td>100.5</td>
</tr>
</tbody>
</table>

1 Base fluid I:

<table>
<thead>
<tr>
<th>Wt. Percent</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.5</td>
<td>Hercolube C</td>
</tr>
<tr>
<td>34.5</td>
<td>Hercolube F</td>
</tr>
</tbody>
</table>

1 Base fluid II:

<table>
<thead>
<tr>
<th>Wt. Percent</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.0</td>
<td>Hercolube A</td>
</tr>
<tr>
<td>24.5</td>
<td>Hercolube F</td>
</tr>
</tbody>
</table>

### TABLE III—GEAR FATIGUE TEST RESULTS

<table>
<thead>
<tr>
<th>Runs</th>
<th>Formulation of Table II</th>
<th>Antiscuff Additive Name and Wt. Percent</th>
<th>Relative Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formulation of Table II</td>
<td>Antiscuff Additive Name and Wt. Percent</td>
<td>Relative Rating</td>
</tr>
<tr>
<td>2</td>
<td>Formulation of Table II</td>
<td>Antiscuff Additive Name and Wt. Percent</td>
<td>Relative Rating</td>
</tr>
</tbody>
</table>

It is claimed:

1. A lubricant composition consisting essentially of an ester based synthetic fluid of lubricating viscosity and a small minor amount of an ester oil-soluble amide of a hydrogenated dimer acid having the formula:

\[
\text{HCONH} \quad \text{R} \quad \text{R'}
\]

where \( \text{R} \) is the hydrocarbon residue of a hydrogenated dimer of a polyolefinic fatty acid of about 16 to 22 carbon atoms, and \( \text{R'} \) is selected from the group consisting of hydrogen and hydrocarbon radicals of up to about 20 carbon atoms and \( x \) is a number up to about 1.7, said amide of a hydrogenated dimer acid having on the average up to about 0.5 olefinic bond per molecule and being present in an amount effective to improve lubricity and load carrying properties of said ester based lubricant.

2. The composition of claim 1 containing 0.1 to 0.5 percent by weight of said amide of a hydrogenated dimer acid.

3. The composition of claim 2 wherein \( \text{A} \) is a residue of a hydrogenated dimer acid containing an average of less than 0.5 olefinic double bond.

4. The composition of claim 1 wherein the ester base fluid is an ester of an alkanol of 4 to 20 carbon atoms and alkane carboxylic acid of 4 to 18 carbon atoms.

5. The composition of claim 1 wherein the ester base fluid contains a minor oxidation inhibiting amount of an...
ester base fluid soluble monoalkaline metal salt having the following structural formula:

\[
\begin{align*}
R'O & \equiv C - CH_3 \\
& \equiv N - Z - N \\
& \equiv CH_2 - C - OR''
\end{align*}
\]

wherein M is an alkaline metal and R'' is a non-olefinic, non-acetylenic hydrocarbon radical having on the average about 3 to 18 carbon atoms, and Z is an alkylene radical of 1 to 20 carbons.

6. The composition of claim 4 containing 0.1 to 0.5 percent by weight of said amide of a hydrogenated dimer acid.

7. The composition of claim 5 wherein A is a residue of a hydrogenated dimer acid containing an average of less than ½ olefinic double bond.

8. An ester oil-soluble amide of a hydrogenated dimer acid having the formula:

\[
\begin{align*}
A & \equiv (\text{COOH})_2 \\
& \equiv (\text{CONRR'})_x
\end{align*}
\]

wherein A is the hydrocarbon residue of a hydrogenated dimer of a polyolefinic fatty acid of about 16 to 22 carbon atoms, R and R' are selected from the group consisting of hydrogen and hydrocarbon radicals of up to about 20 carbon atoms and x is a number up to about 1.7, said amide of a hydrogenated dimer acid having on the average up to about ½ olefinic bond per molecule.

9. The amide of claim 8 wherein A is a residue of a hydrogenated dimer acid containing an average of less than ½ olefinic double bond.

10. The amide of claim 9 wherein A contains about 34 carbon atoms, x is about 1 and R and R' are H.