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LUBRICATING COMPOSITIONS

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This invention relates to superior lubricating materials, and more particularly to improved non-hydrocarbon lubricants.

Mineral oil lubricants, such as those made from paraffin base petroleum oils or naphthenic base petroleum oils, are useful for most lubricating purposes when the conditions to which said lubricants are subjected are relatively mild. However, lubricants of petroleum origin are limited in their utility by certain inherent characteristics. For example, especially when employed for aviation purposes, a lubricant is often subjected to wide temperature variations, such as hot ground temperatures and the extremely cold temperatures encountered at high altitudes, for instance at about 10,000 to 20,000 feet elevation. Under these conditions, the ordinary mineral oil base lubricants fail to function properly, either being too fluid when warm, or too stiff when cold.

The tendency of mineral oils to oxidize rapidly, especially in the presence of certain metallic substances such as copper, iron oxide, etc., is well-known. While the addition of anti-oxidants corrects this adverse feature to a limited extent, in many instances mineral oil lubricants are unsatisfactory, due to sludge and gum formation, both of which are results of oxidation reactions.

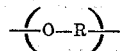
Certain non-hydrocarbon substances of synthetic origin have been used for specialized lubrication purposes. For example, polymeric alkylene oxides, such as polymerized propylene oxide, have been used for lubricating purposes. Other similar polymers have found restricted use as substitutes for mineral oil lubricants. Many of these have hydroxyl or alkoxyl end-groups on one or both ends of the polymeric chain. These various liquid polymeric lubricants have one or more properties which make their substitution for mineral oil advantageous for certain lubrication purposes. For example, the viscosity indices of many of them are relatively high, in comparison with those of mineral oils, and for this reason operate over a comparatively wide temperature range. However, due to the free hydroxyls or loosely bound terminal alkoxyl groups, the synthetic lubricants are usually unsatisfactory for many purposes, since they are unstable towards oxidizing influences, change their characteristics relatively rapidly during engine use, volatilize at relatively low temperatures, absorb water from the surrounding atmosphere, etc.

It is an object of this invention to provide improved non-mineral oil lubricants. It is another object of this invention to provide a non-petroleum base lubricant having improved resistance

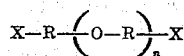
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to oxidation. It is a third object of this invention to provide a process for preparing non-hydrocarbon lubricants having substantially no ability to absorb water. It is still another object of this invention to provide new lubricants which are thermally stable. Other objects will be obvious from the following description of the present invention.

Now, in accordance with this invention, it has been found that liquid polymers having repeating structural units of the general configuration

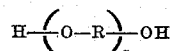


wherein R is any organic radical (especially a hydrocarbon radical) form unexpectedly superior lubricating compositions when at least one of the end-groups of each polymer chain is an amino radical. Thus, the general formula of the lubricants of the present invention is



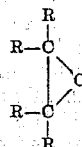
wherein R is an organic radical (preferably a hydrocarbon radical), n is an integer, and at least one of the X's is an amino (including substituted amino) group and the other is a group such as a hydroxyl, ether or ester group. Lubricants having the above configuration have unexpectedly high resistance to oxidation, respond to a much greater extent to inhibitors than if the amino group is absent, and exhibit superior characteristics when used as engine lubricants.

Lubricants having the above configuration are derived, for example, from the polymers and copolymers of alkylene oxides and alkylene glycols which have the general formula



wherein n is an integer and R is any organic, preferably hydrocarbon, radical.

Polymers having the above configuration are generally prepared from alkylene oxides, such as those having the general formula



wherein the R's are hydrogens or organic radicals, particularly hydrocarbon radicals.

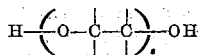
Alkylene oxides which form such polymers include ethylene oxide, propylene oxide, 1,2-butyl-

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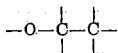
ene oxide, 2,3-butylene oxide, isobutylene oxide, tetramethylethylene oxide, n-hexylethylene oxide, methylphenylethylene oxide, cyclohexene oxide, methylcyclohexene oxide, 1,2-cetene oxide; and other substances containing the epoxide linkage such as epichlorohydrin epibromohydrine, and glycidides such as glycidol and 1,2-epoxybutanol-2, and glycidyl ethers such as glycidyl isopropyl ether, as well as derivatives and polymerizable homologs and analogs of the above substances.

Copolymers of the alkylene oxides include the copolymers of ethylene oxide and propylene oxide; the copolymers of ethylene oxide and isobutylene oxide; the copolymers of propylene oxide and epichlorohydrin; the copolymers of propylene oxide and 1,2-butylene oxide; the copolymers of propylene oxide and glycidol and the copolymers of propylene oxide and isobutylene oxide.

Glycols forming polymers which may be improved according to the present invention include those derived from ethylene glycol and having the general formula

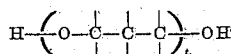


wherein s is an integer and the free carbon valences are satisfied with hydrogens or organic radicals. Preferably s is a whole number from 1 to 10, and still more preferably from 1 to 4. While the carbon constituents may be hydrogen or any organic radical, it is preferred that each

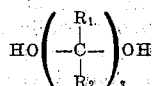


group have at least 2 hydrogen substituents, the balance being hydrocarbon, preferably alkyl, radicals. When s is 1, such glycols include ethylene glycol, propylene glycol, butylene glycol, etc. When s is more than 1, the glycols include diethylene glycol, triethylene glycol, tetraethylene glycol, pentaethylene glycol, and the corresponding propylene, butylene, etc. glycols. When s is more than 1, mixed glycols useful in the present invention include ethylene propylene glycol, diethylene propylene glycol, diethylene dipropylene glycol, etc. as well as their substituted derivatives, and polymerizable homologs and analogs.

The glycols having the general configuration



wherein t is an integer and the unsatisfied carbon valences carry hydrogen atoms or organic substituents, are all derived theoretically from trimethylene glycol. Hence, glycols of the above configuration will be referred to herein as the trimethylene glycols. When t is 1, the trimethylene glycols have the general formula

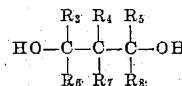


Preferably, R_1 and R_2 in the above formula are hydrogens. In such case, the polymers are formed from trimethylene glycol itself. If R_1 and/or R_2 are not hydrogens, they may be organic radicals such as alkyl, aralkyl, aryl, etc., radicals. Preferably if they are not hydrogens, they are hydrocarbon radicals, especially saturated lower aliphatic hydrocarbon radicals, but may also be groups which contain olefinic or acetylenic linkages. Typical of the trimethylene alkyl substituted glycols are the methylated tri-

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methylene glycols, including 1-methyl-1,3-propanediol; 2-methyl-1,3-propanediol; 1,1-dimethyl-1,3-propanediol; 1,2-dimethyl-1,3-propanediol; 1,3-dimethylpropane-1,3-diol; 2,2-dimethylpropane-1,3-diol; 1,1,2-trimethylpropane-1,3-diol; 1,1,3-trimethylpropane-1,3-diol; 1,2,2-trimethylpropane-1,3-diol; 1,2,3-trimethylpropane-1,3-diol; 1,1,2,2-tetramethylpropane-1,3-diol; 1,1,3,3-tetramethylpropane-1,3-diol; 1,2,3,3-tetramethylpropane-1,3-diol; 1,1,2,2,3-pentamethylpropane-1,3-diol; and hexamethylpropane-1,3-diol.

In place of the methyl groups other alkyl groups may be utilized, such as ethyl, propyl, butyl, amyl, hexyl, heptyl, octyl, nonyl, decyl, etc., radicals, as well as their isomers. Preferably, when alkyl groups are the substituents R_1 and/or R_2 , they have from 1 to 10 carbon atoms, and still more preferably from 1 to 5. It will be understood that R_1 and R_2 may be similar or dissimilar groups. Thus, when expanding the general formula given hereinbefore to its indicated number of carbon atoms, it then becomes



wherein R_3 through R_8 are either hydrogen atoms or similar or dissimilar organic (especially hydrocarbon) radicals. Those derivatives of trimethylene glycol, other than trimethylene glycol itself, which give the most satisfactory polymers for general use have either one or two of the R 's as lower alkyl groups. Thus, 2-methyl-1,3-propanediol and 2,2-dimethyl-1,3-propanediol, form excellent polymers when treated according to the method of the present invention.

Other lower alkyl substituted trimethylene glycols which polymerize readily are 1-methyl-2-ethyl-1,3-propanediol; 2-methyl-2-ethylpropane-1,3-diol; 1-methyl-3-ethyl-1,3-propanediol; 2-methyl-2-butyl-1,3-propanediol; 2-methyl-3-butyl-1,3-propanediol; and the homologs, analogs and derivatives of the same.

Cycloaliphatic radicals may be one or more of the substituents represented by R_3 to R_8 in the above general formula. Thus, R_3 through R_8 may be such radicals as cyclohexyl, methylcyclohexyl, dimethylcyclohexyl, ethylcyclohexyl, etc. However, open-chain alkyl substituents give polymers having preferred properties.

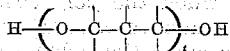
The polymers have somewhat different properties if the trimethylene glycol derivative contains other active groups, such as additional hydroxyls, or carboxyls, carbonyls, or elements such as halogens, sulfur, nitrogen, phosphorus, selenium, tellurium, etc.

While the polymers formed may be prepared from trimethylene glycol alone, or from a single trimethylene glycol derivative, copolymers also may be prepared in order to vary to a certain degree the properties of the polymeric lubricant for a particular purpose. Thus, trimethylene glycol may be copolymerized with trimethylene glycol derivatives, or two or more trimethylene glycol derivatives may be copolymerized. While any proportions of the monomers may be employed in preparing the copolymeric materials, copolymers having greater than about 10 parts of one monomer to 1 part of the other (or others) show no substantial difference in properties from a polymer prepared from the first monomer alone. Therefore, it is a preferred practice, when preparing copolymers to use proportions of

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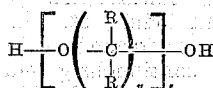
monomers from about 10:1 and about 1:1. Copolymers having monomer ratios of 5:1 and of 6:4 as well as 1:1 show well defined differences in properties from polymers prepared from any single monomer.

When t in the general formula



is more than 1, it preferably is from 2 to 5, but may be from 2 to 10 or even higher. Such glycols are the dimers, trimers, etc., of the monomeric trimethylene glycols. They include the lower polymers of single trimethylene glycols, or the lower copolymers of mixed trimethylene glycols.

Other glycols from which polymers of the present invention may be prepared have the general formula



wherein z is an integer, y is an integer greater than 5 and the R substituents attached to y carbons are hydrogens or organic radicals, particularly hydrocarbon radicals. Preferably z is an integer less than 10, and more preferably is an integer from 1 to 4. Actually, when z is more than 1, the glycol is a dimer, trimer, etc., of the corresponding monomeric glycol. The polymethylene glycols polymerizing most readily are those in which y is an integer from 6 to 20.

Monomeric, unsubstituted glycols falling within the above formula include hexanediol-1,6; heptanediol-1,7; octanediol-1,8; nonanediol-1,9; decanediol-1,10; dodecanediol-1,12; and polymerizable homologs, analogs and derivatives of the same.

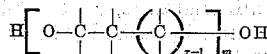
The above glycols are those in which all of the R substituents attached to the y carbons are hydrogens. When R's other than hydrogens are present, they may be hydrocarbon radicals, such as aliphatic, aromatic, or alicyclic hydrocarbon radicals, or radicals containing non-hydrocarbon members, such as hydroxyl, carboxyl, or carbonyl groups, or sulfur, selenium, tellurium, phosphorus or nitrogen atoms. Preferably, however, any organic radicals attached to the glycol are hydrocarbon radicals. Of these, the aliphatic hydrocarbons are preferred, and the saturated lower aliphatic radicals give the most versatile polymeric lubricants. Hence, the preferred R's, other than hydrogen, are the lower alkyl groups, such as methyl, ethyl, propyl, isopropyl, butyl, sec butyl, tert butyl, amyl, isoamyl, hexyl, etc., groups. Again, even when R's other than hydrogen are present, it is preferred that the monomeric glycol contain a preponderance of hydrogen substituent R's. The most reactive glycols are those in which less than 4 R's are other than hydrogen, and the greatest reactivity is possessed by those having 2 or less R's which are organic radicals.

Glycols which fall within the above classification include 1,6-heptanediol; 1,6-octanediol; 1,6-nonanediol; 1,7-dodecanediol; 1,8-nonanediol; 1,8-decanediol; 1,8-dodecanediol; 1,9-decanediol; 1,9-dodecanediol; 1,10-dodecanediol; 2,7-octanediol; 2,7-nonanediol; 2,7-decanediol; 2,7-dodecanediol; 2,8-nonanediol; 2,8-decanediol; 2,8-dodecanediol; 2,9-decanediol; 2,9-dodecanediol; 2,3-dimethyl-1,6-hexanediol; 2,4-dimethyl-1,6-hexanediol; 2,5-dimethyl-1,6-hexanediol; 2,2-dimethyl-1,6-hexanediol; 3,3-di-

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methyl-1,6-hexanediol; 4,4-dimethyl-1,6-hexanediol; 5,5-dimethyl-1,6-hexanediol; 2-methyl-3-ethyl-1,7-heptanediol; 2-ethyl-3-methyl-1,7-heptanediol; 3,3-diethyl-1,7-heptanediol; 3,4-diisopropyl-1,8-octanediol; etc., and their polymerizable homologs, analogs and derivatives.

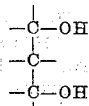
The lubricants of the present invention may be derived from polymers of one or more glycols of the above type, or are copolymers of one or more glycols of the above type with alkylene glycols wherein the glycollic hydroxyls are separated by either 2 or 3 carbon atoms. These two latter classes of glycols have the general formula



wherein m is an integer and x is an integer less than 3. Thus, when x and m are 1, the general formula becomes that of an ethylene glycol derivative:

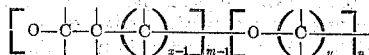


wherein the remaining valences are satisfied with hydrogens and/or organic radicals. When m is 1 and x is 2 the general formula becomes that of a trimethylene glycol derivative:



wherein the remaining valences are satisfied with hydrogens and/or organic radicals. When m in the above general formula is 1, the glycols are monomers. However, the polymers, and especially the lower polymers such as the dimers, trimers, tetramers, etc., of the ethylene glycols and trimethylene glycols readily polymerize with polymethylene glycols having more than 5 carbon atoms separating the glycollic hydroxyls.

The polymers and copolymers described above may be expressed in a single general formula having the essential configuration

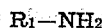


wherein m and n are integers, x is an integer less than 3, and y is an integer greater than 5, the free valences being either hydrogens or organic substitutes.

In accordance with one phase of the present invention, the stable lubricants of the present invention may be prepared by reaction of the end groups of said polymers, either during or subsequent to polymerization with ammonia or an amine.

The amines useful for the preparation of the stable polymers of the present invention are primary or secondary amines of aliphatic, aromatic or aliphatic-aromatic configurations.

Primary aliphatic amines are one of the preferred classes useful in forming the stable lubricants of the present invention. These have the general formula



wherein R_1 is an alkyl group. While R_1 may be an alkyl group having any number of carbon atoms, those having the greatest stabilizing action on the subject lubricants have from 3 to 15 carbon atoms, and optimum results are obtained when R_1 is an alkyl group containing from 3 to 8

carbon atoms. Thus, this latter optimum group is represented by propylamine, isopropylamine, butylamine, sec-butylamine, tert-butylamine, amylamine, isoamylamine, hexylamines, heptylamines and octylamines.

Other members of the preferred group include higher primary aliphatic amines include decylamine, dodecylamine, etc. The primary aliphatic amines may be regarded as hydrocarbons having a —NH_2 group replacing one of the hydrogens attached to a carbon atom. Thus, the preferred group of amines also includes, among others, 2-aminobutane, 2- or 3-aminopentane, 2-, 3-, or 4-aminohexane, 2-, 3-, 4-, or 5-aminooctane, etc. Other branched primary amines include 2-ethylhexylamine, 3-ethylhexylamine, 4-ethylhexylamine, 2-methylheptylamine, and their analogs and homologs.

Another preferred group of amines useful for the preparation of the stable lubricants of the present invention are the secondary aliphatic amines. These include amines having similar or dissimilar alkyl groups, and have the general formula



wherein R_1 and R_2 are alkyl groups. It is preferred that R_1 and R_2 be similar alkyl groups, each having from 3 to 15 carbon atoms, and optimum results are obtained when the alkyl groups each have from 3 to 8 carbon atoms. Thus, the optimum group includes dipropylamine, diisopropylamine, dibutylamine, di-sec-butylamine, di-tert-butylamine, diamylamines, dihexylamines, diheptylamines and dioctylamines.

Mixed secondary aliphatic amines include methylaminoethane, 1- or 2-methylaminopropane, 1- or 2-ethylaminobutane, 1-, 2- or 3-isopropylaminopentane, etc.

Aromatic amines of either primary or secondary configuration may be employed in the production of the stable lubricants described herein. Thus aniline and naphthylamine, as well as derivatives thereof, react with the subject polymers to form stable lubricants. The amines described above may contain other groups or elements other than hydrocarbons. Other substituents which may be present include acyl and hydroxyl groups, as well as sulfur, selenium, or tellurium. Thus, aminophenols and aliphatic hydroxylamines may be employed according to the present invention:

When alkylene oxides are the monomers from which the stable lubricants of present invention are prepared, it is a preferred practice to add an amine to the polymerization reaction mixture, thus allowing the amine to form end-groups of the polymer chains substantially as they are formed.

Alkylene oxides may be polymerized by heating the monomer at temperatures from about 25°C . to about 175°C . (preferably 35°C . to 150°C .) in the presence of catalysts such as alkali metal hydroxides, aluminum chloride, boron trifluoride, or salts such as stannic chloride. Inert diluents, such as hydrocarbons or chlorinated hydrocarbons are preferably present to promote uniformity of reaction, and provide temperature control.

The various amines described hereinbefore may be added to the above reaction mixture containing a monomeric alkylene oxide, a catalyst and, optionally, a diluent. Depending upon the constituents and the reaction conditions the re-

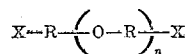
action may be conducted in liquid, emulsion or gaseous phases or in more than one of such phases. Ammonia and the more volatile amines, such as methylamine, etc., may be used especially when polymerization is conducted in the gas phase. The higher boiling amines are more properly used when the polymerization is carried out in an emulsion or solution state. However, especially when the polymerization is carried out in an autoclave or other closed system the gaseous or low boiling amines likewise may be used in an emulsion or solution polymerization.

The alkylene glycols are polymerized under somewhat different conditions. The monomeric (or dimer, trimer, etc.,) glycol is heated at a temperature from about $150\text{--}250^\circ\text{C}$. (preferably $175\text{--}225^\circ\text{C}$.) in the presence of a dehydration catalyst, such as sulfuric acid, phosphoric acid, iodine, hydrogen iodide, etc., under conditions whereby the water formed during the reaction is substantially continuously removed from the polymerization zone. Preferably, a diluent is used during the polymerization, since it can aid in the control of the reaction and form an azeotrope with the water of polymerization, thus facilitating the removal thereof.

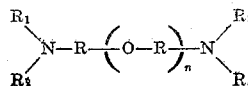
While an amine may be added to the alkylene glycol polymerization system, preferably the end-group conversion is effected subsequent to polymerization. Likewise, polymers of alkylene oxides may be treated with an amine subsequent to (instead of during) polymerization. In carrying out the reaction, the amine and polymer are heated in the presence of a dehydration catalyst, preferably in the presence of a solvent.

In carrying out the end-group conversion either during or subsequent to polymerization, enough of the amine is added to replace one or more of the end-groups of each polymer chain. While one or both end group hydroxyls of some chains may be completely replaced by an amino (including substituted amino) group, as little as 2% conversion of the end-group hydroxyls to amines in any single product has been found to provide lubricants having excellent stability and superior lubricating properties. These lower proportions of amino groups may be formed by diluting the amino-substituted product with non-substituted material or by other methods.

The lubricants of the present invention contain polymers which have the general formula



wherein R is any organic radical, n is an integer and at least one of the X 's is an amino (including substituted amino) end-group, the remainder being a hydroxyl, ester or ether group. Thus, when both end-groups have been completely converted, the polymer has the general formula



wherein R is any organic radical, R_1 , R_2 , R_3 and R_4 are hydrogen radicals or substituents such as aliphatic or aromatic radicals, and n is an integer.

As indicated in the preceding paragraph, those end-groups not converted with amines may be in the form of hydroxyls or converted hydroxyls. Thus the polymers may be treated with etherifying agents or esterifying agents either during or subsequent to polymerization in order to effect

partial conversion to ether or ester end-groups. Furthermore, subsequent to the introduction of amino end-groups, the polymers may be treated with acids to form amine salts.

The lubricants comprising polymers of the alkylene oxides or alkylene glycols containing amino end-groups are highly resistant to oxidation and have a superior response to oxidation inhibitors, as compared with lubricating polymers having no amino end-groups. The subject lubricants may contain additives further modifying their properties, including anticorrosion agents such as organic acid materials which form water-insoluble metallic salts, extreme pressure agents such as chlorinated hydrocarbons and hydroxy-alkyl sulfides and disulfides, viscosity index improvers, pour-point depressants and oxidation inhibitors such as substituted aromatic amines, phenols, and amino phenols. Likewise, soaps or other gelling agents may be added thereto for the formation of greases.

The following examples are presented to illustrate the preparation and stability properties of the lubricants of the present invention:

EXAMPLE I

One hundred parts glycidyl isopropyl ether was mixed with 315 parts isopentane and 5.4 parts di-isopropylamine. Sixteen and one-half parts borontrifluoride-ether complex was added slowly under reflux (30° C.). After one hour the mixture was washed with water and heated at 100° C. under reduced pressure. An 87% yield of a polymer was recovered having the following properties:

Molecular weight	773
Centipoises viscosity at 100° F.	100.5
Centipoises viscosity at 212° F.	103.4
Viscosity index	91
Nitrogen content	per cent. 0.15

For comparison, a similar polymer was prepared, omitting the di-isopropylamine. The latter polymer had the following properties:

Molecular weight	785
Centipoises viscosity at 100° F.	103.5
Centipoises viscosity at 212° F.	107
Viscosity index	94

EXAMPLE II

The polymerization of glycidyl isopropyl ether was carried out as described in Example I, except that phenyl-alpha-naphthylamine was added to the polymerization reaction mixture instead of di-isopropylamine. Seventy-five grams of the resulting polymer, containing phenyl-alpha-naphthylamine end-groups, was subjected to oxidation by bubbling oxygen therethrough at 140° C. It required 19 hours for the polymer to absorb 1800 cc. oxygen.

EXAMPLE III

To a solution of 42 parts propylene oxide in 100 parts isopentane, 0.55 part of boron-trifluoride-ether complex was slowly added at the reflux temperature of the isopentane. After standing one hour, an equal volume of water was added to destroy the catalyst. The polymer was recovered by distilling off the isopentane, and moisture was removed by heating at 100° C. under 2 mm. of mercury pressure. The polymerization was repeated, 5.4 parts di-isopropylamine being added to the reaction mixture prior to the

addition of borontrifluoride. The products had the following properties:

	Hydroxyl End-Groups	Di-isopropyl-amino End-Groups
Centipoises Viscosity, 100° F.	65.2	19.5
Centipoises Viscosity, 212° F.	8.61	3.71
Viscosity Index	112	80
Pour Point	-40	-45

EXAMPLE IV

The oxidation stabilities of the two polymers prepared as described in Example III were tested in the presence of 1.5% phenyl-alpha-naphthylamine. Seventy-five gram samples were heated at 150° C. in the presence of one sq. cm. copper per gram of oil, at an initial oxygen pressure of 50 lbs. p. s. i. Table I below gives the time required for the oxygen pressure to decrease 10 lbs. p. s. i. and 20 lbs. p. s. i., as well as the time at which the rate of oxidation increased beyond the initial rate (the induction period).

Table I

Polymer	Hydroxyl End-Groups	Di-isopropyl-amino End-Groups
Time for pressure to drop 10 p. s. i.	29	27
Time for pressure to drop 20 p. s. i.	32½	55
Induction period	28	100

EXAMPLE V

The two polymers prepared as described in Example I were subjected to the oxidation test described in Example IV. 1.5% phenyl-alpha-naphthylamine being added to each polymer prior to the test. The results are given in Table II, below:

TABLE II

	Hydroxyl End-groups	Di-isopropyl-amino End-groups
Hours to absorb 250 cc. oxygen	2	30
Hours to absorb 500 cc. oxygen	2.5	35
Hours to absorb 1,000 cc. oxygen	3	37
Hours to absorb 1,800 cc. oxygen	4	38

We claim as our invention:

1. A lubricating composition comprising as the major lubricating constituent thereof a mixture of linear polymers of glycidyl isopropyl ether having a molecular weight of about 773 and a nitrogen content of about 0.15%, said nitrogen content being contained in di-isopropylamino end groups attached to polymeric members of said mixture, and a minor amount, sufficient to stabilize said mixture against oxidation, of phenyl-alpha-naphthylamine.

2. A lubricating composition comprising as the major lubricating constituent thereof a mixture of linear polymers of glycidyl isopropyl ether having a molecular weight of about 773, a minor proportion of said polymers having phenyl-alpha-naphthylamino end groups, the amount of said amino end groups being at least 2% of the end groups of all of the polymers, and in addition thereto a minor amount, sufficient to stabilize said mixture against oxidation, of phenyl-alpha-naphthylamine.

3. A lubricating composition comprising as the major lubricating constituent thereof a mixture of linear polymers of glycidyl isopropyl ether

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having a molecular weight of about 773, a minor proportion of said polymers having amino end groups selected from the class consisting of diisopropyl amino end groups and phenyl-alpha-naphthyl amino end groups, the amount of said amino end groups being at least about 2% of the end groups of all of the polymers, and in addition thereto a minor amount, sufficient to stabilize said mixture against oxidation, of phenyl-alpha-naphthylamine.

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