SUMMARY OF THE INVENTION

[0015] An objective of the present invention is to provide a lubricating composition capable of providing at least one of (i) a lubricating composition capable of reducing viscosity increase (often having a viscosity of less than 12 mm^2/sec (cSt) at 100 °C at a soot loading of 6 weight % or more), and/or (ii) a lubricating oil composition that maintains a relatively stable viscosity over a wide range of temperatures. This could be desirable because viscosity index improvers or DVMs may be employed to control viscosity over a wide temperature range and to control soot. It may also be desirable if a viscosity index improver were capable of achieving (i) and (ii).

[0016] Unless otherwise indicated, each chemical or composition referred to herein should be interpreted as being a commercial grade material which may contain the isomers, by-products, derivatives, and other such materials which are normally understood to be present in the commercial grade. However, the amount of each chemical component is presented exclusive of any solvent or diluent oil, which may be customarily present in the commercial material, unless otherwise indicated.

[0017] The invention provides a lubricating composition comprising an oil of lubricating viscosity and 0.1 wt % to 15 wt % of a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent, and an amine, wherein the amine is an acyclic polyamine, wherein the polyolefin is a polyisobutylene having a number average molecular weight of 350 to 5000, wherein the ethylenically unsaturated aromatic acylating agent is cis-cinnamic acid, trans-cinnamic acid, or mixtures thereof, and wherein the lubricating composition has a sulphated ash content of 0.3 wt % to 1.2 wt %, or 0.5 wt % to 1.1 wt % of the lubricating composition.

[0018] The invention also provides a lubricating composition as described herein, wherein the compound is obtained by a process comprising: (1) reacting the polyolefin with the ethylenically unsaturated aromatic acylating agent; and (2) reacting the product of step (1) with the amine.

[0019] The invention also provides a method of lubricating an internal combustion engine comprising supplying to the internal combustion engine a lubricating composition comprising the lubricating composition of the invention.

[0020] The invention further provides the use of 0.1 wt % to 15 wt % of a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent, and an amine in a lubricant as a dispersant or dispersant viscosity modifier in an internal combustion engine lubricant, wherein the amine is as defined herein, wherein the polyolefin is as defined herein, a polybutene, wherein the ethylenically unsaturated aromatic acylating agent is as defined herein, and wherein the lubricating composition has a sulphated ash content of 0.3 wt % to 1.2 wt %, or 0.5 wt % to 1.1 wt % of the lubricating composition.

~~[0017]~~ **[0021]** In one embodiment the present invention provides a lubricating composition comprising an oil of lubricating viscosity and a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~, and an amine.

~~[0018]~~ **[0022]** In one embodiment the present invention provides a lubricating composition comprising an oil of lubricating viscosity and a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~, and an aromatic amine (typically wherein the aromatic amine is not a heterocycle).

~~[0019]~~ **[0023]** In one embodiment the present invention provides a lubricating composition comprising (i) an oil of lubricating viscosity, (ii) a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~, and an amine, and (iii) an overbased metal-containing detergent.

~~[0020]~~ **[0024]** In one embodiment the lubricating composition disclosed herein has a sulphated ash content of 0.3 wt % to 1.2 wt %, or 0.5 wt % to 1.1 wt % of the lubricating composition. The sulphated ash content may be determined by ASTM D-874.

~~[0021]~~ **[0025]** The compound disclosed herein may be borated, or non-borated, typically non-borated.

~~[0022]~~ **[0026]** In one embodiment the invention provides a lubricating composition wherein the compound disclosed herein may be present at 0.1 wt % to 15 wt %, or 1 wt % to 14 wt %, or 2 wt % to 12 wt %, or 4 wt % to 9 wt % of the lubricating composition. Typically the compound is present at an actives level of about 50 wt %

of the ranges quoted. In other words, on an actives basis the compound may be present at 0.05 to 7.5 wt %, or 0.5 wt % to 7 wt %, or 1 wt % to 6 wt %, or 2 wt % to 4.5 wt % of the lubricating composition.

~~[0023]~~ [0027] In one embodiment the invention provides a lubricating composition comprising the compound disclosed herein and an alkylated diarylamine (such as an alkylated diphenylamine, or an alkylated phenylnapthylamine). The alkylated diphenylamine may include di-nonylated diphenylamine, nonyl diphenylamine, octyl diphenylamine, di-octylated diphenylamine, di-decylated diphenylamine, decyl diphenylamine and mixtures thereof. In one embodiment the diphenylamine may include nonyl, diphenylamine, dinonyl diphenylamine, octyl diphenylamine, dioctyl diphenylamine, or mixtures thereof. In one embodiment the diphenylamine may include nonyl, diphenylamine, or dinonyl diphenylamine. The alkylated diarylamine may include octyl, di-octyl, nonyl, di-nonyl, decyl or di-decyl phenylnapthylamines.

~~[0024]~~ [0028] When present, the alkylated diarylamine may be present at 0.01 wt % to 5 wt %, or 0.05 wt % to 3 wt %, or 0.1 wt % to 1 wt % of the lubricating composition.

~~[0025]~~ [0029] In one embodiment the invention provides a lubricating composition wherein the compound as disclosed herein may be present at 2 wt % to 12 wt % (or typically 4 wt % to 9 wt %) and the alkylated diphenylamine may be present at 0.05 wt % to 3 wt % (or typically 0.1 wt % to 1 wt %) of the lubricating composition.

~~[0026]~~ [0030] In one embodiment the invention provides a method of lubricating an internal combustion engine comprising supplying to the internal combustion engine a lubricating composition as disclosed herein.

~~[0027]~~ [0031] In one embodiment the invention provides for the use of the compound described herein in a lubricant as a dispersant or dispersant viscosity modifier.

~~[0028]~~ [0032] In one embodiment the invention provides for the use of the compound disclosed herein in a lubricant as a dispersant or dispersant viscosity modifier in an internal combustion engine lubricant. Typically the dispersant or dispersant viscosity modifier is useful to mitigate soot thickening in an engine lubricant.

DETAILED DESCRIPTION OF THE INVENTION

~~[0029]~~ [0033] The present invention provides a lubricating composition, a method for lubricating an engine as disclosed above, and a use of the compound as disclosed above.

Polyolefin

~~[0030]~~ [0034] The polyolefin may be a homopolymer or a copolymer. The polyolefin may be derivable (or derived) from an olefin with 2 to 20, or 2 to 10, or 2 to 4 carbon atoms. The polyolefin is known in the state of the art.

~~[0031]~~ [0035] In one embodiment, the polyolefin may be a polybutene, typically a polyisobutylene. Typically the polyisobutylene has a number average molecular weight of 350 to 5000, or 550 to 3000 or 750 to 2500. Typically, when the reaction product of the invention is a homopolymer (such as polybutene) the homopolymer may be part of a dispersant.

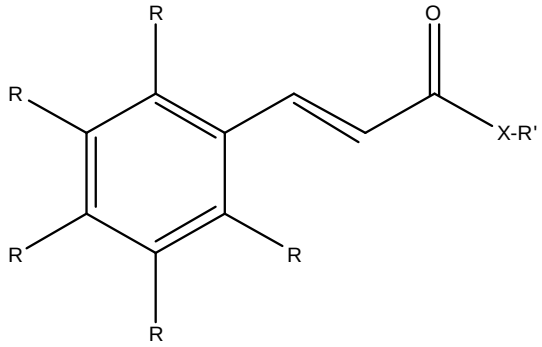
~~[0032]~~ [0036] When in the form of a copolymer, the polyolefin may be a copolymer of butene and isoprene, or an ethylene-Ű-olefin copolymer. In one embodiment the polyolefin may be a copolymer of an ethylene and propylene copolymer. Typically, when the reaction product of the invention is a copolymer the copolymer may be a dispersant viscosity modifier.

~~[0033]~~ [0037] The number average molecular weight of a copolymer derivable from a butene and isoprene copolymer, or an ethylene-Ű-olefin copolymer may be 500 to 200,000, 5000 to 200,000, 5,000 to 100,000, or 5,000 to 75,000.

Ethylenically Unsaturated Aromatic Acylating Agent (or Carboxylic Reactant)

~~[0034]~~ [0038] The ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~ may include cis-cinnamic acid, trans-cinnamic acid, phenylpropiolic acid, phenyl maleic anhydride, or mixtures thereof, or derivatives thereof (such esters, partial esters, amides, or partial amides (typically esters, or partial esters)). In one embodiment the ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~ may include cis-cinnamic acid, trans-cinnamic acid, phenylpropiolic acid, or mixtures thereof. In one embodiment the ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~ may include trans-cinnamic acid, or mixtures of cis and trans cinnamic acid.

~~[0035]~~ [0039] In one embodiment the ethylenically unsaturated acylating agent may also include a derivative of cinnamic acid that may be represented by the formula:



wherein

X may be ï O-, >NR",

R' and R" may independently be hydrogen or a hydrocarbyl group (typically containing 1 to 50, or 1 to 20 carbon atoms, and

R may independently be hydrogen, -OH, -OR, NR'R", or hydrocarbyl, and any two R groups together with other atoms may form 5 or 6 membered rings that may be saturated or unsaturated.

~~[0036]~~ [0040] Examples of a derivative of cinnamic acid include 3,4-(methylenedioxy)cinnamic acid, 3,4,5-trimethoxy-trans-cinnamic acid, 4-(dimethylamine)cinnamic acid, sinapic acid, 2-hydroxycinnamic acid, 3,4-dimethoxycinnamic acid, 3-hydroxy-4-methoxycinnamic acid, 4-methoxycinnamic acid, α-methylcinnamic acid, caffeic acid, coumarin, trans-3-hydroxycinnamic acid, 4-hydroxy-3-phenyl-2(5H)-furanone, (E)-3-(naphthalene-2-yl)acrylic acid, trans-3-(4-methoxybenzoyl)acrylic acid, 3-indoleacrylic acid, 2,3-diphenyl-acrylic acid, or 3-(1-naphthyl)acrylic acid.

Amine

~~[0037]~~ The amine may be ~~a monoamine or~~ a polyamine. The amine may be a linear or branched~~, cyclic~~ or acyclic amine, or combinations thereof. ~~When the amine is cyclic, the amine may be either an aromatic amine or a non-aromatic amine.~~

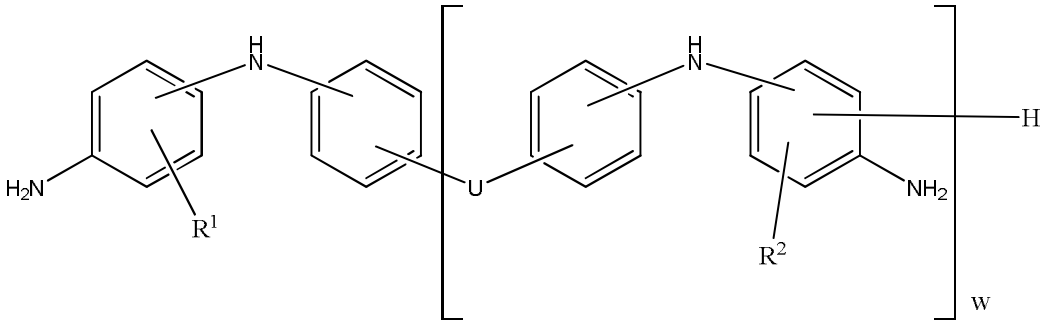
[0041]

~~[0038]~~ [0042] In one embodiment the amine may be acyclic, typically an acyclic polyamine. The polyamine may be an aliphatic polyamine such as an

ethylenepolyamine, a propylenepolyamine, a butylenepolyamine, or mixtures thereof. In one embodiment the polyamine may be an ethylenepolyamine. In one embodiment the aliphatic polyamine may be selected from the group consisting of ethylenediamine, diethylenetriamine, triethylenetetramine, tetraethylene-pentamine, pentaethylenehexamine, polyamine still bottoms, and mixtures thereof.

~~[0039]~~ [0043] In one embodiment the amine may be an aromatic amine (typically wherein the aromatic amine is not a heterocycle). The aromatic amine includes coupled products of aniline, nitroaniline, aminocarbazole, 4-aminodiphenylamine (ADPA), and includes coupling products (also referred to as coupled products) of ADPA. In one embodiment the amine may be ~~4-aminodiphenylamine (ADPA), or~~ coupling products of ADPA.

~~[0040]~~ [0044] Coupled products of ADPA may be represented by the formula (1):



Formula (1)

wherein independently each variable,

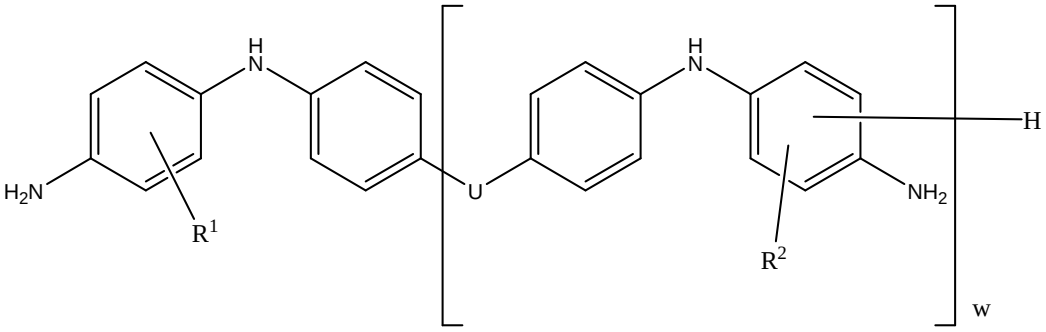
R^1 may be hydrogen or a C_{1-5} alkyl group (typically hydrogen);

R^2 may be hydrogen or a C_{1-5} alkyl group (typically hydrogen);

U may be an aliphatic~~,~~ or alicyclic ~~or aromatic~~ group, with the proviso that when U is aliphatic, the aliphatic group may be linear or branched alkylene group containing 1 to 5, or 1 to 2 carbon atoms; and

w may be 1 to 10, or 1 to 4, or 1 to 2 (typically 1).

~~[0041]~~ [0045] In one embodiment the coupled ADPA of Formula (1) may be represented by Formula (1a):



Formula (1a)

wherein independently each variable,

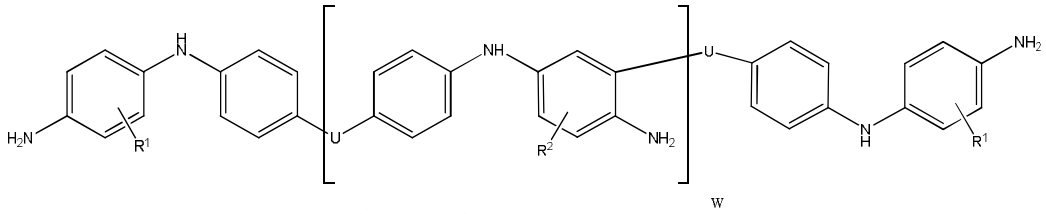
R^1 may be hydrogen or a C_{1-5} alkyl group (typically hydrogen);

R^2 may be hydrogen or a C_{1-5} alkyl group (typically hydrogen);

U may be an aliphatic~~,~~ or alicyclic ~~or aromatic~~ group, with the proviso that when U is aliphatic, the aliphatic group may be linear or branched alkylene group containing 1 to 5, or 1 to 2 carbon atoms; and

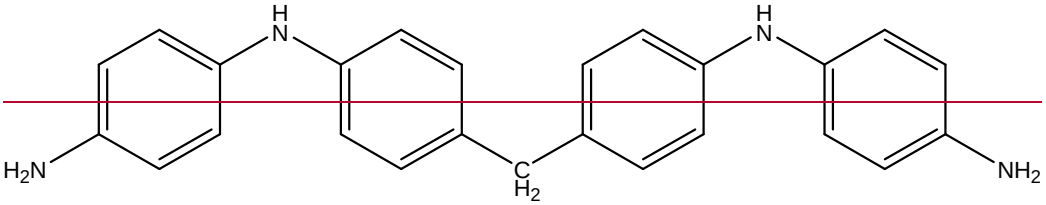
w may be 1 to 10, or 1 to 4, or 1 to 2 (typically 1).

~~[0042]~~ [0046] Alternatively, the compound of Formula (1a) may also be represented by:



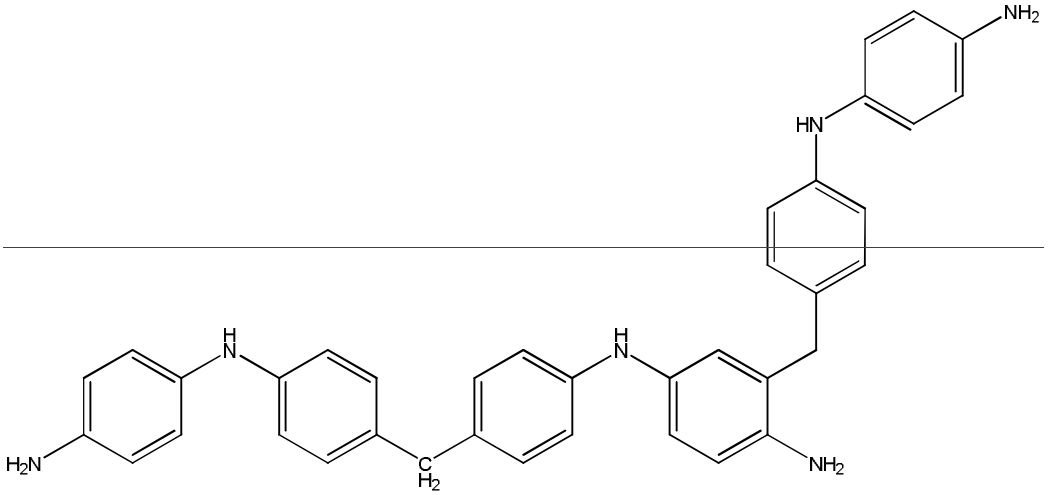
wherein each variable U, R^1, and R^2 are the same as described above and w is 0 to 9 or 0 to 3 or 0 to 1 (typically 0).

~~In one embodiment the aromatic amine may have at least 3 or aromatic groups. Examples of an amine having at least 3 aromatic groups may be represented by any of the following Formulae (2) and/or (3):~~



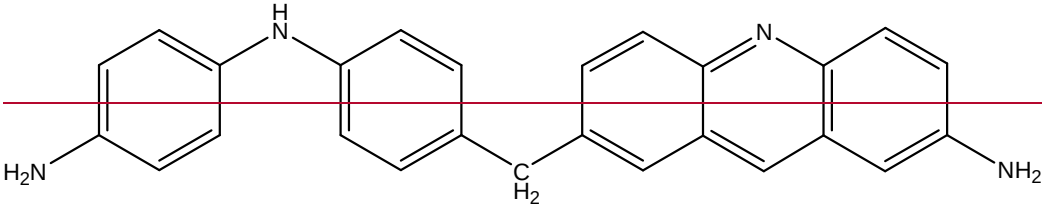
~~Formula (2)~~

~~or~~

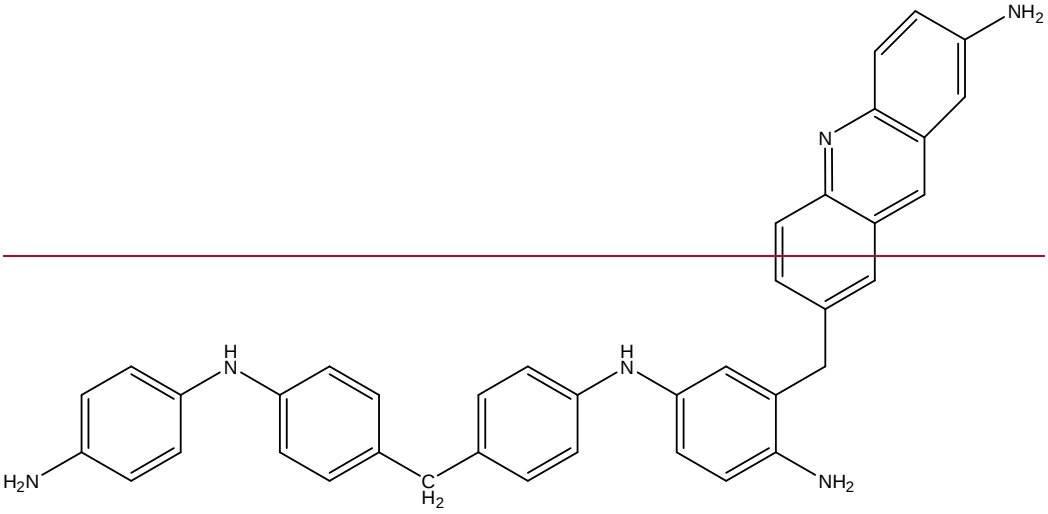


~~Formula (3)~~

~~A coupled aromatic amine can be made by the reaction of an aromatic amine with an aldehyde (such as formaldehyde). A person skilled in the art will appreciate that compounds of Formulae (2) and (3) may also react with the aldehyde described below to form acridine derivatives. Acridine derivatives that may be formed include compounds represented by Formula (2a) or (3a) below. In addition to these compounds representing these formulae, a person skilled in the art will also appreciate that other acridine structures may be possible where the aldehyde reacts with other benzyl groups bridged with the >NH group. Examples of acridine structures include those represented by Formulae (2a) and (3a):~~

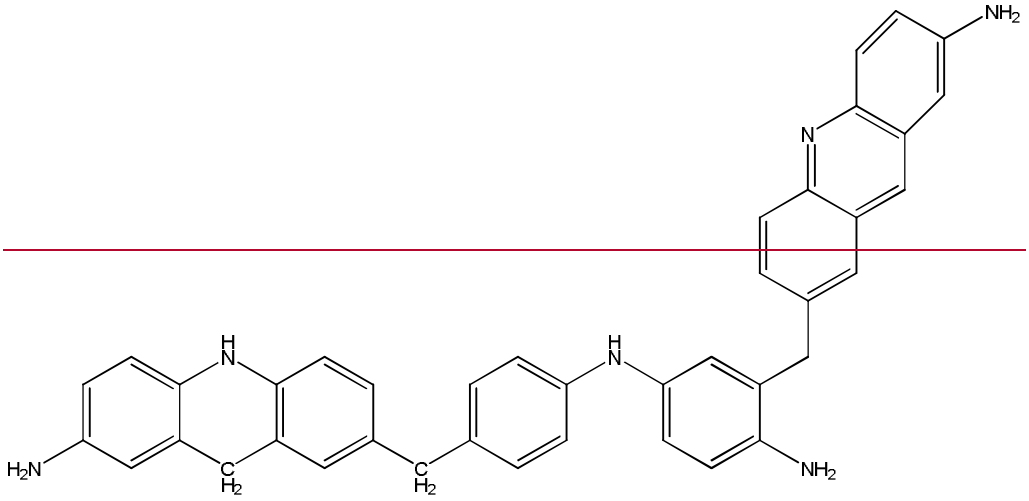


~~Formula (2a)~~



~~Formula (3a)~~

~~Any or all of the N-bridged aromatic rings are capable of such further condensation and perhaps aromatisation. One other of many possible structures is shown in Formula (3b).~~



~~Formula (3b)~~

~~Examples of the coupled ADPA include bis[p-(p-aminoanilino)phenyl] methane, 2-(7-amino-acridin-2-ylmethyl)-N-4-{4-[4-(4-amino-phenylamino)-benzyl]-phenyl}-benzene-1,4-diamine, N^4-{4-[4-(4-amino-phenylamino)-benzyl]-phenyl}-2-[4-(4-amino-phenylamino)-cyclohexa-1,5-dienylmethyl]-benzene-1,4-diamine, N-[4-(7-amino-acridin-2-ylmethyl)-phenyl]-benzene-1,4-diamine, or mixtures thereof.~~

The coupled ADPA may be prepared by a process comprising reacting the aromatic amine with an aldehyde. The aldehyde may be aliphatic, alicyclic or aromatic. The aliphatic aldehyde may be linear or branched. Examples of a suitable aromatic aldehyde include benzaldehyde or o-vanillin. Examples of an aliphatic aldehyde include formaldehyde (or a reactive equivalent thereof such as formalin or paraformaldehyde), ethanal or propanal. Typically the aldehyde may be formaldehyde or benzaldehyde.

~~[0043]~~ [0047] The process may be carried out at a reaction temperature in the range of 40 ºC to 180 ºC, or 50 ºC to 170 ºC.

~~[0044]~~ [0048] The reaction may or may not be carried out in the presence of a solvent. Examples of a suitable solvent include diluent oil, benzene, t-butyl benzene, toluene, xylene, chlorobenzene, hexane, tetrahydrofuran, water, or mixtures thereof.

~~[0045]~~ [0049] The reaction may be performed in either air or an inert atmosphere. Examples of suitable inert atmosphere include nitrogen or argon, typically nitrogen.

~~[0046]~~ [0050] Alternatively, the coupled ADPA may also be prepared by the methodology described in Berichte der Deutschen Chemischen Gesellschaft (1910), 43, 728-39.

~~[0047]~~ [0051] The compound of the invention may be obtained/obtainable by a process comprising:

Step (1) reacting a polyolefin (typically a polybutene such as polyisobutylene) with an ethylenically unsaturated aromatic acylating agent (or carboxylic reactant); and

Step (2) reacting the product of step (1) with an amine.

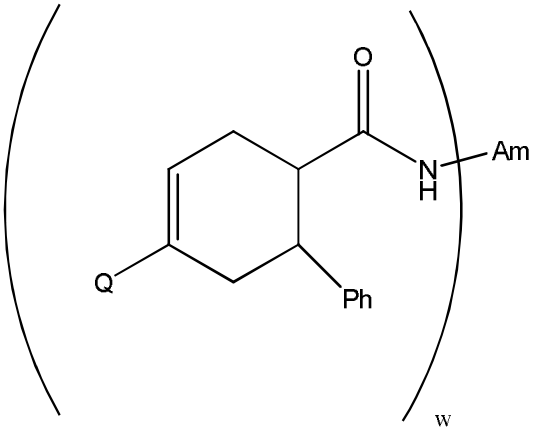
~~[0048]~~ [0052] The polybutene may be reacted with chlorine to provide a substance capable of undergoing a Diels-Alder reaction with the ethylenically unsaturated acylating agent. Alternatively, the polybutene and/or the ethylene alpha olefin may be reacted with the ethylenically unsaturated acylating agent in the presence of a radical initiator.

~~[0049]~~ [0053] The mole ratio of polyolefin to ethylenically unsaturated aromatic acylating agent (or carboxylic reactant) may range from 5:1 to 1:5, or

3:1 to 1:3, or 2:1 to 1:2, or 1:1. When the mole ratio is about 1:1 the product of step (1) is typically mono-substituted.

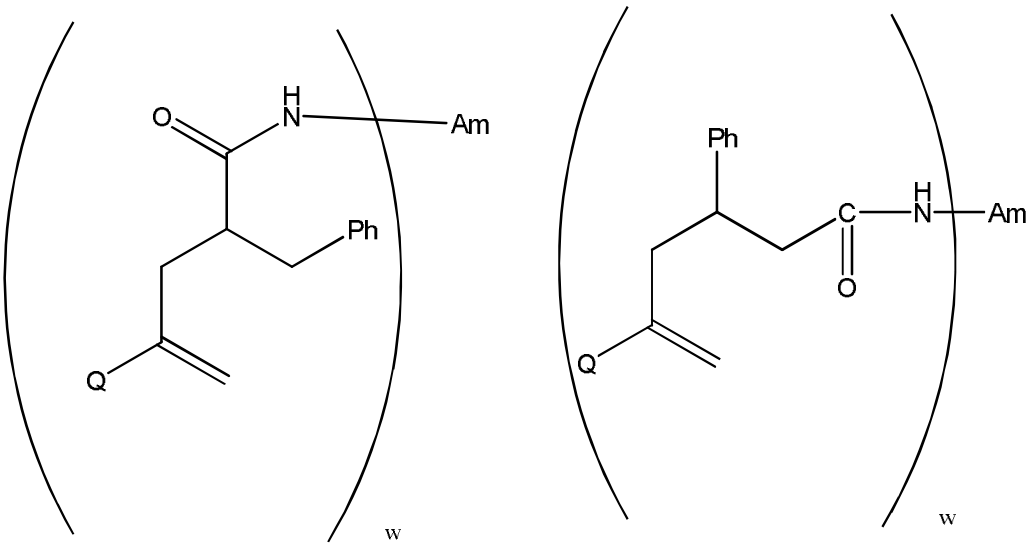
~~[0050]~~ [0054] Step (2) of the process reacts an amine with the product of step (1) by processes known to a person skilled in the art. The mole ratio of the amine to the product of step (1) may vary from 0.3:1 or 0.5:1 or 1:1 or 2:1, to 3:1 or to 2:1, e.g., 0.5:1 to 2:1. In certain embodiments, the relative amounts may be expressed in terms of the ratio of nitrogen atoms to carbonyl groups, and typical N:CO ratios may include 0.5:1 to 5:1. Typically the product of step (2) is in the form an amide.

~~[0051]~~ [0055] When the polyolefin is a polyisobutylene, the ethylenically unsaturated acylating agent is trans-cinnamic acid, and any amine disclosed herein are reacted, the product formed may be represented by formulae:



(typical product from Diels-Alder reaction)

or



(typical products from ñeneò reaction)

wherein w may be 1 to 5, or 1 to 3 (depending on the mole ratio of the product of the amine to the product of step (1) or step (i));

Q may be the residue of polybutene;

Ph may be phenyl group derivable from trans-cinnamic acid;

and Am may be the residue of the amine reacted.

~~[0052]~~ [0056] The compound of the invention may be obtained/obtainable by a process comprising (i) reacting a polyolefin copolymer (typically an ethylene-Ŭ-olefin copolymer) with an ethylenically unsaturated aromatic acylating agent (or carboxylic reactant); and (ii) reacting the product of (i) with an amine.

~~[0053]~~ [0057] The ethylenically unsaturated aromatic acylating agent (or carboxylic reactant) may be grafted onto the polyolefin copolymer (typically an ethylene/propylene copolymer) in a number of ways. It may be grafted onto the polymer in solution or in molten form using a radical initiator. The free-radical induced grafting of ethylenically unsaturated carboxylic acid materials may also be conducted in solvents, such as hexane or mineral oil. It may be carried out at an elevated temperature in the range of 100 ºC to 250 º such as 120 ºC to 190 ºC or 150 ºC to 180 ºC. If grafting is conducted in a solvent such as a mineral lubricating oil solution, the solution may contain 1 wt % to 50 wt %, or 5 wt % to 30 wt % based on the initial total oil solution, of the polyolefin copolymer, typically under an inert environment.

~~[0054]~~ [0058] The free-radical initiators which may be used include peroxides, hydroperoxides, and azo compounds, typically those which have a boiling point greater than about 100 °C and which decompose thermally within the grafting temperature range to provide free radicals. Representative of these free-radical initiators include azobisisobutyronitrile and 2,5-dimethyl-hex-3-yne-2,5-bis-tertiary-butyl peroxide. The initiator is typically used in an amount of 0.005 wt % to 1 wt % based on the weight of the reaction mixture solution. The grafting is typically carried out in an inert atmosphere, such as under nitrogen blanketing. The resulting polymer intermediate is characterized by having the aromatic acylating functions within its structure.

~~[0055]~~ [0059] In a melt process for forming a graft polymer, the ethylenically unsaturated aromatic acylating agent (or carboxylic reactant), with the optional use of a radical initiator, is grafted onto molten rubber using rubber masticating or shearing equipment. The temperature of the molten material in this process may be 70 °C to 250 °C. Optionally, as a part of this process or separate from this process, mechanical shear and elevated temperatures can be used to reduce the molecular weight of the copolymer to a value that will eventually provide the desired level of shear stability for the lubricant application. In one embodiment, such mastication can be done in a twin screw extruder properly configured to provide high shear zones, capable of breaking down the polymer to the desired molecular weight. Shear degradation can be done before or after grafting with the maleic anhydride. It can be done in the absence or presence of oxygen. The shearing and grafting steps can be done in the same extruder or in separate extruders, in any order.

~~[0056]~~ [0060] In an alternative embodiment, the ethylenically unsaturated aromatic acylating agent (or carboxylic reactant), may be first condensed with an amine (as described herein) and the condensation product itself then grafted onto the polymer backbone in analogous fashion to that described above.

~~[0057]~~ [0061] The amount of the ethylenically unsaturated aromatic acylating agent (or carboxylic reactant) on the polymer chain, and in particular the amount of grafted carboxylic acid on the chain is typically 1 wt % to 5 wt % based on the weight of the polyolefin backbone, and in an alternative embodiments 1.5 wt % to 4 wt 5, or 1.5 wt % to 3.5 wt %. These numbers represent the

amount of ethylenically unsaturated aromatic acylating agent (or carboxylic reactant) monomer and may be adjusted to account for acid monomers having higher or lower molecular weights or greater or lesser amounts of acid functionality per molecule, as will be apparent to the person skilled in the art

~~[0058]~~ [0062] The product of step (i) may then be functionalised by the amine in step (2). This reaction step is similar to that described above for polybutene.

~~[0059]~~ [0063] The product of step (ii) may in some instances be a dispersant viscosity modifier (DVM).

Oils of Lubricating Viscosity

~~[0060]~~ [0064] The lubricating composition comprises an oil of lubricating viscosity. Such oils include natural and synthetic oils, oil derived from hydrocracking, hydrogenation, and hydrofinishing, unrefined, refined, re-refined oils or mixtures thereof. A more detailed description of unrefined, refined and re-refined oils is provided in International Publication WO2008/147704, paragraphs [0054] to [0056] and in the corresponding paragraphs of US-2010-0197536. A more detailed description of natural and synthetic lubricating oils is described in paragraphs [0058] to [0059] respectively of WO2008/147704. Synthetic oils may also be produced by Fischer-Tropsch reactions and typically may be hydroisomerised Fischer-Tropsch hydrocarbons or waxes. In one embodiment oils may be prepared by a Fischer-Tropsch gas-to-liquid synthetic procedure as well as other gas-to-liquid oils.

~~[0061]~~ [0065] Oils of lubricating viscosity may also be defined as specified in April 2008 version of "Appendix E - API Base Oil Interchangeability Guidelines for Passenger Car Motor Oils and Diesel Engine Oils", section 1.3 Sub-heading 1.3. "Base Stock Categories". In one embodiment the oil of lubricating viscosity may be an API Group II or Group III oil.

~~[0062]~~ [0066] The amount of the oil of lubricating viscosity present is typically the balance remaining after subtracting from 100 wt % the sum of the amount of the compound of the invention and the other performance additives.

~~[0063]~~ [0067] The lubricating composition may be in the form of a concentrate and/or a fully formulated lubricant. If the lubricating composition of the invention (comprising the additives disclosed herein) is in the form of a concen-

trate which may be combined with additional oil to form, in whole or in part, a finished lubricant), the ratio of the of these additives to the oil of lubricating viscosity and/or to diluent oil include the ranges of 1:99 to 99:1 by weight, or 80:20 to 10:90 by weight.

~~[0064]~~ [0068] A lubricating composition may be prepared by adding the product of the process described herein to an oil of lubricating viscosity, optionally in the presence of other performance additives (as described herein below).

Other Performance Additives

~~[0065]~~ [0069] The composition optionally comprises other performance additives. The other performance additives include at least one of metal deactivators, viscosity modifiers, detergents, friction modifiers, antiwear agents, corrosion inhibitors, dispersants (other than the compound of the invention), dispersant viscosity modifiers (other than the compound of the invention), extreme pressure agents, antioxidants, foam inhibitors, demulsifiers, pour point depressants, seal swelling agents and mixtures thereof. Typically, fully-formulated lubricating oil will contain one or more of these performance additives.

~~[0066]~~ [0070] In one embodiment the lubricating composition further includes other additives. In one embodiment the invention provides a lubricating composition further comprising at least one of a dispersant (other than the compound of the invention), an antiwear agent, a dispersant viscosity modifier (other than the compound of the invention), a friction modifier, a viscosity modifier, an antioxidant, an overbased detergent, or mixtures thereof. In one embodiment the invention provides a lubricating composition further comprising at least one of a polyisobutylene succinimide dispersant, an antiwear agent, a dispersant viscosity modifier, a friction modifier, a viscosity modifier (typically an olefin copolymer such as an ethylene-propylene copolymer), an antioxidant (including phenolic and aminic antioxidants), an overbased detergent (including overbased sulphonates and phenates), or mixtures thereof.

~~[0067]~~ [0071] The dispersant may be a succinimide dispersant, or mixtures thereof. In one embodiment the dispersant may be present as a single dispersant. In one embodiment the dispersant may be present as a mixture of

two or three different dispersants, wherein at least one may be a succinimide dispersant.

~~[0068]~~ [0072] The succinimide dispersant may be derived from an aliphatic polyamine, or mixtures thereof. The aliphatic polyamine may be aliphatic polyamine such as an ethylenepolyamine, a propylenepolyamine, a butylenepolyamine, or mixtures thereof. In one embodiment the aliphatic polyamine may be ethylene-polyamine. In one embodiment the aliphatic polyamine may be selected from the group consisting of ethylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenehexamine, polyamine still bottoms, and mixtures thereof.

~~[0069]~~ [0073] The dispersant may be an N-substituted long chain alkenyl succinimide. An example of an N-substituted long chain alkenyl succinimide is polyisobutylene succinimide. Typically the polyisobutylene from which poly-isobutylene succinic anhydride is derived has a number average molecular weight of 350 to 5000, or 550 to 3000 or 750 to 2500. Succinimide dispersants and their preparation are disclosed, for instance in US Patents 3,172,892, 3,219,666, 3,316,177, 3,340,281, 3,351,552, 3,381,022, 3,433,744, 3,444,170, 3,467,668, 3,501,405, 3,542,680, 3,576,743, 3,632,511, 4,234,435, Re 26,433, and 6,165,235, 7,238,650 and EP Patent Application 0 355 895 A.

~~[0070]~~ [0074] The dispersant may also be post-treated by conventional methods by a reaction with any of a variety of agents. Among these are boron compounds, urea, thiourea, dimercaptothiadiazoles, carbon disulphide, alde-hydes, ketones, carboxylic acids, hydrocarbon-substituted succinic anhydrides, maleic anhydride, nitriles, epoxides, and phosphorus compounds.

~~[0071]~~ [0075] The dispersant may be present at 0.01 wt % to 20 wt %, or 0.1 wt % to 15 wt %, or 0.1 wt % to 10 wt %, or 1 wt % to 6 wt %, or 1 to 3 wt % of the lubricating composition.

~~[0072]~~ [0076] In one embodiment the lubricating composition of the invention further comprises a dispersant viscosity modifier. The dispersant viscosity modifier may be present at 0 wt % to 5 wt %, or 0 wt % to 4 wt %, or 0.05 wt % to 2 wt %, or 0.2 wt % to 1.2 wt % of the lubricating composition.

~~[0073]~~ [0077] The dispersant viscosity modifier may include functional-ised polyolefins, for example, ethylene-propylene copolymers that have been

functionalized with an acylating agent such as maleic anhydride and an amine; polymethacrylates functionalised with an amine, or styrene-maleic anhydride copolymers reacted with an amine. More detailed descriptions of dispersant viscosity modifiers are disclosed in International Publication WO2006/015130 or U.S. Patents 4,863,623; 6,107,257; 6,107,258; and 6,117,825. In one embodiment the dispersant viscosity modifier may include those described in U.S. Patent 4,863,623 (see column 2, line 15 to column 3, line 52) or in International Publication WO2006/015130 (see page 2, paragraph [0008], and preparative examples are described paragraphs [0065] to [0073]).

~~[0074]~~ [0078] In one embodiment the invention provides a lubricating composition which further includes a phosphorus-containing antiwear agent. Typically the phosphorus-containing antiwear agent may be a zinc dialkyldithiophosphate, a phosphite, phosphate, phosphonate, ammonium phosphate salt, or mixtures thereof. Zinc dialkyldithiophosphates are known in the art. The antiwear agent may be present at 0 wt % to 3 wt %, or 0.1 wt % to 1.5 wt %, or 0.5 wt % to 0.9 wt % of the lubricating composition.

~~[0075]~~ [0079] In one embodiment the invention provides a lubricating composition further comprising a molybdenum compound. The molybdenum compound may be selected from the group consisting of molybdenum dialkyldithiophosphates, molybdenum dithiocarbamates, amine salts of molybdenum compounds, and mixtures thereof. The molybdenum compound may provide the lubricating composition with 0 to 1000 ppm, or 5 to 1000 ppm, or 10 to 750 ppm 5 ppm to 300 ppm, or 20 ppm to 250 ppm of molybdenum.

~~[0076]~~ [0080] In one embodiment the invention provides a lubricating composition further comprising an overbased metal-containing detergent. The metal of the metal-containing detergent may be zinc, sodium, calcium or magnesium.

~~[0077]~~ [0081] The overbased metal-containing detergent may be selected from the group consisting of non-sulphur containing phenates, sulphur containing phenates, sulphonates, salixarates, salicylates, and mixtures thereof.

~~[0078]~~ [0082] The overbased metal-containing detergent may also include "hybrid" detergents formed with mixed surfactant systems including phenate and/or sulphonate components, e.g. phenate/salicylates, sulphonate/phenates,

sulphonate/salicylates, sulphonates/phenates/salicylates, as described; for example, in US Patents 6,429,178; 6,429,179; 6,153,565; and 6,281,179. Where, for example, a hybrid sulphonate/phenate detergent is employed, the hybrid detergent would be considered equivalent to amounts of distinct phenate and sulphonate detergents introducing like amounts of phenate and sulphonate soaps, respectively.

~~[0079]~~ [0083] Typically an overbased metal-containing detergent may be a zinc, sodium, calcium or magnesium salt of a phenate, sulphur containing phenate, sulphonate, salixarate or salicylate. Overbased salixarates, phenates and salicylates typically have a total base number of 180 to 450 TBN. Overbased sulphonates typically have a total base number of 250 to 600, or 300 to 500. Overbased detergents are known in the art. In one embodiment the sulphonate detergent may be a predominantly linear alkylbenzene sulphonate detergent having a metal ratio of at least 8 as is described in paragraphs [0026] to [0037] of US Patent Application 2005065045 (and granted as US 7,407,919). The predominantly linear alkylbenzene sulphonate detergent may be particularly useful for assisting in improving fuel economy.

~~[0080]~~ [0084] Typically the overbased metal-containing detergent may be a calcium or magnesium overbased detergent

~~[0081]~~ [0085] Overbased detergents are known in the art. Overbased materials, otherwise referred to as overbased or superbased salts, are generally single phase, homogeneous Newtonian systems characterized by a metal content in excess of that which would be present for neutralization according to the stoichiometry of the metal and the particular acidic organic compound reacted with the metal. The overbased materials are prepared by reacting an acidic material (typically an inorganic acid or lower carboxylic acid, preferably carbon dioxide) with a mixture comprising an acidic organic compound, a reaction medium comprising at least one inert, organic solvent (mineral oil, naphtha, toluene, xylene, etc.) for said acidic organic material, a stoichiometric excess of a metal base, and a promoter such as a phenol or alcohol. The acidic organic material will normally have a sufficient number of carbon atoms to provide a degree of solubility in oil. The amount of excess metal is commonly expressed in terms of metal ratio. The term "metal ratio" is the ratio of the total equivalents of the metal to the equivalents of the acidic organic compound. A neutral

metal salt has a metal ratio of one. A salt having 4.5 times as much metal as present in a normal salt will have metal excess of 3.5 equivalents, or a ratio of 4.5. The term ñmetal ratio is also explained in standard textbook entitled ñChemistry and Technology of Lubricantsò, Second Edition, Edited by R. M. Mortier and S. T. Orszulik, Copyright 1997. In one embodiment, the lubricant composition comprises at least one overbased detergent with a metal ratio of at least 3, or at least 8, or at least 15.

~~[0082]~~ [0086] The overbased detergent may be present at 0 wt % to 15 wt %, or 0.1 wt % to 10 wt %, or 0.2 wt % to 8 wt %, or 0.2 wt % to 3 wt %. For example, in a heavy duty diesel engine the detergent may be present at 2 wt % to 3 wt % of the lubricating composition. Similarly, for example, in a passenger car engine the detergent may be present at 0.2 wt % to 1 wt % of the lubricating composition.

~~[0083]~~ [0087] In one embodiment the lubricating composition includes an antioxidant, or mixtures thereof. The antioxidant may be present at 0 wt % to 15 wt %, or 0.1 wt % to 10 wt %, or 0.5 wt % to 5 wt %, or 0.5 wt % to 3 wt % of the lubricating composition.

~~[0084]~~ [0088] Antioxidants include sulphurised olefins, alkylated diphenylamines (as described previously), hindered phenols, molybdenum compounds (such as molybdenum dithiocarbamates), or mixtures thereof.

~~[0085]~~ [0089] The hindered phenol antioxidant often contains a secondary butyl and/or a tertiary butyl group as a sterically hindering group. The phenol group may be further substituted with a hydrocarbyl group (typically linear or branched alkyl) and/or a bridging group linking to a second aromatic group. Examples of suitable hindered phenol antioxidants include 2,6-di-tert-butylphenol, 4-methyl-2,6-di-tert-butylphenol, 4-ethyl-2,6-di-tert-butylphenol, 4-propyl-2,6-di-tert-butylphenol or 4-butyl-2,6-di-tert-butylphenol, or 4-dodecyl-2,6-di-tert-butylphenol. In one embodiment the hindered phenol antioxidant may be an ester and may include, e.g., IrganoxÊ L-135 from Ciba. A more detailed description of suitable ester-containing hindered phenol antioxidant chemistry is found in US Patent 6,559,105.

~~[0086]~~ [0090] In one embodiment the friction modifier may be selected from the group consisting of long chain fatty acid derivatives of amines, long

chain fatty esters, or derivatives of a long chain fatty epoxides; fatty imidazolines; amine salts of alkylphosphoric acids; fatty alkyl tartrates; fatty alkyl tartrimides; and fatty alkyl tartramides. The friction modifier may be present at 0 wt % to 6 wt %, or 0.05 wt % to 4 wt %, or 0.1 wt % to 2 wt % of the lubricating composition.

~~[0087]~~ [0091] As used herein the term ñfattyò or ñfatty alkylò means a carbon chain having 10 to 22 carbon atoms, typically a straight carbon chain.

~~[0088]~~ [0092] Examples of suitable friction modifiers include long chain fatty acid derivatives of amines, fatty esters, or fatty epoxides; fatty imidazolines such as condensation products of carboxylic acids and polyalkylene-polyamines; amine salts of alkylphosphoric acids; fatty alkyl tartrates; fatty alkyl tartrimides; or fatty alkyl tartramides.

~~[0089]~~ [0093] Friction modifiers may also encompass materials such as sulphurised fatty compounds and olefins, molybdenum dialkyldithiophosphates, molybdenum dithiocarbamates, sunflower oil or soybean oil monoester of a polyol and an aliphatic carboxylic acid.

~~[0090]~~ [0094] In one embodiment the friction modifier may be a long chain fatty acid ester. In another embodiment the long chain fatty acid ester may be a mono-ester and in another embodiment the long chain fatty acid ester may be a triglyceride.

~~[0091]~~ [0095] Other performance additives such as corrosion inhibitors include those described in paragraphs 5 to 8 of WO2006/047486, octylamine octanoate, condensation products of dodecenyl succinic acid or anhydride and a fatty acid such as oleic acid with a polyamine. In one embodiment the corrosion inhibitors include the Synalox® corrosion inhibitor. The Synalox® corrosion inhibitor may be a homopolymer or copolymer of propylene oxide. The Synalox® corrosion inhibitor is described in more detail in a product brochure with Form No. 118-01453-0702 AMS, published by The Dow Chemical Company. The product brochure is entitled ñSYNALOX Lubricants, High-Performance Polyglycols for Demanding Applications.ò

~~[0092]~~ [0096] Metal deactivators including derivatives of benzotriazoles (typically tolyltriazole), dimercaptothiadiazole derivatives, 1,2,4-triazoles, benzimidazoles, 2-alkyldithiobenzimidazoles, or 2-alkyldithiobenzothiazoles;

foam inhibitors including copolymers of ethyl acrylate and 2-ethylhexylacrylate and optionally vinyl acetate; demulsifiers including trialkyl phosphates, polyethylene glycols, polyethylene oxides, polypropylene oxides and (ethylene oxide-propylene oxide) polymers; pour point depressants including esters of maleic anhydride-styrene, polymethacrylates, polyacrylates or polyacrylamides may be useful. Foam inhibitors that may be useful in the compositions of the invention include silicones such as polysiloxanes, copolymers of ethyl acrylate and 2-ethylhexylacrylate and optionally vinyl acetate; demulsifiers including trialkyl phosphates, polyethylene glycols, polyethylene oxides, polypropylene oxides and (ethylene oxide-propylene oxide) polymers.

~~[0093]~~ [0097] Pour point depressants that may be useful in the compositions of the invention include polyalphaolefins, esters of maleic anhydride-styrene, poly(meth)acrylates, polyacrylates or polyacrylamides.

~~[0094]~~ [0098] In different embodiments the lubricating composition may have a composition as described in the following table:

Additive	Embodiments (wt %)		
	A	B	C
Compound of the Invention	0.1 to 15	1 to 14	4 to 9
Dispersant	0 to 12	0 to 8	0.5 to 6
Dispersant Viscosity Modifier	0 to 5	0 to 4	0.05 to 2
Overbased Detergent	0 to 15	0.1 to 10	0.2 to 8
Antioxidant	0 to 13	0.1 to 10	0.5 to 5
Antiwear Agent	0 to 15	0.1 to 10	0.3 to 5
Friction Modifier	0 to 6	0.05 to 4	0.1 to 2
Viscosity Modifier	0 to 10	0.5 to 8	1 to 6
Any Other Performance Additive	0 to 10	0 to 8	0 to 6
Oil of Lubricating Viscosity	Balance to 100 %	Balance to 100 %	Balance to 100 %

Industrial Application

~~[0095]~~ [0099] The lubricating composition may be utilised in an internal combustion engine. The engine components may have a surface of steel or aluminium (typically a surface of steel).

~~What is claimed is~~The Claims defining the invention are as follows:

1. A lubricating composition comprising an oil of lubricating viscosity and 0.1 wt % to 15 wt % of a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~, and an amine,

wherein the amine is an acyclic polyamine,

wherein the polyolefin is a polyisobutylene having a number average molecular weight of 350 to 5000, wherein the ethylenically unsaturated aromatic acylating agent is cis-cinnamic acid, trans-cinnamic acid, or mixtures thereof, and~~polybutene~~, and

wherein the lubricating composition has a sulphated ash content of 0.3 wt % to 1.2 wt %, or 0.5 wt % to 1.1 wt % of the lubricating composition.

~~2~~7. The lubricating composition of ~~claim 1~~any one of the preceding claims 1 to 6, wherein the compound is obtained~~/obtainable~~ by a process comprising:

(1) reacting ~~a~~ the polyolefin with the ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~; and

(2) reacting the product of step (1) with the amine.

~~3~~2. The lubricating composition of claim 1 ~~or 2~~ , wherein the ~~acyclic~~ amine is an ethylenepolyamine~~.~~.

~~4~~3. The lubricating composition of claim ~~3~~2, wherein the ethylenepolyamine is selected from the group consisting of ethylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenehexamine, polyamine still bottoms, and mixtures thereof.

~~5. The lubricating composition of any preceding claim 1 to 4, wherein the polyolefin is derivable from an olefin with 2 to 20, or 2 to 10, or 2 to 4 carbon atoms.~~

~~6. The lubricating composition of any preceding claim 1 to 5, wherein the polybutene is a polyisobutylene,~~

~~7~~4. The lubricating composition of any one of the preceding claims 1 to ~~6~~3, wherein the ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~ is ~~cis-cinnamic acid,~~ trans-cinnamic acid, or mixtures of cis-and~~thereof, typically~~ trans-cinnamic acid~~, or mixtures thereof~~.

~~5~~. The lubricating composition of any one of the preceding claims 1 to 4, wherein the polyisobutylene has a number average molecular weight of 550 to 3000.

6. The lubricating composition of any one of the preceding claims 1 to 5, wherein the polyisobutylene has a number average molecular weight of 750 to 2500.

8. The lubricating composition of any one of the preceding claims 1 to 7, wherein the compound is non-borated.

9. The lubricating composition of any one of the preceding claims 1 to 8, wherein the compound is present at 1 wt % to 14 wt %, or 2 wt % to 12 wt % of the lubricating composition.

10. The lubricating composition of any one of the preceding claims 1 to 9, wherein the compound is present at 4 wt % to 9 wt % of the lubricating composition.

11. The lubricating composition of any one of the preceding claims 1 to 10, further comprising an overbased metal-containing detergent.

12. The lubricating composition of claim 11, wherein the overbased metal-containing detergent is selected from the group consisting of non-sulphur containing phenates, sulphur containing phenates, sulphonates, salixarates, salicylates, and mixtures thereof.

13. The lubricating composition of claim 11 or 12, wherein the overbased metal-containing detergent is a sodium, calcium or magnesium salt of a phenate, sulphur containing phenate, sulphonate, salixarate or salicylate, wherein the salixarate, phenate or salicylate has a total base number of 180 to 450 TBN, and wherein the sulphonate has a total base number of 250 to 600, or 300 to 500.

14. The lubricating composition of any one of the preceding claims 1 to 13, further comprising a dispersant ~~which may be~~comprising a succinimide dispersant, or mixtures thereof.

15. A method of lubricating an internal combustion engine comprising supplying to the internal combustion engine a lubricating composition comprising the lubricating composition of any one of the preceding claims 1 to 14.

16. The use of 0.1 wt % to 15 wt % of a compound comprising the reaction product of a polyolefin, an ethylenically unsaturated aromatic acylating agent ~~(or carboxylic reactant)~~, and an amine in a lubricant as a dispersant or dispersant viscosity modifier in an internal combustion engine lubricant,

wherein the amine is ~~an acyclic polyamine~~as defined in any one of the preceding claims 1 to 14,

wherein the polyolefin is as defined in any one of the preceding claims 1 to 14~~a polybutene~~, and

wherein the ethylenically unsaturated aromatic acylating agent is as defined in any one of the preceding claims 1 to 14,

wherein the lubricating composition has a sulphated ash content of 0.3 wt % to 1.2 wt %, or 0.5 wt % to 1.1 wt % of the lubricating composition.

~~17. The use of claim 16, wherein the acyclic amine is an ethylenepolyamine,~~

~~18. The use of claim 16 or 17, wherein the polybutene is a polyisobutylene,~~