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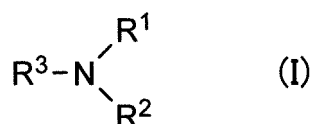
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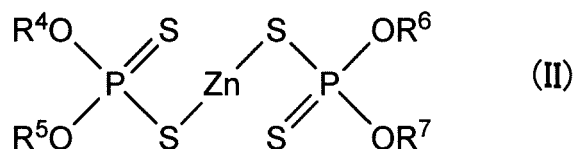
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(54) **LUBRICATING OIL COMPOSITION FOR SHOCK ABSORBER**

(57) The lubricating oil composition for a shock absorber of the present invention contains (A) a base oil containing a mineral oil and/or a synthetic oil, (B) a tertiary amine represented by the following general formula (I), (C) a zinc dithiophosphate represented by the following general formula (II), and (D) a phosphorus acid ester amine salt,



wherein R¹ and R² each independently represent an aliphatic hydrocarbon group having from 1 to 5 carbon atoms, and R³ represents an aliphatic hydrocarbon group having from 12 to 24 carbon atoms, in the general formula (I),



wherein R⁴ to R⁷ each independently represent one selected from an alkyl group and an alkenyl group each having from 1 to 24 carbon atoms, in the general formula (II).

Description

Technical Field

5 **[0001]** The present invention relates to a lubricating oil composition for a shock absorber, in particular, to a lubricating oil composition for a shock absorber that is for use for a shock absorber for cars.

Background Art

10 **[0002]** In a body of cars and the like, used is a suspension integrated with a shock absorber for reducing the vibration of the body caused by road surface roughness, the shaking thereof which occurs in quick acceleration or sudden braking, and the like. The structure of the shock absorber is based on a cylindrical structure that utilizes the resistance of oil to flow. Specifically, used is the structure having small holes bored in a hydraulic piston. In the slide part between the cylinder and the piston rod, a bush is provided to be a bearing and sealability is secured by an oil seal. In general, the
15 bush is formed of bronze, and the oil seal is formed of rubber.

[0003] During expansion and contraction movement, a shock absorber may receive a great lateral force, and in the case, friction is generated in a bush. The generation of friction may be a factor to worsen the riding comfort performance, and therefore it is desired to reduce friction to the bush. In addition, in the case where the tightening force of the oil seal is increased to improve the dust resistance, it is also desired to reduce the friction coefficient to the oil seal in order to
20 better the riding comfort performance.

[0004] Heretofore known is a lubricating oil composition for a shock absorber, in which a phosphorus acid ester as an extreme-pressure agent is blended and a secondary amine is further blended, for example, as shown in PTL 1. However, this lubricating oil composition could not still sufficiently reduce the friction to bronze-made bushes and rubber-made oil seals.

25 **[0005]** In addition, for example, in PTL 2, it is known to blend a tertiary amine in a lubricating oil composition for continuously-variable transmissions, along with an extreme-pressure agent composed of a phosphorus acid ester, and a metal compound such as a metal sulfonate or the like. However, when this lubricating oil composition is used in a shock absorber without modifying, the friction for bronze-made bushes and for rubber-made oil seals could not still be sufficiently reduced.

30 **[0006]** Further, heretofore, it is known to use a zinc dialkyldithiophosphate as the friction regulator in a lubricating oil composition for a shock absorber (see PTL 3). However, even if a zinc alkyldithiophosphate were simply blended in the lubricating oil compositions described in PTLs 1 and 2, the friction level to bronze-made bushes or rubber-made oil seals could not always be reduced. In addition, in the lubricating oil compositions in which an extreme-pressure agent is blended, precipitates may be generated during storage, thereby causing a problem in point of long-term stability.
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Citation List

Patent Literature

40 **[0007]**

PTL 1: WO 2008/038667 A1

PTL 2: WO 2011/037054 A1

PTL 3: JP 2009-13380 A
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Summary of Invention

Technical Problem

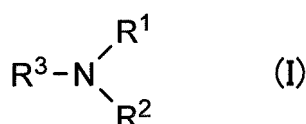
50 **[0008]** The present invention has been made in consideration of the above-mentioned problems, and its object is to provide a lubricating oil composition for a shock absorber capable of reducing the friction coefficient to bronze-made bushes and rubber-made oil seals without generating precipitates for a long period of time, even with blending an extreme-pressure agent therein.

55 **Solution to Problem**

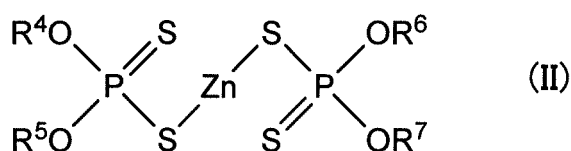
[0009] The present inventors have assiduously studied and, as a result, have found that, with blending a specific zinc dithiophosphate in a lubricating oil composition for a shock absorber in addition to a specific tertiary amine therein, the

oil composition can reduce the friction coefficient to rubber and bronze. In addition, the present inventors have ascertained that the precipitates caused by an extreme-pressure agent is generated through the reaction with a zinc dithiophosphate, and have found that, when a phosphorus acid ester amine salt which does not react with a zinc dithiophosphate for a long period of time is blended as an extreme-pressure agent, the friction coefficient to rubber and bronze can be reduced without generation of precipitates, and have completed the present invention as described below.

(1) A lubricating oil composition for a shock absorber, containing (A) a base oil composed of a mineral oil and/or a synthetic oil, (B) a tertiary amine represented by the following general formula (I), (C) a zinc dithiophosphate represented by the following general formula (II), and (D) a phosphorus acid ester amine salt.



R^1 and R^2 each independently represent an aliphatic hydrocarbon group having from 1 to 5 carbon atoms, and R^3 represents an aliphatic hydrocarbon group having from 12 to 24 carbon atoms in the general formula (I).



R^4 to R^7 each independently represent one selected from a linear, branched or cyclic alkyl group having from 1 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 1 to 24 carbon atoms in the general formula (II).

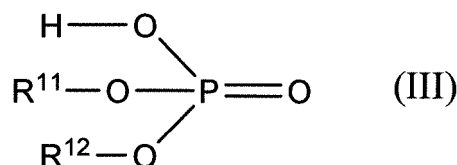
(2) The lubricating oil composition for a shock absorber according to the above (1), wherein R^1 and R^2 each are independently selected from a linear, branched or cyclic alkyl group having from 1 to 5 carbon atoms and a linear, branched or cyclic alkenyl group having from 1 to 5 carbon atoms, and R^3 is selected from a linear, branched or cyclic alkyl group having from 12 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 12 to 24 carbon atoms in the general formula (I).

(3) The lubricating oil composition for a shock absorber according to the above (1) or (2), wherein R^3 in the general formula (I) is a linear, branched or cyclic alkyl group having from 16 to 20 carbon atoms.

(4) The lubricating oil composition for a shock absorber according to the above (3), wherein R^3 in the general formula (I) is a stearyl group.

(5) The lubricating oil composition for a shock absorber according to any of the above (1) to (4), wherein R^4 to R^7 in the general formula (II) each are independently one selected from a linear, branched or cyclic alkyl group having from 10 to 20 carbon atoms and a linear, branched or cyclic alkenyl group having from 10 to 20 carbon atoms.

(6) The lubricating oil composition for a shock absorber according to any of the above (1) to (5), wherein the phosphorus acid ester amine salt (D) is an amine salt of an acidic phosphoric acid ester represented by the following general formula (III).



R^{11} is selected from a hydrogen atom, a linear, branched or cyclic alkyl group having from 8 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 8 to 24 carbon atoms, and R^{12} is selected from a linear, branched or cyclic alkyl group having from 8 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 8 to 24 carbon atoms in the general formula (III).

(7) The lubricating oil composition for a shock absorber according to the above (6), wherein R^{11} and R^{12} in the general formula (III) each are independently an alkyl group having from 16 to 20 carbon atoms or an alkenyl group having from 16 to 20 carbon atoms.

(8) The lubricating oil composition for a shock absorber according to any of the above (1) to (7), which contains from 0.01 to 3% by mass of the tertiary amine (B).

(9) The lubricating oil composition for a shock absorber according to any of the above (1) to (8), which contains from 0.01 to 3% by mass of the zinc dithiophosphate (C).

(10) The lubricating oil composition for a shock absorber according to any of the above (1) to (9), which is a lubricating oil composition for a shock absorber for cars.

(11) The lubricating oil composition for a shock absorber according to any of the above (1) to (10), wherein R¹ and R² in the general formula (I) each have 1 or 2 carbon atoms.

Advantageous Effects of Invention

[0010] According to the present invention, there can be provided a lubricating oil composition for a shock absorber capable of reducing the friction coefficient to bronze-made bushes and rubber-made oil seals without generation of precipitates for a long period of time, even with blending an extreme-pressure agent therein.

Description of Embodiments

[0011] The present invention is described in more detail below.

[0012] The lubricating oil composition for a shock absorber of the present invention contains (A) a base oil, (B) a tertiary amine, (C) a zinc dithiophosphate and (D) a phosphorus acid ester amine salt.

[0013] The components are described in detail below.

[(A) Base Oil]

[0014] As the base oil in the lubricating oil composition for a shock absorber of the present invention, usable are mineral oil and/or synthetic oil.

[0015] Examples of the mineral oil include paraffin-based mineral oil, intermediate-based mineral oil, naphthene-based mineral oil and the like, which are obtained by usual refining processes such as solvent refining, hydrotreating or the like, those prepared by isomerizing wax produced through Fischer-Tropsch process or the like (gas-to-liquid wax) or mineral oil-based wax, and the like.

[0016] Examples of the synthetic oil include hydrocarbon synthetic oil, ether synthetic oil, etc. As examples of the hydrocarbon synthetic oil, there are mentioned α -olefin oligomers such as polybutene, polyisobutylene, 1-octene oligomer, 1-decene oligomer, ethylene-propylene copolymer, etc. and hydrides thereof; alkylbenzene, alkylnaphthalene, etc. Examples of the ether synthetic oil include polyoxyalkylene glycol, polyphenyl ether, etc.

[0017] As the base oil, one alone of the above-mentioned mineral oil and/or the above-mentioned synthetic oil may be used, or two or more of them may be used. Further, a combination of at least one mineral oil and at least one synthetic oil may be used.

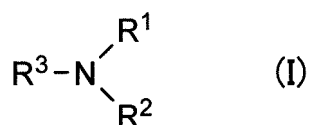
[0018] As the base oil, preferred is a mineral oil among the above, from the viewpoint of the solubility of additives therein.

[0019] The kinematic viscosity of the base oil is not specifically limited. However, in the case where the lubricating oil composition for a shock absorber of the present invention is used as a shock absorber oil for cars for example, the kinematic viscosity at 40°C thereof is preferably from 2 to 20 mm²/s, more preferably from 5 to 14 mm²/s. In the case where two or more of mineral oil and/or synthetic oil are used, the above numerical values mean the kinematic viscosity of the base oil of the mixture thereof.

[0020] The content ratio of the base oil (A) in the total amount of the lubricating oil composition for a shock absorber is preferably from 80 to 99% by mass, more preferably from 90 to 98% by mass.

[(B) Tertiary Amine]

[0021] The tertiary amine for use in the lubricating oil composition for a shock absorber of the present invention is represented by the following general formula (I).



[0022] In the general formula (I), R¹ and R² each independently represent an aliphatic hydrocarbon group having from

1 to 5 carbon atoms, and R^3 represents an aliphatic hydrocarbon group having from 12 to 24 carbon atoms.

[0023] In the general formula (I), preferably, R^1 and R^2 each independently represent a linear, branched or cyclic alkyl group having from 1 to 5 carbon atoms or a linear, branched or cyclic alkenyl group having from 1 to 5 carbon atoms. R^1 and R^2 may be different from each other or may be the same, but preferably, the two are the same. R^3 is preferably a linear, branched or cyclic alkyl group having from 12 to 24 carbon atoms or a linear, branched or cyclic alkenyl group having from 12 to 24 carbon atoms.

[0024] In the present invention, when the carbon number of R^1 and R^2 were larger than 5, in particular, the friction coefficient to bronze could not be sufficiently lowered. From this viewpoint, the carbon number of R^1 and R^2 is preferably smaller, and each carbon number is preferably 1 or 2, and each carbon number is most preferably 1. From the viewpoint of enhancing the stability and further reducing the friction coefficient, more preferably, R^1 and R^2 each are an alkyl group.

[0025] Specifically, examples of R^1 and R^2 include a methyl group, an ethyl group, a propyl group, a butyl group, a pentyl group, a vinyl group, a propenyl group, a butenyl group and a pentenyl group, and these may be linear, branched or cyclic. Among these, preferred are a methyl group and an ethyl group, and most preferred is a methyl group.

[0026] When the carbon number of R^3 in the tertiary amine (B) falls outside the above-mentioned range, there might occur some disadvantages that for example the solubility in base oil worsens, or the friction coefficient to bronze could not be sufficiently lowered. From these viewpoints, the carbon number of R^3 is preferably from 16 to 20, more preferably 18.

[0027] Regarding the tertiary amine (B), the main component thereof is preferably a tertiary amine where R^3 has from 16 to 20 carbon atoms, and is more preferably a tertiary amine where the carbon number of the group is 18. The wording "the main component" means that the component is 50% by mass or more of the total amount of the tertiary amine (B), and the content ratio is preferably 80% by mass or more, more preferably 90% by mass or more.

[0028] For enhancing the stability and further lowering the friction coefficient, R^3 is preferably an alkyl group. Moreover, R^3 is preferably linear.

[0029] Examples of the alkyl group of R^3 include a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, a heptadecyl group, an octadecyl group, a nonadecyl group, an eicosyl group, a heneicosyl group, a docosyl group, a tricosyl group, and a tetracosyl group, and these may be linear, branched or cyclic. Examples of the alkenyl group include a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, a heptadecenyl group, an octadecenyl group, a nonadecenyl group, an eicosenyl group, a heneicosenyl group, a docosenyl group, a tricosenyl group and a tetracosenyl group, and these may be linear, branched or cyclic, and in these, the double bond may be at any position.

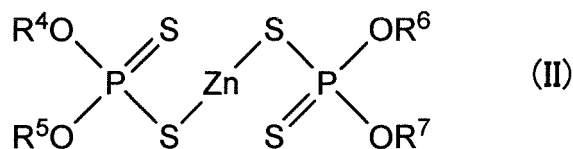
[0030] Of those, preferred are a hexadecyl group, an octadecyl group such as a stearyl group, an octadecenyl group such as an oleyl group, an eicosyl group, etc., and most preferred is a stearyl group.

[0031] Preferred specific compounds of the tertiary amine (B) include dimethylmonostearylamine, diethylstearylamine, etc.

[0032] Preferably, the tertiary amine (B) is contained in an amount of from 0.01 to 3% by mass relative to the total amount of the lubricating oil composition for a shock absorber. Falling within the range, the tertiary amine can reduce the friction coefficient for bronze with the suitable amount. From this viewpoint, more preferably, the tertiary amine is contained in an amount of from 0.1 to 1.5% by mass relative to the total amount of the lubricating oil composition for a shock absorber.

[(C) Zinc Dithiophosphate]

[0033] The zinc dithiophosphate for use in the present invention is represented by the following general formula (II).



[0034] In the general formula (II), R^4 to R^7 each independently represent a linear, branched or cyclic alkyl group having from 1 to 24 carbon atoms or a linear, branched or cyclic alkenyl group having from 1 to 24 carbon atoms. These may be different from each other or may be the same, but from the viewpoint of easiness in production, these are preferably the same.

[0035] In the present invention, use of the zinc dithiophosphate along with the tertiary amine can favorably lower the friction coefficient of the lubricating oil composition to bronze and rubber.

[0036] In the general formula (II), the carbon number of R^4 to R^7 is preferably from 10 to 20, more preferably from 12 to 18. When the carbon number in the zinc dithiophosphate is limited to fall within the range, in particular, the friction coefficient for rubber can be effectively reduced.

[0037] Also preferably, R^4 to R^7 are linear, and preferably R^4 to R^7 each are an alkyl group.

[0038] Examples of the alkyl group of R^4 to R^7 include a methyl group, an ethyl group, a propyl group, a butyl group, a pentyl group, a hexyl group, a heptyl group, an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, a heptadecyl group, an octadecyl group, a nonadecyl group, an eicosyl group, a heneicosyl group, a docosyl group, a tricosyl group and a tetracosyl group, and these may be any of linear, branched or cyclic ones. Examples of the alkenyl group include a vinyl group, a propenyl group, a butenyl group, a pentenyl group, a hexenyl group, a heptenyl group, an octenyl group, a nonenyl group, a decenyl group, an undecenyl group, a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, a heptadecenyl group, an octadecenyl group, a nonadecenyl group, an eicosenyl group, a heneicosenyl group, a docosenyl group, a tricosenyl group and a tetracosenyl group, and these may be any of linear, branched or cyclic ones, and the double bond may be at any position therein.

[0039] Of those, preferred are a dodecyl group such as a lauryl group, a tetradecyl group, a hexadecyl group, an octadecyl group such as a stearyl group, an eicosyl group, an octadecenyl group such as an oleyl group, and most preferred is a lauryl group.

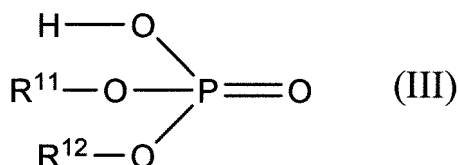
[0040] Preferably, the zinc dithiophosphate (C) is contained in an amount of from 0.01 to 3% by mass relative to the total amount of the lubricating oil composition for a shock absorber. Falling within the above range, the zinc dithiophosphate (C) can reduce the friction to bronze and rubber with the suitable amount. From this viewpoint, more preferably, the zinc dithiophosphate (C) is contained in an amount of from 0.1 to 1.5% by mass relative to the total amount of the lubricating oil composition for a shock absorber.

[(D) Phosphorus Acid Ester Amine Salt]

[0041] Examples of the phosphorus acid ester amine salt (D) include an acidic phosphoric acid ester amine salt obtained by reacting an acidic phosphoric acid ester and an amine, and/or an acidic phosphorous acid ester amine salt obtained by reacting an acidic phosphorous acid ester and an amine. In the present invention, preferred is an acidic phosphoric acid ester amine salt.

[0042] In the present invention, the phosphorus acid ester amine salt (D) has a function as a so-called extreme-pressure agent, and can better wear-resistant properties while preventing burning out. Incidentally, even in long-term storage, the phosphorus acid ester amine salt (D) does not react with, for example, the zinc dithiophosphate (C) to generate precipitates.

[0043] As the acidic phosphoric acid esters, for example, those represented by the following general formula (III) are used.



[0044] In the general formula (III), R^{11} represents a hydrogen atom, an alkyl group having from 8 to 24 carbon atoms or an alkenyl group having from 8 to 24 carbon atoms. Of those, preferred is an alkyl group or an alkenyl group. R^{12} represents an alkyl group having from 8 to 24 carbon atoms or an alkenyl group having from 8 to 24 carbon atoms.

[0045] The alkyl group and the alkenyl group of R^{11} and R^{12} may be linear, branched or cyclic, but are preferably linear. Further, the alkyl group and the alkenyl group of R^{11} and R^{12} each preferably have from 12 to 24 carbon atoms, more preferably from 16 to 20 carbon atoms, and even more preferably, one or both of R^{11} and R^{12} have 18 carbon atoms.

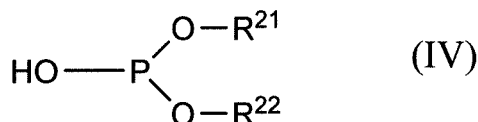
[0046] The main component of the acidic phosphoric acid ester to constitute the amine salt (D) is preferably one where R^{11} and R^{12} have from 16 to 20 carbon atoms, more preferably one where R^{11} and R^{12} have 18 carbon atoms. The wording "the main component" means that the content ratio of R^{11} and R^{12} having from 16 to 20 carbon atoms (or 18 carbon atoms) in the total amount of the alkyl group and the alkenyl group of R^{11} and R^{12} in the acidic phosphoric acid ester to constitute the amine salt (D) is 50% by mass or more, and the content ratio is preferably 80% by mass or more, more preferably 90% by mass or more.

[0047] Examples of the alkyl group of R^{11} and R^{12} include an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, a heptadecyl group, an octadecyl group, a nonadecyl group, an eicosyl group, a heneicosyl group, a docosyl group, a tricosyl group and a tetracosyl group, and these may be any of linear, branched or cyclic ones. Examples of the alkenyl group include an octenyl group, a nonenyl group, a decenyl group, an undecenyl group, a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, a heptadecenyl group, an octadecenyl group, a nonadecenyl

group, an eicosenyl group, a heneicosenyl group, a docosenyl group, a tricosenyl group and a tetracosenyl group, and these may be any of linear, branched or cyclic ones, and the double bond may be at any position therein.

[0048] Of those, preferred is a linear alkyl or alkenyl group, and most preferred is an octadecenyl group such as an oleyl group. A specific example of the acidic phosphoric acid ester is dioleil acid phosphate.

[0049] As the acidic phosphorous acid esters, for example, those represented by the following general formula (IV) are used.



[0050] In the general formula (IV), R^{21} represents a hydrogen atom, an alkyl group having from 8 to 24 carbon atoms or an alkenyl group having from 8 to 24 carbon atoms. Of those, preferred is an alkyl group or an alkenyl group. R^{22} represents an alkyl group having from 8 to 24 carbon atoms or an alkenyl group having from 8 to 24 carbon atoms.

[0051] The alkyl group and the alkenyl group of R^{21} and R^{22} may be linear, branched or cyclic, but are preferably linear. Further, the alkyl group and the alkenyl group of R^{21} and R^{22} preferably have from 12 to 24 carbon atoms, more preferably from 16 to 20 carbon atoms. Even more preferably one or both of R^{21} and R^{22} have 18 carbon atoms.

[0052] The main component of the acidic phosphorous acid ester to constitute the amine salt (D) is preferably one where R^{21} and R^{22} have from 16 to 20 carbon atoms, more preferably one where R^{21} and R^{22} have 18 carbon atoms. The wording "the main component" means that the content ratio of R^{21} and R^{22} having from 16 to 20 carbon atoms (or 18 carbon atoms) in the total amount of the alkyl group and the alkenyl group of R^{21} and R^{22} in the acidic phosphorous acid ester to constitute the amine salt (D) is 50% by mass or more, and the content ratio is preferably 80% by mass or more, more preferably 90% by mass or more.

[0053] Examples of the alkyl group of R^{21} and R^{22} include an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, a heptadecyl group, an octadecyl group, a nonadecyl group, an eicosyl group, a heneicosyl group, a docosyl group, a tricosyl group and a tetracosyl group, and these may be any of linear, branched or cyclic ones. Examples of the alkenyl group include an octenyl group, a nonenyl group, a decenyl group, an undecenyl group, a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, a heptadecenyl group, an octadecenyl group, a nonadecenyl group, an eicosenyl group, a heneicosenyl group, a docosenyl group, a tricosenyl group and a tetracosenyl group, and these may be any of linear, branched or cyclic ones, and the double bond may be at any position therein.

[0054] The amine to form the phosphorus acid ester amine salt may be any of primary amines, secondary amines and tertiary amines, and preferred are primary amines. The amine is represented by a general formula NR_3 , in which, preferably, from one to three of R's each are an aliphatic hydrocarbon group, and the remainder is a hydrogen atom. Here, the aliphatic hydrocarbon group is preferably an alkyl group or an unsaturated hydrocarbon group having from 1 to 2 unsaturated bonds. The alkyl group and the unsaturated hydrocarbon group may be linear, branched or cyclic, but are preferably linear.

[0055] Of the total amount of the aliphatic hydrocarbon group constituting the amine, preferably, 80% by mass or more is an alkyl group and/or an unsaturated hydrocarbon group having one unsaturated bond.

[0056] When the phosphorus acid ester amine salt is liquid at room temperature (25°C), it is preferred from the viewpoint of the solubility in base oil and the viewpoint of preventing precipitation at low temperatures. For this, the carbon number of the above aliphatic hydrocarbon group is preferably from 6 to 20, more preferably from 12 to 20.

[0057] Examples of the amine include dilaurylamine, dimyristylamine, distearylamine, dioleilamine, trilaurylamine, trimyristylamine, tristearylamine, trioleylamine, tallow amine, etc.

[0058] One alone or two or more of these alkyl amines may be used either singly or as combined.

[0059] The content of the phosphorus acid ester amine salt (D) is preferably from 0.1 to 3% by mass relative to the total amount of the lubricating oil composition for a shock absorber, more preferably from 0.2 to 1% by mass.

[0060] Preferably, the component (D) is, after prepared as a phosphorus acid ester amine salt, mixed with the other components to produce the lubricating oil composition for a shock absorber, but a phosphorus acid ester and an amine may be separately blended in the composition and reacted in the composition to form the amine salt.

[0061] In the lubricating oil composition for a shock absorber of the present invention, the total amount of the acidic phosphoric acid ester and the acidic phosphorous acid ester not forming the amine salt is preferably less than 0.05% by mass, more preferably less than 0.01% by mass, and even more preferably, these are not contained in the lubricating oil composition for a shock absorber.

[0062] The acidic phosphoric acid ester and the acidic phosphorous acid ester not forming the amine salt may react with the zinc dithiophosphate (C) to generate precipitate during long-term storage, but when the amount thereof is

restricted to less than 0.05% by mass or so, precipitates hardly generate.

[Optional Additive Component]

[0063] The lubricating oil composition for a shock absorber of the present invention can suitably contain, as an optional additive component (E), at least one selected from ash-less dispersants, friction regulators, antioxidants, viscosity index improvers and antifoaming agents, within a range not detracting from the object of the present invention. Also if desired, this may contain any other additives heretofore generally used in lubricating oil compositions for a shock absorber, such as metal-based detergents, rust preventive agents, metal deactivators, pour-point depressants, etc.

[0064] The content ratio of the optional additive component (E) in the total amount of the lubricating oil composition for a shock absorber is, in general, preferably 10% by mass or less, more preferably from 3 to 8% by mass.

[0065] Examples of the ash-less dispersant include succinimides, boron-containing succinimides, benzylamines, boron-containing benzylamines, succinates, amides of mono or dicarboxylic acids typified by fatty acid or succinic acid. Of those, preferred are fatty acid amides.

[0066] Examples of the friction regulator include partial ester compounds to be obtained through reaction of a fatty acid and an aliphatic polyalcohol. In the partial ester compounds, the fatty acid is preferably a fatty acid having a linear or branched hydrocarbon group with from 6 to 30 carbon atoms, in which the carbon number of the hydrocarbon group is preferably from 8 to 24, more preferably from 10 to 20. Examples of the fatty acid include saturated fatty acids such as caproic acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, arachic acid, behenic acid, lignoceric acid, etc.; and unsaturated fatty acids such as myristoleic acid, palmitoleic acid, oleic acid, linoleic acid, etc.; and preferred is oleic acid. The aliphatic polyalcohol is a di- to hexa-alcohol, including ethylene glycol, glycerin, trimethylolpropane, pentaerythritol, sorbitol, sorbitan, etc. Preferred is sorbitan. One alone or two or more of these partial ester compounds may be used either singly or as combined.

[0067] In addition, aliphatic saturated monoamines and unsaturated monoamines having from 10 to 20 carbon atoms or so such as stearylamine, oleylamine, etc., are also preferably usable as the friction regulator.

[0068] Examples of the antioxidant include monocyclic phenolic antioxidants such as 2,6-di-tert-butyl-p-cresol, 2,6-di-tert-butyl-4-ethylphenol, etc.; polycyclic phenolic antioxidants such as 4,4'-methylenebis(2,6-di-tert-butylphenol), 2,2'-methylenebis(4-ethyl-6-tert-butylphenol), etc.; amine-based antioxidants including monoalkyldiphenylamine compounds such as monoctyldiphenylamine, monononyldiphenylamine, etc., dialkyldiphenylamine compounds such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine, 4,4'-dinonyldiphenylamine, etc., polyalkyldiphenylamine compounds such as tetrabutyldiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine, tetranonyldiphenylamine, etc., and naphthylamine compounds such as α -naphthylamine, phenyl- α -naphthylamine, butylphenyl- α -naphthylamine, pentylphenyl- α -naphthylamine, hexylphenyl- α -naphthylamine, heptylphenyl- α -naphthylamine, octylphenyl- α -naphthylamine, nonylphenyl- α -naphthylamine, etc.; and sulfur-containing antioxidants such as 2,6-di-tert-butyl-4-(4,6-bis(octylthio)-1,3,5-triazin-2-ylamino)phenol, thioterpene compounds including a reaction product of phosphorus pentasulfide and pinene, etc., dialkyl thiodipropionates including dilauroyl thiodipropionate, distearyl thiodipropionate, etc. Among those, preferred are monocyclic phenolic antioxidants from the viewpoint of improving sludge resistance.

[0069] Examples of the viscosity index improver include polymethacrylate, dispersive polymethacrylate, olefinic copolymer (for example, ethylene-propylene copolymer, etc.), dispersive olefinic copolymer, styrenic copolymer (for example, styrene-diene hydrogenated copolymer, etc.), etc. Preferred is polymethacrylate.

[0070] As the antifoaming agent, preferred are high-molecular-weight silicone antifoaming agents. With containing the high-molecular-weight silicone antifoaming agent, the antifoaming ability is effectively demonstrated. As the high-molecular-weight silicone antifoaming agent, for example, organopolysiloxane and fluorinated organopolysiloxanes such as trifluoropropylmethyl silicone oil and the like are mentioned.

[0071] Examples of the metal-based detergent include neutral metal sulfonates, neutral metal phenates, neutral metal salicylates, neutral metal phosphonates, basic sulfonates, basic phenates, basic salicylates, overbased sulfonates, overbased salicylates, overbased phosphonates, etc. Examples of the rust preventive agent include metal-typed sulfonates, succinates, etc. Examples of the metal deactivator include benzotriazole, thiadiazole, etc. Examples of the pour-point depressant include polymethacrylate having a weight-average molecular weight of from 50,000 to 150,000 or so, etc.

[0072] The kinematic viscosity at 40°C of the lubricating oil composition for a shock absorber of the present invention is, from the viewpoint of low-temperature flow ability, preferably 18 mm²/s or less, more preferably from 2 to 15 mm²/s.

[0073] With containing the tertiary amine (B) and the zinc dithiophosphate (C), the lubricating oil composition of the present invention can reduce the friction coefficient to bronze and rubber. In addition, with containing the phosphorus acid ester amine salt (D) as an extreme-pressure agent, the oil composition can better wear-resistant properties and burning-out resistance, and is therefore favorable as a lubricating oil composition for a shock absorber. Further, in the present invention, the extreme-pressure agent is the phosphorus acid ester amine salt (D), which does not react with, for example, the zinc dithiophosphate (C) to generate precipitates.

[0074] Regarding the lubricating oil composition for a shock absorber of the present invention, the friction coefficient μ to rubber is preferably less than 0.09 under a load of from 1 to 3 kgf, and is preferably less than 0.08 under a load of from 5 to 7 kgf or so. The friction coefficient μ to bronze is preferably less than 0.18 under a load of 1 kg or so, preferably less than 0.20 under a load of from 2 to 3 kgf, and preferably less than 0.28 under a load of from 5 to 7 kgf.

[0075] In the present invention, when the friction coefficient μ to rubber and bronze falls within the above range, a riding comfort performance is bettered. The friction coefficient μ is measured according to the method to be mentioned below.

[0076] The lubricating oil composition for a shock absorber of the present invention can be used in any of a multi-cylinder shock absorber and a single-cylinder shock absorber, and can be used in any shock absorbers for cars and motorcycles. Especially preferred is use for cars.

[0077] In addition, the lubricating oil composition for a shock absorber of the present invention is especially favorably used in a shock absorber having a bush whose inner wall being the slide face to a piston rod is at least formed of bronze such as phosphor bronze or the like and having an oil seal that is formed of rubber. In particular, this is further favorable for those in which the tightening force of the oil seal is increased to improve the dust resistance.

[0078] The slide face of the piston rod to the bush is generally formed of chromium, for example, by chromium plating or the like.

[0079] Further, the lubricating oil composition for a shock absorber of the present invention can be also favorably used as a hydraulic oil for industrial use, a hydraulic oil for construction use, etc.

Examples

[0080] Next, the present invention is described in more detail by Examples, but the present invention is not whatsoever restricted by these Examples.

[0081] Evaluations of physical properties in the present invention were carried out according to the following methods.

[Evaluation Methods]

1. Kinematic Viscosity

[0082] Measured according to JIS K2283.

2. Friction Coefficient to Rubber

[0083] Using a Bowden type reciprocating friction tester, the friction coefficient μ to rubber was measured under the following test conditions. In Table 1, this is expressed as "rubber μ ".

Temperature: 23°C (room temperature)

Rate: 0.3 mm/s

Amplitude: 10 mm

Test piece: NBR/chromium-plated plate (50 × 1,000 × 5 mm)

Load: any of 1 kgf, 2 kgf, 3 kgf, 5 kgf or 7 kgf

[0084] For the rubber (NBR), a rubber plate was cut into a disc having a diameter of 15 mm, and pushed out by a ball having a diameter of 12.7 mm. A few drops of a sample oil were put onto the plate, running-in operation (at a rate of 20 mm/s for 2 minutes) was performed, and then the test was performed.

3. Friction Coefficient μ to Bronze

[0085] Using a Bowden type reciprocating friction tester, the friction coefficient μ to bronze was measured under the following test conditions. In Table 1, this is expressed as "bronze μ ".

Temperature: 23°C (room temperature)

Rate: 0.3 mm/s

Amplitude: 10 mm

Test piece: phosphor bronze ball (ball having a diameter 12.7 mm)/chromium-plated plate (50 × 1,000 × 5 mm)

Load: any of 1 kgf, 2 kgf, 3 kgf, 5 kgf or 7 kgf

[0086] A few drops of a sample oil were put onto the plate, running-in operation (at a rate of 20 mm/s for 2 minutes)

was performed, and then the test was performed.

4. Storage Test

- 5 **[0087]** The prepared lubricating oil composition for a shock absorber was put in an airtight container and kept therein in an environment at 23°C (room temperature) for 30 days, and then the appearance thereof was observed.

Examples 1 to 3 and Comparative Examples 1 to 5

- 10 **[0088]** As shown in Table 1, lubricating oil compositions for a shock absorber of Examples 1 to 3 and Comparative Examples 1 to 5 were prepared, and tested for measuring the friction coefficient to rubber and bronze, and tested in the storage test.

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Table 1

	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
(A) Mineral Oil 1	79.55	79.55	79.55	80.05	80.02	80.05	79.55	79.55
(A) Mineral Oil 2	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
(B) Tertiary Amine 1	0.50	-	0.50	-	0.50	-	0.50	0.50
(B) Tertiary Amine 2	-	0.50	-	-	-	-	-	-
(C) Zinc Dithiophosphate 1	0.80	0.80	-	0.80	-	-	0.80	0.80
(C) Zinc Dithiophosphate 2	-	-	0.80	-	-	-	-	-
(C) Zinc Dithiophosphate 3	-	-	-	-	-	0.80	-	-
(D) Extreme-Pressure Agent 1	0.50	0.50	0.50	0.50	0.10	0.50	-	-
Extreme-Pressure Agent 2	-	-	-	-	0.30	-	0.50	-
Extreme-Pressure Agent 3	-	-	-	-	-	-	-	0.50
Extreme-Pressure Agent 4	-	-	-	-	0.50	-	-	-
Extreme-Pressure Agent 5	-	-	-	-	0.20	-	-	-
Antioxidant	0.30	0.30	0.30	0.30	0.20	0.30	0.30	0.30
Ashless Dispersant	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Friction Regulator 1	0.50	0.50	0.50	0.50	-	0.50	0.50	0.50
Friction Regulator 2	0.05	0.05	0.05	0.05	0.01	0.05	0.05	0.05

Lubricating Oil Composition

(continued)

	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Friction Regulator 3	-	-	-	-	0.30	-	-	-
Metal Deactivator	-	-	-	-	0.02	-	-	-
Antifoaming Agent	0.10	0.10	0.10	0.10	0.15	0.10	0.10	0.10
Viscosity Index Improver	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
40°C Kinematic Viscosity of Mixed Base Oil	8.54	8.54	8.54	8.54	8.54	8.54	8.54	8.54
40°C Kinematic Viscosity of Composition	11.2	11.3	11.1	11.3	11.7	11.3	11.4	11.3
Rubber μ load 1 kgf	0.078	0.079	0.081	0.084	0.063	0.106	-	-
Rubber μ load 2 kgf	0.080	0.081	0.082	0.081	0.059	0.098	-	-
Rubber μ load 3 kgf	0.080	0.082	0.081	0.076	0.062	0.094	-	-
Rubber μ load 5 kgf	0.068	0.072	0.073	0.068	0.062	0.086	-	-
Rubber μ load 7 kgf	0.065	0.070	0.072	0.062	0.061	0.080	-	-
Bronze μ load 1 kgf	0.161	0.165	0.169	0.196	0.274	0.253	-	-
Bronze μ load 2 kgf	0.180	0.185	0.186	0.233	0.225	0.285	-	-
Bronze μ load 3 kgf	0.159	0.168	0.176	0.254	0.249	0.309	-	-
Bronze μ load 5 kgf	0.262	0.276	0.277	0.298	0.321	0.247	-	-
Bronze μ load 7 kgf	0.247	0.262	0.270	0.255	0.365	0.249	-	-
Storage Test	good	good	good	good	good	good	precipitated	precipitated
* In Table 1, "-" means "not blended" or "not measured".								

* Materials in Table 1 are as follows.

[0089]

- 5 Mineral oil 1: paraffinic mineral oil, 40°C kinematic viscosity: 7.117 mm²/s, viscosity index: 109, density (15°C): 0.8200 g/cm³.
Mineral oil 2: paraffinic mineral oil, 40°C kinematic viscosity: 29.48 mm²/s, viscosity index: 131, density (15°C): 0.8399 g/cm³.
- 10 **[0090]** The viscosity of the base oil prepared by mixing the base oil 1 and the base oil 2 in each of Examples and Comparative Examples is as shown in the Table.
- Tertiary amine 1: dimethylmonostearylamine.
Tertiary amine 2: diethylmonostearylamine.
- 15 Zinc dithiophosphate 1: zinc dilauryldithiophosphate of the general formula (II) where R⁴ to R⁷ are all lauryl groups.
Zinc dithiophosphate 2: zinc dioleyldithiophosphate of the general formula (II) where R⁴ to R⁷ are all oleyl groups.
Zinc dithiophosphate 3: zinc dithiophosphate of the general formula (II) where R⁴ to R⁷ are a mixture of n-hexyl group, isopropyl group and n-butyl group.
- 20 Extreme-pressure agent 1: amine salt of dioleoyl acid phosphate of the formula (III) where R¹¹ and R¹² are oleyl groups (acidic phosphoric acid ester amine salt). As the amine, tallow amine was used.
Extreme-pressure agent 2: dilauryl hydrogenphosphite (phosphorous acid ester).
Extreme-pressure agent 3: dioleoyl acid phosphate (acidic phosphoric acid ester).
Extreme-pressure agent 4: ethyl-3-[[bis(1-methylethoxy)phosphinothioyl]thio] propionate (dithiophosphate).
Extreme-pressure agent 5: tricresyl phosphate (TCP).
- 25 Antioxidant: 2,6-di-tert-butyl-p-cresol (DBPC).
Ashless dispersant: fatty acid amide (reaction product of isostearic acid and tetraethylenepentamine).
Friction regulator 1: sorbitan monooleate.
Friction regulator 2: monooleylamine.
Friction regulator 3: glycerin partial ester
- 30 Metal deactivator: thiadiazole compound (2,5-bis(1,1,3,3-tetramethylbutanedithio)1,3,4-thiadiazole).
Antifoaming agent: silicone antifoaming agent (dimethylpolysiloxane, 20°C kinematic viscosity = 12500 cSt).
Viscosity index improver: polymethacrylate compound (PMA, Mw = 140,000).

35 **[0091]** As obvious from Examples 1 to 3, with containing the tertiary amine (B) and the zinc dithiophosphate (C), the lubricating oil compositions for a shock absorber can sufficiently reduce the friction coefficient to rubber and bronze in a broad load range. In addition, since the extreme-pressure agent composed of the phosphorus acid ester amine salt (D) was blended, the oil composition did not generate any precipitate in storage for 1 month, and the long-term storage stability thereof is good.

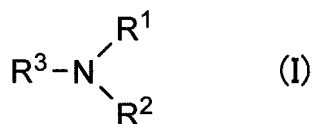
40 **[0092]** On the other hand, as shown in Comparative Examples 1 to 3, the lubricating oil compositions for a shock absorber not containing any one or both of the tertiary amine (B) and the zinc dithiophosphate (C) could not sufficiently lower the friction coefficient to rubber and bronze in a broad load range. In addition, as shown in Comparative Examples 4 and 5, when a phosphoric acid ester or a phosphorous acid ester was used as the extreme-pressure agent along with the zinc dithiophosphate, the composition generated precipitates after 1 month, and the long-term storage stability thereof was not good.

Industrial Applicability

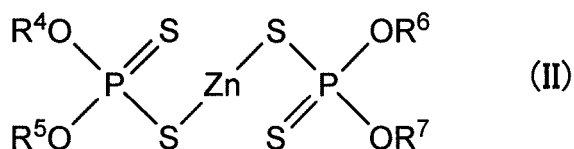
45 **[0093]** The lubricating oil composition for a shock absorber of the present invention can be used in various shock absorbers, and for example, can be favorably used in both a multi-cylinder shock absorber and a single-cylinder shock absorber, and in addition, can be used in shock absorbers for both cars and motorcycles. Especially preferred is use for cars.

Claims

- 55 1. A lubricating oil composition for a shock absorber, comprising (A) a base oil composed of a mineral oil and/or a synthetic oil, (B) a tertiary amine represented by the following general formula (I), (C) a zinc dithiophosphate represented by the following general formula (II), and (D) a phosphorus acid ester amine salt,

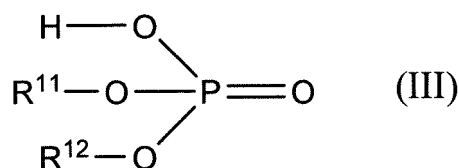


wherein R¹ and R² each independently represent an aliphatic hydrocarbon group having from 1 to 5 carbon atoms, and R³ represents an aliphatic hydrocarbon group having from 12 to 24 carbon atoms in the general formula (I),



wherein R⁴ to R⁷ each independently represent one selected from a linear, branched or cyclic alkyl group having from 1 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 1 to 24 carbon atoms in the general formula (II).

2. The lubricating oil composition for a shock absorber according to claim 1, wherein R¹ and R² each are independently selected from a linear, branched or cyclic alkyl group having from 1 to 5 carbon atoms and a linear, branched or cyclic alkenyl group having from 1 to 5 carbon atoms, and R³ is selected from a linear, branched or cyclic alkyl group having from 12 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 12 to 24 carbon atoms in the general formula (I).
3. The lubricating oil composition for a shock absorber according to claim 2, wherein R³ in the general formula (I) is a linear, branched or cyclic alkyl group having from 16 to 20 carbon atoms.
4. The lubricating oil composition for a shock absorber according to claim 3, wherein R³ in the general formula (I) is a stearyl group.
5. The lubricating oil composition for a shock absorber according to any of claims 1 to 4, wherein R⁴ to R⁷ in the general formula (II) each are independently one selected from a linear, branched or cyclic alkyl group having from 10 to 20 carbon atoms and a linear, branched or cyclic alkenyl group having from 10 to 20 carbon atoms.
6. The lubricating oil composition for a shock absorber according to any of claims 1 to 5, wherein the phosphorus acid ester amine salt (D) is an amine salt of an acidic phosphoric acid ester represented by the following general formula (III):



wherein R¹¹ is selected from a hydrogen atom, a linear, branched or cyclic alkyl group having from 8 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 8 to 24 carbon atoms, and R¹² is selected from a linear, branched or cyclic alkyl group having from 8 to 24 carbon atoms and a linear, branched or cyclic alkenyl group having from 8 to 24 carbon atoms in the general formula (III).

7. The lubricating oil composition for a shock absorber according to claim 6, wherein R¹¹ and R¹² in the general formula (III) each are independently an alkyl group having from 16 to 20 carbon atoms or an alkenyl group having from 16 to 20 carbon atoms.
8. The lubricating oil composition for a shock absorber according to any of claims 1 to 7, which comprises from 0.01 to 3% by mass of the tertiary amine (B).

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9. The lubricating oil composition for a shock absorber according to any of claims 1 to 8, which comprises from 0.01 to 3% by mass of the zinc dithiophosphate (C).
- 5 10. The lubricating oil composition for a shock absorber according to any of claims 1 to 9, which is a lubricating oil composition for a shock absorber for cars.
11. The lubricating oil composition for a shock absorber according to any of claims 1 to 10, wherein R¹ and R² in the general formula (I) each have 1 or 2 carbon atoms.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/072187

A. CLASSIFICATION OF SUBJECT MATTER

C10M141/10(2006.01)i, C10M133/06(2006.01)n, C10M137/08(2006.01)n,
C10M137/10(2006.01)n, C10N30/04(2006.01)n, C10N30/06(2006.01)n, C10N40/06
(2006.01)n

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10M141/10, C10M133/06, C10M137/08, C10M137/10, C10N30/04, C10N30/06,
C10N40/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CAplus/REGISTRY (STN)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 5-255682 A (Tonen Corp.), 05 October 1993 (05.10.1993), paragraphs [0008] to [0048] (particularly, examples 2, 6 to 8) (Family: none)	1-11
Y	JP 5-331478 A (Tonen Corp.), 14 December 1993 (14.12.1993), paragraphs [0016] to [0019], [0026], [0031]; example 1 (Family: none)	1-11

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search

14 October, 2014 (14.10.14)

Date of mailing of the international search report

28 October, 2014 (28.10.14)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/072187

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 2009/008327 A1 (Idemitsu Kosan Co., Ltd.), 15 January 2009 (15.01.2009), claims; examples & JP 2009-13380 A & EP 2169037 A1 & CN 101688146 A	1-11
A	WO 2008/038667 A1 (Idemitsu Kosan Co., Ltd.), 03 April 2008 (03.04.2008), claims; examples & JP 5280851 B & US 2010/0075877 A1 & EP 2067845 A1 & CN 101517055 A	1-11
A	JP 5-255683 A (Tonen Corp.), 05 October 1993 (05.10.1993), claims; examples (Family: none)	1-11

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REFERENCES CITED IN THE DESCRIPTION

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- WO 2011037054 A1 [0007]
- JP 2009013380 A [0007]