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(54) **LUBRICATING OIL COMPOSITION FOR BUFFERS**

(57) The present invention provides a lubricating oil composition for a shock absorber including: a base oil containing a mineral oil and/or a synthetic oil; (A) a phosphate compound and/or a phosphite compound having a hydrocarbon group having 2 to 18 carbon atoms; and (B) a secondary amine compound represented by the General Formula (I),



wherein R¹ and R² each represent an alkyl group having 1 to 18 carbon atoms, an alkenyl group having 2 to 18 carbon atoms, or a cycloalkane-containing group having 5 to 18 carbon atoms, and R¹ and R² may be the same or different from each other, or may be bonded to each other to form a cyclic structure having 3 to 6 carbon atoms with a nitrogen atom serving as a hetero atom. The lubricating oil composition for a shock absorber of the present invention can increase the friction force between seals and steel parts in the shock absorber of an automobile, improve the control stability when the car is driven at high speeds, and simultaneously improve the ride quality.

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Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a lubricating oil composition for a shock absorber. More specifically, the present invention relates to a lubricating oil composition for a shock absorber, which increases the friction force between a seal and a steel part in the shock absorber of an automobile, improves both control stability when the car is driven at high speed and ride quality, and, moreover, exhibits only slight increases in friction coefficient between the steel parts.

10 BACKGROUND ART

[0002] Lubricating oil for an automobile shock absorber is mainly used to suppress vibration because the oil exhibits a damping force suitable for the automobile and maintains control stability. Particularly in recent years, highway networks are available and cars are driven at high speed in higher blending amounts than ever before. Therefore, the demand is increasing for the automobile that demonstrates excellent performance in terms of high-speed stability and risk-aversion. However, the automobiles now available in our country pose a number of problems. For example, when the steering wheel is turned to change lanes at a rate of 100 to 200 km/h, unstable rolling occurs, thereby reducing the stability of the car body and the required distance for avoiding danger becomes long.

15 **[0003]** The results of studies show that the reasons for those problems reside in magnitude of the friction force at sliding portions such as the portion between an oil seal and a piston rod, the portion between a piston ring and a cylinder at the time when a shock absorber slightly oscillates. In high-speed driving operation, the oscillation is transferred to a tire, a spring, the shock absorber, and the car body, resulting in a state of slight vibration. In such a vibration state, the length of the stroke is usually about 0.4 to 2.0 mm, and the rate of repetition is about 1.5 to 15.0 Hz. Since, under such conditions, the damping force of the shock absorber is difficult to generate, the vibration control is not fully demonstrated. As a result, the friction force is small at the time when the sliding portions such as the portion between an oil seal and a piston rod, the portion between a piston ring and a cylinder start to slide, and the position of the car body easily inclines, which reduces the stability thereof.

20 **[0004]** Therefore, in order to solve the problems described above, the friction force of a lubricating oil for the shock absorber at the sliding portions such as the portion between the oil seal and the piston rod, the portion between the piston ring and the cylinder may be increased. However, merely increasing the friction force causes oil leakage due to wear of the oil seal, increased wear of the piston ring and the cylinder, and increased wear of the bearing and the rod. Therefore, it is required to increase the friction force at the sliding portions such as the portion between the oil seal and the piston rod, the portion between the piston ring and the cylinder without lowering wear-resistant properties. Further, it is empirically known that the ride quality is favorable when a μ_L/μ_H ratio of a friction coefficient " μ_L " at a specific low speed to a friction coefficient " μ_H " at a specific high speed is lower than 1. The friction coefficients are measured using a Bowden type reciprocating friction tester.

25 **[0005]** Disclosed as a lubricating oil composition suitable for a shock absorber of automobiles is a composition containing 0.1 to 1.0% by weight of dithiophosphate diester based on the total amount of the composition relative to lubricant base oil (see, e.g., Patent-Document 1). Moreover, disclosed as an lubricating oil composition for a shock absorber of automobiles is a composition containing (A) 0.05 to 0.3% by weight of amine salt of acid monophosphate, (B) 0.1 to 0.6% by weight of polyalkenylsuccinimide, and (C) 0.3 to 0.8% by weight of acid diphosphite based on the total amount of the composition relative to lubricant base oil (see, e.g., Patent Document 2).

30 In those lubricating oil compositions, the friction force between seals and steel parts is high, but the μ ratio is not prescribed. Further, disclosed is a hydraulic working fluid composition for a shock absorber, which is obtained by incorporating, in a lubricant base oil, [1] at least one nitrogen containing compound selected from (A) specific aliphatic primary amines and (B) succinimides each having a C_{8-30} hydrocarbon group and [2] at least one phosphorated compound selected from (C) phosphates each having a C_{3-10} branched hydrocarbon group and (D) phosphates each having a C_{6-18} (alkyl) aryl group (see, e.g., Patent Document 3). Such a technique of combining phosphorus compounds with nitrogen containing compounds has conventionally been used because of their stabilizing abilities and friction-force reducing abilities of phosphorus compounds. However, there are no descriptions about increasing the friction force and improving the μ ratio with respect to this hydraulic working fluid composition.

35 **[0006]**

Patent Document 1: JP 2003-55681 A

Patent Document 2: JP 2003-147379 A

Patent Document 3: JP 2002-194376 A

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

5 **[0007]** Under such circumstance, the present invention aims to provide a lubricating oil composition for a shock absorber, which increases the friction force between seals and steel parts in the shock absorber of an automobile, improves the control stability when the car is driven at high speeds and simultaneously improves the ride quality, and, moreover, exhibits only slight increase in friction force between steel parts.

10 MEANS FOR SOLVING THE PROBLEM

[0008] The inventors of the present invention have made an extensive research to develop a lubricating oil composition for a shock absorber, which has the above-mentioned desirable properties, and found that such composition described above can be obtained by incorporating, in a base oil, a specific phosphate compound and/or a phosphite compound and a specific secondary amine compound. The present invention has been accomplished based on this finding. The present invention provides:

(1) a lubricating oil composition for a shock absorber, including a base oil containing a mineral oil and/or a synthetic oil, (A) a phosphate compound and/or a phosphite compound having a hydrocarbon group having 2 to 18 carbon atoms, and (B) a secondary amine compound represented by General Formula (I),

[Chem 1]



wherein R^1 and R^2 each represent an alkyl group having 1 to 18 carbon atoms, an alkenyl group having 2 to 18 carbon atoms, or a cycloalkane-containing group having 5 to 18 carbon atoms, and R^1 and R^2 may be the same or different from each other, or may be bonded to each other to form a cyclic structure having 3 to 6 carbon atoms with a nitrogen atom serving as a hetero atom;

[0009] (2) a lubricating oil composition for a shock absorber according to Item (1), in which the phosphate compound having a hydrocarbon group having 2 to 18 carbon atoms is acid phosphate having one or two hydrocarbon groups;

(3) a lubricating oil composition for a shock absorber according to Item (1) or (2), in which the phosphite compound having a hydrocarbon group having 2 to 18 carbon atoms is acid diphosphite having two hydrocarbon groups;

(4) a lubricating oil composition for a shock absorber according to any one of Items (1) to (3), in which a blending amount of the phosphate compound and/or the phosphite compound (A) is 0.01 to 4% by mass based on a total amount of the composition;

(5) a lubricating oil composition for a shock absorber according to any one of Items (1) to (4), in which a blending amount of the secondary amine compound (B) is 0.05 to 5% by mass based on a total amount of the composition; and

(6) a lubricating oil composition for a shock absorber according to any one of Items (1) to (5), further including at least one member selected from an ash-less detergent-dispersant, a metal-based detergent, a lubricity improver, an antioxidant, a rust preventive agent, a metal deactivator, a viscosity index improver, a pour point depressant, and an antifoaming agent.

EFFECT OF THE INVENTION

[0010] The present invention can provide a lubricating oil composition for a shock absorber, which increases the friction force between seals and steel parts in the shock absorber of an automobile, improves the control stability when the car is driven at high speeds and simultaneously improves the ride quality, and, moreover, exhibits only slight increase in friction coefficient between steel parts.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011] A lubricating oil composition for a shock absorber of the present invention (hereinafter, may be simply referred to as lubricating oil composition) is developed for the purpose of increasing the control stability when the car is driven at high speeds and simultaneously improving the ride quality.

In order to improve the control stability when the car is driven at high speeds, it is important to increase the friction force between seals and steel parts. In order to improve the ride quality, it is preferable to adjust the μ_L/μ_H ratio of a friction coefficient " μ_L " at a rate as low as 1.0 mm/s to a friction coefficient " μ_H " at a rate as high as 3.0 mm/s to be lower than 1. The friction coefficients are measured using a Bowden type reciprocating friction tester. It is preferable to satisfy such conditions, and to reduce the friction coefficient between steel parts as low as possible without lowering the wear-resistant properties at sliding portions.

The lubricating oil composition of the present invention satisfies the above-mentioned requirements by incorporating as essential ingredients, in a base oil, (A) a phosphate compound and/or a phosphite compound having a hydrocarbon group having 2 to 18 carbon atoms and (B) a secondary amine compound with a specific configuration.

[0012] As a base oil in the lubricating oil composition of the present invention, a mineral oil and synthetic oil are usually used. There is no limitation on the types of the mineral oil and synthetic oil, and others, and mentioned as the mineral oil is, for example, paraffin-based mineral oil, intermediate-based mineral oil, or naphthene-based mineral oil obtained by usual refining processes such as solvent refining, hydrotreating, etc.

Mentioned as the synthetic oil are, for example, polybutene, polyolefine [α -olefin (co)polymer], various kinds of esters (e.g., polyol esters, dibasic acid esters, phosphates), various kinds of ethers (e.g., polyphenylethers), alkylbenzene, and alkyl naphthalene.

In the present invention, as the base oil, the above-mentioned mineral oils may be used alone or as a mixture of two or more members. Moreover, the above-mentioned synthetic oils may be used alone or as a mixture of two or more members. Further, a combination of at least one mineral oil and at least one synthetic oil may be used.

Since the lubricating oil composition of the present invention is mainly used as shock absorber fluid in automobiles mainly for passenger use, the viscosity of the base oil is preferably within the range of 2.0 to 15.0 mm²/s, and more preferably 4.0 to 9.0 mm²/s in terms of kinematic viscosity at 40°C.

[0013] In the lubricating oil composition of the present invention, the phosphate compound and/or phosphite compound which are used as the component (A) have a hydrocarbon group having 2 to 18 carbon atoms in the molecule. Mentioned as the hydrocarbon groups having 2 to 18 carbon atoms are alkyl groups having 2 to 18 carbon atoms and alkenyl groups having 2 to 18 carbon atoms, aryl groups having 6 to 18 carbon atoms, aralkyl groups having 7 to 18 carbon atoms, etc. The alkyl groups and alkenyl groups may be straight chain, branched, or cyclic. Examples of such alkyl groups and alkenyl groups include ethyl groups, n-propyl groups, isopropyl groups, n-butyl groups, isobutyl groups, sec-butyl groups, tert-butyl groups, various pentyl groups, various hexyl groups, various octyl groups, various decyl groups, various dodecyl groups, various tetradecyl groups, various hexadecyl groups, various octadecyl groups, cyclopentyl groups, cyclohexyl groups, aryl groups, propenyl groups, various butenyl groups, various hexenyl groups, various octenyl groups, various decenyl groups, various dodecenyl groups, various tetradecenyl groups, various hexadecenyl groups, various octadecenyl groups, cyclopentenyl groups, cyclohexenyl groups, etc.

Examples of the aryl group having 6 to 18 carbon atoms include phenyl groups, tolyl groups, xylyl groups, and naphthyl groups. Examples of the C₇₋₁₈ aralkyl group include benzyl groups, phenethyl groups, naphthylmethyl groups, methylbenzyl groups, methylphenethyl groups, and methylnaphthylmethyl groups.

[0014] As the phosphate compounds used in the present invention, acid monophosphate, acid diphosphate, and triphosphate can be mentioned, for example.

Examples of the acid monophosphate include monoethyl acid phosphate, mono-n-propyl acid phosphate, mono-n-butyl acid phosphate, mono-2-ethylhexyl acid phosphate, monolauryl acid phosphate, monomyristyl acid phosphate, monopalmityl acid phosphate, monostearyl acid phosphate, and monooleyl acid phosphate.

Examples of the acid diphosphate include di-n-butyl acid phosphate, di-2-ethylhexyl acid phosphate, didecyl acid phosphate, didodecyl acid phosphate (dilauryl acid phosphate), di(tridecyl) acid phosphate, dioctadecyl acid phosphate (distearyl acid phosphate), and di-9-octadecenyl acid phosphate (dioleyl acid phosphate).

[0015] Examples of a triphosphate include triaryl phosphate, trialkyl phosphate, trialkylaryl phosphate, triarylalkyl phosphate, and trialkenyl phosphate, for example, triphenyl phosphate, tricresyl phosphate, benzyldiphenyl phosphate, ethyldiphenyl phosphate, tributyl phosphate, ethyldibutyl phosphate, cresyldiphenyl phosphate, dicresylphenyl phosphate, ethylphenyldiphenyl phosphate, di(ethylphenyl)phenyl phosphate, propylphenyldiphenyl phosphate, di(propylphenyl)phenyl phosphate, triethylphenyl phosphate, tripropylphenyl phosphate, butylphenyldiphenyl phosphate, di(butylphenyl)phenyl phosphate, tributylphenyl phosphate, trihexyl phosphate, tri(2-ethylhexyl)phosphate, tridecyl phosphate, trilauryl phosphate, trimyristyl phosphate, tripalmityl phosphate, tristearyl phosphate, and trioleyl phosphate.

Of the above-mentioned phosphate compounds, acid monophosphate and acid diphosphate are preferable from the viewpoint of the performances and the like.

[0016] On the other hand, as the phosphite compound, acid diphosphite and triphosphite can be used, for example. Examples of the acidic diphosphite include di-n-butylhydrogen phosphite, di-2-ethylhexylhydrogen phosphite, didecylhydrogen phosphite, didodecylhydrogen phosphite (dilaurylhydrogen phosphite), dioctadecylhydrogen phosphite (distearylhydrogen phosphite), di-9-octadecenylhydrogen phosphite (diolelylhydrogen phosphite), and diphenylhydrogen phosphite.

Further, examples of the triphosphite include triethyl phosphite, tri-n-butyl phosphite, triphenyl phosphite, tricresyl phosphite, tri(nonylphenyl)phosphite, tri(2-ethylhexyl)phosphite, tridecyl phosphite, trilauryl phosphite, triisooctyl phosphite, diphenylisodecyl phosphite, tristearyl phosphite, and trioleyl phosphite.

[0017] Of the above-mentioned phosphite compounds, acid diphosphite is suitable from the viewpoint of the performances and the like.

In the lubricating oil composition of the present invention, as the component (A): at least one of the phosphate compounds may be used; at least one of the phosphite compounds may be used; or a combination of at least one of the phosphate compounds and at least one of the phosphite compounds may be used.

The blending amount of the component (A) is preferably within the range of 0.01 to 4% by mass based on the total amount of the composition. When the blending amount thereof is within the above range, the wear-resistant properties at sliding portions are sufficient. When the component (A) is used in combination with secondary amine which is a component (B) mentioned below, requirements of the lubricating oil composition for the above-mentioned shock absorbers can be satisfied. The blending amount of the component (A) is more preferably within the range of 0.03 to 3% by mass, and particularly preferably within the range of 0.1 to 2% by mass.

[0018] The secondary amine compound used as the component (B) in the lubricating oil composition of the present invention has a structure represented by General Formula (I).

[Chem 2]

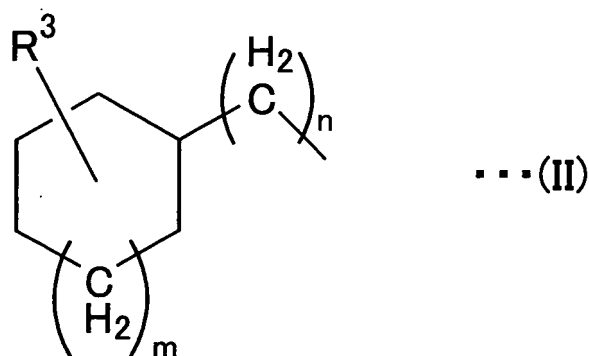


[0019] In General Formula (1), R^1 and R^2 represent an alkyl group having 1 to 18 carbon atoms, an alkenyl group having 2 to 18 carbon atoms, or a cycloalkane-containing group having 5 to 18 carbon atoms, respectively. R^1 and R^2 may be the same or different from each other, or may be bonded to each other to form a cyclic structure having 3 to 6 carbon atoms with a nitrogen atom serving as a hetero atom.

The alkyl group having 1 to 18 carbon atoms may be straight-chained or branched one. For example, a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, various pentyl groups, various hexyl groups, various octyl groups, various decyl groups, various dodecyl groups, various tetradecyl groups, various hexadecyl groups, and various octadecyl groups are mentioned.

The alkenyl group having 2 to 18 carbon atoms may be straight-chained or branched one. For example, an aryl group, a propenyl group, various butenyl groups, various hexenyl groups, various octenyl groups, various decenyl groups, various dodecenyl groups, various tetradecenyl groups, various hexadecenyl groups, and various octadecenyl groups are mentioned.

[Chem 3]



[0020] As the cycloalkane-containing group having 5 to 18 carbon atoms, groups having the total number of carbon atoms of 5 to 18 represented by General Formula (II) can be mentioned.

In General Formula (II), R^3 represents a hydrogen atom, an alkyl group having 1 to 8 carbon atoms, or an alkenyl group having 1 to 8 carbon atoms, m represents an integer of 0 to 3, and n represents an integer of 0 to 10.

The alkyl group having 1 to 8 carbon atoms represented by R^3 may be straight-chained or branched one. For example, a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, various pentyl groups, various hexyl groups, and various octyl groups are mentioned.

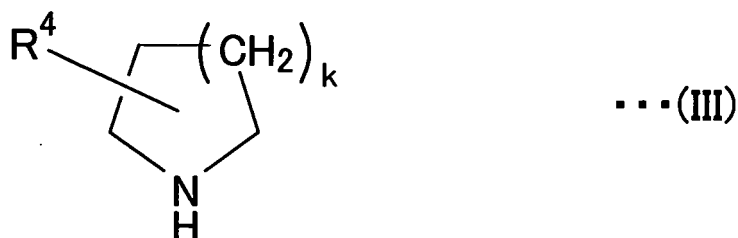
The alkenyl group having 2 to 8 carbon atoms represented by R^3 may be straight-chained or branched one. For example, a vinyl group, an aryl group, a propenyl group, various butenyl groups, various pentenyl groups, various hexenyl groups, and various octenyl groups are mentioned.

Examples of the group having total carbon atoms of 5 to 18 represented by General Formula (II) include a cyclopentyl group, a methylcyclopentyl group, a cyclopentylmethyl group, a 2-cyclopentylethyl group, a cyclohexyl group, a methylcyclohexyl group, a cyclohexylmethyl group, a 2-cyclohexylethyl group, a cyclooctyl group, a cyclooctylmethyl group, and a 2-cyclooctylethyl group.

R^1 and R^2 in General Formula (I) may be the same or different from each other, but it is preferable that R^1 and R^2 be the same from the viewpoint of ease of manufacture. Moreover, R^1 and R^2 may be bonded to each other to form a cyclic structure having 3 to 6 carbon atoms with a nitrogen atom serving as a hetero atom. As such compounds, cyclic amine represented by General Formula (III) can be mentioned, for example.

[0021]

[Chem 4]



[0022] In General Formula (III), R^4 represents a hydrogen atom, an alkyl group having 1 to 8 carbon atoms, or an alkenyl group having 2 to 8 carbon atoms, and k represents an integer of 0 to 3.

The same descriptions as in the alkyl groups having 1 to 8 carbon atoms and alkenyl groups having 2 to 8 carbon atoms represented by R^3 apply to the alkyl groups having 1 to 8 carbon atoms and alkenyl groups having 2 to 8 carbon atoms represented by R^4 .

In the present invention, specific examples of the secondary amine compound used as the component (B) include di-n-

butyl amine, di-n-hexyl amine, di-n-octyl amine, di-2-ethylhexyl amine, dilauryl amine, dimyristyl amine, dipalmityl amine, distearyl amine, dioleyl amine, dicyclopentyl amine, dicyclohexyl amine, prrolidine, 2-methylpyrrolidine, piperidine, 2-methylpiperidine, and hexamethylene imine.

[0023] In the lubricating oil composition of the present invention, the secondary amine compounds represented by General Formula (I) may be used alone or in combination of two or more members as the component (B).

The blending amount of the component (B) is preferably within the range of 0.05 to 5% by mass based on the total amount of the composition. When the blending amount thereof is within the above range, the composition exhibits favorable stability against oxidative deterioration of the above-mentioned phosphate compounds and/or the phosphite compounds as the component (A) and favorable storage stability, can satisfy the above-mentioned requirements of the lubricating oil composition for a shock absorber, and is imparted with excellent wear-resistant properties at the sliding part. The blending amount of the component (B) is preferably within the range of 0.1 to 3% by mass, and more preferably 0.1 to 2% by mass.

When a primary amine compound is used as the component (B), the above-mentioned requirements of the lubricating oil composition for a shock absorber cannot be satisfied.

[0024] The lubricating oil composition of the present invention can, as required, contain at least one additive selected from various additives insofar as the object of the present invention is not adversely affected. Example of such additives include ash-less detergent-dispersants, metal-based detergents, lubricity improvers (lubricity improvers other than the component (A)), antioxidants, rust preventive agents, metal deactivators, viscosity index improvers, pour point depressants, and antifoaming agents.

Here, examples of the ash-less detergent-dispersants include succinimides, boron-containing succinimides, benzylamines, boron-containing benzylamines, succinates, and monovalent or bivalent carboxylic amides typified by fatty acids or succinic acids.

Examples of the metal-based detergents include neutral metal sulfonate, neutral metal phenate, neutral metal salicylate, neutral metal phosphonate, basic sulfonate, basic phenate, basic salicylate, over-based sulfonate, over-based salicylate, over-based phosphonate, etc. The blending amount of the above substance is usually 0.1 to 20% by mass, and preferably 0.5 to 10% by mass based on the total amount of lubricating oil composition.

[0025] As the lubricity improvers, extreme pressure agents, antifricition agents, and oiliness agents are mentioned. For example, organic metal compounds such as zinc dithiophosphate (ZnDTP), zinc dithiocarbamate (ZnDTC), oxymolybdenum organo phosphorodithioate sulfide (MoDTP), oxymolybdenumdithiocarbamate sulfide (MDTC), etc., are mentioned. The blending amount of the above-mentioned lubricity improvers is usually 0.05 to 5% by mass, and preferably 0.1 to 3% by mass based on the total amount of lubricating oil composition.

Moreover, sulfur-based extreme pressure agents such as sulfurized oils, sulfurized fatty acids, sulfurized esters, sulfurized olefins, dihydrocarbyl polysulfides, thiadiazole compounds, alkylthio carbamoyl compounds, triazine compounds, thioterpene compounds, dialkyl thiodipropionate compounds are mentioned. The blending amounts of the above-mentioned sulfur-based extreme pressure agents are usually 0.05 to 2% by mass based on the total amount of lubricating oil composition.

Further, mentioned are oiliness agents including aliphatic saturated and unsaturated monocarboxylic acids such as stearic acids and oleic acids; polymerized fatty acids such as dimer acids and hydrogenated dimer acids; hydroxy fatty acids such as ricinoleic acids and 1,2-hydroxystearic acids; aliphatic saturated and unsaturated monohydric alcohols such as lauryl alcohol and oleyl alcohol; aliphatic saturated and unsaturated monoamines such as stearyl amine and oleylamine; and aliphatic saturated and unsaturated monocarboxylic acid amides such as lauric acid amide and oleamide. The blending amount of the above substance is usually 0.01 to 10% by mass, and preferably 0.1 to 5% by mass based on: the total amount of lubricating oil composition.

[0026] The antioxidants include an amine-based antioxidant, phenol-based antioxidant, and a sulfur-based antioxidant, which can be used in the conventional lubricants. Each of these antioxidants may be independently used or two or more of them may be used in combination. Examples of the amine-based antioxidant include monoalkyldiphenylamine-based compounds such as monoctyldiphenylamine and monononyldiphenylamine; dialkyldiphenylamine-based compounds such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine, and 4,4'-dinonyldiphenylamine; polyalkyldiphenylamine-based compounds such as tetrabutylldiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine, and tetranonyldiphenylamine; and naphthylamine-based compounds such as α -naphthylamine, phenyl- α -naphthylamine, butylphenyl- α -naphthylamine, pentylphenyl- α -naphthylamine, hexylphenyl- α -naphthylamine, heptylphenyl- α -naphthylamine, octylphenyl- α -naphthylamine, and nonylphenyl- α -naphthylamine.

[0027] Examples of the phenol-based antioxidant include monophenol-based compounds such as 2,6-di-tert-butyl-4-methylphenol and 2,6-di-tert-butyl-4-ethylphenol; and diphenol-based compounds such as 4,4'-methylenebis(2,6-di-tert-butylphenol) and 2,2'-methylenebis(4-ethyl-6-tert-butylphenol).

Examples of the sulfur-based antioxidant include thioterpene-based compounds such as 2, 6-di-tert-butyl-4-(4,6-bis(octylthio)-1,3,5-triazin-2-ylamin o)phenol, and a reactant of phosphorus pentasulfide and pinene; and dialkyl thiodipro-

pionate such as dilauryl thiodipropionate and distearyl thiodipropionate.

The blending amounts of these antioxidants are usually about 0.01 to 10% by mass, preferably 0.03 to 5% by mass on the basis of the total amount of the lubricating oil composition.

[0028] The rust preventive agents include metal sulfonates and succinate. The blending amounts of these rust preventive agents are generally about 0.01 to 10% by mass, preferably 0.05 to 5% by mass on the basis of the total amount of the lubricating oil composition in terms of the advantage of mixing.

The metal deactivators include benzotriazole and thiadiazole. Preferable blending amounts of these metal deactivators are generally about 0.01 to 10% by mass, preferably 0.01 to 1% by mass on the basis of the total amount of the lubricating oil composition in terms of the advantage of mixing.

Examples of the viscosity index improver include polymethacrylate, dispersed polymethacrylate, olefin-based copolymer (e.g., ethylene-propylene copolymer), dispersed olefin-based copolymer, and styrene-based copolymer (e.g., styrene-diene hydrogenated copolymer).

The blending amounts of these viscosity index improvers are generally about 0.5 to 35% by mass, preferably 1 to 15% by mass on the basis of the total amount of the lubricating oil composition in terms of the advantage of mixing.

[0029] As pour point depressants, polymethacrylates and the like whose weight average molecular weight is about 50,000 to 150,000 can be used.

As antifoaming agents, high-molecular-weight silicone antifoaming agents are preferable. By incorporating the high-molecular-weight silicone antifoaming agents, the antifoaming ability is effectively demonstrated and the ride quality is improved.

As the high-molecular-weight silicone antifoaming agents, organopolysiloxane can be mentioned, and fluorine containing organopolysiloxanes such as trifluoro propylmethyl silicone oil are particularly preferable. In view of the balance of antifoaming effects and cost efficiency, the blending amounts of the above-mentioned high-molecular-weight silicone antifoaming agents are preferably 0.005 to 0.1% by mass, and more preferably 0.008 to 0.08% by mass based on the total amount of the composition.

[0030] In the lubricating oil composition for a shock absorber of the present invention, when the friction coefficients " μ_L " and " μ_H " at the rates of 1.0 mm/s and 3.0 mm/s are measured using a Bowden type reciprocating friction tester under the experimental conditions mentioned later, the friction coefficient " μ_H " is preferably 0.4 or higher, and more preferably 0.5 or higher. When the friction coefficient " μ_H " is 0.4 or higher, the control stability at the time when the car is driven at high speeds becomes excellent.

The μ_L/μ_H ratio is preferably lower than 1, and more preferably 0.7 or higher and lower than 1. When the μ_L/μ_H ratio is lower than 1, the ride quality is excellent. When the μ_L/μ_H ratio is 0.8 or higher, the ride quality is excellent and shock sensation by the human body is small.

The friction coefficient μ between steel parts, which is measured under the conditions mentioned later, is usually 0.3 or lower. The increase in the friction coefficient is small compared with the case where a phosphate compound and/or a phosphite compound are added without adding a secondary amine compound.

[0031] As described above, the present invention provides a lubricating oil composition obtained by compounding a base oil and the components (A) and (B), and further, as required, various additives, and a lubricating oil composition usually containing a base oil and the components (A) and (B), and further, as required, various additives.

EXAMPLES

[0032] Hereinafter, the present invention will be described in more detail with reference to Examples and Comparative Examples, but is not limited thereto.

· Bowden friction test (1)
<Measurement of Friction Coefficient Between Rail and Steel Part>
Tester: Bowden type reciprocating friction tester
Experimental conditions

Oil temperature: 20°C

Load: 9.8 N

Stroke: 10 mm

Rate: 1.0 mm/s, 3.0 mm/s

Number of Frictions: 50 times

Friction material: Upper: rubber (A437),

Lower: chrome plating board

Under the above-mentioned experimental conditions, the friction coefficient μ_L at a rate of 1.0 mm/s and the friction

coefficient μ at a rate of 3.0 mm/s were measured and simultaneously, the μ_L/μ_H was calculated.

· Bowden friction test (2)
<Measurement of Friction Coefficient Between Steel Parts>
Tester: Bowden type reciprocating friction tester
Experimental conditions

Oil temperature: 40°C
Load: 9.8 N
Stroke: 10 mm
Rate: 3.0 mm/s
Number of Frictions: 50 times
Friction material: Upper: ball (SUJ-2),
Lower: SPCC board

Under the above-mentioned experimental conditions, the friction coefficient μ was measured.

[0033] The type of each component used for preparing a lubricating oil composition is as follows.

- (1) Base oil: paraffin-based, kinematic viscosity of 10 mm²/s at 40°C
- (2) Phosphorous compound

A-1: mono-n-butyl acid phosphate
A-2: di-n-butylhydrogen phosphite
A-3: di-n-butyl acid phosphate
A-4: di-2-ethylhexylhydrogen phosphite
A-5: di-2-ethylhexyl acid phosphate
A-6: mono-2-ethylhexyl acid phosphate
A-7: dilaurylhydrogen phosphite
A-8: diolelylhydrogen phosphite
A-9: monooleyl acid phosphate

- (3) Amino compound

B-1: di-n-butyl amine
B-2: di-2-ethylhexyl amine
B-3: trade name: Armeen 2C, main component: dilauryl amine, manufactured by LION AKZO CO., LTD.
B-4: trade name: Armeen 2HT, main component: distearyl amine, manufactured by LION AKZO CO., LTD.
B-5: piperidine
B-6: dicyclohexyl amine
b-1: monooleyl amine

- (4) Others

C-1: polybutenyl succinimide (ash-less detergent-dispersant)
C-2: 2,6-di-t-butyl-p-cresol (antioxidant)

[0034] Examples 1 to 19 and Comparative Examples 1 to 6

Lubricating oil compositions each containing the respective components shown in Table 1 were prepared, and the compositions were subjected to Bowden friction tests (1) and (2).

The Bowden friction test (1) was carried out as described above, and the friction coefficients μ_L and μ_H between seals and steel parts were measured, and further, the μ_L/μ_H ratio was calculated. The friction coefficient μ_H is preferably 0.4 or higher, and more preferably 0.7 or higher and lower than 1. The μ_L/μ_H ratio is preferably lower than 1. The Bowden test (2) was carried out as described above, and the friction coefficient between steel parts was measured. In this case, the friction coefficient $\mu_{(P+A)}$ between steel parts in a composition obtained by compounding a phosphorus compound and an amine compound was measured, the friction coefficient μ_P between steel parts was measured in the case where no amine compound was included with respect to the compound in which the friction coefficient $\mu_{(P+A)}$ was measured, and the $\mu_{(P+A)}/\mu_P$ ratio was calculated. The lower the $\mu_{(P+A)}$ value, the better.

[0035] [Table 1]

Table 1-1

			Example					
			1	2	3	4	5	6
Composition (part by mass)	Base oil		98.76	98.61	98.39	98.52	98.07	98.56
	Phosphorous compound	A-1	0.26	-	-	-	-	0.26
		A-2	-	-	-	-	-	-
		A-3	-	0.41	-	-	-	-
		A-4	-	-	-	-	-	-
		A-5	-	-	0.63	-	-	-
		A-6	-	-	-	0.50	-	-
		A-7	-	-	-	-	-	-
		A-8	-	-	-	-	-	-
		A-9	-	-	-	-	0.95	-
	Amine compound	B-1	-	-	-	-	-	-
		B-2	-	-	-	-	-	-
		B-3	-	-	-	-	-	-
		B-4	-	-	-	-	-	-
		B-5	0.18	0.18	0.18	0.18	0.18	-
		B-6	-	-	-	-	-	0.38
		b-1	-	-	-	-	-	-
	Others	C-1	0.50	0.50	0.50	0.50	0.50	0.50
		C-2	0.30	0.30	0.30	0.30	0.30	0.30
Bowden Friction Test (1)		μ _L	0.89	0.89	0.80	0.86	0.63	0.94
		μ _H	0.90	0.98	0.87	0.95	0.64	0.97
		μ _L /μ _H	0.99	0.91	0.92	0.91	0.98	0.97
Bowden Friction Test (2)		μ _(P+A)	0.14	0.15	0.18	0.24	0.13	0.14
		μ _(P+A) /μ _P	1.0	1.2	1.3	1.0	1.4	1.0
(Note) μ _(P+A) : Friction coefficient between steel parts in a composition containing a phosphorous compound and an amine compound. μ _P : Friction coefficient between steel parts of the composition containing no amine compound, whose friction coefficient μ _(P+A) was measured.								

[0036] [Table 2]

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Table 1-2

			Example					
			7	8	9	10	11	12
Composition (part by mass)	Base oil		98.39	98.41	98.19	97.87	98.25	97.80
	Phosphorous compound	A-1	-	-	-	-	-	-
		A-2	0.43	-	-	-	-	-
		A-3	-	0.41	-	-	-	-
		A-4	-	-	-	-	0.67	-
		A-5	-	-	0.63	-	-	-
		A-6	-	-	-	-	-	-
		A-7	-	-	-	-	-	-
		A-8	-	-	-	-	-	1.12
		A-9	-	-	-	0.95	-	-
	Amine compound	B-1	-	-	-	-	0.28	0.28
		B-2	-	-	-	-	-	-
		B-3	-	-	-	-	-	-
		B-4	-	-	-	-	-	-
		B-5	-	-	-	-	-	-
		B-6	0.38	0.38	0.38	0.38	-	-
		b-1	-	-	-	-	-	-
	Others	C-1	0.50	0.50	0.50	0.50	0.50	0.50
		C-2	0.30	0.30	0.30	0.30	0.30	0.30
Bowden Friction Test (1)		μ_L	0.92	0.90	0.80	0.45	0.88	0.62
		μ_H	0.94	0.99	0.83	0.62	1.00	0.72
		μ_L/μ_H	0.71	0.91	0.96	0.73	0.88	0.86
Bowden Friction Test (2)		$\mu_{(P+A)}$	0.18	0.18	0.28	0.12	0.14	0.13
		$\mu_{(P+A)}/\mu_P$	1.1	1.4	2.0	1.3	0.8	0.9
(Note) $\mu_{(P+A)}$: Friction coefficient between steel parts in a composition containing a phosphorous compound and an amine compound. μ_P : Friction coefficient between steel parts of the composition containing no amine compound, whose friction coefficient $\mu_{(p+A)}$ was measured.								

[0037] [Table 3]

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Table 1-3

			Example						
			13	14	15	16	17	18	19
Composition (part by mass)	Base oil		98.24	98.28	97.74	97.28	97.74	97.48	98.15
	Phosphorous compound	A-1	-	-	-	-	-	-	-
		A-2	0.43	-	-	-	0.41	-	-
		A-3	-	0.41	0.41	-	-	-	-
		A-4	-	-	-	-	-	0.67	-
		A-5	-	-	-	-	-	-	-
		A-6	-	-	-	-	-	-	0.50
		A-7	-	-	-	0.88	-	-	-
		A-8	-	-	-	-	-	-	-
		A-9	-	-	-	-	-	-	-
	Amine compound	B-1	-	-	-	-	-	-	-
		B-2	0.53	0.53	-	-	-	-	-
		B-3	-	-	1.05	-	1.05	1.05	1.05
		B-4	-	-	-	1.04	-	-	-
		B-5	-	-	-	-	-	-	-
		B-6	-	-	-	-	-	-	-
		b-1	-	-	-	-	-	-	-
	Others	C-1	0.50	0.50	0.50	0.50	0.50	0.50	0.50
		C-2	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Bowden Friction Test (1)		μ_L	0.76	0.72	0.57	0.41	0.57	0.49	0.49
		μ_H	0.80	0.82	0.64	0.55	0.64	0.55	0.57
		μ_L/μ_H	0.99	0.88	0.89	0.75	0.89	0.90	0.86
Bowden Friction Test (2)		$\mu_{(P+A)}$	0.14	0.19	0.19	0.13	0.19	0.31	0.22
		$\mu_{(P+A)}/\mu_P$	0.9	1.4	1.5	1.3	1.5	1.9	1.0
(Note) $\mu_{(P+A)}$: Friction coefficient between steel parts in a composition containing a phosphorous compound and an amine compound. μ_P : Friction coefficient between steel parts of the composition containing no amine compound, whose friction coefficient $\mu_{(P+A)}$ was measured.									

[0038] [Table 4]

Table 1-4

			Comparative Example					
			1	2	3	4	5	6
Composition (part by mass)	Base oil		98.37	98.20	97.98	98.00	97.68	98.25
	Phosphorous compound	A-1	0.26	-	-	-	-	-
		A-2	-	0.43	-	-	-	-
		A-3	-	-	-	-	-	-
		A-4	-	-	0.67	-	-	-
		A-5	-	-	-	0.63	-	-
		A-6	-	-	-	-	-	-
		A-7	-	-	-	-	-	-
		A-8	-	-	-	-	-	-
		A-9	-	-	-	-	0.95	0.95
	Amine compound	B-1	-	-	-	-	-	-
		B-2	-	-	-	-	-	-
		B-3	-	-	-	-	-	-
		B-4	-	-	-	-	-	-
		B-5	-	-	-	-	-	-
		B-6	-	-	-	-	-	-
		b-1	0.57	0.57	0.57	0.57	0.57	-
Others	C-1	0.50	0.50	0.50	0.50	0.50	0.50	
	C-2	0.30	0.30	0.30	0.30	0.30	0.30	
Bowden Friction Test (1)		μ _L	0.16	0.09	0.10	0.12	0.10	0.09
		μ _H	0.18	0.09	0.11	0.10	0.10	0.19
		μ _L /μ _H	0.89	1.00	0.91	1.20	1.00	0.47
Bowden Friction Test (2)		μ _(P+A)	0.26	0.14	0.33	0.42	0.34	*0.09
		μ _(P+A) /μ _P	1.9	0.9	2.1	3.0	3.8	-
(Note) μ _(P+A) : Friction coefficient between steel parts in a composition containing a phosphorous compound and an amine compound. μ _P : Friction coefficient between steel parts of the composition containing no amine compound, whose friction coefficient μ _(P+A) was measured. *0.09: Value of a composition containing no amine compound								

[0039] As is clear from Table 1, in each of the lubricating oil compositions (Examples 1 to 19) of the present invention, the friction coefficients μ_H are as high as 0.55 or more (The friction coefficients μ_H of Comparative Examples 1 to 6 are 0.09 to 0.19), and the μ_L/μ_H ratio is less than 1. Therefore, the control stability when the car is driven at high speeds is favorable and simultaneously the ride quality is excellent, and, moreover, an increase in the friction coefficient between steel parts is small compared with Comparative Examples.

INDUSTRIAL APPLICABILITY

[0040] The lubricating oil composition for a shock absorber of the present invention is obtained by compounding a combination of a specific phosphorus compound and an amine compound in a base oil, and the lubricating oil composition for a shock absorber of the present invention can increase the friction force between seals and steel parts in the shock absorber of an automobile, improve the control stability when the car is driven at high speeds, and simultaneously

improve the ride quality.

Claims

1. A lubricating oil composition for a shock absorber, comprising:

a base oil containing a mineral oil and/or a synthetic oil;

(A) a phosphate compound and/or a phosphite compound having a hydrocarbon group having 2 to 18 carbon atoms; and

(B) a secondary amine compound represented by General Formula (I),

[Chem 1]



wherein R^1 and R^2 each represent an alkyl group having 1 to 18 carbon atoms, an alkenyl group having 2 to 18 carbon atoms, or a cycloalkane-containing group having 5 to 18 carbon atoms, and R^1 and R^2 may be the same or different from each other, or may be bonded to each other to form a cyclic structure having 3 to 6 carbon atoms with a nitrogen atom serving as a hetero atom.

2. A lubricating oil composition for a shock absorber according to claim 1, wherein the phosphate compound having a hydrocarbon group having 2 to 18 carbon atoms is acid phosphate having one or two hydrocarbon groups.

3. A lubricating oil composition for a shock absorber according to claim 1, wherein the phosphite compound having a hydrocarbon group having 2 to 18 carbon atoms is acid diphosphite having two hydrocarbon groups.

4. A lubricating oil composition for a shock absorber according to claim 1, wherein a blending amount of the phosphate compound and/or the phosphite compound (A) is 0.01 to 4% by mass based on a total amount of the composition.

5. A lubricating oil composition for a shock absorber according to claim 1, wherein a blending amount of the secondary amine compound (B) is 0.05 to 5% by mass based on a total amount of the composition.

6. A lubricating oil composition for a shock absorber according to claim 1, further comprising at least one member selected from an ash-less detergent-dispersant, a metal-based detergent, a lubricity improver, an antioxidant, a rust preventive agent, a metal deactivator, a viscosity index improver, a pour point depressant, and an antifoaming agent.

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER		
C10M169/04(2006.01)i, C10M105/06(2006.01)i, C10M105/18(2006.01)i, C10M105/36(2006.01)i, C10M105/38(2006.01)i, C10M105/74(2006.01)i, C10M107/02(2006.01)i, C10M107/08(2006.01)i, C10M133/06(2006.01)i, 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) C10M169/04, C10M105/06, C10M105/18, C10M105/36, C10M105/38, C10M105/74, C10M107/02, C10M107/08, C10M133/06, C10M133/44, C10M137/02, C10M137/06, C10N30/00, 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 1996-2007 Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-172660 A (Nippon Mitsubishi Oil Corp.), 26 June, 2001 (26.06.01), Claims; Par. Nos. [0005] to [0007], [0010]; example 2 (Family: none)	1-6
X	JP 2006-117733 A (Nippon Oil Corp.), 11 May, 2006 (11.05.06), Claims; Par. Nos. [0068], [0159]; examples & EP 1803799 A1 & WO 2006/043606 A1	1-6
X	JP 11-35960 A (Showa Shell Sekiyu Kabushiki Kaisha), 09 February, 1999 (09.02.99), Claims; Par. Nos. [0007], [0010], [0013], [0014]; examples (Family: none)	1-6
☐ 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 22 November, 2007 (22.11.07)		Date of mailing of the international search report 11 December, 2007 (11.12.07)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

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Continuation of A. CLASSIFICATION OF SUBJECT MATTER
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C10N30/00(2006.01)n, C10N40/06(2006.01)n

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

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