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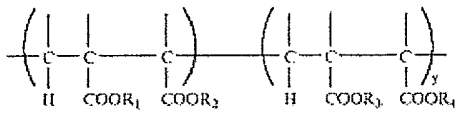

(I)

(57) Abstract: A lithium grease composition which can be sealed in a small motor bearing to reduce noise, composed of 5-20 % by weight of a thickener and 95-80 % by weight of a base oil, wherein said grease composition adopts lithium soap as the thickener, which is synthesized from lithium hydroxide and a higher fatty acid with 10 to 20 carbon atoms and/or a higher hydroxyfatty acid with one or more hydroxyl groups and 10 or more carbon atoms, and the base oil includes, as a main component, a polymer ester oil (A) in which 8 or more ester groups are arranged in a comb tooth form on one side of chain molecules constituted by eight or more carbon atoms which is expressed by general formula 1: (In the formula, each of R_1, R_2, R_3 and R_4 is an alkyl group, where x is an integer and $x \geq 2$, and y is an integer and $y \geq 2$.) and the base oil (40C) has a viscosity of 25 to 80mm^2/s.

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LITHIUM GREASE COMPOSITION SEALED IN A SMALL MOTOR BEARING TO REDUCE NOISE

Technical Field

The present invention relates to a grease composition for motor bearings for small motors, particularly home electric appliances such as an air conditioner, motor bearings for information equipment such as a hard disk driver and the like, and more specifically to a noise reduction grease sealed in a bearing for a small motor to reduce the rotation noise of the motor.

Background Art

Generally the use of greases sealed in a bearing is known. The prior art shows a grease composition in which 8 or more ester groups are arranged in a comb tooth form on one side of the chain molecules of oil composed of 8 or more carbon atoms. The grease is formed by adding a urea thickener to a base oil in which a synthetic hydrocarbon oil and a synthetic ester oil are mixed in a weight ratio of 0.65-0.75 : 0.35-0.25. See Japanese Patent No. 3514574 and US Pat.No.5,910,470. This grease is sealed in a ball bearing that supports a belt driven pulley placed in the vicinity of an automobile engine. Such devices makes a quick change in its rotation speed. In order to solve a problem of a unique whistle-like noise that is generated when used in cold climates, the grease is used.

A grease sealed in a similar bearing is shown in Japanese Laid Open Patent Application Publication No. 1994-306383. There a grease composition is sealed in a bearing. The grease composition is formed by adding a urea thickener to a base oil in which a synthetic hydrocarbon oil and a synthetic ester oil are mixed in a weight ratio of 0.65-0.75 : 0.35-0.25.

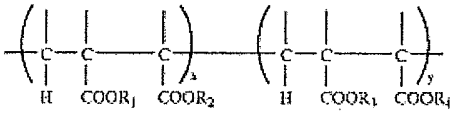
Japanese Patent No. 3324628 shows that when noise reduction and vibration reduction are priority issues for a grease composition sealed in a bearing for an electronic calculator, semiconductor manufacturing device and the like, a noise and torque reducing grease is used. The patent shows a grease with lithium soap as a thickener and an ester oil as a base oil. This lithium-soap-ester grease, however, tends to spatter and has a problem of damaging a recording medium if it is used as

is. There is still a need in the art for improved noise reducing grease compositions sealed in a bearing for a small motor.

Disclosure of the Invention

According to the invention, a noise reducing grease composition and a sealed bearing containing the composition are provided. The bearing is desirably used for small motors particularly for home electronic appliances for example air conditioners, a motor for information equipment such as a hard disk driver and the like, and sealed in a bearing for a small motor to reduce the rotation noise of the motor. The present invention provides a grease composition composed of 5 to 20% preferably greater than 5% and less than 20% by weight of a lithium soap thickener. The thickener is synthesized from lithium hydroxide and a higher fatty acid with 10 to 20 carbon atoms or a higher hydroxyfatty acid with one or more hydroxyl groups and 10 or more carbon atoms, or both. Desirably, the lithium soap thickener accounts for about 7.5% to about 17.5% by weight of the grease composition preferably about 10% to about 15% particularly about 12% to about 13% by weight.

The grease according to the invention also includes 95 to 80% by weight of a base oil. As a component of the ester oil is a polymer ester oil preferably present in a significant amount, desirably in an amount of 20% or greater by weight of the base oil. The polymer base oil has 8 or more ester groups arranged in a comb tooth form on one side of the chain molecules which is expressed by a general formula



FORMULA 1

where each of R_1, R_2, R_3 and R_4 represents an alkyl group, x is an integer satisfying $x \geq 2$, and y is an integer satisfying $y \geq 2$) and the base oil having a viscosity (40C) of 25 to 80mm^2/s. The resulting grease composition has good affinity for the bearing member and has excellent noise reduction properties.

In another aspect of the invention, the base oil is composed of one or more oils in addition to the polymer ester oil. According to the invention, the base oil includes a polymer ester oil of Formula 1 as a significant component preferably in an amount of 20% by weight or more of the base oil. The polymer ester oil (A) should be included as a significant component of the base oil, and more specifically, besides

polymer ester oil (A), one or more of synthetic ester oil (B), synthetic hydrocarbon oil (C) and synthetic ether oil (D) may be included.

Further, according to the present invention, it is preferable that the polymer ester oil (A) accounts for 20-50% by weight of the total of the grease composition, the synthetic ester oil (B) accounts for 10-45% by weight of the total of the grease composition, and the synthetic hydrocarbon oil (C) accounts for 5-45% by weight of the total of the grease composition.

According to the present invention, the lithium soap thickener can be a mixture of a 12-hydroxystearic acid lithium soap and a straight-chain fatty acid lithium soap, wherein the 12-hydroxystearic acid lithium soap accounts for 2.5-10% by weight of the total of the grease composition, and the straight-chain fatty acid lithium soap accounts for 2.5-10% by weight of the total of the grease composition.

Further, according to the present invention, an antioxidant, anticorrosive agent and the like may be added to the grease composition, as additives.

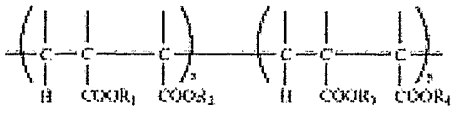
The resulting grease composition sealed in a small motor bearing has excellent acoustic properties, torque reduction, volatilization reduction and long life span.

The preferred embodiment of the present invention is illustrated in the examples. However, it should be expressly understood that the present invention should not be limited solely to the illustrative embodiment.

Modes For Carrying Out The Invention

According to the invention, a noise reducing grease composition and a sealed bearing containing the composition are provided. The bearing is desirably used for a motor for home electronic appliances for example air conditioners, a motor for information equipment such as a hard disk driver and the like, and sealed in a bearing for a small motor to reduce the rotation noise of the motor. The present invention provides a grease composition composed of 5 to 20% preferably greater than 5% and less than 20% by weight of a lithium soap thickener. The thickener is synthesized from lithium hydroxide and a higher fatty acid with 10 to 20 carbon atoms or a higher hydroxyfatty acid with one or more hydroxyl groups and 10 or more carbon atoms, or both. According to the present invention, the lithium soap desirably can desirably be a mixture of a 12-hydroxystearic acid lithium soap and a straight-chain fatty acid lithium soap, wherein the 12-hydroxystearic acid lithium soap accounts for 2.5-10% by weight of the total of the grease composition, and the straight-chain fatty acid lithium soap accounts for 2.5-10% by weight of the total of the grease composition. In the present invention, if the lithium soap accounts less than 5% by weight of the total of the grease composition, the grease becomes too thin, and if the lithium soap accounts for more than 20% by weight of the total of the grease composition, the grease becomes too thick. Desirably, the lithium soap thickener accounts for about 7.5% to about 17.5% by weight of the grease composition preferably about 10% to about 15% by weight particularly about 12% to about 13% by weight of the grease composition.

The grease also includes 95 to 80% by weight of a base oil. A component of the base oil is a polymer ester oil preferably present in a significant amount, desirably in an amount of 20% or greater by weight of the base oil. The polymer base oil has 8 or more ester groups arranged in a comb tooth form on one side of the chain molecules which is expressed by **Formula 1** below:



where each of R_1, R_2, R_3 and R_4 represents an alkyl group, x is an integer satisfying $x \geq 2$, and y is an integer satisfying $y \geq 2$).

The base oil preferably has a viscosity (40C) of 25 to 80mm^2/s. It is preferable, that polymer ester oil component of Formula 1 has a molecular weight of 1000 to 3000 and viscosity (40C) of 100 to 245mm^2/s. The resulting grease composition has good affinity for the bearing member and has excellent noise reduction properties.

In another aspect of the invention, the base oil is composed of one or more oils in addition to the polymer ester oil. According to the invention the base oil includes a polymer ester oil of Formula 1 as a significant component preferably in an amount of 20% by weight or more of the base oil.

The polymer ester oil (A) should be included as a significant component of the base oil, and more specifically, in addition to the polymer ester oil (A), one or more of synthetic ester oils (B), synthetic hydrocarbon oil (C) and synthetic ether oil (D) may be included desirably. Desirably the polymer ester oil has a molecular weight of 1000 to 3000 and viscosity (40C) of 100 to 245mm^2/s and the final base oil has a viscosity (40C) of 25 to 80mm^2/s.

The synthetic ester oil (B) used in the present invention can desirably expressed by general formulae (a), (b) or (c) shown below.

Thus a synthetic diester oil expressed by general formula (a) can be used as (B):

(a) $RCOOH(CH_2)_n\ COOR'$

(where R and R' represent alkyl groups with 3 to 18 carbon atoms, and can be identical or different from each other, and n is 3 to 12.);

a synthetic trimester oil expressed by general formula (b) can be used as (B):

(b) $R(CH_2COO\ R')_3$

(where R and R' represent alkyl groups with 3 to 10 carbon atoms);

a synthetic tetraester oil expressed by general formula (c) can be used as (B):

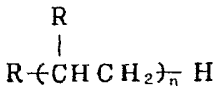
(c) $R(CH_2COO\ R')_4$

(where R and R' represent alkyl groups with 3 to 10 carbon atoms); and

other synthetic neopentyl polyol ester oils can be used.

Preferably, the synthetic ester oil (B) is present in an amount of 10 -45% by weight of the total grease composition.

The synthetic hydrocarbon oil (C) according to the invention can be selected from a variety of hydrocarbon oils. A preferable one is a poly-α-olefin oil or a polybutene and olefin copolymer, that has a viscosity (40°C) of 20 to 100mm^2/s. For safety, it is preferable to employ a synthetic hydrocarbon oil with an ignition point of 220°C or higher. The synthetic hydrocarbon oil desirably has a structure in which α-olefin is low-polymerized to obtain an oligomer and hydrogen is added to its terminal double bond. A typical formula of which may be expressed as follows:



(where R represents an alkyl group, and n represents an integer of 1 to 6). Polybutene can be produced by polymerizing a starting material mainly containing isobutylene by use of aluminum chloride as a catalyst. Polybutene may be used as it is or by adding hydrogen to it. Preferably the synthetic hydrocarbon oil (C) used in the present invention preferably accounts for 5 to 45% by weight of the total of the grease composition.

The synthetic ether oil (D) utilized in the present invention, preferably is an alkyl diphenyl ether, for example dialkyl diphenyl ether, monoalkyl diphenyl ether, a mixture thereof and the like. It is preferable that synthetic ether oil (D) utilized in the present invention account for 10 to 45% by weight of the total of the grease composition. The final base oil desirably has a viscosity (40°C) of 25 to 80mm^2/s.

According to the present invention, it is preferable that the polymer ester oil (A) accounts for 20-50% by weight of the total of the grease composition, the synthetic ester oil (B) accounts for 10-45% by weight of the total of the grease composition, and the synthetic hydrocarbon oil (C) accounts for 5-45% by weight of the total of the grease composition.

Alternatively, according to the present invention, it is desirable that polymer ester oil (A) accounts for 20-50% by weight of the total of the grease composition, synthetic ester oil (B) accounts for 10-45% by weight of the total of the grease composition, synthetic hydrocarbon oil (C) accounts for 5-15% by weight of the total

of the grease composition, and synthetic ether oil (D) accounts for 10-45% by weight of the total of the grease composition.

The grease composition of the present invention may contain various additives that are commonly used for greases. Such additives include antioxidants such as phenyl-α(β)-naphtylamine, alkyl diphenylamine, phenothiazine, t-butylphenol and the like, and anticorrosive agents such as metal sulfonate, non-ionic anticorrosive agents, amine anticorrosive agents an the like.

The resulting grease composition sealed in a small motor bearing according to the present invention has excellent acoustic properties, torque reduction, volatilization reduction and long life span.

Specific examples will be discussed next; however, the present invention should not be restricted by the working examples.

Examples 1-13 of the Invention

As a thickener, a lithium soap synthesized from lithium hydroxide, stearic acid and 12-hydroxysteraric acid was employed.

As a base oil, a polymer ester oil with a viscosity (40°C) of approximately 140mm^2/s was used. As a synthetic ester oil, a tetraester oil and/or diester oil were used. DOS (di-2-ethylhexyl sebacate) was used as a diester oil, and PE (pentaerythritol ester) was used as a tetraester oil.

As a synthetic hydrocarbon oil, poly-α-olefin oil was used.

As a synthetic ether oil, an alkyl diphenyl ether oil was used.

Alkyl diphenylamine was employed as an antioxidant and calcium sulphonate was employed as an anticorrosive agent.

The components were mixed in ratios as shown in Table 1, and heated to 220 to 230°C while being stirred until the entire mixture became fluid. The solution was poured into a stainless steel container so as to form a depth of 3 to 5mm and cooled to 50°C or lower. A grease composition was obtained by homogenizing it using a three-roll mill. The component ratios of the grease compositions and the results of the tests are reported in Table 1.

TABLE 1

		Example	1	2	3	4	5	6	7	8	9	10	11	12	13
Composition	Thickener	Higher hydroxyfatty acid lithium soap	8.5	8.5	10.0	8.5	8.5	8.5	8.5	8.5	8.5	2.5	8.5	8.5	8.5
		Higher fatty acid lithium soap	3.5	3.5	2.5	3.5	3.5	3.5	3.5	3.5	3.5	10.0	3.5	3.5	3.5
	Base oil	Polymer ester oil	40.0	40.0	40.0	40.0	40.0	20.0	20.0	20.0	40.0	40.0	40.0	40.0	50.0
		Synthetic hydrocarbon oil	44.0				31.5	5.5	14.5	30.0	5.5	5.5	5.5	5.5	5.5
		Pentaerythritol ester oil		44.0	18.5	31.5	12.5	33.0	24.0		26.0	13.0		6.5	16.0
		Diester oil								34.0			13.0	6.5	
		Alkyl diphenyl ether oil			25.5	12.5		25.5	25.5		12.5	25.5	25.5	25.5	12.5
	Additive	Antioxidant Anticorrosive Agent, etc.	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
185AProperty and perf1ormance	Base oil viscosity	(40C) mm^2/s	56.04	54.23	71.50	61.98	55.52	51.37	51.73	26.48	62.24	71.79	58.69	85.39	73.47
	Mixture thickness	(25C)	258	255	250	261	256	254	258	253	263	280	255	261	263
	Dropping point	C	187	188	195	185	186	190	188	189	190	188	185	187	189
	Bearing characteristics	Acoustic properties	A	A	A	A	A	A	A	A	A	A	A	A	A
		Torque reduction	A	A	B	A	A	A	A	A	A	B	A	B	B
		Volatilization reduction	B	A	A	A	B	A	A	B	A	A	B	A	A
		Long lifespan	A	A	A	A	A	A	A	B	A	B	B	B	B
	Overall evaluation		B	A	B	A	B	A	A	B	A	B	B	B	B

Comparative Examples 1-6

In the same manner as in the examples 1-13 of the invention, comparative grease compositions 1-4 were prepared by mixing components. Moreover, two commercially available greases with known base oils and thickeners were adopted as comparative examples 5 and 6, as shown on Table 2. On Table 2, the symbol ++ indicates a component that is mixed in.

The mixture examples and the results of the tests are shown on Table 2.

Table 2

Comparative Example			1	2	3	4	5	6
Composition	Thickener	Higher hydroxyfatty acid lithium soap	8.5	8.5			++	++
		Higher fatty acid lithium soap	3.5	3.5	12.0	12.0	++	++
	Base oil	Polymer ester oil						
		Synthetic hydrocarbon oil			25.0			
		Pentaerythritol ester oil		67.0		28.0		++
		Diester oil		17.0	59.0	56.0		++
		Mineral oil	84.0				++	
	Additive	Antioxidant Anticorrosive Agent, etc.	4.0	4.0	4.0	4.0	++	++
Property and performance	Base oil viscosity	(40°C) mm^2/s	99.85	25.60	15.25	15.15	94.66	26.86
	Mixture thickness	(25°C)	259	254	288	278	280	250
	Dropping point	°C	187	190	184	188	185	193
	Bearing characteristics	Acoustic properties	A	A	A	A	C	A
		Torque reduction	D	A	A	A	D	A
		Volatilization reduction	C	B	D	D	C	B
		Long lifespan	D	C	D	D	D	C
	Overall evaluation		D	C	D	D	D	C

The mixture thickness was obtained on the basis of JIS K2220 7, while the dropping point was obtained on the basis of JIS K2220 8. In the bearing characteristics test, grease components to be tested were sealed in a small bearing, and their rotational torques and acoustic properties were measured at room temperature, and also their volatile amounts and the acoustic properties (acoustic life duration) of the bearings were measured after 1000 hours of the bearing rotation test at a rotation frequency of 3000rpm under an atmosphere temperature of 100°C. Regarding the acoustic properties, the Anderon values were measured using an Anderon meter before and after the bearing rotation test. The rotational torques were measured using a torque tester at 3000rpm, under a 2kg load, at room temperature. As for the volatile amount, the bearing

was weighed before and after the bearing rotation test, and the difference was obtained. In relation to the evaluation results of each, the results of judgment made in accordance with performances required for a motor bearing grease composition are listed on Table 1 (examples) and Table 2 (comparative examples). A smaller Anderon value indicates better acoustic properties, and a lower torque and smaller volatile amount are better in performance. The evaluation was made on 4-level scale. "A" is especially excellent, "B" is excellent, "C" is average, and "D" is poor. The unit for the base oil viscosity is mm^2/s.

The lithium grease composition sealed in a small motor bearing of the present invention contributes to a longer lifespan of a bearing and maintains the low noise properties. As a result, it is an eco-friendly grease, which is expected to be in high demand and has various possibilities of industrial application.

The foregoing is considered as illustrative only to the principles of the invention. Further, since numerous changes and modification will occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described above, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

Claims

1. A lithium grease composition sealed in a small motor bearing to reduce noise comprising:

a) more than 5% to less than 20% by weight of a lithium soap thickener;

b) said thickener synthesized from lithium hydroxide and

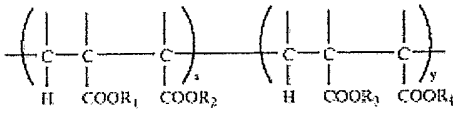
i) a higher fatty acid with 10 to 20 carbon atoms or

ii) a higher hydroxyfatty acid with one or more hydroxyl groups and 10 or more carbon atoms, or

iii) both i and ii ;

c) 95 to 80% by weight of a base oil;

d) said base oil including a polymer ester oil in which 8 or more ester groups are arranged in a comb tooth form on one side of chain molecules which is expressed by Formula 1



(where each of R_1, R_2, R_3 and R_4 represents an alkyl group, x is an integer satisfying $x \geq 2$, and y is an integer satisfying $y \geq 2$)
and said base oil having a viscosity (40°C) of 25 to 80mm^2/s.

2. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 1, further comprising said base oil including a synthetic ester oil.

3. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 1, further comprising said base oil including a synthetic hydrocarbon oil.

4. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 1, further comprising said base oil including a synthetic ether oil.

5. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 2 further comprising said base oil including a synthetic ether oil.

6. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 3 further comprising said base oil including a synthetic ether oil .

7. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 3 further comprising said base oil including a synthetic ester oil.

8. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 1 further comprising said base oil including a synthetic ester oil, a synthetic hydrocarbon oil and a synthetic ether oil.

9. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 1 wherein the base oil includes one or more of the oils selected from the group of a synthetic ester oil , a synthetic hydrocarbon oil and synthetic ether oil.

10. The lithium grease composition sealed in a small motor bearing to reduce noise according to claims 8 wherein polymer ester oil accounts for 20 to 50% by weight of the total of the grease composition, synthetic ester oil accounts for 10 to 45% by weight of the total of the grease composition, and synthetic ether oil accounts for 10 to 45% by weight of the total of the grease composition.

11. The lithium grease composition sealed in a small motor bearing to reduce noise according to claims 8 or 9 wherein polymer ester oil accounts for 20 to 50% by weight of the total of the grease composition, synthetic ester oil accounts for 10 to 45% by weight of the total of the grease composition, and synthetic hydrocarbon oil accounts for 5 to 45% by weight of the total of the grease composition.

12. The lithium grease composition sealed in a small motor bearing to reduce noise according to claims 8 or 9 wherein said polymer ester oil accounts for 20 to 50% by weight of the total of the grease composition, said synthetic ester oil accounts for 10 to 45% by weight of the total of the grease composition, said synthetic hydrocarbon oil accounts for 5 to 15% by weight of the total of the grease

composition, and said synthetic ether oil accounts for 10 to 30% by weight of the total of the grease composition.

13. The lithium grease composition sealed in a small motor bearing to reduce noise according to claims 1 to 9 wherein said lithium soap is a mixture of a 12-hydroxystearic acid lithium soap and a straight-chain fatty acid lithium soap (with 10 to 20 carbon atoms), said 12-hydroxystearic acid lithium soap accounts for 2.5 to 10% by weight of the total of the grease composition, and said straight-chain fatty acid lithium soap (with 10 to 20 carbon atoms) accounts for 2.5 to 10% by weight of the total of the grease composition.

14. The lithium grease composition sealed in a small-motor bearing to reduce noise according to any one of claims 1 to 9 further comprising said grease composition includes an antioxidant or an anticorrosive agent or both an antioxidant and an anticorrosive agent .

15. The lithium grease composition sealed in a small motor bearing to reduce noise according to any one of claims 1 to 9 wherein said polymer ester oil is present in an amount of 20 to 50 % by weight of said grease.

16. The lithium grease composition sealed in a small motor bearing to reduce noise according to claims 1 to 9 wherein in d) said polymer ester oil is present in a significant amount of 20% or greater by weight of said base oil.

17. The lithium grease composition sealed in a small motor bearing to reduce noise according to claims 1 to 9 wherein in d) said polymer ester oil has a molecular weight of 1000 to 3000 and a viscosity (40°C) of 100 to 245mm^2/s.

18. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 9 wherein said synthetic ester oil is

a) a synthetic diester oil having the formula:

$RCOOH(CH_2)_n\ COOR'$

(where R and R' represent alkyl groups with 3 to 18 carbon atoms, and can be identical or different from each other, and n is 3 to 12.);

b) a synthetic trimester oil having the formula :

$R(CH_2COO\ R')_3$

(where R and R' represent alkyl groups with 3 to 10 carbon atoms);

c) a synthetic tetraester oil having the formula :

$R(CH_2COO\ R')_4$

(where R and R' represent alkyl groups with 3 to 10 carbon atoms); or

d) a synthetic neopentyl polyol ester oil .

19. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 9 wherein said synthetic hydrocarbon oil is a poly-α-olefin oil or a polybutene and olefin copolymer, that has a viscosity (40°C) of 20 to 100mm^2/s.

20. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 9 wherein said synthetic ether oil (D) is an alkyl diphenyl ether.

21. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 20 wherein said synthetic ether oil (D) is dialkyl diphenyl ether, monoalkyl diphenyl ether, or a mixture thereof .

22. The lithium grease composition sealed in a small motor bearing to reduce noise according to any one of claims 1 to 10 wherein the lithium soap thickener is about 7.5% to about 17.5% by wt.

23. The lithium grease composition sealed in a small motor bearing to reduce noise according to any one of claims 1 to 10 wherein the lithium soap thickener is about 10% to about 15% by wt.

24. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 11 wherein the lithium soap thickener is about 7.5% to about 17.5% by wt.

25. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 11 wherein the lithium soap thickener is about 10% to about 15% by wt.

26. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 12 wherein the lithium soap thickener is about 7.5% to about 17.5% by wt.

27. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 12 wherein the lithium soap thickener is about 10% to about 15% by wt.

28. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 24 wherein in d) said polymer ester oil has a molecular weight of 1000 to 3000 and a viscosity (40°C) of 100 to 245mm^2/s.

29. The lithium grease composition sealed in a small motor bearing to reduce noise according to claim 26 wherein in d) said polymer ester oil has a molecular weight of 1000 to 3000 and a viscosity (40°C) of 100 to 245mm^2/s.

30. A lithium grease composition comprising:

a) more than 5% to less than 20% by weight of a lithium soap thickener;

b) said thickener synthesized from lithium hydroxide and

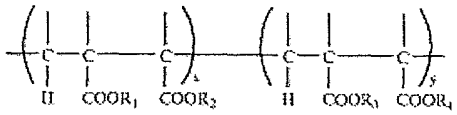
i) a higher fatty acid with 10 to 20 carbon atoms or

ii) a higher hydroxyfatty acid with one or more hydroxyl groups and 10 or more carbon atoms, or

iii) both i and ii ;

c) 95 to 80% by weight of a base oil;

d) said base oil including a polymer ester oil in which 8 or more ester groups are arranged in a comb tooth form on one side of chain molecules which is expressed by Formula 1



(where each of R_1, R_2, R_3 and R_4 represents an alkyl group, x is an integer satisfying $x \geq 2$, and y is an integer satisfying $y \geq 2$)

and said base oil having a viscosity (40°C) of 25 to 80mm^2/s.

31. The lithium grease composition according to claim 30 further comprising said base oil including a synthetic ester oil.

32. The lithium grease composition according to claim 30 further comprising said base oil including a synthetic hydrocarbon oil.

33. The lithium grease composition according to claim 30 further comprising said base oil including a synthetic ether oil.

34. The lithium grease composition according to claim 31 further comprising said base oil including a synthetic ether oil.

35. The lithium grease composition according to claim 32 further comprising said base oil including a synthetic ether oil.

36. The lithium grease composition according to claim 32 further comprising said base oil including a synthetic ester oil.

37. The lithium grease composition according to claim 30 further comprising said base oil including a synthetic ester oil, a synthetic hydrocarbon oil and a synthetic ether oil.

38. The lithium grease composition according to claim 30 wherein the base oil includes one or more of the oils selected from the group of a synthetic ester oil , a synthetic hydrocarbon oil and synthetic ether oil.

39. The lithium grease composition according to claim 37 wherein polymer ester oil accounts for 20 to 50% by weight of the total of the grease composition, synthetic ester oil accounts for 10 to 45% by weight of the total of the grease composition, and synthetic ether oil accounts for 10 to 45% by weight of the total of the grease composition.

40. The lithium grease composition according to claims 37 or 38 wherein polymer ester oil accounts for 20 to 50% by weight of the total of the grease composition, synthetic ester oil accounts for 10 to 45% by weight of the total of the grease composition, and synthetic hydrocarbon oil accounts for 5 to 45% by weight of the total of the grease composition.

41. The lithium grease composition according to claims 37 or 38 wherein said polymer ester oil accounts for 20 to 50% by weight of the total of the grease composition, said synthetic ester oil accounts for 10 to 45% by weight of the total of the grease composition, said synthetic hydrocarbon oil accounts for 5 to 15% by weight of the total of the grease composition, and said synthetic ether oil accounts for 10 to 30% by weight of the total of the grease composition.

42. The lithium grease composition according to claims 30 to 38 wherein said lithium soap is a mixture of a 12-hydroxystearic acid lithium soap and a straight-chain fatty acid lithium soap (with 10 to 20 carbon atoms), said 12-hydroxystearic acid lithium soap accounts for 2.5 to 10% by weight of the total of

the grease composition, and said straight-chain fatty acid lithium soap (with 10 to 20 carbon atoms) accounts for 2.5 to 10% by weight of the total of the grease composition.

43. The lithium grease composition according to any one of claims 30 to 38 further comprising said grease composition includes an antioxidant or an anticorrosive agent or both an antioxidant and an anticorrosive agent.

44. The lithium grease composition according to any one of claims 30 to 38 wherein said polymer ester oil is present in an amount of 20 to 50 % by weight of said grease.

45. The lithium grease composition according to claims 30 to 38 wherein in d) said polymer ester oil is present in a significant amount of 20% or greater by weight of said base oil.

46. The lithium grease composition according to claims 30 to 38 wherein in d) said polymer ester oil has a molecular weight of 1000 to 3000 and a viscosity (40°C) of 100 to 245mm^2/s.

47. The lithium grease composition according to claim 38 wherein said synthetic ester oil is

a) a synthetic diester oil having the formula:

$RCOOH(CH_2)_n\ COOR'$

(where R and R' represent alkyl groups with 3 to 18 carbon atoms, and can be identical or different from each other, and n is 3 to 12.);

b) a synthetic trimester oil having the formula:

$R(CH_2COO\ R')_3$

(where R and R' represent alkyl groups with 3 to 10 carbon atoms);

c) a synthetic tetraester oil having the formula:

$R(CH_2COO\ R')_4$

(where R and R' represent alkyl groups with 3 to 10 carbon atoms); or

d) a synthetic neopentyl polyol ester oil.

48. The lithium grease composition according to claim 38 wherein said synthetic hydrocarbon oil is a poly-α-olefin oil or a polybutene and olefin copolymer, that has a viscosity (40°C) of 20 to 100mm^2/s.

49. The lithium grease composition according to claim 38 wherein said synthetic ether oil (D) is an alkyl diphenyl ether.

50. The lithium grease composition according to claim 49 wherein said synthetic ether oil (D) is dialkyl diphenyl ether, monoalkyl diphenyl ether, or a mixture thereof.

51. The lithium grease composition according to any one of claims 30 to 39 wherein the lithium soap thickener is about 7.5% to about 17.5% by wt.

52. The lithium grease composition according to any one of claims 30 to 39 wherein the lithium soap thickener is about 10% to about 15% by wt.

53. The lithium grease composition according to claim 40 wherein the lithium soap thickener is about 7.5% to about 17.5% by wt.

54. The lithium grease composition according to claim 40 wherein the lithium soap thickener is about 10% to about 15% by wt.

55. The lithium grease composition according to claim 41 wherein the lithium soap thickener is about 7.5% to about 17.5% by wt.

56. The lithium grease composition according to claim 41 wherein the lithium soap thickener is about 10% to about 15% by wt.

57. The lithium grease composition according to claim 53 wherein in d) said polymer ester oil has a molecular weight of 1000 to 3000 and a viscosity (40°C) of 100 to 245mm^2/s.

58. The lithium grease composition according to claim 55 wherein in d) said polymer ester oil has a molecular weight of 1000 to 3000 and a viscosity (40°C) of 100 to 245mm^2/s.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/27331

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : C10M 117/04, 169/04; F16C 33/10
US CL : 508/465, 466, 468, 496, 519, 539, 579, 581, 591; 384/13
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)
U.S. : 508/465, 466, 468, 496, 519, 539, 579, 581, 591; 384/13

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST search terms: grease, lithium, bearing, noise, ester

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,910,470 A (MINAMI et al) 08 June 1999 (08.06.1999), column 2, line 15 to column 4, line 16.	1-58
Y	US 6,232,278 B1 (SHIBAYAMA et al) 15 May 2001 (15.05.2001), column 1, line 29 to column 2, line 63.	1-58
Y	US 6,417,143 B1 (MIKAMI et al) 09 July 2002 (09.07.2002), column 2, line 41 to column 6, line 56.	1-58
Y	US 6,265,361 B1 (AKIYAMA et al) 24 July 2001 (24.07.2001), column 1, line 52 to column 5, line 3.	1-58
Y	US 6,258,762 B1 (AKIYAMA) 10 July 2001 (10.07.2001), column 1, line 32 to column 4, line 41.	1-58
A	US 6,407,043 B1 (MOEHR) 18 June 2002 (18.06.2002), column 1, line 4 to column 3, line 43.	1-58
A, P	US 6,794,342 B2 (KOMIYA et al) 21 September 2004 (21.09.2004), column 1, line 7 to column 3, line 36.	1-58

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

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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