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MAGNESIUM AND ALUMINUM SULFONATE GREASES

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The present invention relates to improved grease compositions. More particularly, the present invention relates to improved grease compositions having the requisite properties for multi-purpose usage with the additional advantage of lower cost than currently available greases.

The present application is a continuation-in-part of application Serial No. 768,089, filed October 20, 1958 and now abandoned.

It is very beneficial to have available a multi-purpose grease which can be used for the lubrication of wheel bearings, water pumps, chassis bearings, universal joints, electric motors, high-speed antifriction bearings, and sleeve bearings. The presence of a multi-purpose grease has these two significant advantages: first, the reduction of grease inventory, and, secondary, the elimination of the danger of bearings being lubricated with an improper grease.

Lithium-base greases have been widely used as multi-purpose greases. These greases have a wide range of applications. Typical characteristics of lithium-base greases are:

- (1) smooth or buttery texture
- (2) high melting points (usually 350° F.)
- (3) good low temperature pumpability
- (4) highly water resistant
- (5) excellent shear stability
- (6) good metal wetting properties

A disadvantage associated with lithium-base greases is the cost. Due to the relative scarcity of lithium, the cost of lithium-base greases is objectionable to some consumers.

It is an object of the present invention to provide grease compositions which have properties substantially equivalent to those of the lithium-base greases. It is another object of the present invention to provide a grease composition which has higher melting points than lithium-base greases. It is still another object of the present invention to provide grease compositions having good utilization of a thickening agent and which is relatively inexpensive. It is yet another object of the present invention to provide a process for preparing grease compositions having the advantages of the afore-mentioned objects. Other objects will become apparent as the invention is hereinafter more thoroughly described.

Broadly stated, the improved grease compositions of the present invention comprise an oleaginous vehicle and a thickening agent comprising a mixed cation overbased sulfonate. More specifically, the thickening agent comprises a magnesium or aluminum inorganic compound dispersed in a magnesium or aluminum sulfonate, with the additional characterization that the cation present in the magnesium or aluminum inorganic compound is either wholly or partially different from the cation of the sulfonate.

Broadly stated, the improved grease compositions of the present invention are prepared by a process which comprises:

- (a) Forming a first solution comprising an oil-soluble sulfonic acid, oleaginous vehicle and a metal-containing compound which is either an aluminum alkoxide or a magnesium alkoxide-carbonate complex;
- (b) Adding a second solution of a metal-containing

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compound which is either an aluminum alkoxide or a magnesium alkoxide-carbonate complex, but which is unlike the metal-containing compound of step (a), to the first solution;

(c) Adding water to the combined solution;

(d) Removing the solvents.

Alternatively, the metal-containing alkoxide of step (a) may be interchanged with the metal-containing alkoxide-carbonate complex.

Having stated the nature of my invention, it may be well at this time to discuss aluminum and magnesium greases as prepared by prior art methods. This will enable us to ascertain wherein the greases of my invention provide an improvement.

Aluminum soap greases are generally clear and virtually transparent. They have a smooth texture and are insoluble in water and substantially anhydrous. They usually give more body to a grease for a given amount of soap than the usual Ba, Ca, Sr or Na soap greases. They have a softening point of 160–200° F., depending upon the acid employed.

Resistance to shear or cooking is generally not too satisfactory. They are also somewhat more thixotropic than other conventional greases, but this is not serious enough to be a detriment.

Texture or phase changes with variations in temperature are one of the more serious drawbacks to the use of aluminum soap greases. When products of this type are heated, their normal plastic structure becomes rubbery and cohesive. This generally occurs between 160–180° F. In the rubbery state, the grease will frequently pull away from metal and fail to act as a lubricant. Also, the physical characteristics of a grease which has reached this rubbery state and is then cooled are difficult to predict.

A disadvantage in the preparation of aluminum greases is the carefully controlled cooling cycle that is required for satisfactory products. Milling of the finished grease is also usually required to remove the false body from freshly cooled aluminum greases.

Additives are generally required in aluminum soap greases to partially overcome the various shortcomings pointed out above.

Magnesium soap greases are not common in industry, although greases can be made from magnesium soaps. Melting points of reported magnesium soap greases vary from 140–167° F. The magnesium soaps have a very strong tendency to hydrate in the presence of water, which causes greases of these soaps to be quite sensitive to water.

The greases of the present invention differ from aluminum soap greases in that they have considerably higher dropping points, do not undergo deleterious phase transitions such as a formation of rubber gels, and are not shear sensitive. Our greases have excellent thixotropic properties. In addition, it is well to note that the process employed in producing our greases is not complicated by involved cooling procedures, nor is milling required to remove false body. The greases of our invention are of smooth, buttery consistency, usually are clear amber in color, and have excellent water resistance.

Before proceeding with specific examples illustrating my invention, it might be well to indicate the nature of the materials required in the process.

SULFONIC ACIDS

Oil-soluble sulfonic acids suitable for use in the present invention include alkyl sulfonic acids, alkaryl sulfonic acids, the so-called mahogany or petroleum sulfonic acids, and the like. The mahogany sulfonic acids include particularly the oil-soluble aromatic sulfonic acids from petroleum. Many of the aromatic sulfonic acids have cycloalkyl (i.e., naphthenic) groups in the side chains

attached to the benzene ring. The mahogany sulfonic acids may include non-aromatic sulfonic acids produced in conventional sulfuric acid refining of lubricating oil distillates and from the industrial use of fuming sulfuric acid in the refining of petroleum. The industrial production of oil-soluble mahogany sulfonic acids from petroleum is well understood in the art and is described in the literature. Normally, the alkyl sulfonic acids require about 24 carbon atoms for oil solubility. The alkaryl sulfonic acids, however, require an alkyl portion totalling only about 18 carbon atoms. To attain the requisite oil solubility, therefore, requires that the hydrocarbon portion of the sulfonic acid have a molecular weight between 350 and 1,000. Preferably, this molecular weight is between 400 and 700. Particularly useful sulfonic acids include diwaxbenzene sulfonic acids, diwaxtoluene sulfonic acids, and postdodecylbenzene sulfonic acids. The wax used in making the wax aromatic sulfonic acid is obtained from different sources of crude petroleum oil. Various grades of paraffin wax are made with different melting points. The 126–128° F. (52.2–53.3° C.) melting point wax is a mixture of organic compounds with the molecular weight averaging in the range of 330–340. The average carbon content of this mixture of organic compounds will be around 24. As the melting point of the wax decreases, the carbon content of the mixture will average as low as 18 or a little lower.

Other sulfonic acids which may be used in the process of this invention include, for example, mono- and poly-wax substituted naphthalene sulfonic acids, diphenyl ether sulfonic acids, dicetyl thianthrene sulfonic acids, dilauryl beta-naphthol sulfonic acids, dicapryl nitronaphthalene sulfonic acids, unsaturated paraffin wax sulfonic acids, hydroxy substituted paraffin wax sulfonic acids, tetraamylene sulfonic acids, mono- and poly-chlorosubstituted paraffin wax sulfonic acids, nitrosoparaffin wax sulfonic acids, cycloaliphatic sulfonic acids, such as, lauryl-cyclo-hexyl sulfonic acids, mono- and poly-wax substituted cyclo-hexyl sulfonic acids, and the like. The expression "petroleum sulfonic acid" is intended to cover all sulfonic acids derived from petroleum products.

A preferred sulfonic acid for the present invention is postdodecylbenzene sulfonic acid prepared by sulfonating postdodecylbenzene. Postdodecylbenzene is a by-product of the manufacture of dodecylbenzene, being the "bottoms" after distilling off dodecylbenzene and postdodecylbenzene overhead. This material is also known as stripped postdodecylbenzene, the terms being synonymous in this disclosure. For the sake of simplicity, postdodecylbenzene is often referred to as PDB and will be so used in this disclosure.

Postdodecylbenzene consists of monoalkylbenzenes and dialkylbenzenes in the approximate mole ratio of 2 to 3. Its typical properties are as follows:

Specific gravity at 38° C.	0.8649
Average molecular weight	385
Percent sulfonatable	88

A.S.T.M. D-158 Engler, ° F.:

I.B.P.	647
5	682
50	715
90	760
95	775
F.B.P.	779

Refractive index at 23° C. 1.4900

Viscosity at:

—10° C., centipoises	2800
20	280
40	78
80	18

Aniline Point, ° C. 69

Pour Point, ° F. -25

OLEAGINOUS MATERIALS

The oleaginous liquid vehicle employed in these compositions may be a mineral lubricating oil obtained by any of the conventional refining procedures, or by the newer "super-refining" procedures (e.g., hydrotreating and/or deep dewaxing). Other oleaginous materials which may be used are vegetable oils, such as corn oil, cottonseed oil, castor oil, etc., and animal oils, such as lard oil, sperm oil, etc. For some purposes, a synthetic lubricating oil can be employed. The term "synthetic lubricating oil," as used herein, means materials derived synthetically which are suitable as lubricants. It does not include super-refined mineral lubricating oils. Examples of suitable synthetic lubricants include the silicones, polyalkylene glycols, diesters, and fluorocarbons.

METAL-CONTAINING COMPOUNDS

Both aluminum alkoxides and magnesium alkoxide-carbonate complexes are used in the process of the present invention.

The aluminum alkoxides used in the present invention are prepared by the reaction of an alcohol with aluminum metal. The aluminum used in the process can be in the form of bars, rods, turnings, or pellets. The term "alcohol," as used herein, refers to aliphatic alcohols containing from 1 to 8 carbon atoms and ether alcohols containing from 3 to 8 carbon atoms. The term "ether alcohols" refers to materials having the generic formula $\text{AOCH}_2\text{CH}_2\text{OH}$ where A is either a C_1 to C_8 hydrocarbon group or the organic radical $\text{CH}_2\text{CH}_2\text{OR}_1$ wherein R_1 is a C_1 to C_4 hydrocarbon group.

In order to be suitable for the preparation of aluminum alkoxides, which are useful in preparing my greases, alcohols must meet the following requirements: be reactive with aluminum, be relatively volatile, and the aluminum alkoxides prepared therefrom must be relatively soluble in hydrocarbon solvents.

Of the normal straight-chain alcohols, the primary alcohols are more reactive with aluminum than the secondary or tertiary alcohols. Also, as a rule, the reactivity of the normal straight-chain alcohols increases with an increase in boiling point. Unfortunately, however, the solubility in common hydrocarbon solvents of the aluminum alkoxide prepared from normal primary alcohols is not appreciable.

The reactivity of primary branched-chain alcohols is comparable to primary normal alcohols of similar boiling point; and in addition, their solubility is considerably improved.

The ether alcohols, 2-methoxy ethanol and 2-ethoxy ethanol also have the advantages of being both reactive with aluminum and having the requisite solubility properties. In addition, they are relatively volatile.

All of the alcohols require the addition of a small quantity of mercuric chloride to initiate the reaction with the exception of 2-ethyl butyl and 2-ethyl hexyl alcohols. These alcohols, however, require initiation unless the aluminum surface is thoroughly cleaned.

A list of suitable alcohols, and their boiling points, is given below in order of increasing reactivity:

	° C.
Isopropyl alcohol	82.5
Tertiary butyl alcohol	82.9
Secondary butyl alcohol	99.5
Methyl alcohol	64.7
n-Propyl alcohol	98
n-Butyl alcohol	117
Isobutyl alcohol	107
2-methoxy ethanol	124
2-ethoxy ethanol	135
n-Amyl alcohol	138
n-Hexyl alcohol	157
2-ethyl butyl alcohol	149
2-ethyl hexyl alcohol	184

Preferred alcohols, for reason of meeting the aforementioned requirements more completely, are the following: primary, branched-chain alcohols containing from 4 to 8 carbon atoms, isopropanol, 2-methoxy ethanol and 2-ethoxy ethanol. The more preferred alcohols include the preceding with the exception of isopropanol.

The magnesium alkoxide-carbonate complex is formed by a process which comprises:

(a) Reacting magnesium with an excess of an alkanol forming an alkanol insoluble magnesium alkoxide,

(b) Forming an alkanol soluble magnesium alkoxide-carbon dioxide complex by passing carbon dioxide through the magnesium alkoxide-alkanol mixture until a soluble complex is obtained.

The preparation of the magnesium alkoxide-carbonate complex is described in U.S. Patent No. 2,895,913, issued July 21, 1959 to Robert L. Carlyle and Earl F. Morris. In addition, the preparation of magnesium alkoxide-carbonate complex is described in application Serial No. 15,031, filed March 31, 1960, and having the same assignee as the present application. Magnesium alkoxide-carbonate complexes prepared by the process of either the patent or application are suitable for use in the present invention.

Patent No. 2,895,913 employs an alkanol containing less than 6 carbon atoms. Application Serial No. 15,031 employs ether alcohols containing from 3 to 8 carbon atoms. The ether alcohols are referred to as glycol ethers in the application.

The disclosures of U.S. Patent No. 2,895,913 and application Serial No. 15,031 are made a part of the present application.

SOLVENTS

In general, the volume of solvents provided by the solutions of the various reactants is sufficient for the process. If necessary, additional solvents may be used. These solvents include the following: petroleum naphtha, other aliphatic hydrocarbon solvents, aromatics, alcohols. In general, any volatile organic solvent is satisfactory provided it does not possess a sufficiently active hydrogen atom or ion to decompose the alkoxide.

The amount of thickener or gelling agent which may be used in the greases of this invention may vary from 6 to 50 percent of the grease, depending on the consistency desired and on the type of sulfonate used. In general, the preferred range is from 8 to 15 percent.

The sulfonate content of the thickener may vary from 40 to 90 percent, with the preferred range being from 60 to 80 percent.

The aluminum and magnesium are present in the thickener in the proportions as shown below (all parts are on a weight basis).

Al/Mg

Suitable	1:01 to 1:10
Preferable	1:1 to 1:5
Most preferable	1:1 to 1:4.84

The dispersed inorganic materials in these grease systems are characterized as having a cation which is at least partially unlike the cation of the dispersing agent (oil-soluble sulfonate). In other words, the cation of the dispersed inorganic material is either wholly or partially unlike the cation of the dispersing agent. For example, if the cation is magnesium for the dispersing agent, the cation for the dispersed inorganic materials is either wholly aluminum or a mixture of magnesium and aluminum. Preferably, the cation of the dispersed inorganic material is predominately unlike the cation of the dispersing agent.

While the exact composition of the dispersed inorganic materials in these grease systems is not known, it is known that the anions of these materials consist of an admixture of oxide, hydroxide and carbonate. For reason of simplicity, the concentration of the dispersed phase in the

examples is expressed in terms of magnesium hydroxide or aluminum hydroxide.

The thickener of the present invention affords a reduction in cost of from 30 to 40 percent. Because of the large quantity of multi-purpose grease consumed, the annual reduction in cost is considerable.

The proportions of materials used in the process conform in general to the proportions present in the final product.

In order to disclose more clearly the nature and the advantages of the present invention, reference will hereinafter be made to certain specific embodiments which illustrate the flexibility of the herein-described process. It should be clearly understood, however, that this is done solely by way of example and is not to be construed as a limitation upon the spirit and scope of the appended claims.

Example I

PREPARATION OF ALUMINUM ISOBUTOXIDE

Materials used:

15.5 parts aluminum metal (99.9% Al—bar stock)
294.5 parts mixed solvent (40% xylene—60% isobutanol)

Procedure.—The aluminum was added to a three-necked, 500-milliliter, round-bottomed flask equipped with thermometer and reflux condenser. The mixed solvent was then added to the flask. This was followed with the addition of two drops of a saturated solution of mercuric chloride in isobutanol. Heat was applied to the flask and the solvents refluxed until all of the aluminum had reacted. Upon cooling the flask, a clear product was obtained which contained 5.05% (weight) aluminum.

Example II

PREPARATION OF MAGNESIUM ISOBUTYL CARBONATE

Materials used:

25 parts magnesium metal (bar stock)
553 parts isobutanol
515 parts methanol

Procedure.—The magnesium was added to a three-necked, two-liter, round-bottomed flask equipped with two reflux condensers, and a CO₂ gas frit. Five hundred and fifteen parts of isobutanol and 515 parts of methanol were added to the flask. A catalytic amount (0.2 part) of mercuric chloride was added to the flask. The contents were heated to reflux temperature and blowing with CO₂ gas was commenced. After about 20 hours, all of the magnesium had reacted whereupon the methanol was removed by heating to an overhead temperature of 96° C. CO₂ blowing was continued while removing the methanol. After cooling, 38 parts of isobutanol was added to the flask. The product contained a 4.5% (weight) magnesium.

Example III

PREPARATION OF MIXED CATION OVERBASED SULFONATE GREASE

Materials used:

A. 401 parts PDB sulfonic acid (0.572 milliequivalents per gram—total acidity; 0.517 milliequivalents per gram—sulfonic acidity; 494 combining weight, naphtha-solvent)
1090 parts 400 SSU at 100° F. pale oil
55 parts aluminum isobutoxide solution in xylene (5.6% Al)
B. 264 parts magnesium isobutyl carbonate solution in isobutanol (4.7% Mg)
C. 60 parts water

Procedure.—The Group A materials were added to a modified Hobart mixer. The mixture was heated to 50° C. and, while maintaining agitation, the magnesium isobutyl carbonate solution was added. This was fol-

lowed by adding the water. While still maintaining agitation, the pot contents were heated to 200° C. to remove the volatile solvents and unreacted water. At this temperature, the product was grease-like in consistency. After cooling, the grease was homogenized to give a light brown, clear, somewhat granular-textured grease. The addition of one percent or less of high-molecular weight fatty acids eliminates this granulation. This grease had a theoretical composition as follows:

	Percent
Aluminum hydroxy sulfonate	8.3
Aluminum hydroxide	Nil
Magnesium hydroxide	2.4
400 pale oil	89.3

The physical properties on this grease are given in the table.

Example IV

PREPARATION OF MIXED CATION OVERBASED SULFONATE GREASE

Materials used:

- A. 401 parts PDB sulfonic acid (same as Example III)
- 1090 parts 400 SSU at 100° F. pale oil
- 264 parts magnesium isobutyl carbonate solution in isobutanol (4.7% Mg)
- B. 55 parts aluminum isobutoxide solution in xylene (5.6% Al)
- C. 60 parts water

Procedure.—The procedure used was the same as in Example III, with the exception of the magnesium and aluminum solutions being interchanged. The grease gel began forming in this reaction in the range of 150° C. The product was grease-like under working conditions at 230° C. The product was clear, light brown in color, and had a buttery texture. It had the following theoretical composition:

	Percent
Magnesium sulfonate	10.38
Magnesium hydroxide	1.86
Aluminum hydroxide	0.72
400 pale oil	87.18

The physical properties for this grease are given in the table.

Example V

PREPARATION OF MIXED CATION GREASE FROM NATURAL SULFONIC ACID

Materials used:

- A. 135 parts petronic acid (1.53 milliequivalents per gram—total acidity; 53.8%—sulfonic acid; 44.5%—diluent oil)
- 823 parts light intermediate cycle oil having a viscosity of 900 SSU at 100° F.
- 19.5 parts water
- 237 parts magnesium methyl carbonate in methanol (5.05% Mg)
- B. 137 parts aluminum isobutoxide in xylene (5.32% Al)
- C. 88 parts water

Procedure.—The Group A materials were added to a modified Hobart mixer. The mixture was heated to 100° C. to remove methanol. While maintaining agitation; the aluminum isobutoxide solution was added, followed by the addition of the 88 parts of water. The volatile solvents were removed by heating to 150° C. at atmospheric pressure, followed by heating to 210° C. under a nitrogen atmosphere. The product was fluid at 210° C. but cooled to a grease. After homogenizing twice, the grease had a penetration of 300 mm. $\times 10^{-1}$.

It was dark brown in color and work-stable. This grease had a theoretical composition as follows:

	Percent
Magnesium sulfonate	7.5
Magnesium hydroxide	0.6
Aluminum hydroxide	2.1
Cycle oil	89.8

Example VI

PREPARATION OF MIXED CATION GREASE IN SYNTHETIC BASE FLUID

1. Preparation of Intermediate—materials used:

- A. 3080 parts PDB sulfonic acid (0.56 milliequivalents per gram—total acidity; 26.5% sulfonic acid; 23.5%—oil; solvent—naphtha)
- 776 parts di-2-ethylhexyl azelate
- 116 parts water
- B. 2427 parts magnesium isobutyl carbonate in isobutanol (4.03% Mg)

Procedure.—The Group A materials above were placed in a suitable reaction flask. The mixture was heated with stirring to 55° C., whereupon the magnesium isobutyl carbonate solution was added. The volatile solvents were removed by heating to 130° C., followed by heating to 165° C. under a nitrogen atmosphere. A dark, bright, fluid product resulted having the following composition:

	Percent
Mg PDB sulfonate	33.2
Magnesium hydroxide	2.3
Di-2-ethylhexyl azelate	64.5

2. Preparation of Grease—materials used:

- A. 867 parts intermediate
- 1442 parts di-2-ethylhexyl azelate
- B. 111 parts aluminum isopropoxide (13.17% Al)
- 440 parts benzene (solvent for above)
- C. 148 parts water

Procedure.—The Group A materials were added to a modified Hobart mixer. The mixture was heated to 50° C., and the aluminum isopropoxide in benzene was added. This was followed by the addition of the water. The volatile solvents were removed by heating to 200° C. while stirring. While still hot, 11.8 parts of phenothiazine was added as an oxidation inhibitor. The physical properties on this grease are shown in the table.

TABLE

Physical Properties of Greases

	Commercial Lithium Grease	Example III	Example IV	Example VI
Dropping point, °F. 1.....	367	438	470	390
Penetration:				
As received.....	250	300	260	227
60 strokes 2.....	275	340	310	295
10,000 strokes.....	290	350	315	355
Water washout, percent 3.....	2.75	5.8	1.4	2.5
Navy gear wear—Wt. loss, 1,000 cycles.....				
5-pound load.....mg..	2.2	3.0	2.8	
10-pound load.....mg..	7.4	4.5	4.8	

1 ASTM method D 566.

2 ASTM method D 217.

3 ASTM method D 1364.

In summary, the novel greases of this invention have been shown to have properties equivalent or superior to those of lithium-base greases. In addition, the novel greases of this invention have a substantially reduced thickener cost. Furthermore, the greases of this invention may be produced by a relatively convenient process.

While particular embodiments of the invention have been described, it will be understood, of course, that the invention is not limited thereto, since many modifications may be made; and it is, therefore, contemplated to cover

by the appended claims any such modifications as fall within the true spirit and scope of the invention.

The invention having thus been described, what is claimed and desired to be secured by Letters Patent is:

1. A lubricating grease composition comprising an oleaginous vehicle and a minor proportion, sufficient to form a grease, of a mixture of an oil-soluble sulfonate and a basic compound wherein the cation of said sulfonate and said basic compound is selected from the group consisting of aluminum and magnesium, the anion of said basic compound comprises an admixture of oxide, hydroxide and carbonate, said grease-forming agent being further characterized in that the aluminum and magnesium are present in the range of proportions from 1:01 to 1:10, expressed as aluminum to magnesium on a weight basis.

2. A lubricating grease composition comprising from about 50 to about 94 percent by weight of an oleaginous vehicle and from about 6 to about 50 percent by weight of a grease-forming agent, said grease-forming agent comprising a mixture containing from about 40 to about 90 percent by weight of an oil-soluble sulfonate and from about 10 to about 60 percent of a basic compound, wherein the cation of both said sulfonate and said basic compound is selected from the group consisting of aluminum and magnesium, the anion of said basic compound comprises an admixture of oxide, hydroxide and carbonate, said grease-forming agent being further characterized in that the aluminum and magnesium are present in the range of proportions from 1:01 to 1:10, expressed as aluminum to magnesium on a weight basis.

3. A lubricating grease composition as defined in claim 2 wherein the oleaginous vehicle is selected from the group consisting of mineral lubricating oils and synthetic lubricating oils.

4. A lubricating grease composition as defined in claim 3 wherein the oil-soluble sulfonate is an alkaryl sulfonate.

5. A lubricating grease composition as defined in claim 3 wherein the oil-soluble sulfonate is a petroleum sulfonate.

6. A lubricating grease composition as defined in claim 4 wherein the aluminum and magnesium are present in the grease-forming agent in the range of proportions from 1:1 to 1:5 expressed as aluminum to magnesium on a weight basis.

7. A lubricating grease composition as defined in claim

5 wherein the aluminum and magnesium are present in the grease-forming agent in the range of proportions from 1:1 to 1:5 expressed as aluminum to magnesium on a weight basis.

8. A lubricating grease composition as defined in claim 4 wherein the aluminum and magnesium are present in the grease-forming agent in the range of proportions from 1:1 to 1:4.84 expressed as aluminum to magnesium on a weight basis.

9. A lubricating grease composition as defined in claim 5 wherein the aluminum and magnesium are present in the grease-forming agent in the range of proportions from 1:1 to 1:4.84 expressed as aluminum to magnesium on a weight basis.

10. A lubricating grease composition comprising from about 85 to about 92 percent by weight of an oleaginous vehicle selected from the group consisting of mineral lubricating oils and synthetic lubricating oils and from about 8 to about 15 percent by weight of a grease-forming agent, said grease-forming agent comprising a mixture containing from about 60 to about 80 percent by weight of an oil-soluble sulfonate and from about 20 to about 40 percent by weight of a basic compound, wherein the cation of both said sulfonate and said basic compound is selected from the group consisting of aluminum and magnesium, the anion of said basic compound comprises an admixture of oxide, hydroxide and carbonate, said grease-forming agent being further characterized in that the aluminum and magnesium are present in the range of proportions from 1:1 to 1:5, expressed as aluminum to magnesium on a weight basis.

11. A lubricating grease composition as defined in claim 10 wherein the oil-soluble sulfonate is selected from the group consisting of alkaryl sulfonates and petroleum sulfonates.

12. A lubricating grease composition as defined in claim 11 wherein the aluminum and magnesium are present in the grease-forming agent in the range of proportions from 1:1 to 1:4.84, expressed as aluminum to magnesium on a weight basis.

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