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STABILIZED LITHIUM BASE GREASE

Richard A. Butcosk, East Hempstead, N. Y., assignor to Socony-Vacuum Oil Company, Incorporated, a corporation of New York

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This invention relates to lubricating grease compositions suitable for use over a wide range of operating temperatures. More specifically, the present invention is concerned with lithium base greases of excellent lubricating character and stable when used at temperatures varying from about -70° F. to about 250° F.

In recent years, a demand has been created for greases of outstanding lubricating character which retain their grease structure during use over a wide range of operating temperatures. Typical of such a demand is that created by the aircraft industry. For efficient aircraft operation, greases should have low temperature torque properties such that they will flow properly at temperatures as low as about -70° F. In addition, the greases should be of low volatility and retain their grease structure at temperatures at least high as 250° F. Failure to retain grease structure results in high consumption of grease and frequent servicing. Other desirable features of such greases are: homogeneity and smooth, unctuous consistency; water resistant; resistant to oxidation; resistant to oil separation; and resistant to sheer or breakdown upon working or milling.

The demand for greases of the foregoing specification has not been satisfied to date, except by resort to expensive operating procedures. It has been found, for example, that lithium base greases containing vehicles comprising esters of dibasic organic acids, such as di-octyl sebacate, are suitable for low temperature operations. They also have the desired homogeneous nature and smooth consistency, and have satisfactory water resistance. Yet, these lithium base greases do not retain their gel structure at high temperatures (e. g. 250° F.), and are deficient in oxidation stability. One approach taken to effect improvement of these lithium base greases involves a special film-cooling technique to obtain satisfactory grease structure. As will be evident to those skilled in the art, film-cooling is a slow and expensive procedure requiring special equipment. Another approach taken to effect such improvement involves the use of a lithium soap of 12-hydroxy stearic acid and quick cooling. Still another approach involves the use of a very high soap content grease. Still another means adopted to improve grease structure is the use of a mixed soap, namely the use of a calcium soap in admixture with the lithium soap. However, calcium-lithium base greases are deficient in mechanical stability and have lower melting points, thus requiring their use at lower operating temperatures (e. g. below 250° F.).

It is an object of this invention, therefore, to

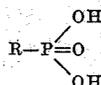
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provide a grease effective over a wide temperature range, particularly from about -70° F. to about 250° F. A further object is to provide a grease which retains its original character over a wide range of operating conditions. Another object is to provide a grease of desired character which can be manufactured by conventional grease procedures in conventional grease-making equipment. Other objects of the invention will be apparent from the following description.

It has now been discovered that lithium base greases containing vehicles comprising esters of polybasic organic acids are greatly enhanced by the incorporation therein of small amounts of certain lithium phosphonates and/or lithium phosphinates, such that the foregoing objects are realized.

The lithium phosphonates contemplated herein are lithium salts of the phosphonic acids represented by general Formula I:

(I)



wherein R is an aliphatic group containing from about four to about 22 carbon atoms per molecule, a mono-cyclic aryl group, an alkylated mono-cyclic aryl group, a mono-cyclic naphthyl group or an alkylated mono-cyclic naphthyl group.

Typical of such phosphonate soaps are the mono- and di-lithium salts, and mixtures of such mono- and di-lithium salts, of the following acids: n-butyl phosphonic acid; iso-butyl phosphonic acid; amyl phosphonic acids; 2-ethyl-hexyl phosphonic acid; tetradecyl phosphonic acid; n-octadecyl phosphonic acid; eicosanyl phosphonic acid; docosanyl phosphonic acid; phenyl phosphonic acid; cresyl phosphonic acid; dodecyl benzene phosphonic acid; cyclohexyl phosphonic acid, etc. Particularly effective of such soaps are the di-lithium salts of the following acids: 2-ethyl-hexyl phosphonic acid; tetradecyl phosphonic acid; n-octadecyl phosphonic acid; phenyl phosphonic acid; and dodecyl benzene phosphonic acid.

As indicated above, it has also been discovered that the closely related lithium phosphinates are effective when incorporated in corresponding lithium base greases. The lithium phosphinates of this invention are lithium soaps of the phosphinic acids represented by general Formula II:

(II)



wherein R_1 and R_2 can be the same or different and are selected from the groups represented by the symbol R in general Formula I above.

Representative of such soaps are the lithium salts, and mixtures thereof, of the following acids: di-(n-butyl) phosphinic acid; di-(amyl) phosphinic acids; n-butyl, amyl phosphinic acid; di-(2-ethyl hexyl) phosphinic acid; di-(tetradecyl) phosphinic acid; methyl, n-octadecyl phosphinic acid; di-(phenyl) phosphinic acid; di-(cyclohexyl) phosphinic acid, etc. Lithium di-(2-ethyl hexyl) phosphinate and lithium di-(phenyl) phosphinic acid are two salts which have proven particularly satisfactory.

The lithium salts of the phosphonic and phosphinic acids represented above by the general formulae can be prepared by any of the methods known in the art. An excellent review of methods of preparation of phosphonic and phosphinic acids and their corresponding metal salts, is provided by the recent text of G. M. Kosolapoff "Organophosphorus Compounds," Wiley; New York; 1950.

As shown above, the metal component of the phosphonate and/or phosphinate salt is lithium. It will be apparent that the lithium soap can be prepared by reacting lithium hydroxide, for example, with a phosphonic or phosphinic acid. It will be noted also that the metal used in the soap component of the grease and also in the modifier, that is the phosphonate and/or phosphinate, is the same. This is a decided advantage in preparing the grease, and avoids the difficulties normally encountered in balancing the proportions of mixed metals in a mixed base grease.

The lithium phosphonates and/or phosphinates are used in amounts of the order of from about 0.25% to about 5%, by weight of the grease. Generally, however, particularly advantageous behavior is realized with from about 0.75 to about 2.5% of a lithium phosphonate; similarly, excellent results have been obtained with from about 0.5 to about 1.5% of a lithium phosphinate.

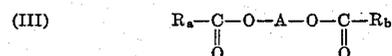
The lithium fatty acid soaps constituting the major soap component of the greases of this invention are prepared with fats and fatty acids generally used in soap type greases. Such fatty materials contain from about eight to about twenty-two carbon atoms per molecule. Representative of such materials are vegetable, animal and fish fatty oils, and hydrogenated fatty materials thereof. Stearin, stearic acid, cottonseed oil acids, oleic acid, palmitic acid, myristic acid, 12-hydroxy stearic acid, hydrogenated fish oils such as "Hydrogenated Fish Oil, Iodine No. 77" and "Hydrofol" are typical. Preferred soaps, however, are lithium stearate and the lithium soap of 12-hydroxy stearic acid. Methods of preparation of lithium soaps are well known in the art and discussion of the same is believed to be unnecessary.

It is also contemplated that the greases can contain relatively minor amounts of other soaps, such as soaps of alkaline earth metals and aliphatic fatty acids. Typical of such soaps are calcium stearate, strontium stearate and barium stearate, calcium palmitate and the like.

The oils of the greases contemplated herein include synthetic vehicles comprising esters of aliphatic dibasic acids. Suitable acids from which the esters are derived are: sebacic, glutaric, azelaic, succinic, malonic, phthalic, adipic, pimelic and suberic. Typical alcohols used in preparing the esters are: butyl, iso-butyl, hexyl, octyl,

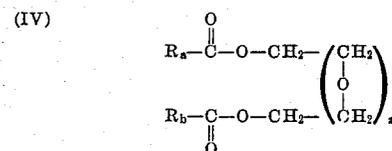
2-ethyl hexyl, cyclohexyl, 2-ethyl butyl, 3-methyl butyl. Accordingly, esters of the type suitable herein include: di-(2-ethyl hexyl) sebacate, dibutyl glutarate, dihexyl azelate, diamyl succinate, didecyl malonate, dibutyl phthalate, di-(2-ethyl hexyl) adipate. It will be understood, that, in accordance with present day knowledge of such synthetic vehicles, simple or mixed esters are contemplated, as are esters containing one or more substituent groups such as halogen, phosphorus, sulfur, nitrogen.

Other synthetic vehicles suitable herein are esters of poly alcohols and monocarboxylic acids. These synthetic ester vehicles can be represented by general Formula III:



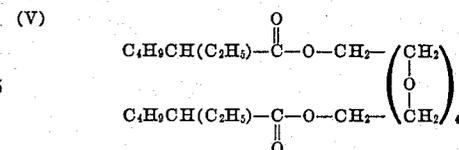
wherein R_a and R_b are either the same or different aliphatic groups, such as amyl, isoctyl, 2-ethyl hexyl, etc., and A represents an alkyl ether group such as ethylene oxide, propylene oxide, butylene oxide and the like.

Particularly advantageous of such esters of poly alcohols and monocarboxylic acids are those represented by general Formula IV below:



wherein R_a and R_b are described above in connection with general Formula III and x is an integer from 1 to 8.

Representative of such esters is polyethylene glycol di-(2-ethyl hexoate), also referred to as polyglycol, dioctoate. This material has the following Formula V:



and has the following properties:

Specific gravity, 20/20° C	0.982
Pour point, ° F	-70
Flash point, ° F	402
Fire point, ° F	455
Viscosity, centistokes:	
@ 210° F	3.01
@ 130° F	7.5
@ 100° F	12.2
@ -40° F	3529
Viscosity, S. U. S. @ 100° F	67
Viscosity index	115
Approximate molecular weight	446

The latter material is marketed under the designation "Ucon" Brand Fluid 818, or Flexol Plasticizer 4G0.

The synthetic vehicles described above and contemplated for use in the greases of this invention generally have a viscosity from about 40 seconds to about 300 seconds, S. U. V., at 100° F. Particularly desirable are those having a viscosity of the order of 60-70 seconds, S. U. V., at 100° F.

The proportions of the lithium soap, lithium phosphonate and/or phosphinate, and synthetic ester lubricant are balanced in order to provide

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greases of the desired character. The lithium soap or soaps comprise from about 8 to about 20 per cent (by weight) of the finished grease, and preferably from about 10.0 to about 17.0 per cent. For example, when more than 20% of a lithium soap is used in the grease, the grease becomes hard and unsuited for use over a wide range of temperatures such as contemplated herein. The lithium phosphonate and/or phosphinate, as indicated above is present in the finished grease in amounts ranging from 0.25 to about 5 per cent. The ester lubricant constitutes the balance of the grease. Accordingly, the various constituents (on a dry basis) of the new greases can vary within the following limits:

	General	Preferred
Lithium Soaps.....	8-20	10-17
Lithium Phosphonates.....	0.25-5	0.75-2.5
Lithium Phosphinates.....	0.25-5	0.5-1.5
Ester Lubricant.....	Balance to 100 percent	

It is to be understood that the greases of this invention can also contain other characterizing materials. For example, the greases can contain grease antioxidants such as amines, phenols, sulfides, etc., and lubricity improving agents such as free fat, free fatty acids, esters of alkyl and/or aryl acids, sulfurized fats, lead soaps, etc. These characterizing materials do not detract from the lubricating value of the greases contemplated herein nor do they detract from the beneficial properties imparted by the phosphonate and/or phosphinate salt; rather, these characterizing materials serve to impart their customary properties to the grease.

By way of illustration, the greases of this invention can be formed in the following manner. A phosphonic acid in water, or low molecular weight aliphatic alcohol, is neutralized with sufficient lithium hydroxide to phenolphthalein end point, thereby forming a lithium phosphonate. The phosphonate is mixed with lithium soap, such as lithium stearate, and with approximately one half of the diester vehicle to be used. The ingredients are mixed thoroughly and, while agitated constantly, are heated to a temperature of about 380-390° F. for about 20-30 minutes. The balance of the diester vehicle is then added and the resulting mixture is heated to 400-410° F. for 15-20 minutes. The product is withdrawn from the vessel in which it is prepared and is poured into a suitable mold, as a pan. The grease product is allowed to cool to room temperature, about 20-25° C., whereupon it solidifies. The solid grease is then cut into cakes of the desired size, and milled to desired consistency.

It is to be understood that the lithium phosphonate can be used as a pre-formed product, rather than formed in situ through reaction of lithium hydroxide and alkyl or aryl phosphonic acid. Similarly, the lithium soap or soaps used can be pre-formed as shown above or can be prepared in situ by reaction of a suitable lithium salt and fat or fatty acid.

Other suitable methods for preparing the greases include preparation of a lithium stearate and a lithium phosphonate in an unsaponifiable media by neutralization of the stearic and phosphonic acids with lithium hydroxide, and then admixing the stearate and phosphonate and unsaponifiable media with the ester vehicle. The resulting mixture is then heated to 400-420° F. for a suitable period of time and then allowed to cool to room temperature, about 70° F.

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A note of caution should be given in connection with the preparation of the greases. Inasmuch as esters are susceptible to saponification, they should not be used in the preparation of the grease until the formation of the lithium soap is complete, if a lithium soap is formed in situ. If they are formed in the diesters, they should be reacted at relatively low temperatures such as 80 to 200° F.

The greases of this invention are illustrated by the following examples tabulated in Table I below. Provided also in Table I are comparable examples in which lithium base greases other than those contemplated herein are illustrated. Each of the greases shown in Table I was prepared according to the procedure first described above.

In Table I, the appearance and performance characteristics of the greases are recited. Salient tests, other than visual inspection, are those which demonstrate the resistance of the grease to disintegration by shearing stresses.

The Shell Roll Test used is that which is described in The Institute Spokesman; March 1, 1943; pages 1, 4 and 5; this publication is the official organ of the National Lubricating Grease Institute. This test reveals mechanical stability or sheer resistance of the grease.

Another significant test is the resistance of grease to milling. This was investigated by two methods, one by milling with a spatula, and the other by processing in the automatic worker. The latter method is the A. S. T. M. method (D217-48) for preparing greases for the determination of worked penetration. However, for the purpose of this investigation, the grease sample under test was subjected to 100,000 double strokes (using $\frac{1}{8}$ " holes), instead of the 60 double strokes (using $\frac{1}{4}$ " holes) prescribed for a conventional work penetration test. Accordingly, the test conditions used in this investigation were more rigorous than those customarily used.

The oil separation test used is that which is normally used for lithium base greases, and measures oil separated from grease during a 24 hour period, with the grease sample maintained at 210° F. in a constant temperature oven. (U. S. Government Specification ANG-25.)

In reviewing the results set forth in Table I, it will be noted that greases 1 through 4, 8 and 10, represent various combinations of lithium base greases without lithium phosphonate or phosphinate. All of these greases are deficient in structure and suffer from excessive oil separation.

Greases 5, 6, 7, 9, and 11 through 15, represent novel compositions of the present invention. These greases form firm blocks or cakes upon cooling in the pans. Without the phosphonate or phosphinate salt, the center of the greases in the pans are semi-fluid and the sides are extremely firm. The lithium phosphonates and phosphinates cooperate in the greases to impart the property of easy milling; they also provide a mechanically stable buttery grease with low bleeding or oil separation in storage. The greases retain their properties at elevated temperatures, that is, they do not change materially in consistency at elevated temperatures.

Greases 16 through 22 are still other greases containing lithium or magnesium salts—other than phosphonates or phosphinates—as improving agents. All of these greases are markedly inferior to the novel greases contemplated herein.

Table I—Continued

Experiment No.	16	17	18	19	20	21	22
Lithium Stearate	15.0	10.0	10.0	5.0	10.0		
Lithium 12 Hydroxy Stearate	do	do	do	do	do		
Lithium Salt of Tetra Decyl Phosphonic Acid	do	do	do	do	do		
Lithium Salt of Benzene Phosphonic Acid	do	do	do	do	do		
Lithium Salt of n-Octadecane Phosphonic Acid	do	do	do	do	do		
Lithium Salt of 2 Ethyl Hexyl Phosphonic Acid	do	do	do	do	do		
Lithium Salt of Di (2 Ethyl Hexyl) Phosphinic Acid	do	do	do	do	do		
Lithium Salt of Benzene Phosphinic Acid	do	do	5.0	10.0	10.0	15.0	15.0
Lithium Laurate	do	do	do	do	do		
Lithium Behenate	do	do	do	do	do		
Lithium Naphthenate	do	do	do	do	do		
Magnesium Stearate	2.0	2.0	85.0	85.0	80.0	85.0	85.0
Polyethylene Glycol Dk-2-Ethyl Hexoate)	83.0	88.0	85.0	85.0	80.0	85.0	85.0
Di(2-Ethyl Hexyl) Sebacate	do	do	do	do	do	do	do
Appearance of Liquid Grease @ 40° F	Transparent Mussy and Semi-Fluid Center.	Transparent Semi-Fluid.	Transparent Semi-Fluid.	Transparent Sides Mussy, Center Semi-Fluid.	Transparent Sides Mussy and Center.	Transparent Sides Mussy, Center Semi-Fluid.	Transparent Sides Mussy, Center Semi-Fluid.
Appearance of Pan Cooled Grease.	Transparent Mussy and Semi-Fluid Center.	Transparent Semi-Fluid.	Transparent Semi-Fluid.	Transparent Sides Mussy, Center Semi-Fluid.	Transparent Sides Mussy and Center.	Transparent Sides Mussy, Center Semi-Fluid.	Transparent Sides Mussy, Center Semi-Fluid.
Appearance of Milled Grease.	Transparent Mussy and Semi-Fluid Center.	Transparent Semi-Fluid.	Transparent Semi-Fluid.	Transparent Sides Mussy, Center Semi-Fluid.	Transparent Sides Mussy and Center.	Transparent Sides Mussy, Center Semi-Fluid.	Transparent Sides Mussy, Center Semi-Fluid.
Mechanical Stability: (Automatic Worker 100,000 Double Strokes, 1/4 inch Holes)	100	100	100	100	100	100	100
Shell Roll Test, 2 hours:	100	100	100	100	100	100	100
Shell Micro Penetration, Initial	100	100	100	100	100	100	100
Shell Micro Penetration, After Test	100	100	100	100	100	100	100
Oil Separation @ 210° F for 24 hours, percent	0	0	0	0	0	0	0
ASTM Dropping Point, °F	242	242	242	242	242	242	242

Manufacturing processing includes kettle cooling, conventional pan cooling or quick cooling (shock chilling). This is shown by the results provided in Table II, below. The greases shown in Table II were prepared in the same manner as those described above in connection with Table I, with the exception of the cooling technique employed. The rate of kettle cooling, while maintaining agitation of the grease, is determined by a temperature decrease from 420° F. to 150° F. during a time interval of 2 1/4 hours. With conventional pan cooling (no agitation), the temperature was decreased from 420° F. to room temperature, about 80° F., during a three hour period. Film cooling or quick cooling (no agitation) brought the temperature down from 420° F. to about 100° F. in less than ten minutes.

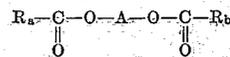
Table II

	Kettle Cooled	Pan Cooled	Quick Cooled
Ingredients, Percent by Wt.:			
Lithium stearate	15.0	15.0	15.0
Lithium tetradecyl phosphonate	2.0	2.0	2.0
Polyethylene glycol di(2-ethyl hexoate)	83.0	83.0	83.0
Physical Properties:			
ASTM Penetration @ 77° F	242/242	268/282	244/264
50,000 strokes (1/4" holes)	306	331	326
Shell Roll Test, 2 hours			
Micro Penetration:			
Before	60	88	79
After	93	103	110

Taking into consideration all of the test data of Table II, it is evident that the three greases are extremely stable and most satisfactory, regardless of the cooling technique employed.

I claim:

1. In a lithium base grease comprising a lubricating liquid comprising an ester of an organic acid and an alcohol selected from the group consisting of esters of aliphatic dibasic acids and of alcohols having from about four to about ten carbon atoms per molecule and esters represented by general formula



wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and A represents an alkyl ether group, and a lithium soap, the improvement which comprises: incorporating therein a minor amount, sufficient to increase the stability of said grease, of a lithium salt of an acid selected from the group consisting of



and



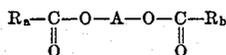
wherein R is selected from the group consisting of an aliphatic hydrocarbon group containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, an alkyl-substituted monocyclic aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group, and wherein R₁ and R₂ are selected from the group consisting of the same and different R groups.

2. The grease defined by claim 1 wherein the lithium salt is present in an amount from about

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0.25 per cent to about 5 per cent by weight, of the grease.

3. A lubricating grease comprising: a dibasic acid ester vehicle selected from the group consisting of esters of aliphatic dibasic acids and of alcohols having from about four to about ten carbon atoms per molecule and esters represented by general formula



wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and A represents an alkyl ether group, a lithium soap in quantity sufficient to substantially thicken said vehicle, and a minor amount, sufficient to increase the stability of said grease, of a lithium salt of a phosphonic acid represented by the general formula



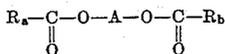
wherein R is selected from the group consisting of an aliphatic hydrocarbon group containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, and an alkyl-substituted aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group.

4. The grease defined by claim 3 wherein the lithium phosphonate is present in an amount from about 0.75 per cent to about 2.5 per cent by weight, of the grease.

5. A lubricating grease comprising: a lithium soap content from about 8 to about 20 per cent by weight, about 0.25 to about 5 per cent by weight of a lithium salt of a phosphonic acid represented by the general formula



wherein R is selected from the group consisting of an aliphatic hydrocarbon group containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, and an alkyl-substituted aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group, and the balance a dibasic acid ester vehicle selected from the group consisting of esters of aliphatic dibasic acids and of alcohols having from about four to about ten carbon atoms per molecule and esters represented by general formula



wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and A represents an alkyl ether group.

6. A grease as defined by claim 5 wherein the ester is di(2-ethyl hexyl) sebacate.

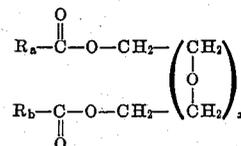
7. A grease as defined by claim 5 wherein the phosphonate is lithium tetradecyl phosphonate.

8. A lubricating grease comprising: about 15 per cent by weight of lithium stearate, about 2 per cent by weight of lithium tetradecyl phosphonate and the balance di(2-ethyl hexyl) sebacate.

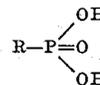
9. A lubricating grease comprising: a vehicle comprising an ester of a polyhydric alcohol and

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a monocarboxylic acid represented by the general formula



wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and x is an integer from 1 to 8, a lithium soap in quantity sufficient to substantially thicken said vehicle, and a minor amount, sufficient to increase the stability of said grease, of a lithium salt of a phosphonic acid represented by the general formula

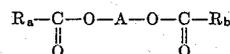


wherein R is selected from the group consisting of an aliphatic hydrocarbon group containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, and an alkyl-substituted aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group.

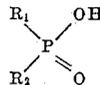
10. A grease as defined by claim 9 wherein the phosphonate is lithium tetradecyl phosphonate.

11. A grease as defined by claim 9 wherein the vehicle is polyethylene glycol di(2-ethyl-hexanoate) having a molecular weight of about 446.

12. A lubricating grease comprising: a dibasic acid ester vehicle selected from the group consisting of esters of aliphatic dibasic acids and of alcohols having from about four to about ten carbon atoms per molecule and esters represented by general formula



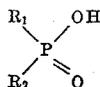
wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and A represents an alkyl ether group, a lithium soap in quantity sufficient to substantially thicken said vehicle, and a minor amount, sufficient to increase the stability of said grease, of a lithium salt of a phosphonic acid represented by the general formula



wherein R_1 and R_2 are selected from the group consisting of an aliphatic hydrocarbon group containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, an alkyl substituted monocyclic aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group.

13. The grease defined by claim 12 wherein the lithium phosphinate is present in an amount from about 0.5 per cent to about 1.5 per cent of the grease.

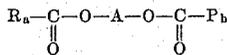
14. A lubricating grease comprising: a lithium soap content from about 8 to about 20 per cent by weight, about 0.25 to about 5 per cent by weight of a lithium salt of a phosphonic acid represented by the general formula



wherein R_1 and R_2 are selected from the group consisting of an aliphatic hydrocarbon group

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containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, an alkyl-substituted monocyclic aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group, and the balance of a dibasic acid ester vehicle selected from the group consisting of esters of aliphatic dibasic acids and of alcohols having from about four to about ten carbon atoms per molecule and esters represented by general formula



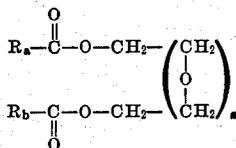
wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and A represents an alkyl ether group.

15. A grease as defined by claim 14 wherein the ester is di(2-ethyl hexyl) sebacate.

16. A grease as defined by claim 14 wherein the phosphinate is lithium di(2-ethyl hexyl) phosphinate.

17. A lubricating grease comprising: about 15 per cent by weight of lithium stearate, about 2 per cent by weight of lithium di(2-ethyl hexyl) phosphinate and the balance di(2-ethyl hexyl) sebacate.

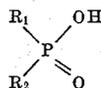
18. A lubricating grease comprising: a vehicle comprising an ester of a polyhydric alcohol and a monocarboxylic acid represented by the general formal



wherein R_a and R_b are aliphatic groups each having from about five to about eight carbon atoms and x is an integer from 1 to 8, a lithium soap in quantity sufficient to substantially thick-

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en said vehicle, and a minor amount, sufficient to increase the stability of said grease, of a lithium salt of a phosphinic acid represented by the general formula



wherein R_1 and R_2 are selected from the group consisting of an aliphatic hydrocarbon group containing from about four to about twenty-two carbon atoms, a monocyclic aryl group, an alkyl-substituted monocyclic aryl group, a monocyclic naphthene group and an alkyl-substituted naphthene group.

19. A grease as defined by claim 18 wherein the phosphinate is lithium di(2-ethyl hexyl) phosphinate.

20. A grease as defined by claim 18 wherein the vehicle is polyethylene glycol di(2-ethyl-hexanoate) having a molecular weight of about 446.

21. A lubricating grease comprising: about 15 per cent by weight of lithium stearate, about 2 per cent by weight of lithium di(2-ethyl hexyl) phosphinate and the balance polyethylene glycol di(2-ethyl hexanoate) having a molecular weight of about 446.

RICHARD A. BUTCOSK.

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