United States Patent Office 2,858,273 Patented Oct. 28, 1958

2,858,273

EXTREME PRESSURE LUBRICATING GREASE

Harry J. Worth, Fullerton, Calif., assignor to Union Oil Company of California, Los Angeles, Calif., a corporation of California

No Drawing. Application May 28, 1956
Serial No. 587,454

11 Claims. (Cl. 252—36)

This invention relates to lubricating greases and particularly to greases suitable for use in bearings which are subject to high loads and sudden shock such as are encountered in the chassis of heavy trucks and the like, as well as for use in industrial applications where in addition to the above conditions high or moderately high temperatures may be encountered. Thus in particular the invention relates to greases, for example calcium base greases, having extreme pressure and antiwear characteristics which greases possess good mechanical stability even at elevated temperatures. It relates particularly to lubricating greases thickened with calcium soaps of hydroxy fatty acids, as for example 12-hydroxy stearic acid, and containing materials which greatly improve the extreme pressure characteristics of the grease and other materials which stabilize the grease with respect to consistency when worked or used at elevated temperatures.

The preparation of calcium base greases of relatively stable character using hydroxy fatty acids and particularly 12-hydroxy stearic acid as the soap-forming ingredients is well known in the art. Moreover it is known to add sulfur and/or chlorine-containing materials to greases of various types to improve the extreme pressure characteristics of such greases. It is found, however, that the addition of such compounds to greases and particularly calcium 12-hydroxy stearate greases causes instability with respect to consistency when the grease is used in bearings particularly if temperatures in the bearings are relatively high. Moreover relatively large proportions of such extreme pressure agents must be added in order to obtain a moderate degree of load-carrying ability and antiwear characteristics.

Applicant has found that starting with a grease prepared from the calcium soap of hydroxy fatty acids, particularly calcium 12-hydroxy stearate, if he adds a sulfur and/or chlorine containing extreme pressure agent in amounts sufficient to impart desirable E. P. characteristics to the grease, the grease has poor mechanical stability. The mechanical stability of a grease is readily determined by measurements made with a penetrometer before and after working or beating at elevated temperatures. For example it is found from penetration tests made on a grease containing E. P. additives and having an original penetration, as measured by the Shell micropenetration test, of 120 show an increase of 80 to 100 or more points in the penetration following working at 250° F. for 3 hours. In some cases the grease becomes fluid following such working and is far too soft to permit a penetration determination to be made.

Applicant has further found that the proportion of E. P. agent required to produce a grease having the desired E. P. and antiwear characteristics may be greatly reduced by incorporating in the grease, together with such E. P. agent, small amounts of a hydroxy organic compound containing 3 or 4 hydroxyl groups per molecule, such as for example glycerine or pentaerythritol. Although this combination of additives produces the desired effect of imparting unusually good E. P. and antiwear characteristics the resulting greases are found to have very poor mechanical stability.

Applicant has now found that if in addition to the E. P. agent and the organic hydroxy compound, he adds relatively small proportions of triethanolamine or a soap of triethanolamine, as for example triethanolamine 12-hydroxy stearate, he obtains a grease which has exceptionally high extreme pressure and antiwear characteristics and which also has good mechanical stability. Most of such compositions are found to be fully as stable as the original grease prepared without additives. In fact in some cases the mechanical stability of the grease containing the three additive materials is even greater than the grease without additives.

It is an object of this invention to prepare a grease having high extreme pressure characteristics, which grease does not soften objectionably in service at elevated temperatures.

A further object of this invention is to provide a grease having all of the advantages of a calcium 12-hydroxy stearic acid grease, and in addition having high extreme pressure and antiwear characteristics.

It is a more particular object of this invention to prepare an extreme pressure grease having antiwear characteristics and consisting primarily of mineral oil thickened to grease consistency with calcium 12-hydroxy stearate and containing a sulfur and/or chlorine type extreme pressure agent, a hydroxy organic compound having 3 to 4 hydroxyl groups per molecule and triethanol amine or a triethanolamine soap.

The present invention resides in a calcium base grease in which a hydroxy fatty acid such as 12-hydroxy stearic acid is saponified with calcium oxide or calcium hydroxide to produce the soap, which grease contains relatively small amounts of a sulfur and/or chlorine containing extreme pressure agent or agents, relatively smaller percentages of an organic compound containing 3 to 4 hydroxyl groups per molecule, and a small proportion sufficient to impart mechanical stability to said grease of triethanolamine or a triethanolamine soap. The invention may be otherwise stated as comprising an extreme pressure, antiwear lubricating grease which grease is stable when worked or when used at ordinary or elevated temperatures, containing as essential constituents a mineral lubricating oil, the calcium soap of hydroxy fatty acid to thicken the oil and produce a grease-like composition, a relatively small amount of an extreme pressure agent selected from the class consisting of sulfur and/or chlorine containing extreme pressure agents, a relatively smaller proportion of a compound such as glycerine or pentaerythritol and a small proportion of triethanolamine or a soap thereof. The invention resides also in methods of making such greases.

In practicing the invention, a grease is prepared by heating a mixture of calcium hydrate, a chemically equivalent amount of 12-hydroxy stearic acid, and an amount of mineral lubricating oil equal to from 0.5 to about 4 parts per part of 12-hydroxy stearic acid. This mixture is stirred and heated to a temperature of about 225° F. over a period of 3 to 4 hours to effect saponification and partial dehydration of the reaction mixture. At this time an additional 2 to 10 parts of oil per part of original 12-hydroxy stearic acid is added, while continuing the heating and agitation and the alkalinity of the product is adjusted by adding either additional quantities of 12-hydroxy stearic acid or calcium hydrate as required to bring the grease to a neutral or slightly alkaline condition. Following this adjustment small amounts of a conventional oxidation inhibitor as for example 0.2 to 1% by weight of a hydrocarbon-substituted diphenyl amine are added if desired and between about 0.5% and about 5% by weight of an extreme pressure agent, as for ex-

ample sulfurized fish oil, chlorinated paraffin wax, or a mixture of these two materials, between about 0.2% and about 0.8% by weight of a tri- or tetrahydroxy organic compound, as for example glycerine or pentaerythritol, and between about 0.2% and 1.0% by weight of triethanol amine are added and well mixed into the grease. The percentages indicated for inhibitor, E. P. agent, hydroxy compound and triethanol are based on the weight of finished grease.

Agitation of the grease is continued while the remainder of the oil desired is incorporated in the grease. Generally approximately half the total amount of oil to be used is added prior to the adjustment of alkalinity and prior to the addition of inhibitor, E. P. agent, etc., the remainder of the oil being added slowly as the grease is agitated until cooled. Following the addition of the final amounts of oil to bring the grease to the desired grade and following cooling, the product is ready for packaging. During the final steps of preparation it may be pumped through screens and/or special working or homogenizing devices to stabilize the consistency and to produce a smooth grease-like product. Greases prepared in this manner have good mechanical stability and high E. P. and antiwear characteristics.

Although in the above preparation the E. P. agent, hydroxy compound and triethanolamine were all added during the preparation of the grease it is found that these additives may be incorporated in a finished grease by suitable procedures. Thus a finished grease may be placed in a grease kettle and the additives incorporated therein by simple agitation at ordinary or slightly elevated temperatures or the finished grease may be passed through a mixing or homogenizing device in a continuous manner, the desired amounts of the additives being added to the grease being treated. In order to determine the effect of the various additive materials described herein on the antiwear and E. P. characteristics and on the mechanical stability of greases these additives have been added to and incorporated in finished greases as will be seen from the description particularly as set forth in the examples.

The mechanical stability of greases described herein has been evaluated by means of a test which will be referred to as the "beater test" in which the grease is maintained at 250° F. while being "worked" or agitated for a period of 3 hours. The test unit consists of an open cylindrical steel container 2⅞ inches deep by 3¾ inches in diameter having external means for heating. A ball-bearing assembly (New Departure No. 43207) having a diameter of 2¾" is supported horizontally approximately ¼ inch above the bottom of the container by means of lugs welded to the outer race of the bearing. These lugs engage lugs welded inside the container and prevent the outer race of the bearing from turning. The inner race of the bearing is rotated at a speed of 3600 R. P. M. by means of a shaft engaging the bearing. In running the test approximately ¾ pound of grease is placed in the test unit, brought to a temperature of 250° F. and the shaft engaging the bearing is rotated at 3600 R. P. M. for 3 hours. At the end of this time the grease is cooled and penetration is determined on the cooled grease. It is to be noted that during this test the grease is not aerated since the bearing, which acts as an agitator, remains completely covered and the overall movement of grease in the container is slow enough that a vortex does not form.

Penetration values described herein were determined by means of the Shell micropenetrometer. This apparatus and its method of use are described in The Institute Spokesman for March 1943, volume VI, No. 12, pages 1, 4 and 5.

The load carrying or E. P. characteristics and antiwear characteristics of the greases described herein were determined by means of tests run on the standard Timken lubricant test machine and on a Falex test machine manufactured by the Faville-Levally Corporation. Both of these test machines are well known in the oil industry.

In the Timken test in which a hardened steel ring or "cup" is rotated against a hardened steel test block while being lubricated with the lubricant under test the machine was started and run one minute without load. During the next 9 minutes load was applied at a constant rate sufficient to reach 50 pounds at the end of the nine minute period. When seizure of the test pieces occurred before completion of the test period the test was discontinued and the load at time of seizure was noted. In some cases where it was observed that the grease supported 50 pounds the rate of loading was increased to reach 100 pounds at the end of the test. The load at time of seizure was noted as above.

In the Falex test machine Phosphor bronze pins were run against steel blocks using a load of 1750 pounds for 30 minutes or until seizure occurred. The maximum temperature reached was determined by means of a thermocouple inserted in a hole drilled in a jaw supporting one of the steel blocks. The weight loss of the bronze pin was determined at the end of the test.

E. P. agents which are to be employed in preparing the greases of this invention include any of the well known E. P. agents useful in mineral lubricating oils and greases. These include sulfurized fatty oils, e. g., sulfurized lard oil or fish oil and sulfurized hydrocarbon oils, in each case containing about 8% to about 15% of sulfur; chlorinated fatty oils, chlorinated hydrocarbon oils, chlorinated paraffin wax, and the like, containing 25% to 40% by weight of chlorine; sulfochlorinated hydrocarbons or fatty oils such as those prepared by treatment of these materials with sulfur chlorides; hydrocarbon substituted mercaptothiazoles wherein the hydrocarbon substituent or substituents may be alkyl or aryl groups or may form condensed ring structures with said mercaptothiazoles, e. g. 2-mercapto-benzothiazole; metal hydrocarbon substituted thiocarbamates having the formula



where M is the hydrogen equivalent of a metal, X is oxygen or sulfur and at least one X is sulfur and N is attached to two separate hydrocarbon radicals or in which N forms a part of a heterocyclic ring compound; mixtures of the above sulfur and/or chlorine containing materials; mixtures of any of the above materials with an oil soluble lead salt, e. g. lead naphthenate, lead sulfonate, or the like.

Of the metal thiocarbamates the dithio compounds, i. e. those in which both X's in the above formula represent sulfur are preferred. Moreover the preferred compounds are those having two alkyl hydrocarbon substituents of 1 to about 18 carbon atoms each, such as the methyl, ethyl, propyl, butyl, octyl, dodecyl, etc., groups. The substituents may be the same or different but the total carbon atom content of the substituents should be at least about 4 carbon atoms. Although polyvalent metals generally may be used the alkaline earth metals, calcium, magnesium, strontium and barium, as well as cobalt, iron, nickel, aluminum, tin, chromium, copper, manganese, mercury, lead and zinc are preferred. Of these zinc and nickel appear to be outstanding and are therefore particularly preferred. Zinc dibutyl dithiocarbamate is found to give excellent results. Methods of preparing the above types of compounds are disclosed in United States Patent No. 2,265,851.

One E. P. additive consisting essentially of a mixture of sulfurized fish oil, chlorinated hydrocarbon and lead naphthenate available on the market under the name of Elco SCL and obtainable from Elco Lubricant Corporation of Cleveland, Ohio has been found to be particularly effective in combination with a tri- or tetrahydroxy compound in reducing wear of the type encountered in bearings of the bronze-steel type. This

combination also imparts good E. P. characteristics. Analysis of Elco SCL shows that this material contains approximately 7% by weight of lead as lead oxide, or about 20% of lead naphthenate; 4% by weight of chlorine, or about 20–25% by weight of chlorinated hydrocarbon; and 5.25% by weight of sulfur, or 55–60% by weight of sulfurized fish oil. All of the sulfur and/or chlorine containing E. P. agents described herein as being useful are organic compounds.

The polyhydroxy compounds which cooperate with the E. P. additives to impart exceptional E. P. and antiwear characteristics as indicated hereinabove are those compounds containing 3 or 4 hydroxyl groups per molecule. Glycerin and pentaerythritol appear to have outstanding effect. Dihydroxy alcohols such as the glycols and polyglycols are without effect as are the penta- and hexa-hydroxy compounds e. g. sorban and sorbitol.

The triethanolamine or soaps of triethanolamine such as compounds formed by reacting triethanol amine with fatty acids or hydroxy fatty acids of about 10 to 22 carbon atoms per molecule appear to be specific for the purpose described herein. Diethanolamine and its soaps have some effect but are not the full equivalent of the tri compounds. Commercial triethanolamine which generally contains about 15% of diethanolamine is entirely satisfactory for the purposes described herein.

The greases of this invention will generally contain between about 5% and about 25% to 30% of soap depending upon the physical characteristics desired in the finished grease. Probably between about 5% and about 15% to 18% of soap will generally give the amount of thickening desired in a grease for most purposes.

The proportions of E. P. additives, organic hydroxy compound, and triethanolamine compound to be used is not necessarily depending upon the proportion of soap present. In general the proportions of the mentioned additives are suitable for use with greases containing the full range of soap contents described hereabove.

The amounts of E. P. agent to be used, although previously described as being between 0.5% and 5% based on the total grease, may be decreased to as little as 0.2% and may be increased to as much as 10% particularly where extremely high load carrying ability is desired. The use of such larger proportions is sometimes advisable particularly with those combination additives which contain sulfurized and/or chlorinated materials with oil-soluble lead salts or soaps.

The amounts of organic hydroxy compound to be used will generally be between 0.2% and about 0.8% by weight although when using the higher proportions of E. P. agents indicated as much as 1.0% to 1.2% may be employed.

It is to be pointed out that these hydroxy compounds impart mechanical instability to the grease as do the E. P. additives and it is generally desirable to use minimum amounts of each of these types of additives which will impart the desired load carrying ability and antiwear characteristics.

The amounts of triethanol or triethanolamine soap to be employed will vary with the amounts of E. P. agent and hydroxy compound employed but will be between about 0.2% and about 1.5% and 2.0%. The higher proportions are to be used when large amounts of other additives are employed and/or when the soap form of the additive is employed.

Lubricating oils to be employed in preparing the greases of this invention include substantially all types of mineral lubricating oils. Naphthenic and paraffinic type oils appear to serve equally well.

In the following examples which serve to further illustrate the invention, the weight loss in the Falex test is determined by weighing the bronze test pin before and after completion of the test. The results of the beater test are generally expressed in terms of increase in penetration following the test. Where it is stated for example that the grease softened 40 points it means that the Shell micropenetration following the test was 40 points higher than the penetration determined on the grease before the test.

Example I

A calcium 12-hydroxy stearate grease consisting of 7.5% of this soap in a solvent treated Western paraffinic mineral lubricating oil having a Saybolt Universal viscosity of 750 seconds at 100° F. is prepared from the following ingredients:

	Pounds
12-hydroxy stearic aicd	176
Hydrated lime	25
Lubricating oil	2370

The lime and acid together with 225 pounds of oil and 2 pounds of water is charged to a grease kettle where it is mixed and heated to 225° F. for about 1 hour to effect reaction and partially dehydrate the product. An additional 175 pounds of oil is added and the product heated to a maximum of 255° F. over a period of 3 hours to complete the dehydration. After adding an additional 825 pounds of the lubricating oil the temperature drops to 240° F. and at this point the alkalinity of the grease is adjusted to give a slightly alkaline grease, equivalent to approximately 0.1 mg. KOH/g. An amount of oxidation inhibitor, equivalent to 0.6% by weight of the finished grease is then added and the remainder of the oil is added with continued agitation. The inhibitor employed is a commercial inhibitor obtainable from R. T. Vanderbilt, Inc. under the name of "Agerite Stalite" and consists of octylated diphenyl amines.

The finished grease has an ASTM worked penetration of 293 and a Shell micropenetration of 120.

This grease failed in the Timken test at a load of 14 pounds, seized in the Falex test after 11 minutes at a 1750 pound load and reached a temperature of 295° F. at the time of seizure and softened 47 points to a penetration of 167 in the beater test. This amount of softening is considered satisfactory but the load carrying ability in the Timken test and the antiwear characteristics as indicated by the Falex test are considered unsatisfactory. These considerations are justified in view of the fact that although the grease is retained in truck chassis bearings it permits high wear in such bearings over relatively short periods of use.

Example II

Example I is repeated substituting a lightly solvent treated Western mineral lubricating oil of 500 seconds Saybolt Universal viscosity at 100° F. and 28 V. I. for the 750 viscosity oil described in Example I. This grease has a Shell micropenetration of 125.

This grease is found to have good mechanical stability as indicated by the beater test in which it softens only 50 points but it fails at a load of 13 pounds in the Timken test and seizes after 8 minutes in the Falex test at a temperature of 280° F.

Example III

To a portion of the grease produced in Example I is added 5% by weight of Elco SCL, the mixture of sulfurized fish oil, chlorinated hydrocarbon and lead naphthenate described hereinabove and the additive material is thoroughly worked into the grease to obtain complete dispersion. The resulting product has a penetration of 120. In the beater test the grease softened to such a degree that a penetration could not be determined. This product fails at 20 pounds in the Timken test and although seizure did not occur in the Falex test after 30 minutes the weight loss of the bronze pin was 30 milligrams. This rather high weight loss is considered objectionable. The temperature of the lubricant reached in this test is 250° F. a value which is higher than desirable.

Example IV

Example III is repeated using 7.5% of Elco SCL in place of 5%. The product softened to an extreme degree in the beater test but it is found to hold 50 pounds in the Timken test without seizure.

Example V

To the grease produced in Example I is added 0.5% by weight of glycerine. The glycerine is mixed into the grease so as to obtain complete dispersion. The product is too soft for determination of penetration following beater test. It fails at 18 pounds in the Timken test but in the Falex test it supports 1750 pounds for 30 minutes with a weight loss of only 5 milligrams determined by weighing the bronze pin before and after the test. A temperature of 245° F. was reached in this test.

Example VI

The grease of Example I is modified by incorporating 0.5% by weight of glycerine and 3% of Elco SCL into the grease. This product supports 50 pounds in the Timken test without seizure and in the Falex test it supports 1750 pounds for 30 minutes with a weight loss of 6 milligrams. The maximum temperature reached is 220° F. In the beater test the grease softens to such an extent that a penetration is not obtainable.

Example VII

To a portion of the grease obtained in Example VI is added 0.25% by weight of triethanolamine. This product softens 30 points in the beater test, holds 50 pounds in the Timken test without seizure and in the Falex test after 30 minutes shows a weight loss of only 6 milligrams and a maximum temperature of 220° F.

Example VIII

To the grease of Example I is added 0.25% glycerine, 0.25% triethanolamine and 3% Elco SCL. This product supports 50 pounds in the Timken test, shows a weight loss of 6 milligrams in the Falex test with a maximum temperature of 220° F. and softens only 27 points in the beater test.

Example IX

To the product of Example I is added 0.65% by weight of pentaerythritol and 3% of Elco SCL. This product softens 103 points in the beater test but supports 50 pounds in the Timken test and shows a weight loss of 25 milligrams after 30 minutes in the Falex test with a maximum temperature of 228° F.

It is considered that this grease softens far too much in the beater test and shows undue wear in the Falex test for the purposes desired.

Example X

The grease of Example I is modified by incorporating in it 1.0% by weight of zinc dibutyl dithiocarbamate. This product seized at 40 pounds in the Timken test and softened 80 points in the beater test. In the Falex test this product seized after 15 minutes.

Example XI

To the grease of Example I is added 1.0% by weight of zinc dibutyl dithiocarbamate and 0.5% by weight of glycerine. This product supported 70 pounds in the Timken test, showed a weight loss of the bronze pin of 24 mg. in the Falex test, but was too soft for determining penertation following the beater test.

Example XII

To a portion of the product of Example XI is added 0.25% by weight of triethanolamine. This product supported 50 pounds in the Timken test, showed a weight loss of 15 mg. in the Falex test and softened 25 points in the beater test.

Example XIII

Example XII is repeated, substituting 0.5% by weight of triethanolamine 12-hydroxy stearate for the triethanolamine. This product supported 50 pounds in the Timken test, showed a weight loss of 14 mg. in the Falex test with a maximum temperature of 225° F. and softened 20 points in the beater test.

Example XIV

To the grease of Example I is added 1.0% by weight of zinc dibutyl dithiocarbamate and 0.25% by weight of triethanolamine. This product supported only 40 pounds in the Timken test and seized after 5 minutes in the Falex test. However, this product softened only 25 points in the beater test.

Example XV

To the product of Example XIV is added 0.5% by weight of pentaerythritol. The resulting product supported 50 pounds in the Timken test, showed a weight loss of 15 mg. in the Falex test and softened 20 points in the beater test.

Example XVI

The grease of Example II was modified by incorporating in it 2.5% by weight of sulfurized lard oil containing 12% of sulfur, 2.5% by weight of lead naphthenate and 0.5% by weight of glycerine. This product shows a weight loss of 3 mg. with a maximum temperature of 232° F. in the Falex test but softens more than 100 points in the beater test.

Example XVII

To the grease of Example II is added 0.5% by weight of 2-mercapto benzothiazole and 2.5% by weight of lead naphthenate. This product failed at 40 pounds in the Timken test.

Example XVIII

To the product of Example XVII is added 0.5% by weight of glycerine. The product supports 50 pounds in the Timken test, shows a weight loss of 15 mg. in the Falex test, but softens 100 points in the beater test.

Example XIX

To the product of Example XVIII is added 0.5% by weight of triethanolamine stearate. This product supports 50 pounds in the Timken test, shows a weight loss of 14 mg. in the Falex test with a maximum temperature of 225° F. and softens 40 points in the beater test.

Example XX

To the grease of Example I is added 0.5% of glycerine, 2.0% by weight of sulfurized lard oil, 1.5% of chlorinated paraffin wax containing approximately 35% of chlorine and 0.5% by weight of triethanolamine. This grease supports 50 pounds in the Timken test, shows a weight loss of 10 mg. in the Falex test and softens 30 points in the beater test.

Example XXI

A grease is prepared following the procedure outlined in Example I except that when the oxidation inhibitor is added the following ingredients are also added:

3.0% Elco SCL
0.5% glycerine
0.25% triethanolamine

The percentages are in percent by weight based on the finished grease. The composition of this product corresponds to that of the grease of Example VII and the results of Timken, Falex and beater tests are within experimental error of the results shown in Example VII. It supports 50 pounds in the Timken test, shows a weight loss in the Falex test of 7 mg. and softens 29 points in the beater test.

Example XXII

Example XXI repeated using pentaerythritol in place of glycerine gives a grease having characteristics substantially the same as those of the grease of that example.

Example XXIII

A grease is prepared using the procedure outlined in Example I except that when the oxidation inhibitor is added there is also added the following ingredients. The amounts are indicated in percent by weight of the finished grease.

5.0% chlorinated paraffin wax (40% Cl)
0.6% glycerine
0.3% triethanolamine

The product supports 50 pounds in the Timken test, shows a weight loss of 17 mg. in the Falex test and softens 35 points in the beater test.

Summarizing the data presented in the Examples it is to be pointed out that:

(1) The greases of Examples I and II are typical calcium hydroxy stearate greases having good mechanical stability but lacking in load carrying ability and antiwear characteristics.

(2) The greases of Examples III, IV, X, XVII show the effect of the addition of E. P. agents. In each instance, although there is an increase in load carrying ability and an improvement in antiwear properties over the base grease the increase and/or improvement in these values is not as great as desired. Moreover, in each instance the mechanical stability of the grease is impaired.

(3) The grease of Example V shows the effect of the addition of a polyalcohol containing 3 or 4 carbon atoms per molecule to the base grease. Although the glycerine improved the antiwear characteristics as indicated by the Falex test it resulted in only minor improvement in the load carrying ability and the resulting grease had extremely poor mechanical stability. Substitution of pentaerythritol results in a grease of substantially the same characteristics.

(4) The greases of Examples VI, IX, XI, XVI and XVIII show the effect of adding an E. P. agent in combination with a hydroxy organic compound having 3 or 4 OH groups per molecule. The greases have high load carrying ability and show low wear characteristics but they all have poor mechanical stability.

(5) The grease of Example XIV shows the effect of the addition of an E. P. agent in combination with triethanolamine on the characteristics of the base grease. It will be noted that the grease showed fair load carrying ability in the Timken test but failed in the Falex test. This product possessed good mechanical stability.

(6) The greases of Examples VII, VIII, XII, XIII, XV, XIX and XX to XXIII, inclusive, illustrate this invention. All of these products support at least 50 pounds in the Timken test, support 1750 pounds for 30 minutes in the Falex test without excessive wear and in the beater test show softening of less than the base grease without additives. Thus these greases are considered to have exceptional E. P. and antiwear characteristics and, in addition, to have exceptional mechanical stability.

The foregoing description and examples of this invention are to be considered as illustrative of the invention and are not to be taken as limiting the invention to the particular combinations of additive materials specifically shown, since other combinations of the same or similar additive materials may be employed to produce greases having the extreme pressure and antiwear characteristics and yet having the high mechanical stability described.

I claim:

1. A lubricating grease comprising mineral lubricating oil thickened with 5% to 30% by weight of a calcium hydroxy fatty acid soap and containing small amounts, sufficient to impart E. P., antiwear and good mechanical stability characteristics, respectively to said grease, of (1) an E. P. agent of the class consisting of organic compounds containing sulfur, organic compounds containing chlorine, organic compounds containing sulfur and chlorine, mixtures of said compounds and mixtures of said compounds with oil-soluble lead salts, (2) a compound selected from the class consisting of glycerine and pentaerythritol and (3) a compound selected from the class consisting of triethanolamine and triethanolamine soaps.

2. A lubricating grease comprising mineral lubricating oil, between 5% and 30% of the calcium soap of hydroxy fatty acid, between 0.2% and 10% of an E. P. agent of the class consisting of organic compounds containing sulfur, organic compounds containing chlorine, organic compounds containing sulfur and chlorine, mixtures of said compounds and mixtures of said compounds with oil-soluble lead salts, between 0.2% and 1.2% of a compound selected from the class consisting of glycerine and pentaerythritol and between 0.2% and 2.0% of a compound selected from the class consisting of triethanolamine and triethanolamine soaps.

3. A lubricating grease comprising mineral lubricating oil, between about 5% and about 18% of calcium 12-hydroxystearate and containing between about 0.5% and about 10% by weight of E. P. agent of the class consisting of organic compounds containing sulfur, organic compounds containing chlorine, organic compounds containing sulfur and chlorine, mixtures of said compounds and mixtures of said compounds with oil-soluble lead salts, between about 0.2% and about 0.8% by weight of an organic hydroxy compound selected from the class consisting of glycerine and pentaerythritol, and between about 0.2% and about 1.5% of a stabilizing compound selected from the class consisting of triethanolamine and triethanolamine soaps.

4. A lubricating grease according to claim 2 in which said E. P. agent is a sulfurized fatty oil.

5. A lubricating grease according to claim 2 in which said E. P. agent is a mixture comprising sulfurized fatty oil, chlorinated hydrocarbons and oil-soluble lead soap.

6. A lubricating grease according to claim 2 in which said E. P. agent is a mixture of sulfurized fatty oil and chlorinated paraffin wax.

7. A lubricating grease according to claim 2 in which said E. P. agent is 2-mercapto benzothiazole.

8. A lubricating grease according to claim 2 in which said E. P. agent is a metal hydrocarbon-substituted thiocarbamate.

9. A lubricating grease according to claim 3 in which said E. P. agent is a hydrocarbon-substituted mercaptothiazole and said organic hydroxy compound is glycerine.

10. A lubricating grease according to claim 3 in which said organic hydroxy compound is glycerine and said stabilizing compound is triethanolamine.

11. A lubricating grease according to claim 3 in which said E. P. agent is a mixture of sulfurized fish oil, chlorinated hydrocarbon oil and lead naphthenate and said stabilizing compound is triethanolamine 12-hydroxy stearate.

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