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LUBRICATING COMPOSITION

Carl F. Prutton, Cleveland, Albert K. Smith, Shaker Heights, and Harry E. Johnson, Willoughby, Ohio, assignors, by mesne assignments, to The Lubri-Zol Development Corporation, Cleveland, Ohio, a corporation of Delaware

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This application is a continuation in part of our copending application Serial No. 170,501 filed October 22, 1937.

As disclosed in the patent of Carl F. Prutton No. 2,051,744, granted August 18, 1936, certain desirable improvements in the lubricating properties of lubricating oils may be secured by the combination therewith of certain halogenated organic compounds.

The use of sulphur for the purpose of imparting extreme pressure characteristics to lubricating compositions has been known for some time. It has been well recognized that in order for sulphur when used alone to impart extreme pressure characteristics to lubricating compositions it is necessary that such sulphur be present in active or corrosive form. It has been well known that certain organic compounds of sulphur contain sulphur in such stably bound condition that when such compounds were added in minor amounts to a lubricating composition there was no appreciable increase in film strength.

We have discovered that by the combined use in a suitable oil base of certain halogenated organic compounds and organic sulphur compounds we are able to produce a lubricating composition superior in respect to those which have been available heretofore. The lubricating composition according to our invention is particularly applicable for use as an extreme pressure lubricant. The term "extreme pressure lubrication" is believed to be sufficiently well known to those familiar in the art that more particular definition thereof in this specification is unnecessary.

It is among the objects of our invention, therefore, to provide a lubricating composition which shall be superior to any which has heretofore been available.

Other objects of our invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail one approved combination of ingredients embodying our invention, such disclosed means constituting, however, but one of various forms in which the principle of the invention may be used.

Broadly stated, the improved lubricating compositions of our invention comprise the combination of a major proportion of lubricating oil, an organic halogen compound in a minor amount and a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil.

From the foregoing statement of our invention it will be observed that the lubricating compositions which comprise the same may be divided into three components, viz., the oil base, the halogen compound and the sulphur compound. These three components will first be considered separately and directions then given for the manner in which they may be blended in order to achieve the improved results.

The oil base

The oil base of our lubricating compositions is a lubricating oil of the type best suited for the particular use for which the ultimate composition is designed. When the lubricating compositions of our invention are designed for the lubrication of automobiles, the oil base will of course preferably consist of a refined mineral lubricating oil of lubricating viscosity for the particular point of application. In other words, a conventional gear oil may be used for the lubrication of the gears and generally a lighter, more highly refined, oil will be used in the crank case.

This invention is applicable to lubricating compositions in which the base may consist either entirely or in part of synthetic oils, hydrogenated oils, and voltolized oils.

The oil base may also desirably contain other well known constituents such as those which improve the oiliness, pour point, cold test, and oxidation properties, etc., of the oil. In general, compositions of our invention may be employed with any commercially available addition agents for the above defined purposes since they are generally compatible with the same in the amounts usually used.

The halogen compounds

The halogen compounds used should first be oil-soluble to the extent that the required amounts may be incorporated in the oil base in a stable form of true solution or colloidal suspension so that there will be no separation on storage, even over periods of considerable length and at reduced temperatures.

The halogen compound must be sufficiently non-volatile so that it will not be driven off from the lubricating composition during use. It will generally be found that the halogen compounds should have a vapor pressure less than atmospheric at a temperature of 140° C. and preferably at a temperature of 170° C.

The halogen compounds which may be employed as components of the composition may be divided into two broad classes, cyclic or ring compounds and aliphatic or chain compounds. In general, the ring compounds are more stable and less subject to hydrolysis than are the chain compounds particularly when the halogen is attached to a benzenoid ring structure. Therefore, where moisture and other conditions are encountered which tend to hydrolyze the halogen compounds, the ring compounds are generally preferable. The chain compounds are usually more active than the ring compounds and thus may be employed for the purpose of giving very high extreme pressure characteristics where such is necessary and where the conditions of use permit the employment of the relatively less stable chain compounds.

The class of oxygen and halogen bearing compounds will also be found to be of particular utility in our invention for reasons which may be generally stated as follows: The presence of the oxygen in the same molecule with the halogen tends to increase the tendency of the lubricating composition to be adsorbed on metallic surfaces and to activate the halogen so that the same are made more effective as extreme pressure addition agents. This is particularly true in the case where oxygen is added to the molecule of the relatively stable halogenated carbon ring compounds which might otherwise be so stable as not to be sufficiently reactive with the bearing surfaces under conditions of extreme pressure. Examples of the various halogen bearing compounds which may thus be employed as one component of our composition are as follows:

A.—Aliphatic, such as halogenated:

I.—Hydrocarbons, e. g.,
Hexachlorethane, and notably, those chlorinated or fluorinated hydrocarbons which contain from four to ten or more carbon atoms, e. g.
Chlorinated hexane
Chlorinated octane
Chlorinated decane
Butylene dichloride
Monochlorhexane
1,2 dichlorhexane
Amylene dichloride.
Other halogen substitution or addition products of commercial materials such as petroleum fractions including the paraffins, paraffin wax, foots oil, kerosene, mineral oil, etc.

II.—Amines
Primary, secondary and tertiary, e. g.
Chlorinated or fluorinated, hexylamines, di-amylamines, tri-amylamines, such as:
Chlorinated tri-amyl amines
Chlorinated tributyl amines
Chlorinated hexyl amines

III.—Nitriles, e. g.
Chlorinated or fluorinated:
Ethyl cyanide
Butyl cyanide
Octyl cyanide
Lauryl nitrile
Stearyl nitrile

IV.—Sulphides, e. g.
Chlorinated or fluorinated:
Di-ethyl sulphide
Di-butyl sulphide
Di-octyl sulphide
Di-amyl sulphide
Di-lauryl sulphide
Di-cetyl sulphide

V.—Mercaptans, e. g.
Chlorinated or fluorinated:
Lauryl mercaptan
Cetyl mercaptan
Carnaubyl mercaptan
Ceryl mercaptan
Montanyl mercaptan
Melissyl mercaptan
Myricyl mercaptan

VI.—Thiocyanates (rhodanates) e. g.
Chlorinated or fluorinated:
Ethyl thiocyanate
Butyl thiocyanate
Lauryl thiocyanate
Cetyl thiocyanate
Ceryl thiocyanate

B.—Cyclic compounds, such as halogenated:

I.—Benzene and related compounds such as:

(1) Halogenated benzene, e. g.

(*a*) Chlorinated benzene, e. g.
The dichlorbenzenes, notably the ortho compound

(*b*) Brominated benzene, e. g.
Ortho-dibrom benzene

(*c*) Fluorinated benzene

(2) Halogenated derivatives of benzene such as:

(*a*) Halogenated homologs of benzene, e. g.
Mono-chlor toluene
Mono-chlor xylene
Mono-chlor cymene
Ethyl mono-chlor benzenes
Propyl mono-chlor benzenes
Di-ethyl dichlor benzenes
Propyl dichlor benzenes
Di-ethyl tetrachlor benzenes

(*b*) Halogenated amino derivatives of benzene, e. g.
Chlorinated aniline
Mono-chlor aniline (preferably the ortho-compound)
Mono-chlor di-methyl aniline
Chlorinated toluidines
Chlorinated xylidines
Chlorinated diphenylamine

(*c*) Halogenated hydrobenzenes, e. g.
Hydrogenated dichlor-benzenes
Dichlorhexahydrobenzene (dichlor cyclohexane)

II.—Polyphenyls, and related compounds, including diphenyl, diphenyl benzenes, etc., such as
(1) Halogenated diphenyl, e. g.
(a) Chlorinated diphenyl, e. g.
Mono-chlor diphenyls
Dichlor diphenyls
Tri-chlor diphenyls
(b) Brominated diphenyl, e. g.
The mono-brom diphenyls
(c) Fluorinated diphenyl
(2) Halogenated derivatives of diphenyl, such as,
(a) Halogenated homologs of diphenyl, e. g.
Chlorinated phenyl-toluenes
Ethylated, or propylated, chlorinated diphenyl, e. g. di-ethyl tetrachlor diphenyl
(b) Halogenated amino derivatives of diphenyl, e. g.
Chlorinated phenyl-anilines
Chlorinated phenyl-toluidines
Chlorinated diphenyl amines
Chlorinated xenyl amines
(c) Halogenated hydrodiphenyls, e. g.
Chlorinated phenyl hexahydrobenzene
Chlorinated dodecahydrodiphenyl

III.—Naphthalene and related compounds, such as
(1) Halogenated naphthalene
(a) Chlorinated naphthalene, e. g.
α-mono-chlor naphthalene
(b) Brominated naphthalenes, e. g.
α-mono-brom naphthalene
(c) Fluorinated naphthalene
(2) Halogenated derivatives of naphthalenes, such as:
(a) Halogenated homologs of naphthalenes, e. g.
Chlorinated methyl naphthalenes, such as α-methyl naphthalene
Chlorinated ethyl, propyl, or isopropyl naphthalenes
(b) Halogenated amino derivatives of naphthalene, e. g.
Chlorinated naphthylamines
Mono-chlor naphthyl amine
(c) Halogenated hydronaphthalenes, e. g.
Chlorinated decahydronaphthalene
Chlorinated tetrahydronaphthalene

IV.—Phenanthrene and anthracene and related compounds, such as:
(1) Chlorinated phenanthrene, chlorinated anthracene
(2) Halogenated derivatives of phenanthrene and anthracene such as:
(a) Halogenated homologs, e. g.
Chlorinated 1-methyl phenanthrene
Chlorinated 3-methyl phenanthrene
Chlorinated 9,10 dimethyl phenanthrene
Chlorinated propyl and isopropyl derivatives of phenanthrane such as retene
Chlorinated dimethyl anthracenes
Chlorinated α-methyl anthracene
Chlorinated β-methyl anthracene
Chlorinated propyl and isopropyl derivatives of anthracene
(b) Halogenated amino derivatives, e. g.
Chlorinated phenanthryl-amines
Chlorinated anthramines
(c) Halogenated hydrophenanthrenes and halogenated hydroanthracenes, e. g.
Chlorinated retene oil (contains hydro retene)

V.—Chrysene, picene, and related compounds, including their derivatives, such as homologs, amino derivafives and other substitution products.

VI.—Bridged ring compounds, such as the terpenes and related compounds, and their derivatives, e. g. chlorinated pinene.

VII.—Heterocyclic compounds, such as pyridine, quinoline pyrrole, thiophene, and derivatives of them, e. g. mono-chlor pyridine.

VIII.—Nitriles derived from any of the above compounds, e. g.
Chlorinated:
Benzonitrile
Tolunitriles
Benzyl cyanide
Naphthyl cyanide
Xenyl cyanide
Cyclohexyl cyanide

IX.—Sulphides derived from any of the above compounds, e. g.
Chlorinated:
Diphenyl sulphide
Dibenzyl sulphide
Dixylyl sulphides
Di-naphthyl sulphides
Dixenyl sulphides
Dicyclohexyl sulphide

X.—Mercaptans derived from any of the above compounds, e. g.
Chlorinated:
Benzyl mercaptan
Phenyl benzyl mercaptans
Naphthyl mercaptans
Phenyl propyl mercaptans
Cyclohexyl mercaptan

XI.—Thiocyanates, e. g.
Chlorinated:
Benzyl thiocyanate
Phenyl ethyl thiocyanate
Phenyl propyl thiocyanate
Cyclohexyl thiocyanate

It will be noted that the above enumerated examples of the organic ring compounds which are usually preferred when stability is a particularly desired characteristic are, in general, compounds of the aryl type, i. e., compounds containing benzenoid ring structures and also of the type in which the halogen is directly attached to an atom

which is a part of such ring structure. Very satisfactory results may be obtained when two or more different halogens are present in the same molecule, ortho brom chlor benzene being a good example of such a compound. If the aromatic compounds have been alkylated, they are often especially effective.

Especially good results are generally secured when the halogen in the composition is present in the form of an oxygen containing or bearing organic ring compound. This class of addition agents has the desirable property of increased oiliness stability as compared with the chain compounds generally, and at the same time a sufficient amount of activity so as to impart the necessary properties to the utimate composition.

The oxygen and halogen containing or bearing organic ring compounds, above referred to, may be classified as follows, viz:

I. "Carbon ring" type compounds
- (a) Of the aromatic, or allied type, including derivatives of benzene, naphthalene, anthracene, etc., also compounds of the bridged ring type, such as the terpenes, and related compounds.
- (b) Of the class including the cycloparaffins, cyclo-olefines, etc. Examples of this class are derivatives of the following:
  - (1) Hydrogenation products of benzene (e. g. cyclohexane, cyclohexene, cyclohexadiene).
  - (2) Hydrogenation products of naphthalene (e. g. decahydronaphthalene, tetrahydronaphthalene, etc.).
  - (3) Naphthenes, naphthenic acid, etc.
- (c) Of mixed type such as derivatives of indene, hydrindene, hydranthracene, etc.

II. "Heterogeneous ring" type compounds
- (a) Of the aromatic or allied type including derivatives of pyridine, quinoline, etc.
- (b) Other types such as furan and its derivatives and derivatives of triophene, pyrrole, etc.

The foregoing compounds may also be classified according to the nature of the attachment of the oxygen to the compound, viz.:

I'. Directly attached to one or more carbon atoms, as in the case of:
- (1') Ethers and analogous compounds
- (2') Compounds containing the ≡C—OH radicle, such as alcohols and other derivatives of carbinol (including phenols, cresols, naphthols, etc.)
- (3') Compounds containing the carbonyl (=C=O) radicle, such as aldehydes, ketones, quinones, (e. g., anthra quinone) acids, esters and salts of organic acids, thio-acids and esters of thio-acids.
- (4') Compounds in which oxygen forms a part of the ring structure, e. g., furan and its derivatives, etc.
- (5') Compounds with an inorganic radicle where the oxygen is directly attached to a carbon atom
  - Arsenite
  - Hypochlorite
  - Phosphite
  - Thiophosphate
  - Thiophosphite
  - B-hydroxylamines

II'. Indirectly attached through the means of some other atom, i. e., in the form of an inorganic radicle, e. g.:
- Arsenate
- Chlorate
- Chlorite
- Cyanate
- α-hydroxylamine
- Nitrate
- Nitrite
- Nitro
- Nitroso
- Oxime
- Perchlorate
- Phosphate
- Sulphate
- Sulphite
- Sulphinic acid
- Sulphone
- Sulphonic acid
- Sulphoxide
- Thio-sulphate

In addition to the substituents containing oxygen, other substituents may also be present without destroying, and in certain cases improving, the effect on the lubricating qualities of the oil such as other aryl groups, alkyl groups, and amino and substituted amino groups, imino, azo, hydrazo, hydrozine, nitrile, mercapto, sulphide, polysulphide.

Specific examples of compounds of the various classes of halogen and oxygen containing ring compounds are listed in the co-pending application of Carl F. Prutton, Ser. No. 737,070 filed July 26, 1934.

This second component of the composition, i. e., that which supplied halogen, will, for certain purposes, desirably be in the form of a halogen and oxygen bearing organic compound. While it is preferable to have both oxygen and halogen present in the same molecule when employing this type of second component of our composition, desirable results may nevertheless be effected by the combined use as the second component of the composition of a halogen bearing organic ring compound which does not contain oxygen with a separate organic oxygen compound. Such separate organic oxygen compound may be any of the organic ring compounds listed in said application, Ser. No. 737,070 as being the ones from which halogen derivatives may be prepared and in addition any similar organic oxygen compounds which do not contain ring structures, for example, alkyl, allyl, etc., alcohols, ethers, aldehydes, ketones, acids, esters and salts. Of these compounds the carboxylic acids and the esters and salts of such acids are preferred, e. g., fatty oils, vegetable oils, oleic acid, stearic acid, amyl acetate, butyl stearate, dibutyl phthalate, methyl salicylate, naphthenic acid, butyl naphthenate; sodium, calcium and aluminum stearates and oleates; sodium, calcium and lead naphthenates.

The organic sulphur compounds

As previously indicated, the third component of our composition is sulphur in the form of a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil.

In other words, our invention comprises the combined use of a halogen compound and relatively inactive sulphur to the end that the cooperation between the second and third components of our composition results in the achievement of a film strength in the resultant composition which is due to the cooperation between such second and third components. In other words, the organic sulphur compound is of the type or present in amounts such that it, when used alone without the halogen, does not substantially increase the film strength of plain mineral oil but which, when used in conjunction with a halogen compound, is activated by the latter to the production of an unexpected result flowing from the cooperative effect of the second and third components of our composition.

While there is no generally accepted standard machine or test procedure in universal use today for the purpose of determining extreme pressure characteristics of a lubricating composition, nevertheless there are a number of machines available to-day which are currently being used with fairly uniform and satisfactory results. The well-known Almen machine was employed in making determinations referred to herein. When in our specification and claims we refer to the fact that the sulphur compound is of the type or present in such amounts as to not substantially increase the extreme pressure characteristics of a plain mineral oil, we means such characteristics as would be determined by the use of either the Timken or Almen machine under the conditions of test prescribed by the manufacturers of such machines.

The effect of sulphur compounds in increasing film strength is enormously enhanced by the presence of halogen-containing, or of halogen- and oxygen-containing, organic compounds, especially if the relative proportions of such sulphur and halogen compounds are within certain ranges. Sulphur compounds in amounts which have a negligible effect in increasing film strength when used by themselves are very effective when used in combination with the proper proportion of halogen-bearing organic compounds. Organic sulphides, disulphides, mercaptans, mercaptoles, thio-acids, and their esters, dithio-acids, and their esters, sulphones, sulphoxides, sulphonic acids, and their esters, sulphinic acids, and their esters, sulphone amides, sulphone chlorides, thio-amides, thio-anilides, organic thiocyanates, organic xanthates etc., (which may or may not contain a ring structure) are examples of sulphur compounds which act in this way. The table below shows the results obtained when solutions in mineral oil of such compounds, along and with halogen compounds such as chlorinated paraffin wax and chlorinated diphenyl ether, were tested on an Almen lubricant testing machine. The chlorinated wax contained about 40% of chlorine and had been treated to remove free chlorine and hydrogen chloride. The chlorinated diphenyl ether contained a total of about 45% chlorine with about 10% chlorine in the form of addition products, and had been treated with quick-lime at a temperature of about 90° C. The increase in film strength of the oil caused by compounds dissolved in it is shown, and is stated in terms of additional pounds of weight applied to the loading arm of the machine required to cause breakdown, as compared with the oil alone.

Percent of dibenzyl disulphide	Percent of chlorinated wax	Average increase in breakdown load
0	4	8
0	8	12
1	0	1
2	0	2
1	4	More than 24
2	8	More than 24
Percent of benzyl thiocyanate		
0.5	0	2
0.5	4	More than 24
Percent of diphenyl sulphide	*Percent of chlorinated diphenyl ether*	
0	1	6
0	2	8
0	4	9
0.5	0	0
2.9	0	0
5.8	0	2
0.5	1	10
2.9	2	14
5.8	4	22
Percent of diphenyl disulphide		
2	0	4
2	1	22
Percent of dibenzyl disulphide		
1½	3	More than 24
3	0	4
3	1½	More than 24
Percent of amyl mercaptan		
1.5	0	0
1.5	3	More than 24
Percent of dilauryl sulphide		
0.5	0	3
0.5	4	More than 24
Percent of dibutyl disulphide		
0.5	0	4
0.5	0.5	14
Percent of product of reaction of butylene diamine with CS_2		
3	0	4
3	3	More than 24
*Percent di-methylbenzyl sulphide**		
½	0	3
½	1½	More than 24

*This material was an impure product containing about 10 per cent total sulphur and about 3 per cent total chlorine, the latter in non-hydrolizable form. It was prepared by chlorinating boiling xylene until the boiling point reached 200° C. and allowing the chlorinated xylene to react with sodium sulphide in alcoholic solution. The product separated as a heavier oily layer and was treated with calcium oxide at 100° C.

Following is a list of additional specific examples of organic sulphur compounds which have been found satisfactory for use:

Tallow mercaptan (the reaction product of chlorinated tallow with NaHS)
Tri-o-cresyl thiophosphate
Di (di-isobutylene) disulphide
Dibutyl sulphide
Di-amyl sulphide
Di-amyl disulphide
Dihydroxy diphenyl disulphide
Alkylated hydroxy phenyl disulphides
Lauryl thiocyanate
Benzyl ester of xanthic acid

For other specific examples of organic sulphur compounds which may thus be employed as the third component of the composition of our invention, reference may be had to the list of organic sulphur compounds contained in the copending application of Carl F. Prutton, Ser. No. 193,960 filed March 4, 1938.

In order to protect bearings, gears, etc. from very severe overloads, it is sometimes advisable to use a halogen-containing compound which is so unstable as to be appreciably corrosive under

normal conditions. Since chain compounds are generally more corrosive, i. e. more unstable than ring compounds, they are admirably suited for this purpose. In these circumstances the corrosive effect of such chain compounds and of halogenated organic ring compounds of the addition type for example, may be greatly inhibited by the addition of certain other oil-soluble compounds, such as (1) organic bases, aromatic and alkyl amines, triethanolamine, quinoline, etc., (2) organic phosphates, e. g., tri-butyl phosphate, tri-phenyl phosphate, tri-cresyl phosphate, etc. Also certain of the halogen and sulphur compounds referred to above have similar corrosion-inhibiting effects, notably, (1) the phosphates of chlorinated ring compounds, e. g. tri-chlorphenyl phosphate, (2) mercaptans and chlor-mercaptans. For other specific examples of corrosion inhibitors reference may be had to copending applications, Ser. Nos. 119,132; 297,872; 297,873; 297,874; 297,875 and 297,876.

Percentages and proportions

The percentages and proportions within which the three components of our improved lubricating compositions are employed will depend largely upon the purpose for which the lubricating composition is designed and the character of the three components themselves.

In general, the addition agents which are added to the lubricating oil base should have a vapor pressure less than atmospheric at the temperatures to which the finished product is subjected either during storage or use. For the lubrication of ice machines, one type of addition agent would be suitable which however might be entirely unsuited for the lubrication of internal combustion engines operating at extremely high temperatures. In general, the addition agents which comprise the second and third components of our composition should have a vapor pressure less than atmospheric at 140° C. and preferably at 170° C.

The second component of our composition, i. e. the halogen bearing compound will be employed in percentages which are dictated by the results desired and the type of oil base and sulphur compound with which they are combined, etc. For most purposes, the halogen bearing compounds will be employed in percentages less than 20% of the total composition. In most cases, amounts less than 10% will be employed and for certain uses such as for crank case oils in internal combustion engines, amounts less than 5% will be employed. In general, the halogen bearing compound will be required to be present in amounts in excess of .02% in order to be effective. The ranges of percentages which may be given therefore for the amount of halogen bearing organic compound which is employed may be given as from about .02% to about 20%; from about .1% to about 10% and from about .5% to about 5%.

When a separate organic oxygen compound is employed in combination with a halogen bearing organic compound as the second component of our composition, such oxygen compound will generally be employed in amounts from about .10% to about 10%.

The organic sulphur compounds employed as the third component of our composition will generally be employed in the range of from about .01% to about 20%. For most uses, this range will be from about .01% to about 10%, the range of from about .05% to about 5% being usually preferred.

Especially good results are secured when the halogen compound employed is selected from the general class which contains from about 25% to about 50% of halogen. With this class of halogen compounds optimum results will be secured in high-temperature lubricants by the employment of from one-tenth to 2% of the halogenated compounds.

As above indicated, optimum results are secured by maintaining a certain proportional relationship between the second and third components depending upon the relative activity of these components. Thus for example, with a relative very inactive sulphur compound and a relatively very active halogen compound the proportional relationship would be in the range of one part of the sulphur compound to one part of the halogen compound. With the sulphur compound relatively less inactive and the halogen compound of relatively low activity, the proportional relationship would be in the range of one part of the sulphur compound to about ten parts of the halogen compound. Intermediate ranges which have been successfully employed have been one part of sulphur compound to five parts of halogen compound and one part of sulphur compound to two parts of halogen compound. For the most part good results will be obtained with a proportional relationship of about one part of sulphur compound to three parts of halogen compound.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the materials employed in carrying out the process, provided the ingredient or ingredients stated in any of the following claims or the equivalent of such stated ingredient or ingredients be employed.

We therefore particularly point out and distinctly claim as our invention:

1. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of an organic halogen compound.

2. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of an aromatic halogen compound.

3. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of an aliphatic halogen compound.

4. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound of the class consisting of aliphatic sulphides and alipathic polysulphides in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of an organic halogen compound.

5. A lubricating composition comprising the combination of a major proportion of mineral oil, an organic disulphide in an amount in which such compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of an organic halogen compound.

6. A lubricating composition comprising the combination of a major proportion of mineral oil, dibenzyl disulphide in an amount in which such compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of an organic halogen compound.

7. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogen-bearing petroleum derivative.

8. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogenated petroleum wax.

9. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogenated mineral oil.

10. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogenated foots oil.

11. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound of the class consisting of sulphides and polysulphides in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogenated petroleum fraction.

12. A lubricating composition comprising the combination of a major proportion of mineral oil, a relatively inactive organic sulphur compound of the class consisting of sulphides and polysulphides in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a chlorinated paraffin wax.

13. A lubricating composition comprising a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and from about 0.10% to about 10% of an organic halogen compound having a vapor pressure less than atmospheric at a temperature of 140° C.

14. A lubricating composition comprising a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and from about 0.10% to about 10% of an aromatic halogen compound having a vapor pressure less than atmospheric at a temperature of 140° C.

15. A lubricating composition comprising a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and from about 0.10% to about 10% of an aliphatic halogen compound having a vapor pressure less than atmospheric at a temperature of 140° C.

16. A lubricating composition comprising a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and from about 0.50% to about 5% of an organic halogen compound having a vapor pressure less than atmospheric at a temperature of 170° C.

17. A lubricating composition comprising a major proportion of mineral oil, a relatively inactive organic sulphur compound in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and from about 0.10% to about 10% of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

18. A lubricating composition comprising a major proportion of mineral oil, a relatively inactive organic sulphur compound of the class consisting of aromatic sulphides and aromatic polysulphides in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

19. A lubricating composition comprising a major proportion of mineral oil, an organic polysulphide in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

20. A lubricating composition comprising a major proportion of mineral oil, an aromatic polysulphide in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

21. A lubricating composition comprising a major proportion of mineral oil, an organic disulphide in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

22. A lubricating composition comprising a major proportion of mineral oil, an aromatic disulphide in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain min-

eral oil, and a minor amount of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

23. A lubricating composition comprising a major proportion of mineral oil, dibenzyl disulphide in an amount in which such sulphur compound would not substantially increase the extreme pressure characteristics of a plain mineral oil, and a minor amount of a halogen bearing petroleum derivative having a vapor pressure less than atmospheric at a temperature of 140° C.

CARL F. PRUTTON.
ALBERT K. SMITH.
HARRY E. JOHNSON.