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(54) Method of warm forming and extrusion of metal and metal working compositions useful therein.

(57) Warm forming and extrusion of metals, particularly ferrous-containing metals, at elevated temperatures are disclosed wherein a lubricant composition containing a rare earth metal halide is applied to the surface of the metal prior to the deformation thereof. Lanthanum trifluoride and cerium trifluoride are particularly useful. The compositions include : a liquid base, preferably an animal oil, vegetable oil, fat or fatty ester ; a viscosity enhancer, preferably an asphaltic material ; a lubricant effective at elevated temperatures ; and the rare earth metal halide.

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METHOD OF WARM FORMING AND EXTRUSION OF METAL AND METAL WORKING COMPOSITIONS USEFUL THEREIN

The present invention generally relates to the warm forming and extrusion of metals and to improvements in compositions that can advantageously be used in these metal working operations. More particularly, this invention is directed to the warm forming and extrusion of metals at temperatures above about 600°C (1,100°F). In this regard, an important aspect of the present invention is directed to the use of rare earth metal halides, such as cerium or lanthanum trifluoride, in compositions used in the warm forming and extrusion of steel.

Warm forming and extrusion of metal are processes generally involving applying a metal working, lubricant composition to the surface of the metal prior to the deformation thereof. As such, these compositions need to meet a variety of requirements. For example, in addition to lubrication performance, they must provide protection of the metal surface from abrasion and like damage. Furthermore, they should be relatively easy to apply and remove as well as compatible with subsequently applied coating materials.

Many of these metal working lubricant compositions are homogeneous blends formulated for a specific application where certain properties are favored over others but which necessarily are a compromise between conflicting requirements. Heterogeneous metal working lubricants, such as for example dispersions of lubricant substances in water or other volatile medium are also known. Such heterogeneous lubricants are intended, upon application to a metal workpiece and evaporation of the volatile medium, to leave a continuous homogeneous lubricant film on the metal workpiece.

To achieve a balance of properties compositions useful in the warm forming of metal, these compositions generally employ a range of oils, waxes, soaps and occasionally polymeric materials, each of which has advantages for specific applications. For example, U.S. Patent No. 4,687,587 to Daglish et al. discloses a lubricant for metal forming comprising discrete particles of a waxy material having a softening point above the metal-forming temperatures in a solid or viscous monomeric organic carrier. Similarly, U.S. Patent No. 3,873,458 to Parkinson discloses a process for cold forming or shaping metal having a resin-oil coating prepared from a dispersion of a copolymer of ethylene and acrylic acid in a lubricant oil. Correspondingly, U.S. Patent No. 3,167,511 to Crawford et al. discloses the use of chlorinated polypropylene in a lubricating oil as a lubricant for broaching, cutting and rolling metal. These and other lubricants known in the art, however, fail to provide the needed lubrication and surface protection to a metal workplace during the forming or extrusion thereof at temperatures above about 1,100°F (about 600°C).

A precoating is often applied to the metal before the application of the lubricant. This precoating can contain, for example, lime, zinc phosphate and/or soaps. The use of such a precoating procedure, however, also fails to permit the warm forming and extrusion of metal at the high temperatures desired for the forming and extrusion of numerous metal parts, particularly those made from hard metals.

It has been known for some time that rare earth trifluorides such as lanthanum trifluoride and cerium trifluoride are useful as solid lubricants. See Rare Earth Fluorides and Oxides--An Exploratory Study of Their Use as Solid Lubricants at Temperatures to 1,800°F (about 1,000°C) NASA TND-5301, 1969). Similarly, U.S. Patent No. 4,507,214 to Aldorf discloses the use of rare earth metal halides in a lubricating grease to form a lubricating composition to lubricate wheel bearings. U.S. Patent No. 4,715,972 to Pacholke likewise describes the use of cerium fluoride as one of several solid lubricant particle additives for gear oil. Correspondingly, U.S. Patent No. 3,830,280 to Larsen discloses the use of rare earth halide such as cerium trifluoride or lanthanum trifluoride as lubricants for die casting components. None of these prior art disclosures, however, contains any suggestion of a liquid metal working lubricant composition which is suitable for the warm forming and extrusion of metals at high temperatures, e.g. temperatures above about 600°C (1,1000°F).

An object of this invention is to provide an improved composition and method useful for lubrication in the warm forming and extrusion of metals especially at high temperatures.

An embodiment of the present invention provides a metal working lubricant composition which is stable and does not decompose at elevated temperatures above about 600°C (1,100°F).

The invention may be embodied in a metal working composition which exhibits improved lubricating characteristics during metal forming and extrusion at high temperatures but also protects the surface of the metal workpiece from corrosion and abrasion, continues to provide lubrication after the cooling of the metal, but is readily removable from the metal workpiece after the latter has been removed from the form.

The present invention is directed to improvements in methods for warm forming and extrusion of metals, and to compositions useful therein. These improvements permit the performance of those metal working operations at temperatures of up to about 1000°C (1,800°F) and higher.

In accordance with an important aspect of the present invention, the methods and compositions thereof which are especially useful in warm forming and extruding metal involve the use of a rare earth metal halide in such compositions. These compositions are liquids having a viscosity less than about 1,500 S.U.S. at about 38°C (100°F) and include a liquid base, viscosity enhancer increasing the viscosity of the composition to between about 150 and about 1,500 S.U.S. at 100°F (about 38°C) ; a lubricant effective at elevated temperatures of at least about 400°F (about 200°C), and a rare earth metal halide. Optional components include graphite and/or molybdenum disulfide.

Detailed Description

In the process of warm forming metal, liquid lubricant is generally applied to the metal by flooding, dipping, brushing or spraying on the part, preferably on a continuous process with the overflow being collected and returned to a central reservoir for recirculation. Consequently it is required that the lubricant composition be a liquid. In order that it be able to provide the necessary lubrication it should have a viscosity at 100°F (about 38°C) of between about 150 and about 1,500 S.U.S. Liquid compositions of this viscosity can be pumped and at the same time furnish the needed lubricity. Following application of the liquid lubricant deformation of takes place followed by removal of the lubricant from the formed product. Often the metal workpiece has a precoating which can contain lime, zinc phosphate and/or soaps.

It has now been found that the incorporation of rare earth metal halides into the lubricant composition increases the temperature at which metal forming can be effected to about 1,800°F (about 1000°C) and higher. This is a significant increase from prior methods which have an upper limit of effective performance of about 1,100°F (about 600°C). Thus, the present process can be performed at temperatures between about 300°F (about 150°C) and 1,800°F (about 1000°C). For many applications, the process is performed at temperatures between about 900°F (about 480°C) and 1,500°F (about 820°C).

Likewise in the extrusion of metal, liquid lubricant is applied so that a lubricant film is present between the extruded billet and the die. As with warm forming, the viscosity of this liquid composition should be between about 150 and about 1,500 S.U.S. at 100° F (about 38°C).

The presence of a rare earth metal halide in the lubricant composition raises the temperature at which extrusions can be effected in an efficient manner to about 1,800°F (about 1000°C) and higher. Prior compositions do not afford the necessary lubrication and metal protection properties at these high temperatures.

Since the methods of warm forming and extrusion of metal allow for the use of temperatures of up to about 1,800°F (about 1000°C) and higher, they are particularly valuable in applications using the ferrous metals e.g. steel as well as other metals such as, for example, copper, bronze, brass and aluminum. These methods can be performed at temperatures between about 300°F (about 150°C) and 1,800°F (about 1000°C). For the forming and extrusion of many objects, however, temperatures between about 900°F (about 480°C) and 1,500°F (about 820°C) are generally employed.

Various liquid compositions can be used to perform the present methods.

One such composition is an oil based composition. A particularly useful oil-based composition comprises the following components :

1) liquid base
2) viscosity enhancer to increase the viscosity of the composition to between 150 and 1,500 S.U.S. at 100°F (about 38°C)
3) lubricant effective at elevated temperatures of at least about 400°F (about 200°C)
4) rare earth metal halide.

Among optional components of the lubricant composition of this invention are graphite and molybdenum disulfide.

The amount of the liquid base component in the composition will vary with the specific method being performed and the metal being warm formed or extruded. In general this component constitutes from about 40 to about 90 weight percent of the composition.

Various animal oils, vegetable oils, fats, fatty esters and mixtures thereof can be used as the liquid base in the present lubricant compositions. Since this non-petroleum derived material constitutes an important portion of the composition, its selection will necessarily materially effect the physical characteristics of the composition, such as its viscosity and adherence to the metal workpiece.

It is preferred that the base be a fat, e.g. a triglyceride. Since triglycerides are made by esterifying the three hydroxy groups of glycerin with fatty acids, often the triglycerides will contain unreacted fatty acids. Fatty acids are in general straight-chain compounds, containing from about 8 to about 18 carbon atoms. A particularly useful triglyceride, prime burning lard oil, is about 99.5 weight percent triglycerides or related compounds and less than 0.5 weight percent fatty acids. Another useful base is soybean oil having lubricating viscosities from 50 S.U.S. to about 1,000 S.U.S. at 100°F (about 38°C). Also useful are oleic acid, sulfurized lard oil, marine oil triglyceride, rape seed oil, tall oil and paraffin oil.

Since the purpose of the viscosity enhancer is to have a liquid composition with a viscosity of from about 150 to about 1,000 S.U.S. at 100°F (about 38°C), a variety of materials that will increase viscosity of a liquid can be used. A particularly useful viscosity enhancer is asphaltic material. In addition to increasing the viscosity of the liquid base, it also improves the adhesion of the composition and imparts lubricity. In general the viscosity enhancer should be present in an amount of from about 2 to about 25 weight percent of the composition. Other viscosity enhancers that can be used in the present composition are polybutene, aluminum stearate and degras.

Numerous lubricants can be used as the low temperature lubricant composition of the present composition so long as they provide efficient lubrication at a temperature of at least about 400°F (about 200°C) and preferably from about 400°F (about 200°C) to about 1,100°F (about 600°C). A particular class of lubricants of value in the present compositions are sulfur-containing compounds. These lubricants are well known in the art and provide good lubrication properties at temperatures up to about 1,100°F (about 600°C). Sulfurized mineral oil and sulfurized fatty oil are useful for this component. Examples of other such materials are sulfurized fat, mineralized sulfur, sulfurized hydrocarbons, sulfurized caster oil, sulfurized and chlorinated oil, and the like.

In general, the sulfurized compound can be present in an amount of from about 5 to about 50 weight percent of the lubricant composition ; however, for most purposes this amount will be between about 10 and about 20 weight percent.

In accordance with an important aspect of the present invention, the metal working lubricant composition includes a rare earth metal halide, preferably fluoride. While other halides such as the chloride are known, available and useful, the fluorides are more preferred. In particular the race earth trifluorides such as lanthanum trifluoride and cerium trifluoride are preferred. Normally these rare earth metal halides are present in amounts of up to from about 2 to about 30 weight percent or higher of the composition with an amount of from about 5 to 10 percent being generally desired. The particle size of the rare earth metal fluoride should be relatively fine.

In addition other solid lubricants can also be included in the present composition as optional components. These solid lubricants which include molybdenum disulfide and graphite can each be present in amounts up to about 10 weight percent of the composition. Their presence can improve the overall lubricity of the composition.

Other optional lubricants that can be included in the present compositions include mica, calcium carbonate and zinc stearate.

The molybdenum disulfide, other optional solid lubricants and the rare earth metal halide can be incorporated as finely divided powders having a particle size for example, from about 0.01 microns (μm) to about 100 microns (μm), preferably from about 0.1 to about 45 microns (μm). This invention, however, is not limited to any specific particle size component.

The composition of this invention can be prepared by standard procedures known to the art. In general they can be prepared by mixing the ingredients at a slightly elevated temperature. In order to make a uniform mixture, the rare earth metal trifluoride should be added slowly with mixing. Sufficient mixing, about an hour, should be performed so as to obtain a uniform composition. As an alternative procedure, the composition of the present invention can be prepared by milling its components.

In addition to oil based compositions, it is often desirable to have available a water-based composition, which can be lower in cost and toxicity. Such compositions are composed of the same components as the oil-based compositions ; i.e. liquid base, viscosity enhancer, lower temperature lubricant effective at temperatures of at least about 400° F (about 200°C) and rare earth metal halide.

Thus while many of the operative components of the water-based compositions are identical to the components in the oil-based compositions, there are certain distinctions.

As with the oil-based compositions, the aqueous compositions utilize a viscosity enhancer. Generally, this can be any material that increases the viscosity of the composition to between about 150 and 1,500 S.U.S. at 100°F (about 38°C) and is water compatible. Useful materials include cellulose compounds such as sodium carboxymethyl cellulose, glycols, such as diethylene glycol, propylene glycol and butylene glycol, and certain specialized waxes, such as Carbowax 3350.

Since it is more difficult to obtain a uniform mixture in water than in oil, usually there should also be present in the composition wetting agents and dispersants. As is general with water-based compositions containing solid components, the wetting agents and dispersants assist in retaining particles in dispersion so that the composition will be uniform. Numerous dispersants and wetting agents are known in the art.

Optional components in an aqueous composition of the present invention include defoamers,anti-microbial agents and corrosion inhibitors. These components can perform useful functions in the present compositions.

Since it is uneconomical to ship water, rather than prepare compositions containing water, it is often desirable to prepare a concentrate that is shipped to the site of the warm forming or extrusion operation as a concentrate and then dilute it with water to a composition usable in the method for warm forming or extruding metal. In preparing a concentrate that can be diluted to an aqueous composition, a glycol such as diethylene glycol, propylene glycol or butylene glycol may be used in the composition as the viscosity enhancer.

It has been found that the heretofore described lubricant compositions provide excellent lubrication in the warm forming and extrusion of metals at temperatures in excess of 1,100°F (about 600°C). The composition is stable at temperatures higher than 1,100°F (about 600°C) and is stable at 1,800°F (about 1000°C) or higher. Furthermore, the composition protects the metal from corrosion and abrasion and can be easily applied and removed by conventional means.

In its application for warm forming and extrusion of metal, the present composition is applied to the metal by conventional methods such as dipping, flooding, brushing or spraying. For best results it is preferred that the viscosity of the composition be between about 500 and 1,000 S.U.S. at 100°F (about 38°C). This permits ready application of the lubricant composition to the metal. Among the metals for which the present composition may be used are steel, copper, bronze, brass, aluminum and the like. Other metals may also be used in the present method for warm forming which comprises applying deformation pressure to metal which has been coated with the present composition. This method is especially applicable to metals being formed at temperatures up to and in excess of 1,100°F (about 600°C) and up to about 1,800°F (about 1000°C) and higher.

Also the composition of the present invention can be used in the extrusion of metals. In this method, metal, including those previously described as being applicable for metal forming are coated with the present composition and extruded at temperatures up to about 1,800°F (about 1000°C) and higher. The composition of the present invention provides excellent lubrication and protection of the metal from corrosion and abrasion.

EXAMPLE 1

The improved high temperature performance of the metal working composition and method of the present invention was demonstrated by comparing the performance of a commercially available metal working lubricant (EXTRUDOIL 519HT), a chemically identical commercial metal working lubricant which also includes molybdenum disulfide (EXTRUDOIL 519HT-MOS), and a metal working composition chemically identical to the EXTRUDOIL 519HT-MOS which also included cerium trifluoride. Both the EXTRUDOIL 519HT and EXTRUDOIL 519HT-MOS are available from Witco Corporation, Allied-Kelite Division.

The EXTRUDOIL 519HT product is composed of #1 Lard Oil (a prime burning lard containing 99.5 weight percent glyceride derivatives and less than 0.5 weight percent free fatty acids), an asphaltic viscosity enhancer, and a lubricant constituent made up of a sulfurized fatty oil and a sulfur-containing mineral oil. The EXTRUDOIL 519HT-MOS contains the same ingredients as EXTRUDOIL 519HT in the same relative amounts and, in addition includes 10 percent, by weight, of a molybdenum disulfide dispersion. The metal working lubricant product embodying the present invention contained the same ingredients as the EXTRUDOIL 519HT in the same relative amounts and, in addition, included 5 percent, by weight, each of a molybdenum disulfide dispersion and cerium trifluoride.

Each of these metal working lubricants was tested during the extrusion of 15/16 inch diameter 1050 steel wire to form cam shaft lobes with a National Machinery Model 1000 extruder having a carbide die. The die was flooded with the lubricant which was continuously recirculated and the extrusion temperatures incrementally raised while observing the performance of the lubricant.

The EXTRUDOIL 519HT metal working lubricant which did not contain molybdenum disulfide or a rare earth metal halide worked well within the temperature range of 800-900°F (about 430-480°C). Increasing the temperature beyond 900°F (about 480°C) decomposed the composition and at these higher temperatures there was insufficient lubrication to form the lobe.

The EXTRUDOIL 519HT-MOS metal working lubricant containing molybdenum disulfide but not containing a rare earth halide permitted formation of the lobe at temperatures between about 1,000°F (about 540°C) and 1,100°F (about 600°C). Increasing the temperature beyond 1,100°F (about 600°C) decomposed the composition and mused insufficient lubrication to form the lobe.

The metal working lubricant which contained cerium trifluoride permitted formation of the lobes at temperatures of 1,500°F (about 820°C) and above without any observable breakdown of the metal working lubricant.

Thus the present compositions can be used effectively at temperatures not readily lubricated by prior petroleum-based compositions. This permits the ready formation of warm molded and extruded parts efficiently at temperatures of about 1,500°F (about 820°C) and higher.

The following examples are illustrative of other compositions which are within the scope of the present invention. Examples 2-9 describe oil based compositions ; Examples 10-13 describe aqueous compositions of the present invention ; and Examples 14 and 15 describe concentrates which are readily dispersible in water.

Example 2

Component	Weight Percent
#1 Lard Oil	54
Asphaltic Type Material	14
Sul-Perm 18*	11
Mineralized Oil Containing Sulfur	6
Molydenum Disulfide Dispersion	5
Graphite	5
Cerium Trifluoride	5

*Sul-Perm 18 is a sulfurized fatty oil having a viscosity at 100°F (about 38°C) of approximately 2,800 S.U.S. to 3,300 S.U.S.; a flash point of 450°F (about 232°C); a fire point of 490°F (about 254°C); a weight of 8.4 pounds per gallon; and containing 17 weight percent sulfur.

Example 3

Component	Weight Percent
#1 Lard Oil	40
Asphaltic Type Material	8
Sulfurized/Chlorinated Oil	29
Molydenum Disulfide Dispersion	12
Lanthanum Trifluoride	11

Example 4

Component	Weight Percent
Marine Oil	56

Example 4 (CONT.)

Component	Weight Percent
Asphaltic Type Material	15
Sulfurized Caster Oil	19
Graphite	5
Cerium Trifluoride	5

Example 5

Component	Weight Percent
Soybean Oil	70
Aluminum Stearate	4
Sulfurized Fat	12
Mineralized Oil Containing Sulfur	10
Zinc Stearate	2
Cerium Trifluoride	2

Example 6

Component	Weight Percent
Soybean Oil	65
Degras	4
Sulfurized Sperm Oil	12
Mica	5
Cerium Trifluoride	14

Example 7

Component	Weight Percent
Rape Seed Oil	60
Polybutene	20
Pearsall OA 319*	10
Lanthanum Trifluoride	10

*Pearsall OA 319 is a synthetic sulfurized sperm oil replacement containing about 17.8 weight percent sulfur having a viscosity of 270 S.U.S. at 210°F (about 99°C) and 3,000, S.U.S. at 100°F (about 38°C) and weighing 8.6 pounds per gallon.

Example 8

Component	Weight Percent
Tall Oil	58
Asphalt	5
Pearsall OA 319	15
Base 380*	5
Graphite	3
Lanthanum Trifluoride	14

*Base 380 is a sulfurized hydrocarbon having a sulfur content of 38 weight percent, weighing 9.2 pounds per gallon, having a viscosity at

Example 9

Component	Weight Percent
Sulfurized Lard Oil	65
Asphaltic Type Material	15
Di-tert-nonyl Polysulfide	6
Pearsall OA 377*	5
Calcium Carbonate	3
Cerium Trifluoride	6

*Pearsall OA 377 is a sulfurized olefinic hydrocarbon containing typically 36 weight percent sulfur and having a viscosity at 51 S.U.S. at 210°F (about 99°C) and 245 S.U.S. at 100°F (about 38°C) and weighing 8.58 pounds per gallon. It is completely soluble in naphthinic and paraffinic oils and has a flash point of 335°F (about 168°C) and a fire point of 360°F (about 182°C).

Example 10

Component	Weight Percent
Water	40

Example 10 (CONT.)

Component	Weight Percent
Diethylene Glycol	1
Carboxymethyl Cellulose	0.5
Sodium Hydroxide (50%)	5
Adipic Acid	5
Molybdenum Disulfide Dispersion	18.5
Cerium Trifluoride	30

Example 11

Component	Weight Percent
Water	60
Diethylene Glycol	2
Carboxymethyl Cellulose	1
Sodium Hydroxide	15
Adipic Acid	10
Molybdenum Disulfide Dispersion	5
Cerium Trifluoride	7

Example 12

Component	Weight Percent
Water	40
Diethylene Glycol	5
Borax	1
Tripolyphosphate	20
N-10 (surfactant)	1
Carboxymethyl Cellulose	1
Molybdenum Disulfide Dispersion	7
Cerium Trifluoride	25

Example 13

Component	Weight Percent
Water	60

Example 13 (CONT.)

Component	Weight Percent
Diethylene Glycol	10
Borax	2
Tripolyphosphate	10
N-10 (surfactant)	1
Carboxymethyl Cellulose	5
Molybdenum Disulfide Dispersion	6
Cerium Trifluoride	6

Example 14

Component	Weight Percent
Borax	38
Dispersant	1
Carboxymethyl Cellulose	1
Adipic Acid	5
Sodium Hydroxide Granules	5
Graphite	30
Molybdenum Disulfide Dispersion	10
Cerium Trifluoride	10

Example 15

Component	Weight Percent
Borax	30
Dispersant	0.5
Carboxymethyl Cellulose	0.5
Adipic Acid	10
Sodium Hydroxide Granules	5
Molybdenum Disulfide Dispersion	10
Graphite	19
Cerium Trifluoride	25

It will be understood that the above-described embodiments of the present invention are merely illustrative of the present invention.

Claims

1. A method of warm-forming metal wherein a lubricant is applied to the surface of a metal workpiece which is thereafter formed, characterized in that the lubricant includes a rare earth metal halide.

2. The method of claim 1 wherein the temperature at which said metal workpiece is formed is between about 150°C (300°F) and about 1000°C (1,800°F).

3. The method of claim 2 wherein the temperature at which said metal workpiece is formed is between about 480°C (900°F) and about 820°C (1,500°F).

4. A method of metal extrusion wherein a lubricant is applied to the surface of the metal being supplied to an extrusion die, characterized in that the lubricant includes a rare earth metal halide.

5. The method of claim 4 wherein the extrusion temperature is between about 150°C and about 1000°C.

6. The method of claim 4 wherein the extrusion temperature is between about 480°C and 820°C.

7. The method of any one of claims 1 to 6 wherein the lubricant is a liquid.

8. The method of any one of claims 1 to 7 wherein the rare earth metal halide is present in an amount of up to about 30 weight percent of the lubricant composition.

9. The method of any one of claims 1 to 8 wherein the rare earth metal halide is a lanthanide halide.

10. The method of any one of claims 1 to 8 wherein the rare earth metal halide is cerium halide.

11. The method of claim 9 wherein the lanthanum halide is lanthanum trifluoride.

12. The method of claim 11 wherein the cerium halide is cerium trifluoride.

13. The method of claim 12 wherein the cerium trifluoride is present in an amount of up to about 10 weight percent of the lubricant composition.

14. The method of any one of claims 1 to 13 wherein the lubricant composition also contains up to about 10 weight percent graphite.

15. The method of any one of claims 1 to 14 wherein the lubricant composition also contains up to about 10 weight percent molybdenum disulfide.

16. The method of any one of claims 1 to 15 wherein the metal is a ferrous metal.

17. The method of claim 16 wherein the metal is steel.

18. The method of any one of claims 1 to 15 wherein the metal is copper, bronze, brass or aluminium.

19. A liquid metal working lubricant composition having a viscosity less than about 1,500 S.U.S. at 38°C useful in the warm forming and extrusion of metal at temperatures up to about 1000°C, said lubricant composition comprising : a liquid base ; a viscosity enhancer ; a lubricant effective at elevated temperatures, and a rare earth metal halide.

20. The composition of claim 19 wherein the liquid base is an oil.

21. The composition of claim 20 wherein the liquid base is animal oils, vegetable oils, fats, fatty esters or mixtures thereof.

22. The composition of any one of claims 19 to 21 wherein the viscosity enhancer is asphaltic material.

23. The composition of any one of claims 19 to 22 wherein the lubricant contains sulfur.

24. The composition of claim 23 wherein the sulfur containing lubricant is sulfurized mineral oil, sulfurized fatty oil, elemental sulfur or mixtures thereof.

25. The composition of claim 19 wherein the liquid base is water.

26. The composition of any one of claims 19 to 25 wherein the liquid base is present in an amount of from about 40 to about 90 weight percent of the composition ; the viscosity enhancer is present in an amount of from about 2 to about 25 weight percent of the composition ; the lubricant effective at elevated temperatures is present in an amount of from about 5 to about 50 weight percent of the composition, and the rare earth metal halide is present in an amount of from about 2 to about 30 weight percent of the composition.

27. The composition of any one of claims 19 to 26 which also contains up to about 10 weight percent of molybdenum disulfide.

28. The composition of any one of claims 19 to 27 which also contains up to about 10 weight percent of graphite.

29. The composition of any one of claims 19 to 28 wherein the rare earth metal halide is a fluoride.

30. The composition of claim 29 wherein the rare earth metal halide is lanthanum trifluoride.

31. The composition of claim 29 wherein the rare earth metal halide is cerium trifluoride.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 0991

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 315 532 (COMPAGNIE FRANCAISE DE PRODUITS INDUSTRIELS) * Column 2, line 56 - column 3, line 26; column 4, lines 18-30; column 5, lines 3-10,30-33; column 11, line 25; column 1, lines 14-30 *	1-13,16-21,25,29-31	C 10 M 125/00 C 10 M 125/18 C 10 M 163/00 C 10 M 169/04 C 10 M 173/02 // (C 10 M 125/00 C 10 M 125:02 C 10 M 125:18 C 10 M 125:22) (C 10 M 163/00 C 10 M 125:02 C 10 M 125:18 C 10 M 125:22 C 10 M 135:02 C 10 M 159:04) (C 10 M 169/04 C 10 M 101:04 -/-
A	DATABASE, PATENT ABSTRACTS OF JAPAN, Tokyo, JP; & JP-A-59 081 394 (KOBE SEIKOSHO K.K.) 30-10-1982 * Abstract *	19-24,27,28	
A	DE-A-2 647 375 (DOW CORNING) * Claims 1,2; page 3, line 31 - page 4, line 23 *	14,15,25,27,28	**TECHNICAL FIELDS SEARCHED (Int. Cl.5)**
D,A	US-A-3 830 280 (E.I. LARSEN)		C 10 M
D,A	US-A-4 507 214 (H.E. ALDORF)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-05-1991	HILGENGA K.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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Application Number

EP 91 30 0991

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
			C 10 M 105:32 C 10 M 125:02 C 10 M 125:18 C 10 M 125:22 C 10 M 135:02 C 10 M 159:04) (C 10 M 173/02 C 10 M 125:02 C 10 M 125:18 C 10 M 125:22 C 10 M 135:02 C 10 M 145:40) C 10 N 40:24
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-05-1991	HILGENGA K.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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