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LUBRICATING COMPOSITION AND METHOD

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This application is a continuation-in-part of co-pending application Ser. No. 438,403, filed Mar. 9, 1965 and now abandoned.

This invention relates to an improved lubricating composition and more particularly it relates to an improved soap-type lubricant which is useful in lubricating metal surfaces prior to deformation.

In the art of cold forming metal, e.g., metal deformation or metal drawing, it is customary to provide a lubricant coating on the metal surface to be deformed. Many substances have heretofore been used to provide the desired lubrication of the metal surface during the deformation operation, such as oils, waxes, soaps, and the like. The lubricant material most frequently used, at least in recent years, has been a soap-type lubricant, and particularly a lubricant containing a soap of a fatty acid. Such a lubricant generally has been applied to the metal surface to be deformed as a hot aqueous soap solution. In some instances, and particularly where a difficult drawing or deforming operation is involved, before the application of the soap-type lubricant, it is customary to provide a chemical coating on the metal surface to be deformed. Typical of such chemical coatings are phosphate coatings, oxide coatings, oxalate coatings, sulfide coatings, and the like. In both cases, i.e., when the lubricant is applied over bare metal or over a chemical coating, the lubricant crushes to a continuous, unctuous film upon the application of pressure to the metal surface, which continuous film has been found to provide an excellent parting layer between the metal and the die during the deforming operation.

Normally, these soap-type lubricants are applied so as to provide a lubricant coating weight on the metal surface of about 100 to 200 milligrams per square foot. In some instances, however, as for example where a particularly severe deforming operation is involved, it has been found that a heavier lubricant coating may be desirable, such as one of about 400 to 500 milligrams per square foot. In applying these lubricants to obtain the heavier coating weights, difficulties have sometimes been encountered in obtaining a substantially smooth and even lubricant coat. Moreover, in such instances, a non-uniform flow of the lubricant has also been experienced. Because of these difficulties, it has not been commercially practical to obtain these desired higher lubricant coating weights when using the soap-type lubricants as have been described hereinabove.

It is, therefore, an object of the present invention to provide a novel soap-type lubricant composition which is useful in metal deforming operations.

Another object of the present invention is to provide a novel soap-type lubricant composition, which composition may be applied with substantially uniform lubricant flow to obtain a substantially even, thicker and heavier lubricant coating than has been possible with prior lubricants.

A further object of the present invention is to provide an improved process for the deforming of metal surfaces, which process utilizes the improved soap-type lubricant composition of the present invention.

These and other objects will become apparent to those skilled in the art from the description of the invention which follows.

Pursuant to the above objects, the present invention

includes a lubricant composition concentrate of the soap-type, which composition comprises in combination a compound selected from the group consisting of alkali metal pyrophosphates and alkali metal tetraborates, and a soap of a fatty acid, wherein at least a portion of the soap, in an amount of at least 0.2 percent by weight of the lubricant composition, but less than about 50 percent by weight of the soap present in the lubricant composition, is a fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum. Such lubricant compositions have been found to give excellent results in metal deforming operations when applied either directly to the bare metal surface to be deformed or when applied over a chemical coating on the metal surface, such as a phosphate coating, an oxide coating, an oxalate coating, a sulfide coating, or the like.

More specifically, the improved lubricant concentrate compositions of the present invention are comprised of an alkali metal pyrophosphate and/or an alkali metal tetraborate in a combined amount within the range of about 3 to about 75 percent by weight of the composition, and a fatty acid soap in an amount within the range of about 15 to about 97 percent by weight of a composition, and wherein there is contained at least 0.2 percent by weight of the lubricant composition but less than about 50 percent by weight of the soap present in the lubricant composition of a fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc, and aluminum. By the term "alkali metal pyrophosphate" and "alkali metal tetraborate," as used in the specification and claims, it is intended to include the pyrophosphates and tetraborates of lithium, sodium, potassium, cesium and rubidium. Of these, excellent results have been obtained when using tetrapotassium pyrophosphate (TKPP) and sodium tetraborate (borax) and primary reference will be made hereinafter to these materials. This is not, however, to be taken as a limitation of the present invention but only as being exemplary thereof.

Additionally, it is to be appreciated that in referring to the present composition as containing a soap, it is intended to include both of those compositions which contain the soap, per se, as well as those compositions which contain ingredients which react to form the soap in situ in the composition, such as those compositions containing a fatty acid, or a fat, or an oil and an alkaline material, such as a metallic hydroxide or metallic carbonate. Typical of the fatty acid soap used or formed in situ are those containing about 8 to about 22 carbon atoms, with those containing about 12 to about 18 carbon atoms being preferred. Typical of the metallic hydroxides or carbonates used, when the soap is formed in situ, are those of sodium, potassium, lithium, ammonia, calcium, magnesium, zinc and aluminum.

With regard to the fatty acid soap component of the present composition, at least a portion of this component in an amount equivalent to at least 0.2 percent by weight of the lubricant composition but less than about 50 percent by weight of the soap present in the lubricant composition is a fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum. Generally, it has been found to be desirable if the fatty acid soap selected from the group indicated hereinabove is present in the composition in an amount within the range of about 0.5 to about 15 percent by weight of the lubricant composition, and preferably within the range of about 0.8 to about 10 percent by weight of the lubricant composition. It will be appreciated, however, that amounts of the fatty acid soap selected from the indicated group in excess of 15 percent may be used if desired, for ex-

ample, amounts as high as 30 percent by weight of the lubricant composition. Even greater amounts may be used in some instances. In general, however, it has been found to be desirable if these larger amounts of the selected fatty acid soap are not used and that the major amount of the fatty acid soap component in the composition is a fatty acid soap of sodium. Thus, in its most preferred embodiment, the lubricant concentrate composition of the present invention contains a fatty acid soap of sodium in an amount within the range of about 65 to about 75 percent by weight of the lubricant composition, a fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum in an amount within the range of about 0.8 to about 10 percent by weight of the lubricant composition and the remainder of the composition, to make 100 percent, being tetrapotassium pyrophosphate and/or sodium tetraborate.

In addition to the alkali metal pyrophosphate and/or alkali metal tetraborate and the soap, the compositions of the present invention may also contain various other adjuvants, depending upon the particular characteristics of lubricant composition which are desired in each instance. For example, various so-called pigment materials, both meltable and unmeltable, may be included in the lubricant composition. Additionally, organic resinous or polymeric binding materials may also be included in the composition, as well as rosin acid and/or various rosin soaps. Other additives, such as corrosion inhibitors, dyes, perfumes, and the like, may also be present in the lubricant composition as desired.

Exemplary of pigment materials which may be included in the lubricant compositions of the present invention are antimony oxide, antimony sulfide, arsenous oxide, arsenous sulfide, barium pyrophosphate, bismuth sulfide, boric anhydride, calcium tetraborate, calcium carbonate, cadmium pyrophosphate, cobalt sulfide, chromium fluoride, copper sulfide, ferrous sulfide, ferrous phosphate, lead borate, lead chromate, lead molybdate, lead oxide, lead phosphate, lead metasilicate, lead sulfide, manganese pyrophosphate, manganese borate, mercury sulfide, mercury chloride, molybdic oxide, nickel sulfide, molybdenum sulfide, vanadium pentoxide, zinc borate, zinc phosphate, clays, including diatomaceous earth, fuller's earth, and the like. These and similar pigment materials may be added to the composition, in addition to the alkali metal pyrophosphate and/or tetraborate, or as a replacement for a portion thereof in the composition. Where such pigments are included in the lubricant composition, amounts within the range of about 0.1 percent to about 80 percent by weight of the composition are typical, with amounts within the range of about 3 percent to about 75 percent being preferred.

Exemplary of binders which may be used are acrylic ester polymers, e.g., polymethacrylates, alkyl resins such as the glycerolphthalic anhydride type, cellulose acetate, cellulose nitrate, cumaroneindene polymers, styrene polymers, chlorinated diphenyl, chlorinated rubber, ethylene polysulfide polymers, chlorinated paraffins, neoprene rubber, vinyl chloride, vinyl acetate, melamine polymers, urea-aldehyde polymers, casein-formaldehyde polymers, phenol-formaldehyde polymers, starch, sodium naphthenate, amber, asphalt, bitumen, gilsonite, dextrin, gelatin, gum arabic, and the like. Where such binders are used in the lubricant composition of the present invention, they are typically present in amounts within the range of about 0.1 percent to about 25 percent by weight of the lubricant composition, with amounts within the range of about 1.0 percent to about 15 percent being preferred.

The rosin acids which are suitable for inclusion in the present lubricant compositions may be in the form of commercial gum or wood rosin, tall oil, or may be extracted from tall oil residues. Accordingly, as used in the specification and claims, the term "rosin acid" is intended in its generally understood sense and may also include such specific acids as abietic acid, neo-abietic acid, pimaric acid, levo-pimaric acid, dextro-pimaric acid, iso-dextro-pimaric acid, mixtures thereof, and the like, and the rosin soaps are soaps made from these acids. Where rosin soaps and/or rosin acids are included in the lubricating composition, they are typically present in amounts within the range of about 0.1 percent to about 30 percent by weight of the lubricant composition, and preferably are present in amounts within the range of about 0.5 percent to about 10 percent.

Corrosion inhibiting materials which may be included in the subject lubricant composition are exemplified by the alkali metal nitrates, the alkali metal nitrites, and the like. These and other inhibitors as are known to those in the art, when used, are typically present in amounts within the range of about 0.1 percent to about 5.0 percent by weight of the lubricant composition and are preferably present in amounts within the range of about 0.1 percent to about 3.0 percent. Dyes, such as Bismarck brown, and the like, and perfumes or other materials for imparting a pleasant odor to the composition, such as pine oil and the like, may also be incorporated in the lubricant composition in amounts sufficient to impart the desired color and odor to the composition.

In addition to the above adjuvants, the lubricant concentrate composition of the present invention may also contain water, the amount depending upon the physical form which is desired for the concentrate composition. Typically, water in amounts up to about 80 percent by weight of the lubricant composition may be used, with amounts within the range of about 15 percent to about 75 percent by weight of the lubricant composition being preferred. As will be appreciated by those in the art, in determining the physical form or consistency of the lubricant concentrate composition which is desired, consideration will, of course, be given to the manner in which the composition is to be handled, packaged and transported. Accordingly, the amount of water included in the lubricant concentrate composition may vary widely and in some instances may even exceed 80 percent by weight, which has been indicated hereinabove as being typical.

Even when water in an amount of 75 percent by weight of the lubricant composition is used, the composition may still be sufficiently concentrated as to be undesirable for many applications to metallic surfaces. Accordingly, in formulating a working composition for application to a metal surface, the concentrated lubricant composition will generally be further diluted with water. Typical working compositions may contain the lubricant concentrate in amounts within the range of about 10 to about 400 pounds per hundred gallons of solution. Generally, where a heavier lubricant coating is desired on the metal surface, such as a coating of at least 200 milligrams per square foot, it has been found to be desirable to use a more concentrated lubricant composition, such as those containing at least about 125 pounds of the lubricant concentrate per hundred gallons of solution.

The aqueous working lubricant composition containing the lubricant concentrate in amounts within the range of about 10 to about 400 pounds per hundred gallons of solution will have a Babcock number within the range of about 0.1 to about 15.2 and a titration number within the range of about 3.0 to about 80.0. The Babcock number is obtained by the following procedure: A 100 milliliter Cassia flask is provided with a 50 milliliter sample of the working solution and to this sample 30 milliliters of 50 percent sulfuric acid is added and thoroughly admixed. The flask is then placed in a hot water bath having a temperature between about 82 degrees centigrade and boiling. The level of the water should be high enough to cover most of the neck of the Cassia flask. After about 15 to 30 minutes, sufficient hot, boiled water is added to bring the oily layer into the graduated neck of

the flask. When the oily layer has separated sharply, usually in about 5 minutes, the difference between the readings of the lower and upper edges of the oily column in the neck is the Babcock number. The titration number is obtained by the following procedure: 50 milliliters of the hot lubricant solution at 70 degrees centigrade is put into a beaker with about 120 milliliters of hot water. This solution is then titrated with 0.88 N sulfuric acid. The titration number is the number of milliliters of the sulfuric acid needed to titrate the lubricant solution to the bromcresol green end point.

The working lubricant solutions, as described above, may be applied to the metal surfaces to be deformed in various ways, such as by immersion, flow coating, by spraying, or by roller application. For such applications, the lubricant temperature may be widely varied, from about room temperature, i.e., about 20 degrees centigrade, up to about 100 degrees centigrade. Generally, for application by immersion techniques, higher temperatures of the lubricant composition are desired, such as temperatures of about 60 to 100 degrees centigrade. For roller applications, lower temperatures, such as from room temperature up to about 60 degrees centigrade, may be used. It has been found that in the latter instance, i.e., the roller application of the lubricant composition at room temperature, it may be desirable to use the lubricant composition as a concentrate with no further dilution, applying the composition to the rolls with air pressure, a reciprocating piston pump, or a centrifugal pump, or the like. It is believed that the details of the various techniques whereby the lubricant composition of the present invention may be applied are sufficiently familiar to those in the art that further description of such methods are not necessary.

As has been noted hereinabove, the lubricant composition of the present invention is particularly adapted for application to chemically coated metal surfaces, prior to the deformation of the surfaces. Suitable chemical coatings which may be applied to the surfaces prior to the application of the present lubricant composition include phosphate coatings, oxide coatings, oxalate coatings, sulfide coatings, and the like.

In forming metal articles, in accordance with the process of the present invention, the subject lubricant composition is applied to the bare metal surface or to a chemically coated metal surface using application techniques as have been indicated hereinabove to obtain the desired amount of the lubricant composition on the surface. The lubricant coating thus obtained is dried, and thereafter the coated surface is subject to drawing, cold forming, or other deforming operations. Generally, the application of the chemical coating to the metal surface, such as a phosphate coating, or the application of the lubricant to a bare metal surface, is preceded by a cleaning or pickling step and a rinse to remove the cleaning or pickling solution. Frequently, between the application of the chemical coating and the lubricant coating, the chemically coated surface is also rinsed to remove any unreacted coating material. Although this latter rinse may be a water rinse, alkaline or neutralizing rinses may also be used. It is believed that the composition and nature of the various chemical coating materials and rinses, as well as the manner in which they may be applied to the metal surfaces, and the specific details of the various metal deforming operations, such as cold forming and drawing, are all sufficiently well known to those in the art that a further detailed description of these compositions and processes is not necessary.

It has been found that the lubricant composition of the present invention which contains a fatty acid selected from the group consisting of fatty acids of lithium, potassium, calcium, magnesium, ammonia, zinc and aluminum, are characterized by having uniform flow properties when used at higher concentrations, such as those in excess of about 125 pounds of lubricant per hundred gallons of working solution, and that further, when used at these concentrations, have a low viscosity and provide a substantially uniform, even lubricant coating on the metal surface, even when the coating has a coating weight of at least 200 milligrams per square foot. In contrast, similar lubricant compositions but which do not contain the fatty acid selected from the indicated group, when used at similar high concentrations, have a higher viscosity and do not have the desired uniform flow characteristics and the lubricant coating obtained from their application is frequently uneven. Such unevenness in the lubricant film has been found to be particularly disadvantageous where a difficult or a hard drawing operation is to be effected. This unevenness in lubricant flow is particularly disadvantageous where a polished surface is being deformed, in that after the deforming operation, the ridges in the lubricant coating are found to be reproduced on the deformed surface. Such a phenomenon is known in the art as "coining." A lubricant composition which has shown a particularly good improvement in flow characteristics when a fatty acid selected from the above group is incorporated therein is described in a co-pending United States application Ser. No. 387,984, filed Aug. 6, 1964, and now abandoned.

In order that those skilled in the art may better understand the present invention and the manner in which it may be practiced, the following specific examples are given. In these examples, unless otherwise indicated, the temperatures are given in degrees centigrade and parts are by weight.

Example 1

A lubricant concentrate was made of 75 percent of a soduim tallow soap and 25 percent of tetrapotassium pyrophosphate (anhydrous). To this concentrate was added 0.2 percent by weight of aluminum stearate. Water was then admixed with this lubricant composition to obtain an aqueous working lubricant solution containing 1.25 pounds of the lubricant concentrate per gallon of solution. This aqueous lubricant solution was maintained at a temperature of about 80 degrees centigrade and bare 4 inch by 6 inch steel panels were immersed therein for one minute. The panels were then removed from the lubricant composition and dried at about 120 degrees centigrade. The dried panels were found to have a lubricant coating thereon having a coating weight of about 1155 milligrams per square foot. This lubricant film was of a substantially uniform thickness and showed no evidence of unevenness or ridging. This lubricant film was found to be suitable for protecting the metal to which it was applied during relatively severe drawing operations.

Example 2

By way of comparison, the procedure of Example 1 was repeated with the exception that the lubricant composition used did not contain any aluminum stearate. This composition was quite viscous and when applied to the steel panels, as in Example 1, produced a heavy, uneven and substantially unuseable lubricant film which had very poor reflow characteristics.

Example 3

A lubricant concentrate composition was formulated as in Example 1 with the exception that aluminum stearate was present in the composition in an amount of 0.8 percent by weight of the concentrate. Water was then added to this concentrate to form a working lubricant solution containing 1.25 pounds of lubricant per gallon of solution. Steel bumper blanks, which had previously been coated with a conventional zinc phosphate coating, were then roller coated with the lubricant composition, the bumper blanks being at a temperature of about 60 degrees centigrade. After the application of the lubricant to the phosphate coated bumper blanks, the blanks were dried and there was formed on the blanks a lubricant film having a coating weight within the range of 210 to 250 milligrams

per square foot. This film was substantially even and had good reflow characteristics, as was evidenced by the fact that there was no ridging in the lubricant film. After the film was dried, bumpers were formed from the blanks by subjecting the blanks to a standard cold forming operation. In each instance, a satisfactory bumper was obtained. After the forming operation, none of the bumpers obtained showed any evidence of coining on the surface as a result of unevenness in the lubricant film applied.

By way of comparison, the above procedure was repeated with the exception that the lubricant material used did not contain aluminum stearate. In this instance, the lubricant film produced was uneven and it showed appreciable ridging. After the forming operation, the bumpers obtained showed appreciable coining on the surfaces thereof, as a result of the uneven and ridged lubricant film which had been applied.

Example 4

The procedure of Example 1 was repeated with the exception that the lubricant concentrate used contained 87 percent of a sodium tallow soap, 10 percent sodium tetraborate (borax) and 3 percent aluminum stearate. This concentrate was mixed with water to form a working lubricant solution having a concentration of one pound per gallon. Application of this lubricant to bare steel panels as in Example 1 produced a lubricant film having a coating weight of 530 milligrams per square foot, which film was smooth, without ridges, and suitable for protecting the metal during relatively severe drawing operations.

Example 5

The procedure of the preceding example was repeated with the exception that the lubricant concentrate contained 72 percent of the sodium tallow soap, 25 percent borax and 3 percent aluminum stearate. Working lubricant solutions were made up of this material having a concentration of 1 pound per gallon and 1⅛ pounds per gallon. Application of these lubricant solutions to bare steel panels as in the preceding example produced lubricant films having coating weights of 852 and 885 milligrams per square foot, respectively. In each instance, the lubricant films were level, and substantially uniform, and after drying showed no evidence of ridging or reflow.

By way of comparison, a similar lubricant concentrate was formulated with the exception that it contained 75 percent of the soap and no aluminum stearate. The lubricant film obtained from applying this concentrate from a working solution containing only ¾ of a pound per gallon of the concentrate was uneven and evidenced several reflows.

Example 6

The procedure of Example 1 was repeated with the exception that the lubricant concentrate contained 770 parts by weight of a sodium tallow soap, 257 parts by weight of anhydrous tetrapotassium pyrophosphate and 8.5 parts by weight of lithium stearate. The application of this concentrate to bare metal panels from a working lubricant solution having a concentration of 1.5 pounds per gallon produced an excellent lubricant film showing no evidence of reflows.

Example 7

The procedure of Example 6 was repeated with the exception that the lubricant concentrate contained 75 parts by weight of the soap, 25 parts by weight of the tetrapotassium pyrophosphate and 10 parts by weight of lithium stearate. The lubricant film produced was substantially the same as that formed in Example 6.

Example 8

Five additional runs were made using the procedure of Example 6. In these runs, the following materials were substituted for the lithium stearate used in the lubricant concentrate of Example 6: calcium stearate, zinc stearate, magnesium stearate, potassium stearate and ammonium stearate. In each instance an excellent lubricant film was obtained which film was substantially even and had uniform flow characteristics.

The procedure of the preceding example is repeated using lubricants containing as the principle soap, sodium stearate, sodium palmitate, and the like; both tetrapotassium pyrophosphate and borax; and containing a lithium tallow soap, aluminum palmitate, and the like, to obtain similar results.

While there have been described various embodiments of the invention, the compositions and methods described are not intended to be understood as limiting the scope of the invention, as it is realized that changes therewithin are possible, and it is further intended that each element recited in any of the following claims is to be understood as referring to all equivalent elements for accomplishing the same results in substantially the same or equivalent manner, it being intended to cover the invention broadly in whatever form its principles may be utilized.

What is claimed is:

1. A lubricant composition useful in lubricating metal surfaces prior to deformation which consists essentially of an admixture of from about 3 to about 75 percent by weight of at least one compound selected from the group consisting of alkali metal pyrophosphates and alkali metal tetraborates, from about 15 to about 97 percent by weight of a soap of a fatty acid, water in an amount up to about 80 percent by weight, wherein at least a portion of the soap, in an amount of at least 0.2 percent by weight of the lubricant composition, but less than about 50 percent by weight of the soap present in the lubricant composition, is a fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum, the remainder of the fatty acid soap being a fatty acid soap of sodium.

2. The lubricant composition as claimed in claim **1** wherein the fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum, is present in the composition in an amount within the range of about 0.2 percent to about 30 percent by weight of the lubricant composition.

3. The lubricant composition as claimed in claim **2** wherein there is 65–75% by weight of a fatty acid soap of sodium, 0.4–10% by weight of a fatty acid soap selected from the group of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum and the remainder being selected from the group consisting of alkali metal pyrophosphates and alkali metal tetraborates.

4. A method of lubricating metal which comprises coating the metal with the lubricant composition as claimed in claim **1**, drying the coating thus obtained, and thereafter deforming the metal.

5. The method as claimed in claim **4** wherein the lubricant composition is an aqueous solution of a concentrate, which contentrate is an admixture of from about 3 to about 75 percent by weight of at least one compound selected from the group consisting of alkali metal pyrophosphates and alkali metal tetraborates, from about 15 to about 97 percent by weight of a soap of a fatty acid, up to about 80 percent by weight of water, and wherein at least a portion of the soap, in an amount within the range of about 0.2 percent to about 30 percent by weight of the lubricant composition, is a fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum.

6. The method as claimed in claim **5** wherein the concentrate composition contains 65–75% by weight of a fatty acid soap of sodium, 0.4–10% by weight of a fatty acid soap selected from the group of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum and the remainder being selected from the group consisting of alkali metal pyrophosphates and alkali metal tetraborates.

7. A metal surface having deposited thereon a lubricating amount of the lubricant composition as claimed in claim 1.

8. The metal surface as claimed in claim 7 wherein the lubricant composition comprises an admixture of from about 65 to about 75 percent by weight of a sodium soap of a fatty acid, from about 0.4 percent to about 10 percent by weight of the fatty acid soap selected from the group consisting of fatty acid soaps of lithium, potassium, ammonia, calcium, magnesium, zinc and aluminum and the remainder being selected from the group consisting of alkali metal; pyrophosphates and alkali metal tetraborates.

9. The metal surface as claimed in claim 8 wherein the metal surface is a chemically coated metal surface.

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