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3,600,310

## LUBRICANT FOR METAL WORKING

Alan R. Eyres and Jacques C. Dillon-Corneck, Mullica Hill, N.J., assignors to Mobil Oil Corporation, New York, N.Y.

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11 Claims

### ABSTRACT OF THE DISCLOSURE

The present invention provides a superior metal rolling lubricant composition useful as a pre-coating oil and as a coating in rolling operations comprising a mineral oil, a fatty acid or the polymers or glycerides thereof, and a wax, preferably a paraffin wax such as slack wax. The composition may also contain a sulfurized mineral oil, or fats, or other sulfur-containing compounds, as well as organic phosphates or phosphites to provide increased protection to the metal surface during coiling and uncoiling. The lubricant composition provided is particularly useful in the cold rolling of steel.

### BACKGROUND OF THE INVENTION

#### Field of the invention

The invention is concerned with compositions useful in treating metal surfaces, particularly ferrous metals. It is especially concerned with oil compositions useful as coatings for protection of metal surfaces during storage and as lubricants during steel cold rolling operations.

As cold rolling lubricants, the compositions of this invention reduce gouging and scratching of the metal surfaces during cold rolling. They also are effective in providing clean surfaces following heat treatment, as in annealing processes. This latter property is believed to be due in part to any residual oil being burned off during annealing. The major factor, however, is the ability of the composition to effectively float metal fines, tramp oil and "diet" present in the emulsions used with the inventive compositions, thus eliminating the possibility of these being deposited on the rolled metal to contribute to discoloration after annealing.

#### Description of the prior art

Various types of lubricant compositions have been used in metal working, as for example in cold rolling processes involving ferrous metals. For the most part, however, such compositions provide inadequate lubrication or cause objectionable surface discoloration or imperfections. In many instances, they are ineffective in preventing the formation of rust during processing.

The art has made several attempts to overcome the deficiencies of presently used lubricants. One such attempt is outlined in U.S. Pat. No. 3,298,954, which is directed to compositions containing polybutenes, fatty acids, and in some cases, sperm oil wax. U.S. 3,071,544 describes an emulsifiable oil which, in addition to its other stated advantages, is alleged to have the ability to provide a clean metal strip upon annealing of the metal after the rolling operation. Such oil comprises an emulsifier, a mineral lubricating oil, an alkali metal or alkanol-amine salt of petroleum sulfonic acids, an organic monocarboxylic acid, as for examples oleic and stearic, or an alkanol ester thereof, and an alkanolamine. The acid or the alkanolamine may be in slight excess.

It is not believed, however, that either of the just-mentioned patents, or any art known, discloses the com-

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positions of this invention, and particularly the advantages which are derived from their use.

It will be noted from the above art that mineral oil-based lubricants have been used almost exclusively in cold rolling steel, but suffered the disabilities mentioned in the first paragraph under this section, namely, inadequate lubrication and the forming of objectionable discoloration on the metal surface and the inability to prevent deposits upon annealing. The patentee in U.S. Pat. No. 3,071,544, in his attempt to overcome certain of these deficiencies, compounded a complex mixture of materials for use as an emulsion. In the second patent mentioned, U.S. 3,298,954, patentee used polybutenes as a substitute for mineral oils as his solution to the problems inherent in the use of mineral oil. While both of these compositions are no doubt effective for their intended purposes, they do have among others, the disadvantage of relatively higher cost.

While it is true that the requirements for metal working lubricants have recently become more stringent because of new alloys, demands for higher production rates, and the like, it is also true that the metal working industry is seeking improved lubricants which are economical for use in its operations. The composition of this invention has that advantage. Basically, the discovery herein is that the inexpensive mineral oil base can be used in a composition which overcomes the disadvantages of prior art mineral oil-based lubricants, when such lubricant contains a naturally occurring wax such as slack wax. The advantages of such a composition will become apparent from the remainder of this disclosure.

### SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a lubricant composition comprising a liquid lubricant, especially a mineral lubricating oil, an acid or acid derivatives selected from the group consisting of an aliphatic monocarboxylic acid having from about 12 to about 26 carbon atoms, a polymer or a glyceride thereof and a wax, preferably a paraffin wax such as slack wax, which composition may have additionally present therein an agent for imparting additional load carrying properties thereto.

The composition is especially useful as a precoating for steel to prevent corrosion thereof during storage before rolling, to provide lubrication during coiling and uncoiling processes to prevent surface scratching and gouging, to provide lubrication during rolling in the first pass of a reversing mill or first stand of a tandem mill and to maintain the circulated mill coolant in a clear condition by floating fines, tramp oil and dirt to the surface in the reservoir of the circulation system.

### DESCRIPTION OF SPECIFIC EMBODIMENTS

The liquid lubricants used in this invention include naphthenic and paraffinic mineral oils having a kinematic viscosity in the range of from about 80 through about 350 S.U.S. at 100° F., as well as synthetic lubricants such as synthetic ester lubricants and alkylene oxide-derived fluids. This liquid lubricant is present in the amounts ranging from about 50% to about 90% by weight of the neat composition, and preferably from about 60% to about 85% by weight.

From about 1% to about 10% by weight of the composition is an aliphatic monocarboxylic acid having from about 12 to about 26 carbon atoms or a polymer or glyceride thereof. This range includes lauric, myristic, palmitic and stearic acids, which are normally solid at room temperature and normally insoluble in mineral oils and water. Preferably the saturated acids are employed, and the more preferred one is hydrogenated tallow fatty acid. Also included are other designated fatty acids such

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as soya bean fatty acid. No great problems have been encountered, nor are any contemplated which cannot be overcome in their use since at elevated mixing temperatures and at mill operating conditions these acids, polymers and glycerides may become liquified and miscible with the mineral oil, while at low temperatures the paraffin wax present solidifies and maintains the solid fat in a stable suspension. For application to the metal surface, the composition must be heated to such a temperature that the wax/oil/fat mixture becomes liquified to ensure a uniform coating on the metal surface; under these conditions a homogeneous mixture is maintained.

The lubricant composition contains from about 5% to about 15% by weight of a wax, such as slack wax, i.e., a light neutral wax obtained by dewaxing the oil fraction to crystallize the higher melting hydrocarbons present therein and pressing, filtering or centrifuging to separate the oil fraction. An example of such a wax is one containing about 10% oil, having a M.P. of 50° C., and having a viscosity of 38.5 S.U.S. at 210° F. In the lubricant composition of the present invention, this so-called slack wax is the preferred wax. Useful compositions may be achieved by using a lesser quantity of another wax, such as beeswax or another paraffin wax, of similar molecular weight distribution, although such a composition may be more expensive. At the present time, it is believed that waxes of higher molecular weights may give rise to annealing problems due to the inability to remove them prior to annealing operations.

The lubricant composition may also contain from about 0.5% to about 25% by weight of an agent for imparting load carrying characteristics thereto. Preferably a sulfurized mineral oil, such as a solvent refined 150 S.U.S. 100° F. paraffin oil containing about 0.6% by weight of dissolved sulfur. Such load carrying (or E.P.) agents are well known to the art. However, it may be mentioned that other sulfurized fats and oils, as well as many other sulfur-containing compounds may be used. In addition, phosphates and phosphites, such as bis (nonylphenyl) phosphite, are also useful.

The function of a load carrying, or E.P., agent is to provide increased protection against gouging and scratching in the processing of metals, as in coiling and uncoiling operations. In rolling processes, this has only comparatively recently become a problem, since heretofore the weight of the metal coils was not sufficient to introduce appreciable metal to metal contact with currently used precoat lubricants.

However, with the advent of larger and more powerful equipment for handling metal coils, large coil weights are becoming more common. With such high weights, lubricant compositions used in metal rolling operations must protect the metal surfaces from scratching and gouging, and the inventive compositions serve to reduce both.

Having discussed the invention in general terms, the following will show how the lubricants are prepared and utilized.

Lubricant compositions were prepared using the following substances:

(I)

Parts by weight

|                                 |    |
|---------------------------------|----|
| Mineral oil                     | 81 |
| Hydrogenated tallow fatty acids | 4  |
| Slack wax                       | 15 |

(II)

|                                 |    |
|---------------------------------|----|
| Mineral oil                     | 61 |
| Hydrogenated tallow fatty acids | 4  |
| Slack wax                       | 15 |
| Sulfurized mineral oil          | 20 |

The mineral oil is a naphthenic oil having a viscosity of 300 S.U.S. at 100° F.

The hydrogenated tallow fatty acid is a commercial grade tallow acid containing from 1 to 3% myristic acid, 23 to 33% palmitic acid and 65 to 77% stearic acid.

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The sulfurized mineral oil is 150 S.U.S. at 100° F. solvent refined paraffinic oil containing 0.6% dissolved sulfur.

For comparative purposes, 30 parts of a conventional lubricant in 70 parts of a mineral oil having a viscosity of 100 S.U.S. at 100° F. was prepared.

The conventional lubricant is one containing 51% of a naphthenic oil having a viscosity of 29 c.s. at 100° F. and 49% of fatty matter, including 4.2% of free fatty acidity. The fatty matter has the following composition:

| Acid              | Number of carbons | Weight percent |
|-------------------|-------------------|----------------|
| Myristic.....     | 14                | 3.0            |
| Palmitic.....     | 16                | 23.1           |
| Palmitoleic.....  | 16                | 3.0            |
| Stearic.....      | 18                | 18.1           |
| Oleic.....        | 18                | 38.0           |
| Linoleic.....     | 18                | 4.5            |
| Unidentified..... |                   | 10.3           |
| Total.....        |                   | 100.0          |

The final composition had the following approximate analysis:

(III)

Parts by volume

|              |    |
|--------------|----|
| Mineral oil  | 85 |
| Fatty matter | 15 |

A commercially available emulsion was used in connection with the cold rolling operations of Examples 3 and 4. This emulsion is constituted substantially as follows: 97-98% water and 2-3% of a composition comprising 70% of a mineral and 30% of a fatty material containing an amine as emulsifier plus a small amount of non-ionic emulsifier. The neat composition has a viscosity of 51 cs. at 100° F. and a saponification number of 60.

The substances comprising the composition of this invention may be mixed in any convenient order. Since the product is normally a solid at ambient temperatures, adequate mixing may be accomplished by applying heat to the mixing chamber. A temperature just above the melting point of the highest melting component is sufficient for this purpose.

## EXAMPLE 1

## Comparative anti-rust properties

Two tests were used. One was the standard "Salt Spray" test; the other was the so-called "QCT Cabinet" test.

Salt Spray Test.—Steel test panels were coated with the various compositions and were hung in a spray cabinet maintained at 95° F. and the panels were sprayed with a 3% aqueous sodium chloride solution for 5 minutes in each hour for the duration of the test. Times given in the table below indicate interval before first rust spot appeared.

QCT Cabinet Test.—A "cabinet" is constructed so that the base and sides make up the reservoir for the water and the roof is made up from the various test panels. In this test, water was placed in the reservoir or tank and was heated to 100° F. Steel panels were coated on one side and were hung to form a roof over the tank. In this manner, water was allowed to condense on the treated side. The results in the following table show the times required for the first rust spots to appear.

|                              | Composition |    |      |
|------------------------------|-------------|----|------|
|                              | I           | II | III  |
| QCT Cabinet Test, hours..... | 33-48       | 30 | 9-24 |
| Salt Spray Test, hours.....  | 4           | 8  | 1.30 |

From the above data, it is evident that it requires a longer time for rust spots to appear in either the QCT Cabinet Test or in the salt spray test when using Composition I and II. The results obtained in the Cabinet Test

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show significant improvements with these two compositions compared to Composition III. The Salt Spray Test, however, indicates an even more significant suppression of corrosion, in that rusting is suppressed for from about 3 to about 6 times longer than when using Composition III.

#### EXAMPLE 2

##### Comparative E.P. properties

The test used was the well-known 4-Ball Test. The following results were obtained by running the test for 1 minute at 1800 r.p.m.

| Load, kg. | Composition |          |       |
|-----------|-------------|----------|-------|
|           | I           | II       | III   |
| 100.....  | Weld.....   | 2.20 mm. |       |
| 150.....  |             | 1.65 mm. | 2.53. |
| 200.....  |             | 2.31     | Weld. |
| 250.....  | Weld.....   |          |       |

The results of this example establish utility of lubricant compositions exemplified by Composition II as having E.P. properties. Composition I, which contains the same substances as Composition II except for the sulfurized oil, has no appreciable E.P. properties, since welding occurred at the lowest 100 kg. load. Composition III fails at 200 kg., and Composition II does not fail until the load reaches 250 kg.

#### ANALYSIS OF THE CONVENTIONAL EMULSION

|                                 | First day of trial using Composition III as coating |          | Last day of trial using Composition I as coating |          |
|---------------------------------|-----------------------------------------------------|----------|--------------------------------------------------|----------|
|                                 | Skimming materials                                  | Emulsion | Skimming materials                               | Emulsion |
| Iron content, p.p.m.....        | 1,500                                               | 190      | 6,200                                            | 110      |
| pH.....                         |                                                     | 6.8      |                                                  | 7.1      |
| Emulsion strength, percent..... |                                                     | 2        |                                                  | 3        |

#### EXAMPLE 3

##### Comparative cleanliness of annealed strips

Although the product may be applied to the surface of the metal in any convenient way, as by brushing and the like, it is preferable in large scale treatment to use a circulating system as was done in this embodiment.

The lubricant compositions (Compositions I and III) were applied to a low carbon steel strip having a thickness of from 1.8 to 5 mm. by means of a circulating system consisting essentially of a reservoir heated by electrical resistance to a temperature of between 91° F. and 114° F., a pump, lines (heated to the same temperature) for dripping the product on both sides of the strip, a steel roll for distribution and a return line for returning the excess to the reservoir.

The metal strip was passed from 3 to 5 times, according to width, through a production scale 58"-wide single stand 4-high reversing mill at a maximum speed of about 650 m./min. The final thickness was 0.8 to 2.5 mm. As previously indicated, a conventional emulsion at a temperature of 113° F. was used.

The coils were annealed in a cracked gas (i.e., a mixture of nitrogen and hydrogen, usually 90 to 95% hydrogen and 5 to 10% nitrogen) atmosphere at 1472° F. (800° C.), and, after annealing, the cleanliness of the strip was determined on a skin pass mill using the "scotch tape" method. In this method, a piece of scotch tape is applied to the strip surface and transferred to clean white paper to provide a permanent record of the amount of loose dirt adhering to the strip surface.

The initial strip was obtained from coils which had been coated with Composition III. After annealing and passing through the skin pass mill, the coil was dirty, as indicated by the many particles adhering to the scotch tape.

Subsequent strips were obtained following a change-over to Composition I. On the first day's operation, the

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cleanliness of the annealed strip was rated as "medium" or "normal," i.e., the scotch tape had picked up very few particles. Three days following the substitution of Composition I, the cleanliness of the annealed strip was rated as excellent, the scotch tape being virtually free of adhering particles.

Following the end of the test with Composition I, Composition III was again used as the coating. After two days, the annealed strip was again as dirty as it had been at the start of the test with Composition III.

#### EXAMPLE 4

##### Comparative flotation effectiveness

The cleanliness shown by the use of Composition I is attributable, in large measure, to its ability to aid in floating the fine particles of metal, impurities and the like present in the emulsion. This allows easy removal of such particles, as by skimming or decanting. In this way, it is possible to remove from the emulsion those foreign substances which tend to adhere to the metal and which as a consequence produce dirty surfaces in subsequent processing of the metal.

As is shown by the following data, compared to Composition III (first day), Composition I (last day) provides skimming material having higher iron content and allows lower iron content in the emulsion, in spite of the increase in the emulsion strength over the period of the test.

On the first day of the trial, Composition III was being used; Composition I was in use on the last (third) day of the trial.

The results established the fact that Composition I is a superior flotation agent.

So far as is known, no other pre-coat oil is also useful as a flotation agent. While the combination of acid and wax in mineral oil is probably essential for good flotation, it is believed that the ingredient most responsible is the wax. It is known that temperature plays an important role, both in the preparation of the composition and in the temperature of the emulsion used in rolling operations.

With regard to the temperature of preparation, it must be sufficiently high to melt the acid, its polymer or glyceride so this ingredient can become distributed uniformly throughout the blend. Obviously then, the temperature during preparation of the composition must be at least above the melting points of the acid or acid derivative and the wax in the blend. Unless a homogeneous mixture is obtained, wax and/or acid will tend to separate, thus in effect destroying the flotation properties of the composition.

Prior art coatings containing no emulsifiers, when washed off the metal strip by an emulsion, tend to float to the surface of the emulsion, but do not carry with them a significant amount of fines, or not enough to prevent dirty surfaces upon annealing of the metal. The inventive compositions are also washed off the surfaces during rolling operations and they float to the surface of said emulsion. In contrast, however, most of the fines are carried along, and these can be easily skimmed or decanted, thus preventing their contact with the metal surface.

The inventive compositions containing oil, wax and acid or its derivatives, and which may also contain a load carrying agent, work well as flotation agents at emulsion temperatures used for best results in metal rolling. Generally, the lower end of the temperature range is between about 90° F. and 110° F. Also, such temperatures usual-

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ly range up to 140° F. to 150° F., but the preferred temperature is between about 110° F. and 120° F. The compositions of this invention are operative as flotation agents within this range so long as there is a sufficient amount of the composition present in the emulsion to cause flotation of the fines.

Taken as a whole, the above tests involving the compositions of this invention show that the inventive lubricants are indeed exceptional. They are compounded of simple and readily available materials, thus providing inexpensive lubricants to the art. Depending upon the composition selected, they provide (1) greater protection against rusting of metal surfaces, (2) lubricants having good E.P. properties, (3) metal surfaces which are clean and clear of foreign matter, and (4) compositions which are excellent floating agents for fines which are present in the emulsions used in metal rolling. All in all, the results show the discovery of compositions which could not have been discerned from the presently known art.

What is claimed is:

1. A lubricant composition comprising (a) at least 50% of a mineral lubricating oil; (b) about 1 to 10% of an aliphatic monocarboxylic acid having from about 12 to about 26 carbon atoms or a derivative thereof selected from the group consisting of polymers and glycerides; and (c) about 5 to 15% of a wax selected from the group consisting of paraffin wax and beeswax.

2. The composition of claim 1 which has therein an agent for imparting load carrying properties thereto.

3. The composition of claim 1 wherein said wax is slack wax.

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4. The composition as defined in claim 1 wherein the acid derivative is hydrogenated tallow fatty acid.

5. The composition as defined in claim 1 wherein the wax is paraffin wax.

6. The composition of claim 1 wherein said lubricating oil is present in an amount of from about 50% to about 90% by weight.

7. The composition of claim 6 which has therein from about 0.5% to about 25% by weight of an agent for imparting load carrying properties thereto.

8. The composition of claim 7 wherein the said agent is a sulfurized mineral oil.

9. The composition as defined in claim 7 wherein the acid derivative is hydrogenated tallow fatty acid.

10. The composition as defined in claim 7 wherein the wax is paraffin wax.

11. The composition as defined in claim 7 wherein the wax is slack wax.

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DANIEL E. WYMAN, Primary Examiner

W. H. CANNON, Assistant Examiner

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