

UNITED STATES PATENT OFFICE

2,578,585

COMPOSITION FOR FORMING A DRY, HOMOGENEOUS, SELF-ADHERENT LUBRICATING FILM ON METAL STOCK

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No Drawing. Application August 11, 1949,
Serial No. 109,822

14 Claims. (Cl. 252-28)

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This invention relates to dry lubricants for lubricating metal bars, rods, sheets, and the like, during the pressure forming thereof.

The present invention relates particularly to a composition of which an aqueous solution thereof is applied to the metal stock and caused, or permitted, to dry thereon, thereby forming on the stock a dry homogeneous self-adherent lubricating and protecting film which, during the formation of the metal stock to the desired shape, supplies the necessary lubrication to the stock and die surfaces.

For the purposes of illustration, the present invention is described as applied in the deep drawing of sheet steel and steel alloys in pressure dies for which it is particularly adapted, its application to drawing, stamping and shaping of other kinds of metal sheet and rod stock, to cold heading, and to wire drawing, being apparent from the illustrative example.

The present invention in general is used for the same purposes and in the same manner as the compositions disclosed in the Whitbeck Patent No. 2,470,062, issued on May 10, 1949, and the application of Gilbert H. Orozco, Serial No. 53,376, filed October 7, 1948, and constitutes an improvement over such metal lubricating compositions.

In the above identified patent there is disclosed a dry composition which comprises essentially water soluble high titre soap, having a titre or melting point of from about 36° to 42° centigrade, and borax, the soap being within the range of 10% to 33% of the composition and the borax being from about 90% to 67%. This composition is applied to the stock by dissolving it in water in an amount of about one to thirty ounces of the dry mix per gallon and then dipping the stock therein or flowing the solution thereon and then drying the stock so as to deposit thereon a dry, homogeneous, adherent lubricating and protecting film. The lower concentration in the aqueous solution is used for relatively bright smooth surfaces, the concentration being increased as the roughness of the surface and the porosity of the metal increases.

While the patented composition above discussed functions in the desired manner in most instances, there are certain disadvantages attendant to its use under certain circumstances. For example, the patented composition is undesired when employed in conjunction with hard water, which is water containing metals. When hard water is employed with the patented composition, the soap present therein is found to react with the metal present in the water resulting in

the formation of insoluble metallic soaps. The formation of these objectionable metal soaps breaks down or reduces, or destroys the adhesion of the resulting lubricating film to the metal stock and consequently the film scuffs off during initial contact with the forming die and is not carried with the metal stock into the die.

Moreover, even in soft water, the new composition of the present invention constitutes a distinct improvement over the patented composition. For example, the new compositions have been found to adhere to the surface of the metal stock regardless of the water used far better than the patented compositions thus lessening any possibility of the lubricant being scuffed off during initial and subsequent contact of the metal with the die.

It has been found that these objectionable characteristics can be eliminated and a thin film which, particularly when hard water is used in the solution, provides the necessary lubricity and adherence at the lower die temperatures prevailing during the initial forming of the stock as well as the subsequent higher die temperatures, may be had, said film being a completely water-soluble composition consisting essentially of the following ingredients and proportions by dry weight:

	Range	Preferred
	Parts	Parts
A water-soluble aliphatic polyhydric alcohol having less than four hydroxy groups, fatty acid ester thereof or mixture of either or both, and having a melting point of at least 40° C.	about 5-30	about 15-20
A water-soluble alkali metal borate	about 95-70	about 85-75

In the aforesaid composition, the polyhydric alcohol and esters thereof have been identified by a generic terminology. However, all such compounds falling within the definition of the generic class will not be found to be of utility in conjunction with the borates to form the desired composition due to certain additional properties the alcohols or esters must possess in order to perform their intended function. These additional properties are (1) that the compounds must be water-soluble, (2) they must be inert with respect to additional ingredients present in the composition as well as the ingredients in the water, (3) they must be solid and, as hereinbefore indicated, possess a melting point of at least 40° C., (4) they must be substantially non-hygroscopic, and (5) they must possess a flash point sufficiently high that they will not ignite from the heat of friction during the forming operation.

In other words, the generic terminology employed herein and in the appended claims is intended to include only those compounds coming within the generic terminology and which in addition possesses the additional properties above enumerated. Illustrative and non-limiting examples of compounds satisfying each of the above requirements are polyethylene glycol, polyethylene glycol oleate, di-glyceryl stearate, propylene glycol stearate, di-glycol stearate, etc.

A particularly preferred material is polyethylene glycol and may be any one of the different water-soluble compounds having a melting point of at least about 40° C. up to about 60° C. A preferred fatty acid ester and one particularly adapted to combine with the polyethylene glycol as a mixture is polyethylene glycol oleate. The oleic content of this material aids in providing particularly strong adhesion with a somewhat lower melting point and in addition acts, to some extent, as a plasticizer and coupler.

The polyhydric alcohols, fatty acid esters thereof or mixtures employed herein in lieu of the soaps disclosed in the Whitbeck Patent No. 2,470,062 have been identified as possessing a melting point of at least 40° C. while the soaps of the patented composition have a melting point or titre of from between about 36 to 42. It must be realized that these two different sets of temperatures do not possess the same meaning. In other words, the so-called melting point or titre of the soap is the melting point of only the fatty content of the soap and not the melting point of the soap containing the fatty content plus additional ingredients. However, the melting point of the polyhydric alcohol or fatty acid ester thereof is the temperature at which the entire compound melts. For example polyethylene glycol having a melting point of 48° C. would melt at a much lower temperature than a soap having a titre of 48° C. In other words, the present compounds employed in lieu of the soaps would melt at a lower temperature than a soap having a titre equal to the melting point of the polyhydric alcohol or ester.

The surprising and improved utility of these alcohols and esters in combination with the borates is somewhat of a phenomena since the draws are becoming more severe and charring of the lower melting point ingredients occurs. Normally one would then assume that any improved lubricating composition over that disclosed in the Whitbeck patent would be one in which the melting point of the lowest melting point ingredient i. e. alcohol or ester, would be greater than that of the soap of the Whitbeck patent. However, the polyhydric alcohols and esters thereof have been found to work contrary to this belief and impart new and improved characteristics to the finished lubricant over that disclosed in the Whitbeck patent.

It has been hereinbefore indicated that the polyhydric alcohols or esters thereof may be employed as mixtures. In the following discussion relative to such mixtures, polyethylene glycol and polyethylene glycol oleates will be employed as illustrative materials. The combined use of polyethylene glycol and the oleate is based ordinarily on the finish of the metal stock. For example, when the metal stock has a mirror finish the polyethylene glycol oleate is used alone due to the fact that it is more polar than the polyethylene glycol alone. When the metal has a smooth finish somewhat rougher than the bright mirror finish, a mixture of the oleate and the alcohol will be found necessary since a thicker film is required. However, the oleate content must not be too great

since an excess in a film of the required thickness for the rougher stock would result in an excessive tackiness which is highly objectionable. This problem is not present in the mirror finish since only a thin film is necessary and the tackiness does not become a problem. On a still rougher surface on the order of vitreous enamel stock, the polyethylene glycol must be used in an excess over that of the oleate due to the increased need for a thicker protective coating for the metal surface and the resulting likelihood of objectionable tackiness if a large amount of oleate is present. In summation therefore, the mixtures will be determined to a large extent by the surface of the metal stock with the oleates being used in excess when the surface is highly polished and requires only a thin lubricating and protecting film whereas an excess of the alcohol will be found desirable when the surface of the stock is rough. As stated above, the compounds employed in the above discussion, while preferred, are used only for illustrative purposes since other fatty acid esters of aliphatic polyhydric alcohol having less than four hydroxy groups may be substituted for the oleate, i. e. propylene glycol stearate, glycerol monostearate, diglycol stearate etc. Moreover, there may be a mixture of the alcohol with a number of esters in lieu of a simple mixture of the alcohol and a single ester.

The borates which are employed in conjunction with the polyhydric alcohols or esters thereof have been identified as water-soluble alkali metal borates which would include borax, lithium borate, and potassium borate. Borax is the preferred material since, in certain methods of application, the other water soluble borates tend to disburse the alcohol or ester and if the coated stock stands for any considerable time it tends to become tacky. However, as will be pointed out more in detail hereinafter, there are times when the lithium borate and potassium borate may be used. The ingredients going to make up the completed lubricating composition are to be employed only within certain stated percentages or parts. These limitations are critical and must be observed. In the following illustrative examples of compounding the lubricating compositions in dry form, polyethylene and/or polyethylene glycol oleate and borax will be employed, for the sake of convenience, as illustrative of the materials.

The lowest minimum amount of polyethylene glycol when used separately from the esters that may be employed is 5 parts by dry weight, relative to the borax. If an amount lower than 5 parts is employed there is insufficient adherence of the resulting film to the surface of the metal stock and improper lubrication occurs at the low initial friction heat of the metal and the die. If the polyethylene glycol is employed in an amount in excess of more than 30 parts dry weight relative to the borax, the film is brittle initially but becomes thermoplastic under the heat of the die at temperatures below those commonly reached in die forming and rod and wire forming and as a result it peels off during the closing of the dies or initial passage through the ring die and chills as a hard crust on the radii of the dies where the temperatures are somewhat lower.

The polyethylene glycol oleate may be either in mono- or di-form, either separately or admixed so long as it satisfies the standards hereinbefore given. The oleate is satisfactory for many purposes but should be kept in a range from between about five to twenty parts relative to about ninety-five to eighty parts of borax

since, as hereinbefore discussed, different degrees of smoothness of the surface of the metal require different degrees of thickness of lubricating film.

In employing a mixture of polyethylene glycol and polyethylene glycol oleate the proportions of the two relative to each other should be from between about five to twenty parts for the polyethylene glycol and from about twenty parts to a trace for the oleate, one being increased as the other is decreased.

An example of the above mixture, the dry composition may be twenty-five parts polyethylene glycol and seventy-five parts borax. To modify this composition, it would contain from five to twenty parts of polyethylene glycol and twenty parts to a trace of the oleate, with the borax being the same. In other words, the glycol and the oleate being arranged in inverse relation to each other to total the twenty-five parts.

Having described in detail the component compounds going to make up my new and improved all-purpose, and one particularly suitable for use in hard water, lubricating composition, it becomes convenient to give a few illustrative examples of completed compositions in dry weight:

Example 1

Polyethylene glycol	Parts
Borax	15
	85

Example 2

Polyethylene glycol	Parts
Borax	22
	78

Example 3

Polyethylene glycol	Parts
Polyethylene glycol oleate	20
Borax	80

Example 4

Polyethylene glycol oleate	Parts
Lithium borate	7
	93

Example 5

Polyethylene glycol	Parts
Potassium borate	28
	72

Example 6

Glycerol monostearate	Parts
Polyethylene glycol oleate	12
Potassium borate	88

Example 7

Propylene glycol stearate	Parts
Lithium borate	30
	70

Example 8

Diglycol stearate	Parts
Borax	18
	82

Example 9

Propylene glycol stearate	Parts
Diglycol stearate	20
Lithium borate	80

Example 10

Polyethylene glycol stearate	Parts
Propylene glycol stearate	15
Borax	85

For applying the new and improved composition of the present invention to the metal prior to its formation, an aqueous solution thereof is made using the concentration of from one ounce per gallon of water to saturation, depending on the roughness of the surface of the stock and the severity of the draw. Metal stock with smooth or mirror finish can be coated sufficiently with the concentration of four ounces per gallon for severe draws. As the roughness and porosity of the stock surface increases the concentration is increased unless a very light draw is contemplated. For very rough and porous stock such as vitreous enamel stock, a saturated solution is deemed best. For very light draws, as low as one ounce per gallon can be used on relatively smooth surface stock.

The aqueous solution as above prepared is ordinarily applied to the metal stock by a simple dipping operation and then permitted to dry whereby there is formed on the surface of the metal stock, a dry homogeneous, self-adherent lubricating and protecting film. The metal stock containing the film is then pressure formed into the desired shape without any detriment to the dies or the surface of the metal. After the desired formation the formed article is then washed with water thereby removing completely any traces of the lubricating film. In other words, after the washing step, the surface is then ready to receive any subsequent operation, i. e. vitreous enameling, painting, electro-plating, etc., without any additional washing, cleaning, or pickling operation.

It should be particularly noted that the aqueous solution of the composition may be applied to the metal stock and the lubricating film permitted to dry thereon. The coated metal stock may then be stored and not formed into the desired shape until some future date. The unique feature or characteristic of the composition is extremely advantageous since it permits the metal manufacturer or steel mill operator to provide small metal fabricators with metal already containing a lubricating and protecting film. When such a procedure is employed it should be mentioned that borax should be employed as the borate since it has been found to essential in holding the film in a dry and homogeneous state. However, in such circumstances, a mixture of alkali metal borates may be employed so long as borax is present in the predominating amount. In other words, the borate may consist of a major amount of borax and a minor amount of lithium or potassium borate. Such a mixture has been found advantageous for many purposes where the fabrication occurs shortly after the application of the aqueous solution.

Where the metal stock is dipped in the water solution and dried and then passed within a very short time to the forming dies, potassium or lithium borate, either alone or in admixture, will be found to be of utility. Under such circumstances certain objectionable characteristics of these borates, i. e. tendency to disperse the polyhydric compounds, are not encountered due to the prompt fabrication. Therefore, borax is the preferred borate due to its utility for all purposes although the remaining alkaline earth metal borates possess utility when employed properly.

In employing a mixture of borax and another borate, it should be noted that as the proportion of borax increases, the softness and tackiness of the film decreases. In other words, the remaining borates may be admixed with the borax to

control the plasticity and tackiness of the dry, homogeneous film.

The term "consisting of" as employed herein and in the appended claims to define the coating composition or film formed thereby is intended to define a composition or film containing the claimed ingredients, in the relative ranges stated, as the active constituents of such composition or film but is not meant to exclude the presence of minor amounts of conventional compounds or ingredients, whether lubricating or not, the use of which is common in the lubrication of metals during the forming operations.

Having thus described our invention, we claim:

1. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts

Water-soluble material having a melting point of at least about 40° C. and selected from the group consisting of polyethylene glycol, fatty acid esters of aliphatic polyhydric alcohols having less than four hydroxy groups, and any mixtures of any of the foregoing ----- 5-30
Alkali metal borate ----- 95-70

2. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts 35

Water-soluble material having a melting point of at least about 40° C. and selected from the group consisting of polyethylene glycol, fatty acid esters of aliphatic polyhydric alcohols having less than four hydroxy groups, and any mixtures of any of the foregoing ----- 15-25
Alkali metal borate ----- 85-75

3. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry, homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts 50

Water-soluble fatty acid ester of aliphatic polyhydric alcohol having less than four hydroxy groups and having a melting point of at least about 40° C. ----- 5-30
Alkali metal borate ----- 95-70

4. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry, homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts

A mixture of polyethylene glycol and water soluble material having a melting point of at least about 40° C. and selected from the group consisting of fatty acid esters of aliphatic polyhydric alcohols having less than four hydroxy groups, and any mixtures of the foregoing ----- 5-30
An alkali metal borate ----- 95-70

5. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry, homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts

Polyethylene glycol having a melting point in excess of 40° C. ----- 5-30
Alkali metal borate ----- 95-70

6. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry, homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts

Polyethylene glycol oleate having a melting point of at least about 40° C. ----- 5-30
An alkali metal borate ----- 95-70

7. A coating material for admixture with water for coating a piece of blank metal stock and forming thereon a self-adherent, dry, homogeneous, lubricating and protecting film consisting essentially of the following ingredients by weight, dry:

Parts

A mixture of polyethylene glycol and polyethylene glycol oleate, said mixture having a melting point of at least about 40° C. ----- 5-30
An alkali metal borate ----- 95-70

8. A composition in accordance with claim 1, wherein the alkaline earth metal borate is borax.

9. A composition in accordance with claim 5 wherein the alkali metal borate is borax.

10. A composition in accordance with claim 6 wherein the alkali metal borate is borax.

11. A composition in accordance with claim 7 wherein the alkali metal borate is borax.

12. A composition in accordance with claim 1 wherein the alkali metal borate is lithium borate.

13. A composition in accordance with claim 1 wherein the alkali metal borate is potassium borate.

14. A composition in accordance with claim 1 wherein the alkali metal borate is selected from the group of mixtures consisting of a mixture of borax and potassium borate; a mixture of borax and lithium borate; and a mixture of borax, potassium borate, and lithium borate.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
Re. 23,184	Whitbeck	Dec. 20, 1949

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