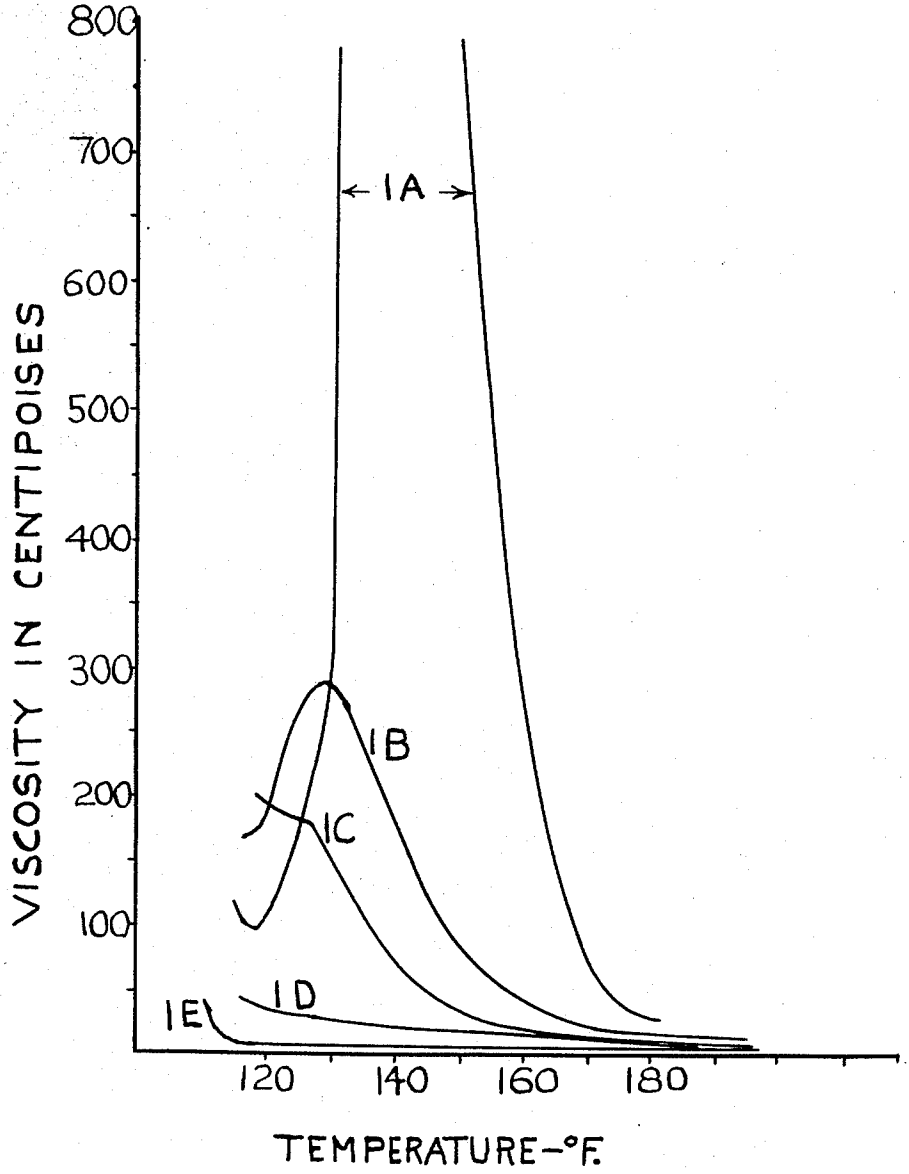
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DRAWING LUBRICANT

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DRAWING LUBRICANT

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This invention relates to the lubrication of metals in drawing operations. The invention provides new and improved soap-borax compositions which are modified importantly to alter the viscosity characteristics in aqueous solution. More specifically, the invention is concerned with the use of polyethylene glycols in controlled amounts to modify the viscosity of aqueous solutions of soap-borax mixtures therein to obtain controlled increase in viscosity to the point of solidification.

A better understanding of the invention will be had by reference to the drawing which represents the temperature-viscosity curves of soap-borax mixtures containing various amounts of polyethylene glycol.

Curve 1A represents the temperature-viscosity curve of a 60% borax, 40% soap mixture at 10% concentration by weight in water.

Curve 1B shows the viscosity-temperature curve of a 60% borax, 39.5% soap and 0.5% polyethylene glycol mixture in aqueous solution at 10% concentration.

Curve 1C shows the temperature-viscosity curve for a 60% borax, 39% soap, 1% polyethylene glycol mixture at 10% concentration in water.

Curve 1D shows the temperature-viscosity curve of a 59% borax, 39% soap and 2% by weight polyethylene glycol mixture at 10% concentration in aqueous solution.

Curve 1E shows the temperature-viscosity curve of a 57% borax, 38% soap and 5% polyethylene glycol composition at 10% concentration in water.

Soap-borax mixtures which are used as lubricants in cold drawing of steel exhibit unusual viscosity curves as observed by change in temperature. The shape of this viscosity curve is shown in Curve 1A. It is seen that below 180° F. the viscosity increases greatly to a point where it is extremely viscous at approximately140° but that as cooling continues below 140°, the material just as quickly drops in viscosity until the solidification point of the material is reached at below 120° F.

This unusual viscosity curve exhibited by the 60% borax, 40% soap mixture at 10% concentration in water has serious adverse effects in applying the lubricant to steel panels which are subsequently to be drawn or extruded. For example, if a steel panel is withdrawn from a 60% borax, 40% soap mixture at 10% concentration at 160° F., upon cooling rapid thickening of the film of lubricant on the metal takes place and apparent solidification would be reached at about 140° F. However, as cooling continues, this coating begins to drain again. An apparently firmly coated surface shortly erupts into a checkerboard or alligator design caused by the breaking away from the metal surface of portions of the lubricant composition.

This alligator surface if sought to be introduced into the drawing die would be scuffed off, would build-up and clog the die and would otherwise disrupt the drawing operation until the defective parts are removed, and the die cleaned. Thus, it is evident that lubricating compositions which exhibit the reverse temperature-viscosity curve in aqueous solution shown by Curve 1A are unsuitable for assembly line techniques where repeated satisfactory lubrication of the stock is essential.

In addition to the eruption of the surface caused by the lubricant starting to run again, which renders the coating unsatisfactory, other bad effects have been noted. In some cases instead of the lubricant film erupting on the surface, entire coatings of lubricant have been observed dropping off as the viscosity drops. This renders the blanks unfit for drawing.

On the other hand a moderate increase in viscosity as the temperature is lowered is very desirable for lubrication in that the coating weight of the metal stock can be effectively controlled by utilizing the increased viscosity at a specific temperature. However, it must be emphasized that compositions must be avoided which show first, an increase in viscosity, and then, a decrease in viscosity prior to solidification. Such compositions have a temperature-viscosity curve such as shown by Curve 1A and Curve 1B.

It is desirable in regulating the amount of lubricant which is to be deposited on metal stock to have an immersion bath at a specific temperature of known viscosity and then removing the stock from the bath, drying it at this temperature where this known viscosity exists. Thus, effective control of the thickness of the lubricant coating on metal stock can be obtained by controlling the viscosity of the lubricant composition in aqueous solution. If heavier coatings are required, it is merely necessary to drop the bath temperature 10° Fahrenheit.

I have now discovered that the addition of 0.75 to 2.0% of a polyethylene glycol having a molecular weight of at least 1000 will give a desirable temperature-viscosity curve to aqueous solutions of fatty acid-metal borate compositions so that the thickness of lubricant compositions can be controlled by selection of temperature. Thus, by the addition of a small amount of polyethylene glycol having a molecular weight of at least 1000 the characteristic viscosity curve of soap-borax mixtures in water is sufficiently modified and reasonably controlled so that a moderate increase in viscosity between the normal use temperature and the solidification point can be obtained. Thus, merely by controlling the amount of the polyethylene glycol added to soap-metal borate mixtures, the thickness of the lubricant coating on metal stock can be controlled.

The criticality of the amount of polyethylene glycol which can be added to effect benefits of my invention is readily seen by a study of the drawing. Curve 1A which is the viscosity curve of a 60% borax, 40% soap mixture without any polyethylene glycol added shows a tremendous increase in viscosity in the vicinity of 160 to 140° F. and an equally steep drop in viscosity between 140 and 120° F. This reversed viscosity-temperature index is unsuitable in the application of lubricants to metal because of the dripping after apparent solidification at noted heretofor.

When as little as 0.5% of polyethylene glycol having a molecular weight of at least 1000 is added to soap-borax mixtures and placed in water at about 10% concentration, the viscosity curve is importantly modified as shown in Curve 1B. It can be noted here that the temperature-viscosity curve is not as steep as Curve 1A and that a maximum of about 290 centipoises is reached at a temperature of 130° F. This is to be compared with a maximum viscosity of approximately 2000 centipoises at about 140° F. reached by the soap-borax composition without polyethylene glycol.

However, it is apparent that even with 0.5% by weight addition of polyethylene glycol the soap-borax mixture at 10% concentration in water still exhibits a reverse slope as shown by the change in viscosity between 130 and 120° F. in Curve 1B. This reverse slope in the viscosity temperature curve causes the alligatoring effect and renders lubricants on stocks unsatisfactory as heretofor noted.

When the polyethylene glycol additive is increased to 1% in the soap-borate mixture and the mixture is then

placed in aqueous solution at about 10% concentration, the temperature-viscosity curve of the soap-borax mixtures is more greatly modified, and even more importantly, the maximum peak and reverse slope are eliminated. This can be observed in Figure 1C. It is noted that the viscosity will increase gradually with decreasing temperature and does not reach a maximum and then decrease prior to solidification. Thus, at least 0.75% of polyethylene glycol is needed to eliminate the reversal of the viscosity with change in temperature. Curve 1D shows the same curve with 2% of the polyethylene glycol additive in the soap-borax composition and when it is used at 10% concentration in water. It is noted in curve 1D that there is only a moderate increase in viscosity as the temperature is lowered, and it is observed that the 2% addition would represent the upper concentration limit of my invention.

When polyethylene glycol additive is as great as 5%, as is the case in curve 1E, there is no change of viscosity with change in temperature. With such a composition there cannot by any control of lubricant thickness on metal stock by selection of temperature.

The compositions used in preparing the curves of the drawing are shown in Table 1 below.

Table 1

Composition	Alkali metal borate	Fatty Acid Soap		Polyethylene Glycol		Water
		Titer	Amount	Amount	Mol. Wt.	
A	Sodium tetraborate—468	46	304	0	--------	7,020
B	do	46	308	3.9	4,000	7,020
C	do	46	304	7.8	4,000	7,020
D	do	46	308	15.6	4,000	7,020
E	do	46	308	39	4,000	7,020

All parts by weight.

The polyethylene glycols useful for practicing my invention are the glycols which are solids at room temperature. Thus, they are the polyethylene glycols having a molecular weight in excess of 1000. Table 2 below shows representative polyethylene glycols which were used in preparing lubricating solutions in water which exhibited the desired temperature-viscosity curves.

Table 2

Molecular weight of Polyethylene glycol	Dry Lubricant Composition				Conc. in water (percent weight)	Viscosity—Centipoises				
						Temp., ° F.				
	Percent Polyethylene glycol	Percent Sodium tetraborate	Percent fatty acid soap	titer soap		180	160	140	120	100
1,500	2	59	39	46	10	7	23	100	425	--------
1,500	2	60	38	42	10	5	10	20	55	185
1,500	5	60	35	46	10	30	30	33	35	--------
4,000	0.5	60	39.5	46	10	15	43	[A] 185	180	--------
4,000	0.75	60	39.25	39	10	5	10	20	60	170
4,000	1.0	60	39	46	10	10	20	75	195	--------
4,000	1.0	60	39.0	42	10	5	15	35	115	300
4,000	2.0	59	39	46	10	10	15	23	35	--------
4,000	5.0	57.5	37.5	46	10	5	5	7	7	--------
6,000	1.0	60	39	46	10	7	25	95	190	--------
62 [B]						30	200	Solid	100 (estimated)	--------

[A] Reached maximum of 290 at 130° F.
[B] Ethylene glycol.

The polyethylene glycol of 1500 molecular weight when used at 2% concentration in a mixture with sodium tetraborate and fatty acid soap of 39 titer shows a viscosity-temperature curve which gradually increases as the temperature drops without reversing the viscosity-temperature curve. When polyethylene glycol of 1500 molecular weight is used at 5% of the sodium tetraborate-fatty acid soap mixture, there is no change in the viscosity with temperature and, hence, the 5% concentration is unsatisfactory.

The compositions using polyethylene glycol of 4000 molecular weight show that concentrations of 1 or 2% polyethylene glycol exhibit the desired viscosity-temperature relationships. The composition with only 0.5% polyethylene glycol showed the reverse temperature-viscosity characteristic which renders it unsuitable for application of lubricants to metal stock. Similarly, the polyethylene glycol of 4000 molecular weight used at 5% concentration shows no change in viscosity with temperature and, hence, does not exhibit the characteristic desired for lubricating purposes.

A 1% polyethylene glycol composition of molecular weight 6000 with sodium tetraborate and fatty acid soap of 46° titer at 39% concentration when dissolved in water at about 10% concentration shows the desired viscosity increase as the temperature drops. An aqueous solution of ethylene glycol at 2% concentration in a 60% sodium tetraborate, 38% fatty acid soap of 46° titer exhibited the characteristic viscosity-temperature curve of soap-borax mixtures of curve 1A which, in effect, is equivalent of the temperature-viscosity relationship without any polyethylene glycol present.

While the invention has been described in terms of polyethylene glycols, it is believed that the ethylene ether linkage is responsible for bringing about the desired modification of the viscosity curves of soap-borax mixtures in water. Thus, alkyl phenoxy polyoxyethylene ethanol compositions have also been satisfactorily used in modifying the viscosity temperature characteristics of sodium tetraborate-fatty acid mixtures. Also, a condensate of ethylene oxide with a hydrophobic base formed by condensing ethylene oxide with propylene glycol has been used satisfactorily in modifying viscosity temperature relationships of the soap-borax mixtures.

Thus, it is my belief that it is the ethylene ether linkages which are important in bringing about the desired control of the viscosity. While the examples shown herein are primarily those of the polyethylene glycols, esters and ethers of the same materials are satisfactory in practicing my invention. The esters and ethers may be alkyl or aryl or mixed alkyl aryl compounds. Similarly, poly-

propylene glycol is satisfactory in practicing my invention.

The preferred borate in formulating the compositions of my invention is the sodium tetraborate compound which may be anhydrous or hydrated in form and is most conveniently used as the decahydrate which is commercially available under the name borax. Other metal borates which are satisfactorily used are lithium and potassium borates. Other metal borates such as barium, magnesium, manganese, iron, copper, zinc and lead borate may also be used in practicing my invention since the borate does not enter into chemical reaction in practicing my invention, but is merely deposited as a film on the metal stock. The borates may be any water soluble or water insoluble borate and may be used singularly or in admixture with other borates. The borates may contain minor amounts of impurities such as silicates, carbonates or oxides without interfering with the practice of my invention.

The fatty acid soaps which are useful in forming the compositions of my invention are the soaps which are used in making the borax-soap lubricants which are well known to the art. These soaps may be low titer soaps; they may be the intermediate titer soaps and can also be the high titer soaps as disclosed in U.S. Patent 2,470,062. Representative soaps without reference to their titer or melting point are palm oil soap, tallow soap, stearic acid soap, cocoa butter soap, palmitic acid soap and many other soaps all of which are familiar to the worker skilled in the art. The ratio of fatty acid soap to metal borate can vary over wide limits depending on the nature of the drawing operation. The fatty acid soap may vary from 15 to 45 percent by weight of the dry mixture while the metal borate will be the difference allowing of course for the inclusion of 0.75 to 2.0% by weight of the final mixture of polyethylene glycol.

The dry lubricant compositions are preferably used at 9 to 12% concentration in water although compositions in which the lubricant is as low as 5% or as high 20% by weight of the final mixture can be used.

While the invention has been described and claimed in terms of metal borate, fatty acid soap and polyethylene glycol, it is to be understood that other materials may be present either in the dry composition or in the aqueous solution which do not seriously affect the temperature-viscosity relationship of the compositions. For example, small amounts of disodium phosphate may be present for the purposes of inhibiting corrosion and rust formation of the steel stock. It is also the usual practice to have small amounts of wetting agents present which assist in the deposition of any lubricant on the metal stock. The wetting agents may be added in small amounts of from .01 to 0.5%. At these small concentrations the wetting agents will not seriously affect the temperature-viscosity relationship of the soap-borax mixtures.

The dry compositions of my invention may be prepared in any manner well-known in the art. For example, the material may be prepared by placing the finely-ground borate in a ribbon blender to which is added the fatty acid soap and the polyethylene glycol. Mixing in the blender is continued until uniform composition is obtained. Similarly, preparation of the aqueous solutions of the lubricant is made by adding from 10 to 20% of the dried lubricant composition to water under conditions of agitation to insure uniform mixing and dissolving of the soluble constituents.

Thickness of the lubricant coating on metal stock may be controlled by the temperature at which the stock is removed from the solution or at the temperature at which a lubricating liquid is sprayed upon the metal stock. It is desirable that the lubricating bath have automatic temperature controls in order to maintain the desired temperature. Useful temperatures for applying the lubricating compositions in my invention are from 140 to 180° F.

The aqueous solution of the lubricant may be applied to the metal stock by dipping the stock in a bath of the solution or by applying it as a spray or by flowing it on roller applications. In the event that extreme drawing pressures are used, a thicker coating of lubricant will be required and thus, the metal stock will be subjected to contact with the lubricant at about 130° F. For less extreme drawing applications where a thinner amount of lubricant is desired, the metal stock will be coated by the lubricating bath or sprayed at a temperature of 140° F. Where even smaller amounts of lubricant are desired, the metal stock will be coated at 150° C.

Another important feature of the controlled viscosity of the aqueous compositions of my invention is the fact that the solidification of the materials on the walls of the spray chambers caused by using a soap-borax mixture without the polyethylene glycol additive is avoided. Since the presence of the polyethylene glycol materially lowers the viscosity of the aqueous solution of the soap-borax mixture, this material will no longer cling to the walls at the relatively high temperatures at which it is applied in the spray booths but will then be drained down where it can be collected and reused.

In a typical commercial application of my invention the following composition was used in a three stage machine. In the first stage the metal stock consisting of enameled iron sheets was subjected to a spray cleaner of an alkaline type applied in water at 4½ ounces per gallon. From the first stage the enameled iron stock was automatically carried to a high pressure water spray rinse. After application of the water rinse, the enameled iron was moved into the lubricant applicator chamber. This comprised a roller coated lubricant applicator in which both the upper and lower rolls applied the lubricant. The lubricant was charged at 12.4 ounces per gallon of water at a temperature of 150 to 160° F. The dry lubricant consisted of the following composition: sodium borate, decahydrate 70.9%, rust inhibitor 2.%, polyethylene glycol (molecular weight 4000) 1.4%, sodium soap of 35 to 38 titer, 18.7%, wetting agent, 0.2%. The enameled iron blanks were then drawn at high pressure to form stove tops of satisfactory shape.

While my invention has been described in terms of particular ingredients and while specific examples have been given, it is not intended that my invention be limited thereby in any manner but they are given merely for illustrative purposes.

I claim:

1. A drawing lubricant for application to metal stock from admixture with water consisting essentially of from 15 to 45% by weight fatty acid soap, a metal borate, and from 0.75 to 2.0% by weight of the solid materials of a polyethylene glycol having a molecular weight of at least 1000.

2. The lubricant composition of claim 1 in admixture with water at a concentration of from 5 to 20% by weight of the final mixture.

3. A drawing lubricant for application to metal stock from admixture with water comprising from 15 to 45% by weight of fatty acid soap, from 54.25% to 84.25% by weight of a metal borate and from 0.75 to 2.0% by weight of a polyethylene glycol having a molecular weight of at least 1000.

4. The lubricant composition of claim 3 in admixture with water at a concentration of from 5 to 20% by weight of the final mixture.

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