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LUBRICANT FOR METAL COLD FORMING

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No Drawing. Filed Aug. 18, 1965, Ser. No. 480,816

Claims priority, application Germany, Aug. 20, 1964,

M 62,160

4 Claims. (Cl. 72-42)

This invention relates to an improved lubricant composition and more particularly it relates to an improved lubricant composition suitable for use in metal deformation processes, such as the cold forming of metal.

In the cold forming of metals, particularly, in operations involving difficult shaping or so-called "deep-drawing" operations, it is customary to use a lubricant material on the metal surface which contains one or more pigments suspended in a liquid or at least semi-liquid component. Typical of the liquid materials which may be used are mineral oil or animal or vegetable oil while flowers of sulfur, graphite, molybdenum sulfide and calcium carbonate are exemplary of pigment materials which are commonly used. The use of such lubricants have, however, been found to be somewhat disadvantageous in that the pigments contained in the lubricant can be removed from the metal surface only with great difficulty after the cold forming operation has been completed. Frequently, a light coating of the pigment dust remains on the metal surface, which coating not only detracts from the appearance of the formed workpiece but also is detrimental to further processing of the workpiece, such as painting, plating, or the like.

In an effort to overcome these difficulties, it has also been proposed to use lubricants which contain water-soluble pigments. Thus, it has been proposed to utilize a lubricant containing mineral oil and a solid, water-soluble, oil-insoluble carbohydrate, such as sucrose. Compositions of this type have not been found to be completely satisfactory since the carbohydrates used therein form sticky, syrup like masses when they come into contact with even small amounts of water. Since it is almost impossible to avoid the introduction of even minor amounts of water during the handling of these lubricant materials, their utility in cold forming operations has been extremely limited. It has further been proposed to utilize lubricant compositions containing up to about 10% of a water-soluble pigment, such as trisodium phosphate. The separating or parting action of such lubricants has, however, not been found to be sufficiently great to be satisfactory in difficult cold forming operations, such as "deep-drawing" processes. Accordingly, up to the present time, no completely satisfactory lubricant compositions have been available for use in difficult cold forming operations.

It is, therefore, an object of the present invention to provide an improved lubricant composition for use in the cold forming of metal.

A further object of the present invention is to provide an improved lubricant composition for metal cold forming operations, which lubricant has a good separating or parting action but which can be easily removed from the formed part using conventional cleaning compositions.

Another object of the present invention is to provide an improved process for the deformation of metal surfaces, which processes utilize the improved 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

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includes a lubricant composition which comprises at least 20% by weight of a finely divided inorganic water-soluble, non-deliquescent salt and an organic lubricant material having a softening or melting point which is not in excess of about 90° centigrade, the inorganic salt being substantially uniformly dispersed throughout the organic lubricant, the amount of the organic lubricant being at least sufficient to provide for the dispersion of the inorganic salt and the entire composition being substantially free of water. It has been found that by the use of the above lubricant composition, difficult, deep-drawing operations are carried out satisfactorily and the lubricant residue on the formed pieces is easily removed by conventional cleaning methods.

More specifically, in the practice of the present invention, the subject lubricant compositions comprise the water-soluble, non-deliquescent inorganic salt or pigment in an amount within the range of about 20 to about 80% by weight of the composition. Desirably, the inorganic salt or pigment used has a relatively high melting point, e.g., above about 200 degrees centigrade, although in some instances, lower melting point materials may be used. Exemplary of the inorganic pigment materials which may be included in the present composition are various alkali metal salts such as the alkali metal silicates, alkali metal pyrophosphates, alkali metal fluoroborates, alkali metal halides, alkali metal nitrites, alkali metal carbonates, alkali metal bicarbonates, and the like. It is to be appreciated, that as used in the specification and claims, the term "alkali metal" is intended to refer to lithium, sodium, potassium, cesium and rubidium. Of these, the preferred alkali metal is sodium and for this reason, primary reference hereinafter will be made to this material. This is not, however, to be taken as a limitation on the alkali metal which may be used, as satisfactory results are also obtained with other alkali metal compounds, such as those of potassium.

Accordingly, preferred alkali metal compounds for use in the compositions of the present invention are typified by the sodium silicates, including the ortho silicates, meta silicates and di-silicates; sodium pyrophosphates, including the dihydrogen pyrophosphate; ($\text{Na}_2\text{P}_2\text{O}_7$ and $\text{Na}_4\text{P}_2\text{O}_7$); sodium fluoroborate (NaBF_4); sodium halide, including sodium chloride, sodium bromide, sodium fluoride, and sodium iodide; sodium nitrite; sodium carbonate; and sodium bicarbonate. Of these, the latter two, namely, sodium carbonate and sodium bicarbonate have been found to be especially useful. It is to be further appreciated that inorganic pigment materials of the above type which contain water of crystallization may also be used in the present composition, provided that the compounds used do not form solutions which are substantially free of crystal phases in the transition from one hydrate state to another.

It has further been found that it is desirable if the inorganic pigment materials are of a very fine particle size, typical particle sizes being less than about 500 millimicrons and preferably within the range of about 20 to about 200 millimicrons. Exemplary of a typical finely divided pigment material which may be used is sodium bicarbonate having the following sieve analysis—

Particle size in millimicrons:	Weight proportion in percent
Greater than 150	0.24
75 to 150	3.46
40 to 75	56.3
40 or less	40.0

The organic lubricant component of the present composition is an organic material, either aliphatic, aromatic or mixed aliphatic-aromatic having a softening point which is not in excess of about 90° centigrade. This

organic lubricating material is present in the composition in an amount at least sufficient to permit the substantially complete, uniform dispersion of the inorganic pigment material therein. Preferably, the organic lubricant material is present in the composition in an amount within the range of about 80 to about 20% by weight of the composition, although in some instances amounts of less than about 20% may be used provided there is still sufficient of the organic lubricant to provide for the dispersion of the inorganic pigment material.

The organic lubricant materials used may be in the form of an oil, a paste, or a solid and are exemplified by mineral oil, animal and vegetable oils and fats, fatty acids and fatty acid amides containing from 4 to 26 carbon atoms, waxes, paraffin wax, halogenated hydrocarbons, halogenated hydrocarbon waxes, such as those containing 18 to 26 carbon atoms and 20 to 80% of chemically combined chloride, petroleum jelly, petroleum sulfonate, sulfonated oils, montan wax and the like, as well as mixtures of one or more of these materials. Additionally, water soluble organic lubricant materials may also be used in order to provide lubricant compositions which may be even more easily removed from the formed pieces following the drawing operation. Exemplary of such water-soluble lubricants are polyvalent alcohols, such as glycerine and sorbitol; polyalkylene oxides, such as polyethylene oxide and polyethylene-polypropylene oxide; condensation products of polyethylene oxide with alkyl phenols containing 1 to 12 carbon atoms in the alkyl group, fatty acids, fatty alcohols and fatty amines, containing four to twenty-six carbon atoms in the alkyl group, and the like; Turkey red oils, fatty acid polydiethanolamides and the like. In general this organic lubricant material may be classified as aliphatic organics having from about 4 to 100 carbon atoms.

Alternatively, in order to provide a more easily removable lubricant composition, the non-water soluble organic lubricants, as have been set forth hereinabove, may be admixed with an emulsifying agent, particularly a non-ionic emulsifier. Exemplary of such emulsifying agents are the ethoxylated alkyl phenols, ethoxylated fatty alcohols and the like, such as those having 4 to 26 carbon atoms in the alkyl portion of the compound. Typically such emulsifiers will be present in the compositions in amounts within the range of about 0.1 to about 5% by weight.

The lubricant compositions of the present invention are formulated by admixing the inorganic pigment material and the organic lubricant material so as to effect a substantially uniform dispersion of the pigment in the lubricant. This may be accomplished using a suitable mixing or stirring apparatus. The admixing of the lubricant and pigment materials may be carried out at any suitable temperature, temperatures within the range of about 20 to about 100 degrees centigrade being typical. Where the organic lubricant material is a solid at room temperature, the mixing operation may be facilitated by using a temperature above the melting point of the material in order more easily to effect a dispersion of the inorganic pigment in the lubricant.

The lubricants of the present invention may be applied to the metal surfaces to be deformed in any convenient manner, as for example by brushing, roller coating, spraying, flowing, immersion, or the like. The metal surface to which the lubricant composition is applied may have been subjected to a cleaning operation prior to the application of the lubricant, although this has not been found to be necessary as satisfactory results have also been obtained when applying the lubricant to an oily surface. Additionally, the metal surface may have been given a chemical coating, such as a phosphate coating, an oxide coating, a sulfide coating, an oxalate coating, or the like. Such chemical coatings and the processes for applying them to metal surfaces to be deformed are well known to those in the art so that a further and detailed description of these proc-

esses is not deemed to be necessary. After subjecting the metal surfaces coated with the lubricants of the present invention to a drawing operation, it is found that the residual lubricant material is easily removed from the metal surfaces using a conventional alkaline cleaner. Additionally, during the drawing operation, it is found that by the use of the lubricant compositions of the present invention, higher annular holder pressures can be used in the press without tearing or rupturing the metal being deformed. The use of as high an annular holder pressure as possible is desired since the higher the pressure used the more of a decrease is obtained in point formations in the drawing operation.

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, temperatures are given in degrees centigrade and percents are by weight.

Example 1

An organic lubricant base was formulated containing 38% by weight of neutral degrass and 62% by weight of mineral oil having a viscosity of 4.5° Engler at 50° centigrade. To this lubricant base were added various inorganic materials in varying amounts as indicated hereinafter, to form lubricating compositions. Blank steel sheets having a thickness of about 1 millimeter were coated with the various lubricant compositions and benzene tank halves, 50 x 40 x 20 centimeters, were formed from the lubricant coated steel sheet by deep drawing in one drawing operation. In each instance, the press was operated at the maximum annular holder pressure possible without tearing the steel sheet in the drawing operation. Using this procedure the following results were obtained:

Organic Lubricant Base Content in Percent by Weight	Inorganic Pigment Content in Percent by Weight			Maximum Annular Holder Pressure in Tons
	NaBF ₄	NaHCO ₃	Na ₄ P ₂ O ₄	
100	-----	-----	-----	50
87	13	-----	-----	60
84	16	-----	-----	75
80	20	-----	-----	130
67	33	-----	-----	1 167
67	-----	33	-----	140
48	-----	52	-----	1 167
80	-----	-----	20	140
67	-----	-----	33	1 167

¹ Maximum value for the press used.

Example 2

The procedure of Example 1 was repeated with the exception that the following lubricant compositions were used in place of those set forth in the preceding example:

(A)

	Percent
Sodium bicarbonate	33
Neutral degrass	25
Mineral oil, having a viscosity of 4.0° Engler at 50° C.	42

(B)

Sodium bicarbonate	33
Stearin pitch	25
Mineral oil, having a viscosity of 4.5° Engler at 50° C.	42

(C)

Beef tallow	25
Mineral oil, having a viscosity of 4.5° Engler at 50° C.	42
Sodium bicarbonate	33

(D)

Sodium bicarbonate	33
Mineral oil having a viscosity of 4.5° Engler at 50° C.	67

Blank steel sheets were coated with the above lubricant compositions as in Example 1 and benzene tank halves were again drawn from the lubricant coated blanks in a single drawing operation but using a larger press than in example. In each instance, the maximum annular holder pressure was found to be within the range of 140 to 190 tons.

Example 3

The procedure of Example 2 was repeated with the exception that in the lubricant compositions used, the sodium bicarbonate content was increased from 33% to 52%. Upon drawing the steel blanks coated with these lubricant compositions, as in Example 2, the maximum annular holder pressure in each instance was found to be about 260 tons.

Example 4

The procedure of Example 1 was repeated using the following lubricant compositions:

(A)		Percent
NaBF ₄ -----		45
(B)		
Oleic acid polydiethanolamide -----		55
Sodium bicarbonate -----		33
Addition product of polypropylene oxide and polyethylene oxide with ethylene diamine -----		67
(C)		
Na ₄ P ₂ O ₇ -----		55
N,N,N',N' - tetrakis(2 - hydroxypropyl)ethylenediamine -----		45
(D)		
Na ₂ H ₂ P ₂ O ₇ -----		32
Condensation product of polypropylene oxide and polyethylene oxide -----		68
(E)		
Sodium bicarbonate -----		35
Ethoxylated fatty amine -----		5
Ethoxylated fatty alcohol -----		60

In each instance, excellent results were obtained upon subjecting the lubricant coated metal blanks to the drawing operation and the use of high annular holder pressures was possible in each case.

It was further noted that in all of the above examples, after the drawing operation, the lubricant composition was easily removed from the formed piece with a conventional alkaline cleaner. Due to the water-soluble nature of the organic phase of the lubricant composition used in Example 4, it was noted that these materials were removed even more easily from the formed sheets than were the lubricants of Examples 1, 2 and 3. In

no instance, however, was any difficulty encountered in cleaning the lubricant from the formed piece using a conventional alkaline cleaner.

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 principle may be utilized.

What is claimed:

1. A method of deforming a metal surface which comprises coating the metal surface with a lubricant composition comprising from about 20% to 80% by weight of a finely divided inorganic water-soluble non-deliquescent salt, selected from the group consisting of alkali metal fluoroborates, pyrophosphates, and bicarbonates and from about 80% to 20% by weight of an organic lubricant material having a softening point which is not in excess of 90° centigrade, the inorganic salt being substantially uniformly dispersed throughout the organic lubricant, the amount of the organic lubricant being at least sufficient to provide for the dispersion of the inorganic salt and the entire composition being substantially free of water, and, thereafter, deforming the thus-coated metal surface in a cold forming operation.

2. The method as claimed in claim 1 wherein the inorganic salt in the lubricant composition is sodium bicarbonate having a particle size which is not substantially in excess of about 500 millimicrons.

3. The method as claimed in claim 2 wherein prior to the application of the lubricant composition to the metal surface, the metal surface is coated with a chemical coating material.

4. The method as claimed in claim 3 wherein the chemical coating material is a phosphate coating material.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,390,562

July 2, 1968

Werner Rausch et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, lines 28 and 29, "ppreciated" should read -- appreciated --.
Column 4, line 38, " $\text{Na}_4\text{P}_2\text{O}_4$ " should read -- $\text{Na}_4\text{P}_2\text{O}_7$ --. Column 5, line 25, cancel "Oleic acid polydiethanolamid---55" and insert the same in Group (A), same column 5.

Signed and sealed this 31st day of March 1970.

(SEAL)

Attest:

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