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COLD FORMING LUBRICANT AND METHOD OF APPLYING SAME

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This invention relates to lubricants to be used on metals during the cold forming thereof and particularly to such lubricants used in the cold extrusion of metals.

In the cold extrusion of relatively malleable metals such as, for example, aluminum, magnesium, copper and other alloys, the reduction and surface ratios attainable is dependent upon the efficiency of the lubricating layer existing between the metal billet and the die surface.

The term "reduction and surface ratios" refers to the ratio of the cross-sectional areas and the ratio of the surface areas of the metal article after extrusion to the corresponding dimensions of the original metal billet.

Many standard lubricants, such as petroleum oil and greases, may be used to achieve small reduction and surface ratios, i.e., ratios of from 2:1 to 3:1. This is particularly true when the cross-sectional area of the metal billet, that is, the metal article prior to extrusion, is small. When these ratios approach or exceed 5 to 1 and the cross-sectional area of the metal billet is increased, conventional lubricants break down and fail under the heat and shearing forces occurring during extrusion. In order to achieve higher reduction and surface ratios, efforts have been made to develop new lubricants suitable for use under the conditions found in extrusion. An example of such lubricants are those having a phosphate base. The complex and metastable nature of the phosphate base lubricants makes reproducibility difficult and the lubricant is frequently marginal if not unsatisfactory. In addition, the use of such phosphate lubricants adversely affect the surface finish of the extruded metal. For example, extruded aluminum tubing to which phosphate base lubricants have been applied has a dull, cloudy and uneven surface finish. As the reduction and surface ratios are increased above approximately 7:1 and the cross-sectional area of the metal billet is increased, the efficiency of the phosphate lubricant decreases. As a result of lubricant failure, the extruded metal welds itself to the die or tooling, causes excessive wear on the die or tends to cause "stick-slip" extrusion, giving the resulting extruded product a nonuniform cross-section.

Accordingly, one of the principal objects of the present invention is to provide a lubricant suitable for use in the cold forming of metals which overcomes the above disadvantages.

A further object of the present invention is to provide a lubricant which will allow metals to be extruded at low temperatures and at high reduction and high surface ratios.

A further object of this invention is to provide a lubricant suitable for use at high pressures and high surface temperatures.

A further object is to provide a lubricant which may be applied to a metal billet in a uniform and controllable manner.

A further object of this invention is to provide a method for applying a cold extrusion lubricant to a metal billet.

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Still another object of this invention is to provide a metal billet suitably lubricated for use in the cold extrusion process.

Other objects and advantages of this invention will be apparent, it is believed, from the following detailed description of a preferred embodiment thereof.

Generally, the lubricant, which is the subject of the present invention, is in the form of an emulsion and comprises a mixture of a fatty acid, soap or ester thereof and an organic acid in a selected solvent.

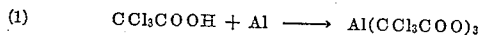
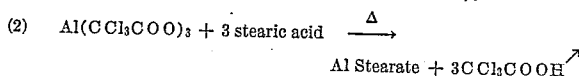
For this purpose of this specification, the term "lubricating agent" will refer to the fatty acid or derivatives thereof indicated above, and the term "reactant" will refer to the organic acid.

In order to achieve satisfactory lubrication at high reduction and surface expansion ratios, i.e., 5:1 or more, it is essential that the lubricant adheres firmly to the metal billet, that it maintains its presence on the expanding surface under the conditions found in the cold extrusion process and that it does not adversely affect the surface finish of the extruded article. For the purposes of this specification the terms "cold forming" and "cold extrusion" refer to the working of a metal at temperatures below its recrystallization temperature and include such processes as cold rolling, deep drawing and wire drawing in addition to extrusion. Fatty acids and their esters and metallic soaps, are well known lubricants. However, under the conditions of cold extrusion such compounds are not sufficient by themselves to give satisfactory lubrication. I have determined that by the use of a reactant, a chemical bond is formed between the surface of the metal billet and the lubricant. The exact nature of this bond is not completely understood. However, it may be hypothesized that under the conditions of the process of applying the lubricant to be discussed below, the following reactions occur:

The organic acid in the presence of the selected solvent reacts with the metal billet to form the metal salt of the organic acid. This metal salt in turn reacts with the lubricating agent to form the metal salt of the fatty acid and to reform the organic acid used. Upon heating, the organic acid is driven off, leaving the metal salt of the fatty acid.

Since a stoichiometric excess of fatty acid is used, there also remains a layer of the unconverted fatty acid. The surface of the metal billet may then be defined as one having a multilayer composition, the first layer being the pure metal, the intermediate layer being the metal salt of the fatty acid used, and the top layer being the lubricating agent. It will be understood that these layers are closely interrelated and theoretically, under what might be termed ionic interaction, are chemically bonded to one another.

The following equations are illustrative of the nature of the reactions which theoretically take place to form the intermediate layer. For the purpose of this illustration, trichloroacetic acid is chosen as the reactant, RCOOH, a fatty acid, is the lubricating agent, and the metal billet is formed from aluminum.



By testing the pH of the resulting coated billet it has been determined that substantially all of the organic acid is removed during the process since the coating is substantially neutral. While the reactions may not occur in the precise way indicated, it is apparent, from an examination of the coating, and the efficiency of the lubricant in the cold extrusion process, that some form

of chemical bond exists between the surface of the metal billet and the lubricant itself.

Because of the chemical as distinguished from the physical nature of the bonding of the lubricant to the billet, reduction and surface expansion ratios as high as 33 to 1 have been attained without lubricant failure. It has further been observed that wear on the die has been considerably reduced and that the use of a lubricant in accordance with this invention results in an extruded metal product characterized by excellent surface characteristics.

The lubricating agent used in the cold extrusion lubricant may consist of one or more compounds selected from the group of organic compounds normally considered as fatty acids or the derivatives thereof having the general formula $(R_1COO)_nR_2$ where n is 1, 2, or 3. R_1 may be a nonpolar monovalent organic radical containing 7 or more carbon atoms which may include a hydroxyl constituent or which may include a branch carbon chain or a carbon chain interrupted by an ether linkage. R_2 represents a radical selected from the group consisting of hydrogen, a metal and a saturated hydrocarbon. Generally speaking, depending on the solvent, any metallic salt may be used as the lubricating agent. However, the sodium and potassium salts of fatty acids are considered unsatisfactory when water is used as the solvent. It has been observed that while the lithium salt is substantially insoluble in water and, therefore, satisfactory, the sodium and potassium salts ionize and preferentially attack the metal billet to form an alkali metal salt rather than the acid metal salt. The presence of the caustic salt considerably reduces the efficiency of the lubricant and I, therefore, prefer to use only solvent insoluble metal salts in the lubricant.

At high reduction and surface expansion ratios the lubricating agent must be saturated to prevent "stick-slip" phenomena. Compounds wherein the total number of carbon atoms in the R_1 group in the above illustration is less than 7, are normally inoperative because of their volatility under the conditions of cold extrusion, the lack of an adequate soapy quality, and their general inability to act as a lubricant. As the reduction and surface expansion ratios are increased, the length of the chain in the lubricating agent must be increased, there being a direct relation between the length of the chain and its ability to act as a lubricant at increasing reduction ratios. While there is theoretically no upper limit to the number of carbon atoms suitable for use in the lubricating agent, practically speaking, compounds wherein R_1 has more than 22 carbon atoms are difficult to obtain and the increased chain length above that point does not appreciably increase the lubricating ability of the compound.

As indicated in Equation 2 above, the lubricating agent reacts with the acid metal salt to form the fatty acid metal salt and to reform the reactant. Since the boiling point of the reactant, as will be discussed below, is lower than the glazing temperature, the reactant is removed from the billet.

Examples of compounds suitable for use as a lubricating agent are: caprylic, pelargonic, capric, lauric, myristic, palmitic, phenylstearic, arachidic, behenic and stearic acids, the corresponding esters and the metallic salts thereof, hydroxystearic acid and similar hydroxy homologs of the acids, esters and salts named, 2-ethyl caprylic acid and similar branch-chain fatty acids, lanolin, beeswax and hydrogenated jojoba oil. Lanolin is a complex mixture of sterols and sterol esters, beeswax is a mixture of esters of long chain fatty acids and alcohols, and jojoba oil consists mainly of esters composed of C_{18} to C_{22} acids and alcohols.

The reactant is an organic acid having the following characteristics:

(1) An ionization constant equal to or greater than 10^{-4} .

(2) A boiling point below the glazing temperature, i.e., below the melting point of the lubricating agent.

(3) The temperature of decomposition of the reaction product between the acid and the metal billet is below the glazing temperature.

Examples of such acids are:

Performic	Formic
Peracetic	Fumaric
Monobromoacetic	Maleic
α Bromopropionic	Malonic
Monochloroacetic	Oxalic
α Chloropropionic	Phthalic
Dichloroacetic	Salicylic
Trichloroacetic	

In addition to the lubricating agent and reactant, additional ingredients may be used advantageously to effect specific purposes. Typically, the lubricating agent is suspended in a solvent. When an aqueous solution is used, wetting agents may be advantageously incorporated to disperse the insoluble lubricating agent in water. The viscosity of the composition may be controlled by the addition of suitable binders. To observe the thickness and completeness of the lubricant as applied to the metal billets a dye may be advantageously used. Further, parting compounds may be included to prevent metal-to-metal contact. Finally, since the lubricant is either sprayed or painted onto the metal billet in relatively uneven amounts, a leveling compound may be used to cause the formation of a uniform level coat around the billet.

The wetting agents which may be incorporated in order to disperse the insoluble soaps, esters and fatty acids in water may be selected from a wide group of commercial compounds and such choice is determined by their chemical stability, their ability to keep the emulsion dispersed and to keep the tacky point above the operating temperature. Examples of such wetting agents are: a polyoxyalkylene derivative of sorbitan monostearate having a molecular weight of about 1300 (Tween 60, manufactured by Atlas Powder Co.), polyoxyethylene sorbitan monooleate (Tween 80, manufactured by Atlas Powder Co.), sorbitan monostearate (Span 60, manufactured by Atlas Powder Co.), sorbitan monooleate (Span 80, manufactured by Atlas Powder Co.), oxyethylene nonylphenol (Tergitol NPX, manufactured by Union Carbide Co., composition approximately one mole of oxyethylene per mole of nonylphenol), polyoxyethylene nonylphenol (Tergitol NP14, manufactured by Union Carbide Co., composition approximately 14 moles of oxyethylene per mole of nonylphenol), polyoxyethylene nonylphenol (Tergitol NP35, manufactured by Union Carbide Co., composition approximately 35 moles of oxyethylene per mole of nonylphenol), sulfated castor oil (manufactured by Baker Castor Oil Co.), alkyl aryl sulfonate (Duponol G, manufactured by Du Pont de Nemours & Co.), alkyl aryl sulfonate (Textilana MW, manufactured by Textilana Corp.), polyoxypropylene glycol (Pluronic L 62, manufactured by Wyandotte Chemicals Corp.), and fatty alkanolamides (Emcol 5100T, manufactured by Witco Chemical Co.). Other similar wetting agents may be used.

Binders suitable for use to control the viscosity of the lubricant are materials such as gum tragacanth, starch, dextrine, casein, and glue. Other similar thixotropic materials may be used. While the use of a dye is not essential to the lubricant, it may be used advantageously for at least two purposes, first, the final glazed lubricant in the thickness used is transparent and the inclusion of a dye provides a visible film, the relative thickness of which can be judged by the intensity of the color; secondly, if the dye chosen acts as a pH indicator, the evolution of acid during the curing operation can be readily followed by the change in color. In addition, if the dye chosen is an acid pH indicator, the acid concentration can be observed. For example, when trichloroacetic acid is

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used as the reactant and oil soluble green (No. 3126 distributed by Mefford Chemical Co.) was used as the dye, it was observed that during the spraying and drying of the lubricant a magenta color was formed, indicating with this dye a pH of 1. This condition occurred primarily at the surface of the metal indicating a strong concentration of the acid at the place desired. Oil soluble dyes and other dyes which do not participate in the reaction may be used.

Parting compounds well known in the extrusion art to prevent metal-to-metal contact may also be included. Examples of such compounds are talc, mica, graphite, chalk, borax, lithopone, zinc oxide, white lead and polyhydric alcohol esters of bentonite ("Bentones," manufactured by National Lead Co.).

As indicated above, in order to achieve a uniform thickness, leveling compounds may be added to the cold extrusion lubricant to eliminate brush strokes and to provide a smooth, level surface. Examples of such compounds are carboxy-methylcellulose, tricresyl phosphate, glycerine, lecithin, ethylene glycol and sorbitan borate.

Although water is satisfactory as a solvent in forming the emulsion, other volatile solvents which do not react with the metal billet or enter into unfavorable side reactions with the other constituents may be used. Examples of such solvents are acetone, methylethyl-ketone, methyl, ethyl, and isopropyl alcohols and kerosene.

The relative proportions of the various constituents included in the cold extrusion lubricant may be varied over a wide range and depend, to a large extent, on the reactivity of the particular metal to be extruded, the pH of the lubricant, the reduction and surface expansion ratio desired and the lubricating qualities of the fatty acids or derivatives thereof used. The effective by weight ratio of lubricating agent to reactant may vary from 100:20 to 100:1. The use of increased amounts of reactant, particularly if the reactant is volatile, does not substantially affect the efficiency of the lubricant. Such excess reactant adds nothing to the lubricant and cannot increase the efficiency thereof. If less than the indicated minimum of reactant is used, the intermediate layer will be incomplete and the resulting lubricant will be physically rather than chemically bonded to the metal billet. Based on 100 parts by weight lubricating agent, the following indicates satisfactory by weight ranges for the additional constituents which may be advantageously used in the composition:

	Maximum, parts	Minimum, parts
Wetting agent.....	5	1/2
Blinder.....	5	1/2
Parting compound.....	30	1/10
Leveling compound.....	5	1/10

The amount of solvent to be used in the compound should be sufficient to have a thin, regularly dispersed solution, preferably in the range of from 400 to 2000 parts solvent to 100 parts lubricating agent. If dye is used, a sufficient quality should be present to adequately color the emulsion.

The metals to which the cold extrusion lubricant may be applied include any metal to which the cold extrusion process is commercially practicable, provided the indicated reactions can occur. Examples of such metals are aluminum, iron, copper, lead, silver, magnesium and the alloys thereof. By the use of this lubricant, reduction and surface expanding ratios from 5 to 1, to 33 to 1, have been readily achieved.

The process by which the lubricant is applied to the metal billet consists essentially of four steps: cleaning, application, glazing and cooling.

In order to achieve the chemical bond indicated above, it is necessary that the metal billet be chemically clean.

The cleaning can be accomplished by etching, the use

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of suitable solvents or sandblasting. The chemically clean surface is essential for application of the lubricant to the billets where the surface expansion is large. In cases of relatively small surface expansion, sufficient reaction takes place to maintain the adhesion of the lubricant even though the billets are not clean.

The lubricant may be applied by any of the standard methods of paint application. It is desirable to obtain a uniform coat of controlled thickness. The coating weight will vary according to the material and type of extrusion and may be in the range of from 100 to 6000 milligrams of cured lubricant per square foot.

In order to obtain a smooth, hard coat which will adhere to the billet, the coated billet is heated above the melting point of the lubricant. The temperature is, therefore, dependent on the choice of lubricating agent and may be varied from 200° F. to 500° F. The heating time required depends on the heat capacity and surface to volume ratios of the billet, the heating being continued until the reaction is complete. The heated billet is tacky, or sticky, and it is, therefore, necessary to cool the billet below the tacky point prior to handling. As indicated above, the wetting agent, if used, affects the tacky point. If the billet is tacky at room temperature, too much wetting agent has been included in the emulsion. The above indicated process of forming a coated billet, using the cold extrusion lubricant provides a billet having a slippery, smooth, coat of lubricant which adheres firmly, through chemical reaction, to the metal.

The following are specific examples of the composition of the cold extrusion lubricant, the process by which it is applied to the billet, and the results of the extrusion of coated metal billets at temperatures below the recrystallization temperatures thereof.

In each of the examples given, the materials used are of commercial grade unless otherwise specifically indicated. In the extrusions, a Lake Erie 2500-ton horizontal extrusion press was used.

EXAMPLE I

Formulation of cold extrusion lubricant

The following individual constituents were weighed out in the quantities indicated:

	Grams
Lithium stearate	570
Zinc stearate	380
Span 60	10
Tween 60	10
Green dye (oil soluble green No. 3126 distributed by Mefford Chemical Co.)	2.5
Gum tragacanth	10
Trichloroacetic acid	100

To a conventional colloid and blending mill having a 10 gallon vat and a cooling jacket surrounding the vat was added 9 liters of hot water (160° F.). The 10 grams of Span 60 was then added, the solution being continuously agitated by a mechanical mixer. After the Span 60 dissolved, the Tween 60 and green dye were added and allowed to dissolve. To this solution the trichloroacetic acid was added and then the gum tragacanth was sprinkled in slowly and allowed to dissolve. The lithium stearate was then added slowly and when the mixture had become homogenous, water was introduced into the cooling jacket to lower the temperature of the solution in the vat. The zinc stearate was then added and the resulting slurry agitated continuously for one and one-half hours to break up the large aggregates and homogenize the mixture. After such agitation, the colloid mill was started to form the final mixture. The use of the colloid mill is particularly advantageous if the lubricant is to be applied to the billets by spray guns, it being my experience that the needle valves of the spray guns become clogged unless the colloidal suspension is finely divided. Any standard colloid mill is satisfactory. The purpose of the milling

and colloidizing is merely to form a homogenous, finely divided colloidal suspension. The emulsion was milled until a finely dispersed emulsion was formed (approximately three-fourths of an hour) and the finished lubricant collected into a storage drum.

Preparation of billets

Prior to the application of the lubricant to the billets the exposed surface areas were cleaned in the following manner: A hollow aluminum cylinder (commercial aluminum with minimum impurities) 23¾ inches long having an internal diameter of 4.97 inches and an external diameter of 6.51 inches was immersed in a concentrated nitric acid bath at room temperature for one minute, water-rinsed for one minute, washed with 1% caustic soda at 175° F. for three minutes, water-rinsed at room temperature for one minute, washed again with nitric acid for one minute, water-rinsed at room temperature for one minute, and finally, thoroughly washed with water having a temperature of 132° F. The billet was then air-dried for two hours on an inclined ramp to allow the interior bore to drain.

Application of lubricant

The prepared cold extrusion lubricant was sprayed on the external surfaces of the cleaned metal billet, using a De Vilbiss M.B.C. spray gun with an FX-type needle valve. The bore of the billet was sprayed with a ¾ inch by 30 inch extension on the spray gun having a 360° spray-head. The lubricant was supplied to the spray gun from a 5 gallon pot. The pressure on the lubricant was 50 p.s.i. and the air pressure on the gun was 60 p.s.i. Spraying was continued until a uniform coat as determined by clear color density throughout was obtained. Spraying was accomplished in the following manner. The etched billet was loaded on an angle iron track approximately 30 feet long. The bore of the billet was sprayed with the extended gun for approximately 3½ seconds. The billet was then placed on a set of rotating wheels to permit rotation of the billet, the rate of rotation being adjusted to approximately 7½ r.p.m. The billet was permitted to make two complete revolutions while spraying back and forth for approximately 25 seconds, the spraying covering the entire external surface. Examination of the resulting coating showed that there was approximately 1500 milligrams of solvent free lubricant per square foot of surface area. The coated billet was then transported to an indirectly heated oven. The temperature of the oven was maintained at 470° F. The billet was placed in the oven for curing and allowed to cure for 35 minutes. It was observed that the temperature of the billet in the oven was raised to 400° F. After curing the billet was removed from the oven and allowed to cool. It was noted that the tacky point was approximately 215° F. Below that temperature the surface of the billet was smooth, hard, and slippery. The billet was then ready for extrusion.

Extrusion of billet

As indicated above, a Lake Erie 2500-ton horizontal extrusion press was used. The die had a minimum bore diameter of 5 inches. The punch head was ground to 0.015 inch smaller than the bore diameter. A mandrel having an O.D. of 4.910 inches was positioned on the punch. The die was preheated to 145° F. and the mandrel heated to 280° F. The billet was then preheated to 220° F., inserted into the press and extruded at a pressure of approximately 950 tons p.s.i. A washing bath was positioned at the exit of the extrusion die through which the extruded aluminum tube passed. The tube, in passing through the bath was cooled and allowed to pass out onto a cooling tray. The heel was cut off and the extruded tube allowed to cool. The resulting extruded product was an aluminum tube having a mean

O.D. of 5.000 inches, a mean I.D. of 4.910 inches and a mean wall thickness of 0.045 inch. The tube was approximately 32 feet in length and had a clear, regular surface with a minimum of discoloration and die or extrusion marks. The reduction and surface ratio was determined to be approximately 20 to 1.

The following are examples of cold extrusion lubricants which may be prepared and applied to metal billets by the methods shown in Example I. In these examples the quantities are indicated in parts by weight.

EXAMPLE II

	Parts
Lithium stearate	57
Zinc stearate	38
Span 60	1
Tween 60	1
Oil soluble green No. 3126	0.25
Gum tragacanth	1
Trichloroacetic acid	20
Water	900

EXAMPLE III

Lithium laurate	100
Polyoxyethylene nonylphenol	2
Gum tragacanth	1
Oil soluble green No. 3126	0.25
Peracetic acid	10
Water	900

EXAMPLE IV

Beeswax (yellow)	95
Behenic acid	5
Methoxycellulose	2
Span 60	1
Tween 60	1
α-Chloropropionic acid	12
Isopropyl alcohol	300

EXAMPLE V

Hydrogenated jojoba oil	95
Arachidic acid	5
Carboxymethylcellulose	2
Ricinoleate polyoxyethylene ester	1
Formic acid	5
Mica (300 mesh)	10
Water	300

EXAMPLE VI

Zinc hydroxystearate	95
Hydroxystearic acid	5
Monobromacetic acid	12
Ethyl alcohol	900

EXAMPLE VII

Zinc palmitate	95
Palmitic acid	5
Maleic acid	11
Alkylaryl sulfonate	1
Casein	1
Water	900

EXAMPLE VIII

Lanolin	30
Lithium stearate	40
Stearic acid	5
Zinc stearate	25
Gum tragacanth	1
Oil soluble green No. 3126	0.25
Tween 60	1
Span 60	1
Oxalic acid	12
Water	900

EXAMPLE IX

Lithium stearate -----	100
Span 60 -----	1
Tween 60 -----	1
Gum tragacanth -----	1
Phthalic acid -----	15
Water -----	900

In the above examples other organic acids having the properties previously indicated may be substituted for the reactant specified.

In addition, other fatty acids, their metallic salts or esters may be substituted for the lubricating agent specified. It is to be understood that as the chain length of the fatty acid or its derivative is decreased, the maximum reduction and surface ratios must be decreased.

In these examples parting compounds, such as talc, mica, graphite, chalk or borax may be included to increase the ease of extrusion particularly when shorter chain lubricating agents are used.

In addition to commercial aluminum, the following alloys of aluminum have been successfully lubricated and extruded using the lubricant and methods indicated in the examples:

61S	CS11
52S	11S
17S	3S
J51S	2S
14S	

It will also be apparent, it is believed, that the lubricant will be satisfactory in cold forming processes other than extrusion such as, for example, cold rolling.

Having fully described my invention, it is to be understood that I do not wish to be limited to the precise details of the examples set forth but my invention is of the full scope of the appended claims.

I claim:

1. A lubricant for use in the cold forming of selected metal billets consisting essentially of: a mixture of a lubricating agent, a reactant, and a solvent; said lubricating agent being a compound having a melting point between 200° F. and 500° F. and having the general structure



where n is 1, 2, or 3, R_1 is a monovalent nonpolar organic radical having at least 7 carbon atoms and R_2 is a radical selected from the group consisting of H, metals and saturated hydrocarbons; said reactant being an organic acid having an ionization constant of at least 10^{-4} and a boiling point less than the melting point of said lubricating agent, said acid being capable of reacting with the metal in said selected billets to form a reaction product, the temperature of decomposition of said reaction product being less than the melting point of said lubricating agent; the by weight ratio of said reactant to said lubricating agent in said mixture being not less than 1 to 100; the by weight ratio of solvent to lubricating agent being in the range of from 400:100 to 2000:100.

2. An emulsified lubricant for use in the cold forming of selected metal billets consisting essentially of: a lubricating agent, a reactant, and water; said lubricating agent being a mixture of at least two compounds selected from the group consisting of fatty acids having more than 7 carbon atoms, the insoluble metal salts and esters thereof; said reactant being an organic acid having an ionization constant of at least 10^{-4} and a boiling point less than the melting point of said lubricating agent, said acid being capable of reacting with the metal in said selected billets to form a reaction product, the temperature of decomposition of said reaction product being less than the melting point of said lubricating agent; the by weight ratio of reactant to lubricating agent being in the range of from 1:100 to 20:100; the by weight ratio of water to

lubricating agent being in the range of from 400:100 to 2000:100.

3. An emulsified lubricant for use in the cold forming of selected metal billets consisting essentially of the following ingredients by weight: a lubricating agent selected from the group consisting of fatty acids having more than 7 carbon atoms, the insoluble metal salts and esters thereof, and mixtures of the acids, esters and salts 100 parts; a reactant, said reactant being an organic acid having an ionization constant of at least 10^{-4} and a boiling point less than the melting point of said lubricating agent, said acid being capable of reacting with the metal in said selected billets to form a reaction product, the temperature of decomposition of said reaction product being less than the melting point of said lubricating agent; 1-15 parts; a volatile solvent, 400-2000 parts; a wetting agent, 0.5-5 parts; a binder selected from the group consisting of gum tragacanth, starch, dextrine, casein, and glue, 0.5-5 parts.

4. A coating composition as claimed in claim 3 wherein the lubricating agent is a mixture of lithium stearate and zinc stearate.

5. A coating composition in accordance with claim 3 wherein the reactant is trichloroacetic acid.

6. A method of applying a cold extrusion lubricant to an unformed metal billet, the steps comprising: applying a uniform coating of a lubricant comprising a reactant and a lubricating agent to said billet and heating said billet to a glazing temperature between 200° F. and 500° F., said reactant being an organic acid having an ionization constant of at least 10^{-4} and a boiling point less than said glazing temperature, said acid being capable of reacting with the metal in said selected billets to form a reaction product, the temperature of decomposition of said reaction product being less than said glazing temperature; said lubricating agent being a compound having the general structure



where n is 1, 2, or 3, R_1 is a monovalent nonpolar organic radical having at least 7 carbon atoms and R_2 is a radical selected from the group consisting of H, metals and saturated hydrocarbons; the by weight ratio of said reactant to said lubricating agent in said lubricant being not less than 1 to 100.

7. A method of applying a cold extrusion lubricant to an unformed metal billet, the steps comprising: cleaning said billet to remove surface impurities therefrom; applying a uniform coating of a lubricant comprising a reactant and a lubricating agent to said billet; heating said billet to a glazing temperature of between 200° F. and 500° F. and cooling said billet to a temperature below 200° F., said reactant being an organic acid having an ionization constant of at least 10^{-4} and a boiling point less than said glazing temperature, said acid being capable of reacting with the metal in said selected billets to form a reaction product, the temperature of decomposition of said reaction product being less than said glazing temperature; said lubricating agent being a compound having the general structure



where n is 1, 2, or 3, R_1 is a monovalent nonpolar organic radical having at least 7 carbon atoms and R_2 is a radical selected from the group consisting of H, metals and saturated hydrocarbons, the by weight ratio of reactant to lubricating agent being in the range of from 1:100 to 15:100; the amount of said coating applied to said billet being in the range of from 100 to 6000 milligrams per square foot of surface area.

8. A coated metal article comprising: a metal billet and a thin film covering said billet, the film consisting essentially of the lubricant set forth in claim 2.

9. An emulsified lubricant for use in the cold forming of selected metal billets consisting essentially of the fol-

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lowing ingredients by weight: a lubricating agent selected from the group of compounds having a melting point between 200° F. and 500° F. and having the general structure



where n is 1, 2, or 3, R_1 is a monovalent nonpolar organic radical having at least 7 carbon atoms and R_2 is a radical selected from the group consisting of H, metals and saturated hydrocarbons and mixtures of the acids, esters and salts thereof, 100 parts; a reactant, 1-15 parts, said reactant being an organic acid having an ionization constant of at least 10^{-4} and a boiling point less than the melting point of said lubricating agent, said acid being capable of reacting with the metal in said selected billets to form a reaction product, the temperature of decom-

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position of said reaction product being less than the melting point of said lubricating agent; a volatile solvent, 400-2000 parts; a wetting agent, 0.5-5 parts; a binder selected from the group consisting of gum tragacanth, starch, dextrine, casein, and glue, 0.5-5 parts.

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