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LUBRICATION OF METAL DURING HOT WORKING

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ABSTRACT OF THE DISCLOSURE

This invention relates to the lubrication of metal during the hot working thereof with a metal salt selected from alkali metal carbonates, alkali metal halides, and mixtures thereof which have been heat treated at a temperature which is at least that of the first critical point of transition of said salt.

The invention relates to the lubricating of metal during the hot working thereof, and relates more particularly to lubrication applied during the drawing of wire and the extrusion of steel.

It is well known that during the hot working of ferric metal, such as iron or steel, particularly during drawing and extrusion, the drawing and extrusion press tools, such as the drawing and extrusion dies, are subjected to large mechanical and thermic stresses. The tools are therefore subjected to great wear which, in turn, leads to badly finished surfaces of the hot worked articles, such as the drawn wire or extruded steel.

Many suggestions have been advanced to eliminate the aforesaid wear, by improving the lubrication of these tools. Lubricants for this purpose that have become known to date may be classified in two groups.

One of these groups includes homogeneous substances. Among these there have become of great practical importance glass material either in piece form or in pulverized form, or glass-like material; these materials do not have any definite melting point and remain highly viscous during a certain melting interval under the influence of the forming or casting temperatures; the lubricants of this group have attained importance particularly for the extrusion of highly alloyed steels. For the working in connection with mass steels, however, the lubricants of this group have been found to be too expensive. Another disadvantage of lubricants of this first group is furthermore that it is very costly to remove the remainder of the glass from the worked metal, as for instance this necessary removal of the glass remainders from extruded steel is possible only after the steel has been cooled by jets or pickling. The high cost of removal of the glass remainder is particularly disadvantageous in connection with extruded tubes which need to be worked while they still retain the extrusion heat in order to be competitive with welded tubes.

The second group of lubricants is formed of heterogeneous materials, such as the well-known mixtures of oil with graphite, pitch, lime, borate and the like. The hot working temperatures usually are above 1000° C. At such high temperatures, the oil of the aforesaid lubricant mixtures is subject to volatilize or to decompose whereby the additives thereafter may easily be removed, so that the work piece and the tool will come into direct metallic contact, and the wear will commence. Further well-known mixtures for lubricants are composed of finely ground substances which have crystallographic stratified lattice, like graphite, molybdenum, sulfide or mica, and inorganic salts, for instance sodium hydroxide or potassium hydroxide, sodium cyanide or potassium cyanide and

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alkali dichromates or alkali disilicates. These salts are fluid at the aforesaid hot working temperatures, and serve the purpose to guarantee the transport and the even distribution of the solid lubricant particles. These type lubricants, however, have two disadvantages: namely, owing to their organic contents they are restricted to be used as lubricants only in connection with metals where there is no danger of carburization; and furthermore, they are relatively expensive.

At hot working processes, particularly for the extrusion of steel, there has heretofore prevailed the opinion that the lubricant at the hot working temperature needed to have a relatively high viscosity in order to provide for good lubrication. The technical literature is replete with warnings not to use any lubricants which have a definite melting point and which become liquefied at the hot working of the metal, without remaining viscous within a large temperature range. This opinion was based on research in connection with sodium carbonate, barium chloride, alkali acetate or similar salts which had been used for the drawing of wire and the forming of sheet metal and in connection with which the observation had been made that these lubricants have no lubricating effect at the hot working of the metal.

It has, however, been found that such salts or mixtures of salt surprisingly do have excellent lubricating qualities during hot working of metal, particularly during the extrusion of steel, if they are subjected to a heat treatment in accordance with the instant invention before they are applied as lubricants. The heat treatment comprises heating of the lubricant, before the hot metal working, to an elevated temperature which corresponds to or is higher than the temperature of its critical point of transition, namely its first critical point of transition. For soda this first critical point of transition is at 356° C., for potash (potassium carbonate) at 400° C.

It is accordingly among the objects of the invention to provide a lubricant, for lubricating metal during the hot working thereof, which has good lubricating qualities at said hot working temperatures.

It is another object of the invention to provide methods for lubricating the metal during the hot working thereof.

It is still a further object of the invention to provide methods for producing such a lubricant.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The lubricants of the instant invention are very fluid at the aforesaid hot working temperature of the metal and have a viscosity which corresponds approximately to that which water has at room temperature. These lubricants wet the work piece rapidly, and thereby fulfill an important prerequisite for the formation of a closed lubricant film.

Applicants believe that the surprising change in the lubricating qualities mentioned of the salts referred to, owing to the heat treatment described, may perhaps have the following two causes: Firstly, the complete drying prevents the formation of water vapor bubbles during the hot working of the metal, which bubbles would cause the rupture of the lubricant film and the consequent dangerous welding action between the extruded tube and the extrusion die. Secondly, after the heat treatment the high temperature modification is retained for a long time, owing to the slow speed of transition change. This modification lends itself to deformation much more readily than the normal salt; a breaking up into parts of sintered round lubricant bodies, such as disks or rings, will thereafter not occur at the beginning of the extrusion; such a breaking up into parts had in the past caused damage to the surfaces of the extruded work pieces, and a high degree of wear of matrixes.

The instant lubricant has the advantage of improving lubrication between the extruded work piece and the extrusion die, thereby rendering possible the creation of smooth surfaces on the extruded work piece, and increasing the life of the dies.

The viscosity of the molten carbonate at 1000° C. is only .015 poise, and at 1100° C. only .005 poise, thus comparable to ether. Where alkali carbonates are used, no carburization is found during the extrusion of chromium steels.

The instant lubricants have the further advantage of being a good deal less expensive than the lubricants for the instant purpose used heretofore, and their use offers no drawback to the further working of the work piece.

The remainder of the salt may be removed from the work piece, either by washing with water, or by hydraulic descaling.

For lubricating of the block, the press arbor, or the matrix, lubricant in accordance with a modification of the instant invention may be composed of sodium carbonate and/or potassium carbonate to which prior to the heat treatment of the lubricant there has been admixed a small amount of magnesium oxide powder. When sodium carbonate is used, the magnesium oxide concentration will be about from 2 to 7 percent by weight, preferably 5 percent; when potassium carbonate is used, the magnesium oxide concentration will be about from 7 to 12 percent by weight, preferably 9 percent; and when mixtures of sodium carbonates and potassium carbonates are used, the magnesium oxide concentration admixed will be about from 5 to 10 percent by weight, preferably 7 percent.

The aforesaid modified embodiment offers the advantage that the scaling of the blocks is considerably reduced; the scaling, in fact, is reduced to about one-third up to one-sixth of the extent which had been obtained with the use of a lubricant composed of alkali carbonates but without the admixtures of the magnesium oxide. Applicants believe that the reason for this may be found therein that there is formed on the surface of the heated steel block beneath the molten carbonate layer an $\text{Fe}_2\text{O}_3 \cdot \text{MgO}$ -spinel. The wear resistance of the tools is increased two-fold to three-fold, and the surfaces of the extruded tubes are free from injuries.

In accordance with another modification, the instant invention provides for adding to the sodium carbonate and/or the potassium carbonate a corrosion preventing salt. The corrosion preventing salt is added before the aforesaid heat treatment, and may for instance be a phosphate or a chromate, particularly potassium chromate, added at a rate of from .1 to 3.0 percent by weight, preferably at .3 percent by weight.

In accordance with one example, steel tubes of a soft carbon steel were extruded, and the lubricant of the aforesaid type used was sodium carbonate to which there had been added prior to the heat treatment of the sodium carbonate .3 percent by weight of potassium chromate. Inspection of the tubes revealed that even after a prolonged storing of the tubes in moist atmospheric surroundings, the tubes did not show any corrosion.

In accordance with the invention, the previously described lubricating had been carried out with salts or salt mixtures in powder form.

For some purposes, however, such as for lubricating at horizontal extrusion or for the lubrication of certain parts, it is recommended to use lubricant bodies rather than pulverized lubricants, for instance round bodies such as disks or rings. While lubricant bodies as such are known, the instant invention provides for bodies of the type of the instant novel composition and manufacture.

In order to form such lubricant bodies from the aforesaid salts or salt mixtures in accordance with the instant invention, the invention provides for the mixing of the powdered salt or salt mixtures with a second salt of low melting point. The second salt may be an alkali nitrate, for instance sodium nitrate, and the second salt is ad-

mixed at from .5 to 5.0 percent by weight, preferably from .3 to 3.0 percent by weight. The mixture is thereafter pressed in a form at room temperature, and then heated to a temperature of from 400° C. to 800° C., preferably from 550° C. to 600° C., and sintered.

Instead of using the second salt with a low melting point, there may be used a pulverized melt which consists of an eutectic compound composed of at least two different alkali salts. The melt is added at the same rate as had previously been indicated for the second salt with a low melting point. An eutectic compound of sodium carbonate and potassium carbonate may for instance be composed of 60 percent by weight of potassium carbonate and 40 percent by weight of sodium carbonate.

During mixing of the alkali salt powder with the additive salt or salt mixture, it is recommended to add water at the rate of from .3 to .5 percent by weight.

Lubricant bodies, such as rings or disks, produced in accordance with the instant invention show after the pressing and sintering an excellent cohesion. If the lubricant bodies do not shrink enough during the sintering, they may adhere to the press form; it has been found, however, that the sintered rings or disks may easily be removed from the form, and be stored indefinitely, if the body has a pore volume of about 30 percent; this desired density may be achieved by the mixture of fine and coarse alkali carbonate powder. For instance, where two-thirds coarse ground or "heavy" soda is mixed with one-third fine ground or "light" soda with the addition of about 3 percent by weight of sodium nitrate, there are obtained bodies which retain their shape well after the heating and sintering.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what we claim as new and desire to be secured by Letters Patent, is as follows:

1. The method of lubricating metal during the hot working thereof the combination of the steps of (1) heat treating a metal salt which is a member of the class consisting of alkali metal carbonates, alkali metal halides and mixtures thereof by heating said salt to a temperature having an elevation of at least that of its first critical point of transition, said salt being known to be readily soluble in water, (2) applying a lubricant comprising the heat treated salt of (1) to the surface of the metal to be worked, (3) bringing the metal and lubricant to the proper temperature required for the working of said metal.

2. The method of lubricating metal during the hot working thereof the combination of the steps of (1) heat treating an alkali metal carbonate which is the member of the class consisting of sodium carbonate, potassium carbonate and their mixtures, by heating the said carbonate to an elevated temperature exceeding that of their first critical point of transition, which is 356° C. for sodium carbonate and 400° C. for potassium carbonate, (2) applying a lubricant comprising the heat treated carbonate of step (1) to the surface of the metal to be worked, (3) bringing the metal and lubricant to the proper temperature required for the working of the metal, said temperature being above the melting point of said carbonate.

3. The method of claim 2, wherein magnesium oxide of very fine particle size is added to the carbonate prior to the heat treatment step (1).

4. In a method, as claimed in claim 2, the step of admixing to the water soluble salt prior to the heat treatment thereof of from about .1 to about 3.0 by weight of a corrosion preventing salt.

5. In a method, as claimed in claim 4, said corrosion preventing salt being taken from the group consisting of phosphates and chromates.

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6. In a method, as claimed in claim 5, said corrosion preventing salt being potassium chromate.

7. The method of claim 3, wherein the quantities of admixture of the magnesium oxide powder in percent by weight being

(a) from about 2 to about 7 where the salt is sodium carbonate powder,

(b) from about 7 to about 12 where the salt is potassium carbonate powder, and

(c) from about 5 to about 10 where the salt is a mixture of the powders.

8. The method of claim 3, wherein the quantities of admixture of the magnesium oxide powder in percent by weight being

(a) 5 where the salt is sodium carbonate powder,

(b) 9 where the salt is potassium carbonate powder, and

(c) 7 where the salt is a mixture of the aforesaid powders.

9. The process of producing a lubricant for lubricating metal during the hot working thereof, the steps comprising treating a salt taken from the group consisting of alkali carbonates, alkali halides, and mixtures thereof, by heating it to a temperature having an elevation of at least that of its first critical point of transition, said salt having a melting point below the temperature of said hot working of the metal, wherein while said salt is in the powder form, there is added thereto from about 0.5 to about 5.0 percent by weight of an alkali metal nitrate followed by pressing the so obtained salt mixture at room temperature to form the shape of a round lubricating body and subsequently heating the mixture to a tem-

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perature from about 400° C. to about 800° C., and sintering the said formed round lubricating body.

10. The process of claim 9, wherein said salt consists of an eutectic mixture composed of sodium carbonate and potassium carbonate.

11. The process of claim 9, wherein said alkali metal is sodium nitrate admixed to said water soluble salt at from about .3 to about 3.0 percent by weight, said heating being carried out at a temperature of from 550° C. to 600° C.

12. The process of claim 9 with the additional step of adding during the mixing step and prior to the pressing and heating steps of from about 3 to about 5 percent by weight of water.

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