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⑦① Applicant: **ROCOL LIMITED**  
Rocol House  
Swillington Leeds LS26 8BS(GB)

⑦② Inventor: **Cattell, Harold George**  
16 Hammerton Drive  
Garforth Leeds(GB)

⑦④ Representative: **Farwell, William Robert et al,**  
**PHILLIPS & LEIGH 7 Staple Inn Holborn**  
London WC1V 7QF(GB)

⑤④ **Hot metal forging and stamping lubricant composition.**

⑤⑦ A lubricant composition for use in working hot metals at 300° to 1100°C comprising a metal phosphate giving lubricity to the composition and a gas-releasing metal carbonate or bicarbonate aiding separation of workpiece and tool.

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HOT METAL FORGING AND STAMPING LUBRICANT COMPOSITIONField of Invention

The invention relates to lubricants for the working of hot metals, particularly in forging and stamping.

State of the Art

Over the years many different materials have been used as lubricants in the forging and stamping industry. The purpose of such lubricants is to provide:-

- 1) Reduction in friction between the tool (die) and the workpiece.
- 2) Reduction in wear of the tool.
- 3) The correct surface finish of the workpiece.
- 4) In the case of deep or complex forging, sufficient release or 'lift' of the workpiece from the tool.

The use of either oil based lubricants, having a high boiling point, or sawdust, has been long known. Both traditional lubricants have good lubricating and release properties but tend to decompose at the high temperatures involved leading to large volumes of smoke which are obnoxious and represent a health hazard to the operator.

As an alternative, aqueous dispersions of solid lubricants such as graphite or molybdenum disulphide have been used. These solids have been shown to be effective lubricants, but tend to be expensive and dirty in use, and liable to lead to blockage of equipment when applied by hand-held or automatic spray systems.

More recently, lubricants generally referred to as synthetic lubricants have been developed, based on aqueous solutions of inorganic or organic compounds. A frequent component in such lubricants is sodium bicarbonate; for example, in conjunction with sodium nitrite (B.P. 1 499 154) or with sodium pentaborate (U.S.P. 4 104 178).

These lubricants radically reduce the fuming associated with the use of mineral oil or sawdust and are much cleaner in use than solid lubricant dispersions. However when used in the forging of particularly deep or complex workpieces, the synthetic lubricants so far available do not meet all requirements and in particular give insufficient 'lift' of the workpiece from the tool.

#### The Invention

Essentially we have found that an excellent combination of properties is obtained by the use of phosphates in conjunction with carbonates or bicarbonates, preferably the latter, as lubricants for working hot metals, particularly in forging and stamping.

Thus the invention provides compositions of alkali metal or other metal phosphates and carbonates or bicarbonates, as such or made up in solution or slurry form ready for application; and a method of forging or otherwise working hot metals by plastic deformation in which use is made of such composition as a lubricant. Both the tools and if desired the workpieces may be coated.

Preferably the carbonates or bicarbonates and phosphates are water soluble, but compositions in which either or both are insoluble and which are applied in slurry form or dry form are not excluded. Alkali metal or alkaline earth metal carbonates or bicarbonates are convenient. The function of the phosphates is to give lubricity. The function of the carbonate or bicarbonate is to decompose to give carbon dioxide at working temperatures of 300° to 1100°C, with the effects explained herein. The original components of the composition or their decomposition products provide a lubricating film of molten salts.

The components of the composition may be chosen to give a graduated response of melting and/or release of gas, and for example low melting materials such as lower fatty acid salts may be included in the composition with the main components. Sodium acetate is an example of these low melting materials, which may also act as a binder for the other components at the lower temperatures and themselves also release gaseous decomposition products.

Compositions may thus give a graduated response spreading useful effects over a considerable range of temperature, first by melting and breakdown of the sodium acetate, then by melting of the phosphate, and finally by breakdown of the carbonate or bicarbonate.

The phosphates are of course chosen not to have excessive acidity releasing carbon dioxide prematurely particularly when the compositions are made up in water for application. They may be salts of any of the 'phosphoric' acids, i.e. those in which the phosphorus is in oxidation state V, including condensed or polyphosphate salts.

Advantages and Details

It has been found that the compositions

- a) Have good wetting properties on hot metal surfaces at temperatures of the order of 300°C, leaving a solid salt coating on them.
- b) Remain in contact, first as a solid, then as a melt, with metal surfaces subject to rapid heating to temperatures in excess of 1000°C.
- c) Evolve gas at a steady rate over a wide temperature range, a fact thought important in providing 'lift' from the tool.

The weight ratio of the phosphate to the carbonate or bicarbonate has been found to be best at 1:1 to 5:1 but compositions in at least the range 0.16:1 to 25:1 are useful.

For certain applications, as noted above, the addition of a salt of a lower carboxylic acid, conveniently an alkali metal or alkaline earth metal salt and in particular a  $C_1 - C_5$  salt such as sodium acetate, improves release of the workpiece from the tool even further.

The composition optionally also contains other ingredients, as known in themselves in the field, for example clay thickeners. In such a way, a total system can be designed for ease of application and controlled coverage of the lubricant over the die.

The compositions when applied to both the top and bottom die, prior to the forging of a workpiece, have been found to show all the desirable characteristics 1) to 4) set out earlier and to be non-fuming.

The compositions can be applied as concentrated aqueous solutions for particularly severe operations or more diluted. They can be easily dosed and handled, are stable when stored, and are economical in use.

The proportions of the various ingredients, e.g. alkali metal phosphate and alkali metal carbonate, or bicarbonate, or optional ingredients of the lubricant composition, according to the invention, and the concentration of the phosphate and carbonate or bicarbonate in the solution as applied, together with optional ingredients, may be varied over a wide range depending on the particular application and the temperature involved.

Preferred ranges of compositions within the general range above are given below, first for a dry salt composition from which the lubricant composition as applied can be made up and secondly for the composition as applied.

Dry Lubricant Composition for Subsequent Dissolution in Water

Sodium Polyphosphate—— 5-50 parts by weight  
Sodium Bicarbonate—— 2-30 parts by weight  
Sodium Acetate —— 0-20 parts by weight

Water Based Lubricant Composition

Sodium Polyphosphate —— 5-50 parts by weight  
Sodium Bicarbonate —— 2-30 parts by weight  
Sodium Acetate —— 0-20 parts by weight  
Minor ingredients (for  
example surfactant, dye,  
pH adjuster, thickening  
agent and/or antioxidant)—— Up to 10 parts by weight  
Water —— As required.

Examples

The following are examples of compositions illustrating the invention, including test results on the compositions and on comparative compositions not according to the invention.

Examples 1 and 2

<u>Ingredients</u>	<u>Composition</u> <u>% by weight</u>			
	2A (Comparative)	3A	4A (Example 1)	5A (Example 2)
Sodium Polyphosphate (Calgon)	5	-	15	15
Sodium Bicarbonate	-	5	5	5
Sodium Acetate	15	3	-	5
Thickening Agent (Macaloid)	1	1	1	1
Water	Balance	Balance	Balance	Balance

CALGON is the registered trade name for sodium polyphosphate manufactured by Albright & Wilson Limited.

MACALOID is the registered trade name for bentonite clay manufactured by Steetley Minerals Limited.

The above compositions, identified as 2A, 3A, 4A, 5A were prepared by dissolving the sodium polyphosphate, sodium bicarbonate, and sodium acetate in the water, mixing at high speed and then adding the thickening agent.

Laboratory tests were carried out to provide an indication as to suitability for use as lubricants in the forging and stamping industry. The compositions were applied by (a) spraying and (b) swabbing onto a metal

surface at 300°C and their wetting properties observed. The metal surfaces, once coated with lubricant were then placed in a furnace at 1100°C and the subsequent decomposition of the lubricant observed.

### Results

- 2A - Gave poor wetting both when sprayed and  
(No swabbed. Melted rapidly and gave rapid  
carbonate) gassing when placed in furnace, but over  
a narrow temperature range.
- 3A - Gave poor wetting when swabbed though not  
(No when sprayed. Melted fairly rapidly but  
phosphate) gave only moderate gassing when placed in  
furnace.
- 4A - Gave good wetting both when sprayed and  
swabbed. Melted slowly leaving a white  
coating when placed in furnace. Gas was  
evolved at a steady rate over a prolonged  
period.
- 5A - Gave good wetting both when sprayed and  
swabbed. Melted slowly leaving a white  
coating when placed in furnace. Gas was  
evolved at a steady rate, but initially  
more gas was observed.

### Example 3

The composition below was prepared using a mixing



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vessel and a paddle stirrer. The sodium polyphosphate, sodium bicarbonate, and sodium acetate were dissolved in the water and the thickening agent dispersed, with rapid stirring, in this solution:

Sodium Polyphosphate (Calgon)	1.5Kg
Sodium Bicarbonate	0.5Kg
Sodium Acetate	0.5Kg
Thickening Agent (Macaloid)	0.1Kg
Water	7.4Kg

This composition, applied by swab, was then used to forge stainless steel valve bodies using a 1½ tonne drop hammer. The operation took place without difficulty and with easy removal of the component from the die. Difficulty had been found previously, using both traditional solid lubricant dispersions and inorganic salt solutions, with such removal.

#### Example 4

The composition below was prepared using a mixing vessel and a paddle stirrer. The sodium polyphosphate, potassium carbonate and sodium acetate were dissolved in the water with rapid agitation.

Sodium polyphosphate	1.5Kg
Potassium carbonate	0.5Kg
Sodium acetate	0.3Kg
Water	7.7Kg

This formulation is of a viscosity which can be readily

applied using hand-held or automatic spray systems, though a thickening agent can readily be added to allow the lubricant to be applied by swab as in Example 3.

The above formulation was then used as a forging lubricant for the manufacture of the following components under ordinary works conditions:

- (i) Universal Coupling weighing 6Kg made from EN8 steel, using a 2 tonne drop hammer. The lubricant was diluted with three parts water, and when applied allowed the operation to take place without difficulty and with easy removal of the component from the die.
- (ii) Suspension Arm weighing 5Kg made from EN5 steel using a 1½ tonne drop hammer. The lubricant was diluted with one part water and when applied, allowed the operation to take place without difficulty and with easy removal of the component from the die.
- (iii) Steering Drop Arm weighting 20Kg made from EN8 steel using a 2 tonne drop hammer. The lubricant was diluted with three parts water and allowed the operation to take place without difficulty and with easy removal of the component from the die.
- (iv) Steering Box weighing 6Kg made from EN9 steel using a 1½ tonne drop hammer. The lubricant was diluted with three parts water and allowed the operation to take place without difficulty and with easy removal of the component from the die.
- (v) Hook weighing 4Kg made from EN9 steel using 1½ tonne drop hammer. The lubricant was diluted with five

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parts water and allowed the operation to take place without difficulty and with easy removal of the component from the die.

CLAIMS

1. A lubricant composition for use in working hot metals at 300° to 1100°C comprising a metal phosphate giving lubricity to the composition and a gas-releasing metal carbonate or bicarbonate aiding separation of workpiece and tool.
2. A composition according to claim 1, comprising further sodium acetate or other low-melting lower fatty acid salt.
3. A composition according to claim 1 or 2 wherein the weight ratio of phosphate to carbonate is 0.16:1 to 25:1, preferably 1:1 to 5:1.
4. A composition according to any preceding claim wherein either or both of phosphate and carbonate or bicarbonate is an alkali metal salt.
5. A composition according to any preceding claim wherein the phosphate is a polyphosphate.
6. A composition according to any preceding claim comprising:  
Sodium Polyphosphate——5-50 parts by weight  
Sodium Bicarbonate——2-30 parts by weight  
Sodium Acetate——0-20 parts by weight

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7. A method of working a hot metal by plastic deformation at 300° to 1100°C wherein a composition as set out in any one of claims 1 to 6 is applied to workpiece and/or tool before and/or during the operation.



European Patent  
Office

# EUROPEAN SEARCH REPORT

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Application number  
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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	FR - A - 1 286 265 (CHEMISCHE FABRIK BODENHEIM RUDOLF A. OETKER K.G.)  * Claims 1-3 *	1,3-6	C 10 M 3/02 7/02
A	FR - A - 872 173 (PRODUITS CHIMIQUES T.B.I.)  * Claims 1,7; example 1 *	1,3-6	
A	DE - C - 853 481 (C. KRUG)  * Claim *	1,3;4	TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
A	US - A - 2 343 036 (C.W. WILSON)  * Page 1, column 7, lines 33-50 *	1,3-6	C 10 M B 21 C B 21 J C 21 D B 23 K
A	FR - A - 1 586 736 (VEB STAHL- UND WALZWERK GRODITZ)  * Claim *	1	
A	US - A - 3 372 113 (G. NAESER et al.)  * Claims 1,5,9 *	1	CATEGORY OF CITED DOCUMENTS
A	FR - A - 1 175 221 (PHOENIX-RHEINROHR A.G. VEREINIGTE HUTTEN- UND ROHRENWERKE)  * Claims 1-6 *	1	X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
<input checked="" type="checkbox"/> The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search The Hague		Date of completion of the search 09-03-1982	Examiner ROTTSAERT

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>US - A - 3 931 020</u> (L.E. BURGESS) * Claims 1-24 *	1	
D	& GB - A - 1 499 154  --		
A	<u>US - A - 2 076 793</u> (L.A. SALENDER) * Claim 1 *	2	
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			TECHNICAL FIELDS SEARCHED (Int. Cl.3)