(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 321 206 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
25.06.2003 Bulletin 2003/26

(21) Application number: **01961302.5**

(22) Date of filing: **03.09.2001**

(51) Int Cl.[7]: **B21J 3/00**, B21K 7/00

(86) International application number:
PCT/JP01/07590

(87) International publication number:
WO 02/020193 (14.03.2002 Gazette 2002/11)

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **05.09.2000 JP 2000267883**

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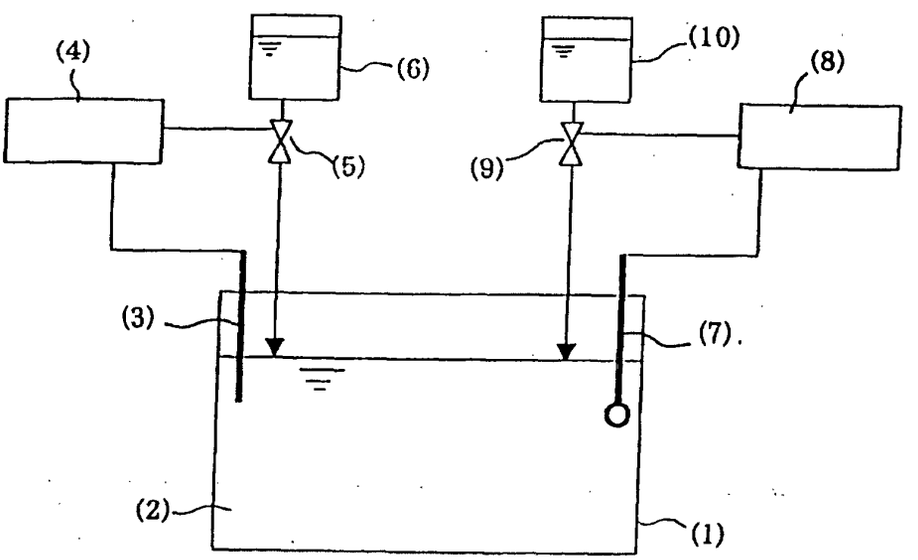
(54) METHOD OF CONTROLLING WATER BASE-PROCESS TYPE LUBRICATING AND PROCESSING FLUID FOR COLD FORGING

(57) An effective and simple controlling process for an aqueous lubricant of one process type used for cold forging of metallic material are explained.

The process is carried out on an aqueous lubricant of one process type containing at least one water soluble inorganic salt. In order to obtain a preferred weight of the lubricative coating layer by applying this aqueous lubricant, the electric conductivity of the aqueous lubricant are measured and controlled in a preferred level by supplementing a constituent to the aqueous lubricant.

Fig. 1



EP 1 321 206 A1

Description

FIELD OF THE INVENTION

[0001] The present invention is related to a process for controlling aqueous lubricant of one process type used for cold forging of metallic material, and is aiming at providing improved lubricant onto a surface of a metallic material without applying any previous chemical treatment. Said lubricant is suitable for cold forging manufacturing of parts to be used for transportation machineries, etc.

BACKGROUND ART

[0002] Generally, in cod forging of a metallic materials such as stainless steel, lubricative coating is carried out onto the surface of a metallic material for aiming at preventing a surface defects of burning and biting which may be caused from direct contact of a metallic material to be processed with a mold and a tool used in the forging process.

[0003] There are two types of the coated layers to be formed onto the surface of a metallic material, one of which is the type that a lubricant is being adhered directly onto the surface of the metallic material and the other is the type that a lubricant is being used onto the chemical layer being formed previously over the surface of the metallic material.

[0004] The lubricative coating formed by being adhered directly onto the surface of a metallic material has less cohesion performance than the lubricative coating formed by being used lubricant onto the chemical layer formed previously over the surface of the metallic material, and therefore, the former type is generally used for the cold forging with less amount of deformation.

[0005] In case of the latter type, the chemical layer is firstly formed on the surface of a metallic material through a chemical processes such as phosphate layer forming process or oxalate layer forming process, which generally form the chemical layer suitable as a carrier of a lubricant, and a lubricant having high lubricative property is used following to the formation of such chemical layer. In this type, the formed film has a bilayer structure consisting of a chemical layer as a carrier and a lubricant layer, which has high resistant property against surface defects. From this reason, this type has been widely employed in the field such as wire drawing, tube drawing and cold forging. Particularly, in the cold forging where severe deformation is required, a process firstly forming the chemical layer comprising phosphate or oxalate and then using a lubricant onto the chemical layer is popularly employed.

[0006] The lubricant applied onto the chemical layer may be divided into major two groups in terms of the usage. The first group includes a lubricant to be mechanically adhered onto the chemical layer and the second group were lubricant reacts with the chemical layer.

[0007] The first group of lubricant includes one prepared by using mineral oil, vegetable oil or synthetic oil as a base oil and containing an extreme pressure additive in the base oil, and one prepared by dissolving a solid lubricant, such as graphite and molybdenum disulfide, together with a binder component into the water. These lubricants have advantage of easy for controlling the solution since they can be used simply by means of spray coating or dipping coating, however, as they have just a low lubricative properties, they tend to be used for a case where less amount of deformation of metallic material is required.

[0008] On the other hand, in the second group of lubricant, a reactive soap such as sodium stearate is used for a case where particularly high lubricative property is required. The reactive soap reacts with the chemical layer to provide high lubricative properties.

[0009] However, since the reactive soap gives a chemical reaction, control of the composition of the reactive soap solution, temperature control and renewal control of the deteriorated solution are required during the process.

[0010] On the other hand, it is a big issue to reduce waste products arising from the industries for global environmental protection, and therefore, a lubricant and a lubricative process, those which do not produce waste products, are highly desired. Further, the conventional process that contains coating layer and reactive soap, some simplification and improvement is now required, since it is necessary to have a processing plant of wide area, greater time and complex control at every steps of the process.

[0011] For example, in the step of forming the coating layer of phosphate, many complex analysis including free acidity of the solution, total acidity and concentration of the solution are carried out. manually by means of neutralization titration. Further, in the step of reactive soap application, complex analysis of free acidity and concentration of the solution are regularly and manually carried out, and the supplement of the reduced compounds has to be carried out.

[0012] A prior art of "Aqueous lubricant applicable for cold plastic deformation of metallic material" disclosed in JP-10-8085 A can be cited. This relates to an aqueous lubricant used for cold plastic deformation processing of metallic materials, which comprise (A) water soluble inorganic salt, (B) solid lubricant, (C) oil component selected from a group consisting of mineral oil, animal oil, vegetable oil and synthetic oil, (D) surface active agent and (E) water, and in which containing substance and oil are dispersed and emulsified homogeneously.

[0013] This prior art is related to an aqueous non-reactive type lubricant, and is aiming at simplifying the conventional

three processes of phosphate layer formation, water rinsing and reactive soap application into one process. The present invention is also related to a aqueous lubricant used as a lubricant of one process type, namely a lubricant without any previous chemical treatment for making a chemical layer. That is, in the present invention, the lubricative coating layer is formed directly on the surface of the metallic material by contacting the metallic material with the aqueous lubricant by means of dipping or the like, without forming any chemical layer previously on the surface of the metallic material. This type of lubricant is generally called as lubricant of one process type.

[0014] From the knowledge of the inventors of the present invention, the concentration of the containing substance is extremely important when using such type of this aqueous non-reactive lubricant. Because, in case of non-reactive lubricant, the weight of the lubricative coating layer, namely the amount of the coating, is decided based on the concentration of the containing substance in the solution. The weight of the coating layer is an important factor since it greatly affects the lubricative performance and resistance to the surface defect. The weight of the coating layer is calculated as below, based on the weight difference between before and after the lubrication treatment and the area of the metallic material.

Weight of coating layer = (Weight of metallic material after lubrication treatment - Weight of metallic material before lubrication treatment)/(Area of metallic material processed).

[0015] Therefore, accurate concentration control of the containing substance in the lubricant is absolutely important for attaining a constant weight of the coating layer. However, since much labor is required for the determination of the concentration, it has been incovenient to employ the non-reactive lubricant in the industry.

DISCLOSURE OF THE INVENTION

[0016] Therefore, it is an object of the present invention to solve the problem of the conventional art as described above and to provide a new control process of the aqueous lubricant of one process type used for cold forging wherein all operations are simplified and is further favorable for the protection of global environment.

[0017] The inventors of the present invention have made investigation for solving the problems described above and have found on the aqueous lubricant containing at least one water soluble inorganic salt that the concentration of the containing substance in the aqueous lubricant can be controlled by controlling the electric conductivity of the aqueous lubricant.

[0018] That is, the present invention is directed to a process to control aqueous lubricant of one process type containing at least one water soluble inorganic salt and is used for cold forging characterized in that the process comprises a step to control the concentration of the aqueous lubricant by measuring the electric conductivity of the aqueous lubricant at the time of coating the aqueous lubricant on to the surface of the metallic material, and a step to supplement the constituent to the aqueous lubricant in order to keep the concentration of the aqueous lubricant at a prefered level.

[0019] The present invention is also directed to a process to control the aqueous lubricant of one process type used for cold forging as explained above, wherein one water soluble inorganic salt is at least one selected from a group consisting of sulphate, silicate, borate, molybdate and tungstate. And the main use of said aqueous lubricant is for manufacturing of parts for automobiles, motorcycles and other transportation machineries, such as engines, power trains and chassis.

BRIEF DESCRIPTION OF DRAWINGS

[0020]

Fig. 1 shows an embodyment of the apparatus used for carrying out the control process according to the present invention ;

Fig. 2 shows an example of the relation between the concentration and the electric conductivity of the aqueous lubricant ;

Fig.3 shows an example of the relation between the electric conductivity of the aqueous lubricant and the weight of the coating layer formed on the surface of the metallic material.

MODES FOR CARRYING OUT THE INVENTION

[0021] Now, the present invention is further described in detail. In the present invention of the process for controlling the aqueous lubricant of one process type used for cold forging, an aqueous lubricant, which contains at least one water soluble inorganic salt may be used. And the present invention may use the electric conductivity of the aqueous lubricant arisen by the water soluble inorganic salt contained therein.

[0022] As described before, the weight of the lubricative coating layer formed on the metallic material is very important when coating the surface of a metallic material with the aqueous lubricant of one process type for cold forging. In this case, the weight of the lubricative coating layer formed on the metallic material is closely related with the concentration of the aqueous lubricant. And the concentration of the aqueous lubricant is closely related with the electric conductivity of the aqueous lubricant. Therefore, the control of the electric conductivity may result in the control of the concentration of the aqueous lubricant, and further, it may result in the control of the weight of the lubricative coating layer formed on the surface of the metallic material. That is, the weight of the lubricative coating layer is reduced by lowering the electric conductivity, namely by diluting the aqueous liquid with water, while the weight of the coating layer increases by increasing the electric conductivity by adding, for example, the concentrated aqueous lubricant solution. Therefore, the amount of the lubricative coating layer can be controlled by means of controlling the electric conductivity of the aqueous lubricant without doing a concentration measurement of the aqueous lubricant.

[0023] In an industrial operation, it is required to keep the important operational item to be in a favourable target value. And in cold forging operation, many items such as a preparation of suitable cold forging tool, a suitable cold forging speed and the suitable weight of the lubricative coating layer on the metallic material must be controlled. The suitable weight of the lubricative coating layer may be obtained by control the concentration of the aqueous lubricant. However, the control of the concentration of the aqueous lubricant by a conventional process may be a complex operation, since it needs a measurement of the concentration of the aqueous lubricant frequently. However in the present invention, the concentration of the aqueous lubricant can be obtained easily and precisely by simple operation of measurement of electric conductivity.

[0024] And favorable weight of the lubricative coating layer may continuously be obtained by controlling the electric conductivity of the aqueous lubricant to be in the target value by supplementing the constituent by using, for example, a concentrated aqueous lubricant solution to the aqueous lubricant in operation.

[0025] The preferred water soluble inorganic salt includes, but is not specifically limited to, at least one selected from a group consisting of sulphate, silicate, borate, molybdate and tungstate.

EMBODYMENT

[0026] Now, the examples for carrying out the present invention are given below.

<Aqueous lubricant>

[0027] Available aqueous lubricant used in the present invention containing borate as water soluble inorganic salt (Trademark; Fine Ryube E750HF, manufactured by Nihon Parkerizing Co., Ltd) is diluted with pure water so as to be adjusted the concentration respectively to 50% 60% and 70%, and each aqueous lubricants of 50 liters are prepared.

<Measurement>

[0028] The electric conductivity of the aqueous lubricant is measured by using a commercially available electric conductivity measuring meter. A cleaned steel specimen (cylindrical shape, diameter 50mm, length 150mm) is treated with the aqueous lubricant to form a lubricative coating layer onto the surface of the steel specimen, and the weight of the lubricative coating layer (the amount of the coating) is determined by detracting the weight of the steel before coating from the weight of the steel after coating.

<Continuous Processing Test>

[0029] A apparatus shown in Fig. 1 was prepared. The volume of a aqueous lubricant tank (1) for the aqueous lubricant (2) is 50 liters and the temperature of the aqueous lubricant (2) is set at 60°C. A meniscus sensor (3) was set at the meniscus level of the aqueous lubricant, and the meniscus controller (4) is set to work when the meniscus level of the aqueous lubricant comes 1 cm down from the initial meniscus level automatically by opening the electromagnetic valve (5), thereby pure water from a water supply tank (6) flow into the aqueous lubricant (2), Said electromagnetic valve was set to be closed when the meniscus level reaches to the initial level. The meniscus level of the aqueous lubricant is usually coming down in operation as it is consumed by adhering to the steel material and by

evaporation owing to be heated at 60°C.

[0030] Whereas, the electric conductivity of the aqueous lubricant measured by the electric conductivity sensor (7) is displayed on the electric conductivity controller (8). The electromagnetic valve (9) opens when the electric conductivity is decreased to an extent of 2% from the initial value, and flow the condensed aqueous lubricant (Fine Ryube E750HF (100%)) from a condensed aqueous lubricant tank (10) for supplementing the constituent of the aqueous lubricant, and the electromagnetic valve (9) is set to automatically close when the electric conductivity has recovered to the initial value in order to discontinue the supplement of the condensed aqueous lubricant. Under the condition as described above, 6,000 pieces the steel specimen were continuously treated with the aqueous lubricant of the respective concentration. The weight of the lubricative coating layer (the amount of the coating) of each steel specimen was checked in extractive manner, and the steel specimen having a lubricative coating layer were subjected to cold forging to evaluate the lubricative performance.

[0031] The relation between the concentration of the aqueous lubricant and the electric conductivity are shown in Fig.2, and good relation can be recognized between these two. The relation between the electric conductivity and the weight of the lubricative coating layer are shown in Fig. 3, and good relation can be recognized between these two. Therefore, it is understood that the weight of the coating layer may decrease along with the reduction of the electric conductivity being resulted by diluting the aqueous lubricant. Consequently, it shows that the control of the weight of the coating layer can be achieved by controlling the electric conductivity of the aqueous lubricant.

[0032] The results of the continuous processing test are shown in Table 1. It shows that the weight of the lubricative coating layer may be controlled at a constant level by controlling the electric conductivity of the aqueous lubricant, and that good cold forging can be done by this process without arising any problem.

[Table 1]

Treatment order of specimen in continuous process	50% Electric Conductivity 27 mS/cm		60% Electric Conductivity 30 mS/cm		70% Electric Coductivity 33 mS/cm	
	Lubricative Coating layer mg/m²	Cold forging performance	Lubricative Coating layer mg/m²	Cold forgong performance	Lubricative Coating layer mg/m²	Cold forging performance
First	8. 8	Good	9. 8	Good	10. 5	Good
1000th	8. 9	Good	9. 7	Good	10. 6	Good
2000th	8. 7	Good	9. 7	Good	10. 6	Good
3000th	8. 8	Good	9. 8	Good	10. 6	Good
4000th	8. 8	Good	9. 7	Good	10. 5	Good
5000th	8. 7	Good	9. 7	Good	10. 6	Good
6000th	8. 8	Good	9. 8	Good	10. 6	Good

ADVANTAGE OF THE INVENTION

[0033] As clearly understood in the explanation above, the present invention provides advantageous effect in cold forging process by using aqueous lubricant of one process type, wherein the simple and precise control of the weight of the lubricative coating layer can be obtained by controlling the electric conductivity of the aqueous lubricant and by supplementing the constituent to the aqueous lubricant in the operation.

Claims

1. A process for controlling aqueous lubricant of one process type containing at least one water soluble inorganic salt and is used for cold forging, wherein concentration of the aqueous lubricant is controlled by controlling electric conductivity of the aqueous lubricant at the time of processing, and the electric conductivity of the aqueous lubricant is controlled by supplementing constituent to the aqueous lubricant.

2. The process for controlling aqueous lubricant of one process type used for cold forging according to claim 1, wherein one water soluble inorganic salt is at least one selected from a group consisting of sulphate, silicate, borate, molybdate and tungstate.

Fig. 1

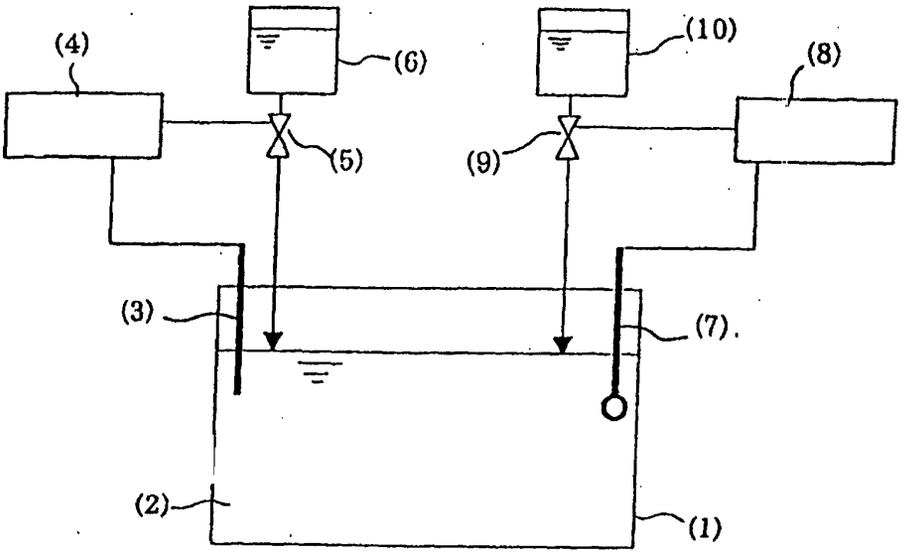


Fig. 2

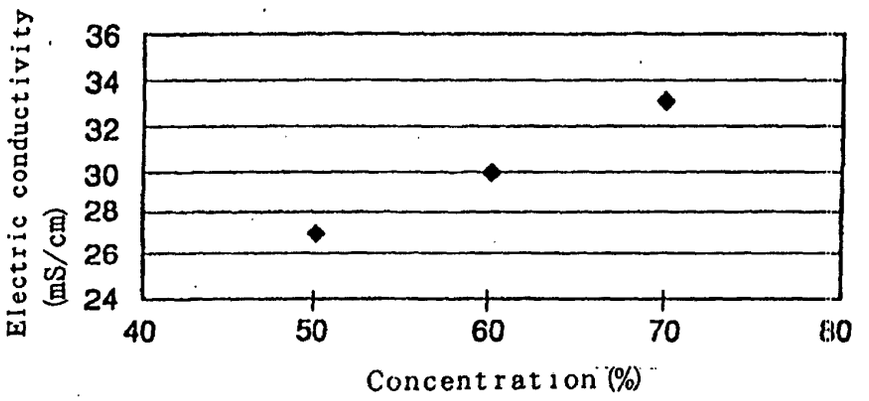
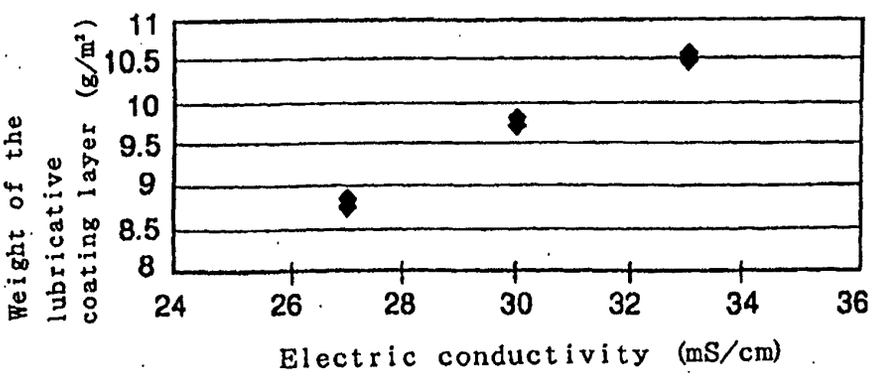


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/07590

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] 3/00, B21K 27/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B21J 1/00-13/14, 17/00-19/04, B21K 1/00-31/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Jitsuyo Shinan Toroku Koho 1996-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Toroku Jitsuyo Shinan Koho 1994-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2-115033 A (Toyota Motor Corporation), 27 April, 1990 (27.04.90), Full text (Family: none)	1-2
Y	US 4936127 A (Asarco Incorporated), 26 June, 1990 (26.06.90), Full text; & EP 399181 A & JP 3-57505 A	1-2
Y	JP 10-36876 A (Makoto Fukkusu K.K., Futoshi YAMANAKA), 10 February, 1998 (10.02.98), Full text (Family: none)	1-2
Y	WO 97/48783 A (HENKEL CORPORATION), 24 December, 1997 (24.12.97), Full text; & US 6194357 B & EP 917559 A & JP 10-8085 A	1-2

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 November, 2001 (30.11.01)	11 December, 2001 (11.12.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/07590

C (Continuation). *DOCUMENTS CONSIDERED TO BE RELEVANT*

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 7-26280 A (Sumitomo Metal Industries, Ltd., Palace Chemical K.K.), 27 January, 1995 (27.01.95), Full text (Family: none)	1-2
Y	JP 6-1991 A (Nippon Parkerizing Co., Ltd.), 11 January, 1994 (11.01.94), Full text (Family: none)	1-2
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PY	JP 2000-309793 A (Nippon Parkerizing Co., Ltd.), 07 November, 2000 (07.11.00), Full text (Family: none)	1-2

Form PCT/ISA/210 (continuation of second sheet) (July 1992)