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FABRICATION OF LIGHT METALS

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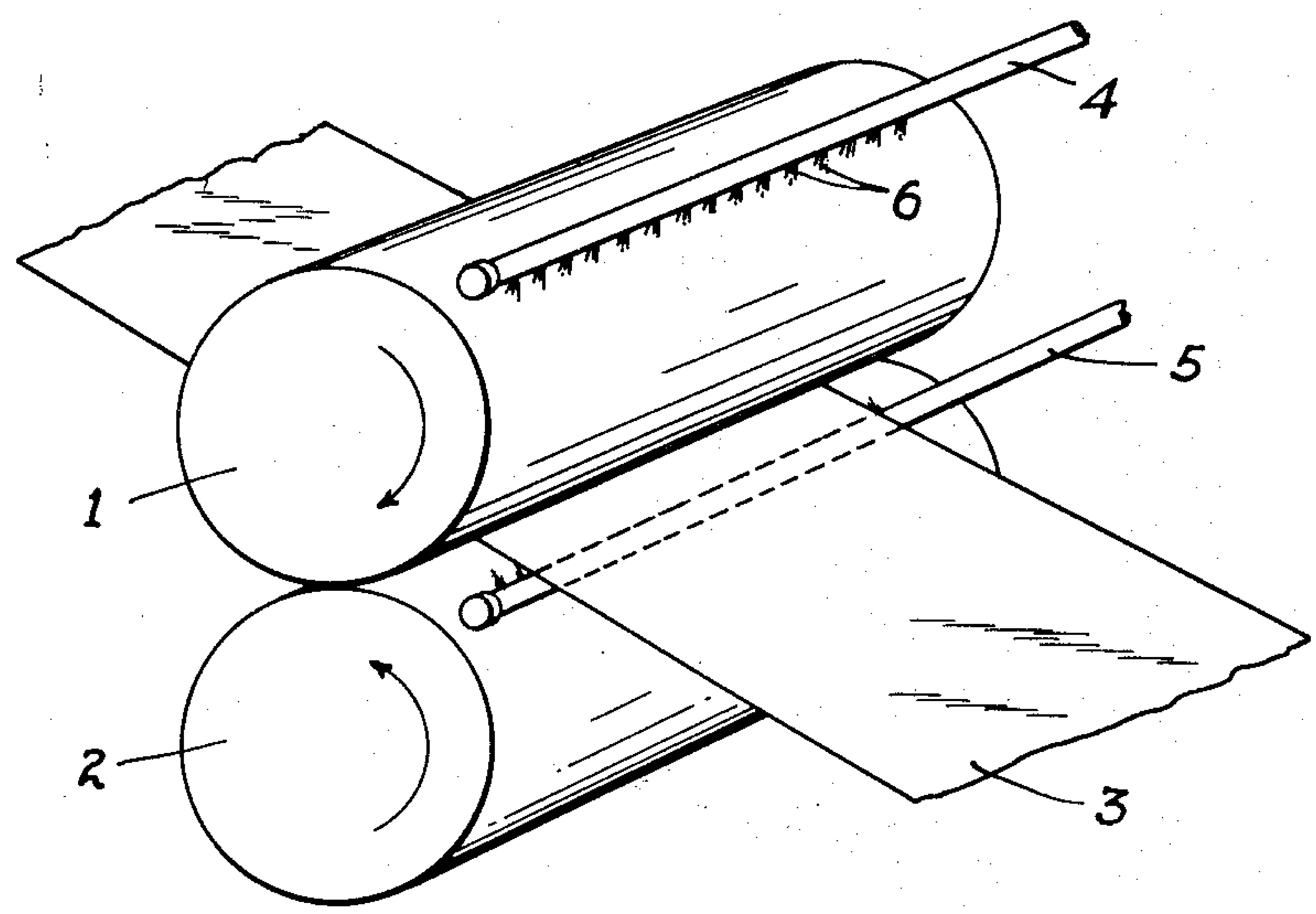

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FABRICATION OF LIGHT METALS

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1

This invention relates to improved processes of working, deforming, machining or otherwise changing the size or shape of light metals. The processes in question are various and include those generally described by the terms: extrusion, drawing, forging, pressing, broaching, machining, cutting, rolling, and the like. In any event, they are those processes by which a piece of light metal is altered in shape, size or section as distinguished from processes in which pieces of metal are merely assembled into a structure. These processes will, for convenience, be generically termed fabricating or shaping light metals, the terms "fabricating" and "shaping" being used equivalently herein. The light metals to which the improvements of this invention relate are aluminum and magnesium, or workable, deformable or shapable alloys which contain at least 70 per cent by weight of one of those light metals. This application is a continuation-in-part of Serial No. 626,164, filed November 1, 1945, and now abandoned.

In fabrication or shaping processes by which light metals are worked, deformed or otherwise changed in size and shape the instrumentality or tool which serves as the agent in the operation and bears directly on the surface of the light metal is commonly made of steel, bronze, cemented carbide or other metal alloys or metallic compounds. During such fabrication a coating forms on the tool. This coating is believed to be composed, at least in part, of light metal or an oxide or other compound thereof. Such coatings form to some extent whether the light metal be rolled, extruded, drawn, forged, pressed, broached, or otherwise altered in shape, size or section. This contamination of the tool surface often materially affects the quality of the article produced in that the surface of the article is often marred by imperfections or is rough or of lessened polish or brilliance. In some cases these coatings otherwise adversely affect the efficiency of the fabrication operation.

The principal aim and object of this invention is to so improve methods of fabricating or shaping light metals as to prevent, diminish or suppress the contamination of the tool by this coating and the effects of such contamination. In achieving this result in accordance with this invention other important incidental objects may likewise be achieved, as is hereinafter explained.

In accordance with this invention, these objects are obtained in whole or in part, by maintaining at the interface of the light metal and the fabricating instrumentality or tool during fabrication or shaping, the BF_3 or BF_4 radical, which radicals may, under some circumstances, exist as ions. In other words, there is furnished at said interface a compound or complex which contains BF_3 or BF_4 and which is stable under

2

the conditions at the interface, in the sense that the BF_3 or BF_4 is available at the interface during the fabricating operation. These compounds or complexes are selected from the group consisting of MBF_4, $RHBF_4$, and $X \cdot BF_3$, where M represents an inorganic radical or ion, R represents a nitrogen-containing organic compound having a basic character, i. e. amines and amides, and where X represents a substance or carrier which will sorb or hold BF_3 when treated therewith. Those substances which contain a BF_4 radical are the inorganic fluoborates or the HBF_4 acid salts of amines and amides. Those substances which contain sorbed or held BF_3 comprise a wide range of complexes, and in a few instances perhaps compounds, which may be prepared in various ways but which, for the most part, may be conveniently prepared by exposing the base material X to direct contact with gaseous BF_3. Whether these substances be compounds or complexes or a solution of BF_3 in the base material or merely the undefined result or reaction product of the treatment with BF_3 of a material which has an unsatisfied valence which will act as an acceptor of BF_3, they are, for the purpose of this invention, alike in basic function if they will deliver to the light metal tool interface amounts of BF_3 under the conditions existing at that interface during the fabricating operation, i. e., if they are "stable."

Examples of compounds represented by the formula MBF_4 are the following: ammonium fluoborate, potassium fluoborate, sodium fluoborate, lithium fluoborate, calcium fluoborate, cadmium fluoborate, lead fluoborate, barium fluoborate, copper fluoborate, tin fluoborate, nickel fluoborate and zinc fluoborate.

The formula $RHBF_4$ represents the reaction product of hydrofluoboric acid and an aliphatic, aromatic or heterocyclic, mono- or polyamine or hydroxy amine or an amide. Amines such as the following can be used: butyl amine, amyl amine, ethylhexylamine, dodecylamine, didodecylamine, dioctadecylamine, trihexylamine, ethylene diamine, diethylene triamine, triethylene tetramine, di(2-ethylhexylamine), tri-n-amyl amine, aniline, 3-phenyl propylamine, 2-pentyl-4,5-dimethyl-4-hexanooxyethyl-2-oxazoline, 2-pentyl-4, 4-bis-(hexanooxymethyl) - 2 - oxazoline, 2 - nonyl-4-ethyl-4-caproxymethyl-2-ethyl oxazoline, monoethanolamine, diethanolamine, triethanolamine, aminoethanolamine, diethylaminoethanol, 3-di-n - amylamino - propylamine, monoisopropanolamine, phenyl ethanolamine, ethyl phenylethanolamine, phenyl diethanolamine, o-dimethylaminoethyl-p-octyl phenol, 4-amino - 3 - pentadecyl phenol, nitron, phenyl morpholine, and 1-hydroxyethyl-2-heptadecenyl glyoxalidine. Examples of amides which can be used are acetamide, propionamide, butyramide, benzamide, cinnamide, nicotinamide, diacetamide, triacetamide, n-hexadecyl amide and n-octadecyl amide.

The carrier or substance represented by X in the formula $X \cdot BF_3$ may be selected from a wide range of substances, among them being diethyleneglycoloieate, butyl stearate, acetamide, N-hexyl ether, 4,5 dihydro-1,4 diphenyl-3,5 phenylamino 1,2,4 triazole, pyridine, morpholine, dioxane, aniline, urea, oleic acid, linoleic acid, lard oil, butyl acetyl ricinoleate, cetyl alcohol, tallow, diethylenetriamine and oxazolines.

The formula $X \cdot BF_3$, it should be understood, does not necessarily imply an equimolecular ratio between X and BF_3, but rather that the organic material may be associated with BF_3 in any proportion.

Among the compounds or substances represented by MBF_4, $RHBF_4$ and $X \cdot BF_3$ are a number which are not, in the sense of this invention, stable. This lack of stability, however, may be simply and easily determined by testing of a complex or compound (if information is not readily available) to determine whether it will retain its BF_3 or BF_4 content until delivered at the interface and then make it available at the temperatures and conditions obtained at the interface. Because of direct thermal decomposition or because of hydrolysis of the compound into components, one of which is insoluble or gaseous, or because of other similar reasons, the compound or complex may not be physically or chemically capable at the temperatures and conditions of the fabrication process of delivering BF_3 or BF_4 in effective form at the interface.

It will be apparent that "stability" of the compound or complex, as that term is herein used, is relative and is dependent upon interface conditions which are necessarily chosen by the operator to obtain the fabricated product desired. The inorganic fluoborates, the reaction products of hydrofluoboric acid and the basic nitrogen-containing organic compounds and those substances represented by the formula $X \cdot BF_3$ are efficient to accomplish the objects of this invention if choice be made of them, in accordance with the principles above indicated. Thus, for instance, calcium fluoborate will be efficient to deliver BF_4 to the interface and thereby prevent or partially prevent contamination of the tool if not mixed with water. However, if, as in hot rolling of light metal, there is used a mixture of calcium fluoborate and a water-oil emulsion, hydrolysis of the calcium fluoborate will take place with the consequent formation of sufficient insoluble calcium fluoride, thus removing the active fluoborate from the mixture. Sodium fluoborate, potassium fluoborate and many other fluoborates, however, will act efficiently in the presence of water. Lithium fluoborate decomposes at relatively low temperatures; when used as a solid film it may be incapable of delivering BF_3 at the interface when the working operations are conducted at elevated temperatures, say in excess of about 200 or 300° F. On the other hand, a compound of higher thermal stability, such as potassium fluoborate, may be unsatisfactory when temperatures are about 300° F. because it does not readily yield BF_3 at such relatively low temperatures, but may be effective to make BF_3 available at temperatures of about 500° F. or even higher. Other factors may likewise enter into such a selection, depending upon the choice of the operator. For instance, some of the fluoborates are less expensive than others, and, also, some of the heavy metal fluoborates may be considered less desirable than the alkali metal or alkaline earth fluoborates, because of the possibility that the presence of a heavy metal radical or ion at the working interface might cause minute contamination of the metal article being produced, with consequent corrosion or other difficulties. Similar principles apply to the selection of complexes represented by $X \cdot BF_3$. The capability of any such complex to deliver BF_3 to the light-metal tool interface when a given set of conditions are there existent is readily ascertainable by simple test. The carrier or substance represented by X in the formula may also be selected by the operator with other properties in mind, such as, for instance, properties of lubrication, wetting or the like. A wide range of substances has been found to be adapted to deliver BF_3 to the interface, as indicated hereinabove, their use depending upon the temperature of the operation and other considerations of the type previously mentioned.

Although the precise manner is not known in which the BF_3- and BF_4-containing substances act at the tool-light metal interface to prevent contamination of the tool, it is believed that the BF_3 and BF_4 portions of those substances either eliminate or greatly reduce any wetting of the tool by the light metal and any diffusion of the light metal into the tool surface. Metal pick-up by the tool is thought to originate with the minute points of light metal which become welded to the tool. The presence of BF_3 or BF_4 appears to prevent the occurrence of such welding. One theoretical explanation of this action is that the BF_3 or BF_4 saturates the molecular field of force present on the metallic surfaces. In any event, no visible film appears on either the work metal or the tool and hence it is considered that whatever protective film is formed is transitory and occurs only at the interface between the light metal and tool under the influence of the heat and pressure incident to working of the light metal.

The mechanics of bringing the aforesaid complexes or compounds to the interface between the light metal and the tool and maintaining it there during the fabricating operation will vary with the nature of the fabricating process employed. In processes, such as rolling or cutting, where a liquid lubricant or coolant is customarily furnished at the interface, the compound or complex or solution containing BF_3 or BF_4 may be added to the liquid, thereby insuring maintenance of an effective agent at the interface without necessity of extra operations. In fabricating processes such as extrusion or drawing where, in common practice, a lubricant of the grease or solid type is normally applied at the interface, the compound or complex may be incorporated in said lubricant. In many fabrication operations, however, little or no lubricant is furnished at the interface. In such case maintenance of the compound or complex at the interface during the fabrication operation involves extra operations. For instance, where the fabrication tool is hot, the compound or complex may be incorporated in a slurry or solution with a liquid vaporizable at the temperature of the tool and applied at intervals to the surface of the tool with the result that upon vaporization of the liquid a dry coating of the compound or complex will be formed on the tool surface, which coating may be renewed as is necessary. Where the tool temperatures are low, a slurry or solution of said compound or complex may be continuously fed to the tool-light metal interface during fabrication or the slurry may be formed with a liquid phase which evaporates quickly so that application of the slurry to the tool will soon result in the forming on the tool of a coating of the solid phase of the slurry. Conversely, the coating may, in same or similar manner, be applied to the light metal rather than to the tool or the coating may be applied to both metal and tool. In any event, the manner of applying the substance or material which contains or carries BF_3 or BF_4 is one of expedience and convenience taking into account the inherent stability of the compound or complex selected and the particular fabricating process employed.

In general, those substances having an organic base should not be used at metal working temperatures above 400° F. Also, some inorganic compounds, such as lithium fluoborate, as referred to hereinabove, cannot be used at higher temperatures because the compound decomposes too quickly. On the other hand, most of the inorganic compounds can be employed both at the lower working temperatures and above 400° F. The hot working of light metals seldom, if ever, involves shaping at temperatures above 1000° F. Most of the alkali and alkaline earth fluoborates are sufficiently stable above 400° F. to serve satisfactorily in delivering BF_3 or BF_4 to the tool-metal interface during such hot working operations.

The manner in which a slurry or emulsion containing the BF_3 or BF_4 complex or compound may be applied in a metal working operation is illustrated in the accompanying single figure drawing showing schematically a perspective view of one form of apparatus suitable for carrying out the invention. In the figure metal strip **3** is rolled between rolls **1** and **2**. The emulsion, which prevents roll contamination, is supplied through perforated pipes **4** and **5** and is projected against the rolls in the form of jets **6** so that it is carried to the roll-metal interface.

The amount of compound or complex containing BF_3 or BF_4 which need be present at the tool interface in order to achieve the objects of this invention will depend upon the conditions encountered. However, a sufficient amount should be present to provide at least 0.01 per cent by weight of the BF_3 or BF_4 radical or ion with respect to the total weight of the composition used at the tool-light metal interface. If the tool or work is to be coated with one of these compounds or complexes, a visible coating which is continuous, or even considerably discontinuous, will usually serve to achieve the desired result. Where the compound or complex is added to a grease, or oil or other similar lubricant, I have generally found that noticeable results will be obtained if the BF_3 or BF_4 content of the final grease or oil compound or complex mixture is above about 0.01 per cent by weight of said mixture. If the compound or complex be brought to the interface in solution or slurry or as a component of an oil-water emulsion, it is usually desirable that such solution, slurry or emulsion have a content of BF_3 or BF_4 which is substantially at least 0.01 per cent by weight, this for the reason that lower amounts do not produce noticeable effects in reduction of contamination of the tool and are, therefore, commercially impractical. On the other hand, the

maximum amount is established by such considerations as cost, increased benefits and deleterious effects upon the metal or tool. It is to be understood that other conventional components than water, oil or grease may be present in the composition applied to the tool, work piece or light metal-tool interface to impart particular properties or aid in the proper distribution of the BF_3 or BF_4-containing substance. Once the essential fabricating conditions have been set by the operator, simple trial will readily disclose the actual amount of compound or complex desirably added to reduce or eliminate the effects of tool contamination. The amount of tool contamination which may be tolerated in a given fabrication operation without deleterious effect, and the amount of total contamination which will normally appear in any fabrication operation, depends upon not only the basic operation employed, but likewise the temperature conditions existing at the tool-light metal interface, the particular light metal being processed, the pressures or percentage of reduction employed, the nature of the tool and other various factors which in the first instance are set or determined with respect to the total or over-all purpose of the fabrication operation.

In any event, the choice by the operator of the particular amount of BF_3 or BF_4 desirably present at the interface must first await the selection of all of the conditions otherwise necessary to the ultimate result of the fabrication.

One of the factors which, within limits, may be varied with the direct purpose of enabling the use of a given compound or complex at the interface is temperature. It will be apparent that when temperatures are very high, the thermal stability of any said compounds or complexes will be an inherent limitation to the use of this invention, unless the operator can, by adjustment of temperature factors at the interface, create conditions under which the compound or complex will be sufficiently stable to deliver BF_3 or BF_4 at least for the time necessary to lessen or eliminate tool contamination. Temperature conditions at a light metal-tool interface during a working operation are the result of the starting temperature of the metal, the starting temperature of the tool and the heat generated by the working operation. Often, when high temperatures are necessary, it is possible to attain the desired temperature mainly through the metal itself, the carrier of the compound or complex leaving or maintaining the tool in a cooler condition. If this can be achieved and the compound or complex in question initially applied to the relatively cooler tool surface, it will be possible in many instances to obtain the objects of this invention when the metal is at a temperature at which the selected compounds or complex would otherwise be unstable.

The principles of this invention and the use of these principles in controlling deleterious coating effects at the tool-light metal interface during fabrication operations will now be specifically illustrated by the following descriptions of the invention when practiced in connection with some of the more common methods of fabrication.

Rolling operations

In such operations a light metal billet is shaped by the action of converging roll surfaces. When "hot rolling" is practiced, i. e., when the light metal is at such temperature that any hardening of the metal induced by the working does not produce a product much harder than quarter hard, it is common practice to furnish to the roll-metal interface an aqueous coolant containing amounts of a lubricant or a surface active agent, wetting agent or detergent. When operations are at lower temperatures, the coolant is usually omitted and a small quantity of oil or similar lubricant is applied, more or less continuously, at the interface. Mineral oils of low viscosity, for example, kerosene, are used for this purpose with or without the addition of animal, vegetable or fish oils in relatively minor quantity. When the principles of this invention are applied to rolling operations, the compound or complex which forms the source of BF_3 or BF_4 is mixed with the coolant or with the lubricant normally furnished to the rolling interface, the result being a decrease in the contamination of the tool and deleterious effects resulting therefrom. An incidental drawback of the use of the invention may be a noticeable decrease in the "bite" of the rolls at the interface—a condition which is more pronounced when the metal is at a high temperature during rolling. This drawback, however, is often balanced by the advantages derived from clean roll surfaces, particularly where a product of superior surface qualities is the desired result of the rolling operation. The amount of BF_3 or BF_4 required to produce a noticeable commercial improvement is usually in excess of the amount represented by the boron-fluorine equivalent of 0.1 per cent by weight of $NaBF_4$ in the mixture. Good operating results are obtained during rolling when the metal is at high temperature if the amount of BF_3 or BF_4 present at the interface is that represented by the equivalent boron-fluorine in a mixture of 0.3 to 1 per cent by weight of $NaBF_4$ with the coolant. Increasing amounts are not harmful, but where the coolant consists of an oil-water emulsion, increased amounts of added compound or complex may tend to break the emulsion.

Serious tool contamination is often encountered when the light metal is hot rolled. In such cases the results of the invention are best realized if the compound or complex containing the BF_3 or BF_4 is delivered to the working interface in mixture with an aqueous emulsion containing at least 1 per cent and preferably 1 to 10 per cent by weight of at least one substance selected from the class consisting of lubricants, for example, the so-called soluble oils, and surface active agents.

A listing of many surface active agents is given in Industrial Engineering Chemistry, volume 35 (1943) at page 126. Illustrative examples of various types follow:

Type	Example
Soap	Monoethanolamine oleate.
Sulfated aliphatic esters	Turkey-red oil.
Aliphatic sulfates	Sodium oleyl sulfate.
Complex amino esters	Ester of oleic acid and sodium aminoethyl sulfonate.
Aliphatic sulfonates	Sodium oleyl sulfonate.
Alkyl aryl sulfonates	Keryl benzene sulfonate.
Cation active compounds	Cetyl pyrydinium chloride.
Esters and ethers	Glycerol monostearate.

As a group, the inorganic fluoborates are used with better results in the rolling of light metals than are the complexes of the $X \cdot BF_3$ type, so long as the particular fluoborate selected is stable under the conditions existing at the roll-light metal interface. When an aqueous coolant is used, those fluoborates, such as calcium fluoborate, which hydrolyze so that BF_3 or BF_4 is not available or is considerably reduced in quantity, should be avoided. The preferred compounds are the alkali metal fluoborates, including ammonium fluoborate, especially the sodium and potassium compounds. Excellent results have also been obtained with zinc fluoborate and the HBF_4 salt of ethanolamine.

Forging and drawing operations

In metal working the operations of forging and drawing, including upsetting, hot pressing and the like, are closely allied and, with respect to this invention, may be generally treated as of the same class. In many of such operations it is common practice to use a lubricant of the solid or grease type which is periodically applied to the tools. In other instances, lubricants in a more liquid form, such as thick oils, are used, and in still other instances light drawing oils are used as lubricants. In many instances, however, no lubricant is present at the working interface. When forging and drawing operations are carried out under conditions where the metal and the tools are at low temperatures, examples of such operations being tube drawing or reducing, deep drawing of sheet into cup-shape form and spinning, I prefer to use, in the practice of this invention, a complex of the $X \cdot BF_3$ type, which is oil soluble or readily dispersible in oil. Examples of such complexes are butyl stearate $.BF_3$ and tallow $.BF_3$ wherein the BF_3 constitutes about 15 per cent by weight of the complex. I have obtained excellent results when about 5 per cent by weight of these complexes are mixed with an oil of appropriate viscosity.

When such fabricating operations are carried out at relatively high temperatures, as is the case in many forging and hot pressing operations, I have found it convenient to bring the BF_3 or BF_4 to the hot tools in the form of a solution or a slurry of the compound or complex, the solvent or the liquid phase of the slurry being one which will vaporize upon contact with the tools. I prefer to use in such operations a water solution of an alkali metal fluoborate, particularly sodium, potassium or ammonium fluoborate, and to apply the solution to the hot tool to build up on the tool surface a coating of the fluoborate. Alternatively, the compound or complex may be conveniently applied in admixture with a heavy grease or oil if the fabricating process in hand will admit the use of such a lubricant. Efficiency of even the more stable of these compounds or complexes in elimination of tool contamination and the effects thereof appear to decrease when the temperatures of the tool and metal at the tool-metal interface exceed 500° F., and when the temperatures exceed about 700° F., the effect of even the most stable of the compounds diminishes appreciably, probably because of rapid loss of the compounds.

In the use of my invention to prevent tool contamination in forging and drawing operations, I have found that an incidental advantage is also obtained, this advantage evidencing itself in a notable decrease in the pressures necessarily applied between tool and metal in order to effect the proper deformation. This decrease appears whenever the BF_3 or BF_4 is present at the tool-metal interface in amount sufficient to have noticeable effect in reducing tool contamination.

Extrusion operations

In those operations in which solid light metal is forced through an orifice to form a shape roughly corresponding to said orifice, which operations are generally described as extrusion operations, I have found that maintaining the BF_3 or BF_4 at tool-metal interface, in accordance with my invention, not only decreases or eliminates tool contamination but also greatly increases the efficiency of the extrusion process. These effects are particularly noticeable if tool and metal temperatures are less than 500° F. Above about 500° F. these effects become less noticeable. As previously pointed out, however, if it is necessary to the success of the operation that the metal must be at such temperatures, it is often possible to obtain the results of this invention by maintaining the tools at a lower temperature. In extrusion operations it is customary to lubricate extrusion tools, which tools include not only the die which defines the extrusion orifice but also the walls which confine the metal behind the die, by the use of a heavy oil or grease, such as those composed of hydrocarbons or mixtures of them and metallic soaps. Therefore, it is convenient in connection with such operations to bring the BF_3 or BF_4 to the metal-tool interface by mixing the compound or complex containing the same with said grease or oil. As above mentioned, simple trial will determine the amount necessary to prevent tool contamination, and if this amount is used, the extrusion pressures necessarily employed in the extrusion operations will often be reduced. Such fluoborates as those of sodium, potassium and ammonium are examples of compounds that are useful for this purpose, when applied as aqueous solutions or dispersed in oil.

In extrusion of light metals, I prefer to add to the lubricant an amount of the compound or complex which, measured in terms of equivalent boron-fluorine, is equal to about 1 per cent by weight of KBF_4. While the elimination, by the use of my invention, of the ill effects of tool contamination in such operations is of importance, the incidental advantages obtained may often be of even greater importance. The use of this invention will allow an increase in speed of extrusion per unit pressure employed. In working with aluminum alloys of high tensile strength, which are some of the most difficult light metals to extrude, I have obtained increases in speed of as much as 300 per cent, thereby greatly increasing the efficiency of the expensive extrusion installations. It will be noted that this improvement will allow the operator to maintain the same speed while reducing the extrusion pressure and that thereby an operator may increase the range of usefulness of the extrusion apparatus, or even employ apparatus of lighter design.

The above specific illustrations of the application of my invention to roling operations, to extrusion operations and to drawing and forging operations, have been concerned mainly with a discussion as to the usefulness of the invention in respect to the elimination of tool contamination. I have also observed, however, that when the BF_3 or BF_4 is present at the metal-tool interface in amount sufficient to at least reduce tool contamination, and when the compound or complex containing the BF_3 or BF_4 is mixed with an oil, grease or other lubricant, the efficiency of the lubricant is often increased, apparently the film strength of the oil and its load bearing capacity are bettered, the operation proceeds with less frictional resistance, and at times the wear upon the tool is likewise reduced.

It will be evident from the above description of my invention that when the compound or complex containing BF_3 or BF_4 is used in a lubricant, it need not necessarily be soluble in the lubricant in order to obtain the desired effect, and indeed I have found that oil or grease insoluble compounds or complexes may be mixed or dispersed in the lubricant with good results.

While I have described my invention with respect to light metals, as above defined, I have generally observed that the invention is comparatively more efficient when used in connection with the fabrication of aluminum and its alloys than when used in the fabrication of magnesium and its alloys, particularly in respect to the elimination to tool contamination. However, I have further observed that the difference is merely one in degree and that the magnesium base light metals are materially benefited. By the use of the formulae, MBF_4, $RHBF_4$, $X \cdot BF_3$ I do not indicate the valence of any radical or ion of the indicated compounds or complexes since such indication forms no part of this invention.

Having thus described my invention, I claim:

1. In a process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool, the improvement consisting in controlling tool contamination and the effects thereof by supplying at the interface of the tool and light metal a composition containing a stable substance, the essential active constituent of which is a boron-fluorine combination selected from the group consisting of BF_3 and BF_4, in an amount sufficient to provide at least 0.01% by weight of said boron-fluorine combination with respect to the total weight of the composition applied to the light metal-tool interface, said substance being selected from the group consisting of MBF_4, $RHBF_4$ and $X \cdot BF_3$, where M represents an element or radical selected from the group consisting of the metals and the ammonium radical, R represents a basic nitrogen-containing organic compound and X represents a compound selected from the group consisting of basic nitrogen-containing organic compounds and organic oxy compounds, said substance being stable under operating conditions until called upon to deliver the said boron-fluorine combination to the light metal-tool interface, substantially as described.

2. In a process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool, the improvement consisting in controlling tool contamination and the effects thereof by supplying at the interface of the tool and metal a composition containing a sufficient amount of a metal fluoborate to provide at least 0.01% by weight of the boron-fluorine radical or ion with respect to the total weight of the composition applied to the light metal-tool interface.

3. In a process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool, the improvement consisting in controlling tool contamination and the effects

thereof by supplying at the interface of the tool and metal a composition containing a sufficient amount of an alkali metal fluoborate to provide at least 0.01% by weight of the boron-fluorine radical or ion with respect to the total weight of the composition applied to the light metal-tool interface.

4. In a process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool in the presence of an aqueous emulsion containing 1 to 10% by weight of the substance selected from the group consisting of lubricants and surface active agents, the improvement consisting in controlling tool contamination and the effects thereof at the interface of the tool and metal by adding to said aqueous emulsion a stable substance, the essential active constituent of which is a boron-fluorine combination selected from the group consisting of BF_3 and BF_4, in an amount sufficient to provide at least 0.01% by weight of said boron-fluorine combination with respect to the total weight of the emulsion applied to the light metal-tool interface, said substance being selected from the group consisting of MBF_4, $RHBF_4$ and $X \cdot BF_3$, where M represents an element or radical selected from the group consisting of the metals and the ammonium radical, R represents a basic nitrogen-containing organic compound and X represents a compound selected from the group consisting of basic nitrogen-containing organic compounds and organic oxy compounds, said substance being stable under operating conditions until called upon to deliver said boron-fluorine combination to the light metal-tool interface.

5. A process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool in the presence of an aqueous emulsion containing 1 to 10% by weight of a substance selected from the group consisting of lubricants and surface active agents, the improvement consisting in controlling tool contamination and the effects thereof at the interface of the tool and metal by adding to said aqueous emulsion a sufficient amount of a metal fluoborate to provide at least 0.01% by weight of the boron-fluorine radical or ion with respect to the total weight of the emulsion applied to the light metal-tool interface.

6. In a process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool in the presence of an aqueous emulsion containing 1 to 10% by weight of a substance selected from the group consisting of lubricants and surface active agents, the improvement consisting in controlling tool contamination and the effects thereof at the interface of the tool and metal by adding to said aqueous emulsion a sufficient amount of an alkali metal fluoborate to provide at least 0.01% by weight of the boron-fluorine radical or ion with respect to the total weight of the emulsion applied to the light metal-tool interface.

7. In a process of rolling the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is subjected to the action of a roll in the presence of an aqueous emulsion containing 1 to 10% by weight of a substance selected from the group consisting of lubricants and surface active agents, the improvement consisting in controlling roll contamination and the effects thereof at the interface of the roll and metal by adding to said aqueous emulsion a stable substance, the essential active constituent of which is a boron-fluorine combination selected from the group consisting of BF_3 and BF_4, in an amount sufficient to provide at least 0.01% by weight of said boron-fluorine combination with respect to the total weight of the emulsion applied to the light metal-tool interface, said substance being selected from the group consisting of MBF_4, $RHBF_4$ and $X \cdot BF_3$, where M represents an element or radical selected from the group consisting of the metals and the ammonium radical, R represents a basic nitrogen-containing organic compound and X represents a compound of the group consisting of basic nitrogen-containing organic compounds and organic oxy compounds, said substance being stable until called upon to deliver the said boron-fluorine combination to the light metal-tool interface.

8. In a process of rolling the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is subjected to the action of a roll in the presence of an aqueous emulsion containing 1 to 10% by weight of a substance selected from the group consisting of lubricants and surface active agents, the improvement consisting in controlling roll contamination and the effects thereof at the interface of the roll and metal by adding to said aqueous emulsion a sufficient amount of a metal fluoborate to provide at least 0.01% by weight of the boron-fluorine radical or ion with respect to the total weight of the emulsion applied to the light metal-tool interface.

9. In the process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool and the surface of said tool becomes contaminated by a coating containing said metal, the improvement consisting in decreasing the pressures necessary to effect said shaping by supplying at the interface of the tool and metal a composition containing a stable substance, the essential active constituent of which is a boron-fluorine combination selected from the group consisting of BF_3 and BF_4, in an amount sufficient to provide at least 0.01% by weight of said boron-fluorine combination with respect to the total weight of the composition applied to the light metal-tool interface, said substance being selected from the group consisting of MBF_4, $RHBF_4$ and $X \cdot BF_3$ where M represents an element or radical selected from the group consisting of the metals and the ammonium radical, R represents a basic nitrogen-containing organic compound and X represents a compound of the group consisting of basic nitrogen-containing organic compounds and organic oxy compounds, said substance being stable until called upon to deliver the said boron-fluorine combination to the light metal-tool interface.

10. In that method of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which confined light metal is extruded through an orifice under the action of pressure exerted on

said confined metal in which the surface of the metal-forming tools becomes contaminated with a coating containing said light metal, the improvement consisting in decreasing the pressures necessarily applied to effect such extrusion by supplying at the interface of the tool and metal a composition containing a stable substance, the essential active constituent of which is a boron-fluorine combination selected from the group consisting of BF_3 and BF_4, in an amount sufficient to provide at least 0.01% by weight of said boron-fluorine combination with respect to the total weight of the composition applied to the light metal-tool interface, said substance being selected from the group consisting of MBF_4, $RHBF_4$ and $X \cdot BF_3$ where M represents an element or radical selected from the group consisting of the metals and the ammonium radical, R represents a basic nitrogen-containing organic compound and X represents a compound of the group consisting of basic nitrogen-containing organic compounds and organic oxy compounds, said substance being stable until called upon to deliver the said boron-fluorine combination to the light metal-tool interface.

11. In a process of shaping the light metals, aluminum, magnesium and alloys containing at least 70% by weight of one of such metals, in which the light metal is worked, deformed, cut or otherwise altered in size or section by the action of a tool in the presence of an oil, the improvement consisting in controlling tool con-

tamination and the effects thereof at the interface of the tool and metal by adding to said oil a substance, the essential active constituent of which is a boron-fluorine combination selected from the group consisting of BF_3 and BF_4, in an amount sufficient to provide at least 0.01% by weight of said boron-fluorine combination with respect to the total weight of the oil applied to the light metal-tool interface, said substance being selected from the group consisting of MBF_4, $RHBF_4$ and $X \cdot BF_3$ where M represents an element or radical of the group consisting of the metals and the ammonium radical, R represents a basic nitrogen-containing organic compound and X represents a compound of the group consisting of basic nitrogen-containing organic compounds and organic oxy compounds, said substance being stable until called upon to deliver the said boron-fluorine combination to the light metal-tool interface.

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