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METHOD OF TREATING METALS

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The present invention, relating as indicated to a method of treating metals, is more particularly directed to a method of treatment of such metals as steel, for example, for the purpose of conditioning and protecting the same during working to partially or wholly prevent hardening of the metal during working operations, whether the operations be that of drawing, rolling, forging, or any other operation, producing a flow of the metal and a change in form of the article in question. A further object of the invention is the provision of a method for integrally affixing a coating of a protective nature to the exposed surface of an article of the material referred to. A still further object is the provision of a bimetallic product in the form of a base of such metal as steel, for example, coated with a relatively thin protective coating of a material such as aluminum in which two metals are integrally bonded together.

The principal object of the invention is the provision of a method of coating the metal to be worked with a material which apparently alloys with the surface of the metal article, or at least so firmly adheres thereto that it is not removed by ordinary working operations, and which has the effect of apparently insulating the article from the usual effects of the flowing of metal, that is, from the effect of the metals hardening in proportion to the amount of plastic deformation under the rolling, forging or other treatment.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the following description setting forth in detail one approved method of carrying out the invention, such disclosed method, however, constituting but one of the various ways in which the principle of the invention may be used.

My invention consists, briefly stated, in treating the metal article which is to be worked with a mixture of finely divided metal capable of alloying or adhering firmly thereto and an acid or salt having fluxing properties. The article when so coated or treated with this mixture, which may be suspended for convenience in a suitable vehicle, such for example as water, varnish or similar material, is then furnaced to drive off the flux, leaving the metal of the composition coating firmly united to the surface of the article which is to be worked.

As an example of the composition which I have found successful for the purpose indicated, I have used a mixture consisting of equal parts of finely divided aluminum and finely divided boric acid. This mixture is then suspended either in a resin varnish, water or other non-carbonizing material in the proportions of from 20 to 25 parts of the mixture to 75 to 80 parts of the varnish.

The metal to be coated, for example steel, is first cleaned by being passed through an acid bath, after which it is immediately dipped into my improved mixture which forms a coating all over the metal article and is then heated to approximately 1450°–1475° Fahr., or such temperature as will insure the thorough bonding of the two metals employed. In this operation the liquid, of course, has been entirely evaporated or burned off, leaving a coating which appears to contain aluminum and which is firmly bonded to, or alloyed with the surface of the metal article. It is important that the steel or other metal to be coated be in an absolutely clean condition for coating, and to insure this the material should be dipped into the coating bath immediately following the cleaning bath. It is also important that the coated material be heated immediately following the dipping as any delay allows the coating material, and particularly the vehicle if varnish is employed, to harden.

Other materials may be employed for the suspending vehicle instead of varnish or water, and I have used a starch base of about the usual consistency with good results, while still other materials, such as gums and compositions low in carbon can also be employed.

I am unable to explain the action which occurs from the use of my improved coating, further than to say that there is apparently an interaction between the coating metal, that is the aluminum, and the base metal, such for example a steel, produced by the boric acid and the temperature at which the coated article is heated. The aluminum, however, is coated integrally onto the steel and forms a continuous coating over the entire surface which remains throughout the drawing or other forming operations and which becomes smoother and more highly polished with each succeeding operation affecting the article. The resulting product is therefore an article having a relatively thin but continuous coating containing or formed of a light non-rusting material, such as aluminum. Tests indicate that the mixture of aluminum and boric acid when fused together onto the metal in the manner indicated produces an alloy at the surface or at the point of junction between the coating and the article consisting of an iron aluminum boride, although there is also probably free aluminum contained

in the coating and either mechanically bonded thereto or bonded directly to the surface of the metal article.

In the drawing of tubes employing my improved process the tube is first coated as already described, then furnaced to fix and bond the aluminum coating on the steel, after which a lubricating composition is applied to the surface of the coated tube in the usual practice. Thereafter, at least for a number of draws or passes, no further lubricating composition need be applied. As the metal is protected from the effects of hardening during these operations it does not require to be pickled or annealed and hence the original lubricating composition remains on the surface and serves for all of the operations required without the application of any successive lubricating coatings.

I am unable to accurately describe the action which occurs by reason of the presence of the coating described. The steel or other metal which is being worked does harden under the action of the working, but does not become sufficiently brittle to break, although it hardens progressively with repeated cold working. The action of the coating is, I think, partially a lubricating action which prevents the usual effect of the working tools on the surface of the article undergoing the working. For example, if a tube is being drawn the die through which it passes ordinarily exerts a tremendous pull on the surface of the tube causing a hardening of the metal and eventually the formation of very slight cracks in the surface of the material which, upon further working, cause immediate breakage transversely of the article. The action of the coating apparently is to partially lubricate the surface of the article, reducing the frictional drag or action of the dies in the case of drawn articles and preventing or putting off the formation of hair-line cracks which eventually lead to breakage. It is also possible that the coating exerts an insulating effect and causes the material to retain within itself the heat generated by the molecular arrangement during the draw, thus permitting the heat thus generated to partially, at least, self-anneal the tube or other article. It will be understood, however, that I put forward these theories purely as suggestions and that I do not state them as accurate conclusions.

In the drawing of tubes in which both the outer and inner surfaces are affected the tube is of course coated with my composition both inside and out, and thus both surfaces are protected and covered with the thin coating of the non-rusting or light metal.

The uses to which the present invention may be put are obviously very numerous and will suggest themselves readily to those skilled in the various arts, but among the uses may be mentioned protection to metals for all sorts of forming or flowing operations such as rolling, forging, drawing, hammering and the like. The primary effect of this treatment of metal is to prevent entirely, or at least to greatly reduce, the effect of flowing of the metal in various operations. Tubes coated by my improved method can be subjected to a number of passes, greatly changing the diameter and wall thickness of the tube, without hardening of the metal to an extent causing breakage and without any intermediate pickling or annealing operations. I have drawn tubes a varying number of passes without any intermediate annealing and even without relubrication of the surface of the material. For example, I have drawn a series of tubes, giving the initial tube seven successful draws, reducing the diameter and wall thickness at each draw, and have then further reduced the tube thus produced by five sinking operations without any intermediate pickling or annealing, and without any relubrication except a single thin coating of lubricant between the drawing and the sinking operations. By a sinking operation I mean a drawing operation in which the tube diameter is reduced, but without reduction in the wall thickness. I have drawn tubes through from four to twelve passes without a single intermediate annealing and have found the metal in the final article of substantially the same hardness as in the original tube. This action I am unable to explain, but I have satisfactorily demonstrated it on many occasions and with different types of materials, when the operations to which the articles were subjected were drawing, rolling, forging and hammering operations.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In a method of drawing tubes, the steps which consist in applying to the inner and outer surfaces of the tube, a varnish low in carbon having finely powdered aluminum suspended therein, fixing and bonding such finely divided aluminum on to the surface of said tube in the form of a thin continuous film, and then drawing said tube through successive dies to modify its diameter or thickness without intermediate heating operations.

2. In a method of drawing tubes, the steps which consist in applying to the inner and outer surfaces of the tube, a varnish low in carbon having finely powdered aluminum suspended therein, fixing and bonding such finely divided aluminum on to the surface of said tube in the form of a thin continuous film, applying a coating of lubricating composition to the surface of said tube, drawing said tube through dies to modify its diameter, and then recoating said tube with lubricating composition, and re-drawing it a number of times to further modify its diameter or thickness without intermediate annealing operations.

3. In a method of treating steel to prevent hardening during operations involving flowing of the metal, the steps which consist in applying to the surface of the steel, a liquid low in carbon having finely divided aluminum particles and boric acid suspended therein, furnacing the coated article to substantially remove the liquid and to cause the boric acid to flux the aluminum on to the steel in the form of a thin continuous film, applying a lubricating composition to said coated articles and then passing the same through a series of drawing means to modify the thickness thereof without any intermediate annealing operations.

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