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COLD WORKING METAL

Harry K. Ihrig, Milwaukee, Wis.

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This invention relates to the cold working of metals, and more particularly to the cold drawing of tubes and other sections.

A major object of the invention is to provide a method of cold working metal, especially cold drawing ferrous metal tubing, which is simple and may be practiced easily, effects substantial savings as compared with prior practice in the art, is free from disadvantages encountered heretofore, avoids or reduces the production of surface defects such as result, for instance, from seizing, chattering and similar phenomena encountered in tube drawing, and which is applicable to stainless steel and other alloy steels that are normally difficult to draw.

Another object is to provide a lubricant for use in the practice of such a method which is cheap, readily used, not only does not interfere with present drawing practice but actually speeds up operations, which, among other things, is easily applied to the stock and removed from it after the completion of working operations, and which reduces die and tool costs as well as otherwise effecting substantial economies.

The invention is applicable particularly to the cold drawing of tubing for which reason it will be described with particular reference thereto. In such operations a lubricant is used to assist the drawing and to minimize the formation of surface defects. For the drawing of ordinary steels materials such as tallow and tallow emulsions have been commonly used; special oils and solid lubricants have been used also, especially for alloy steels of certain types. Such lubricants are not wholly satisfactory from all standpoints or for use in drawing all classes of steels. Tallow lubricants, for instance, are not satisfactorily applicable to the drawing of all steels or to the production of small-diameter thin-walled tubes which when drawn with such lubricants must be annealed, pickled and relubricated after each pass, and they can not be used for the drawing of stainless steel tubing. Where such lubricants are used the common practice is to burn off the residual oil, and this is objectionable not only because of the fumes that are formed, but also because of the danger of carburizing the surface of the tubing.

Stainless steels present especially serious difficulties in drawing, and the ordinary drawing lubricants are totally unsuited in the drawing of such material. Generally speaking, to produce drawn products of satisfactory character and surface finish it has been necessary to draw such tubing at relatively low rates of speed and with small reductions at each pass, even with the best lubricants.

Largely because of the foregoing considerations the standard practice in this country in the manufacture of seamless stainless steel tubing has been to dip the tubes in lead to provide a film thereof which acts as the drawing lubricant. Lead affords good lubrication but its use is attended by various objectionable features. For instance, to avoid embrittlement of the tubes when annealed the lead residue must be removed, which is usually accomplished by means of nitric acid, which is a relatively expensive cleaning agent. Removal of lead residues is particularly necessary, however, where such tubes are for apparatus used in the production of food stuffs and medicines because of the toxic properties of lead. The use of lead increases drawing costs materially in comparison with the simple lubricants, such as oils, which may be used with some classes of steels.

Special drawing oils have been proposed for the drawing of stainless steels, but these also involve disadvantageous features. Such oils are burned on the tubes, and this is likely to cause carburization, especially of the inner surface of the tube. This is so objectionable to the users of stainless steel tubes as to constitute a basis for their rejection. Also, such carburized surfaces are likely to crack and tear apart in drawing.

I have discovered, and it is upon this that my invention is predicated, that the stated objects of the invention are attained by providing the metal which is to be cold worked with a coating comprising a resinous material which is substantially insoluble in oil but is soluble in volatile solvent and through which there is distributed a finely divided solid material which separates the metal and die, and thus acts as a lubricant, in the cold working operation. Such a coating provides satisfactory lubrication in cold working and cold drawing, and it is particularly adapted to the drawing of stainless steel with production of satisfactory surface finish and at rates higher than heretofore feasible and with greater drafts. These and other advantages alluded to hereinafter have been demonstrated amply by the practice of the invention for a substantial period of time on a commercial scale.

The coating whose use characterizes the present invention is formed by applying to the tube or other article which is to be cold worked a suspension of the solid lubricating material in a solution of the resinous material in a volatile solvent. The resinous material acts as a binder to hold the solid lubricant in place upon the surface of the article being drawn. As the metal is deformed in the die or dies the continuity of the film of binder is broken and the solid finely divided material then acts as a lubricant between the die and the article being drawn.

To avoid premature or undesired softening or removal of the lubricating coating the resinous material should be one which is insoluble, or substantially so, in the oils which are commonly

used as coolants in drawing operations. In accordance with the invention, however, the resinous materials used are soluble in volatile solvents. Solutions of the resinous material in such solvents afford excellent media in which to suspend the solid material to permit easy and satisfactory production of coating films. Also, when the coating has been applied to the article it can be dried rapidly and easily by mere evaporation. The resinous material should not be hard enough to cause scratching of the tubing or other article being drawn or worked. Although various resinous materials possessing these characteristics are known, I now prefer to use shellac because it is readily available, cheap, and, as extensive commercial use has demonstrated, is particularly adapted to the practice of the invention. Other resinous materials embodying the characteristics just stated are also available, for instance various synthetic resins, or plastics. Their solutions should be of such concentration as to give the desired bonding of the solid lubricant. As a further example, I have found that a flexible dewaxed shellac sold as "Elastolac" by Glyco Products Co. Inc., 146 Lafayette Street, New York, New York, works excellently. That material is easily soluble in water, alcohol, esters and ketones, but is insoluble in oils. A water solution sold by the maker and which operates satisfactorily has a solid content of 44 per cent.

The solid, finely divided material contained in the coating possesses the major advantage that, unlike tallow, oil and similar lubricants, it is not squeezed out in the drawing operations. These solid particles separate the die from the metal being worked. Because that action prevents metal-to-metal contact between the tube and the working tools and thus reduces the tendency to galling, seizing, chattering and the like, these solid agents are referred to herein as lubricants for brevity and ease of reference. Although they are physically different from oily lubricants, and perform in much better fashion, their action is broadly one of lubricating in the sense of preventing metal-to-metal contact. In consequence of their action the solid material permits tubes to be drawn at higher speeds than heretofore. Likewise, due to the improved lubricating action the life of dies and tools is increased as compared with prior practice using other lubricants.

The solid inorganic materials should, of course, not be hard enough or abrasive enough to cause scratching of the surface of the tubing where that is objectionable in the finished product. A variety of such materials are available but inorganic materials are best suited to the purposes of the invention, and among these lithopone, whiting and rouge or other similar form of iron oxide, may be mentioned as characteristic.

The proportions of the resinous material and the solid lubricant will vary according to the steel and the particular conditions under which it is to be drawn, and upon the particular solid and resinous material used. Stated generally, there must be sufficient solid material to effect satisfactory lubrication, and enough resinous material to hold it in place until the metal is deformed. However, these relations are exemplified by the following compositions which have been used satisfactorily in the commercial production of stainless steel tubing.

One such composition comprises 40 gallons of orange shellac (4 lb. cut), 92 gallons of denatured alcohol and 160 pounds of lithopone. Another exemplary composition is 80 gallons of orange shellac (4 lb. cut), 92 gallons of denatured alcohol and 160 pounds of iron oxide (rouge).

In the use of these and other compositions embodied within the invention the tubing or other article is treated with the composition to provide a continuous and substantially uniform coating over the surfaces which are to be exposed to working tools. This may be accomplished readily by painting the articles with or dipping them into a tank containing the composition although for many purposes the most satisfactory results are obtained by spraying the composition onto the articles. The coating is then dried by permitting the solvent to evaporate. Many volatile solvents will evaporate with sufficient rapidity under conditions of plant operation, which is advantageous because it eliminates the necessity for using drying or burning-on ovens. If it is desired to expedite the drying, however, this can be accomplished simply by increasing the circulation of heated or unheated air over the articles, although if desired the articles may be passed through drying ovens. The coated tube or other article may be cold worked or drawn at any time after the coating has been dried.

When tubes are to be drawn it is generally necessary to apply the lubricant to both the inner and outer surfaces of the tube. This can be accomplished most readily by dipping the article in a tank of the coating composition, removing the tube and standing it at an angle, say 45°, to the horizontal to effect drainage of the excess composition. When these and other articles are dipped or painted care should be taken to avoid the formation of tears, which might cause the formation of surface defects due to non-uniformity in thickness of the coating.

Although the coated tubes may be drawn directly it is preferred in most instances to dip them in an oil which acts as a coolant in the drawing operation. For this purpose cheap grades of oil, such as light fuel oil, may be used, expensive drawing oils and compositions being wholly unnecessary.

Various advantages flow from the practice of this invention. A major advantage is reflected by the ability to increase greatly the rate at which, for example, stainless steel tubing may be drawn. As an indication of this, the invention was used in cold drawing the entire stainless steel tube output of one seamless steel tubing manufacturer. This permitted the draw benches to be speeded up from the maximum speed of 3 to 4½ feet per minute attainable in practice prior to this invention, to 9 feet per minute, the maximum speed attainable on the benches in use at that plant, and there was every indication that even higher drawing speeds may be used. In consequence of this and other economies in time resulting from the practice of the invention, shipments of stainless steel tubing were increased almost 90 per cent as compared with prior practice involving the use of the then available lubricants.

The invention is applicable not only to the drawing of small tubing, but also to large tubing which generally tends to cause trouble. In prior practice in one plant such large tubes almost always chattered badly and it was often neces-

sary to slow down or even to start and stop the bench frequently in order to get the tube drawn, or to reduce the severity of the pass. These difficulties were entirely eliminated through the practice of the present invention.

In addition to the speeding up of production resulting from improved lubrication, experience has shown that the practice of this invention avoids seizing of the dies and mandrels and reduces their breakage. Experience has indicated that much longer die and mandrel life is obtained, which further increases drawn output because of the elimination of time necessary heretofore consequent upon the changing of tools due to frequent breakage of dies or mandrels.

Moreover, the product is of improved quality, as evidenced by the fact that in the period in which the present invention has been practiced commercially, the rejections in inspection have been decreased by about 45 per cent.

The drawn tubes may be cleaned easily and readily to remove the residues of resinous material. This might be burnt off but as surface carburization is objectionable, particularly in the case of stainless steel products, this is generally undesirable. I have found, however, that the residue of shellac can be removed quickly and easily by dipping the drawn tubes in a bath of sodium dichromate and sulfuric acid of, for instance, 60° Bé. strength. This has the advantage also that it frees the articles from residues of cooling oil, leaving the washed tubes perfectly clean.

According to the provisions of the patent statutes, I have explained the principle and method of practicing my invention and have described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. That method of working metal which comprises providing the metal with a coating comprising a resinous material which is substantially insoluble in oil and soluble in volatile solvent, and a finally divided material which is dispersed through said resinous material and acts as a lubricant in working of the metal, and working the thus coated metal.

2. That method of working metal which comprises providing the metal with a coating comprising a resinous material which is substantially insoluble in oil and soluble in volatile solvent, and a finely divided non-metallic inorganic material which is dispersed through said resinous material and acts as a lubricant in working of the metal, and working the thus coated metal.

3. That method of working metal which comprises providing the metal with a coating comprising shellac and a finely divided inorganic material which is dispersed through said shellac and acts as a lubricant in working of the metal, and working the thus coated metal.

4. That method of working metal which comprises providing the metal with a coating comprising shellac and lithopone, and working the thus coated metal.

5. That method of working metal which comprises providing the metal with a coating comprising a resinous material which is substantially insoluble in oil and soluble in volatile solvent, and a finely divided inorganic material which is dispersed through said resinous material and acts as a lubricant in working of the metal, working the thus coated metal, and immersing the drawn metal in a bath of strong sulfuric acid and sodium dichromate to remove residue of said resinous material.

6. That method of cold drawing metal which comprises coating the metal with a suspension of a finely divided inorganic lubricating solid in a solution in volatile solvent of a resinous material that is substantially insoluble in oil, drying the coating on the metal, and cold drawing the coated metal.

7. That method of cold drawing ferrous metal tubing which comprises coating surfaces of the tubing with a solution of oil-insoluble resinous material in volatile solvent having in suspension therein a finely divided lubricating solid, drying the coating, and cold drawing the tubing while thus coated.

8. That method of cold drawing ferrous metal tubing which comprises coating surfaces of the tubing with a solution of oil-insoluble resinous material in volatile solvent having in suspension therein a finely divided non-metallic inorganic lubricating solid, drying the coating, and cold drawing the tubing while thus coated.

9. That method of cold drawing ferrous metal tubing which comprises coating surfaces of the tubing with a solution of shellac in volatile solvent having in suspension therein a finely divided inorganic lubricating solid, drying the coating, and cold drawing the tubing while thus coated.

10. That method of cold drawing ferrous metal tubing which comprises coating surfaces of the tubing with a solution of shellac in volatile solvent having lithopone in suspension therein, drying the coating, and cold drawing the tubing while thus coated.

11. That method of cold drawing ferrous metal tubing which comprises coating surfaces of the tubing with a solution of oil-insoluble resinous material in volatile solvent having in suspension therein a finely divided inorganic lubricating solid, drying the coating, cold drawing the tubing while thus coated, and immersing the drawn tube in a bath of strong sulfuric acid and sodium dichromate to remove residue of said resinous material.

12. A composition for lubricating metal articles in cold drawing comprising a mixture of finely divided solid lubricating material and a solution in volatile solvent of a substantially oil-insoluble resinous material.

13. A composition for lubricating metal articles in cold drawing comprising a mixture of finely divided non-metallic inorganic solid lubricating material and a solution in volatile solvent of a substantially oil-insoluble resinous material.

14. A composition for lubricating metal articles in cold drawing comprising a suspension of finely divided inorganic solid lubricating material in an alcoholic solution of shellac.

15. A composition for lubricating metal articles in cold drawing comprising a suspension of lithopone in a solution of shellac.

16. The method of treating cold drawn tubes and the like coated with a resinous material such as shellac which comprises subjecting them to cleaning reagent comprising strong sulfuric acid and sodium dichromate and thereby cleaning the surfaces of the tube.

HARRY K. IHRIG.