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METAL WORKING

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This invention relates to the working of metal and more particularly to the extrusion of lead.

In the cold-working of lead, there is a tendency for the lead when under pressure to adhere to other metal surfaces. This is particularly true in the extrusion of lead and must be avoided if a product substantially free of surface imperfections is to be produced. It has been customary to provide a lubricant to prevent direct contact between the metal and die and thus retard accumulation of lead on the die surfaces and reduce the pressures required for extrusion. Of the many lubricating materials normally utilized in rolling, drawing, cutting, and similar processes of cold-working other metals, the only lubricants which have met with any appreciable commercial success in lead extrusion contain graphite. For example, a coating comprising graphite and sodium silicate has been disclosed by Gillis in U. S. Patent 2,038,215 as a lubricant for the extrusion of lead-calcium alloys. Lubricants containing solid materials such as graphite or other pigments suspended therein are commonly referred to in the art as pigmented lubricants. While the adhesion of lead to the surface of an extrusion die is retarded and surface imperfections in the product thus avoided when the lead is lubricated with a composition containing graphite, the presence of graphite is undesirable because of inclusions of particles of graphite in the extruded metal. In addition, removal of graphite from the extruded lead surface is extremely difficult and has been a serious problem particularly in the manufacture of articles which must have a bright and clean surface, or are to be electroplated, or are to be cold worked.

Extrusion processes including the lubrication of lead with a composition containing graphite have been found particularly undesirable in the ammunition industry wherein lead is extruded in the form of a wire of a predetermined diameter, cut into predetermined lengths or slugs and swaged into the desired shape. Imperfections in the internal structure of the length of wire or slug such as inclusions of graphite are undesirable as such a slug frequently splits in swaging, assembling with the bullet jacket or while loading in the cartridge case. Further, graphite clings tenaciously to the surface of the slug and gradually accumulates in the profile of the swaging punches thus producing projectiles with imperfect profiles and non-uniform and unpredictable ballistic properties. Non-pigmented lubricating compositions containing aliphatic polyhydric alcohols such as glycerine, diethylene glycol and triethylene glycol in relatively low concentrations have been disclosed heretofore for the shaping of metals other than lead, but such compositions have been found practically ineffective in the extrusion of lead.

One object of the present invention is to provide a process for working metals whereby the aforementioned disadvantages of the prior processes are avoided. Another object of this invention is to provide an improved process for the extrusion of lead. A further object is to provide a lead extrusion process wherein the lead is coated

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prior to extruding with a lubricant consisting of materials which are liquid at normal temperatures. Still another object of this invention is to provide a process for the extrusion of lead in which the lead is coated with a novel non-pigmented lubricant. This invention also has as an object the provision of an improved process for the manufacture of ammunition projectiles.

The foregoing objects and advantages, as well as others which will become apparent from the following description, are accomplished in accordance with this invention by providing a process in which lead is extruded with a lubricant comprising at least about 75% of a liquid aliphatic polyhydric alcohol with less than four hydroxyl groups. For example, glycerine, ethylene glycol, triethylene glycol, propylene glycol (1,2-propanediol), hexylene glycol (2-methyl-2,4 pentanediol) or octylene glycol (4,5-octanediol) and the like, alone, or mixtures thereof, are well suited as the lubricating material, and may have included any suitable diluents such as water, ethyl alcohol or the like and any suitable surface active agents such as castor oil, soluble oils, sulfonated oils, or the like. Excessively high pressures are ordinarily required in the extrusion process when the diluent content of the composition is greater than about 25%. Amounts of surface active agents greater than 10% to 20% are unnecessary and substantially lesser amounts are to be preferred. An aqueous solution of the polyhydric alcohol containing castor oil and a soluble oil has been found particularly advantageous from the standpoint of cost and efficiency.

In the manufacture of ammunition projectiles in accordance with this invention, lead lubricated with a non-pigmented lubricant containing a polyhydric alcohol is extruded in the form of wire, cut to predetermined lengths or slugs and said slugs swaged in consecutive operations without any intermediate washing or polishing operations. This improved process not only offers the advantage of eliminating polishing and cleaning operations but it has also been found that sufficient lubricant adheres to the extruded and cut slugs to lubricate them during the swaging operation, thus making it unnecessary to add a lubricant on the swaging presses. In addition there is, of course, no accumulation of solid material in the profile of the swaging punches and the projectiles produced in accordance with this invention are of uniform quality and have uniform predictable ballistic properties.

While the invention is described herein as relating to the extrusion of lead, it is to be understood that the process of this invention is equally applicable to the extrusion of lead alloys and that in each instance wherein the word lead has been used, lead is to be considered to include alloys of lead as well as metallic lead per se, for example lead-antimony alloys, lead-calcium alloys, lead-arsenic alloys and the like. The composition of this invention may also be utilized advantageously in the extrusion of other metals such as aluminum, non-ferrous alloys, ferrous alloys and the like.

In order to further explain and clarify this invention, following are typical embodiments thereof in which lead stock is extruded in the manufacture of ammunition projectiles.

In the manufacture of .32 caliber projectiles, a cylindrical billet approximately 14 inches in length and about five and one-fourth inches in diameter was cast in a suitable mold from molten metal having the composition of about 97.5% lead and 2.5% antimony. When the metal had solidified and cooled to approximately room temperature, the cast billet was removed from the mold and a substantially uniform continuous film of undiluted chemically pure glycerine was brushed over the surfaces thereof. The completely coated billet was then placed in the die of an extrusion press and wire approximately .25 inch in diameter extruded through the orifice by ap-

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plying approximately 250 tons per square inch pressure against the upper surface of the billet. The wire was then cut into slugs about .66 inch long and swaged to form .32 caliber projectiles. If the lubricant is omitted in the extrusion step of the foregoing example or compositions of relative dilute aliphatic polyhydric alcohols are utilized, impractically high extrusion pressures are required and the lead adheres to the surfaces of the press and die. For instance when sufficient water was included to reduce the concentration to about 60% glycerine, it was impossible to extrude the lead because the composition did not provide sufficient lubrication to prevent inordinately high extrusion pressures in excess of 300 tons per square inch.

In another embodiment, a billet having approximately the same dimensions as that described above was cast in a similar manner from molten metal having the composition of about 99.5% lead and 0.5% antimony. After removal from the mold, the entire surface of the billet was coated, by brushing, with a substantially uniform film of lubricant having the formulation 85% glycerine, 5% soluble oil, 5% castor oil and 5% water. Wire about .18 inch in diameter was extruded from this billet as described above and cut into slugs about .66 inch long. The pressure exerted by the press on the billet varied from 250 to 300 tons per square inch during the extrusion process. The slugs were then transferred to a press where they were swaged to form .22 caliber long rifle projectiles without the addition of any lubricating material on the swaging press.

In a third embodiment of this invention, a billet of approximately the same dimensions as those of the foregoing embodiments was cast from molten metal having the composition of about 98.75% lead and 1.25% antimony. A substantially uniform coating of a lubricant having the composition 45% ethylene glycol, 35% glycerine and 20% water was brushed over the entire surface of the cast billet and wire about .18 inch in diameter extruded therefrom at a pressure of about 300 tons per square inch. The wire was then cut into slugs about .66 inch long and swaged to form .22 caliber long rifle projectiles without adding any lubricant on the swaging press.

In the foregoing embodiments, the lubricant was brushed over the surface of the billet but other methods such as spraying or dipping can be used with equal success in accordance with this invention and although the manufacture of ammunition projectiles was described, the invention is applicable to processing of other metal products.

While the invention has been described with particularity, it is to be understood that various modifications and changes may be made by those skilled in the art without departing from the spirit and scope of the invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

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1. In a method for making ammunition projectiles which involves shaping lead into a wire by forcing the lead through the orifice of an extrusion die, cutting said wire into slugs of predetermined lengths and thereafter shaping the slugs by swaging, the improvement which comprises first coating the surfaces of the lead with an aqueous non-pigmented solution of at least about 75 percent of a liquid aliphatic polyhydric alcohol having less than four hydroxyl groups and then extruding the coated lead, whereby slugs devoid of foreign inclusions and adapted to be swaged into the shape of a projectile without intermediate cleaning and additional lubrication are obtained.

2. In a method which involves shaping lead into a wire by forcing the lead through the orifice of an extrusion die, the improvement which comprises first coating the surfaces of the lead with an aqueous non-pigmented solution of at least about 75 percent of a liquid aliphatic polyhydric alcohol having less than four hydroxyl groups and then extruding the coated lead.

3. The method of claim 2 wherein said solution is composed of about 45 percent ethylene glycol, about 35 percent glycerine and about 20 percent water.

4. The method of claim 2 wherein said solution is composed of about 85 percent glycerine, 5 percent castor oil, about 5 percent soluble oil and about 5 percent water.

5. A lead billet suitable for extrusion into wire and having a coating of a non-pigmented aqueous solution comprising at least about 75 percent polyhydric alcohol having less than four hydroxyl groups bound to the surfaces thereof.

6. The billet of claim 5 wherein said coating is an aqueous solution of about 45 percent ethylene glycol, about 35 percent glycerine and about 20 percent water.

7. The billet of claim 5 wherein said coating is an aqueous solution of about 85 percent glycerine, about 5 percent castor oil, about 5 percent soluble oil and about 5 percent water.

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