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DRAWING BE-CONTAINING ALLOYS

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This invention relates to metal working processes and more particularly to metal drawing processes and has for its object the provision of an improved method of drawing wire, rods and tubes from Be-containing alloys of one of the metals of the group containing Cu, Ni, Fe and Co. The alloys commonly contain from .10-4.0% beryllium with or without small percentages of other associated alloying elements enhancing the precipitation hardening properties of the Be or the electrical and physical properties of the beryllium-containing alloy.

Another object is to facilitate the production of wire, rod and tubular articles from said alloys. Still another object is to improve the drawing properties of said alloys. Other objects and advantages will be apparent as the invention is more fully hereinafter disclosed.

In accordance with these objects, I have discovered that the excessive die wear ordinarily encountered in the drawing of the said alloys and occasioned either by the presence of metal oxide or of beryllide compounds on the surface of said alloys is effectively eliminated by coating the alloy surface with a relatively thin film of a relatively soft metallic lubricant consisting of one of the group of metals Cd, Ag, Sn, Zn and Pb.

The thickness of the metallic lubricating film provided on the Be-containing alloys in accordance with the present invention may vary widely without essential departure therefrom, as one skilled in the art will perceive, depending upon the specific metallic lubricant employed and upon the specific alloy being drawn. In general the thickness of the film should be no more than is required to provide the desired lubrication initially, and an extension of the film over the entire elongated length of the alloy subsequently to drawing. Film thicknesses sufficient to provide a drawing sheath for the alloy however are not within the scope of the present invention.

As one specific embodiment of the present invention, but not as a limitation thereof, the adaptation of the same to a metallic lubricating film comprised of cadmium in the drawing of copper-beryllium alloys containing from .10-4.0% beryllium will be described. I have found that for the purposes of the present invention a cadmium film ranging from a minimum thickness of about .00001 inch to a maximum of about .0002 inch is a satisfactory metallic lubricating film in the drawing of copper-beryllium alloys. In general the thickness of the cadmium film provided may vary within this thickness range with respect to the extent of elongation to be applied to the alloy in one or more drawing passes. In general, a thickness of about .00001 inch is sufficient to provide lubrication of most Cu-Be alloys during a reduction in area of up to as high as 70%, al-

though preferably the total reduction in area would not exceed about 50%.

As hereinabove indicated, the cadmium film thickness should be no more than is necessary to provide surface lubrication over the entire extended length of the alloy being drawn. Accordingly with any given degree of elongation per pass there is a minimum initial film thickness to accomplish this result. Any film thickness over this minimum film thickness is undesired for the purpose of the present invention, although cadmium film thicknesses up to .0002 inch may generally be employed without deleterious results particularly in the larger sized rods and wires. In the drawing of copper-beryllium alloys, however, the alloy is subjected to a plurality of separate drawing passes each pass reducing the cross-sectional area a determined percent, the total number of said separate passes being calculated to accomplish a determined total percent reduction in area before the work hardening characteristics of the alloy are increased to an extent inhibiting further cold mechanical deformation. Under these conditions, therefore, the cadmium film thickness must be at least sufficient to provide for an extension of the metallic lubricating film cover the total extended length obtained in the plurality of drawing passes.

I have found that a cadmium film thickness not in excess of about .0002 is about the maximum permissible lubricating thickness on the surface of any copper-beryllium alloy capable of being subjected to cold mechanical deformation by drawing the same through a die. Thicknesses in excess of this thickness tend to strip off and to clog up the die opening.

I have found that a cadmium film thickness of about .0001 inch is about the most satisfactory thickness to apply generally to all copper-beryllium alloys containing beryllium within the range specified to provide sufficient metallic lubricant for a total reduction in area in a plurality of drawing operations of between 40 to 65%.

In the practice of the present invention, the copper-beryllium alloy at the conclusion of the hot working operation and when at a rod diameter of about .750 inch is first subjected to a high temperature heating followed by a rapid cooling operation heretofore customarily applied thereto to condition the alloy for cold mechanical treatment. The surface of the alloy then is thoroughly cleaned of surface scale and oxides and the cleaned metal surface then is coated with an adherent film of cadmium to a thickness not in excess of about .0002 inch.

This cadmium film coating may be applied in a plurality of ways without essential departure from the present invention. The more firmly adherent the film to the surface of the alloy the better the film is for the purposes of the pres-

ent invention. Film coatings obtained by immersion or deposition plating are preferred. Film coatings obtained by electro-deposition, however, are generally satisfactory for the purposes of the present invention where the current densities employed are sufficient to produce the desired film adherence. Film thicknesses obtained by dipping in a molten metal bath when accompanied by partial surface alloying of the cadmium with the copper appear equally as effective as those obtained by immersion or deposition plating.

Following the surfacing of the alloy with the cadmium film to the desired thickness the subsequent cold drawing of the alloy is accomplished in a manner heretofore well known in the art, with the advantage that by the use of the metallic lubricant the copper-beryllium alloys may be drawn at greater speed rates through the die and in considerably greater quantities than heretofore possible and moreover can be given considerably larger percent reductions in area before the work hardening effects require annealing before further cold reductions can be applied.

As an example of this improvement, copper-beryllium alloys containing about 2% Be ordinarily require about eight (8) anneals during reduction of the same from a size approximating .750 inch to a size approximating .032 inch. On surfacing the alloy with cadmium to a film thickness not in excess of about .0002 inch but preferably to a film thickness approximating .0001 inch, I have found that only about (5) anneals are necessary and that I can cold reduce the alloy between 40% and 65% reduction in area in a plurality of separate drawing operations between each anneal.

As an example of the efficiency of the cadmium lubricant in the drawing of copper-beryllium alloys, wire comprised of copper-beryllium and containing Be about 2% when reduced in diameter from .155 inch to .125 inch, a reduction in area of about 35%, without such a metallic lubricant will destroy the die size of a tungsten carbide die before more than 10 pounds of the wire has been drawn therethrough. With a metallic lubricant and at drawing speeds as high as about 156 feet per minute up to 300 pounds of the wire may be drawn through the die without deleterious effect upon the die size.

The advantage of the present invention is more marked in multiple die drawing of Cu.Be alloys. For example, considerable difficulty heretofore has been experienced in the multiple die drawing of Cu.Be alloys of the smaller sizes where higher drawing speeds are desired of around 500 feet per minute. Ordinarily without the metallic lubricant of the present invention only about 1 to 2 pounds of a Cu.Be alloy containing about 2% Be can be drawn before one or more of the dies is deleteriously affected. By the practice of the present invention and with an initial cadmium thickness of about .0001 inch, for example, between 300 to 500 pounds of wire may be drawn, for example, from a wire size of about .032 inch to a wire size of about .016 inch through a plurality of dies each giving the wire about a 25% reduction in area at drawing speeds as high as 500 feet per minute without deleteriously affecting the plurality of die sizes.

The two examples above given indicate the marked economic advantage gained by the practice of the present invention. When diamond

dies are employed the advantage of the present invention is still more marked, for example, under the same circumstances given in the paragraph above over 1000 pounds of the wire may be drawn as contrasted to less than 200 pounds without the metallic lubricant.

The above noted drawing results are characteristic of those obtainable with all copper-beryllium alloys containing beryllium .10-4.0% by the practice of the present invention. The lower beryllium content alloys appear to draw more easily than the higher beryllium content alloys and to require a lesser thickness metallic lubricating film for the purposes of the present invention.

In general alloys having a base comprised of at least one of the iron group metals and containing from .10-4.0% Be are more difficult to draw cold than are the copper-beryllium alloys hereinabove described. All such alloys, however, appear similarly benefited and in fact can be drawn economically only by the provision of the metallic lubricating film described.

In general, the film thickness employed in the drawing of these alloys is the same as that found most suitable for the higher Be content copper alloys. Nickel-beryllium alloys, for example, are exceedingly difficult to draw commercially due to excessive strain on the draw head and very serious die wear. By the practice of the present invention the drawing of these alloys is materially simplified and rendered commercially practical.

Whereas, hereinabove I have described the present invention giving the metal cadmium as a specific example of the metallic lubricant employed, it is believed apparent that other metals may be employed for such purpose without essential departure therefrom such as, for example, tin, lead, zinc, silver and copper, which for the purpose of the present invention are to be considered substantial equivalents for cadmium. The precise film thicknesses of these metals effective as lubricating film will vary from that thickness hereinabove indicated as being proper for cadmium as one skilled in the art will perceive. The lubricating properties of tin appear to be closely approximate that of cadmium and film thicknesses of tin approximating that hereinabove given for cadmium are equally as good for the purposes of the present invention.

Having hereinabove broadly and specifically described the present invention and given one specific embodiment of the same, it is believed apparent that many modifications may be made therein without essential departure therefrom and all such are contemplated as may fall within the scope of the following claims.

What I claim is:

1. In the cold drawing of copper-beryllium alloys containing from .10-4.0% Be from rod to wire size, the improvement which comprises surfacing the rod with an adherent relatively thin coating of cadmium not exceeding about .0002 inch in thickness.

2. The method of eliminating excessive die wear and drawhead strain in the cold drawing of wire comprised of an alloy of copper containing from .10-4.0% Be which comprises surfacing the wire prior to drawing with a relatively thin film of a metallic lubricant consisting of cadmium, the thickness of said film being not in excess of about .0002 inch.

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