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DRAWING METAL

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The invention relates to the drawing of metal, and more particularly to the cold drawing of metallic tubes.

In the cold drawing of harder metals such as steel and nickel base alloys, it has been known to use softer metals and unctuous materials to lubricate the die through which the metals were drawn. These lubricants usually were applied to the metal stock prior to the drawing operation. When properly applied, a coating of lead has been found to be satisfactory so far as its ability to prevent scratching, pick-up of metal on dies and mandrel, seizing, etc., was concerned, but in some situations a lead or other soft metal coating cannot be used or its use is not economical. For example, in drawing very thin walled tubes and in tube drawing where the starting internal diameter and mandrel diameter are very nearly equal, a lead coating cannot be used on account of the relatively large minimum thickness of lead coating required. Similarly, if it is necessary to give a piece of metal stock a single draw, the cost of applying and removing a lead coating renders its use uneconomical. Unctuous materials have the advantage of ease of application and removal but they are unsatisfactory lubricants for drawing some metals and even where they are operative they have the disadvantage that a very limited number of passes through the drawing die are possible without annealing, pickling and relubricating the stock. The difficulties with the use of unctuous lubricants have been particularly acute in the drawing of stainless steels, nickel-chromium alloys of the type sold under the trade-mark Inconel, and nickel base alloys such as those sold under the trade-mark "K"-Monel. Some improvement in metal drawing over the use of tallow and oil lubricants has been brought about by covering the article to be drawn with an adhesive such as sodium silicate, glue, shellac or the like containing finely divided solids, e. g., lamp black, lithopone, whiting and rouge, but even with these improved lubricants the speed of drawing was slow, frequent recoating was necessary, and the number of passes without the necessity for annealing, pickling and recoating was low.

We have discovered a new lubricant and method of drawing, particularly tube drawing, which greatly increases the speed of draw and the number of passes which the metal being drawn can withstand before requiring annealing, as compared with prior art practices employing the best known adhesive bonded solid powder type of lubricants.

It is an object of our invention to provide a lubricant that may be readily applied to the metal stock prior to the drawing operation and readily removed therefrom after drawing.

It is another object of our invention to provide

a method of lubricating metals for a drawing operation which permits a greater number of passes and greater total reduction in area per application of lubricant and which also enables the drawing to be carried out at higher speeds.

Other objects and advantages of the present invention will become apparent from the following detailed description thereof.

Generally speaking, the lubricant of the present invention may be characterized as a dual layer lubricant. The first layer is a coating of lubricating material applied to the surface or surfaces of the metallic shape that will contact the dies, mandrels, etc., during the drawing operation. The second layer of lubricant is applied over the first layer just before the metal enters the die.

The lubricant which will be applied as the first layer is prepared by suspending finely divided solid lubricant such as graphite or lamp black and roughness producing powder such as lithopone in an adhesive vehicle such as shellac cut with alcohol. This first layer of lubricant is then applied to the article to be drawn by dipping, spraying, brushing, etc. and is permitted to dry before the article enters the die.

The second layer is a dry powdered lubricant, e. g., graphite, powdered soap or preferably a mixture of graphite and soap which is brought into contact with the article being drawn just before it enters the die. Any acceptable wire drawing soap in powdered form can be used in the present process. The roughness producing powder in the first coating apparently drags a layer of the dry powdered lubricant through the die.

The percentage of solid lubricant and roughness producing agent in the adhesive vehicle can vary over a wide range. Two specific examples of lubricants which have given satisfactory results in service had the following compositions, by volume:

Lubricant No. 1		Parts	Lubricant No. 2		Parts
Alcohol		20	Alcohol		20
Shellac		10	Shellac		10
Graphite		1	Lamp black		1
Lithopone		1	Lithopone		1

A screen analysis of the graphite and lithopone gave the following results:

Mesh	Percent graphite	Percent lithopone
On 20		6.0
On 40		14.2
On 50		5.6
On 60		.1
On 80		2.5
On 100		23.1
On 140		30.3
On 200		22.0
Through 200		22.0

In one series of drawing operations employing a lubricant having the above composition, stainless steel tubes having an outside diameter of $2\frac{1}{4}$ inches and a wall thickness of 0.125 inch were coated inside and outside by dipping the tubes in the lubricant, draining and permitting the lubricating layer to dry before the drawing operation. These coated tubes were then slipped over the mandrel, the tube point inserted in the die and clamped to the draw head of a draw bench. A quantity of dry powdered lubricant composed of approximately equal parts of flake graphite and soap was fed into contact with the inner and outer surfaces just before the metal passed into the die opening between the die and the mandrel. The powdered lubricant thus supplied was continuously used up, indicating that it was being dragged through the die opening in the form of a second lubricating coating by the lithopone which gave the inner coating a distinct rough feel. Tubes prepared in this manner could be given twice as many passes at 3 to 6 times the best drawing speed obtainable on the same kind and size of tubes coated with shellac and lithopone and additionally lubricated with oil at the die. Some stainless steel tubes, for example, were given a reduction of about 50% in three passes using the lubricant of the present invention.

The following specific example will demonstrate the advantages of the present invention in the drawing of tubes made of an alloy containing about 80% nickel, 14% chromium and 6% iron.

Tube No.	Lubricant No.	Outside diameter ¹	Wall thickness ¹	No. of passes	Speed of draw ²	Outside diameter ¹	Wall thickness ¹	Percent reduction
1-----	2	2.75	0.049	2	27	2.5	0.035	35
2-----	1	2.75	0.049	2	27	2.5	0.035	35
3-----	2	2.0	0.065	2	44	1.875	0.049	29
4-----	1	2.0	0.065	2	44	1.875	0.049	29

¹ Inches. ² Feet per minute.

The process of the present invention also is highly advantageous in the drawing of age hardenable nickel-copper-aluminum alloy containing approximately 66% Ni, 29% Cu and 2.75% Al as the following specific examples will illustrate:

Tube No.	Lubricant No.	Outside diameter ¹	Wall thickness ¹	No. of passes	Speed of draw ²	Outside diameter ¹	Wall thickness ¹	Percent reduction
5-----	2	2.0	0.165	2	27	1.875	0.109	41
6-----	1	2.0	0.165	2	27	1.875	0.109	41
7-----	2	2.0	0.127	2	44	1.875	0.095	34
8-----	1	2.0	0.127	2	44	1.875	0.095	34
9-----	1	4.0	0.375	10	-----	2.75	0.065	81

¹ Inches.

² Feet per minute.

³ Drawn in steps of 2 passes each with 4 intermediate anneals and 5 dopings.

Graphite is the preferred solid lubricant in the first layer although the present invention contemplates the use of other equivalent powdered lubricants such as finely divided metal powders which may be used in conjunction with or as a substitute for graphite. For example, aluminum powder alone and conjointly with graphite has given satisfactory results in practice. The preferred roughness producing agent is lithopone but other powdered materials of comparable hardness, particle shape and specific gravity can be used instead of lithopone. Suitable roughness producing agents are talc, soapstone, chalk (cal-

cium carbonate) and whiting. Instead of shellac, other adhesives of a drying nature may also be used with satisfactory results. Typical of suitable adhesives are varnish of nitrocellulose or cellulose acetate base; synthetic resins, such as Bakelite, Vinylite, etc., in suitable solvents; solutions of rubber or rubber products such as pliofilm, etc.

Although the present invention has been described in considerable detail in connection with certain specific embodiments, it will be understood that modifications and variations may be resorted to without departing from the scope of the invention as defined in the following claims.

15 We claim:

1. A metal tube prepared for cold drawing, having a coating of drawing compound adhesively bonded to the surfaces of the tube which will contact the die and mandrel during the drawing operation, said drawing compound containing finely divided solid lubricant from the group consisting of graphite and lamp black and finely divided roughness-producing material from the group consisting of lithopone, talc, soapstone, chalk and whiting, whereby the exposed surface of the coating is rough; and solid lubricant from the group consisting of soap and graphite over the exposed rough surface of said coating.

2. A metal tube prepared for cold drawing, having a coating of drawing compound adhesively bonded to the surfaces that will contact the die and mandrel during the drawing operation, said drawing compound containing finely divided solid

lubricant and finely divided roughness-producing material softer than the metal tube, whereby the exposed surface of the coating is rough; and solid lubricant from the group consisting of soap and graphite applied to the exposed rough surface of

60 said coating.

3. The method of drawing metal tubes made of alloys consisting largely of nickel and chromium, which comprises applying to the inner and outer surfaces of the tube a drawing compound containing finely divided solid lubricant from the group consisting of lamp black and graphite, and finely divided roughness-producing material from the group consisting of lithopone, talc, soapstone, chalk and whiting, in an adhesive vehicle; drying said drawing compound to form on said inner and outer surfaces of the tube an adherent coating having an exposed rough surface; applying solid lubricant from the group consisting of graphite and soap over the exposed rough surface of said adherent coating; and drawing the metal tube.

4. The method of drawing metal tubes made of alloys consisting largely of nickel and copper, which comprises applying to the inner and outer surfaces of the tube a drawing compound containing finely divided solid lubricant from the group consisting of lamp black and graphite, and finely divided roughness-producing material from the group consisting of lithopone, talc, soapstone, chalk and whiting, in an adhesive vehicle; drying said drawing compound to form on said inner and outer surfaces of the tube an adherent coating having an exposed rough surface; applying solid lubricant from the group consisting of graphite and soap over the exposed rough surface of said adherent coating; and drawing the metal tube.

5. The method of drawing metal tubes which comprises applying to the surfaces of the tube that will contact the die and mandrel during the drawing operation, a drawing compound containing finely divided solid lubricant and finely divided roughness-producing material in an adhesive vehicle; drying said drawing compound to form on the surfaces of said tube an adherent coating having an exposed rough surface; applying solid lubricant from the group consisting of graphite and soap over the exposed rough surface of said adherent coating; and drawing the metal tube.

6. The method of drawing metal tubes which 30

comprises applying to the surfaces of the tube that will contact the die and mandrel during the drawing operation, a drawing compound containing finely divided solid lubricant and finely divided roughness-producing material in an adhesive vehicle; drying said drawing compound to form on the surfaces of said tube an adherent coating having an exposed rough surface; drawing said tube through a die; and supplying finely divided solid lubricant from the group consisting of graphite and soap to the coated surfaces of said tube as it enters the die, whereby the exposed rough surfaces of said coating drag a quantity of said lubricant with them through the die.

7. The method of drawing metal tubes which comprises applying to the surfaces of the tube that will contact the die and mandrel during the drawing operation, a drawing compound containing finely divided solid lubricant and finely divided roughness-producing material in an adhesive vehicle; drying said drawing compound to form on the surfaces of said tube an adherent coating having an exposed rough surface; drawing said tube through a die; and supplying finely divided solid lubricant to the coated surfaces of said tube as it enters the die, whereby the exposed rough surfaces of said coating drag a quantity of said lubricant with them through the die.

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