WIRE DRAWING METHOD

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ABSTRACT OF THE DISCLOSURE

A method of drawing wire, and especially wire having a steel core clad with soft metal such as aluminum, by first mechanically scoring the wire to provide it with a surface having sharp irregularities, coating the wire with a fine particle size lubricant capable of clinging in the scored surface, compacting the lubricant in a pressure die, and then drawing the wire through a reducing die.

In a broad aspect, the method comprises mechanically scoring the surface of the wire to provide it with a matte finish having sharp surface irregularities, coating the wire with finely divided lubricant which is of a particle size capable of clinging in the sharp surface irregularities of the matte finish, passing the lubricant coated wire through at least one pressure die, and drawing the wire through a reducing die.

More specifically, the method requires that the surface of the wire be provided with a matte finish by blasting it with a liquid suspension of fine abrasive particles in accordance with the teaching of Eppler U.S. Letter Patent No. 2,462,480.

Particularly, the wire is preferably coated with lubricant by passing it through an aerated mass of lubricant so as to avoid high speed cavitation effects.

In a preferred method, also, on each reduction pass of the wire it is passed through a single pressure die having an elongated bore and an included angle of about 6°.

In an alternative method, the wire is passed successively through at least two pressure dies on each pass with the pressure dies of substantially bell shape and having an included angle of about 12°.

The preferred lubricant is a calcium base soap that is commercially available as Standard Industrial Compound, No. 55 XXX.

At least herein, the term “matte finish” means a finish having sharp surface irregularities and having a degree of deviation from a polished surface of the order of that which is produced by blasting electrical conductivity grade aluminum with an aluminum oxide grit having a particle size no larger than that which will pass through a screen of 120 mesh and no smaller than that which will pass through a screen of 240 mesh. A 180 mesh grit is preferred.

The present invention makes it practical to draw aluminum clad steel rod or wire in a dry die at practicable production speeds as high as 800 feet per minute. There is no scratching, scoring, or galloping of the clad surface, nor is there any stripping or upsetting of the cladding. At the same time, there is concurrent reduction of cladding and core despite the thickness of cladding and its relative softness and weakness when compared with the core. The method is particularly applicable to the drawing of electric conductor wire that has a carbon steel core and a cladding of aluminum. In accordance with the present method, the wire may be drawn in one or more passes with a reduction of 20 to 25% in cross-sectional area on each pass.

Successful drawing of aluminum clad steel wire requires that the wire with its coating of lubricant be passed through a pressure die which compacts the lubricant under extremely high pressures. Experimental work has shown that the soap pressure probably exceeds 100,000 p.s.i. and may approach 150,000 p.s.i.

To achieve such pressures, the clearance between the in-going wire and the pressure die must be extremely small, i.e., a difference between the in-going wire diameter and the pressure die diameter of approximately 2% to 3%. Thus, for example, with an in-going wire diameter of \(\frac{3}{32}\) to \(\frac{3}{16}\) inch, the diametral difference is \(\frac{.004}{.007}\) inch. When the diameter of the in-going wire is \(\frac{1}{16}\) inch or less, the diametral difference is \(\frac{.002}{.003}\).

The drawing of wire through pressure dies having such extremely small clearances requires that the lubricant be very finely divided, and this requirement is preferably met by the use of the Standard Industrial Compound, No. 55 XXX grind. The lubricant particles in any given grade, such as X, or XX, or XXX, cover a range of particle sizes; and the aeration causes the material to stratify because the largest particles stay at the bottom of the aerated mass. Thus, even with XXX grind only the finer particles, which are in the upper part of the aerated mass, are contacted by the wire.

At practicable commercial drawing speeds, the very finely divided lubricant which is required for retention in the pressure dies will cavitate and thus leave no lubricant on the wire. By aerating the lubricant chamber to maintain the finely divided lubricant in a "fluid" state, cavitation is eliminated and the required lubricant coating clings to the wire.

Suitable apparatus for practicing the method of the present invention is illustrated in the accompanying drawings in which:

FIG. 1 is a diagrammatic plan view of apparatus for drawing wire in two passes;
FIG. 2 is a longitudinal vertical sectional view of a lubricant chamber and pressure die unit, taken substantially as indicated along the line 2—2 of FIG. 1 on an enlarged scale;
FIG. 3 is a longitudinal central sectional view on an enlarged scale of a preferred form of pressure die and drawing die assembly;
FIG. 4 is a longitudinal central sectional view on an enlarged scale of an alternative pressure die and drawing die assembly;
FIG. 5 is a plan view, enlarged about 400 diameters, of an area of grit blasted wire surface, showing the "matte finish"; and
FIG. 6 is an enlarged sectional view, taken substantially along the line 6—6 of FIG. 5.

Referring to the drawings in greater detail, and referring first to FIG. 1, an aluminum clad steel wire W passes from a cladding process through a vapor grit blast unit 7. As disclosed in U.S. Letters Patent No. 2,462,480, the vapor grit blast unit is of the type in which abrasive material is suspended in a liquid carrier, to provide an abrasive emulsion, and the abrasive emulsion is discharged through a nozzle by means of an air jet.

Referring to FIGS. 5 and 6, the wire is designated WI to show the change from a polished surface to a matte finish. The vapor grit blast produces a multitude of tiny, irregular pits P the margins of which are slightly raised as indicated at r, and the raised margins r and pits P are relatively rough because of the sharp edged abrasive material which forms them.

Examination of the matte surface with a high powered binocular microscope shows that the larger pits P are about .002 inch long, about .001 inch wide, and about .0005 inch deep, with the raised margins r elevated about .0001 above the unpitted surface of the wire.

The method herein disclosed has been used to draw aluminum clad steel wire in which the aluminum clad-
ding is extruded onto the wire under very high pressure. In contrast to the matte finish as illustrated in FIGS. 5 and 6, a 200 power microphotograph of an extruded wire W, before vapor grit blasting, shows that it has only longitudinally continuous surface irregularities of small depth which are incapable of retaining lubricant and which have a deleterious effect on a drawing die.

From the vapor grit blast 7 the wire W1 is water washed in a unit 8, dried in an air dryer 9, and wrapped around a capstan 10 which had pulled it through the cladding and subsequent steps. The wire is coiled loosely about capstan posts 10a from which it is withdrawn to be passed around a sheave 11, around an aligning sheave 12 through a first pressure die drawing unit 13, then about a capstan 14 above which it is collected in loose coils about posts 14a. The wire is reduced in the drawing unit 13 as indicated by the use of reference numeral W2 for the emerging wire.

The wire is then drawn out of the loose coils above capstan 14, around a second equalizing sheave 15, around an aligning sheave 16, through a second pressure die unit 17, and around a capstan 18 above which it may again be stored in loose coils about upright posts 19. If a single pass is enough, the second drawing unit 17 is omitted, while conversely the wire may proceed from the capstan 18 through as many additional draws as are required to reach any desired sized finish.

Referring now to FIG. 2, which illustrates the lubricant chamber and pressure and drawing die assembly of the second pressure die drawing unit 17, brackets 20 and 21 support a lubricant chamber, indicated generally at 22, and a pressure drawing die assembly, indicated generally at 23.

The lubricant chamber 22 is a box having a bottom wall 24, an entry wall 25, an exit wall 26, and side walls 27 of which only one is illustrated in the drawing. An entry hole 28 is provided with a Teflon guide bushing 29 which has only a very small clearance around the wire W, and a hollow entry boss 30 which is welded to the entry wall 25 has an entry bore 31 which is axially aligned with the entry hole 28, and the boss 30 supports a bracket 32 for the aligning sheave 16 by means of which the wire entering the pressure drawing die unit 17 is aligned with the bore 31 and the entry guide bushing 29. The foregoing components are all conventional.

In order that a mass of lubricant L in the lubricant chamber may be maintained in an aerated, fluidized state, a porous wall 33 is secured to brackets 34 which support the relationship between the bottom wall 24 of the chamber so as to provide an air chamber 35 which receives very low pressure air, i.e., 8 to 12 ounces pressure, from an air conduit 36. Conveniently the porous wall 33 of the air chamber may be a piece of 3/8 inch Celotex.

Referring now to FIG. 3, which illustrates the preferred pressure die assembly 23, the exit wall 26 of the lubricant chamber 22 has a die receiving opening 37, and a die carrier clamp 38 which surrounds the opening 37 is secured to the outer surface of exit wall 26 by bolts 39, and clamps a die carrier 40 against said wall. The die carrier 40 is threaded at 41 to receive a die head 42. The die head 42 has a central cavity 43 within which are mounted a pressure die 44 and a reducing die 45, which are separated by a bushing 46. A clamp bushing 47 bears against a face of the pressure die 44, and an annular clamp nut 48 engages threads 49 on the die head 42 to secure the pressure die 44 and reducing die 45 and sealing ring 46 in the chamber 43. The sealing ring 46 produces a space between the pressure die 44 and the reducing die 45, and a pressure relief bore 50 in the wall of the die head 42 communicates with said space.

As is plain from FIG. 3, the pressure die 44 and the reducing die 45 are of substantially identical configuration, but the pressure die has a minimum diameter about 2 or 3 greater than the outside diameter of the wire W, while the reducing die is necessarily of a smaller diameter than the wire W. Each of the dies 44 and 45 has an elongated bore with an included angle of about 6°.

Referring now to FIG. 4, an alternative pressure die unit 123 includes a die head 142 having a cavity 143 within which are mounted a pair of identical pressure dies 144a and 144b which are separated by a sealing ring 146a, and a reducing die 145 which is separated from the pressure die 144a by a sealing ring 146b. The two pressure dies, the two sealing rings and the reducing die are all clamped into the cavity 143 by means of an annular nut 148 which engages a thread 149 on the die head 142. A space between the pressure dies 144a and 144b is connected by a pressure relief bore 150a with the exterior of the die head 142, while a space between the pressure die 144b and the reducing die 145 is in communication with a pressure relief bore 150b.

Each of the identical pressure dies 144a and 144b has a very short tapered bore, and the included angle of the bore is about 12°. The reducing die 145 is identical with the reducing die 45.

In a wire drawing operation conducted in accordance with the present invention, the wire W passes first through the vapor grit blast where it is blasted by an aluminum oxide grit preferably 180 mesh, but which may vary from about 120 to 240 mesh. The vapor grit blast treatment provides the wire with a matte finish as herebefore defined, and to show that there is a difference between the wire entering the vapor grit blast and the wire leaving it, the entering wire is designated by the reference letter W, while the wire after passing through the vapor blast is W1. The grit residue is then washed from the wire and the wire is air dried.

The wire then passes through the first pressure die drawing unit 13, which is identical with the second pressure die drawing unit 17 except for the fact that the pressure die and the drawing die in the first unit are slightly larger than those in the second unit. As the matte surfaced wire W1 passes through the lubricant chamber of the first pressure die drawing unit, it picks up a sufficient quantity of the very fine, aerated lubricant, and as it passes through the first pressure die and into the space between the pressure die and the drawing die, an enormously high pressure is exerted on the powdered lubricant and the wire. The wire constantly carries lubricant into the bore of the pressure die 44, and the very small angle of the pressure die, together with the very small clearance between the wire W1 and the bore of the drawing die, builds up lubricant pressure. As the pressure reaches 100,000 to 150,000 p.s.i. As the wire W1 passes through the first reducing die, its area is reduced between 20 and 25%, and this size reduction is indicated in FIG. 1 by applying the reference numeral W2 to the wire emerging from the first draw.

The second draw is identical with the first, and further reduces the wire by another 20 to 25%, as indicated by use of the reference numeral W3 for wire emerging from the second draw.

We find that if a pressure die having an elongated bore and an included angle of no more than about 6° is used, the lubricant is put into a suitable condition for the reducing step by passing it through only a single pressure die 44. Conversely, where a bell shaped 12° pressure die is used, positive results are obtained only with use of two pressure dies, as illustrated in FIG. 4.

Although vapor grit blasting is the preferred means of providing the matte finish on the wire, other methods may be used, reducing as they produce sharply angled irregularities in the wire surface. Thus for example, a series of very fine toothed rollers may be substituted for the vapor grit blasting to produce the desired matte finish. However, conventional shot blasting, using rounded rather than jagged particles, does not produce the type of finish which will retain the lubricant in the present process.

It is not necessary that the grit blasted and washed
and dried wire go immediately to the drawing units, since it may be stored briefly between the grit blasting and drawing steps.

The foregoing detailed description is given for clearness of understanding only and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

We claim:

1. In die drawing a wire at least a thick outer layer of which is soft metal, the steps comprising, in combination: mechanically scoring the surface of said wire to provide it with a matte finish having sharp surface irregularities; coating said matte finished wire with finely divided dry lubricant which is of a particle size capable of clinging in the sharp irregularities of said matte finish so as to coat the wire with said lubricant; passing said lubricant coated wire through at least one very high pressure die to compact the lubricant on the wire; and drawing said wire through a reducing die, said pressure die and said reducing die being sealed to one another in coaxial relationship.

2. The wire drawing method of claim 1 in which the surface of the wire is mechanically scored by blasting it with a liquid suspension of fine abrasive particles.

3. The wire drawing method of claim 2 in which the abrasive particles are aluminum oxide of a size which will pass through a screen not larger than about 120 mesh and not smaller than about 240 mesh.

4. The wire drawing method of claim 3 in which the abrasive particles are of a size which will pass through a screen of the order of about 180 mesh.

5. The wire drawing method of claim 1 in which the wire is passed through one pressure die having an elongated bore and an included angle of about 6°.

6. The wire drawing method of claim 1 in which the wire is passed successively through at least two pressure dies which are of substantially bell shape and have an included angle of about 12°, said pressure dies being sealed to one another in coaxial relationship.

7. The wire drawing method of claim 1 in which the minimum diameter of the pressure die is about 2% to 3% greater than the diameter of the ingoing wire.

8. The wire drawing method of claim 1 in which the lubricant is a soap having a calcium base.

9. In die drawing a wire at least a thick outer layer of which is soft metal, the steps comprising, in combination: mechanically scoring the surface of said wire to provide it with a matte finish having sharp surface irregularities; and drawing said matte finish wire in a plurality of passes, each of said passes including the steps of coating said wire with dry lubricant which is of a particle size capable of clinging in the sharp irregularities of said matte finish, passing the lubricant coated wire through at least one very high pressure die to compact the lubricant on the wire, and drawing said lubricated wire through a reducing die, said pressure die and said reducing die being sealed to one another in coaxial relationship.

10. In die drawing a clad wire which has a hard metal core and a continuous, coherent, softer metal covering of appreciable thickness bonded to said core, the steps comprising, in combination: grit blasting said wire with a liquid suspension of aluminum oxide particles of a size range not smaller than about 120 mesh and not larger than about 240 mesh, so as to provide it with a matte finish having sharp surface irregularities; passing said matte finished wire through an aerated mass of finely divided calcium base soap lubricant which is of a particle size capable of clinging in the sharp irregularities of said matte finish so as to coat the wire with said lubricant; passing said lubricant coated wire through at least one pressure die which compacts the lubricant on the wire at a pressure in excess of 100,000 p.s.i.; and drawing said wire through a reducing die, said pressure die and said reducing die being sealed to one another in coaxial relationship.

11. The wire drawing method of claim 10 in which the wire is passed through one pressure die having an elongated bore and an included angle of about 6°.

12. The wire drawing method of claim 10 in which the wire is passed successively through at least two pressure dies which are of substantially bell shape and have an included angle of about 12°, said pressure dies being sealed to one another in coaxial relationship.

13. The wire drawing method of claim 10 in which the minimum diameter of the pressure die is about 2% to 3% greater than the diameter of the ingoing wire.

14. The wire drawing method of claim 1 in which the wire is coated by passing it through an aerated mass of lubricant.

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