

[54] **METHOD AND APPARATUS FOR TREATING WIRE**

[75] Inventors: **Howard J. Godfrey**, Pennington;
Stephen W. Homa, Trenton; **Ronald J. Stott**, Beverly, all of N.J.

[73] Assignee: **CF & I Steel Corporation**, Denver, Colo.

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[58] Field of Search 72/41, 43, 44, 45,
72/274, 467

[56] **References Cited**

UNITED STATES PATENTS

1,582,434 4/1926 Simons..... 72/41

2,135,659	11/1938	Elfstrom	72/43
2,349,652	5/1944	Fenner.....	72/467
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FOREIGN PATENTS OR APPLICATIONS

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Primary Examiner—Charles W. Lanham

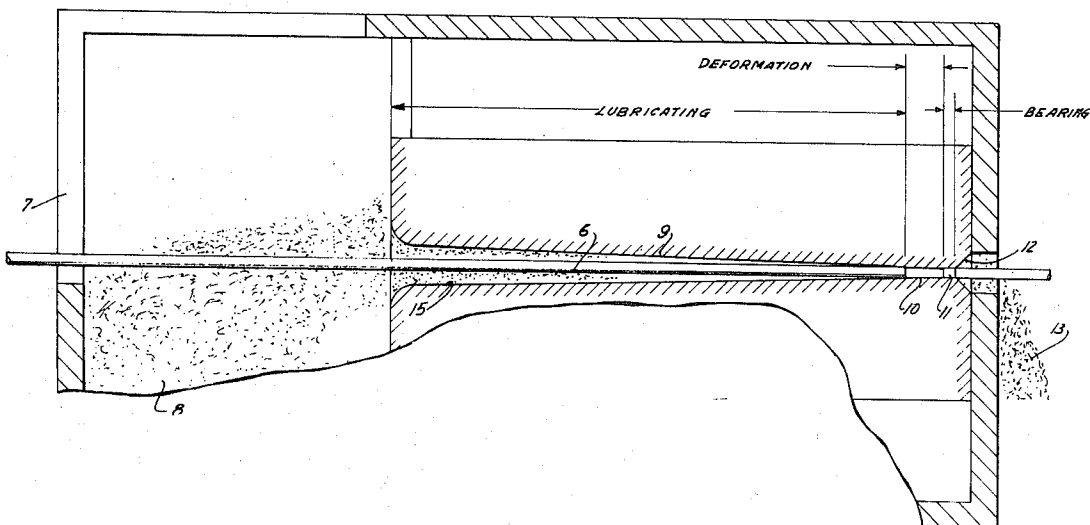
Assistant Examiner—E. M. Combs

Attorney—Dean S. Edmonds et al.

[57] **ABSTRACT**

A method of treating wire, both coated and uncoated, and a wire drawing die which provide improved lubrication of the wire and a lower wire temperature during treatment than have heretofore been obtainable and resulting in a cold drawn wire product having greater tensile strength and core density, considerable increase in cohesive strength and significant improvement in ductility.

3 Claims, 2 Drawing Figures



METHOD AND APPARATUS FOR TREATING WIRE

This application is a continuation, of application Ser. No. 54,122 filed July 13, 1970, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Production of cold drawn wire products.

2. Description of the Prior Art

Fleischmann et al. U.S. Pat. No. 3,080,962 relates to a complicated die system including three dies in series for drawing aluminum coated wire. This three-die system provides a buildup in lubricant pressure (finely powdered soap) in the first two dies so that the lubricant is forced into the third or actual wire drawing die. Should the lubrication not be effective with coated wire, the aluminum or zinc coating will weld to the die, and in the case of uncoated material the wire will become overheated and scrape in the die thus destroying the smooth surface intended for the wire.

Fenner U.S. Pat. No. 2,349,652 discloses a wire drawing die having a small entrance angle ($3\frac{1}{2}^\circ$ to 10°) but it has not proved satisfactory because the die is not long enough to develop the necessary pressure in the lubricant to force it between the wire and the die in the deformation section. The length of the lubricating section has been ignored.

SUMMARY OF THE INVENTION

According to applicant's method, wire of a selected diameter is passed through a reducing die having a lubricating zone followed by a deforming or deformation zone. The wire is continuously drawn through a suitable lubricant, advantageously a dry powder, carrying the lubricant into the lubricating zone within which it is subjected to friction with the wire as it travels through an elongated space of sufficient length and adequate gradual reduction in thickness to cause the friction between the lubricant and the surface of the wire to develop sufficient pressure to force the lubricant in quantity between the wire and the die in the deforming zone.

The wire may be pulled through the die at moderate speeds of 500' or 600' per minute but advantageously it is pulled through at speeds much higher, for example, from about 1,000' per minute to about 1,450' per minute, the wire travelling at these speeds through an elongated lubricating zone in intimate contact with the dry powdered lubricant such as wire drawing soap and then through the deforming zone. The lubricating zone has a wall which is only slightly spaced from the wire and which is constructed to press the lubricant against the wire as it moves through this zone, the speed of the wire in cooperation with the slight spacing of the wall acting to feed the lubricant forward into and through the elongated lubricating zone and the deforming zone and also serving to retard movement of the lubricant in a direction opposite to the forward movement of the wire.

The wall referred to is in the form of a frusto-conical passageway through both the lubricating and the deforming zones, the included angle between the opposite sides of this frusto-conical passageway being identical throughout both the lubricating and deformation sections. Such angle is from about 5° to about 10° . The length of the lubricating zone or section is several times the length of the deformation section, being from about $2\frac{1}{4}$ times to about 10 times the length of the deforma-

tion zone or section. In conventional dies in current use the die angle is about 12° for high carbon steel wire, and about 16° for low carbon steel wire.

Although the wire treated in accordance with the invention is usually carbon steel, alloy steel or stainless steel, rod or wire of copper, aluminum and non-ferrous alloys may also be treated.

Among the advantages resulting from the use of applicants' improved method and apparatus are better lubrication of the wire as it is drawn through the deformation zone resulting in a lower wire temperature and a reduction of the tensile drawing or pulling force and also resulting in a more uniform flow of the metal during the deformation process, together with improved stress distribution in the wire as it passes through the deformation zone. These advantages provide conditions which approach those of hydrostatic extrusion in which no tensile drawing force is required. Although the tension stresses are not eliminated by the present invention the level of tension stress is below the critical value which would result in internal damage to the wire. This has been shown by density measurements and by electron-micrographs of a transverse section through the drawn wire. The longer lubricating length and the smaller clearance between the wire and the die wall produce lubrication which is superior to that achieved in a conventional die. These conditions provide an adequate length to build up the lubricant pressure to such a high value that the lubricant is forced into the deformation section of the die in much greater quantity than in the conventional die. This is indicated by the greater amount of charred lubricant discharged from the die with the wire. All of these factors result in a product that can be distinguished from wire drawn with conventional dies by its mechanical and physical properties as well as its metallurgical structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic central vertical section illustrating the wire drawing die of the present invention;

FIG. 2 is a diagrammatic central vertical sectional view of a conventional die.

DETAILED DESCRIPTION

Referring first to FIG. 2 which shows a conventional die as in current use the wire (not shown) is drawn through the die from left to right. At the entrance there is a wide curved section 1, referred to as a bell section, followed by an entrance angle 2 which merges into the narrow end portion of bell 1. Immediately thereafter is the deformation zone 3 the angle of which is shown as 12° and next to this zone is the bearing section 4 which is cylindrical. The lubricating zone includes bell section 1 and entrance angle 2, the purpose of the bell section being to facilitate the entrance of a powdered lubricant, such as wire drawing soap, the wire being drawn through a mass of this material prior to entering the die. In deformation zone 3 most of the reduction in the diameter of the wire takes place, and bearing section 4 determines the final shape and size of the wire. The wire leaves the die through the relief section 5 which permits the escape of whatever charred soap may pass through the die with the wire.

Referring to FIG. 1 illustrating applicants' die the wire being drawn through the die is indicated at 6 and passes first through a mass of dry powdered lubricant 8 such as soap which is supplied to a container 7. The

wire then enters the long lubricating section 9 of the die, then passing successively through the deformation section 10, bearing section 11, and back relief section 12. It will be noted that the die angle, that is the angle between the opposite walls of the die opening, is quite small, in this case 5°. The charred soap 13 is shown issuing from the die. It may, or may not, be received in a suitable receptacle (not shown). The wire 6 is drawn through the die in a conventional manner as for example by attaching it to a draw bar, or by winding it about a draw "block" or reel which is power driven.

The lubricating section 9 and deformation section 10 are formed by the wall 15 of a frusto-conical passageway which commences at the left where it is joined to the container 7 and which extends to the right or discharge end of deformation section 10. The 5° angle between the opposite sides of frusto-conical wall 15 is continuous throughout the length of lubricating section 9 and deformation section 10. It will be understood that this passageway is formed in a die nib of suitable material, usually tungsten carbide, and this passageway joins the cylindrical passage 11 forming the bearing section, and the conical section 12 forming the back relief section.

The length of the elongated space within the frusto-conical section 15 and the gradual reduction in thickness of this space from the entrance end at the left to the beginning of the deformation zone 10 at the right cause the development of sufficient pressure in the lubricant as it is drawn along by the friction thereof with wire 6 to force the lubricant in quantity between the wire and the walls of the deformation zone 10.

Also with wire 6 traveling at the speeds previously indicated of from about 1,000', per minute to about 1450'1,450'per minute in cooperation with the slight spacing of the wall of the elongated lubricating zone

of the same size through a conventional die which produces the same "draft" or reduction in the diameter of the wire. Furthermore, it has been found that the speed of travel of the wire can be increased from the conventional speed of around 600' per minute to the speeds indicated above. In addition, the temperature of the wire as it leaves the die is lower and the general operating conditions are superior in every respect.

The drawing conditions for a conventional 12° die as illustrated in FIG. 2 and the drawing conditions in a 5° die of the invention as illustrated in FIG. 1 are shown in the following table and indicate that although the deformation length has been increased in the improved die due to the smaller die angle, the lubricating length is considerably more than twice as large:

Wire diameter, in.		12-degree conventional die, lubricating length, in.	5-degree improved die, lubricating length, in.	Percent increase in lubricating length
Before	After			
.058	.050	.422	.968	129
.218	.189	.322	.728	126

In addition the effectiveness of the lubricating length in the improved die is believed to be greater than in the conventional die because the bell section of the latter die is too wide to develop pressure on the powdered lubricant. However, the elongated narrow space between the wire and the wall of the frusto-conical lubricating section of the improved die causes the development of a very high pressure due to the friction between the wire and the lubricant.

The following table illustrates a comparison between the wire drawing conditions found in conventional dies and in the improved die of the present invention.

Example	Material	Wire dia., in.		Lubricating length, in.		Increase in lubricating length, percent
		Start	Finish	Conventional die	Improved die	
1	Aluminized wire	.152	.132		.833	
		.074	.064		.947	
		.147	.126	.360	.822	129
2	Logging rope wire	.054	.047	.427	.982	130
		.218	.191	.332	.753	126
3	do	.085	.075	.413	.947	129
		.350	.304	.382	1.291	238
4	High strength rope wire	.304	.266	.452	1.406	210
		.266	.234	.489	1.494	206
		.406	.358	.370	1.509	307
6	Prestressed concrete strand wire	.358	.316	.413	1.568	280
		.316	.280	.452	1.624	258

contribute to the feed of the lubricant into and through the elongated lubricating zone 9 and into and through the deformation zone 10. This speed of movement and the narrowness of the passageway retard the lubricant from moving in a direction opposite to the forward movement of the wire. These factors together cause the movement of a considerable amount of the powdered soap lubricant through the die. The size of the mass 14 of charred soap which has been observed in the extended experimental use of the invention carried out by the inventors has been found to be of sizable proportions and indicates the considerable amount of soap which travels through the die.

In such experimental use of the invention it has also been found that the pulling force required to be applied to wire 6 is substantially less than when drawing a wire

These data show that the lubricating lengths of the improved dies were at least 100 percent longer than in the corresponding conventional dies. In examples Nos. 1, 2, 3 and 4 the improved dies had 5° angles. In example No. 6 these dies had 9° angles.

It is considered evident that the longer lubricating length and the smaller clearance between the wire and the wall of the improved die explains why the improved die provides better lubrication than a conventional die. These conditions provide an adequate length of the lubricating section to build up the lubricant pressure to such a high value that the lubricant is forced into the deforming section of the die of the invention in much greater quantity than in the conventional die.

By utilizing the method and apparatus of the present invention a cold drawn wire product can be produced

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having increased tensile strength and core density, also increased cohesive strength and improved ductility.

We claim:

1. A wire drawing die for reducing wire to obtain an improved wire of smaller diameter comprising a die member having an extended frusto-conical passageway therethrough, said passageway having continuous walls from end to end and terminating in a short cylindrical portion at the exit end thereof, said passageway having a deformation section adjacent said cylindrical section for reducing the diameter of said wire and a lubricating section immediately preceding the deformation section, the included angle between the walls of the lubricating section being the same as the included angle between the walls of the deformation section, said included angle being between about 5° and 10°, and the length of the lubricating section being several times the

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length of the deformation section.

2. The method of reducing the diameter of a wire which comprises drawing it through a die having a passage therethrough including a portion of frusto-conical shape, said portion having an included angle between about 5° and about 10°, said portion having a minimum diameter smaller than the diameter of the wire and a maximum diameter enough larger than the diameter of the wire so that the wire first engages the die at least about seven-tenths of the distance from the large diameter end to the small diameter end of said portion, and feeding a lubricant to said large diameter end.

3. The method according to claim 2 wherein the wire is drawn through the die at a speed of from about 1,000 feet per minute to about 1,450 feet per minute.

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