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METHOD OF DRAWING WIRE

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This invention relates to the drawing of wire and has for its principal object the substantial elimination of the use of lime in the drawing operation together with the deleterious effects thereof, and to provide a method by which wire of a superior quality may be drawn at a lower cost than is now conventionally possible.

Objects of the invention include the provision of a method of drawing wire by means of which greatly increased speeds of drawing may be had; the provision of a method of drawing wire in which the use of lime during the drawing operation may be substantially eliminated; the provision of a method of drawing wire in which the step of neutralizing the acid of the pickling baths in which the stock rods are treated by the use of a thick lime water slurry may be eliminated; the provision of a method of drawing wire by the practices of which the number of passes between different dies before requiring the application of new interfacial film forming material to the wire is greatly increased as compared to conventional practices; and the provision of a method of drawing wire in which the occurrence of lime streaks often appearing on wire when drawn in accordance with conventional practice may be entirely eliminated, thus resulting in a product of improved appearance; and the provision of a method by the practice of which wire may be produced in a more economical manner and at less expense than is possible by the use of conventional methods.

Other objects of the invention include a method of drawing wire in which a corrosive material or composition is applied to the wire or wire stock immediately prior to passing it through the first die, whereby the pressure applied to the wire or wire stock during the passage through the first die and the resulting rise in temperature during such passage causes the formation of a protective coating on the wire prior to its passage through the following die, such coating providing a superior interfacial film having definite anti-welding properties for the wire stock or wire passing through subsequent dies; the provision of a method as above described in which the corrosive composition is substantially free of lime; and the provision of a method as above described which, when lime is used, may be used in unusually small amounts and does not require it to be baked upon the wire stock, thus affording an economy over conventional practices in the drawing of the wire.

It has heretofore been found necessary in the wire manufacturing industry to follow certain

prescribed and preliminary operations prior to the actual drawing of the wire itself. First, the basic metal which is obtained in the form of billets is heated to elevated temperatures and formed into rods of desired dimension by means of a continuous and usually hot rolling operation, and the rods thus formed are rolled into bundles weighing approximately 300 pounds and stored away.

While the present invention is applicable to wire formed from any desired metal, it is particularly advantageous in connection with the formation of wire from ferrous metals and for that reason the description hereinafter given will, in the main, be directed to the drawing of wire from such ferrous metals. In such case it will be appreciated that in forming the billets into rods as above described the billets must be heated to a temperature between 1600° F. and 2000° F. before the rolling operation is begun.

The above described preliminary operations, particularly in the case of wire formed from ferrous metals, causes the formation of an oxide scale which must be removed by an acid pickling operation prior to attempting the reduction of the rods to wire, and such pickling operation is carried on in accordance with well known and conventional practice. It has then been found necessary to neutralize the corrosive effects of the residual acid of the pickling bath on the rods, and this neutralizing operation is usually accomplished by first washing the rods and then dipping them into a lime water slurry, the concentration of the lime in the mixture being dependent upon the type of finish required on the cold drawn metal. In most instances a substantial coating of lime is deposited on the rods and, to facilitate successive drawing operations, this deposit is then thoroughly dried and this is accomplished by subjecting the coated rods to a baking operation which causes the lime coating to adhere more or less tenaciously thereto.

When it is desired to form such a rod into wire, then the rod prepared as above described is drawn through a series of reducing dies, the baked lime coating above described being allowed to remain on the rod when subjected to such reducing dies. When such a rod is subjected to the first die, and usually when subjected to each fourth die of a series of dies a so-called "lubricant" is applied to the rod. This so-called lubricant is usually in the form of a powdered metallic soap admixed with varying amounts of lime and, of course, becomes mixed with the baked lime coating on the rod at least during the

initial drawing operation. The lime itself is not considered to be a lubricant but is believed to act as a carrier for the metallic soap lubricants and also acts to fortify the soapy film to a point where greater loads of pressure can be carried without rupture of the lubricating film. While such compositions are commonly referred to as lubricants, they are rather a mixture or composition which act to provide an anti-welding interfacial film between the wire being drawn and the dies. Any such so-called lubricating substances must prevent the metal being cold worked from galling onto the dies. Where such galling or picking up of soft metal of the work by the hard die occurs during a drawing operation it causes scratching and breaking of the wire. The established interfacial film must have high anti-welding properties in order to prevent galling because galling is in reality welding and is largely caused by extremely high surface temperatures which often exceed the melting point of the metal being worked. The surface asperities of the work do melt due to frictional heat through contact with the dies but do not weld to the dies if the interfacial film has a sufficient anti-welding property. Accordingly, where the term "lubricant" is employed herein it will be understood to mean a material or composition capable of forming an interfacial film between the wire and the dies during the drawing operations and such an interfacial film as is intended to have the required anti-welding properties.

Such lubricant is used in the form of a powder and as the rod passes through the powder just prior to its entrance to a die, a sufficient amount of the powder is pulled into the die with the rod to form the required interfacial film for such operation. As above stated, fresh lubricant is applied after the rod has passed through a series of four dies in accordance with this conventional practice.

It is a well established fact that wire drawing operations are improved if a slight coating of a type of oxide of the metal of the wire is caused to be formed on the rods being drawn. To that extent certain additional operations have in the past been employed and it is not uncommon to treat the rods either in mild acid solutions or in corrosive salt solutions to purposely create a mild rusted or specially oxidized surface on the rods before they are subjected to the drawing operation, but in all such cases the rods are so treated and sufficient time is allowed to elapse to permit the solution to dry and to create such oxide in a usual manner by exposure to air before the rods are subjected to the drawing operations. As will be appreciated, it is impossible to control the amount of oxide thus built up on a particular rod and the particular amount of oxide thus provided substantially restricts such rod to the production of wire of one type of finish only and renders it unsatisfactory for the production of other types of wire requiring bright finishes.

The above described procedure has introduced a series of problems with which the wire industry inadvertently has had to cope with. The greatest and most serious of these problems is that created by the use of lime. The original baked lime coating, and the lime added to the dry lubricant, is forced by handling and by the drawing operations into the air in the form of a fine powder which tends to float in the air and, as a consequence, is breathed into the lungs of the workmen and frequently causes them to have silicosis. Furthermore, the quality of the

wire is at times marred by lime streaks. For these reasons it has always been the desire of the wire industry to reduce or to eliminate the use of lime in its operations and many experiments and much money have been spent in this direction, but heretofore where results looked encouraging the cost proved exorbitant and as a result the established methods have continued in existence.

I have discovered a new technique or method in wire drawing by means of which not only may the use of lime as a necessary component of the lubricating film in the drawing operations be substantially eliminated, but in addition a method by the practice of which enables certain steps in conventional wire drawing practices to be eliminated, thereby reducing the cost of the finished product. Furthermore, the method is such that the need of applying new lubricant during the successive drawing operations is materially reduced, thus affording a further economy in the formation of the product, and one which results in a product of superior quality being formed.

In accordance with this new technique or method a small percentage of an oxidizing agent which has a controllable corrosive effect on the metal of the wire being drawn, and in dry form rather than a wet mixture or solution which is impossible of use in at least the preliminary die reducing operations, is introduced into the dry lubricant preferably in place of all or part of the limit conventionally employed. By the term "oxidizing agent" or "corrosive material" as herein described and employed as an additive agent in accordance with the present invention, it is to be understood to mean such corrosive agents as may be applicable under the described technique. Such oxidizing agents or corrosive materials should be procurable in powder form and have an affinity for the metals with which they are to react to form compound of the metal. Because of this new addition to the lubricant the necessity for applying the lime coating to the rod after the pickling operation and drying such coating on the rod, together with the expense incident thereto, is eliminated. If the rods are neutralized by a lime or other alkaline solution after the pickling operation, because of partiality or because of economy, the lime or other alkaline solution can be used in extremely low concentrations and the light residual coating resulting in such case does not have to, and preferably is not, baked upon the rods. The dry lubricant to which such corrosive material is introduced may be used without any substantial addition of lime thereto and by the use of this new method it has been demonstrated that wire can be drawn through as high as thirteen sets of reducing dies without requiring the additional application of fresh lubricant thereto.

The theory back of the method of the present invention is the application of a corrosive agent to the wire stock being drawn immediately prior to its passage through a reducing die, a sufficient amount of such corrosive material adhering to the surface of the wire stock thus passing through the die so that the pressure to which both the wire stock and the coating are subjected during such passage through the die, and the elevated temperature to which they are brought because of the work performed in the reduction of the wire stock during its passage through the die, will cause the corrosive agent to substantially immediately react upon the wire stock and to produce thereon a surrounding coating of a compound of the metal of the wire

stock which serves as a most advantageous interfacial film between the wire and the dies during subsequent reducing operations. In other words, the object is to produce the advantages of a lime coating by introducing such corrosive agents into the lubricating composition, the particular type of effect being obtained when the original rod passes through the first die at which point high pressures and temperatures induce the formation of a lubricating film fortified by the oxide formed on the wire stock by the chemical effect of the corrosive agent on the metal of the wire stock. It has been found that the above described method greatly facilitates the drawing operation and produces a superior and more uniform wire, that the lime can be eliminated from the lubricating composition, that special pre-treating and heavy liming is unnecessary, that the deleterious effects resulting from the use of lime are, therefore, eliminated, and that a substantial saving in cost is effected by elimination of heretofore considered necessary pre-treatment steps in the operation on the rods. Furthermore, the proportional amount of the corrosive agent in the dry lubricating mixture may be varied to obtain a controllable thickness of such coating required, a step heretofore uncontrollable for any desired finish of the final wire, thus permitting the original stock rods to be used for providing finished wire having any desired type of finish.

It is well understood in the art that it is impossible to use wet lubricating substances or mixtures for the wire or wire stock particularly in the initial drawing operations where heavy reductions are required as it has been found that attempts to use such wet mixtures results in the frequent breaking of the wire during the drawing operations. For this reason the corrosive agents employed in connection with the present method are of a dry and preferably powdered type. The present method is thus differentiated from those prior art practices in which the rods are subjected to a preliminary oxidizing operation by treatment with an acid solution or with a solution of a corrosive agent and then allowed to dry before the drawing operation. Such preliminary coating operations cannot be relied upon for satisfactory results if employed solely with metallic soaps and without the addition of substantial amounts of lime and inasmuch as the resulting oxide coating may vary during storage of the rods before the reducing operations, such prior practice offers additional difficulties in this respect.

The corrosive agent of the present invention is applied to the rod immediately before its passage through the first die, or before its passage through some intermediate die where the number of reducing operations are sufficiently great to require the addition of a fresh supply of lubricant, and the pressure to which the rod is subjected and the temperature to which it rises during its passage through such dies is sufficiently constant to result in the formation of an extremely uniform coating of substantially predetermined thickness and of continuous and unbroken extent. The formation of this coating is not necessarily confined to the first die after application of the corrosive agent, for if any such agent remains on the stock during passage through subsequent dies, the heat and pressure of the operation or operations will continue the reaction.

Almost any dry finely divided material which

has a corrosive effect on the metal of the wire being drawn may be employed in accordance with the method of the present invention but, of course, it will be appreciated that the corrosive effects of some materials will be greater than that of others and a choice of such materials will, therefore, be indicated for the particular kind of metal being operated on. For instance, where the wire is made from iron or steel the corrosive agents may consist of ammonium chloride, monobasic phosphates, inorganic or organic sulphur compounds, or the like. Examples of compositions of typical lubricating mixtures suitable for use in carrying out the method of the present invention are as follows:

	Per cent
A. Calcium stearate.....	95
Ammonium chloride.....	5
B. Aluminum stearate.....	90
Monobasic phosphate.....	10
C. Calcium stearate.....	80
Aluminum stearate.....	15
Diphenyl disulphide.....	5

It will be appreciated that various combinations of these metallic soaps, together with various combinations of the above identified or other suitable corrosive agents may be employed in the place of the specific examples given.

Similarly where the wire being drawn is of a copper base the inclusions of corrosive material in the dry lubricant must, in accordance with the present invention, be of such character as to act corrosively on the copper base material and it will be appreciated that in some instances materials which may be satisfactory for use in the drawing of ferrous metals into wire will not be suitable for use in the drawing of cupreous metals, and vice versa. However, it may be stated that phosphates, chlorides, and disulphides are satisfactory for use in such case. Metals such as aluminum or alloys thereof and other metals must, of course, be used with corrosives adaptable thereto in each instance. It will thus be appreciated that the type of corrosive agent employed in the dry lubricant in accordance with the present invention may vary in accordance with the type of material being drawn and that although a relatively wide range of dry corrosive agents may be employed in accordance with the present invention, certain of these will be more desirable for use from a practical standpoint than others and will be used for that reason. It will thus be appreciated that the specific examples given are by way of illustration and not by way of limitation.

Having thus described my invention what I claim by Letters Patent is:

What is claimed is:

1. In the manufacture of steel wire, the steps of operating upon a heated billet to form rods, subjecting said rods to a pickling bath, thereafter subjecting said rods to a neutralizing bath including as an element thereof lime without depositing a coating of said lime of material thickness on said rods, then subjecting said rods to a reducing operation by successively passing them through a series of drawing dies, and applying a finely divided mixture comprising a dry lubricant and a powdered material corrosive in effect on the metal of said rods, immediately prior to the passage of said rods through the first of said dies.

2. In the manufacture of steel wire, the steps

of operating upon a heated billet to form rods, subjecting said rods to a pickling bath, thereafter subjecting said rods to a neutralizing bath including as an element thereof lime without depositing a coating of said lime of material thickness on said rods, then subjecting said rods to a reducing operation by successively passing them through a series of drawing dies, and applying a finely divided lime free mixture comprising a dry lubricant and a powdered material corrosive in effect on the metal of said rods, immediately prior to the passage of said rods through the first of said dies.

3. In the manufacture of wire from a ferrous material, the steps of operating upon a billet of said material to form a rod, subjecting said rod to a pickling operation, thereafter subjecting said rod to an acid neutralizing operation in the presence of lime and withdrawing said rod from said operation free of substantial amounts of lime adhered thereto, then subjecting said rods to a reducing operation by passing it successively through a plurality of drawing dies, and applying to said rod immediately prior to its passage through the first of said dies a mixture

comprising a dry lubricant and an agent in dry form capable of chemically interacting with the material of said rod under the heat and pressure generated in said die to oxidize the outer surface of said rod, thereby to form a fortified film on said rods serving itself as a lubricant between said rod and a plurality of said dies to which it is thereafter subjected for further reduction in diameter.

4. In the manufacture of steel wire, the steps of operating upon a heated billet to form rods, subjecting said rods to a pickling bath, thereafter subjecting said rods to a neutralizing bath including as an element thereof lime without depositing a coating of said lime of material thickness on said rods, then subjecting said rods to a reducing operation by successively passing them through a series of drawing dies, and applying a finely divided mixture comprising a dry lubricant and a powdered material corrosive in effect on the metal of said rods, immediately prior to the passage of said rods through at least one of said dies.

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