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ART OF DRAWING FINE STEEL WIRE

Arch W. Harris, Euclid, Ohio, assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey

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1 Claim. (Cl. 148—12.1)

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This invention is an improvement in the art of drawing fine steel wire. The reader unfamiliar with this art and the terminology used by those skilled in it should refer to the appropriate parts of "The Making, Shaping and Treating of Steel," Fifth Edition, published by the Carnegie-Illinois Steel Corporation, the terminology used in the present specification and claim being taken from this text so that the latter can be used as a dictionary in interpreting this terminology.

The following example of the invention serves to disclose the principles involved.

Plain low carbon steel having a composition suitable for drawing into fine wire is hot rolled in the usual manner to No. 5 hot rolled rod, which is .207 of an inch in diameter, and this rod is given the conventional pickling in the usual water solution of sulphuric acid and then rinsed and quickly dried, whereby it becomes clean No. 5 rod. It may be processed otherwise as long as its surface is cleaned enough for the following step.

The invention now diverges from the prior art in that this clean No. 5 rod is now copper coated. To do this, the clean No. 5 rod may be immersed in a water solution approximately containing, by weight, 10% copper sulphate crystals and 3 to 4% sulphuric acid, this solution being maintained at around from 190 to 195° F. and the rod being immersed in this solution for about 3 or 4 minutes. It is necessary to give the rod a dense, fine grain, adherent coating of copper, so the coating solution should include one of the agents commercially available for this purpose in an amount recommended for giving this type of coating and there should be at least 1.5 grams of copper per kilogram of rod. Other and higher copper weight values will be disclosed later.

The coating described above need not be all copper but may be a mixture of copper and up to 30%, by weight of the total, of tin or zinc, but there must be at least 70%, by weight, of copper and in case of its including tin or zinc its weight must be proportioned to give the weights of copper per weight of rod that are disclosed. When there is less than 90% copper, by weight, with the balance tin or zinc, it is preferable to electroplate the coating onto the rod, the electroplating art being adequate to provide for electroplating the described type of coating on the rod. Also, electroplating may be used to coat any of the mixtures or copper alone on the rod, if desired. The term "cupreous" is intended to define either all copper or the described mixtures including at least 70% copper, by weight.

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After the cupreous coating step, the next step is to dry draw the now cupreous coated No. 5 rod to process wire of a size suitable for further reduction by a continuous drawing machine for fine wire, these machines usually being designed to start work with wire of around No. 20 gauge, the size currently varying from around No. 18 to No. 20½ gauge depending on the particular design of the machine used. This dry drawing is done in the usual manner, excepting for the presence of the cupreous coating, by liming the rod with a water solution containing 10% lime by weight, baking the rod to remove acid brittleness and to dry the lime coating on the rod, and drawing to around No. 20 gauge. The process wire at this time has the usual appearance of dry drawn wire excepting that it has a decided cupreous color resulting from its cupreous coating which it still retains to a substantial degree.

This process wire is now spooled onto metal spools and is bright annealed in a hydrogen or other bright annealing atmosphere, to remove the hardness induced by the dry drawing and condition the wire for further drawing to fine wire size, this annealing being done without removing the cupreous coating. A process anneal is sufficient for this purpose. Bell type furnaces may be used with the spooled wire protected by the usual covers while it is hot enough so that exposure to air would cause oxidation of the cupreous coating. The metal spools used must be capable of withstanding the annealing heat without destruction of their function as spools.

After annealing, the annealed, cupreous coated, process wire on the metal spools is neither acid cleaned nor placed in barrels of water, but is taken dry to a continuous drawing machine for fine wire, and there the process wire is introduced dry to the first die hole of the machine and is then drawn by the machine to a fine wire size, such as No. 33 gauge which is .011 of an inch in diameter, while lubricated with the liquid lubricant used conventionally for lubrication and cooling by such machines. The wire, now finished to fine wire size, leaves the machine dry and is ready for sale or further processing in a manner not concerned by the present invention.

Returning now to the description of the thickness of the cupreous coating applied during the cupreous coating of the clean rod, by applying no more than about 2.5 grams of copper per kilogram of rod at that time, the wire leaving the continuous drawing machine for fine wire, when around No. 33 gauge, is bright and has no visible cupreous color. When such uncolored wire is

produced by the prior art practice, the die life of the last few dies is very low during drawing in the continuous machine, because the wire is practically free from any cupreous coating during its drawing through these dies, but in the case of the present invention the die life of these dies is as good as is obtained in the case of the prior art practice of putting so much copper on the process wire that the wire, after being drawn to finished size, has a distinct cupreous color. There is a considerable demand for wire that has no visible color, so this feature is of advantage.

If, in practicing the present invention, it is desired to produce coppered wire, it is necessary to increase the amount of copper coated on the clean rod, prior to the dry drawing, to about 5 or 6 grams of copper per kilogram of rod. This amount of copper in the cupreous coating, when of the type previously described, gives sufficient copper so that the erosion effected by all the drafting fails to remove the copper to a degree making it invisible, the wire when drawn to a fine wire size, such as around No. 33 gauge, having as good a cupreous color as coppered fine wire produced by the prior art.

One advantage of the invention is that in all instances the dry drawn process wire has a visible cupreous coating on it prior to its annealing to condition it for further drawing by the continuous drawing machine for fine wire. It is believed that the heat of the annealing causes the interfaces of the steel and the copper in the coating to alloy, it being understood that the annealing temperatures are insufficiently high to melt the cupreous coating. This belief is supported by the fact that when the fine wire, of around No. 33 gauge and free from any cupreous color, is produced by the practice of the invention, it is always possible to chemically detect copper on the surface of the wire even though the cupreous coating, if present, is completely invisible. It is believed that this accounts for the better die life in the case of the last few dies of the continuous drawing machine when the uncolored fine wire is produced, and this is a feature that should be of value whenever steel must be cold die worked.

Another advantage is the elimination of the acid cleaning and the water barrels required by the prior art practice after the bright annealing of the dry drawn process wire, it being remembered that in the case of this invention the wire is introduced dry to the first hole of the continuous wire drawing machine where the wire is drawn to fine wire size. This acid cleaning and the use of the water barrels for keeping the wire constantly immersed until it is fed to the continuous machines for drawing the fine wire, not only involve considerable cost but also poor working conditions for the workmen, the water barrels usually leaking and the water always slopping about so that the workmen must wear rubber aprons and boots. All of this is eliminated by the present invention, the bright annealed, spooled wire being taken dry to the continuous drawing machine for fine wire. The advantages just described result from the fact that the wire does not rust easily after it is bright annealed with the cupreous coating on it, it being well known that the usual cu-

preous coatings by themselves do not protect against rusting and it being for this reason that the water barrels are required for immersing the wire in the case of the prior art practice.

Still further advantages are that the possibility of acid embrittlement, resulting from the prior art acid cleaning and cupreous coating of the process wire, is eliminated at the time of the baking of the lined rod, it is much easier to obtain a completely uncolored fine wire of more consistent physical properties, as compared to the prior art practice, and there are even more advantages that will be realized by practicing the invention.

It has been mentioned that chemical tests indicate the presence of some copper when the invention is used to produce fine wire free from visible cupreous color. Therefore, it seems appropriate to mention that in spite of this it has been found that the fine wire produced without any color may be galvanized by the hot dip method without contaminating the zinc bath with copper.

I claim:

In the art of drawing fine steel wire which has a bright surface free of visible copper, the improved method which comprises applying a cupreous coating on clean wire drawing stock in an amount from about 1.5 to about 2.5 grams of coating material per kilogram of stock, dry drawing the coated stock and thus forming process wire of a size suitable for further reduction in a continuous fine wire drawing machine, bright annealing the cupreous coated process wire and thereby both conditioning the wire for further drawing and diffusing some of the cupreous coating into the wire surface, introducing the annealed wire in a dry state without cleaning to a continuous fine wire drawing machine, and wet drawing the wire in said machine and thereby both reducing the wire to final gauge and removing all the visible cupreous coating, the surface of the resulting wire consisting entirely of a layer of diffused copper-iron alloy.

ARCH W. HARRIS.

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