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COPPER CLAD WIRE AND METHOD OF PREPARING THE SAME

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Fig. 1.

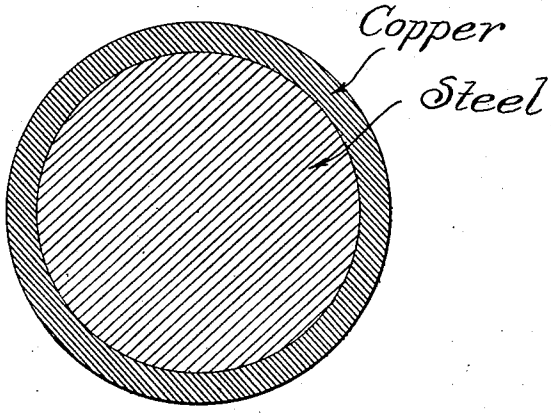
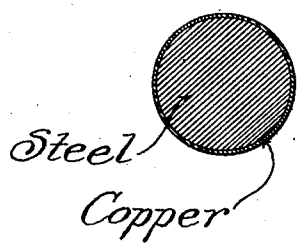


Fig. 2.



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COPPER CLAD WIRE AND METHOD OF PREPARING THE SAME

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7 Claims. (Cl. 204—35)

This invention relates to a copper clad wire and a method of preparing the same, and particularly to a copper clad steel wire of very high tensile strength, which has been drawn after the application of the copper to it.

Copper clad steel wires heretofore have been prepared in two different ways. In the earlier method a casting was prepared in which a large body of copper surrounded a billet or rod of steel. The whole material was reduced to the proper size. It has also been suggested to electroplate copper directly upon a finished wire.

Both of these methods were unsatisfactory for various reasons. The direct electroplating of copper upon a wire has lately come into favor, but this method is expensive. It does not result in uniform copper coatings, and the wires necessarily employed for direct plating have a very low tensile strength.

In accordance with the present invention, a copper clad wire of a tensile strength more than double of that previously produced and at the same time having a copper coating of great uniformity is produced.

The invention is illustrated diagrammatically in the drawing, in which:

Figure 1 represents a cross section of wire before drawing; and Figure 2 a cross section of the wire after drawing.

The wire employed is preferably a high tensile strength, high carbon wire, for example, one having a typical composition as follows:

	Per cent
Carbon	.65
Manganese	.80
Phosphorous	.015
Sulphur	.025
Silicon	.095

Balance is iron, with cases of impurities.

The wire must be carefully cleaned before treatment. The following example illustrates a typical treatment for a .119 inch diameter wire of the above composition which has been patented and limed.

The wire is first run through a 32% hydrochloric acid bath for 1.25 minutes. Before entering the bath the wire is scraped, for instance with steel wool, and after leaving the solution is wiped with rags, and then washed with water, and again wiped. The wire is then treated with an alkaline solution, for example, an alkaline phosphate such as Oakite 42 B solution, at the rate of two ounces to a gallon at an advanced temperature, say 180° F. for about a minute. It is then washed and wiped and run into a copper cyanide plating bath. This bath is suitably one containing 48 grams per liter of copper. 25 grams per liter of free cyanide, containing sodium carbonate as desired.

The solution should be free from hypo, in order to produce as large crystals as possible. A suitable plating density is one of 30 amperes per square foot. Preferably the solution is operated at 150° F. or thereabout, and is kept circulating. The amount of copper plated in this bath may be varied, but suitably is approximately .0008 inch in thickness, which may be procured in about 5 minutes under the conditions specified. Even with a hypo-free solution the crystals are very small compared to copper deposited from an acid bath.

The wire is then washed in cold water and rinsed in hot water.

The wire may then be washed in a sodium cyanide bath containing about 3 ounces per gallon of NaCN at 150° F. for a short time, washed with water, treated with 5% hydrochloric acid, washed with water and wiped, and is then passed into an acid copper plating bath.

Such a bath is suitably a blue vitriol solution containing 55 to 60 grams per liter of copper and about 75 grams per liter of sulfuric acid. A suitable plating density is 225 amperes per square foot at a temperature of 110° F. The bath is preferably agitated violently with air during the plating.

With the bath described a plating time of ¾ to 1¼ minutes is preferred. In this time approximately .0005 inch of copper is deposited. When only a pair of cycles is employed the thickness of this coating should be within approximately .000375 and .00075 inch of thickness.

After removal from the bath the wire is passed through a water wash, then treated with 32% hydrochloric acid, after which it is again washed by running through rags, again passed through an alkaline bath at a concentration of approximately 2 ounces per gallon at a temperature of 180° F., again washed with water by running through rags, and then again placed in a copper cyanide plating bath.

This bath is the same as the cyanide bath heretofore described, but the product is maintained in it only about one minute instead of five, during which time about .0001 inch of copper is deposited. The product is then washed with cold water, and then with hot water. The product may then be passed through sodium cyanide so-

lution containing about 3 ounces per gallon at 150° F. It is then washed with water, in 5% hydrochloric acid for several minutes, and is then washed with water by running through watered rags for several minutes.

The product is then passed into the acid bath, as heretofore described, where it is copper plated for 38 minutes, during which time approximately .016 inch of copper is deposited. The product is then washed with water.

The thicknesses of copper given heretofore are upon the entire diameter of the wire and the thickness in each side is therefore one-half as much.

During the entire plating operation described, the diameter of the wire increases by about .0165 or about 260 to 265 grams copper per kilogram of wire. The coating which is produced in the above described manner is very adherent, and will withstand a 180° bend without breaking or cracking. It will also stand drawing without breaking or cracking.

The wire is drawn down to final size in several steps. This may be done on three or four pass continuous wire drawing machines employing Carboloy dies. Either steel drawing dies or copper drawing dies may be employed. A preferred drafting procedure is as follows:

The .119 wire is first reduced to .104, then to .085, then to .072, then to .061, then to .051, then to .045. At the end the finishing speed of the wire is preferably around 375 feet per minute. No unusual precautions are required.

After drawing, the tensile strength of the wire will be found to be between 245,000 and 270,000 pounds per square inch, as compared to a maximum of about 142,000 pounds per square inch heretofore obtainable. The product also has a torsion between 60 and 80 for an 8 inch piece.

After drawing to final size, the wire may be hot-tinned in accordance with the usual practice, being run through molten tin preferably at a temperature of about 500° F.

The finished wire has a resistance of 16.5 to 17.5 ohms per thousand feet and a conductance of 30%. It can be bent around its own diameter without breaking or cracking. The thickness of the copper on each side of the .045" wire is about .003", and is uniform within .0004" from the average in any single cross section.

If the intermediate acid and cyanide steps are omitted, the final acid coating will rip off from the lower coating under stress. Just why the intermediate coatings act as they do to bind the outer and inner coatings is not thoroughly understood.

Copper from a cyanide solution is ordinarily deposited in very fine crystals. When deposited from acid solution the crystals are enormously greater in size. However, by following the present technique, the acid coating first deposited on the initial cyanide coating has a much smaller size than usual, and it is made so thin that the crystals are generally smaller than the usual size. Likewise, when the second coating is applied, the crystals are larger than normal, and the coating is made so thin that the crystals are above normal size. Similarly, in the last acid coating the initial crystals are smaller than usual.

It is believed that in this manner an intermediate zone of considerable thickness is built up in which the crystal sizes in the acid and cyanide layers approximate each other much more than would ordinarily be the case, and that this zone of uniformity acts as a binder which permits the drawing of the wire without shearing of the coatings.

The copper, when first applied, has a matte finish and is porous. When drawn, however, it is bright, hard, and continuous.

Instead of the cycles here shown, additional alternations may be employed, but are unnecessary.

We claim:

1. A copper clad wire comprising a ferrous base, an adherent layer of copper deposited from a cyanide solution upon the base, a thin layer of copper thereon deposited from an acid solution, a thin layer of copper upon the acid deposited copper which has been deposited from a cyanide solution, and a relatively thick layer of acid deposited copper thereon.

2. A copper clad wire comprising a ferrous base, a cyanide deposited layer of copper upon the base, a layer of acid deposited copper approximately .00025 inch in thickness upon the cyanide copper, a layer of cyanide copper approximately .00005 inch in thickness upon an acid copper, and a relatively thick layer of acid copper over the cyanide layer.

3. The method of forming a copper clad wire, which comprises electroplating a ferrous base with cyanide copper, applying a layer of acid copper thereon, applying a layer of cyanide copper over the acid copper, and then applying a layer of acid copper over the cyanide copper.

4. The method of forming a copper clad wire, which comprises electro depositing copper on a ferrous base from a cyanide solution, depositing copper thereon from an acid solution, the thickness of the acid deposited coating being so small that the crystals are predominantly below normal acid deposited crystal sizes, applying a thin layer of cyanide deposited crystal sizes, applying a thin layer of cyanide deposited copper thereover, the coating being thin enough that the crystals are predominantly larger than the normal cyanide deposited crystals, and then electro depositing a relatively thick layer of acid deposited copper over the base.

5. The method as set forth in claim 4, in which the initial acid coating is approximately .00025 inch in thickness, the second cyanide coating is approximately .00005 inch in thickness, and in which the total acid coatings approximately are very much greater in thickness.

6. The method of forming a copper clad wire of high tensile strength which comprises electroplating a steel wire with at least four alternate layers of cyanide and acid deposited coatings of copper to produce a porous coating, the layers being adherent to each other at their interfaces and the first layer being adherent to the steel.

7. The method of forming a copper clad wire which comprises electroplating a steel wire with at least four alternate layers of cyanide and acid-deposited coatings of copper to produce a porous coating of a thickness of at least about .00825 inch, the layers being adherent to each other at their interfaces and the first layer being adherent to the steel, and then, without having substantially heated the copper clad steel wire, drawing the copper clad steel wire markedly to reduce its cross section, whereby a steel wire having a bright, hard, and continuous copper coating is produced.

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