Jan. 6, 1942. R. C. PIERCE 2,268,617

METHOD OF MAKING COPPER CLAD WIRE

Filed Nov. 1, 1938

Fig. 1.

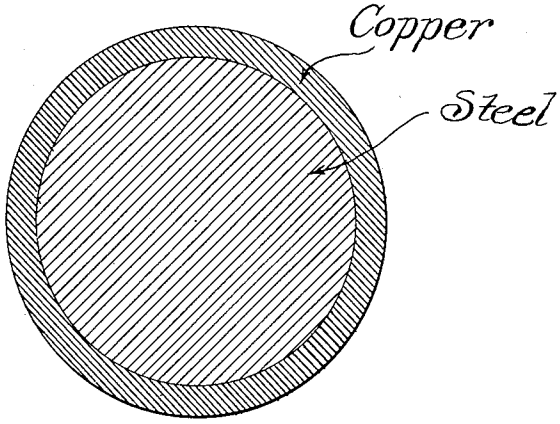
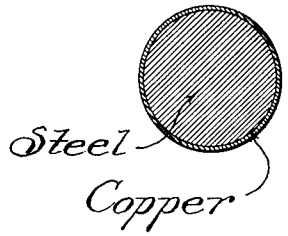


Fig. 2.



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METHOD OF MAKING COPPER CLAD WIRE

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2 Claims. (Cl. 29—188)

This invention relates to a copper clad wire, and more particularly to a uniformly coated copper clad wire in which the copper coating is continuous and of low resistance.

Copper clad wires which are used for transmitting electricity have heretofore been produced, either by casting, followed by drawing, or by electro-deposition upon a drawn wire. Both of these methods have difficulties, and neither one of them produces a wire of great strength. The direct electrical deposition method which has lately grown in favor is only carried out with wires of relatively low tensile strength and produces a coating which is extremely ununiform in cross section.

In accordance with the present invention, a copper clad steel wire is produced which has high tensile strength, low resistance, and is entirely uniform. This is done by electro-deposition upon a steel wire of greater thickness than desired, followed by drawing of the wire with copper upon it to produce a copper clad wire of the desired thickness and having a copper coating thereon which is uniform, continuous conductive and of the desired thickness.

The wire employed may be of any desired size, but from the standpoint of expense it is desirable that the cross section be relatively high. The preferred wire will have a diameter of about ⅛ of an inch, the preferred range being from about .090 inch up to approximately .150 inch. If the diameter is reduced the resistance of high tensile strength wire decreases to such an extent that economical deposition of copper is not practicable.

Surprisingly enough, the presence of the copper upon the wire does not interfere with the effect of the drawing upon the steel. The surface of the steel is compacted in the same manner which would occur if it were drawn without the copper coating.

Copper is applied in any manner by which a continuous adherent coating may be produced. In view of the fact that it is difficult to draw ordinary copper coatings without their splitting or ripping off, it is preferred to follow the method described in the copending application of Orville E. Adler and Maurice J. Krinowitz, filed November 1, 1938, Serial No. 238,278.

The invention is illustrated in the drawing, in which:

Figure 1 represents an end view of a wire before drawing; and Figure 2 an end view of a wire after drawing.

It is preferred to have a thickness of at least one-thousandth of an inch in the finished coating, and preferably in the neighborhood of three-thousandths of an inch. The final thickness of the wire should be below .06 inch.

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
Phosphorus	.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 Oakite 42B solution, at the rate of two ounces to a gallon at an advanced temperature, say 180° F., for about a minute. The Oakite solution is an alkaline solution of a phosphate. 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 solution 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 with .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 coating 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.

While I have discussed only one size of wire, it is obvious that the invention may be applied to various sizes of the wire, and also that the final diameter of the drawn wire may be either large or small.

I claim:

1. The method of forming a copper clad high tensile strength wire having a current-conductive copper coating thereon of great uniformity which comprises electro-coating with a thick layer of adherent copper, a high tensile strength steel wire of predetermined initial thickness greatly in excess of the predetermined final thickness desired, to produce a uniform, porous, electro-conductive, copper layer having a matte surface and having a thickness markedly in excess of the desired conducting layer, and then drawing the so-coated wire in a series of several passes through dies of progressively decreasing cross section to produce a high tensile strength steel core of the predetermined cross section, and altering in such drawing the porous matte copper to a hard, continuous, electro-conductive coating, said coating having strength and adherence characteristics sufficient to withstand acute bending without fracturing.

2. The method as set forth in claim 1, in which the high tensile strength steel core has an initial diameter at least twice its final diameter, in which at least four successive drawing passes are employed and in which the completed copper coating has a thickness of at least about 0.003 inch.

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