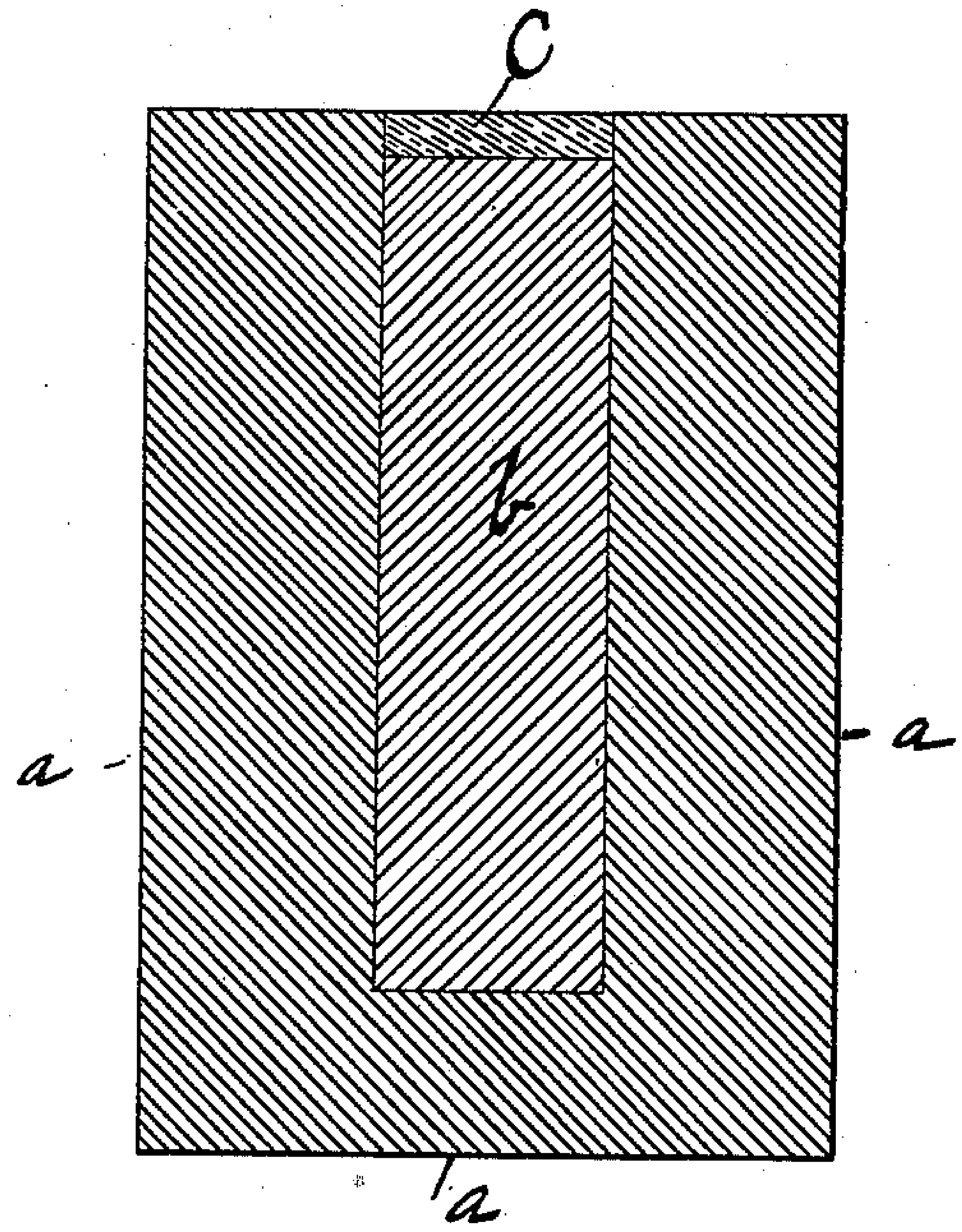
(No Model.)

J. J. WILLIAMSON.

MANUFACTURE OF ELECTRIC CONDUCTORS.

No. 300,179. Patented June 10, 1884.



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MANUFACTURE OF ELECTRIC CONDUCTORS.

SPECIFICATION forming part of Letters Patent No. 300,179, dated June 10, 1884.

Application filed July 23, 1883. (No specimens.)

To all whom it may concern:

Be it known that I, JOHN J. WILLIAMSON, of Boston, in the county of Suffolk and State of Massachusetts, a citizen of the United States, have invented a new and useful Improvement in Electrical Conductors, of which the following is a full, clear, and exact specification, reference being had to the accompanying drawing, forming a part thereof, in which a compound ingot is represented in cross-section, *a* being the exterior casing, *b* the core, and *c* the plug for closing the opening.

Compound electrical wire, of copper and iron or steel, having a steel or iron center and a deposited copper exterior, has been manufactured for some time with more or less success, the manufacture being carried on by plating with copper by electrolysis and previously prepared and drawn copper or steel wire, so that the copper deposit on the exterior of the wire was equal to or greater than the weight of the iron or steel wire itself. The objections to placing the metal of highest conductivity on the exterior and that of the greatest strength on the interior, more particularly when a highly-oxidizable metal is used for strength and a low oxidizable metal for conduction, are great, because if a crack occurs in the least oxidizable and most conductive metal the most oxidizable metal is apt to be attacked and corroded, and a fault arises which speedily ruins the conductor, although the conductive metal is not attacked at all. Again, the strongest metal should, for mechanical reasons, be made of a tubular form, and a highly-conductive metal should be as compactly arranged as possible, so that breaks or faults would be less liable to injure it. Experience has shown, in insulated wires wrapped in tin-foil and in iron wires covered with copper, that the conductive properties of the wire are better when the metal of highest conductivity is on the inside than when the metal of highest conductivity is on the outside, other things being equal. It is therefore desirable to make a strong and durable electric conductor with the metal of highest conductivity on the inside and the metal of highest tensile strength upon the outside. Iron or steel of different qualities is now made so that it can be poured, when fluid, into an ingot of any desirable shape, which can be afterward worked by the roll or the hammer. Such iron or steel as this is malleable, and will be referred to as "malleable metal" hereinafter in this specification, the word "malleable" being used, not in its ordinary sense of a cast-iron partly decarbonized, but in its proper sense of an iron or steel workable by the rolls or hammers of an ordinary manufacturer. I cast of malleable steel or iron a hollow ingot, one end of which is completely closed, as shown in the drawing at *a a a*. This ingot I prefer to make of circular cross-section, and a hollow in it also of circular cross-section, because in rolling or drawing the ingot to billets or wire rods, no matter what shaped grooves in the rolls or shapers it has passed through, the cavity, more especially if filled with the copper core which I have put in, will retain its original section and centrality better than if the ingot and the cavity of the ingot were of any other form of cross-section than circular, or than if the ingot and its cavity were arranged otherwise than around this same axial line. The ingot, being formed, is cleaned upon its outside in the usual way, and the sand core is cleaned from the cavity of the ingot; but the interior of this cavity may be treated in either one of two ways: The sand scale being removed from the interior, if desired, the oxide scale may be left, or, in other words, the interior of the ingot-mold would not be thoroughly scraped and bored out. If the oxide scale is left, the interior should be slightly washed with lamp-black or the like, so that the melted copper poured in may flow more readily. The other method of treating the ingot would be to thoroughly clean the bore or cavity and plate the interior, probably with a bath of molten metal, with tin or zinc or any other metal which would readily combine with the iron or steel on the one side and with the copper which is to be put in on the other. We now have an ingot with a longitudinal cavity. The walls of the ingot are of such thickness that when it is reduced it will contain the proper quantity of strong metal to stand the strain upon it. Into the cavity of this hollow ingot, either hot or cold, copper is introduced. This may be done either by driving or otherwise inserting a copper bolt of proper size to closely fit the cavity, or by pouring in molten copper to the interior. If the molten copper is used, perhaps the best form of preparing the ingot is to leave the oxide or scale upon the iron, while if a copper bolt is inserted in the cavity it is perhaps better to zinc or tin the interior of the ingot; but either way may be adopted with the copper in either condition—molten or solid.

In the drawing, *b* represents the copper interior of the prepared ingot. I prefer to stop the upper end of the ingot-cavity at C either by a metallic plug fitting it closely and driven into it, or by a clay plug, as is usual with puddlers, or by hammering the edges of the ingot on the copper, so that the copper may be completely protected while heating. When the ingot thus prepared is heated, the temperature must of course be one which shall be sufficient for the proper working of the iron or steel. If the end be open or imperfectly closed, a temperature less than that at which copper fuses or at which it becomes brittle, and thus less than a full red heat, while if the iron or steel be closed over the copper or the end be perfectly plugged the highest heat which convenience in working the iron or steel may dictate (not high enough to volatilize the copper) can be employed without regarding the condition of the copper, for that cannot escape even if molten, so that with closed ends a much higher heat may be employed. After the insertion of the copper and heating to a proper temperature, the ingot and its copper core are reduced together in the usual way to billets, bars, or wire rods, and after proper reduction the billets, bars, or wire rods obtained from the ingot are wire-drawn to the desired size.

High conductivity and low induction characterize this wire from all others. It is durable and comparatively cheap. The amount of copper required in it for the same service is comparatively slight for the conducting-surface required; and for tensile strength the steel or iron wire greatly surpasses the regular wire manufactured hitherto.

I am aware that it is old to cast or deposit a metal of comparatively low melting-point on a rod or wire of soft metal of higher melting-point, and then draw the two together into wire, for this is the way that fine platinum wire is made under an envelope of silver.

I am aware that tubes of one metal have occasionally been drawn over bars of another metal, and that the compound bar or rod has then been drawn to wire in a few instances; but thorough annealing has been impossible with this material, so far as I am able to find out; and it is important that any wire to be used for electrical purposes in atmospheric conditions should be annealed before being set up, and more particularly if copper be used, for the annealing of copper puts back its best electrical condition.

If desired, the iron or steel exterior of the wire, when finished or before finishing, may be covered with zinc or tin in the usual form of galvanized wire, and one result of annealing is to prevent the wire from getting cold, short, or losing its temper. The thickness of the envelope of iron or steel will be regulated by the tensile strength required. The thickness of the copper—or, in other words, the size of the cavity in the iron or steel—would be differenced by the requirements of the conductor. Electric-light wire would probably take the largest copper thread of the center and telephone-wire the smallest; but any desired thickness of steel envelope or of copper interior may be made in this way.

Of course the ingot may be rolled or hammered down to wire-rod in the usual way; or the hydraulic drawing-machine may be employed; but this is not the essence of my invention.

I am aware that copper-covered steel or iron wire was described in the Farmer and Milliken Patents, No. 47,940, May 30, 1855, and No. 59,763, of November 20, 1860, and in the patents to Selak Hiler, No. 21,797, October 12, 1858, and No. 248,860, November 1, 1881, and a method of producing it was also described in these patents; and I am also aware that Rosencranz, in his English provisional specification No. 4,193, A. D. 1873, announced, without describing the process of manufacture, such a copper-covered steel wire.

I am also aware that copper-cored steel wire was announced, without any description of the mode of making it, in English provisional specification of Lackenstein, No. 3,666, A. D 1875, and that Farmer and Milliken, in their Patent No. 47,940, after describing the manufacture of a copper-covered wire rolled and drawn from a composite bar, copper-surfaced and iron-cored, prepared by "casting the copper around a wire bar," said: "It will be obvious, however, that the iron can be placed around the copper and the resultant bar drawn out into a wire, leaving the copper in the center; but the first-described construction we consider preferable, as the wire is protected from oxidation and the manufacture of this wire is the more practicable." But I am not aware that before 1865, or since, it was possible to surround a copper bar melting at about 2,000° Fahrenheit with fused malleable or ductile iron or steel at a temperature of over 3,000° Fahrenheit and obtain a result that could be worked into merchantable wire; nor do I believe it has ever been done; nor do I see nor have I heard from any wire-maker of any obvious way of doing this work, but have frequently been told that it had never been done till lately.

I am also aware that the Selak Hiler English Patent No. 1,847, A. D. 1872, describes a process of making copper-centered steel wire by inserting in an aperture made in the center of a cylinder of steel a rod of copper of suitable size, (the insertion to be made while the steel is white hot, or as hot as it will bear without injury,) and then rolling or drawing into wire. He prescribes an acid cleaning process as a necessary preparation, and the use of borax or other suitable flux to cover the surface of the steel adjacent to the copper. The cavity in the steel is described as extending from end to end, and as plugged with clay and only at one end. The copper is to be introduced in granules or in rod form and melted in place. Then the mass is to be cooled to the solidifying temperature of the copper, and then the mass is to be rolled and drawn. The only way described of providing the hollow in the steel cylinder is by drilling a longitudinal hole. If the copper rod be used, it might be inserted cold into the cold hollow cylinder coated with flux, and then heated to the melting-point of copper, or it might be inserted into the heated cylinder. It will be seen from a comparison of these published methods of manufacture that neither one nor all together embody the method described and practiced by me. I do not take a cylinder of steel and bore a hole in it; but I take molten malleable steel or iron and make an ingot which has a hole in it always—in other words, I make my ingot around its hole, and do not made a hole in the ingot. I thus save the work of drilling the hole and the waste of the borings, and make nothing to expensively unmake. I do not, when I put the copper into the hole in the steel, have steel and copper in contact, or even steel and copper separated only by a flux. I have iron oxide painted with carbon in contact with the copper, or I have a metal capable of alloying with both the steel and the copper interposed between the steel and the copper. I do not make the hole in the steel a through hole, but a deep recess naturally closed at one end. I do not leave one end of the copper exposed, but have both ends covered when the highest heat is given.

I do not employ copper and silver, metals of like natures at like temperatures, but steel and copper, metals of opposite natures at like working temperatures. I do not think it is obvious without explanation how to put iron or steel outside of copper and make a workable mass; but I have explained a way of preparing copper-centered ingots of steel or iron which may be heated and worked notwithstanding the opposite natures of their constituents at heats equal to the brittling heats of copper, which temperature would be impracticable to employ with unconfined copper. It will be necessary to pay regard to the matter of temperature for a peculiar reason. Copper volatilizes at a bright yellow heat. Steel at this heat is porous to volatile copper, and if it is volatile the ingot or bar, instead of being copper-cored, will be partly copper-surfaced. The upward limit of working temperature, therefore, must be below the volatilizing-point of the copper core; but it can be carried up to the melting-point of the copper, and in spite of this high temperature the quality of the copper in tenacity, density, homogeneity, and conductivity will be improved in the copper core of the billets, rods, and wire.

The two variant treatments of the interior of the steel part of the ingot before inserting the copper give, for the purposes of the result intended, like results. The wire from given materials in given proportions with either treatment has the same tensile strength and the same conductivity—the two qualities sought—and the insulation and freedom from induction are alike whichever treatment be employed. With good quality of copper in a well-fitting bolt, the removal of scale from the interior of the hollow steel ingot will ordinarily be sufficient, and this removal need not be by pickling or by boring, for the small quantity of mineralized metal left between the copper and steel will injure neither the tensile strength nor conductivity.

I claim as my invention and desire to secure by Letters Patent of the United States—

1. A compound ingot having a core of malleable metal of high electric conductivity and comparatively low fusing temperature, completely inclosed on its sides and ends by a malleable tenacious metal of lower electric conductivity and comparatively high fusing-point, substantially as and for the purposes described.

2. In the preparation of compound ingots of malleable-cast-metal exterior and copper center for the manufacture of electric conductors, the improved method of preparing the interior of the steel envelope for the reception of the copper core, consisting of the removal of sand scale and the application of a carbonaceous wash, or of the equivalent of such manipulations, substantially as described.

JNO. J. WILLIAMSON.

Witnesses:

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