

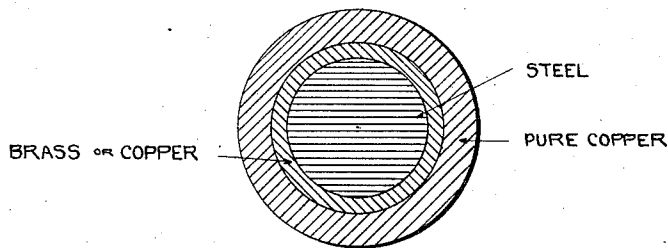
B. E. ELDRED.

PROCESS OF PRODUCING CLAD METALS.

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Inventor

BYRON E ELDRED

Witnesses

Robert M. Sutphen

R. F. Steward

By

K. P. McElroy

Attorney

UNITED STATES PATENT OFFICE.

BYRON E. ELDRED, OF BRONXVILLE, NEW YORK.

PROCESS OF PRODUCING CLAD METALS.

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To all whom it may concern:

Be it known that I, BYRON E. ELDRED, a citizen of the United States, residing at Bronxville, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Processes of Producing Clad Metals, of which the following is a specification.

This invention relates to processes of producing clad metals; and it comprises a method of making compound metal billets having a core of iron, steel or iron-like metal firmly and permanently united to a sheath of copper or copper-like metal by the intermediacy of a linking layer of metal wherein a core of iron or like metal coated with the linking metal is inserted in a comparatively cold condition in a tubular shell of the sheath metal, such shell being employed hot and being of such dimensions that the cooler core will just fit therein, and the assembled core and sheath are heated together whereby the expansion of the core produces a union; all as more fully hereinafter set forth and as claimed.

For many purposes for which clad metals are used, it is desirable to have a core of strong and stiff metal firmly and permanently united to a surrounding layer of a comparatively pure metal like copper, aluminum, gold, platinum, silver and the like; high purity in this coating metal being frequently a great desideratum, as in copper-clad metal for electrical conductors, gold-clad and platinum-clad metal for tooth pins, for leading-in wires for incandescent lamps, etc. It is, however, frequently difficult and expensive to maintain this high degree of purity in the ordinary routine of metallurgical work where the coating metal is used in a fluid condition in the coating operation since metal from the core is apt to diffuse through the coating more or less. In producing a copper sheath on a steel billet, for instance, with the use of melted copper in direct contact with the steel it is difficult to prevent the presence of a few tenths per cent. of iron in the coating, and even this slight amount of impurity will diminish the electric conductivity of copper to a comparatively great extent.

In the present invention, I have therefore devised a method whereby a sheath or shell of copper or any like metal of any desired degree of purity may be directly attached to

the core without being melted to any substantial degree during the process and therefore not being rendered impure by the core metal. To this end, I first produce a core of iron, steel or any of the ordinary "alloy steels" such as nickel steel, manganese steel, etc., or of the iron-like metals, nickel or cobalt, or their alloys, and this core I film with a less oxidizable high-melting, non-ferrous metal such as copper or brass, preferably melting at a lower temperature than the metal next to be applied. The filming may be done in any way. A galvanic coating film of brass, for example, may be applied to a steel billet intended for making copper-clad ware. The coated billet is next carefully washed and dried to free it of acid, if any has been employed, care being taken to avoid oxidation. It is next preferably coated with a thin coating of a fusible mineral substance such as borax or zinc chlorid. This coating may be applied in solution and the solution dried in place. Borax solution is well adapted for the present purposes since in heating the dried borax film gives off steam and when ultimately fused it has oxid dissolving properties. The evolved steam is an efficient means of displacing air in a later operation. The flux-coated billet is next introduced into a shell or sheath of the desired coating metal, say copper, platinum, gold or silver. This shell or sheath should be quite hot, and may advantageously be nearly red hot, and of such dimensions that the cold billet can just be introduced therein with the shell hot and expanded. The assembled core and sheath are next heated. The cold core metal expands and produces a high degree of pressure between itself and the shell. To produce uniformity in this pressure the core and sheath are preferably cylindrical in section but can be of any desired corresponding shapes. Presuming borax to be the flux used, the heat first expels the water of crystallization as steam which effectually dispels all air which may be between the metals to be joined and then liquefies the borax itself. This liquefied borax under the high pressure is expelled longitudinally, the comparatively soft coating metal or linking metal filling all spaces which may be between core and sheath. In using a brass-filmed steel billet within a copper shell, the heating may be carried to a point where the brass becomes liquid; brass melting at a temperature con-

siderably below the melting point of copper. If the assembled core and sheath be heated while lying in a horizontal position, as is usually convenient, and if the sheath be somewhat belled at the ends, as often happens in forcing a tight-fitting core into place, a pellet of brass may be laid against the seam at either end, and it will enter capillaryly, displacing the fluid flux since melted metals have a tendency to wet each other. After the heating, which may ultimately be carried to the softening point of the coating metal, if this be gold, silver or copper, the metals will be found to be firmly and permanently united, so that they may be drawn, rolled and stamped like an object of one metal. This working may be done while the joined metals are still hot, or they may be reheated, being exposed to a soaking heat. A tolerably long continued heat prior to working is generally advantageous since the core metal having been employed cold requires time for uniform heating to a good working temperature. Copper does not readily unite with iron at its ordinary melting temperature, not readily "wetting" iron, though at higher temperatures its ability to unite with iron increases. But in producing a union, temperature and pressure are, to some extent, reciprocal factors, and in the present operation pressure is employed. Brass unites with iron more readily, particularly some grades of brass containing considerable zinc, since zinc is a metal readily uniting with iron. Where a brass-coated steel billet is expanded within a copper sheath, the pressure much enhances the disposition of the brass to unite with the iron and since brass readily unites with copper, being like in nature thereto since it is a cupriferous alloy, a good union of sheath and core is obtained. Under the pressure, moreover, the brass and the copper flow somewhat so as to fill all spaces or unevennesses between core and sheath.

In working the compound billet so obtained at ordinary steel working temperatures, as by rolling or drawing into bars, rods or wires, the quality of the coating metal is much improved for most purposes. Being comparatively soft and being compressed between the relatively stiff core metal and the working tool, while held against the lateral yielding by the basal weld union, it assumes throughout a peculiar texture comparable to the surface texture of hard drawn wire, becoming planished and hard, and all porosities or defects are obviated.

Where commercial cobalt or nickel is employed as the core metal, it is frequently advantageous to heat it to a high temperature (preferably *in vacuo*) to expel contained gases prior to submitting it to the described

operations. Such a preliminary treatment is sometimes advantageous with steel and other ferrous metals.

In producing copper-clad metal for electrical purposes, the copper layer may have any desired degree of purity and it will maintain this purity throughout since the temperatures are not carried high enough to allow iron or other metal from the core or linking layer to diffuse therethrough. The copper sheath or shell used may be produced in any desired manner as by casting or in any of the other ways used to make copper tubing or copper shells.

The linking metal may be copper, bronze, aluminum, gold, silver or any other metal not melting above the melting point of the sheath metal. While it may be applied to the core in any other manner, electrodeposition is suitable. Electrocoatings are usually crystalline and porous and have no more than a mere adhesion to the base metal, so that they are useless for metal which must be subsequently worked, neither are they suitable for coating metals which must be exposed to atmospheric influences, as in telegraph and telephone wire, since moisture entering through porosities will inevitably corrode the underlying base metal in time, a galvanic couple being set up between core and coating metal. But in the described method, under the pressure exerted between core and sheath the porosity of the electrodeposited metal is obviated and a good coherence to the metal on either side is secured. Electrodeposited coatings may therefore be used for the linking layer.

The relative thickness of the core and the sheath may be as desired, but for copper clad electrical goods, the copper is preferably at 10 per cent. of the total weight and may be much more, conductor wires frequently needing but a thin core of steel to give them all required strength. Core and sheath may be, and preferably are, relatively short and thick; that is of relatively large diameter as compared with their length. This at once diminishes the area of contacting metals to be united and increases the resistance of the shell against the expansion of the contained core, thereby also increasing the pressure therebetween. The coated billet once produced can of course be afterward reduced to any dimensions desired. The further the coextension of the joined metals is carried ordinarily the better their character will be.

While under the influence of the heat and pressure, the linking layer merges to some extent with the metal on either side, producing what may be termed a weld union, yet its amount is ordinarily and preferably, too little to allow this merging to have any marked influence on the character of the metal on either side.

The coating metal must be a high-melting, ductile metal of a melting point above 900° F. to allow it to be worked at steel-working temperatures. The metal of the linking layer should be high melting and ductile, and of such character as to allow working of the compound billet at ordinary steel working temperatures. It may of course be applied either to the core or to the interior of the shell to be united thereto, as by electroplating the interior of such shell.

In the accompanying illustration I have shown, a section of a wire or rod produced under this invention. The central core, which may be steel, cobalt, nickel, nickel steel, etc., is marked "Steel" while the outer sheath, which may be pure copper, platinum, silver, gold or the like, is marked "Pure copper." The intervening layer of linking metal, which is shown for clearness of illustration as of exaggerated thickness, and which may be brass, copper or the like, is marked "Brass or copper."

What I claim is:—

1. The process of producing clad metals which comprises coating a relatively stiff metal core with a softer metal, placing said core in a relatively cool condition within a heated and expanded shell of a high-melting, ductile non-ferrous metal, and heating to cause said core to expand against said shell and produce a union.

2. The process of producing clad metals which comprises coating a relatively stiff metal core with a softer metal, placing said core in a relatively cool condition within a heated and expanded copper shell, and heating to cause said core to expand against said shell and produce a union.

3. The process of producing clad metals which comprises coating a ferrous metal core with a softer metal, placing said core in a relatively cool condition within a heated and expanded shell of a high-melting, ductile non-ferrous metal and heating to cause said core to expand against said shell and produce a union.

4. The process of producing clad metals which comprises coating a ferrous metal core with brass, placing said core in a relatively cool condition within a heated and expanded copper shell and heating to cause said core to expand against said shell and produce a union.

5. The process of producing clad metals which comprises coating a relatively stiff metal core with a softer metal and a layer of a steam furnishing fusible flux, placing said core in a relatively cool condition within a heated and expanded shell of a ductile, high-melting, non-ferrous metal and heating to cause said core to expand against said shell and produce a union.

6. The process of producing clad metals which comprises coating a relatively stiff

metal core with a softer metal and a layer of a steam furnishing fusible flux, placing said core in a relatively cool condition within a heated and expanded copper shell, and heating to cause said core to expand against said shell and produce a union.

7. The process of producing clad metals which comprises coating a ferrous metal core with a softer metal and a layer of a steam furnishing fusible flux, placing said core in a relatively cool condition within a heated and expanded shell of a ductile, high-melting, non-ferrous metal and heating to cause said core to expand against said shell and produce a union.

8. The process of producing clad metals which comprises coating a ferrous metal core with brass and a layer of a steam furnishing fusible flux, placing said core in a relatively cool condition within a heated and expanded copper shell, and heating to cause said core to expand against said shell and produce a union.

9. The process of producing clad metals which comprises coating a relatively stiff metal core with a softer metal, placing said core in a relatively cool condition within a heated and expanded shell of a high-melting, ductile non-ferrous metal, heating to cause said core to expand against said shell and produce a union and coextending the metals to perfect the coating.

10. The process of producing clad metals which comprises coating a relatively stiff metal core with a softer metal, placing said core in a relatively cool condition within a heated and expanded copper shell, heating to cause said core to expand against said shell and produce a union, and coextending the metals to perfect the coating.

11. The process of producing clad metals which comprises coating a ferrous metal core with a softer metal, placing said core in a relatively cool condition within a heated and expanded copper shell, heating to cause said core to expand against said shell and produce a union and coextending the metals to perfect the coating.

12. The process of producing clad metals which comprises coating a ferrous metal core with brass, placing said core in a relatively cool condition within a heated and expanded copper shell, heating to cause said core to expand against said shell and produce a union, and coextending the metals to perfect the coating.

13. The process of producing copper clad steel which comprises coating a steel core with a thin layer of brass, placing the coated core in a relatively cool condition within a hot closely fitting copper shell and heating the assembled metals to a temperature above the melting point of the brass but below the melting point of copper.

14. The process of producing clad metals

which comprises providing a core of a metal
of the iron group with a thin coating layer
of a metal melting above ordinary steel
working temperatures, placing said coated
5 core in a comparatively cool condition with-
in a closely fitting hot shell of a metal hav-
ing a melting point above the melting point
of the coating metal and heating the assem-
bled metals above the melting point of the

coating metal but below the melting point 10
of the metal of the shell.

In testimony whereof, I affix my signa-
ture in the presence of witnesses.

BYRON E. ELDRED.

Witnesses:

K. P. McELROY,
LEWIS T. KNOX.