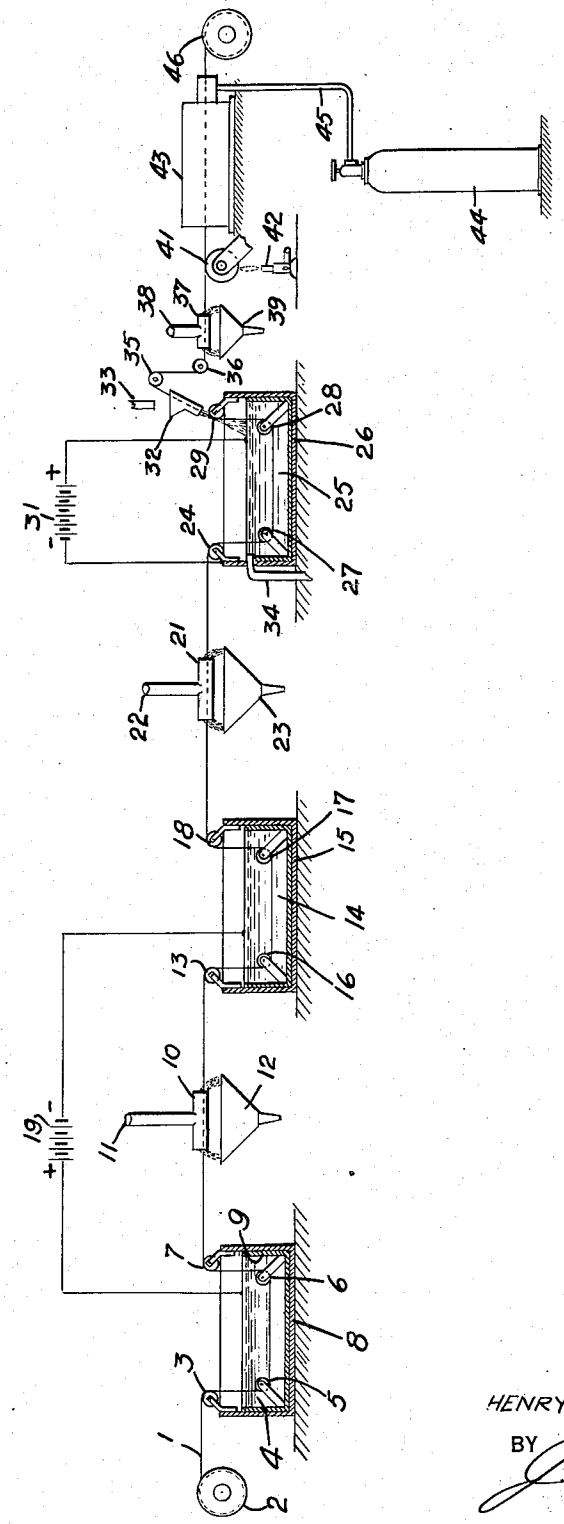
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CHROMIUM COATED WIRE AND METHOD OF MANUFACTURE

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CHROMIUM-COATED WIRE AND METHOD OF MANUFACTURE

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This invention relates to chromium-coated wire and more particularly to wire electroplated with chromium so that it is firmly adherent thereto and a method for accomplishing this result.

An object of my invention is the manufacture of chromium-coated wire, especially for use as leading-in wires, in which the chromium is firmly adherent to the core metal.

Another object of my invention is the manufacture of nickel-iron wire and the like, electroplated with chromium in such a manner that there are no pockets between the plating and the core and the chromium adheres thereto firmly, without peeling off.

A further object of my invention is the production of nickle-iron or nickel-steel-core wire coated with chromium, by first treating the core wire, so that; the chromium may be plated thereon, with the elimination of pockets between the core and the chromium; the plating will not be subject to peeling off and; the wire, if used as a leading-in conductor, will be free from leakage between the coating and the core.

A still further object of my invention is the provision of a method of efficiently plating chromium on a core of nickel-iron or the like and ductilizing the coating so that it will not crack or peel off.

Other objects and advantages of the invention will become apparent as the description proceeds.

As a leading-in conductor for evacuated vessels, for example, incandescent electric lamps, it is necessary to use a material which has a coefficient of expansion substantially equal to that of the glass into which it is sealed. Platinum was formerly used for such purpose but has been dispensed with to a large extent on account of its cost. The material now commonly used for leading-in conductors comprises a bi-metallic wire called "dumet" and usually consists of a core of nickel-steel coated with copper.

In the copending application of Emilio Romanelli, Serial No. 435,027, filed January 4, 1921, Process for the preparation of a compound metal and assigned to the Westinghouse Lamp Company, is disclosed a method of making "dumet" wire by electroplating a coating of copper on a core of nickel-steel and heating the plated material to incipient fusing of the copper plating thereon and a firm welding thereto.

"Dumet" or copper-coated nickel-steel is extensively used for leading-in conductors, but has certain disadvantages, among which are the difficulties encountered when such wire is sealed into hard glass where a fairly high temperature is required for the sealing-in operation. This results in the formation of a coating of oxide on the surface of the wire which is detrimental to the formation of a good seal, and any oxide on that part of leading-in conductors inside of the evacuated vessel is subject to reduction by hydrogen present therein, with the formation of water vapor which is very detrimental to the operation of a lamp.

In the patent to D. S. Gustin, No. 1,576,436 March 9, 1926, Seals and method for making the same and assigned to the Westinghouse Lamp Company, is disclosed a leading-in conductor comprising a nickel-iron core coated with chromium. Such product is very desirable as a leading-in conductor because it is less readily oxidized on heating and any oxide formed thereon will not affect the proper sealing of the same through the glass, as glass readily wets chromium, even though coated with a film of oxide. Another advantage lies in the fact that chromium oxide is not reducible by hydrogen, so that the difficulty mentioned in connection with copper-coated "dumet" wire is obviated.

According to my invention, I produce a chromium-coated, nickel-iron or nickel-steel wire in such a manner that the chromium coating is firmly adherent to the core and ductilized to such a degree that it will not crack or break off upon bending the composite wire and will not contain any pockets or gas between the coating and the core.

Briefly, my method of making chromium-coated wire comprises passing wire through a caustic solution as a cathode, washing the wire in plain water, passing it through an acid solution as an anode until it is rendered passive, that is, until the acid used, which is pref-

erably thirty percent sulphuric acid, has no more effect thereon.

The passage of the material through the aforementioned liquids serves to clean the surface thereof so that chromium or the like may be deposited thereon electrolytically as a firmly adherent film or coating. After emerging from the acid cleaning bath, the wire is preferably washed with water and passed into a chromic acid plating-solution, where it is plated with chromium, as a cathode therein.

The plating solution also preferably contains a small proportion of chromic sulphate, and the wire emerging therefrom, after plating, will be found to be coated with a water-insoluble film of chromic chromous sulphate. To wash off this film, a solution corresponding to the plating solution is preferably employed, after which the wire may be washed in plain water.

The clean wire is then preferably heated to eliminate moisture therefrom and passed into an electric furnace where it is heated to about a bright red heat in an atmosphere of forming gas or hydrogen, where the chromium coating or plating thereon becomes annealed so that the wire may be bent, drawn or otherwise worked without having the chromium coating peel or chip off, because of being so brittle, as unannealed chromium necessarily is.

Such chromium-coated wire will be adequately adapted for use as a leading-in conductor and will obviate the burning of the usual "dumet" wire when sealed into glass in which a high temperature is applied directly to the leading-in wire, for example, in making miniature lamps.

In addition to the foregoing advantages, chromium has such a low coefficient of expansion, that a relatively heavy coating may be used without resulting in too high a coefficient of expansion for the composite metal, as would be apt to occur if copper were used, as in making ordinary dumet wire.

My invention will better be understood by referring to the accompanying drawing, the single figure of which illustrates apparatus for practicing my invention.

Referring to the drawing, the filament or wire 1 to be plated, and which may be composed of a nickel-steel alloy or "invar" steel, is drawn from a spool 2 over pulley 3 into alkaline or caustic solution 4 over pulleys 5 and 6 out of caustic solution, preferably consisting of an alkali metal hydroxide and an alkali metal carbonate, and over pulley 7. The caustic solution may comprise 5% of commercial sodium hydroxide, potassium hydroxide or lye and about the same proportion of sodium carbonate, the exact proportion being immaterial.

The container 8 for the caustic solution may be formed of conducting material, in contact by the solution, such as iron, or may be lined with iron as indicated at 9, and the wire in the solution may be made a cathode as by being connected, through pulley 3, for example, to the negative side of a battery or other source of current.

The tank 8, if conducting, or the lining 9 thereof, may be connected to the positive side of a battery to serve as the anode, or a suitable separate anode may be provided. Only a relatively small current is necessary to be applied thereto, for example, about 4 amp. per square in., as the idea is merely to remove grease and other impurities from the surface of the wire.

The wire, after passing from the pulley 7, may be washed by passing through tube 10 through which water flows, as from supply pipe 11 into drain 12, and from there the wire may pass over pulley 13 into acid solution 14, which may be held in a lead-lined tank 15 similar to tank 8, over pulleys 16 and 17, out of solution 14 and over pulley 18.

The acid solution 14 is preferably about thirty per cent commercial sulphuric acid and the wire, while in such solution, is made an anode in any desired manner, for example, by connecting the positive terminal of a battery to pulley 18 and the negative terminal to the tank or lining thereof. However, the simplest and most convenient arrangement for connecting to the current source is illustrated in the drawing. This consists in connecting the lining 9 of tank 8 to the positive side of battery 19 or other source of current, and the negative side of 19 to the lining of tank 15. The circuit will then be completed by the wire and it is obvious that this arrangement makes the wire 1 a cathode with respect to alkaline solution 4 and an anode with respect to acid solution 14.

The length of wire in the acid solution and the strength of the current flow is so adjusted that the filament is rendered passive, that is, it is not further attacked by the solution as it emerges therefrom. The filament 1, after passing off of pulley 18, may then be washed again, as by passing through tube 21, through which water flows from supply pipe 22 into drain 23. After being washed in tube 21, the filament may pass over pulley 24 into plating solution 25, which may be contained in a lead-lined tank 26 similar to tank 15, over pulleys 27 and 28 therein, out of plating solution and over pulley 29.

The plating solution for chromium plating is preferably composed of from twenty to twenty-five percent of chromium trioxide (CrO_3) forming chromic acid and one-half of one percent of chromic sulphate ($Cr_2(SO_4)_3$) in water. The temperature of the plating bath is preferably from about twenty-five to thirty-five degrees C. and the current density is about seventy-five amperes per square decimeter of plating surface.

The length of the wire in the bath and the speed at which it passes therethrough, are so adjusted that the desired thickness of plating is attained therein. The wire may be made a cathode, while in the plating bath, by being connected to the negative side of battery 31 or other source of current, through pulley 24; the positive side of the battery being either connected to the containing tank 26, if conducting, the conductive lining thereof or a suitable separate anode. The wire, emerging from the plating bath, will be found to be coated with a film of chromic chromous sulphate ($Cr_2(SO_4)_3CrSO_4$) which is not soluble in water and is, therefore, preferably washed off upon emerging from the plating bath by a stream of plating solution in the tube or funnel 32.

The plating solution may flow from supply pipe 33, through the funnel 32 into tank 26 and over-flow therefrom through pipe 34. After washing off the sulphate film, the wire may pass over pulleys 35 and 36 and then through tube of running water 37, fed from supply pipe 38, and flowing into drain 39.

The washed wire is then preferably dried by passing over or around metal wheel or pulley 41, kept heated to a suitable drying temperature, by any suitable means; for example, the gas fire 42. After passing from drying wheel 41, the wire preferably passes into an electric furnace 43 where is is heated, in an atmosphere of forming gas, hydrogen or other gas inert with respect to chromium, to about 1000° to 1200° C. that is, to about a bright red heat.

The forming gas may flow into the electric furnace from tank 44 through pipe 45, as shown, and escape from the furnace at the other end thereof. In the furnace, the wire is heated to anneal the chromium coating and cause it to partially alloy with, or become welded to, the surface of the core material, for example, the nickel-steel wire.

After passing out of the electric furnace 43, the wire may be wound upon the spool or reel 46, when it is ready for use, either in the original size, or the same may be drawn to a smaller size or sizes, as desired.

Chromium-plated wire, formed according to my invention, will be found to be free from surface cracks and liability of the chromium-plating pelling off, and may be used for leading-in conductors or any desired purpose.

Although I have described, in detail, a preferred method of practicing my invention, it is to be understood that the same is merely illustrative and that modifications in the apparatus used, the method of plating, the material used and the metal plated thereon or used for the core material, may be varied within the spirit and scope of the appended claims without departing from the scope of my invention.

What is claimed is:

1. The method of coating a metal with chromium comprising cleaning the same as a cathode in a caustic solution, then as an anode in an acid solution and then electroplating with chromium.

2. The method of coating a metal with chromium comprising immersing the same in an alkaline solution as a cathode, then in an acid solution as an anode until the metal is passive and electroplating with chromium.

3. The method of coating a metallic filament with chromium comprising drawing the same through an alkaline solution as a cathode therein, then through an acid solution as an anode and finally electroplating with chromium.

4. The method of coating a metallic filament with chromium comprising passing the same through an alkaline solution as a cathode therein, washing with water, passing through an acid solution as an anode, washing with water and passing it through a chromic acid solution as a cathode to cause it to be electroplated with chromium.

5. The method of coating a wire with metallic chromium comprising passing it through a solution comprising an alkali-metal hydroxide and an alkali-metal carbonate, while the wire is made a cathode with respect thereto, washing the wire in water, passing it through a solution of sulphuric acid as an anode therein to render the wire passive, washing the wire, passing it into a solution of chromic acid and a small proportion of chromic sulphate as a cathode to electroplate the wire with chromium, washing the wire after it emerges from the plating bath with a solution corresponding to the plating solution, washing with water and drying.

6. The method of coating a wire with metallic chromium comprising passing it through a solution comprising sodium hydroxide and sodium carbonate or the like while the wire is made a cathode with respect thereto, washing the wire in water, passing it through a solution of sulphuric acid as an anode therein to render the wire passive, washing the wire, passing it into a solution of chromic acid with a small proportion of chromic sulphate as a cathode to electroplate the wire with chromium, washing the wire after it emerges from the plating bath with a solution corresponding to the plating solution to remove chromium salts, washing with water, drying and passing the wire through a furnace to anneal the chromium plating and render it ductile and not subject to cracking or peeling off.

7. The method of coating a metal wire with chromium comprising passing it into a solution comprising about five percent of sodium hydroxide or its equivalent and about the

same proportion of sodium carbonate or its equivalent, while the wire is a cathode therein, washing the same with water, passing it through a solution containing about thirty percent of sulphuric acid while making the wire an anode therein until the same is rendered passive, washing with water, passing it into a plating solution comprising about twenty to twenty-five percent of chromium trioxide and about one-half of one percent of chromic sulphate while the wire is a cathode therein to cause the desired amount of chromium to be plated thereon, washing the wire after it emerges from the plating bath with a solution corresponding to the plating solution, washing with water, drying and heating the wire to a temperature of about 1100° C. in an inert environment to anneal the wire and ductilize the coating thereon, so that it is not subject to cracking or peeling off.

8. The method of manufacturing chromium-coated wire comprising cleaning the surface of a metal wire and rendering it passive, electroplating with chromium and ductilizing the plating by passing the plated wire through a furnace and heating it to its annealing temperature.

9. The method of manufacturing a nickel-steel wire with a coating of ductile chromium thereon, comprising passing the wire through an alkaline solution as a cathode therein, washing with water, then passing it through an acid solution as an anode to render it passive, washing with water, passing it into a chromic acid solution as a cathode to cause it to be electroplated with chromium, washing with a chromic acid solution as it emerges from the plating bath, washing with water, drying and annealing to cause the plating to partly alloy with the nickel-steel and become ductilized, so that the plated wire may be bent or worked without the plating cracking or peeling off.

In testimony whereof, I have hereunto subscribed my name this 2nd day of May, 1923.

HENRY KNEELAND RICHARDSON.