Patented May 23, 1933

1,911,023

UNITED STATES PATENT OFFICE

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METHOD FOR PREVENTING EMBRITTLEMENT OF COPPER

No Drawing. Application filed May 1, 1930. Serial No. 449,020.

The present invention relates to a method for treating copper to prevent embrittlement thereof when heated in a reducing atmosphere. Heretofore, when soldering or welding ordinary copper wire, it has been customary to employ illuminating gas to heat the copper to the desired soldering or welding temperature. This temperature is usually well below 850° C. A considerable amount of reducing gas, for example carbon monoxide, is usually present in illuminating gas. Since oxygen in the form of copper oxide is usually present between the grains of untreated copper wire, the carbon monoxide gas reduces the oxide leaving a spongy copper between the copper grains which thereby causes embrittlement of the wire. Substantially the same action occurs in the presence of hydrogen gas which combines with the oxygen in the copper forming steam which blows the copper grains apart and renders the resultant product brittle.

It is an object of the present invention to provide an improved method for treating copper to prevent embrittlement thereof when the copper is heated in a reducing atmosphere. It is a further object of the invention to provide means for restoring the physical and electrical properties of brittle copper to a normal condition.

In carrying out my invention, copper to be treated is heated to a temperature between 600 and 800° C. in a hydrogen atmosphere for a period of time necessary to remove substantially all the oxygen in the copper. The length of time that the copper should be heated depends upon the temperature employed and also on the dimensions of the metal article being treated. If the treatment is applied to copper wire the proper length of the heating period may be determined easily by bending the wire. When the oxygen is substantially entirely removed therefrom, the wire is very brittle and will break easily when bent even slightly.

After the oxygen has been substantially entirely removed from the copper, it is heated in a hydrogen or other non-oxidizing environment to a temperature between 850° and 1000° C. At 850° C. the copper tends to recover a portion of its original ductility and this tendency increases as the temperature of the copper is raised to 1000° C. However, merely heating the copper does not restore its original, physical and electrical properties. In order to procure such a result, the copper is heated in the 850°–1000° C. zone for an appreciable time, for example two or three hours. The copper wire is then cooled to room temperature and cold worked by drawing through a suitable die. The annealing and subsequent cold working is repeated several times, the wire being heated each time to a temperature between 850° and 1000° C. then cooled and cold worked by drawing through a die. When the annealing and cold working operations have been repeated several times, it will be found that the normal physical and electrical characteristics of the copper are restored. Thereafter heating the copper wire in a reducing atmosphere to any temperature below the melting point of the copper will not cause embrittlement thereof.

As an example, I have found that an ordinary untreated copper wire of about 102 mils diameter has a conductivity of about 100.7. When annealed for about three hours at a temperature of about 900 and 950° C. the wire has a diameter of about 104.75 mils and a conductivity of about 93. When cooled to room temperature and then drawn through a die and reduced about 10% in diameter the wire has a conductivity of about 95.6. When annealed again for two hours at 900° C. the conductivity is increased to about 96.2 and when drawn through a die the conductivity is further increased to about 97.1. When the wire is reannealed and cold worked several times so that its diameter is reduced about 60% or to about 40 mils diameter the conductivity of the wire is about 101.3.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of treating copper which comprises annealing the metal at a temperature above 850° C. in a non-oxidizing environment and subsequently cold working it.

2. The method of treating copper which comprises annealing it above 850° C. in a

reducing atmosphere, cooling to room temperature, cold working the metal and again annealing the metal and subsequently cold working it.

3. The method of treating copper which comprises heating the metal in a reducing atmosphere at an elevated temperature lower than 850° C. to thereby substantially remove all the oxygen therefrom, annealing the metal in a non-oxidizing environment and at a temperature between 850° C. and 1000° C., cooling substantially to room temperature, cold working the metal, re-annealing the metal in a non-oxidizing environment at a temperature between 850° C. and 1000° C. and again cold working the metal.

In witness whereof, I have hereunto set my hand this 30th day of April, 1930.

FLOYD C. KELLEY.