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PROCESS OF REFINING COPPER

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9 Claims. (Cl. 75—62)

This invention relates to a process of refining copper, and more particularly to a method of partially or completely densifying and/or deoxidizing copper.

The beneficial effect upon the working properties of copper, such as those properties necessary in wire-drawing, obtained by using copper denser than tough-pitch copper which usually contains oxygen to the extent of approximately .03% to approximately .06% by weight together with varying proportions of gases, has not heretofore been fully appreciated. Also it has heretofore been believed that tough-pitch copper having the above stated oxygen content was particularly suitable for the conduction of electricity and that copper having about .05% oxygen therein had the maximum conductivity, the conductivity decreasing rapidly as the percentage of oxygen in the copper was increased above .05% and decreasing somewhat gradually as the percentage of oxygen decreased from .05%. However, it has been determined by extensive experimentation that with copper of higher purity this theory is probably erroneous, and that copper increases in electrical conductivity as the percentage of oxygen in the copper decreases below .05% if the purity of the copper is correspondingly high. In copper containing relatively large amounts of impurities such as arsenic, antimony, iron, nickel, silicon, etc., the oxygen counteracts the effect of the impurities on the conductivity and therefore if the oxygen content is reduced below a value determined by the amount of the impurities the conductivity of the copper will decrease. The electrical conductivity of copper of high purity as far as has been accurately determined, consistently increases as the percentage of oxygen is reduced below .05%, so that copper having an oxygen content of .01% by weight has a conductivity of about 1% higher than copper of the same purity having .05% by weight of oxygen content. The percentages of conductivity as mentioned hereinbefore are measured by the International Electro-Technical Commission's standard commonly known as the International Standard.

It is an object of the present invention to provide a method of producing high density copper and/or producing copper which has been deoxidized in any desired amount.

In accordance with one embodiment. the invention which is a continuation in part of my copending application Serial No. 492,877, filed November 1, 1930, contemplates a method of producing markedly dense and/or deoxidized copper by subjecting molten copper in which there is present a reducing agent such as hydrogen or carbon monoxide gas or solid carbon to a vacuum to remove the absorbed, adsorbed, and dissolved gases, and/or combined oxygen therefrom.

A better understanding of the invention may be had by referring to the following detailed description of one embodiment thereof. It is proposed to melt tough pitch copper in an electric furnace, preferably of the induction type, wherein the metal is in motion during the melting process and while the copper is maintained in a molten state to apply a vacuum thereto.

Tough pitch copper produced by the usual commercial method of poling the molten oxidized copper with green poles contains a certain amount of hydrogen (H_2) and carbon monoxide (CO) gases and other reducing gases which are taken up during the poling process. The application of a vacuum of 1 to 4 millimeters promotes reactions between the absorbed, adsorbed, dissolved and/or combined oxygen in the copper with the hydrogen and carbon monoxide and produces steam (H_2O) and carbon dioxide (CO_2) which are then withdrawn from the liquid copper by the vacuum, resulting in a materially increased density in the copper due to the elimination of the absorbed, adsorbed, dissolved, and/or combined gases which are drawn off through the vacuum system and expelled into the air. After the vacuum has been applied for a predetermined time the copper may be cast in the usual manner. It has been determined, for example, that 300 grams of tough pitch copper maintained at a temperature of 1150° C. and subjected to a vacuum of 2 millimeters of mercury will be completely deoxidized and practically freed from gases in approximately three minutes.

Copper refined in accordance with the above outlined method has been found to contain so little oxygen that the copper will not become embrittled if heated in a hydrogen atmosphere of 900° C. for 30 minutes.

For most commercial purposes, however, completely deoxidized copper is not required, hence it may be sufficient in the production of commercial grades of copper to employ a lower temperature, a lower degree of vacuum, or a shorter time, or to vary the method in other ways in order to produce a copper having the desired characteristics at a lower cost as compared with completely deoxidized copper.

It appears that copper oxides present in the copper are decomposed under the above described conditions causing the oxygen to be eliminated.

The elimination of this oxygen improves the conductivity of the copper and simultaneously improves the workability of the copper. Other gases which are absorbed, adsorbed, or dissolved in the molten copper are also removed from the copper, and their elimination increases the density of the copper, thereby further improving its conductivity and workability. By carrying the process to the point where the oxygen content by weight is approximately .01%, a product is obtained without undue cost having a conductivity approaching the theoretical ideal of pure deoxidized copper conductivity and having high density. The low oxygen content and/or increased density result in workability equal to or in excess of the best grades of copper heretofore commercially produced.

In some instances it may be desired to deoxidize native or cathode copper. In that event a reducing gas such as hydrogen or carbon monoxide may be introduced below the surface of the molten copper, or the reducing gas may be absorbed through the surface of the molten copper, the absorption being enhanced by the agitation of the copper in the induction furnace. Other reducing agents which form gas on combining with oxygen such as carbon may also be used. The vacuum then removes the oxygen in the same manner as described in connection with tough pitch copper.

Although the present invention has been described as relating to a specific type of furnace, and a specific degree of vacuum applied to the copper during the melting thereof, it is to be understood that the scope of the invention is limited only by the scope of the appended claims.

What is claimed is:

1. A method of refining copper which consists of inductively heating and melting the copper, introducing a reducing agent of hydrogen under the surface of the molten copper to combine with the oxygen, and applying a vacuum of the order of 1 to 4 millimeters to promote reactions between the reducing agent and the oxygen to remove the oxygen from the copper.

2. A method of refining copper containing oxygen and reducing gases including hydrogen and carbon monoxide which consists of melting the copper, and applying a vacuum of the order of 1 to 4 millimeters to promote reactions between the oxygen and reducing gases to liberate them from the copper.

3. A method of refining copper which consists of heating the copper to a temperature of substantially 1150° C. to melt the copper, agitating the molten copper, applying a vacuum in the neighborhood of 2 millimeters and introducing a reducing gas of carbon monoxide under the surface of the molten copper to remove oxygen.

4. A method of refining copper which comprises melting a partially deoxidized copper, introducing a reducing gas of carbon monoxide under the surface of the molten copper and applying a vacuum in the neighborhood of 1 to 4 millimeters to decompose the copper oxide in the copper and form a gaseous reaction product, and removing the reaction product by said vacuum.

5. A method of producing substantially deoxidized copper, which comprises poling molten copper whereby hydrogen and carbon monoxide gases are introduced into the copper, applying a vacuum of the order of 1 to 4 millimeters to the molten copper to promote a reaction between said gases and the oxygen of the copper oxide present in the molten copper, and withdrawing the reaction products by the applied vacuum.

6. A method of refining copper containing oxygen in the form of copper oxide, hydrogen, and carbon monoxide gases, which comprises applying a vacuum at a pressure of not more than 4 millimeters to said copper in the molten state to promote a reaction between the oxygen of the copper oxide and said gases, and withdrawing the reaction products by the applied vacuum.

7. A method of refining copper containing oxygen in the form of copper oxide and carbon monoxide, which comprises applying a vacuum at a pressure of not more than 4 millimeters to the copper in the molten state to promote a reaction between the oxygen in the copper oxide, and the carbon monoxide, and withdrawing the reaction product by the applied vacuum.

8. A method of refining copper containing oxygen in the form of copper oxide and hydrogen, which comprises applying a vacuum at a pressure of not more than 4 millimeters to the copper in the molten state to promote a reaction between the oxygen of the copper oxide and the hydrogen, and withdrawing the reaction product by the applied vacuum.

9. A method of producing substantially deoxidized copper, which comprises poling molten copper to reduce the oxygen content to .03% to .06% whereby hydrogen and carbon monoxide gases are introduced into the copper, applying a vacuum at a pressure of not more than 4 millimeters to the molten copper to promote a reaction between said gases and the oxygen of the copper oxide present in the molten copper, and withdrawing the reaction products by the applied vacuum.

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