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METHOD OF CHROMIZING

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This invention relates to the formation of surface alloys of chrominum on metal objects, and more especially to the formation of such surface alloys on iron and steel. When certain metals, especially iron and steel, are heated in contact with chromium metal powder under suitable conditions, the chromium penetrates the iron or steel and forms a surface alloy of ferro-chrome. This general process of causing one metal to penetrate another is known as cementation, and as applied to chromium it is known as chromizing. In the prior art of chromizing it has been customary to use more or less pure chromium powder, with or without certain diluting materials, and often with certain additional or auxiliary compounds such as chlorides or fluorides which seem to aid the process.

The present invention relates particularly to such auxiliary material, and to a method of chromizing that utilizes it.

An object of this invention is the provision of a novel and improved chromizing material that prevents oxidation of the chromium used.

Another object of this invention is the provision of a novel and improved chromizing material that prevents oxidation of the substance being chromized.

Another object of this invention is the provision of a novel and improved chromizing material that will not attack or react with the articles being chromized.

Still another object of this invention is the provision of a novel and improved chromizing material that will prevent the chromizing charge from sintering together.

A further object of the invention is the provision of a novel and improved method of chromizing that produces quickly a deep coating of chromium alloy.

Other objects will be apparent from the following description.

In the art of chromizing as commonly practiced the articles to be chromized are packed in a powdered material containing free chromium or a high chromium alloy and then heated at a temperature usually exceeding 1000 degrees C. The heating may be done in a neutral or reducing atmosphere, as hydrogen for instance, and the formation of the surface alloy of chromium may be facilitated by the addition of certain auxiliary compounds to the chromium powder. Various compounds having various degrees of effectiveness have been proposed for this purpose, and in the main they consist of certain of the metallic halides. Various theories have been proposed to explain the action of some of these compounds. One is that they vaporize below the temperature at which iron oxidizes and thereby displace the oxidizing atmosphere and prevent its action. Another is that they react with the chromium, or with the iron being chromized, and thereby act as cleaning agents, or as gaseous carriers of chromium, or both.

I have found that ferrous chloride is an excellent addition agent to a chromizing charge comprising powdered chromium metal, and that it is more effective in promotiong chromizing than any of the materials heretofore proposed, and yet its action cannot be explained by any of the theories so far advanced. Its action is particularly effective at the higher range of chromizing temperatures, that is, from 1100 degrees C. to 1350 degrees C., which are necessary to produce thick layers of surface alloy, that is, say, .050'' or more thick.

In the preferred manner of practicing this invention I use finely powdered chromium metal, or ferro-chrome containing a minor percentage of iron. To this is added finely powdered ferrous chloride. The exact percentage of ferrous chloride is not critical but preferably from 5% to 10% by weight is used. Preferably these two materials are ball-milled together for several hours to mix them thoroughly. To this mixture aluminum oxide, or magnesium oxide, or similar materials, may be added as diluents, but I prefer not to use such additions. The article to be cromized is placed in a suitable metal or ceramic container in which it is completely embedded in this chromizing mixture. This container is then placed in any suitable type of furnace, and in order to help prevent oxidation the entire container, or at least the openings in it, may be covered with a suitable powdered refractory material such as alumina, magnesia, gannister, or the like. The furnace is then brought to temperature, and the heating is carried on at a temperature and for a time governed by the depth of surface alloy desired.

The process is operable to a degree on any type of ferrous material such as cast iron, cast steel, simple steel, and alloy steel. In general, however, it works best on low carbon steels, having a carbon content of .25% or less. Higher carbon content progressively decreases the depth of penetration of the chromium, but the presence of the usual alloying elements other than carbon is not harmful. The composition of the ferro-chrome casing produced is not uniform, and the alloy is richest in chromium at the extreme outer

surface, the chromium content at that point being about 50%. Toward the interior the chromium content tapers off progressively to substantially zero. If a chromized article be boiled in nitric acid (about 50% water), that part of the ferro-chrome casing which contains about 12% or more of chromium remains unattacked, while the foundation metal and the remainder of the casing is dissolved away. The thickness of the unattacked casing may be easily measured and is a good criterion of the total thickness of casing originally produced. Where thickness of coating or depth of penetration has been mentioned in this specification, it means the thickness or depth of the portion unattacked by nitric acid when treated as above. An article treated according to the present process for about four hours at 1150 degrees C. to 1200 degrees C. will in general have produced thereon an alloy casing about .010'' thick, heating for about twenty-four hours at about 1300 degrees C. will produce an alloy casing about .060'' thick or thicker. By experience, intermediate temperatures and durations can be chosen to produce any desired intermediate thickness of casing or depth of penetration.

Articles chromized in the mixture or charge of this invention, and especially those chromized at the higher temperatures necessary to produce deep penetration, come out with a clean bright surface requiring no further treatment. The chromium powder remains unoxidized and retains a clean gray appearance, whereas, ordinarily it turns green by partial oxidation. Also, the chromium does not sinter and may readily be separated from the chromized material, and easily crushed for re-use. In contrast ferric chloride and other compounds that have been proposed cause sintering at the higher temperatures, and permit a considerable degree of oxidation and pitting. The use of ferrous chloride therefore produces a novel, desirable, unobvious and unpredictable result.

Having thus described my invention, I claim:

1. The process of chromizing ferrous metals which comprises embedding the article to be chromized in a powdered charge containing ferrous chloride and a source of chromium metal and subsequently heating the same at a temperature of approximately 1150 degrees C. to 1350 degrees C.

2. The process of chromizing which comprises embedding the article to be chromized in a powdered charge containing chromium powder and ferrous chloride and subsequently heating the same for a considerable period of time at a temperature above approximately 1150 degrees C.

3. The process of chromizing which comprises embedding the article to be chromized in a powdered charge containing chromium powder and ferrous chloride in a closed vessel and subsequently heating the same for a considerable period of time at a temperature above approximately 1150 degrees C.

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