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METHOD OF CHROMIZING

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1 Claim. (Cl. 148—14)

This invention relates to the formation of surface alloys of chromium 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 in a suitable protective atmosphere, the chromium penetrates the iron or steel and forms a surface alloy of ferrochrome. 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 compounds such as chlorides or fluorides which seem to aid the process. The use of powdered chromium metal has certain disadvantages, principal of which are its high cost and the fact that it oxidizes rather readily.

An object of this invention is to provide a novel and improved method of chromizing that obviates the use of chromium powder.

Another object of this invention is to provide a novel and improved chromizing material that does not oxidize readily under the conditions of operation.

In brief the present invention comprises heating the metal to be chromized in the presence of either free or combined carbon and a suitable chromium compound reducible by carbon, which substances will react at the operating temperature to produce free chromium metal. The chromium thus formed then penetrates the heated foundation metal producing a chromium alloy on the surface, in the same manner as if free chromium metal had originally been employed. To protect the chromium metal formed, and possibly to aid in its formation, the operation may be carried on in a reducing atmosphere, preferably hydrogen.

Among the substances which may be used in this process to liberate chromium are a mixture of chromium oxide and carbon, and also a mixture of chromium oxide and chromium carbide. The latter mixture is preferable and gives the better results. A mixture of chromium oxide with calcium carbide or certain other metallic carbides may also be used.

In carrying out the present process the metal to be chromized is completely embedded in the chromizing powder in a suitable container. The powder is preferably quite finely ground, so that it will pass through a 100 mesh screen or finer, and its ingredients are intimately mixed. The proportion of the ingredients used should be approximately the theoretical required to bring about complete reaction. Thus if carbon and chromium oxide (Cr_2O_3) are used, the amount of carbon should be just about enough to combine with all the oxygen of the chromium oxide, to form CO. This requires a mixture containing approximately 36 parts of carbon and 152 parts of Cr_2O_3. If chromium carbide and chromium oxide are used the required ratio is approximately 180 parts of Cr_3C_2 to 100 parts of Cr_2O_3.

In the presence of a suitable reducing atmosphere such as hydrogen, the use of carbon in the reaction mixture does not lead to any absorption of carbon by the object being chromized. Also, when only chromium compounds are used, and carbon if necessary, the products of the reaction are free chromium and a gas (carbon monoxide) and no dilution of the freed chromium takes place, and no inert solids are generated which might obstruct cementation.

The container for holding the metal to be chromized and its surrounding charge of powder may be made of any suitable metal or ceramic material, or it may be the muffle of the furnace itself. The furnace may be heated by oil, gas or other fuel, or by electric current, and should be so constructed that a suitable atmosphere, preferably hydrogen, may be maintained around the charge. For small work a satisfactory furnace consists of a refractory tube heated by means of an electrical resistor. For larger work a muffle furnace similar to an enameling furnace, may be used.

The thickness of the surface alloy produced depends of course on the duration and temperature of the operation, as in other methods of chromizing. Similarly also the composition of the surface alloy is not uniform. In the case of steel it tapers evenly from a very high chromium content at the extreme exterior (about 40%) to practically zero a short distance toward the interior. If a piece of steel that has been chromized in this way is boiled in nitric acid (about 50% water) the acid dissolves all the unalloyed steel and also all the alloyed steel containing less than about 12% of chromium, leaving an insoluble alloyed shell unattacked the thickness of which is a good comparative measure of the depth of the surface alloy formed. Thus a piece of steel treated for 24 hours at 1300° C. by the process of this invention was found to have a shell (insoluble in nitric acid as described above) that was .010" thick. On the same piece a further treatment for 19 hours at 1300° and 5 hours at 1350° C.

increased the thickness of the insoluble shell to about .025".

While the illustrative examples given herein have referred to iron and steel, it is obvious that other metals capable of alloying with chromium can be chromized in the same manner. It is also obvious that other mixtures comprising chromium compounds and carbon either free or combined may be used so long as they are capable of producing free chromium when heated to the operating temperatures, without departing from the spirit of the invention.

Having thus described my invention, I claim:

The method of chromizing which comprises heating the object to be chromized at a temperature of approximately 1200° C. to 1400° C. in a reducing atmosphere, in contact with a charge comprising chromium carbide and chromium oxide.

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