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MOLD EQUIPMENT AND METHOD OF MAKING SAME

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This invention relates to permanent mold equipment and is particularly directed to metal mold equipment having oxidized cavity walls.

An object of this invention is to provide a metal mold wherein loose non-compacted metal powders may be sintered and which has a wall surface therein so conditioned that the metal powder does not adhere thereto.

A further object of the invention is to provide a chromium steel mold wherein the chromium may be oxidized by the action of a hot moist atmosphere thereon, and which oxide is not effective by the sintering atmosphere which is non-oxidizing in character and which contains a sufficient small quantity of water to regenerate the oxided surface of the mold during the sintering operation.

Another object of the invention is to provide a permanent mold of durable material which is substantially non-breakable and which due to the hardness thereof does not wear appreciably so that objects molded and sintered therein are always substantially of the same size and shape.

Further objects and advantages of the present invention will be apparent from the following description, wherein a preferred embodiment of the present invention is clearly shown.

One of the recent advances in the art of powdered metallurgy has been the molding and sintering of various shaped objects from metal powders, wherein the metal powders are loosely filled into a mold having a cavity and sintered under suitable conditions in a non-compacted condition. When molding metal powders by this process, the mold surface must be conditioned so as to be non-adhering in nature with respect to the metal powder. Heretofore, in conventional casting practice, the mold surfaces have been sooted or the surface of the mold has been dusted with refractory materials which prevent the molten metal from adhering to the mold surface. In powder metallurgy due to the ease of molding metal powders the use of graphite molds has been prevalent since the objects molded are usually small and the labor required to soot or dust the mold surfaces if a metal mold were used would be incommensurate with the value of the individual part. For this reason graphite molds have been used in the past with more or less success, but graphite is very fragile and upon continued ejection of metal articles from the cavity of the graphite mold the surface thereof being relatively soft is worn, and subsequent articles being molded therein are of a progressively greater size.

This invention is particularly concerned with ferrous metal molds wherein the surface of the mold cavity is conditioned for the subsequent molding of metal powders therein and is non-adherent with respect to the metal powders at the elevated temperatures of sintering. Furthermore, the invention is particularly directed to an oxide coating on the surface of the mold cavity which prevents sticking of the molded article to the mold cavity of the walls thereof, and which conditioned surface is preferably continually renewed during each sintering operation.

I prefer to utilize steel mold bodies having chromium therein in varying percentages, and I have further found it to be desirable in certain instances to include nickel as well as chromium. Likewise chrome plated ferrous metal molds may be used. Chromium has the property of oxidizing under elevated temperature conditions in the presence of water vapor. In differentiation, the majority of metal powders which are commonly sintered are not effected deleteriously by small quantities of water vapor as included in the average non-oxidizing atmosphere. Thus the mold surface may be oxidized and then used under atmosphere conditions which are oxidizing in nature to the mold surface but reducing in nature to the metal powders being sintered. In this manner the oxidized mold surface is regenerated upon each sintering operation to compensate for any slight abrasive action upon the ejection of the sintered article therefrom which would tend to remove the oxide coating. Furthermore, if the coating of oxide is completely over the entire surface of the mold, the mold is uneffected by the oxidizing nature of the sintering atmosphere, since the oxide already formed acts as a protective coating to prevent further oxidation and thereby eliminates any possibility of deterioration of the mold by excessive oxidation.

In order to clarify my invention, the following example is given for illustrative purposes only. A mold is formed from a block of alloy steel containing in the neighborhood of 35% nickel and 15% chromium. The block is bored to provide suitable cavities and is then preferably oxidized in an atmosphere containing water vapor. This may be accomplished by passing the mold through a sintering furnace where in an atmosphere of incompletely burned natural gas is provided which has had the greater portion of the water vapor removed. The minute quantity of water vapor still in the gas, however,

is sufficient to oxidize the chromium in the block and thereby provide a continuous coating thereover. The furnace can be at any desired elevated temperature, but preferably of from 1500° to 2000° F., and a period of treatment ranging from 10 minutes to one half hour is preferably utilized.

After the mold has been oxidized on the surface thereof, it is ready to be used for the molding of metal powders. The powders may be loosely filled into the mold cavities, and then the mold with the metal powders therein may be passed through the same sintering furnace. As previously stated, the atmosphere is preferably one which is reducing in nature with respect to the metal powders though having an oxidizing effect on the chrome steel mold. Thus the molded powders are sintered together, and after cooling may be ejected from the molds and the molds may then be reused.

The present mold and method of making the same may be used in the manufacture of many types of porous metal articles, one of such applications being shown in my copending application, Serial No. 145,747. I do not limit the invention, however, to the molding of metal powders alone, since it is obvious that the surface of the mold will act similarly to prevent sticking or adherence of the molten metals to the surface thereof.

It is manifest that any type of metal mold can likewise be used, especially when molding molten metals, and that the only definite requirement is that the metal surface of the mold is properly oxidized. Thus while chrome steel is particularly applicable in the use of sintering powders due to the use of regeneration at the surface of the metal oxide during sintering, that usual types of commercial steels could be used for the mold, but would require regeneration of the oxide film thereon at periodic intervals. It is to be further understood that the particular percentage of chrome and nickel in my preferred type of mold is not critical, and that chrome steels wherein the chromium ranges from 5% upwards are satisfactory, whereas the nickel may likewise vary from 5% upward. Thus commercial stainless steel, such as the 18–8 stainless steel, yields very satisfactory results.

In some cases, the mold surface can be formed during the first sintering operation. That is, metal powder can be filled into the mold and then the mold with the metal powder therein is placed in the sintering chamber with a moist non-oxidizing gas being present. The surface of the mold is oxidized quite completely by the moisture due to the diffusion of the furnace atmosphere through the powdered metal, and substantially simultaneously the powdered metal is sintered under atmosphere conditions which are non-oxidizing in nature to the powdered metal.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A method of molding metal powders which consists of the steps of, loosely filling the metal powder into a mold the surface of which includes chromium, placing the mold with metal powder therein in a sintering furnace having a non-oxidizing atmosphere therein including a small quantity of water vapor, heating the mold with the non-compacted metal powder therein for a time sufficient to cause the metal powder to sinter together and form a porous metal article and simultaneously cause the surface of the mold to become oxidized with an oxide of chromium, and then removing the porous article from the mold.

2. In a method of molding non-compacted metal powders in a metal mold containing chromium, that step consisting of heating the mold with the non-compacted powder therein under atmosphere conditions which are oxidizing to the chromium of the mold, and non-oxidizing to the metal powders, whereby the metal powder is sintered together and a mold surface is formed which is non-adhering to the sintered metal.

3. A method of molding metal powders which consists of the steps of filling loose metal powder into a mold having an oxidized chromium surface, placing the mold with the metal powder therein in a sintering furnace having an atmosphere therein which is oxidizing to chromium but reducing in nature to the metal powder being sintered in the mold, heating the mold with the loose metal powder therein for sufficient time to sinter the metal powder together and form a porous non-oxidized metal article and simultaneously regenerate the oxidized chromium on the walls of the mold by diffusion of the atmosphere through the porous metal article whereby the mold surface which is non-adhering in nature to the metal article being sintered therein is regenerated during each operation, and then removing the porous article from the mold.

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