

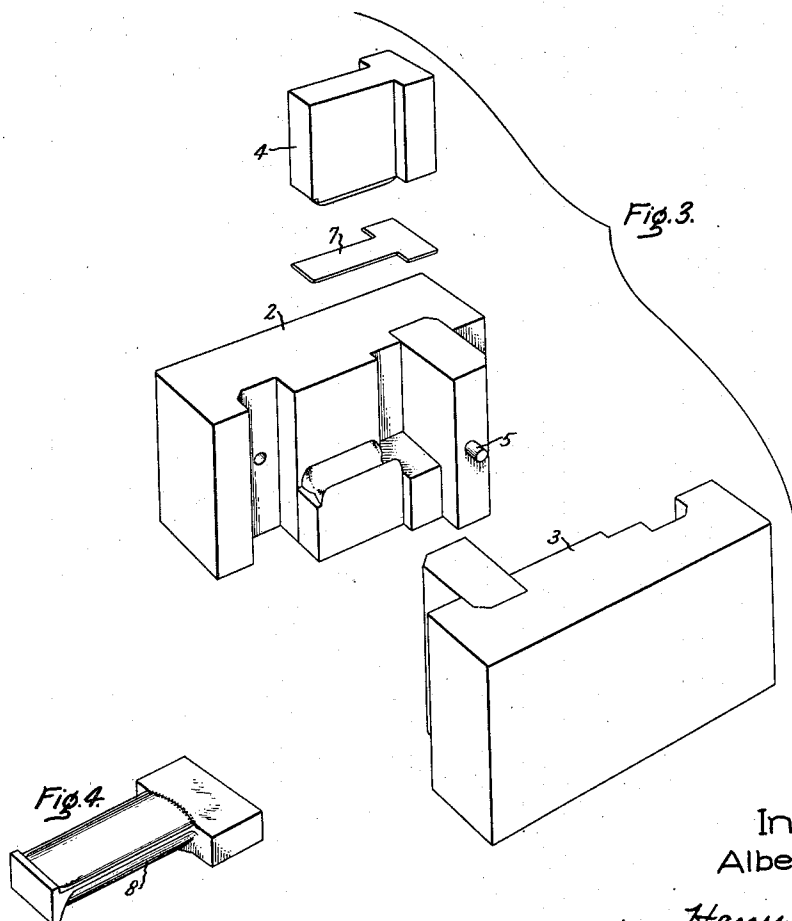
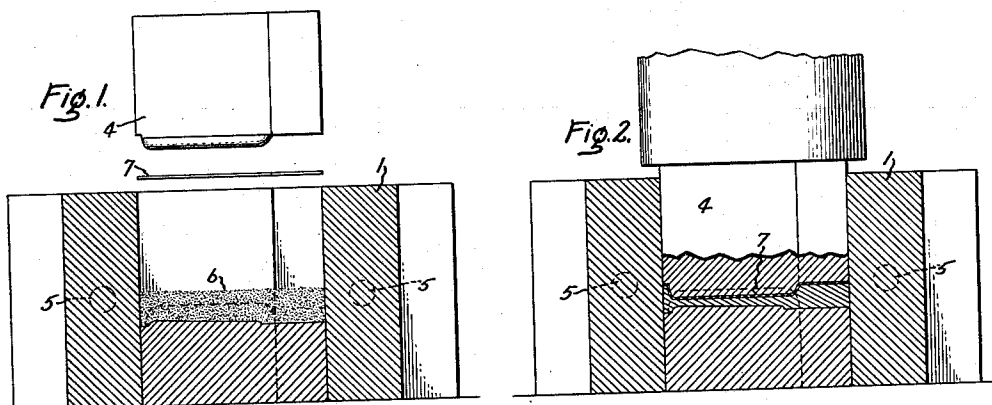
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METHOD FOR PRODUCING HIGH DENSITY SINTERED PRODUCTS

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METHOD FOR PRODUCING HIGH DENSITY
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5 Claims. (Cl. 75-22)

The present invention relates to pressed powdered materials and more particularly to a method for producing high density pressed and sintered products. Prior to the present invention, the process generally employed in the fabrication of pressed powdered materials comprised the materials to be pressed in a steel mold and applying pressure directly to the powdered ingredients by means of a plunger.

In pressing powdered materials it always is desirable to obtain a product which has a uniform maximum density throughout its mass. A maximum density in an alloy can be approached by employing a pressure considerably higher than the maximum flow strength of at least one of the components of the alloy in its work hardened condition. Generally, however, in the production of pressed powdered materials which are thereafter sintered, lower pressures than that are employed so that although some flow takes place the flow stops before all the crevices are filled a result which is due to distortion of the powdered particles and the tendency to make them fit together which at the same time work-hardens them.

By employing a pressure of about 400,000 pounds per square inch, which is well above the flow point of some of the pure metals, for example electrolytic iron, it is possible to obtain a pressed powdered iron product having a density of 7.70 which is within 2% of the maximum density of iron. Under these conditions, if it were possible to obtain a uniform distribution of the powdered material over the cross section of the mold, it might be expected that a uniform maximum density of the metal could be obtained by ordinary compression means. I have found, however, that if the distribution of the powdered material is non-uniform so that one portion of the mold contains more powder than another portion, then the force necessary to cause the compressed powder to flow from the full end to the shallow end of the mold may be greater than the component of pressure available to cause this flow. Under such conditions the plunger will be stopped after completely compressing the full end of the mold and the shallow end will be incompletely compressed.

It is one of the objects of the present invention to provide a method for pressing powdered materials which will result in a product of uniform density throughout the mass of the pressed material. A further object of the invention is the production of a pressed powder product

which will not warp when sintered. Other objects will appear hereinafter.

The novel features which are characteristic of my invention are set forth with particularity in the appended claims. My invention, however, will best be understood by reference to the following specification when considered in connection with the accompanying drawing in which Fig. 1 is a view partly in section, partly in elevation, of an apparatus whereby my invention may be carried into effect; Fig. 2 is a similar view illustrating the position of the various portions of the mold when the powdered ingredients therein have been compressed; Fig. 3 is a perspective view of the various portions of the mold employed in carrying out my invention, while Fig. 4 is a perspective view of a supercharger turbine bucket made in accordance with my improved process.

Referring more particularly to the drawing, I have indicated at 1 a steel mold which comprises stationary portions 2 and 3 and a movable plunger element 4. The parts 2 and 3 are positioned in proper alignment by means of dowel pins 5.

In one method of carrying out my invention, the powdered ingredients 6 are impregnated with paraffin in solution, mixed thoroughly, then dried and placed in the mold 1. The powdered material preferably has a fineness capable of passing through a 200 to 400 mesh screen. The paraffin permits the powdered ingredients to flow easily under pressure. The powdered ingredients are preformed in the mold 1 under a pressure of about 300,000 pounds per square inch and then heated at a temperature of about 500° C. in a reducing atmosphere such as pure dry hydrogen. A temperature of about 500° C. is high enough to distill the paraffin and deoxidize the pressed powder material but is not high enough to cause shrinkage or sintering of the pressed material. After the paraffin has been distilled out of the pressed powder material the latter is again placed in the mold 1. A flexible pad or diaphragm 7 is placed on top of the pressed material and a pressure of about 300,000 pounds applied by means of a plunger 4. Thereafter the pressed material may be sintered, for example by heating for several hours at an elevated temperature but below the melting point of the alloy. If desired, the rubber or other flexible pad employed may be secured to the base of the plunger, or may be placed below the powder; or pads may be placed both below and above the powder, or the powder may be surrounded completely by rubber or the like.

If the powdered materials are pressed without the use of a flexible pad, soft spots will occur wherever there is a scarcity of powder. Such spots are present even when paraffin has been used in preforming the powder material. Before sintering, these reveal themselves by softness and mechanical weakness; after sintering by excessive shrinkage, causing deformation of shape, and by weakness. These defects are absent when a flexible pad is employed, but the contour will be irregular to the extent of the local scarcity of powder. However, if the material is preformed as hereinbefore set forth, this irregularity will be minimized.

The present process is particularly adapted for the production of complex shapes, for example supercharger turbine buckets. A bucket of that type, as indicated in Fig. 4 of the drawing, is crescent shaped in cross section being relatively thick at its deepest portion and tapering therefrom to relatively thin edge portions. Such devices, when produced in accordance with my improved process, remain straight when sintered. However, if produced without the use of a flexible pad the pressed material will curl in the direction of its length.

The flexible pad should be thick enough to permit equalizing the pressure on the powdered ingredients and in general a thickness of about $\frac{1}{32}$ to $\frac{1}{8}$ of an inch will provide satisfactory results.

If desired, the flexible pad may be employed in the preforming operation but preferably it is employed in the final pressing operation after the material has been preformed without the pad. Both methods, however, will yield straight, undistorted products such as turbine buckets and the like.

The preforming may be omitted when articles of regular shape, such as rectangular bars, are to be made. In this case no paraffin is used. The powder material, after mixing, is distributed as evenly as possible in the mold, pressed directly to final form and uniform density with the aid of the rubber pad, and sintered. Or the pressing operation may be performed in two steps, first without the rubber pad and then with it.

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

1. The method for fabricating a body of complex shape and uniform density from powdered ingredients which comprises placing the powder

to be pressed in a rigid mold which has the irregular contour of one of the surfaces of said body, applying pressure to said powder by a rigid plunger and flexible pad, said pad being positioned between the plunger and the body to be pressed and the surface of said plunger having an irregular contour substantially identical with the opposite surface of said body.

2. The method for preventing distortion in a sintered product made from powdered ingredients which comprises preforming the powdered materials into a desired irregular shape, heating the preformed material in a reducing atmosphere at a temperature sufficiently high to deoxidize the material but insufficient to cause shrinking or sintering, thereafter applying pressure to the preformed material in a rigid mold and through a flexible pad in contact with said material.

3. The process of fabricating a pressed powder body which comprises mixing powdered materials comprising said body with paraffin or the like, drying the mixture, pressing it into a desired shape, heating the mixture in a reducing atmosphere at a temperature sufficiently high to drive out the paraffin and deoxidize the shaped material but not to cause sintering or shrinkage, placing the shaped material in a mold and applying pressure to it through flexible means in direct contact with said shaped material.

4. The method for producing a turbine bucket from powdered material which comprises placing mixed ingredients comprising said powder in a mold having the contour of one of the surfaces of said bucket, applying pressure thereto by a plunger and flexible pad, said pad being in direct contact with said ingredients, said plunger having a contour substantially identical with the opposite surface of said bucket.

5. The method of making a turbine bucket which comprises preforming powdered ingredients comprising said powder into substantially the shape of said bucket, placing said preformed bucket in a mold having a contour substantially identical with one side of said bucket, covering said bucket with a flexible pad and applying pressure to it through said pad by means of a plunger having a contour substantially identical with the opposite side of said bucket and thereafter sintering said bucket.

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