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METALLURGICAL POWDER MIXTURES AND MIXING METHODS THEREFOR

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ABSTRACT OF THE DISCLOSURE

Metallurgical powders for making pressed bodies which consist of a metallic powder, e.g. iron powder, and an organic lubricant, e.g. stearic acid, which evaporates after sintering of the pressed body, show during the pressing operation disturbing friction among the powder grains and between the grains and the wall of the matrix. The known organic lubricants impart to the mixture a partially tacky quality even when they are in powder form. It has been found that a free-flowing, trickling quality of the material powder is achieved by adding substances such as silicic acid, titanium dioxide, zirconium dioxide or silicon carbide to above mentioned mixture of metallic powder and an organic lubricant. These inorganic powders should have a grain size below one micron and should be added at a ratio of about 25 percent of said organic lubricant. The powdery mixture may be heated during or after the mixing operation. To improve the tensile strength and ductility of the pressed body, metal oxides such as iron oxide, nickel oxide and chromium oxide may be added.

The invention relates to powder metallurgy, and relates more particularly to a method of preparing a powder mixture that comprises metallic and organic and other powdery components, and to the mixture thus obtained.

During the pressing of metal powder in a powder metallurgical operation in a matrix, there occur two types of frictions namely, friction among the powder grains, and friction between the powder grains and the internal surface of the wall of the matrix. Both types of frictions are operative during the pressure operation, while during the subsequent expulsion of the pressed formed body, out of the matrix, there will occur friction only between the body and the internal surface of the matrix.

It has been proposed, in the past, to add to the metallic powder a powdery lubricant in order to reduce both types of frictions. Such a powdery lubricant included metal soap as well as other powdery lubricants having a high carbon number, higher alkanes and alkenes, as well as esters, amides and amines which are characterized by a dry powdery quality. For the expulsion of the finished formed body out of the matrix, the use of similar ingredients has been found useful, though with a somewhat reduced carbon number, respectively reduced length of the carbon chain.

The well known metal soaps are, however, less usable for the expulsion of the finished formed body from the matrix. The substances useful for this purpose have a wax-like or salve-like, partially tacky quality, even when they are in powder form. For producing a proper formed body in the powder metallurgical operation, however, it is desirable that the metal powder mixture have an adequate trickling or free-flowing quality, particularly if the powder is to be pressed in a single operation into the finished formed body.

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A good free-flowing quality is especially necessary when complex thin-walled bodies are to be made, as the matrices for these bodies have small spaces which must be filled with the powder uniformly, completely and rapidly.

The utilization of the wax-type or salve-type lubricants, to be used for the expulsion of the finished formed body from the matrix, however, is detrimental and often fatal to a free flow of the metal powder.

It is, accordingly, among the principal objects of the invention to provide a powder mixture which, on one hand, provides for a good free-flowing quality, and, on the other hand, reduces to a minimum the friction among the powder grains as well as the friction between the powder grains and the matrix.

Further objects and advantages of the invention will be set forth in part in the following specification and, in part, will be obvious therefrom without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

In accordance with the invention, a mixture is provided that comprises metal powder and organic powdery lubricating components, and the admixture thereto of one or more powdery substances of finest grained inorganic compounds, particularly oxide compounds having a grain size of preferably below one micron. Preferred compounds of this type are silicic acid, titanium dioxide, zirconium dioxide and silicon carbide. One of these compounds, or several of these compounds intermixed, are admixed to the mixture preferably at a ratio of about 25 weight percent of the organic component.

It is essential and critical for success, however, that the inorganic substance be very fine grained.

The powder mixture, in accordance with the invention, shows a surprisingly excellent trickling quality as well as good lubricating quality. While the reason for this is not entirely understood, it is assumed that the lubricating quality of these known ingredients apparently resides therein that their grain sizes remain below a certain magnitude and that they are applied together with the friction reducing components. The admixing of these additional ingredients may be made in accordance with well-known operational steps. The organic and inorganic substances may be admixed to the metal powder, either simultaneously or in succession.

In accordance with a preferred embodiment of the invention, the mixture is heated to a temperature of about 100° C. either during the mixing, or after the mixing has been completed.

Pressed bodies made of iron powder usually are sintered in a reducing atmosphere. In order to improve the mechanical properties of the sintered bodies, the powder mixture may receive additional alloy forming metal oxides, for instance, iron oxide, nickel oxide, chromium oxide, or other oxides. These oxides are reduced during the sintering operation. The occurring finest grained metal possess an extraordinary high reactivity and support the sintering effect.

The invention is explained further in the following examples.

Example I

An iron powder is produced in accordance with the well known pig iron-scale-process with a maximum grain size of 150 microns. A powdery stearic acid is admixed thereto at the rate of .3 percent by weight, which is distributed in the iron powder by mixing for about ten minutes. Subsequently, there is admixed thereto, again in a ten minute mixing operation, a water-free silicic acid at the rate

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of .2 percent by weight, of a grain size of less than one micron. This mixture was pressed at a pressure of 6000 kilograms per square centimeter into a solid cylinder having a diameter of 20 millimeters and a height of 15 millimeters. The measurements may be taken from the following table:

Measurements	Without Inorganic Additives	With Silicic Acid
Density in grams per cubic centimeter.....	6.70	6.71
Specific Expulsion Force in kp. per square centimeter.....	153	118
Flow time in seconds per 50 grams (with a 1 in. funnel opening).....	No flow	30

Example II

The iron powder with stearic acid was produced as in Example I. Instead of silicic acid, however, there was admixed to the mixture iron oxide (Fe_2O_3), also of a grain size of less than 1 micron. The measurements may be gleaned from the table below:

Measurements	Without Inorganic Additives	With Silicic Acid
Density in grams per cubic centimeter.....	6.70	6.69
Specific Expulsion Force in kp. per square centimeter.....	153	190
Flow time in seconds per 50 grams (with a .1 in. funnel opening).....	No flow	32

Example III

Admixture with titanium dioxide yielded the following measurements:

Measurements	Without Inorganic Additives	With Titanium Dioxide
Density in grams per cubic centimeter.....	6.70	6.68
Specific Expulsion Force in kp. per square centimeter.....	153	141
Flow time in seconds per 50 grams (with a .1 in. funnel opening).....	No flow	31

I wish it to be understood that I do not desire to be limited to the exact details described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent is as follows:

1. In a method of producing a metallurgical powder mixture from a mixture of a metallic powder and powdery organic lubricant for reducing friction among the powder grains and between said grains and the matrix wall, said organic lubricant being evaporated during subsequent

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sintering of the pressed body, wherein the improvement comprises

admixing to said metallurgical powder at least one fine grained, powdery inorganic substance for improving the free flow of the mixture, said substance consisting essentially of at least one member of the group consisting of silicic acid, titanium dioxide, zirconium dioxide and silicon carbide,

said inorganic powder having a grain size below one micron, and

heating the powdery mixture to a temperature of about 100° centigrade.

2. In a method as claimed in claim 1 wherein said heating takes place during the mixing.

3. In a method as claimed in claim 1 wherein the heating takes place after the mixing has been completed.

4. In a method as claimed in claim 1 wherein said inorganic substance consists essentially of silicic acid.

5. In a method as claimed in claim 1 wherein said inorganic substance consists essentially of titanium dioxide.

6. In a method as claimed in claim 1 wherein said inorganic substance consists essentially of zirconium dioxide.

7. In a method as claimed in claim 1 wherein said inorganic substance consists essentially of silicon carbide.

8. In a powder mixture used in powder metallurgy produced by mixing a metallic powder and a powdery organic lubricant for reducing friction among the powder grains and between said grains and the matrix wall, said organic lubricant being evaporated during subsequent sintering of the pressed body, wherein the improvement comprises

the admixture of at least one fine grained powdery inorganic compound for improving the free flow of said mixture

said inorganic compound having a grain size below one micron and consists essentially of at least one member of the group consisting of silicic acid, titanium dioxide, zirconium dioxide, and silicon carbide, admitted at a ratio of about 25 percent of said powdery organic lubricant.

9. In a powder mixture as claimed in claim 8 wherein metal oxides are added to said mixture for improving the tensile strength and ductility of the final product, said metal oxide being selected from the group consisting of iron oxide, nickel oxide and chromium oxide.

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