This invention relates to a process for making workpieces at least partly from metal powder, which comprises forming a plurality of bodies from powder consisting at least partly of metal by a first deformation operation causing plastic flow of the metal, bundling said bodies and subjecting said bundled bodies jointly to a second deformation operation which causes plastic flow of the metal treated to effect their union.

The bodies formed in the first deformation operation may take the form of bars or sections. The second deformation operation may be effected, e.g., by extruding, drawing or forging. Bodies made by powder metallurgy may be bundled together with bodies made by other than powder-metallurgical operations, e.g., by casting or working (pressing, rolling, forging etc.). The several bodies may agree or differ in properties and/or composition. Such a process has been disclosed in the co-pending U.S. Patent Application Serial No. 339,175 filed February 26, 1953 and now abandoned.

It has been found that the materials made in this manner, particularly when consisting of aluminum or aluminum alloys, show throughout their cross-section the boundaries between the several bundled bodies to a considerable degree. Whereas the several bodies formed in the first deformation operation are in fact united, the transitions can still be recognized. A closer inspection of these transition zones will show that they are enriched with larger metal particles and/or oxides, depending on the composition of the material.

It is an object of the invention to improve the above-described process of making workpieces from metal powder, if desired in combination with non-metallic powders such as alumina.

It is another object of the invention to provide a process of the type described which will give workpieces of higher uniformity and transverse strength than comparable processes of the prior art.

According to the invention a surface layer is removed at least from the periphery of the bodies formed by the first deformation operation. This surface layer consists of the skin formed on said bodies by said first deformation operation. The bodies are bundled after said surface layer or skin has been removed. The removal may be effected, e.g., by pickling though the bodies formed by the first deformation operation could also be machined on the lathe. The latter procedure, however, would involve an excessive loss of material and is more complicated.

In the case of aluminum and its alloys the pickling may be effected, e.g., with 5% nitric acid and subsequent treatment in a 12% caustic soda solution. This is preferably followed by a short dipping in hydrochloric acid and rinsing off the acid residues with water. The pickling of the bodies formed in the first deformation operation can also be effected in accordance with other known pickling processes to which the material subjected to the first deformation operation is responsive.

If the bodies formed in the first deformation operation are thus pickled, the material deformed in the second deformation operation will no longer show distinct divisions at the transitions between the several bodies united in the bundle nor will these transitions be enriched with larger metal or oxide particles.

The process according to the invention, in which the bodies formed by the first deformation operation is subjected to a pickling treatment to remove a surface layer from the bodies before they are subjected to the second deformation operation results in workpieces of much more uniform structure. Such material can be worked and deformed in a higher degree so that a higher-grade material is obtained.

The pickling of the bodies to be bundled has only a small influence on the strength properties in general though the transverse strength is increased in a favorable manner by such pickling, particularly if the first deformation operation consists of extruding and the pickled bodies are combined in a bundle in which they extend side by side in the direction in which they were extruded. The cross-section of the material made from pickled bars and sections has a much improved appearance compared to the material obtained when the bodies formed by the first deformation operation are bundled without such pickling or other treatment to remove the surface layer. The process according to the invention is particularly suitable for the manufacture of workpieces which are to be subjected to alternating stresses, such as pistons.

The removal of the skin resulting from the first deformation operation will improve the deformability of the bundled material when being worked and the structure of the resulting material.

The process may be explained with reference to the example:

A mixture of 28-30% silicon powder and 72-70% aluminum powder was compacted and extruded to form bars 20 mm. in diameter. The deformation was 1:12. The rods were cut into sections having the length of the receiver. Before the sections were bundled they were shorted dipped in 5% nitric acid and then placed for 10 minutes in 12% caustic soda solution. After removal from the caustic soda solution the bodies were again dipped for a short time in 5% nitric acid solution and thoroughly rinsed with water. The rods thus pickled were bundled and extruded with a deformation of 1:12 to form a uniform bar 90 mm. in diameter. After this material had been subdivided it was swaged to form pistons. The pistons thus obtained are superior to those made without pickling. This is apparent already from the fact that the shape of the pistons is facilitated and the pistons have a higher deformability (elongation) by themselves.

Material made according to the invention is particularly suitable for making parts to be stressed transversely to the direction in which it was extruded because the transverse strength is higher than without pickling.

What is claimed is:

1. A process for making workpieces at least partly from aluminum powder and a powder of a substance to be alloyed thereto, which comprises forming a plurality of bodies from a mixture of aluminum powder and powder of said substance to be alloyed thereto by a first deformation operation causing plastic flow of the aluminum, removing a surface layer at least from the periphery of said bodies, thereafter bundling said bodies and subjecting said bundled bodies to a second deformation operation which causes plastic flow of the aluminum treated to effect their union.

2. A process for making workpieces at least partly from aluminum powder, which comprises forming a plurality of bodies from powder consisting at least partly from a mixture of aluminum powder and powder of said substance to be alloyed thereto by a first deformation operation causing plastic flow of the aluminum, removing a surface layer at least from the periphery of said bodies, thereafter bundling said bodies and subjecting said bundled bodies to a second deformation operation which causes plastic flow of the aluminum treated to effect their union.
of aluminum by a first deformation operation causing plastic flow of the aluminum, pickling said bodies to remove a surface layer therefrom, thereafter bundling said bodies and subjecting said bundled bodies jointly to a second deformation operation which causes plastic flow of the aluminum treated to effect their union.

3. A process for making workpieces at least partly from aluminum powder, which comprises forming a plurality of bodies at least partly from aluminum powder by a first deformation operation causing plastic flow of the aluminum, removing a surface layer from said bodies by dipping them in pickling acid and placing them thereafter in a caustic alkali solution for a time relatively longer than that for which they were dipped in said acid, thereafter bundling said bodies and subjecting said bundled bodies jointly to a second deformation operation which causes plastic flow of the aluminum treated to effect their union.

4. A process for making workpieces partly from aluminum powder, which comprises forming a plurality of aluminum alloy bodies from a mixture of 70-72 parts of aluminum powder and 30-28 parts of silicon powder by a first deformation operation causing plastic flow of the aluminum, removing a surface layer from said bodies by dipping them in pickling acid and placing them thereafter in a caustic alkali solution for a time relatively longer than that for which they were dipped in said acid, thereafter bundling said bodies and subjecting said bundled bodies jointly to a second deformation operation which causes plastic flow of the alloy treated to effect their union.

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