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MANUFACTURE OF NONPOROUS METAL ARTICLES

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2 Claims. (Cl. 75-22)

This invention relates to the manufacture of metal articles or masses and has as its principal object to produce non-porous articles or masses having a high tensile strength and elongation from aluminium alloy powders.

According to the process of the present invention an aluminium alloy powder containing a small proportion of one or more of the elements manganese, magnesium, antimony or titanium or a mixture of an aluminium or aluminium alloy powder and a powder of one or more of the aforesaid elements or an alloy containing the same is subjected to pressure at an elevated temperature of at least 300° C. but below the point of general fusion, for example a temperature of between 400 and 600° C.

A particularly suitable group of alloys are those containing up to 20% of magnesium and up to 5% of manganese for example alloys containing 0.2 to 3.5% of manganese and 1.5 to 6% of magnesium the balance being aluminium.

The process according to the invention may be effected without the use of protective atmosphere although if desired a protective atmosphere may be used. In general the powders will be subjected to pressing in the cold before subjecting them to pressure at an elevated temperature and such cold pressure may if desired be effected at a high pressure, for example more than 5 tons per square inch.

The particles of the powders employed may be of varying shape; for example they may be spherical or angular, for example in the form of lamellae. Preferably the particles should not be finer than about 20 microns or even 40 microns but on the other hand they should pass through a 100 mesh sieve.

Powder particles of lamellae form are particles such as rectangular chips having one long dimension and two short dimensions as distinguished from flakes, spheroids or granules.

In addition to the elements mentioned above, the powders may, if desired, be mixed with other elements or alloys or compounds for example metals which would tend to rupture or dissolve oxide films or metals which would be molten or which would react with the aluminium or with each other to produce a liquid phase during the hot pressing operation.

Examples of suitable additional elements are copper, zinc, silicon, nickel, iron, tin, calcium, lead, cerium, chromium, barium, bismuth, cadmium, indium, lithium, sodium and potassium.

Examples of proportions of some of the elements mentioned above are antimony up to 1%,

titanium up to 5%, silicon up to 5%, iron up to 1%, cerium up to 1%, copper up to 5% and sodium up to 1%.

An alloy containing 1.5 to 6% of magnesium, 0.2 to 3.5% of manganese, an effective amount upon to 5% of silicon, an effective amount up to 1% of antimony and the balance aluminum was found to be desirable.

If desired, calcium hydride, titanium hydride, zirconium hydride, or alkali metal hydrides may be added as described in my United Kingdom Specification No. 503,874, whilst furthermore non-metallic elements or fluxes such as mixtures of fluorides and chlorides may be added.

The use of a temperature of between about 400 and 600° C. is particularly advantageous since these are lower temperatures than those employed in die casting and are so low that metal dies will withstand the temperatures.

The heating may be effected electrically by resistance or induction.

The die in which the hot pressing is effected may, if desired, be non-metallic.

In effecting the hot pressing the speed of operation may in some cases be of importance. Thus for example when using powders having lamellae shaped particles it is possible to obtain a better cohesion of the particles if the speed of pressing is so adjusted that air is expelled whilst at the same time the powder is not blown out of the die whilst, furthermore, it is possible to arrange by suitably choosing the speed of pressing that the lamellae shaped particles are all disposed substantially parallel to each other, thus giving better cohesive properties.

In cases where oxide content is very detrimental there is the possibility of obtaining a pressing which contains no oxide at all. This can be effected by combining together a process of powder manufacture with the process of pressing. For example the powdered aluminium alloy can be manufactured by comminuting by ball milling, disintegrating, or grinding the massive alloy in a protective atmosphere so that no oxidation takes place, and then introducing the powder into dies and cold pressing it in dies and then hot pressing, conducting the whole operations in a protective atmosphere.

After the hot pressing operation the rate of cooling of the product can be controlled, or separate heat treatments may be applied in order to modify the mechanical properties thereof.

After the hot pressing the product can be brought to the desired size if necessary in a press and it can also be mechanically treated

to modify its density or to alter its physical constitution such as by forging, stamping and rolling, if desired whilst still hot.

If desired the product of the invention may have a different composition in different parts thereof for example by using layers of powders of different composition as the initial material.

The following examples illustrate how the process of the invention may be carried into effect:

1. An alloy containing 0.3% of manganese, 2.2% of magnesium, 0.2% of antimony, 0.7% of silicon and the rest aluminium, in the form of spherical shaped particles was first cold pressed at 8 tons per square inch to form a compact and this compact was then subjected to pressure at 4 tons per square inch without the use of a protective atmosphere at 575° C. The product had a tensile strength of 17 tons per square inch and an elongation of 14%.

2. An alloy containing 0.36% of silicon, 1.3% of iron, 2.03% of magnesium, 1.32% of manganese, 0.168% of antimony and the rest aluminium in the form of granular particles was first cold pressed at 10 tons per square inch to form a compact and this compact was then subjected to pressure at 4.5 tons per square inch without the use of a protective atmosphere at 580° C.

Other suitable alloys for use in the process of the present invention are alloys containing 1.0 to 1.2% of manganese, 1.8 to 2.0% magnesium, up to 0.2% of antimony, 0.7% of silicon and the rest aluminium, 5.0 to 10% of magnesium and the rest aluminium, 2% of magnesium, 1.2 to 1.5% of manganese, 0.2% of antimony or titanium and the rest aluminium, 7.5% of magnesium, 0.3% of manganese and the rest aluminium and 2.5 to 5% of magnesium, up to 0.5% of manganese and the rest aluminium.

The process of the present invention has numerous advantages for example cheapness of manufacture, excellent mechanical properties of the product, particularly strength and ductility,

freedom from casting defects such as pinholes, controlled grain size and shape, controlled distribution of the alloying constituents, the possibility of adding constituents which do not or only partially alloy, elimination of wastage of metal inherent in casting, melting and slagging processes, the use of permanent or semi-permanent moulds, accuracy of sizing, possibility of producing articles characterised in that they are formed around and have embedded in them some-pre-formed component, e. g. metallic or non-metallic components, or inclusions of higher or lower density than the main body of the article in order to obtain specialised mechanical or balance characteristics, and the possibility of obtaining alloys having physical or chemical characteristics that are unobtainable by casting methods.

The expression "articles" as used in the appended claims includes "masses."

What I claim is:

1. A metal article comprising a non-porous, compacted, agglomerated mass of particles of metal powder consisting of 1.0 to 1.2% manganese, 1.8 to 2.0% magnesium, 0.2% antimony, 0.7% silicon and the rest aluminum having a tensile strength of 17 tons per square inch and an elongation of 14%.

2. A process for the manufacture of non-porous metal articles of high density, high tensile strength and high elongation comprising cold pressing a pulverulent mass of an aluminum alloy consisting of 1.5 to 6% magnesium, 2 to 3.5% manganese, an effective amount up to 5% silicon, an effective amount up to 1% antimony and the balance aluminum at a pressure of more than five tons per square inch to form a compact, and again pressing the compact at a pressure less than that employed in the cold pressing while at a temperature of about 400 to 600° C. to convert the compact into a non-porous body of high density and high tensile strength.

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