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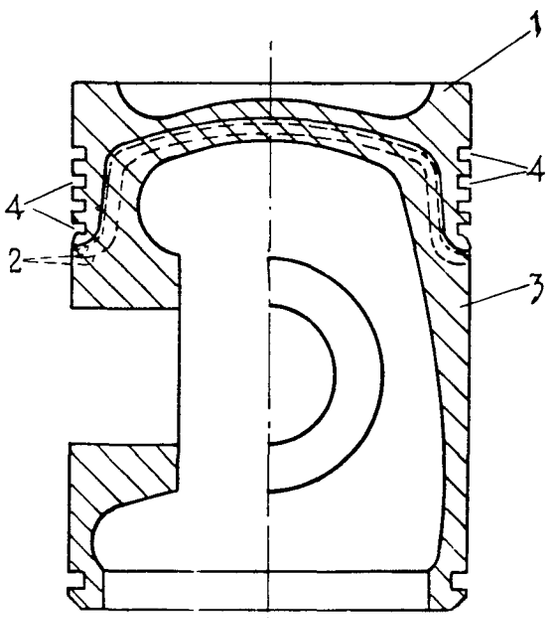
(54) Sintered bodies of composite materials and their manufacture.

(57) A body comprising a mixture of particulate materials is formed by mixing together aluminium and/or an aluminium alloy powder with a proportion of alumina powder, compacting and sintering the resultant mass, and reshaping the resultant mass under pressure after sintering. A body so formed possesses a high hot strength and, by the choice of appropriate proportions of the powdered materials is particularly suitable for forming the crown of an internal combustion engine piston. The invention also relates to the manufacture of such bodies and pistons.



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This invention relates to bodies formed by sintering together mixtures of two or more particulate materials, and to articles incorporating or formed from such bodies, the invention having particular application to pistons for internal combustion engines, and to the manufacture of such pistons.

It is desirable for the crown portion of an internal combustion engine piston to have a high mechanical strength under the temperatures encountered under normal operating conditions and one object of the invention is to provide a body suitable for forming the crown portion of such a piston. However the invention is also applicable to bodies forming or incorporated in other articles, as will be apparent from the following description.

According to one aspect of the invention a body comprising a mixture of particulate materials is formed by mixing together aluminium and/or an aluminium alloy powder with a proportion of alumina powder, compacting and sintering the resultant mass, and reshaping the mass under pressure after sintering.

It has been found that a body formed in this manner possesses a substantially higher hot strength than a body of similar composition formed by a simple sintering process but without any subsequent reshaping, and is by the choice of appropriate proportions of powdered materials particularly suitable for forming the crown of an internal combustion engine piston. For example for this purpose the particle size of the aluminium or aluminium alloy powder and the alumina powder lies between dust and 125 microns, and the body incorporates at least 10% by weight of alumina powder.

However the most suitable particle size of the constituents and the relative proportions thereof in a body in accordance with the invention will depend

upon the use to which the body is to be put, and may readily be found by trial for any particular application of the invention.

According to another aspect of the invention a body comprising a mixture of particulate materials is formed wholly or in part of aluminium and/or an aluminium alloy powder with a proportion of alumina powder, which powders have been mixed together, compacted and sintered, and in which the sintered mass has been reshaped under pressure after sintering.

A body in accordance with the invention may constitute the whole of an article, such as a piston, or only part of an article, for example the crown portion of a piston.

Thus it may be desirable in some cases for different parts of an article, such as a piston, to have different physical properties, for example where they are likely to be subjected to different conditions in use. Accordingly, in a body in accordance with the invention, the proportions of aluminium and/or aluminium alloy powder and alumina powder may vary in a controlled manner from one region of the body to the next.

This makes it possible to provide a controlled graded change of mechanical and thermal properties from one region of the body to another, and thus enables a composite body to be formed with regions having different properties whilst avoiding any substantial discontinuous change of properties which could lead to separation of adjoining regions after a period of use. The thickness of a region with or without a controlled graded change may be from about one millimetre to ten centimetres, or greater, depending upon the nature and intended use of the body.

A body in accordance with the invention may be formed of a plurality of layers incorporating

different proportions of alumina, and bonded together in any convenient manner, for example by sintering. Where there are three or more layers these may be bonded together simultaneously or successively. The reshaping of the body as by forging under heat and pressure in accordance with the invention may take place after all or some of the layers have been bonded together.

Where a body in accordance with the invention forms only part of an article it may, for example, be bonded to another part of the article, where this is of a mainly metallic nature, by friction welding, by sintering under pressure, or in any other suitable manner, either after or before the reshaping of the body. Said other part of the article may be formed of aluminium and/or an aluminium alloy and may also incorporate a proportion of alumina powder.

Thus an article may comprise a body in accordance with the invention having a relatively high proportion of alumina forming a first region of the article, an intermediate region having a relatively smaller proportion of alumina and a third region having a smaller or zero proportion of alumina.

The composition of the intermediate region in such an article may vary in such a case, the region having a relatively high proportion of alumina adjacent the first region and a lower or zero proportion of alumina adjacent the third region. The regions can have the same thickness or different thicknesses depending upon operational requirements.

The invention has particular application to pistons for internal combustion engines.

Thus according to another aspect of the invention a piston has a crown portion formed of controlled proportions of aluminium and/or an aluminium alloy powder and alumina powder which

powders have been mixed together, and a skirt portion formed of aluminium and/or an aluminium alloy with a smaller or zero proportion of alumina. The composite piston is compacted and sintered, and the resultant mass is reshaped under pressure after sintering. Alternatively the crown portion may be compacted, sintered, and shaped under pressure, and then joined to the skirt portion, with or without subsequent reshaping of the entire piston under pressure.

The piston may conveniently have an intermediate region in which the proportion of alumina is intermediate that of the crown and the skirt, and may vary from a maximum adjacent the crown to a minimum adjacent the skirt. Thus the proportion of alumina to aluminium and/or aluminium alloy may vary from the skirt to the crown within the range 0 to 50% by weight.

Preferably the proportion of alumina to aluminium and/or aluminium alloy is from 10% to 50% at the crown, and from 0 to 10% at the skirt.

The intermediate portion may form part of the composite piston, which is compacted, sintered and reshaped after sintering. Alternatively the intermediate portion may form part of the crown portion, or of the skirt portion, which are joined together with or without subsequent reshaping of the entire piston under pressure, and with or without an intermediate surface treatment.

Two pistons in accordance with the invention will now be described by way of example with reference to Figures 1 and 2 of the accompanying drawings in which :

Figure 1 is an axial section of one piston showing two half sections at right angles to each other, and

Figure 2 is a similar view of the second piston.

Referring first to Figure 1, the piston illustrated therein comprises a crown portion 1, an intermediate portion 2, and a skirt portion 3. The crown portion 1 consists of a mixture of aluminium powder and/or an aluminium alloy powder having a particle size of between dust and 125 microns, and between 50 and 10% by weight of alumina powder of approximately the same particle size. The skirt portion 3 similarly consists of the same particle size as in the crown with only a small or zero proportion of alumina.

The intermediate portion as indicated by the broken lines 2 between the crown portion 1 and the skirt portion 3 is also formed of a mixture of aluminium and/or aluminium alloy powder and alumina, the proportion of the alumina being intermediate those of the crown portion and the skirt portion. In some cases the intermediate portion 2 may have a higher proportion of alumina adjacent the crown portion and a lower proportion (which may be zero) of alumina adjacent the skirt portion, the proportion of alumina in such a case preferably varying in a continuous manner throughout the portion.

Preferably the body forming the crown portion extends down along the sides of the piston and is machined or formed with a series of grooves 4 for accommodating the compression rings.

The crown portion, the intermediate portion, and the skirt portion, with their individual mixtures, are compacted, and sintered together, the resultant mass being shaped thereafter to its final shape under heat and pressure.

In a modification without an intermediate portion the proportion of alumina in the skirt may be graded, varying from a maximum, which may be comparable with that in the crown portion, adjacent the latter,

to a minimum, which may be zero, furthest from the crown portion.

In an alternative modification, the crown portion is compacted, sintered and shaped under heat and pressure separately and this procedure is also applied to the intermediate portion and to the skirt portion. The individual portions are then bonded together and pressed under heat and high pressure to their final shape.

In a modification the crown portion, with the intermediate portion, may be bonded to the skirt portion by friction welding or in any other convenient manner.

The material forming the crown portion 1 provides most of the mechanical hot strength of the piston, and has a lower thermal conductivity than the skirt portion, or the intermediate portion where provided.

In another embodiment of the invention as illustrated in Figure 2 the compression ring grooves 4 are formed in an annular body 5 which is fabricated separately from the crown portion 1, but which similarly comprises a mixture of aluminium alloy powder with between 10 and 50% by weight of alumina powder. In forming the body the powders are similarly mixed together compacted and sintered, and subsequently shaped under heat and pressure prior to being bonded to the skirt portion. In this example the crown portion 1 and the body 5 are conveniently supported in the appropriate relative positions in a suitable mould, and the skirt portion formed in situ in the mould, and simultaneously bonded to the crown portion and the body 5.

However the skirt portion itself need not be formed by powder process but may be cast from molten metal or fabricated in any other convenient manner.

Although the invention is especially applicable to pistons, it will be appreciated that bodies in accordance with the invention may also be used to advantage in the construction of other articles, for example solid or hollow cylinders or tapered sections, with or without ribs or flanges, casings, turbine blades and combustors.

CLAIMS

1. A body formed wholly or in part of aluminium and/or an aluminium alloy powder with a proportion of alumina powder, which powders have been mixed together compacted and sintered to form a sintered mass, and in which the sintered mass has been re-shaped under pressure after sintering.

2. A body according to Claim 1 comprising two or more regions having different proportions of aluminium and/or aluminium alloy powder and alumina powder.

3. A body according to Claim 2 in which the proportion of alumina varies in a controlled manner from one region of the body to an adjacent region.

4. A body according to Claim 1 forming part of an article another part of which is mainly metallic, and in which the body is bonded to said other part of the article.

5. A body according to Claim 4 in which the other part of the body is formed of aluminium or an aluminium alloy with or without a proportion of alumina.

6. A body according to Claim 3 having a first region incorporating a relatively high proportion of alumina, an intermediate region incorporating a relatively smaller proportion of alumina, and a third region having a smaller or zero proportion of alumina.

7. A body according to Claim 6 wherein the intermediate region has a relatively high proportion of alumina adjacent the first region and a lower or zero proportion of alumina adjacent the third region.

8. A body according to Claim 1 forming at least the crown portion of the piston of an internal combustion engine.

9. The manufacture of a body of composite materials comprises the steps of mixing together

aluminium and/or an aluminium alloy powder and alumina powder in controlled proportions, compacting the resultant mixture and sintering to form a sintered mass, and reshaping the sintered mass under pressure.

10. The manufacture of a body according to Claim 9 formed as a plurality of regions incorporating different proportions of alumina, including the steps of forming each region separately and subsequently bonding the regions together.

11. The manufacture of a body according to Claim 9 formed as a plurality of regions bonded together wherein the reshaping of the body is effected after some or all of the regions have been bonded together.

12. A piston for an internal combustion engine having a crown portion formed of controlled proportions of aluminium and/or an aluminium powder and alumina powder, and a skirt portion formed of aluminium and/or an aluminium alloy powder with a smaller or zero proportion of alumina, wherein the layers are compacted together and sintered, and the resultant mass is reshaped under pressure after sintering.

13. A piston for an internal combustion engine having a crown portion formed of controlled proportions of aluminium and/or an aluminium powder and alumina powder, and a skirt portion formed of aluminium and/or an aluminium alloy powder with a smaller or zero proportion of alumina, wherein the powders forming the crown portion are compacted and sintered, and shaped under pressure after sintering, and the shaped mass is joined to the skirt portion with or without subsequent reshaping of the entire piston under pressure.

14. A piston according to Claim 12 or 13 having an intermediate region in which the proportion of alumina is intermediate that of the crown and skirt.

15. A piston according to Claim 12 or 13 wherein the proportion by weight of alumina to aluminium or aluminium alloy is from 10% to 50% at the crown and from 0 to 10% at the skirt.

16. A piston for an internal combustion engine substantially as shown in and as hereinbefore described with reference to Figure 1 or 2 of the accompanying drawing.

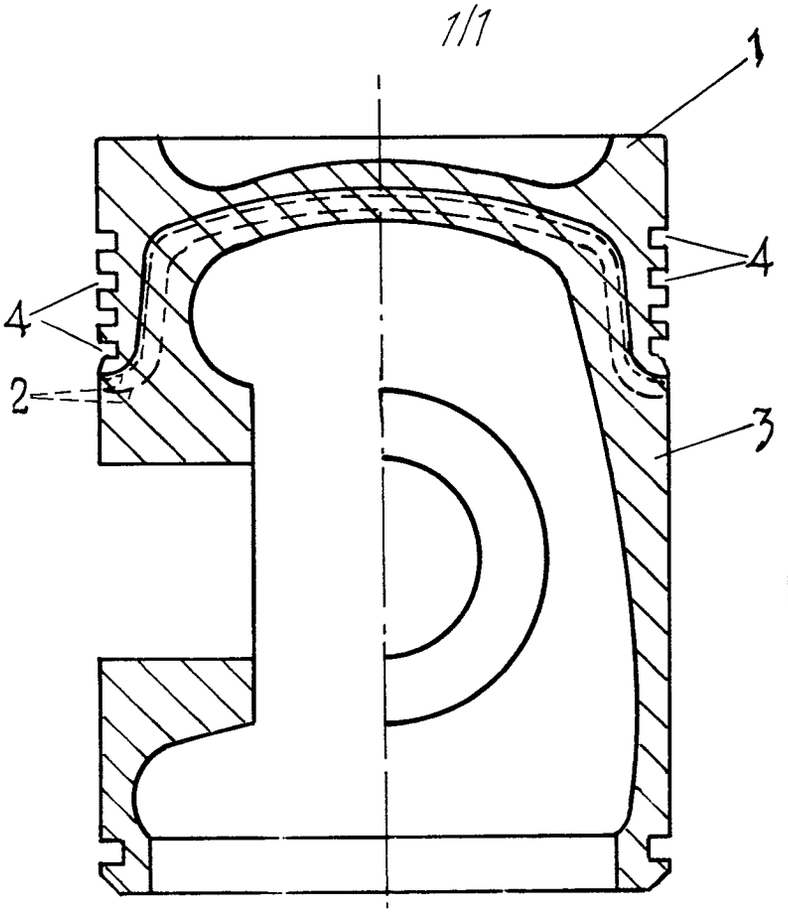

FIG.1.

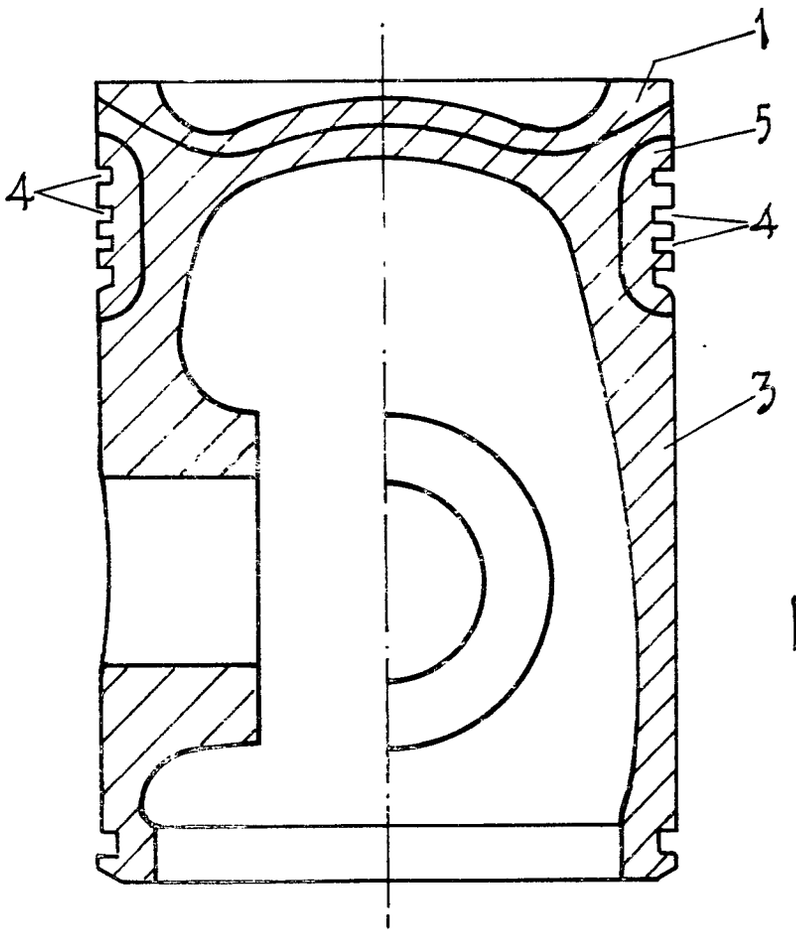

FIG.2.