ABSTRACT OF THE DISCLOSURE

This disclosure relates to a method of casting pistons particularly from aluminum and its alloys. According to the disclosure, a method of casting a metal piston having at least one cavity therein includes the steps of first casting a core from a molten water soluble salt to the shape or configuration of the cavity or cavities to be formed in the piston, casting the metal piston around this core and then dissolving out the soluble core from the cast piston so as to leave the desired cavity or cavities formed in the piston.

The present invention relates to the casting of pistons particularly from aluminum and its alloys, and to soluble cores for use in casting such pistons.

In the manufacture of pistons, it is already known to cast one or more cooling tubes into the piston, the tube or tubes being made for example of steel, copper or aluminum, but in such a process cavities can exist between the outside of a tube and the body of the piston. Cavities may particularly exist on the upper side of a tube where oxides tend to drop around the tube forming a pocket or envelope preventing the material of the piston from closely adhering to the tube. Since the purpose of the tubes is to form ducts through which are conveyed liquid or gas in order to cool the piston, the presence of such cavities reduces the heat transfer between the material of the piston and the tubes and accordingly detracts from the cooling efficiency of the tubes.

It has also been proposed to cast aluminum pistons around a copper tube which is subsequently dissolved away to leave a cooling passage or passages in the piston. However when the copper is dissolved out, an intermetallic of copper and aluminum is left on the surface of the passage which produces an undesirable surface finish giving stress raisers which can lead to fatigue failures.

According to one aspect of the invention, at least one cavity is formed in a piston during the casting of the piston by first forming a core of a water soluble salt to the shape or configuration of the cavity or cavities to be formed in the piston, casting the piston around this core, and then dissolving the core. Preferably the soluble core is formed by casting the molten salt.

The invention also provides a cast metal piston having at least one cavity therein, wherein the metal of the piston apart from any inserts of a different metal on the external surface of the piston, is of substantially constant composition from its external surface to the wall of the cavity or cavities.

The soluble core may be so shaped and positioned relative to the piston mould that when the piston is cast one or more cooling passages are formed behind the ring grooves in the piston. Alternatively or additionally a soluble core may be employed to form a combustion chamber in the crown of the piston. After the piston has been cast it is removed from the mould and the soluble core is dissolved.

It has been found that the soluble core may advantageously be made by casting it from molten sulphate or carbonate based salts and which can be dissolved in water, preferably hot or warm, after the piston has been cast around the core. Such salts when sulphate based have a relatively high solubility at a temperature of 30 to 35° C. Whilst at lower temperatures this solubility is very much reduced. This permits good recovery of the salts which can be extracted from the cooled solution in the crystalline form after the core has dissolved.

Examples of such salts are:

Sodium sulphate by itself
Sodium sulphate with up to 20% potassium sulphate
Sodium sulphate with up to 15% sodium chloride
Sodium carbonate with up to 10% potassium carbonate (All percentages are molar)

The soluble core may be reinforced, where and if required with metal wire or glass fibre members around which the molten salt is cast and whose ends may be arranged to protrude from the cavity formed by the core so that they can readily be removed when the core is dissolved. The core may also be strengthened by the addition of a proportion of refractory or insoluble filler material such as alumina or calcium sulphate.

Examples of such compositions are:

Sodium sulphate with up to 10% aluminum oxide (alumina)
Sodium sulphate with up to 10% calcium sulphate
Sodium carbonate with up to 10% barium carbonate

It is important that the soluble core retains its strength during a casting operation, but its thermal expansion must be as low as is practicable since a high expansion imposes a strain on any reinforcing or support members for the core. Moreover sudden changes in thermal expansion must be avoided. The surface finish of the soluble core must be reasonably smooth in order to impart a good finish to the cavity formed by the core in the piston. The material forming the soluble core must also be sufficiently soluble in water for the core to be dissolved in a time which is reasonable for commercial manufacture.

Further compositions of salts, which fulfil the aforementioned requirements are sodium sulphate with from 2 to 10% of lithium sulphate/40 to 5% of barium sulphate (all percentages are molar). The invention will now be further described by way of example, with reference to the accompanying drawings in which:

FIGURE 1 shows one embodiment of a soluble core which may be used in the method of casting a piston according to this invention.

FIGURE 2 is a cross section through one half of a piston formed around the core of FIGURE 1, and FIGURE 3 shows an embodiment of piston incorporating a combustion chamber.

Referring to FIGURE 1, there is shown a soluble core 1 for forming an annular cooling passage in a piston and which is cast in a mould, such as a metal mould, from a sulphate based salt having one of the compositions hereinbefore set forth. The core comprises a ring shaped portion 2 and four depending limbs 3. It is cast around wire reinforcing members 4 whose ends 4a project from the limbs 3. The limbs serve to support the soluble core on a sand core or metal die plug 5 shown in broken lines and which forms the portion of the piston mould or core around which the piston is cast. After the piston has been cast, for example from an aluminum alloy, the piston sand mould is broken away or the die plug removed and the soluble core 1 is dissolved from the cavity formed in the piston by means of warm or hot water. As shown
in FIGURE 2 the piston 6 thus formed is provided with an annular cooling passage 7 behind the ring belt through which a coolant liquid or gas may be passed via the inlet 7a formed by the support limbs. The reinforcing wires 4 provided in the soluble core may easily be withdrawn from the cavity formed in the piston, since their ends 4a project from the ducts 7 which are formed by the limbs 3.

FIGURE 3 is a cross-section of an embodiment of piston 8 which instead of being formed with an annular cooling passage, as in the embodiment of FIGURE 2, is formed with a cavity 9 in its crown, this cavity serving as a combustion chamber to assist in the combustion of fuel. The cavity 9, which, as can be seen, as an undercut form may readily be fashioned by employing a soluble core of suitable configuration, which is dissolved away after the piston has been cast.

Whilst particular embodiments have been described it will be understood that various modifications may be made without departing from the scope of this invention. Thus the soluble cores can be shaped so as to provide cooling passages of other than plain annular form. For example the passages may include a plurality of radial portions.

It will also be appreciated that other cavities of complex form which it would be difficult or expensive to machine may be formed in a piston by means of the method according to the present invention, besides the cooling passages and combustion chambers specifically described.

I claim:

1. A method of casting a metal piston having at least one cavity therein, which includes the steps of firstly casting a core from a molten water soluble salt to the shape or configuration of at least one cavity to be formed in the piston, whereby the salt core is free from water of crystallization, casting the piston around this core and then dissolving the soluble core.

2. A method of casting a metal piston having at least one cavity therein, which includes the steps of firstly forming at least one core by casting a molten water soluble salt to the shape or configuration of the cavity or cavities to be formed in the piston, whereby the salt core is free from water of crystallization, supporting said at least one core in the piston mould, casting the piston around said at least one core in the mould, removing the piston from the mould and then dissolving the at least one soluble core by means of water.

3. The method as claimed in claim 2, wherein at least one cavity is in the form of a cooling passage.

4. The method as claimed in claim 2, wherein at least one cavity is in the form of a combustion chamber in the crown of the piston.

5. The method as claimed in claim 2, in which the soluble core is made from a sulphate based salt.

6. The method as claimed in claim 5, in which the soluble core comprises sodium sulphate with an additive constituted by a member selected from the group consisting of up to 20% M potassium sulphate, 15% M sodium chloride, 10% M lithium sulphate, 5% M barium sulphate, 10% M aluminium oxide, 10% M calcium sulphate, and 0 to 5% M barium sulphate with 2 to 10% M lithium sulphate.

7. The method as claimed in claim 2, in which the soluble core is made from a carbonate based salt.

8. The method as claimed in claim 7, in which the soluble core comprises sodium carbonate with an additive constituted by a member selected from the group consisting of up to 10% M potassium carbonate and 10% M barium carbonate.

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