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(54) Title: DIE CASTING AND LIKE MOULDS

(57) Abstract

There is disclosed a die casting or like mould having an erosion–resistant mould surface on a mould body adapted for rapid cooling of the mould surface.

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DIE CASTING AND LIKE MOULDS

This invention relates to die casting and like moulds.

Such moulds are made from tool steel, which is expensive, and expensive also to fashion to the desired cavity shape. It is desired to maximise productivity from such an expensive item, and the present invention provides a way of at least substantially improving productivity.

The invention comprises a die casting or like mould having an erosion-resistant mould surface on a mould body adapted for rapid cooling of the mould surface.

The tool steel used for its hardness and wear resistance required to withstand erosion from the molten metal has a relatively low thermal conductivity compared with certain other metals. By adapting the mould for rapid cooling, the cycle time can be reduced and productivity increased.

The mould body may comprise a material of good conductivity, such as copper or a copper alloy, and may be formed by powder metallurgy, or other means.

Forced cooling may be provided for by incorporating fluid heat exchange means. The mould body may have ducting for fluid heat exchange medium.

The mould may be designed to operate at a given moulding temperature and have a chamber containing a heat exchange fluid, the chamber wall being arranged so that at mould operating temperature at least a part of the chamber wall reaches the temperature required to promote nucleate boiling of the heat exchange fluid. Nucleate boiling of the heat exchange fluid will substantially increase the rate of heat transfer from the mould to the fluid. The said part of the chamber wall may lie on or close to an

isotherm within the mould under operating conditions for substantially evenly distributed heat transfer and hence cooling effect.

Cooling channels for flowing heat exchange medium may be drilled into the body of the mould; more complicated shapes as may be desired for approximating to an isotherm can be incorporated as by machining or by building up the mould body from strata, or, perhaps most readily, by forming the mould body using powder metallurgy. Powder metallurgy would also allow cooling circuits to be incorporated via the inclusion of pre-formed tubing.

Embodiments of die casting moulds according to the invention will now be described with reference to the accompanying drawings, in which :

Figure 1 is a cross-section though a first mould, and

Figure 2 is a cross-section through a second mould.

The drawings illustrate die casting moulds 11 having an erosion resistant mould surface 12 in the mould cavity 13 - this can be made from tool steel, maraging steel, or a combination of materials which would optimise erosion resistance and thermal conductivity properties. The moulds 11 however have a mould body 14 adapted for rapid cooling of the mould surface 12.

One way in which rapid cooling is facilitated is to make the mould body 14 of a material having good thermal conductivity such as copper or a copper alloy. There may be some constraints on the material used - depending on the temperatures and rates of heating and cooling involved, it may be desirable to match the coefficient of thermal expansion of the tool steel and the mould body material, and, of course, it will usually be desirable that the two materials bond intimately for optimum heat flow at the

interface. The body material should also have a high enough melting point that it will remain solid at the maximum interface temperature.

As will be seen from the drawings, it is arranged that there is an even thickness of the surface material at least around the cavity 13. This may, of course, be less important for some types of casting than others, and indeed it may be desired to prescribe different thicknesses at different parts of the cavity 13 to control the cooling rate in specific regions of the mould.

The moulds may be produced in any convenient manner. For example, the mould could be fashioned from a copper alloy and a tool steel coating applied. Or the mould could be made by powder metallurgical techniques or built up from strata of different materials which may then be bonded together, for example by hot isostatic pressing.

While the mould body of higher thermal conductivity will undoubtedly reduce the cycle time by conducting heat more quickly away from the cavity 13 hence promoting more rapid freezing of the casting, the provision of forced, convective cooling will help materially in this regard if indeed it would not be satisfactory in many instances even with a solid tool steel mould. To this end, the mould 11 in each embodiment incorporates fluid heat exchange means 15.

In the embodiment of Figure 1, drilled coolant fluid ducting 16 is provided for connection to a coolant fluid - e.g. water-flow, which might be allowed to run to waste or to be recirculated after cooling.

Figure 1 also illustrates the incorporation of a pre-formed cooling tube 41 as could be incorporated in a mould made via powder metallurgy.

Figure 2 illustrates a coolant fluid containing chamber 21 the surface of which proximate the mould cavity 13 lies on or close to a calculated isotherm, again so as to produce even heat transfer and hence cooling at the mould surface.

In such an arrangement, the chamber wall 22 can be arranged to lie so close to the mould surface that the wall 22 temperature rises sufficiently high to promote nucleate boiling of the fluid in the chamber, thus providing cooling over and above straight forward convective cooling. Such a chamber is probably most easily fashioned using powder metallurgy mould construction techniques, though assembly from strata could also serve.

A heat pipe 31 may be used to supplement the cooling arrangement, especially where as shown in Figure 2, a coolant fluid flow would be ineffective e.g. through flow stagnation.

CLAIMS

1. A die casting or like mould having an erosion-resistant mould surface on a mould body adapted for rapid cooling of the mould surface.

2. A mould according to claim 1, of which the mould body comprises - material of good thermal conductivity.

3. A mould according to claim 2, of which the material comprises copper.

4. A mould according to claim 3, of which the copper is comprised in an alloy.

5. A mould according to any one of claims 1 to 4, formed by powder metallurgy.

6. A mould according to any one of claims 1 to 5, incorporating fluid heat exchange means.

7. A mould according to claim 6, in which the mould body has ducting for fluid heat exchange medium.

8. A mould according to claim 6 or claim 7, in which the mould is designed to operate at a given moulding temperature and has a chamber containing a heat exchange fluid the chamber wall being arranged so that at mould operating temperature at least a part of the cavity wall reaches a temperature sufficiently high to vaporise the fluid and cool the mould surface by absorption of heat of vaporisation.

9. A mould according to claim 8, in which the said part of the chamber wall lies on or near an isotherm surface of the mould under operating conditions for substantially evenly distributed cooling effect.

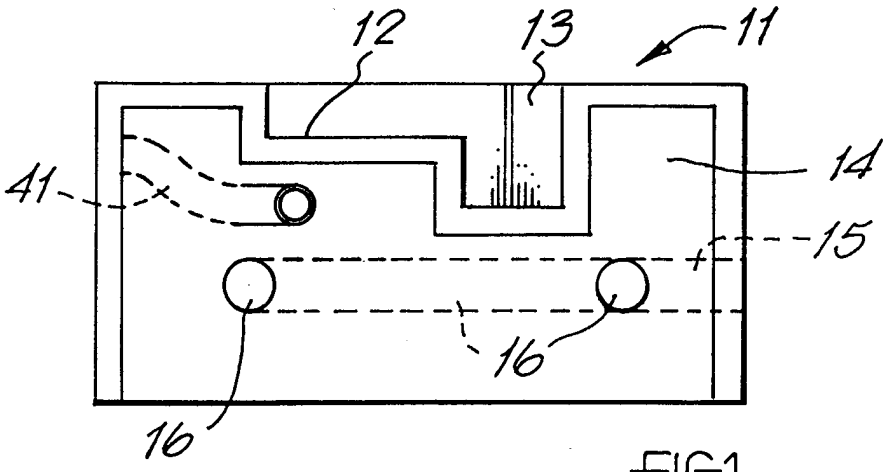

FIG.1

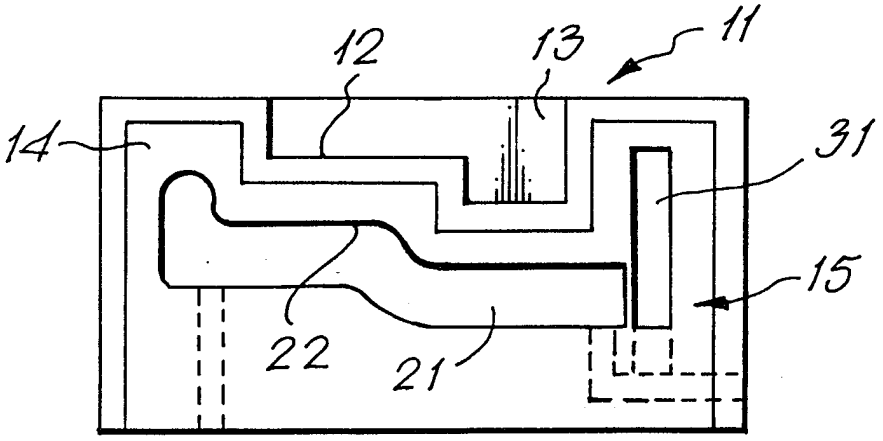

FIG.2

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B22D17/22 B22C9/06 B22C3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B22D B22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
18 February 1998	24/02/1998

Name and mailing address of the ISA	Authorized officer
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