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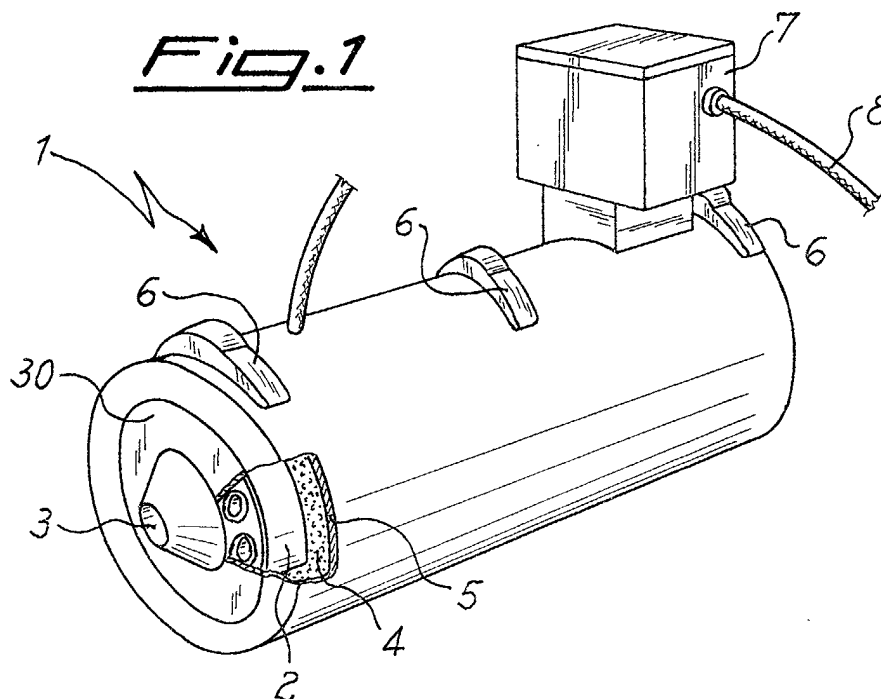
(54) **Nozzle for die-casting apparatus**

(57) The invention relates to a nozzle (1) for die-casting apparatus, used to inject into a mould the molten metal coming from the hot chamber.

In particular, this nozzle is intended for high-temperature applications such as the die-casting of magnesium alloys; for this purpose, to heat efficiently the molten

metal outflow channel, cavities are provided in the nozzle body (2) around the channel, in which heating resistances are housed.

Advantageously, the latter consist of a high-resistance filament immersed in zirconium powder contained in the cavities.



EP 1 354 650 A1

Description

[0001] The invention relates to die-casting of metals in general and more particularly to that performed using the so-called "hot chamber" technique; it is further intended specifically to the die-casting of metals at high temperatures, as occurs in the case of magnesium and its alloys.

[0002] Indeed for metal casting temperatures higher than 500-600°C, problems arise with regard to maintaining these values in the region of the channel which connects the trap of the hot chamber to the mould where the metal is injected; in order to achieve this result, various systems are known.

[0003] One of them consists in using a gas burner with a free flame arranged in position underneath the channel; as can be easily understood, such a system raises several problems with regard to the poor heating efficiency as well as the limited degree of safety and the unreliable operation.

[0004] Indeed, it is obvious that when the channel is heated from below with a free-flame burner, the temperature of its wall will not be uniform: namely it will be higher in the bottom part which is more exposed to the flames and fumes of the burner, and lower in the top part which is not reached by them.

[0005] It follows therefore that in order to keep the molten metal at the high temperature values mentioned above, also the upper zone of the channel must be heated to a temperature higher than that of the molten metal. This means basically that the material (usually a special steel) from which the channel is made operates under critical conditions, in particular in the bottom part which is reached by the flames, so as to be greatly stressed and requires frequent maintenance (with inevitable machine stoppage and all the consequences deriving therefrom).

[0006] This situation is made worse by the fact that, for working requirements, after each casting of workpieces the nozzle with the channel is withdrawn from the mould and subsequently brought back close to it, thereby causing inevitable knocks and vibrations.

[0007] As an alternative to the free-flame burners, electric systems for heating the nozzle channel are known.

[0008] In one case the heating thermal energy is provided by means of Joule effect with a resistance wound around the channel; an example of this kind of heating system is described in German patent application No. 4,439,872.

[0009] Despite the laying of materials for improving the heat transmission to the channel wall, for reaching the high temperatures required by the molten metal it is necessary to subject the electric resistance to a high thermal stress, so that in fact it has a short operating duration since it blows often and must therefore be replaced with a certain frequency.

[0010] As an alternative to this solution, heating of the

channel in the nozzle may be obtained by means of electromagnetic induction; in this case the conductor wound around the channel generates a variable magnetic induction field, so that the wall of the channel is heated by the currents induced inside it.

[0011] In this type of nozzle it is necessary however to cool the inductor windings; this makes them complex to manufacture and difficult to manage. For an example of such a nozzle, reference may be made to the one illustrated in European patent application published under No. 761345.

[0012] The present invention aims to improve the general state of the art described above.

[0013] Namely, the object of the invention is to provide a nozzle for die-casting apparatus which is simple either from the structural and functional point of view, thereby ensuring operational reliability and heating efficiency of the molten metal channel.

[0014] This object is achieved by a nozzle whose characterising features are set out in the claims which will follow.

[0015] These features and the effects arising therefrom will emerge more clearly from the description provided hereinbelow, of a preferred and non-exclusive embodiment of the invention shown in the accompanying drawings wherein:

- Fig. 1 shows a perspective view of a nozzle according to aforesaid embodiment, with a part removed;
- Fig. 2 shows a side view of the nozzle in Fig. 1;
- Fig. 3 is a longitudinal section of a part of the nozzle above;
- Fig. 4 is a view of the part shown in Fig. 3, in the direction of arrow IV therein;
- Fig. 5 shows in detail another part of the nozzle of Fig. 1.

[0016] With reference to these figures, numeral 1 denotes in its entirety a nozzle according to the invention which comprises a main body 2 axially provided with a channel 3 wherein the molten metal flows, coming from the trap (not shown in the drawings), in a manner known per se.

[0017] The nozzle body 2, which will be described in greater detail below, is insulated outside with a layer of thermally insulating material 4 which is in turn enclosed in a casing 5, consisting of a metal sheet rolled up and closed by fasteners 6.

[0018] The nozzle 1 is equipped with a unit 7 housing the terminal block for connection thereof to the cables 8 of the electric power supply, provided by the public mains network.

[0019] The nozzle body 2, shown in detail in Fig. 3 without the insulation, is made from special steel of the type commonly used for these applications; it is provided, at the front, with the typical conical end 20 for engagement with a matching seat of the mould (not shown in the drawings) where the molten metal is injected and,

at the rear, with a tang 21 for engagement thereof with the trap of the hot chamber (not shown).

[0020] Around the central channel 3 cavities 22 extend parallel thereto, between a front annular chamber 23 and a rear annular chamber 24 respectively coaxial with the conical end 20 and the tang 21. These cavities contain inside them (cf. Fig. 5 which shows one of them) the electrical components for heating the nozzle body 2.

[0021] These components comprise, for each cavity, an electrically insulating tubular sleeve 25 made of ceramic material, preferably based on cordierite such as for example that known commercially with the name of Kerostat; the sleeve 25 is filled with a powder 26 of zirconium silicates (Zr Si O_4), wherein an electrical resistance 27 is embedded.

[0022] The latter may consist of a filament of any suitable material resistant to the high temperatures required for these applications; however, in accordance with a preferred embodiment of the invention, this filament is made from austenitic alloys based on nickel and chromium, such as those known commercially by the name of Nikrothal and manufactured by the company Kanthal.

[0023] Using such materials it is possible to produce high-strength small-diameter filaments, thereby reducing to a minimum the space occupied by them so as to have cavities with small dimensions; for instance, in the case of a nozzle body 2 with a maximum external diameter of about 90 mm, the cavities have a diameter of about 11.5 mm.

[0024] In the nozzle according to the invention the filament which forms the resistances 27 is wound helically inside each cavity, with a differential pitch: i.e. thicker towards the end zones E_1 , E_2 , and thinner in the central zone C.

[0025] In this way it is possible to obtain a uniform distribution of the heat supplied by the resistances to the flow channel 3, along the whole longitudinal extension thereof.

[0026] Indeed, the end zones E_1 , E_2 are subject to greater thermal dispersion due to edge effects in the axial direction: the greater density of turns of the filament in these zones allows to compensate for these edge effects, thereby ensuring that the heat produced by the latter is uniform with that of the central zone C.

[0027] In this embodiment of the invention, the filament of the electrical resistance 27 is the same for all the cavities 22: i.e. it is a single filament which passes through all of them, entering into one of the annular chambers 23, 24 and emerging from the other chamber, for continuing into the next cavity.

[0028] In order to insulate the aforementioned annular chambers, the internal wall thereof is lined with sheets of mica agglomerate, for example of the type known commercially by the name of flogopite; moreover, they are filled with the same zirconium powder present in the cavities 22.

[0029] Towards the outside, the chambers 23 and 24 are closed by respective covers 30 (in Fig. 1 only one

of them is visible) fitted into seats 31, 32 especially provided therein.

[0030] Finally it should be mentioned that for the connection of the electrical resistance filament 27 to the terminal block of the control unit 7, the nozzle body 2 is provided in the region of one of the cavities 22, with connectors 33 and 34 through which the ends of the said filament are passed.

[0031] From what has been described above it is possible to understand the operation of nozzle 1.

[0032] More specifically, although fitting of this nozzle to a mould by means of the end 20 and connection thereof to the trap of the hot chamber via the tang 21 are carried out in a manner known per se, as regards heating it is carried out far differently from the present state of the art.

[0033] Indeed, even if it takes place as a result of the Joule effect due to the power dissipated by the electrical resistances 27, it is not difficult to understand that the particular location of the latter in the cavities 23 allows the body 2 of the nozzle to be heated from the inside instead of on its external surface, with a much greater efficiency.

[0034] This is due to the fact that the resistances are no longer wound around the nozzle body, as occurs in the present state of the art.

[0035] Indeed, from the mechanical processing point of view, it is not possible to form a helical cavity inside a forged steel cylinder such as the nozzle body, and for this reason the electrical conductors of the known die casting apparatus, are wound around the outside of the nozzle body.

[0036] It follows therefore that in the case of heating systems with electrical resistances, a part of the thermal energy is inevitably dispersed outwards instead of inwards the nozzle body, where the molten metal channel is located.

[0037] Furthermore, in the case of induction heating very high magnetic fluxes and electrical currents are necessary because of the distance of the induction winding from the metal channel.

[0038] On the other hand, the electrical resistances 27 of the nozzle according to this invention may be arranged inside the body 2 and therefore in a position close to the molten metal channel 3, owing to the cavities 23 which are obtained with normal mechanical boring machining.

[0039] The heating efficiency is therefore significantly increased, all other conditions remaining unchanged.

[0040] This advantageous effect results in the use of an amount of electric power smaller than that of the known heating systems, thereby avoiding to unduly stress the filament of the resistance and improving the operational reliability of the invention.

[0041] In this connection it should be observed that embedding the filament in a means such as zirconium silicate powder, allows to transmit heat by means of conduction and at the same time protects the filament

against oxidation which could reduce the working life thereof.

[0042] Obviously modifications are possible with respect to the example of nozzle according to the invention described above.

[0043] First of all it must be considered that the number, the dimensions and the cross-section of the cavities may differ from those shown. Indeed, although the circular cross-section undoubtedly appears to be the most simple, it could in any case be replaced by more complicated forms, for example elliptical, circular segment or others.

[0044] Second, also as regards the materials significant changes are possible.

[0045] Indeed, the example considered above is specifically intended for the high temperatures used in the die-casting of magnesium alloys; however, it is obvious that the nozzle according to the invention may also be used for processing metals involving lower temperatures.

[0046] Consequently, in such cases it would be possible to use filaments for electrical resistance made of a material different from the Ni and Cr based alloy; similar considerations are also applicable for the zirconium used in the powder filling the cavities 22, which may be replaced by other suitable materials.

[0047] Last, as a further possible variant it has to be mentioned the one which can be obtained by replacing the electrical resistance 27 consisting of a single filament 27 passing in succession through all the cavities, with a plurality of resistances arranged in these cavities like, for example, the three filaments energised respectively by the phases of the industrial mains power supply.

[0048] It is also possible to have resistances connected electrically together in parallel with conductors arranged at the ends, such as conductors formed by rings advantageously housed in the annular chambers 23 and 24, between which said resistances housed in the cavities extend.

[0049] These and further possible variants nevertheless fall within the scope of the claims which follow.

Claims

1. Nozzle for die-casting apparatus, comprising a nozzle body (2) in which an outflow channel (3) for the molten metal is present, at least one electrical conductor (27) associated with the nozzle body for heating thereof, **characterized in that** it comprises a plurality of cavities (22) inside which said at least one electrical conductor is housed and which extend parallel to the outflow channel, in an intermediate position between the latter and the external surface of the nozzle body.

2. Nozzle according to Claim 1, wherein said at least

one conductor comprises an electrical resistance (27).

3. Nozzle according to Claim 2, wherein the electrical resistance (27) is formed by a filament wound helically with a differential pitch, thicker in the zones (E_1 , E_2) at the ends of the cavities (22) than in the central zone (C) thereof.
4. Nozzle according to any one of the preceding claims, wherein the resistance is made from a filament of austenitic alloy comprising Ni and Cr.
5. Nozzle according to any one of the preceding claims, wherein said at least one electrical conductor (27) passes in succession along a plurality of cavities entering into, and coming out of each of them at their ends.
6. Nozzle according to Claim 5, wherein the cavities (22) extend longitudinally between two annular chambers (23, 24) coaxial with the metal outflow channel (3), inside which said at least one conductor passes, for coming out of one cavity and entering into another one.
7. Nozzle according to any one of the preceding claims, wherein the cavities (22) have a circular cross-section.
8. Nozzle according to any one of the preceding claims, wherein said at least one electrical conductor (27) is embedded in a powder or similar type of material (26) present inside the cavities (22).
9. Nozzle according to Claim 8, wherein the material (26) in which said at least one electrical conductor (27) is embedded, is a zirconium silicate powder.
10. Nozzle according to Claim 8 or 9, wherein the electrical conductor (27) and the material (26) in which it is embedded are contained inside electrically insulating sleeves (25) arranged in the cavities (22).
11. Nozzle according to Claim 10, wherein the sleeves (25) are made of cordierite or similar material.

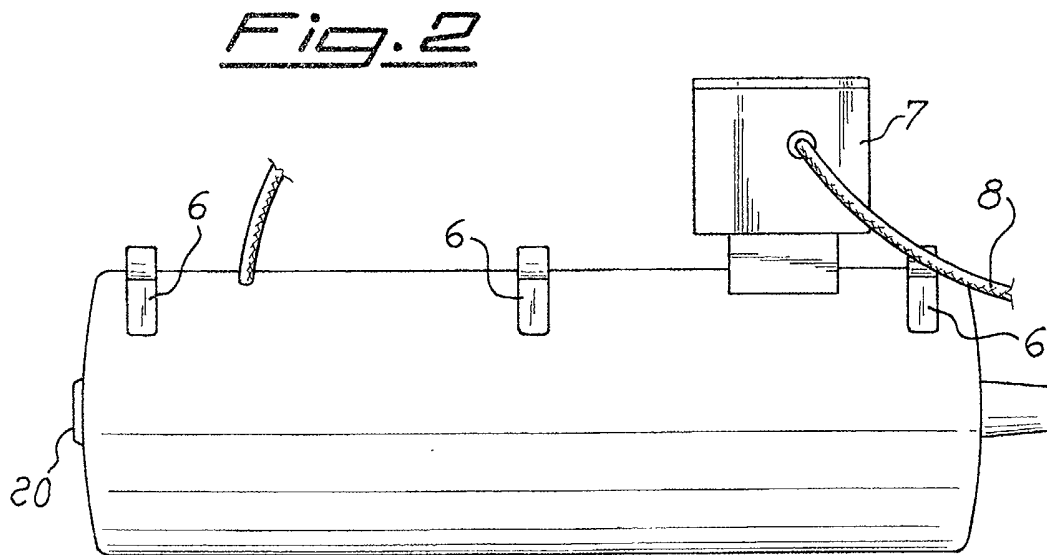
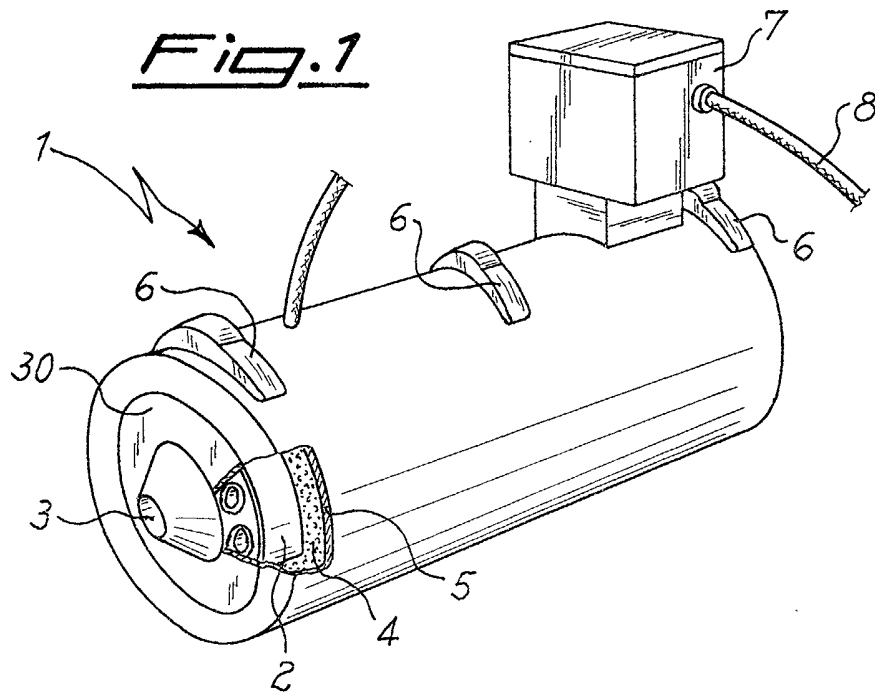


Fig. 3

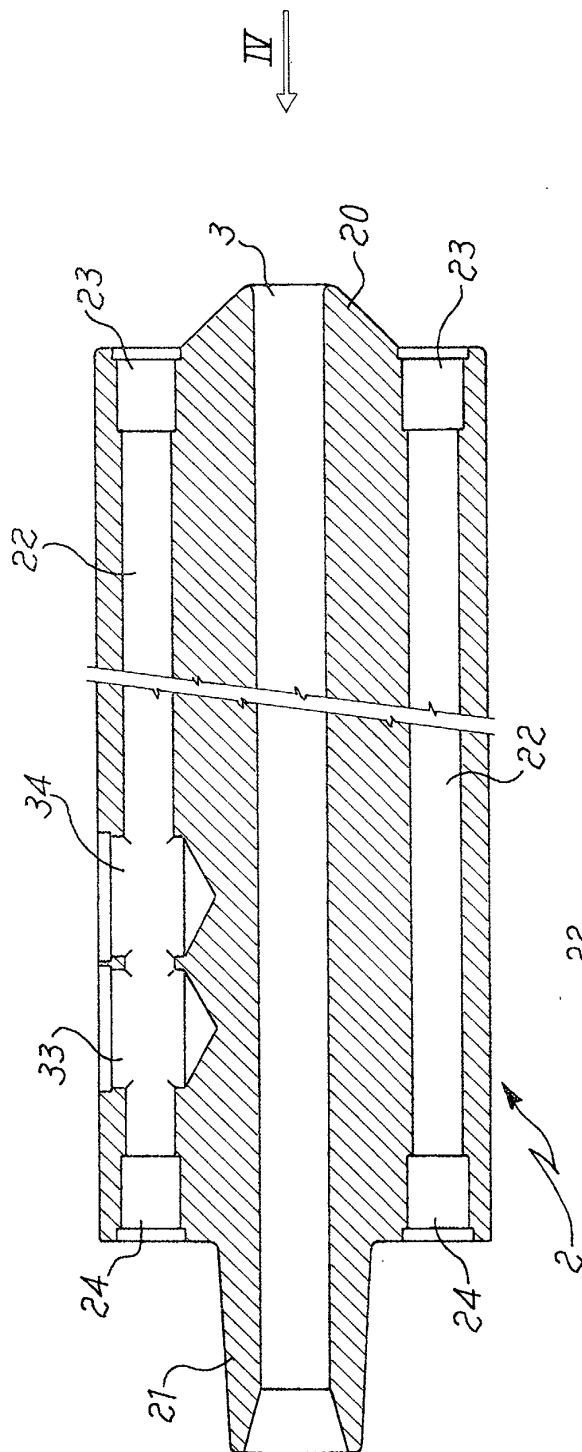


Fig. 4

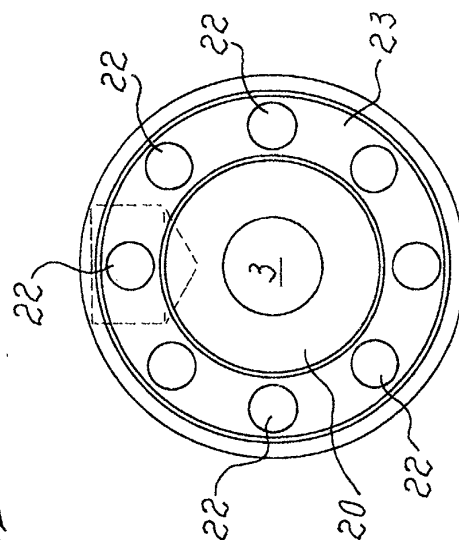
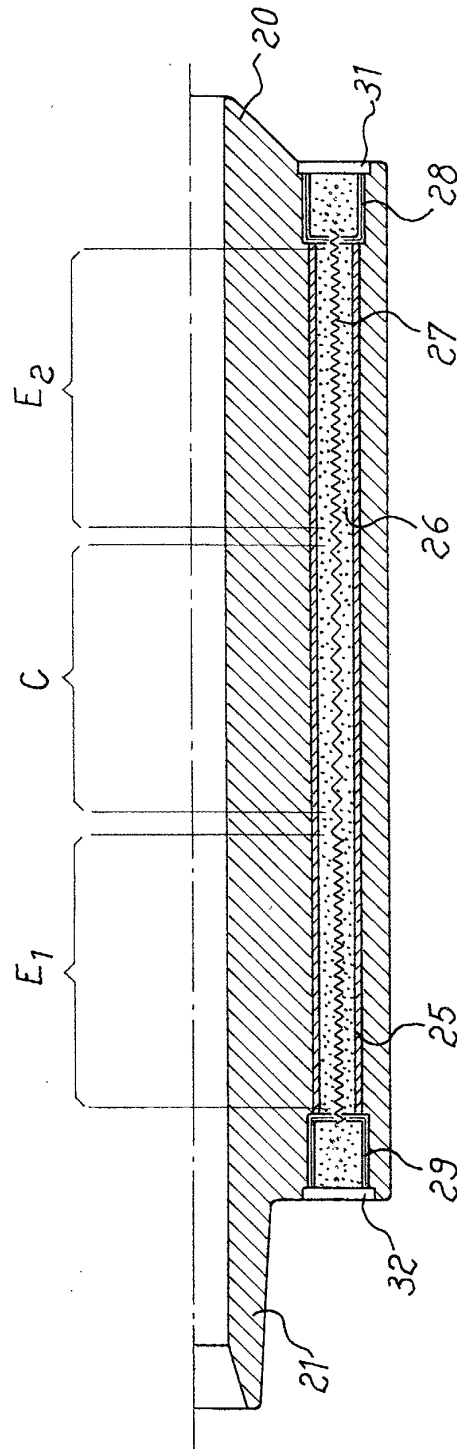


Fig. 5





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EUROPEAN SEARCH REPORT

Application Number
EP 02 42 5245

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