A nozzle heater for pressure die casting machines comprises flow generators (27, 28) that produce a flow of heating medium; heaters (29, 30) for heating the heating medium; conveyors (23, 24, 25) for channelling a flow of hot heating medium towards the parts of a pressure die casting machine to be heated. The conveyors comprise means (33, 36, 40) for channelling the flow of hot heating medium along the walls at least of the nozzle (6) extension (7) of a pressure die casting machine.
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Description

A heater and heating method for parts of pressure die casting machines

Technical field

The present invention relates to a method and an apparatus for heating those parts of pressure die casting machines such as extensions, nozzles and goosenecks that need to be heated to enable the system to operate correctly.

In particular, the invention can be applied to hot chamber die casting machines for low melting point metals and their alloys, such as mazak, lead, tin or magnesium.

The apparatus and method according to the invention are not, however, restricted to these materials but may also be used in machines for pressure die casting of other metals or even plastic.

Background art

As is known, heating the extension and the nozzle at the end of the extension is essential to keep the metal in a molten state while it is being injected from the furnace into the die.

Traditional systems used for this purpose include gas burners (now almost completely phased out), electrical resistance heaters (currently the most common solution) and, less frequently, electromagnetic induction heaters.

One of the main disadvantages of gas systems is the difficulty of constructing burners that can heat in the desired manner both the nozzle (whether made in a single piece or consisting of an extension with insert nozzle applied to the end of it) and the gooseneck.

Further, to maintain effective combustion at the tip of the nozzle, that is to say, in a restricted space, a large amount of air/gas is required. This leads to excessive heating of the ingate at the mouth of the die which must be cooled with a jet of water
which in turn leads to frequent cracking.

Moreover, burners tend to heat the nozzle and the extension on one side only which causes arc distortion and loss of system perpendicularity, with the risk of damaging the nozzle tip, making it very difficult to adjust the fit between the tapers when substituting the extension and resulting in premature wear of the gooseneck.

Another disadvantage of gas heaters is that because the temperature is difficult to control, there is a tendency to overheat the nozzle, resulting in the steel of which the nozzle is made becoming brittle and making it necessary to change the nozzle frequently.

The high uncontrolled temperature applied to the extension (and also to the gooseneck) is also the main cause of steel corrosion and the formation of holes, resulting in the need to change these parts frequently.

In electrical resistance heating systems, the nozzle and extension are heated by armoured heating elements wound radially or longitudinally around them (and normally placed in a protective cylindrical steel shell) or by heating elements placed inside the extension (internal heaters).

One disadvantage of the former type of heating element is that they must be heated to very high temperatures in order to bring the nozzle to the required temperature. This leads to overheating of the steel and internal corrosion which reduces the working life of the extension.

On the other hand, nozzles with internal heating elements, although more thermally efficient, have the disadvantage of being easily breakable and very expensive on account of the special machine processes used to make them.

Further, although the heating element is built into the nozzle, its power supply wires are external and make it very difficult to machine the nozzle when the coupling taper has to be reconditioned.

In electrically heated nozzle systems, the gooseneck is heated by cartridge heating elements housed in appropriate holes made around the runner and gate, and the temperature of the
gooseneck is usually controlled by means of a thermocouple positioned at a point close to the heating elements.

This system can give good results only if all the heating elements are in proper working order at all times. If one of the elements fails, the reading of the thermocouple becomes either too high or too low, with the result that the gooseneck coupling taper is no longer heated in a radially uniform manner, thus becoming ovalized and allowing the injected metal to escape through the seal and come into contact with and irreversibly damage the heating elements.

It should also be noted that incorrect readings of cartridge heating element temperatures, if too high at certain points, also lead to irremediable damage to the gooseneck because they degrade the mechanical, chemical and physical properties of the hot working steel it is made of, resulting in leakage of the molten metal.

The last, and least common, type of heater for this type of application includes electrical induction heaters.

In this system, the nozzle is heated by copper coils with low-voltage, very high-amp power flowing through it.

The copper coils must of course be cooled and a very expensive power generator is required to produce the necessary power.

Even in this type of system, the gooseneck is heated by a cartridge heating element, as in electrical resistance systems, with all the disadvantages listed above.

Prior art also proposes systems (for example US patent 3,809,531) in which the nozzle of a pressure casting machine is heated by a controlled flow of hot gas obtained by a heater or burner.

These solutions have proved unsatisfactory and unsuitable for industrial applications.

The aim of the present invention is, therefore, to overcome the above mentioned disadvantages.

Disclosure of the invention

In accordance with the invention, this aim is achieved by an
apparatus and a method as defined in the appended claims, providing a heater for pressure die casting machines that uses a flow of heating medium, preferably air, appropriately heated and channelled in controlled manner over one or more of the machine parts to be heated.

The advantages achieved by the invention lie essentially in the fact that the heating medium is made to circulate in such a way as to optimise heat exchange between the hot heating medium and the parts at the critical points in the machine, thus ensuring heating efficiency and even distribution of the heat.

In particular, since only the tip of the nozzle is heated by the flow of heating medium and the heat can be directed precisely at the point of contact with the die, it is possible to use to best advantage both one-piece and insert nozzles, and it is also possible to use all kinds of gates, whatever the cooling system they have.

Another advantage is a reduction of thermal wear and improved corrosion resistance, reducing the risk of asymmetrical deformation and misalignment caused by thermal expansion.

Yet another advantage is that the flow of hot heating medium, by precisely heating the end of the extension on the gooseneck side makes it possible to use any suitable tool to remove the extension such as, for example, threaded nuts, wedges or an ordinary pipe wrench.

Further advantages are achieved by also heating the gooseneck with hot heating medium. One such advantage is that when casting starts, the heating of the gooseneck material is much more even than can be achieved with cartridge heating elements. As a result, there is no localised overheating of the gooseneck caused by excessive distance between the thermocouple and the heater, especially when the heating elements closest to the thermocouple are not working.

A yet further advantage is that this prevents deformation of the extension taper coupling resulting in leakage of molten metal, problems due to adjustment difficulties when changing extensions, and irremediable damage to the gooseneck caused by embrittlement and cracking of the steel.
A yet further advantage is that substitution of the heating medium heater, when necessary, can be carried out rapidly and in a cold area, away from the heat produced by the furnace and injection system, eliminating the discomfort and risks of accidents present when working on traditional heating elements.

A yet further advantage is that the system for heating the heating medium permits the attainment of very high temperatures - around 900°C - which means that the apparatus and method according to the invention can advantageously be used also for pressure die casting of magnesium in hot chamber machines.

Brief description of the drawings

The technical characteristics of the invention, with reference to the above aims, are clearly described in the claims below and its advantages are apparent from the detailed description which follows, with reference to the accompanying drawings which illustrate a preferred embodiment of the invention provided merely by way of example without restricting the scope of the inventive concept, and in which:

- Figure 1 is a cross sectional side view of a heater according to the invention;
- Figure 2 is a front view of the second preferred embodiment of the heater;
- Figure 3 shows a heater according to the invention, together with a pressure casting machine and die;
- Figure 4 is a perspective view of the heater according to the invention.

Detailed description of the preferred embodiments of the invention

Described with reference to the accompanying drawings is a heater for a pressure die casting machine 100 of known type and generally comprising a gooseneck 8 consisting of a bottom part 81 designed to be submerged in the crucible 15 of a smelting furnace 17 in a bath of molten material, consisting preferably of mazak, lead, tin, magnesium or plastic, and a part 82 that remains outside the crucible.

The submerged part 81 is hollow and has moving inside it a
reciprocating injection plunger 11 equipped with seals 10 and slidable in a cylinder 93 made in an intermediate cylinder liner or container 9.

The plunger 11 is actuated by a tie rod 12 equipped with a coupling 13 that connects it with a drive cylinder, not illustrated in the drawings.

In almost all pressure casting machines, the upstroke of the plunger 11 draws the molten metal into the injection cylinder 93 through the hole 91 that connects the cylinder 93 with the bath 15.

During its subsequent downstroke, the plunger 11 forces the molten metal previously drawn into the cylinder 93 out through a conduit 92 that connects the bottom of the cylinder with the external part 82 of the gooseneck leading to an outlet chamber 83, preferably having the shape of a truncated cone.

From the chamber 83 the molten metal is pushed under pressure along a hollow cylindrical extension 7, of which one tapered end 14 is attached, preferably by a pressure fit, to the chamber 83 of the gooseneck, while its other end is equipped with a nozzle 6, which may be of the insert type and which, during injection of the molten metal, is held in tight contact with the ingate 3 of a die 1, illustrated in Figure 3 and not described further because it is of known type.

With reference to the drawings, a heater for pressure die casting machines according to the invention comprises:

- at least one flow generator 27, 28 producing a flow of heating medium, preferably air, and consisting, for example, of a fan;

- at least one heating element 29, 30, preferably an electrical heater, capable of heating the fluid to an operating temperature varying, according to the type of molten material to be cast, from 400-500°C to approximately 900°C;

- at least one conveyor 23 for channelling the flow of hot heating medium towards the parts of a pressure die casting machine 100 to be heated, consisting preferably of the extension 7 and/or the insert nozzle 6 and/or the gooseneck 8.

With reference to the embodiment illustrated in Figure 1,
the conveyor 23 comprises a cylindrical conduit 31 which receives
the flow of heating medium flowing out of the heater 29 and
channels it into a sleeve 32 placed around the extension 7 in the
area where the extension 7 fits into the gooseneck 8 and in
contact with the gooseneck by means of a close-fitting cover 43
(preferably sealed) adhering to the surface of the gooseneck.

The sleeve 32 is also connected to a first tapered conduit
38 that channels the heating medium from the cylindrical conduit
31 to an intermediate part, preferably the central part, of the
extension 7.

From here, the heating medium flows into a cylindrical
section 39 of the conveyor 23, placed around the extension 7 in
such a way as to create a cavity 33 between it and the outer
surface of the extension 7 itself.

Advantageously, the cavity 33 is divided by one or more
sealed radial partitions 37 against the wall of the extension 7,
thus forming at least one first longitudinal sector 36 along which
the hot heating medium from the tapered conduit 38 flows towards
the nozzle 6, and at least one second longitudinal sector 40 which
channels the air back from the nozzle 6 to the gooseneck 8, while
still exchanging heat with the extension along the way.

Looking in more detail, the end of the conduit 39 is
equipped with a cover 24 having a central hole in it and placed
around the nozzle 6 of the extension 7. The central hole in the
cover 24 may be totally or partially sealed by the nozzle to form
a chamber 35 which collects the hot heating medium from the first
sectors 36 of the cavity 33.

The total or partial shutting off of the flow through the
central hole in the cover 24 can be accomplished by moving the
cover towards/away from the tip of the nozzle 6. This is important
because adjusting the heating medium outlet makes it possible to
regulate the heating of the contact point between the nozzle 6 and
the ingate 3, permitting use of any type of ingate.

It will be understood that the nozzle 6, which is of the
insert type in the embodiment being described, might also consist
of the end of the extension 7 forming an integral part of the
latter.
From the chamber 35, the heating medium flows into the second longitudinal sectors 40, again coming into contact with the walls of the extension 7 until it reaches a second tapered conduit 41 that ends with an opening, which, during operation, is placed against the non-submerged part 82 of the gooseneck 8.

Preferably, the contact area between the opening of the conduit 41 and the gooseneck 8 is such as to encompass any through holes 26 in the walls of the gooseneck so as to make the hot heating medium flow through the holes 26 towards the non-submerged part of the injection plunger 11.

Advantageously, this increases the temperature of the injection plunger, causing it to expand and thus improving the seal of the scraper, plunger and gooseneck assembly and preventing the metal from solidifying on the sides of the components as happens when the injection stroke is very long and the components are worn.

Heating of the furnace is also accelerated, facilitating the melting of the metal crust in the melt bath and around the gooseneck, and reducing the time required to reach operating temperature after a cold start. This also reduces wear caused by contact between the components and material that has not melted completely.

The holes 26 may be made especially or they may be existing holes used to house the electrical heating elements in machines with electrical heating systems.

In the preferred embodiment illustrated in Figure 2, there is an additional, dedicated fan 28, with respective heater 30, for heating the gooseneck 8.

In this embodiment, a conduit 25 leads into the tapered conduit 41 and channels the additional supply of hot heating medium directly to the gooseneck 8.

Advantageously, the presence of two generators and two heaters reduces gooseneck heating time, the gooseneck being larger in size than the extension and the nozzle and normally requiring more time to reach the required temperature.

The accompanying drawings also schematically show thermocouples 22, 19 for controlling the temperature of the
extension 7 and of the gooseneck 8, respectively.

It will be understood that the number and arrangement of the thermocouples may vary according to the geometry of the machine and the degree of precision required.

It should be noticed, however, that unlike prior art electrical heating systems where the failure of the heating elements closest to the thermocouple creates excessive distance between the heating elements and the thermocouples and easily results in localised overheating of the gooseneck, the heating system according to the present invention, even with the same number and arrangement of thermocouples on the gooseneck, overcomes the problem of localised overheating because the same heating medium flows through all the holes and conduits and allows even distribution of the heat.

Figure 4 illustrates a heater according to the invention. The double arrows indicate the path followed by the heating medium flowing in, the single arrow the return path followed by the heating medium after heat exchange has taken place.

According to an advantageous characteristic of the invention, the heating medium generator/generators) is/are mounted in a safe, protected location, away from possible splashes of molten metal.

According to another advantageous characteristic, the passages of the conveyor/conveyors are insulated so as to reduce heat loss.

Moreover, the conveyor is constructed in such a way that it can be fitted to the pressure die casting machine without removing the nozzle and facilitating maintenance operations such as substitution of the nozzle, extension and gooseneck.

Preferably, once the thermocouples have indicated that the required casting temperature has been reached, the flow of heating medium channelled towards the nozzle tip and to the gooseneck can be reduced to the minimum strictly required to maintain the temperature at the required level.

In a preferred embodiment, the heating medium (normally air though other fluids such as inert gases might be used) may be recirculated, this having the advantage of reducing heat loss and
making it possible to work in an inert or controlled atmosphere (necessary for casting magnesium alloys).

In this embodiment, the heater is equipped with a fluid collector hood 44 (for example an extractor hood), illustrated schematically in Figure 3, which collects the heating medium downstream of the system by enclosing the zone above the crucible 15, and channels it back into the flow generator/generators through recirculation conduits 45.

It will be understood that the invention described may be useful in many industrial applications and may be modified and adapted in several ways without thereby departing from the scope of the inventive concept. Moreover, all the details of the invention may be substituted by technically equivalent elements.
Claims

1. A heater for nozzles of pressure die casting machines, comprising: means (27, 28) for generating a flow of heating medium; means (29, 30) for heating the heating medium; conveyor means (23, 24) for channelling a flow of hot heating medium towards the parts of a pressure die casting machine to be heated, the heater being characterised in that the conveyor means comprise means (33, 36, 40) for circulating the flow of hot heating medium at least along the walls of the extension (7) of a pressure die casting machine.

2. The heater according to claim 1, characterised in that the conveyor means further comprise means (24) for channelling the hot heating medium along the heat exchange walls of the nozzle (6) of a pressure die casting machine.

3. The heater according to claim 1, characterised in that the conveyor means further comprise means (25) for channelling the hot heating medium along the heat exchange walls of the gooseneck (8) of a pressure die casting machine.

4. The heater according to claim 1, characterised in that the means for channelling the flow along the walls of the extension (7) comprise a cylindrical conduit (39) placed around the extension (7) in such a way as to create a cavity (33) between it and at least one part of the outer surface of the extension (7) along which the hot heating medium can flow.

5. The heater according to claim 4, characterised in that the conduit (39) comprises sealed radial partitions (37) against the wall of the extension (7), thus forming in the cavity (33) first longitudinal sectors (36) along which the incoming hot heating medium flows towards the end of the extension (7), and second longitudinal sectors (40) which channel the heating medium back from the end of the extension (7).
6. The heater according to claim 2, characterised in that the means for channelling the hot heating medium along the heat exchange walls of the nozzle (6) comprise a cover (24) having a central hole and placed around the nozzle (6) in such a way as to create a chamber (35) which collects the hot heating medium from the first sectors (36) of the cavity (33) and from which the hot heating medium flows into the second longitudinal sectors (40).

7. The heater according to claim 6, characterised in that the cover (24) is adjustably mounted relative to the nozzle (6) in such a way as to partially or totally seal the central hole in the cover (24).

8. The heater according to claim 3, characterised in that the means (25) for channelling the hot heating medium along the heat exchange walls of the gooseneck (8) comprise a tapered conduit (41) supplied by the sectors (40) and placed next to the gooseneck (8).

9. The heater according to claim 8, characterised in that the contact area between the conduit (41) and the gooseneck (8) is such as to encompass any through holes (26) in the walls of the gooseneck so as to make the heating medium flow through the holes (26) towards the non-submerged part of the injection plunger (11) of the pressure die casting machine.

10. The heater according to one or more of the foregoing claims, characterised in that the conveyor means (23) comprise: a sleeve (32) supplied through a conduit (31) for the heating medium from the generator (27), a first tapered conduit (38) connected to the sleeve (32) and used for channelling the heating medium from the conduit (31) towards an intermediate section of the extension (7); a cylindrical conduit (39) supplied by the tapered conduit (38) and placed around the extension (7); a cover (24) over the cylindrical conduit (39), having a central hole in it and positioned in the vicinity of the nozzle (6) of the extension (7); a second tapered conduit (41) supplied by the cylindrical conduit (39) and placed next to the gooseneck (8).
11. The heater according to claim 10, characterised in that the conveyor (23) consists of at least two separable parts that can be fitted to the pressure die casting machine without having to remove the nozzle and facilitating maintenance operations such as substitution of the nozzle, extension and gooseneck.

12. The heater according to claim 1, characterised in that it comprises an additional fan (28) with a respective heater (30) and conveyors (25) for channelling additional heating medium directly to the gooseneck (8).

13. The heater according to one or more of the foregoing claims, characterised in that it comprises thermocouples (22, 19) for controlling the temperature of the extension (7) and/or of the gooseneck (8).

14. The heater according to one or more of the foregoing claims, characterised in that the heating medium generator/generators is/are mounted in a safe, protected location, away from possible splashes of molten metal from the pressure die casting machine or from the die.

15. The heater according to one or more of the foregoing claims, characterised in that the walls of the conveyor means are insulated to reduce heat loss.

16. The heater according to one or more of the foregoing claims, characterised in that it comprises a hood (43) mounted in contact with the walls of the gooseneck (8).

17. The heater according to one or more of the foregoing claims, characterised in that it comprises means (44, 45) for recirculating the heating medium.

18. The heater according to claim 17, characterised in that the recirculation means comprise a hood (44) placed over and enclosing the zone above the crucible (15), and conduits (45) for
channelling the heating medium back to the flow generator/generators.

19. A method for heating one or more parts (6, 7, 8) of a pressure die casting machine, comprising the steps of: providing means (27, 28) for generating a flow of heating medium; providing means (29, 30) for heating the heating medium; providing conveyor means (23, 24, 25) for channelling a flow of heating medium towards the parts of a pressure die casting machine to be heated by heat exchange, the method being characterised in that it further comprises a step of providing means (33, 36, 40) for circulating the flow of heating medium at least along the walls of the extension (7) of a pressure die casting machine.

20. The method according to claim 18, characterised in that the circulation means are made to channel a flow of heating medium along the following path: an intermediate part of the extension (7); along the extension (7) up to the nozzle (6); from the nozzle (6) along the extension (7) towards the gooseneck (8), the hot heating medium continuously exchanging heat with the parts (6, 7, 8).

21. The method according to claim 19, characterised in that the circulation means are made to channel a flow of heating medium into through holes (26) made in the walls of the gooseneck (8) in such a way that the heating medium flows through the holes (26) towards the non-submerged part of the injection plunger (11) of the pressure die casting machine.

22. The method according to claim 18, characterised in that it comprises a step of checking that the temperature of one or more of the parts (6, 7, 8) has reached the required level and a step of reducing the flow of hot heating medium so as to keep the temperature at the required level.
23. The method according to one or more of the foregoing claims from 19 to 22, characterised in that it comprises a step of recirculating the heating medium.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 B22D17/20 B22D17/04 B22D35/06 B29C45/74

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 7 B22D B29C

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)

EPO-Internal, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

**Date of the actual completion of the International search**

17 February 2005

**Date of mailing of the International search report**

04/03/2005

Name and mailing address of the ISA

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