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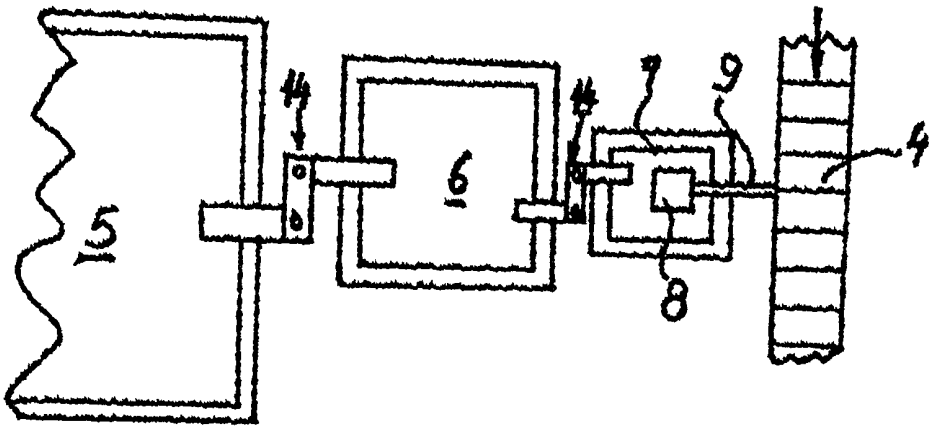

(57) Abstract

The method comprises the steps of: moving the filling head (2, 9) laterally, in order to match the lateral position of the inlet of the mould (4), in unison with one or more of the following parts: filling tube (9), pump (8), pump oven (7), buffer oven (6), and melting oven (5), and moving the filling head (2, 9) axially, in order to match the axial position of the inlet of the mould (4), in unison with one or more of the following parts: filling tube (9), pump (8), pump oven (7), buffer oven (6), and melting oven (5). At least one of said parts (5–8) being present in the filling system is not taking part in at least one of said lateral and axial movements, respectively, whereby a smaller mass has to be moved.

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METHOD OF SUPPLYING MOLTEN METAL TO A MOULD AND APPARATUS FOR PERFORMING SAID METHOD

TECHNICAL FIELD

The present invention relates to counter-gravity casting and more specifically the supply of molten metal to the moulds in a plant, in which the moulds are filled by pumping the molten metal into the mould cavities via a filling head temporarily connected to a filling opening in the mould, the moulds being held stationary and the filling head being moved axially and possibly laterally for providing the temporary connection.

BACKGROUND ART

When casting aluminium alloys and other similar light-metal alloys in such a plant, it is known that the components in direct contact with the molten metal should be made of ceramic material, in order to avoid deterioration of the material. Such material is difficult to machine and flexible connections are difficult to produce. In order to bring the filling head into and out of engagement with the filling opening and in order to move the filling head into register with the filling opening, it is, however, necessary to be able to move the filling head axially and in a transverse direction, respectively. The adjustment in the transverse direction may in some instances be necessary due to varying delivery position of the moulds in e.g. a mould string. From EP-760723 it is known to cast light-metal alloys as described above and this document actually mentions the above axial and lateral movement of the filling head, but is silent regarding the steps to be taken so that these movements can be achieved. Accordingly, it is assumed that the whole filling system is moved in unison to achieve these movements in consideration of the necessity of sealing off the interior of the filling system from the ambient air in order to prevent oxidation of the molten metal.

A casting process of the above-mentioned kind will normally comprise melting down of raw material, e.g. aluminium, in a melting oven. The molten metal is transferred to a buffer oven, in which the molten metal is prepared for casting by temperature regulation, alloy addition, degasification, mixing, etc. From the buffer oven, the molten metal is transferred to the pump oven and pumped through the filling tube and filling head into the moulds. In order to reduce the heat loss from the ovens and in order to provide a possibility of protecting the molten metal from oxidizing by using an inert gas over the molten metal, the ovens are preferably constructed as substantially closed containers. In order to provide the above-mentioned lateral and axial movement of the filling head without moving the whole filling system in unison, it is necessary to provide some kind of flexibility. This flexibility is difficult to provide due to the necessity of using ceramic materials - with inherent inflexible characters - for components in direct contact with the molten metal.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to provide a method and apparatus for use in said method, which makes it possible to perform the mentioned lateral and axial movement of the filling head in an advantageous way, without reducing the possibilities of constructing the ovens as substantially closed containers, and this object is achieved with a method of said kind, which according to the present invention also comprises the features set forth in the characterizing clause of claim 1. With this method, it is possible to provide the necessary flexibility in suitable positions, under consideration of the possibilities of constructing the different ovens in a substantially closed configuration. Preferred embodiments of the method and apparatus for use in the method are revealed in the claims 2-9.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed part of the present description, the invention will be explained in more detail with reference to the exemplary embodiments of

apparatus for supplying molten metal to moulds in a mould string according to the invention shown in the drawings, in which

Figure 1 is a diagrammatic side view of a mould string and apparatus for supplying molten metal to the mould string in accordance with the invention,

Figure 2 illustrates different positions of the flexibility for providing the possibility of performing the lateral and axial movement, respectively, of the filling head,

Figure 3 illustrates a preferred embodiment of an apparatus in accordance with the invention,

Figure 4 shows an arrangement with turning movement of the filling head, filling tube and pump,

Figure 5 shows an arrangement with tilting movement of the filling head, filling tube and pump, and

Figure 6 shows an arrangement with linear movement of the filling head, filling tube and pump in a plane forming an angle with the horizontal plane.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The mould-string plant shown in Figure 1 is considered to be well-known and will, therefore, not be explained in detail. In the filling station, the mould cavities 1 are filled with molten metal, in order to produce the desired moulded articles. In order to supply the molten metal, a filling head 2 is brought into engagement with a filling opening 3 in the mould and the molten metal is pumped into the mould through the filling head 2. In order to bring the filling head 2 into tight engagement with the filling opening 3, it is necessary to be able to move the filling head 2 laterally, i.e. in the direction of transport of the moulds in the mould string 4, so as to compensate for varying delivery positions for the moulds, and to move the filling head axially, i.e. in a direction towards the moulds. After the provision of this engagement, the mould is filled by pumping the molten metal into the mould cavity and the filling opening 3 is closed in a convenient manner as e.g. known from EP-760723. After closing the filling opening 3, the pump 8 pressure is reduced and the filling head 2 may be retracted from the mould ready for engagement with the next mould in the string 4.

The molten metal for filling the moulds is provided by melting raw material metal in a melting oven 5, from which the molten metal is transferred to a buffer oven 6, in which the molten metal is prepared for casting by temperature regulation, degasification, alloy addition, mixing, etc. From the buffer 6, molten metal is transferred to the pump oven 7, which has a relatively low capacity, from which the molten metal is pumped 8 to the filling head 2 via a filling tube 9. The pumping may be performed by means of an electromagnetic pump 8 or a pressure activated pump which is immersed into the molten metal and is connected to the filling tube 9 and filling head 2. Another possibility of pumping the molten metal from the pump oven 7 is by setting the inside of the pump oven 7 under pressure whereby the molten metal will rise up into an immersed filling tube 9 connected to the filling head 2. This last pumping method presupposes that the pump oven 7 can be completely closed, in order to be able to create a sufficient over-pressure inside the pump oven 7.

In principle, it is desirable that each of the ovens 5, 6 and 7 are constructed as closed containers, in order to be able to control the atmosphere above the molten metal. Moreover, the connections between the different ovens are made from rigid materials, due to the fact that all elements in contact with the molten metal must be made of ceramic material or the like, which is able to withstand the influences from the molten metal. The whole system of ovens may be made gas-tight without flexible seals. This would, however, require that in order to provide the lateral and axial movement of the filling head 2, the whole system consisting of melting oven 5, buffer oven 6 and pump oven 7, including pump 8 and filling tube 9, should be moved both laterally and axially to provide the desired lateral and axial movement of the filling head 2. Due to the high mass of this system (up to approximately 100 tons), this solution is not preferred. It is recognized that the movability needed to provide a lateral and axial movement of the filling head 2, respectively, can be provided between any two successive mutually connected components, i.e. filling head 2-filling tube 9, filling tube 9-pump 8, pump 8-pump oven 7, pump oven 7-buffer oven 6, and buffer oven 6-melting oven 5. It must here be emphasized that the movability for the lateral movement need not be provided at the same place as the movability for the axial movement. By splitting the movability up, the movability can be made as a purely linear movability in each of the movability points in the

system. As the axial movement is the most frequently used, the movability for this movement is preferably positioned as close as possible to the filling head 2 in order to reduce the mass to be moved. In a preferred embodiment, the axial movement is provided by movement of the pump 8, the filling tube 9 and the filling head 2 as one unit relative to the pump oven 7, and a possible sealing 10 between the pump 8 and the pump oven 7 is provided by having the pump mounted in a movable lid 11 on the pump oven 7. In this embodiment, the lateral movement may be provided by moving the pump oven 7 and a movable connection may be provided between the pump oven 7 and the buffer oven 6, e.g. by means of a linkage connection 14.

Many other possibilities may be suggested. Among those is the embodiment, in which both the lateral and axial movement are provided by moving the pump 8 relative to the pump oven 7. In this embodiment, the sealing 10 between the pump 8 and the pump oven 7 is preferably provided by mounting the pump 8 in a lid 11 which is slidingly movable relative to the pump oven 7, and the sealing 10 between the lid 11 and the pump oven 7 is provided in the form of a flexible fibre-ceramic sealing mounted on one part and in sliding engagement with the other part.

An example of such a construction is shown in Figure 3, in which the pump 8 is mounted in a pump lid 11 which is laterally and axially movable together with the pump 8. Two pump oven lids 12, 13 are provided to the lateral sides of the pump lid 11, these pump oven lids 12, 13 being movable only in the lateral direction.

In order to provide a sealing 10 between the pump oven 7 and the movable lids 11, 12, 13, the pump lid 11 is provided with flanges at the front and back, which are slidingly engaging flexible sealing elements 10 mounted on the corresponding top edges of the pump oven 7. Furthermore, the side edges of the pump lid 11 are provided with vertical flanges slidingly engaging flexible sealing elements 10 mounted on the corresponding adjacent vertical edges of the two pump oven lids 12, 13. The two pump oven lids 12, 13 are provided with flanges at the front and back, which are slidingly engaging the above-mentioned flexible sealing elements 10 mounted on the corresponding top edges of the pump oven 7, and these lids are further provided with flexible sealing elements 10 along their edges opposite

the edges engaging the pump lid 11, said sealing elements 10 sealingly engaging a large surface flange positioned to the lateral sides of the pump oven 7.

In order to relieve the sealing elements 10 from the weight of the pump oven lids 12, 13, these lids 12, 13 are provided with rollers running on rails positioned along the front and back edges of the pump oven 7 on the outside of the sealing elements 10. The pump lid 11 is fixed to the pump 8 which is mounted on a two-axes-slide system for providing the lateral and axial movement of the filling head 2, filling tube 9, pump 8 and pump lid 11 together, the pump oven lids 12, 13 being connected to that part of the slide system which is providing the lateral movement.

The construction shown has the further function of permitting removal of the pump 8 and pump lid 11 from the pump oven 7, whereafter the two pump oven lids 12, 13 can be brought together to close off the pump oven 7 from the surroundings. This will be an advantage in connection with starting up and closing down the system.

The flexible sealing elements 10 are preferably made of a fibre-ceramic material.

Different ways of providing the axial movement of the filling head are illustrated in Figures 4-6.

Figure 4 shows how a pivotal movement of the pump 8, filling tube 9 and filling head 2 in connection with an appropriate construction of the filling tube 9 provides an axial movement of the filling head 2. Furthermore, Figure 4 shows a linkage connection 14 between the buffer oven 6 and the pump oven 7 for providing the necessary flexibility between those two parts in order to be able to move the pump oven 7 in the lateral direction and keeping the buffer oven 6 stationary.

Figure 5 shows a corresponding construction, in which the pivotal movement of the pump 8, filling tube 9 and filling head 2 is performed in a vertical plane, i.e. a tilting of those parts relative to the pump oven 7.

Figure 6 shows a linear movement of the same components, where the movement is performed in a plane forming an angle with the horizontal plane.

Many other types of movement can be envisaged by a man skilled in the art. Depending on the type of movement performed the sealing 10 between the moving and the stationary parts will have to be constructed in accordance with the necessary movement.

LIST OF PARTS

1	mould cavity
2	filling head
3	filling opening
4	mould string
5	melting oven
6	buffer oven
7	pump oven
8	pump
9	filling tube
10	sealings
11	pump lid
12	pump oven lid
13	pump oven lid
14	linkage connection

CLAIMS

1. Method of supplying molten metal to a mould in a plant, in which the moulds are filled by pumping the molten metal into the mould cavities via a filling head (2) temporarily connected to a filling opening (3) in the mould, the moulds being held stationary and the filling head (2) being moved axially and possibly laterally in order to provide the temporary connection, the supply system optionally comprising a melting oven (5), a buffer oven (6), a pump oven (7), a pump (8), a filling tube (9) and said filling head (2) for registering with said filling opening (3) of the mould, comprising the steps of:

- moving the filling head (2) laterally, in order to match the lateral position of the inlet of the mould, in unison with one or more of the following parts:
- filling tube (9),
- pump (8),
- pump oven (7),
- buffer oven (6), and
- melting oven (5),

and moving the filling head (2) axially, in order to match the axial position of the inlet of the mould, in unison with one or more of the following parts:

- filling tube (9),
- pump (8),
- pump oven (7),
- buffer oven (6), and
- melting oven (5),

characterized in that at least one of said parts (5-8) being present in the filling system is stationary in at least one of said lateral and axial directions respectively.

2. Method in accordance with claim 1, characterized by comprising the provision of suitable, movable connections (14)/sealings (10) between those parts (5-8) which during the lateral and axial movement, respectively, of the filling head (2) are moved relative to one another.

3. Method in accordance with claim 1 or 2, c h a r a c t e r i z e d by the axial movement of the filling head (2) being provided by moving the filling head (2), the filling tube (9) and the pump (8) relative to the remainder of the system.

4. Method in accordance with claim 1 or 2, c h a r a c t e r i z e d by the axial movement of the filling head (2) being provided by axial movement of the filling head (2) and filling tube (9) relative to the remainder of the system.

5. Method in accordance with claim 1 or 2, c h a r a c t e r i z e d by the axial movement of the filling head (2) being provided by a pivotal movement of the filling head (2) and filling tube (9), possibly together with the pump (8), said pivotal movement providing an axial component of movement for the filling head (2).

6. Method in accordance with claim 5, c h a r a c t e r i z e d by said pivotal movement being performed in a horizontal plane (turning) or in a vertical plane (tilting).

7. Method in accordance with claim 1 or 2, c h a r a c t e r i z e d by the axial movement of the filling head (2) being provided by a linear movement of the filling head (2) and filling tube (9), possibly together with the pump (8), said linear movement providing an axial component of movement for the filling head (2).

8. Method in accordance with claim 7, c h a r a c t e r i z e d by said linear movement being provided in an angle relative to the axial direction.

9. Sealing system for use in a method in accordance with any of the preceding claims, in which at least one of the lateral and axial movements, respectively, is provided by moving the pump (8) and filling tube (9) together with the filling head (2), c h a r a c t e r i z e d by the pump (8) being positioned in a lid (11) positioned on top of the pump oven (7), said lid (11) being in pressure contact with a corresponding flange on the pump oven (7), a sealing material (10) being provided between the lid (11) and the flange of the pump oven (7).

10. Sealing system in accordance with claim 9, c h a r a c t e r i z e d by the sealing material (10) being provided in the form of a flexible fibre ceramic material.

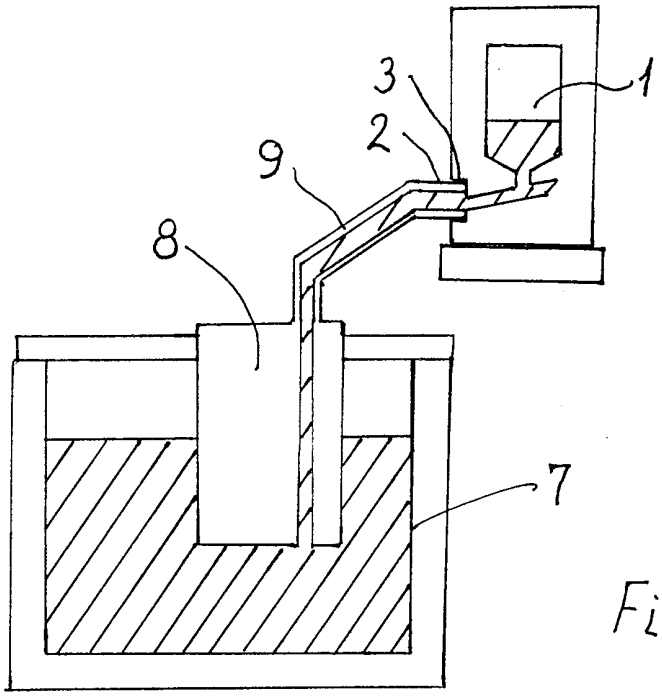


Fig. 1

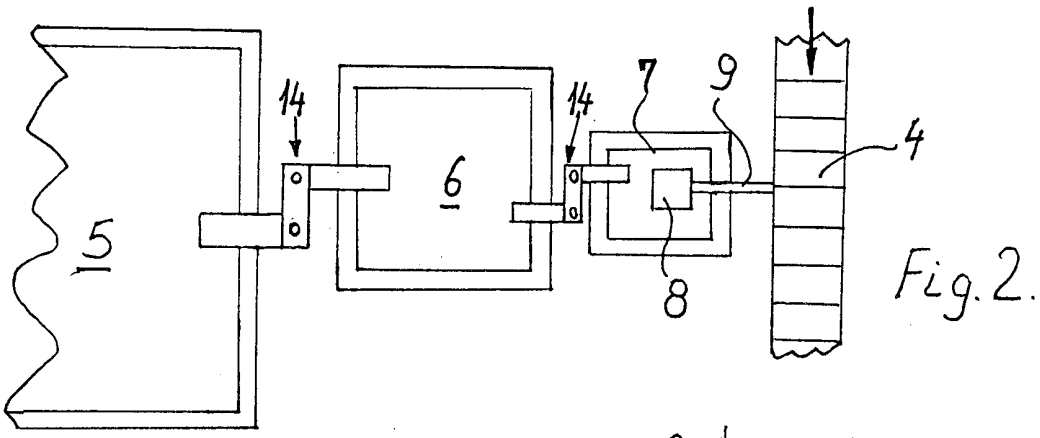


Fig. 2.

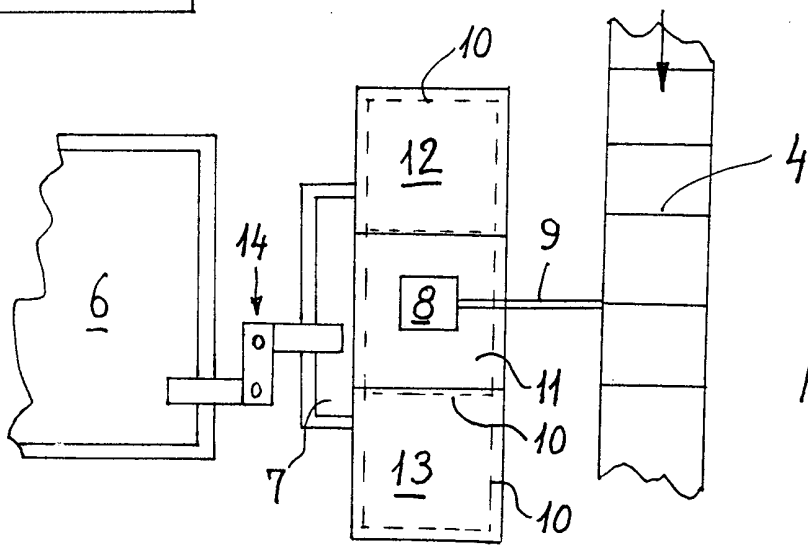


Fig. 3

Fig.4

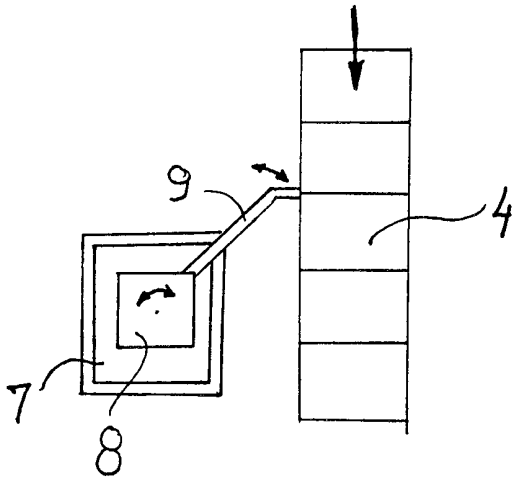


Fig.5

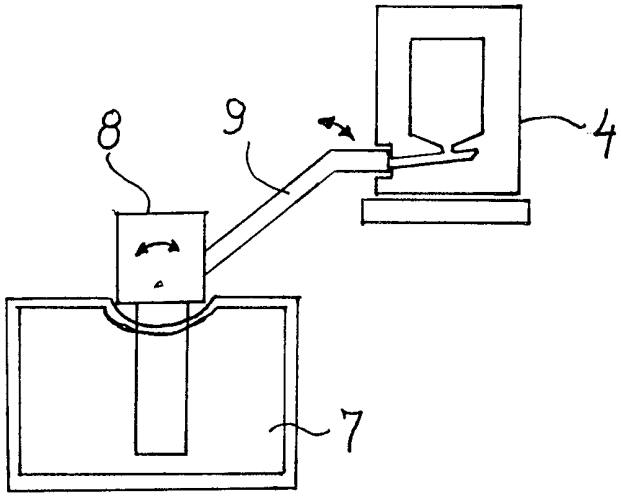
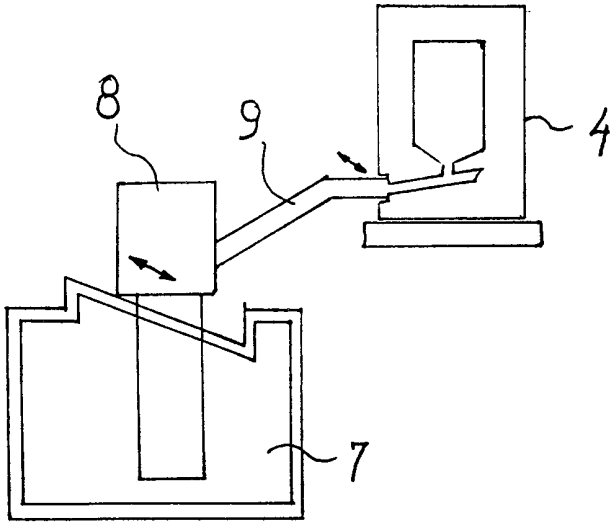


Fig.6



INTERNATIONAL SEARCH REPORT

Intern ial Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B22D35/04

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

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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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Information on patent family members

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