METHOD FOR THE PRODUCTION OF CASTINGS FROM ALLOYS OF METALS AND GASES

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ABSTRACT

Method of and apparatus for dissolving a gas in molten metal and casting the metal in that condition. During the casting process a reservoir with the melt and the mold for the casting are disposed in separate chambers, such chambers being subjected to the pressure of an atmosphere composed by the gas to be dissolved in the molten metal and some other gas which is inert to the metal, the gases being present in such proportion that the partial pressure of the gas to be dissolved in the chamber with the mold is higher than that in the chamber with the reservoir for the melt. Thus, the solubility of the gas, which depends upon its partial pressure, may be equal in the melt, as well as in the solidifying metal; the total gas pressure in both chambers may be chosen in accordance with the requirement of the casting process, so that the melt may be conveyed to the mold.

4 Claims, 2 Drawing Figures
METHOD FOR THE PRODUCTION OF CASTINGS FROM ALLOYS OF METALS AND GASES

The invention relates to a method of production of shaped castings from metals and metal alloys, which contain in solid state a dissolved or chemically bound gas, in such a quantity as to exert an advantageous influence on the physical, chemical or other properties of the material obtained, as well as to an apparatus for the realization of the method. It is known, that gases when contained as a solid solution or chemically bound components in the structure of metals, have an extremely favorable effect on their properties. Nitrogen, as a typical example, induces in a number of iron-based alloys the formation of structures with improved or new properties. It is known on the other hand, that metals can dissolve, when in liquid state substantial gas quantities, but this capacity is greatly reduced when the metal is in solid state. This peculiarity results in very unpleasant effects in foundry practice: the gases dissolved in the molten metal separate during its solidification, forming blowholes and other breaks in the structure. Therefore special measures are required to prevent the gases from dissolving in the melt, or to lead off these gases before the solidification of the metal takes place, e.g., by using vacuum.

It is possible to carry out the casting process in an autoclave at an increased pressure of a gas whose dissolution is desirable. It is essential in this case that the pressure of the gas to be dissolved should be even higher during the solidification of the casting in order to prevent the separation of the gas dissolved, as a result of its lower solubility in the metal in solid state, corresponding to the crystallization temperature. The obtaining of metal-gas alloys in an autoclave is a method that cannot be applied in the routine production of shaped castings from this type of alloys, since they would be too expensive; therefore this method is of importance for laboratory purposes only. The reason for this is that in autoclave casting the molten metal and the casting are disposed simultaneously in the autoclave space. If a high pressure of the gas to be dissolved is produced inside, this will increase its concentration in the melt, and the said gas will separate in the form of blowholes when the casting solidifies.

This can be avoided if the pressure is abruptly increased during the crystallization process. Thus the desired alloy can be obtained, but the melt is saturated with still more gas, this being undesirable and requires a pressure reduction and degassing of the melt. For these reasons, it is not possible in an autoclave apparatus to work with a reservoir for molten metal, containing a larger quantity than required for one casting, which makes such method more expensive.

The object of the present invention is to overcome the existing difficulties in obtaining highly efficient alloys from metals and gases by using a method which eliminates all the disadvantages mentioned, i.e., a method permitting the obtaining by comparatively simple means castings from such alloys in moulds, whereby the molten metal is treated with the gas to be dissolved in a separate reservoir, which is larger compared to the weight of the casting.

According to the present invention this problem is solved in such a way that during the casting process the reservoir with the melt and the mould are disposed in separate chambers, and are subjected to the pressure of an atmosphere composed by the gas to be dissolved, and some other gas which is inert to the metal, in such proportion, that the partial pressure of the gas to be dissolved in the chamber with the mould is higher than that in the chamber with the reservoir for the melt. Thus, the solubility of the gas, which depends on its partial pressure, may be equal in the melt, as well as in the solidifying melt, and the pressure of the gas in both chambers may be chosen in accordance with the requirements of the casting process, i.e., to be equal in both chambers, or to be increased from the side of the chamber with the reservoir for the melt, so that the melt may be conveyed to the mould.

FIG. 1 shows a first embodiment of apparatus, in which the melt is conveyed under the action of gas pressure; and FIG. 2 shows a second embodiment of apparatus, in which the melt is conveyed gravitationally.

Turning now to FIG. 1, the reservoir for the melt 1 is placed in a hermetically closed and heat-insulated or heated chamber 2, and is connected by means of a delivery pipe 3 to the mould, which is closed in another hermetic chamber 5. In order to control the connection between the two chambers, a valve 6 and a barrier 7 are provided on the delivery pipe 3 along the path of the metal, which can be controlled by means of familiar devices, i.e., selectively to close and open the delivery pipe while the process takes place.

Two reservoirs 8 and 9 contain under pressure the gas being dissolved mixed with an inert gas at different and suitably chosen concentrations, while a circulation-regenerative system 10 is provided for purification and returning to these reservoirs the gases that escape from the hermetic chambers with the reservoir for the melt and with the mould. The capacity and the pressure of the gas flows are controlled by the valves 12 to 17.

According to the present invention, the process is carried out in the apparatus of FIG. 1 in the following way.

While the barrier 7 is closed and the valve 6 is open, the chamber 2 with the reservoir for the melt 1 is filled by opening the valve 12 to permit a gas mixture from the reservoir 8 to flow into a tube 11 immersed in the melt for treating it. It is important that the delivery of the gas mixture should be done slowly and should take place through the melt, by means of the pipe 11 or through a porous wall at the bottom of the crucible, thus ensuring a good mixing of the gas with the melt.

At the same time, a gas mixture from reservoir 9 is let in through the valve 13 into the chamber 5 with the mould 4. The pressures in both chambers 2 and 5 are equal during this preparatory stage of the process, so that by opening the barrier 7 no moving of the melt is provoked.

By closing the valve 6 and increasing the pressure in chamber 2, the melt is conveyed along the delivery pipe 3 to the mould 4 and fills it. If the concentration of the active gas in the reservoir 9, respectively in the chamber 5 and the mould 4, is considerably higher than that in the reservoir 8 and in the chamber 2, it is not possible, because of the short time of filling the mould, to enrich considerably the molten metal with gas; but the whole crystallization process in the mould, which begins immediately after filling of the said mould with melt, takes place at a high partial pressure of the active gas, i.e., the gas already dissolved in the melt 1 cannot be separated from the solidifying melt and remains dissolved in the said melt. By making the pressure in each chamber (both the source of the melt and the mould) equal after filling the mould, the superfluous melt from the delivery pipe returns in the reservoir for the melt, and the barrier 7 may be closed. It will be easy, if needed, to increase additionally the pressure of the active gas in chamber 5 during the period till the crystallization of the casting is completed.

The casting is removed from the mould 4 after the active gas from chamber 5 has been sucked through valve 17 in the circulation-regenerative system 10, in order to be returned in reservoir 9. After the removal of the filled mould and the placing of an empty mould and restoring the initial condition of the apparatus, the casting process may be repeated. During the whole time the gas atmosphere in chamber 2 with the reservoir for the melt 1 is not exchanged, while the pressure varies only within narrow limits, so that the melt can be moved towards the mould or back. In accordance with this, valve 16 is operated for sucking the gas from chamber 2 only after the melt in chamber 5 has been totally drained.

According to another quite analogous execution, as shown in FIG. 2, the apparatus may operate while the melt is conveyed to the mould gravitationally. As shown in FIG. 2, the apparatus has the same basic elements as the apparatus of FIG. 1, and designated by the same reference characters. In the apparatus of FIG. 2, however, the reservoir for the melt is disposed higher than the mould 4. The melt flow may be controlled by a known stopper device 18, which is operated from
outside the reservoir for the melt, and opens or closes the pouring hole at the bottom of said reservoir at will.

What is claimed is:

1. A method for the production of castings from alloys of metals and gases, which comprises disposing a reservoir for a melt of metal in a first hermetically closed chamber, disposing a mould in a second hermetically closed chamber, subjecting both chambers to the pressure of an atmosphere composed of the gas to be dissolved in the molten metal and some other gas which is inert to the metal, feeding molten metal from the reservoir into the mould, and controlling the proportions of said gases so that the partial pressure of the gas to be dissolved in the second chamber is higher than that in the first chamber, and maintaining such condition until the casting completely solidifies.

2. A method for production of castings from alloys of metals and gases according to claim 1, wherein the gas pressure in the second chamber is abruptly increased after the mould has been filled with molten metal.

3. A method according to claim 1, wherein the mould is disposed above the reservoir, and causing a charge of metal to be fed upwardly from the reservoir to the mould by increasing the gas pressure in the first chamber with respect to that in the second chamber.

4. A method according to claim 1, wherein the mould is disposed below the reservoir, and comprising feeding a charge of metal from the reservoir to the mould by gravity.