(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 178 296**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **85890256.2**

(22) Date of filing: **11.10.85**

(51) Int. Cl.⁴: **B 22 C 9/06**, B 22 C 9/22

(30) Priority: **12.10.84 YU 23840/84**

(43) Date of publication of application: **16.04.86**
Bulletin 86/16

(84) Designated Contracting States: **AT BE CH DE FR IT LI SE**

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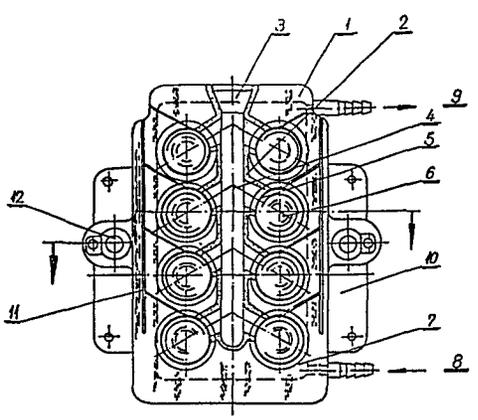
(54) Permanent mould with insert for casting mill balls and other crushing elements.

(57) The subject of this invention is production of permanent metal moulds (1) with insert (2) of the gating system for casting mill balls and other crushing elements.

The known method for mill balls casting are those using moulds of sand-binder mixture which moulds can serve for a single use only. Disadvantage of such moulds is in their lower heat conductivity which affects the structure and properties of produced balls. To get the appropriate quality grade of balls it is necessary, apart from the high content of alloying elements, to apply very complex thermal treatment. Authors of this invention have solved the problem in such a way that one metal mould can serve for repetitive use of several thousand times. With regard to thermo-physical properties of the mould, cooling of cast balls can be very intensive owing to which the casting process gives such structure and other ball properties that balls of high quality can be produced even from materials having a lower content of alloying elements. The problem of ball rising is solved by introducing an insert made from sand-binder mixture in which way the issue of controlled metal solidification in the mould has also been solved.

To increase the operational life of tools (metal moulds), and to make them easy replaceable, and to lower the costs of mould amortization, authors have introduced ball crystallizers (14) in the mould (1) as replaceable part. In this way, after some time of mould operation, only the crystallizers (14) are to be replaced and since all other mould parts (2-13) are rather resistant to wear and tear their operational life will last long.

Crystallizers (14) are made from alloyed steel, suitable for water cooling, or are made from hard copper i.e. Cu-Cd; Cu-Cr; Cu-Ag and Cu-Be to which the alloying elements are added in small quantities which do not affect heat conductivity of copper but on the contrary increase its hardness.



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PERMANENT MOULD WITH INSERT FOR CASTING MILL BALLS AND OTHER CRUSHING ELEMENTS

Technical field

This invention relates to the casting art and more particularly to design and production of permanent metal moulds for casting. According to the International Patent Classification the subject of this invention is classified and coded as B22 C 9/06 and B22 C 9/22.

Technical problem

Technical problem solved by this invention is how to design and produce casting tools i.e. the permanent metal moulds for casting mill balls and other crushing elements using casting technology which ensures controlled solidification of poured metal.

The objective of the present invention is to provide a method for fast and economic production of permanent metal moulds for mill balls and other crushing elements of high quality grade without shrinkage cavities and also to ensure production of permanent metal moulds of long operational life and consequently at low cost calculated per unit of the finished product.

State of art

The known casting methods for production of mill balls and other crushing elements use moulds made from a mixture of sand and binder, and such moulds are used for a single

casting procedure only.

This method has numerous disadvantages i.e.:

For each casting run it is necessary to prepare a new mould so when mass production of mill balls is concerned such method requires extensive use of machines and equipment, high consumption of sand and binder and, of course, lot of labour and availability of large foundry floor area including also the floor area for finishing process.

Moulds made from sand and binder mixture have a lower heat conductivity, compared with metal used for permanent moulds, and therefore mill balls cast in such moulds are of lower properties and this is particularly true for ball structure on which ball hardness depends and consequently tear and wear of the ball itself.

To get the appropriate quality grade of balls cast in moulds made of mixture of sand and binder, it is necessary to provide alloying with a higher content of carbidizing elements, using very complex thermal treatment at high temperatures.

For production of moulds from the mixture of sand and binder for casting mill balls and other ore crushing elements, for grinding cement and other powdered materials, it is normal to use dies and models made from wood, light and non-ferrous metal alloys and steel. Which material will be used for models and dies depends on the method of production of moulds from the mixtures of sand and binder.

Technical problem description

Permanent moulds which are the subject of this invention solve all the problems which normally appear in the known

classic technologies of casting such as:

The moulds which are the subject of this invention are permanent and serve for repetitive use (several thousands of casting runs). In this way only limited number of machines and equipment is used for their production requiring small floor area in the foundry and small number of workers..

Material i.e. metal from which the permanent moulds are made is characterized by better heat conductivity compared to sand moulds, owing to which mill balls produced in such moulds are of adequate properties, of even lower content of alloying elements without regard the complexity of thermal treatment procedure.

The invention refers to metal mould with an insert of the gating system which serves for casting mill balls and other crushing elements. Mill balls and other crushing elements are cast from alloyed iron in metal moulds which provide directed and controlled solidification of metal poured in the mould by means of its gating system inserts.

The ball as a geometric body has the smallest developed surface and volume as compared to all other geometric bodies owing to which it is extremely difficult to produce economically a sound ball without shrinkage cavities when both the ball and the gating system solidify in the mould of same physical-thermal properties. The principle which has to be satisfied in casting technology is that the part which is cast must solidify first then the riser whose role is to "rise" the cast as to prevent occuring of shrinkage holes. When casting balls are concerned the gating system serves for both pouring the matal , i.e. for filling of mould cavity with metal,and "rising" the cast balls to prevent occuring of shirnkage holes in the balls.

This invention solves the problem of making metal moulds of long operational life with regulated metal pouring, controlled solidification of poured metal and"rising" of balls which is described herewith in reference with

Variants presented and figures enclosed.

Variant I, permanent mould with insert having oblique ingates and crystallizer for ball forming, in which crystallizers made from steel or copper alloy are installed.

Fig.1 represents the face side of one half of the mould with gating system insert with oblique ingates and crystallizers for casting mill balls and other crushing elements, in which the following mould parts are numerically marked: 1. mould body; 2. shell insert for gating system inserting; 3. pouring cup; 4. sprue; 5. oblique ingate; 6. cavity in which ball is formed; 6'.gating system cavity for inserting the insert; 7. cooling chamber; 8. connection for filling the chamber with water; 9. connection for draining water from the chamber; 10. plate for cooling chamber closing and for installing the mould on the machine; 11. canals for gas escape from mould cavity; 12. centering pieces.

Fig.2 represents the cross-section of closed mould with gating system insert, with oblique ingates and crystallizers for mill balls and other crushing elements casting, in which the following mould parts are numerically marked:

1. mould body; 2. shell insert for gating system inserting; 4. sprue; 5. oblique ingates; 6. cavity in which the ball is formed; 6'. gating system cavity for inserting the insert; 7. cooling chamber; 8. connection for filling the chamber with water; 10. plate for closing the cooling chamber and installing the mould on the machine; 12. centering pieces; 13. cooling chamber seal ring; 14. ball crystallizer made from alloyed steel or copper. 14' cavity in which crystallizer is installed.

Crystallizers in which balls are formed are made from alloyed steel or copper, i.e. from copper alloy with silver, cadmium or chromium. With respect to good heat conductivity and thermal shock resistance, the solution with the crystallizers

increases the operational life of the moulds and consequently effects the quality of balls in the positive sense. Increase of the operational life in this variant of the mould by several tents more compared to the variant I, is reflected through the cost of the mould and economy of mill balls production.

Variant II, permanent mould with gating system insert, with horizontal ingates and crystallizers, as shown in Figs. 3 and 4, is made from grey or nodular cast and in which moulds crystallizers of alloyed steel or copper, i.e. copper alloy with silver, cadmium or chromium are installed.

Fig.3 represents the face side of one half of the mould with gating system insert with horizontal ingates and crystallizers designed for casting mill balls and other crushing elements, and in which figure the following mould parts are numerically marked:

1. mould body; 2. shell insert for gating system inserting; 3. pouring cup; 4. sprue; 5. horizontal ingate; 6. cavity in which ball is formd; 6' gating system cavity for inserting the insert; 7. cooling chamber; 8. connection for draining water from cooling chamber; 10. plate for closing the cooling chamber and installing the mould on the machine; 11. canals for gas escape from the mould cavity; 12. centering pieces.

Fig.4 represents the cross-section of closed mould with gating system insert, with horizontal ingates and crystallizers for casting mill balls and other crushing elements, in which figure the following parts of the mould are numerically marked: 1. mould body; 2. shell insert for gating system inserting; 4. sprue; 5. horizontal ingate; 6. cavity in which ball is formed; 6'. gating system cavity for inserting the insert; 7. cooling chamber; 8. connection for filling the chamber with water; 10. plate for cooling chamber closing and for installing the mould on the machine; 12. centering pieces; 13. cooling chamber seal ring; 14. crystallizer made from

alloyed steel or copper; 14'. cavity in which the crystallizer is installed.

Permanent moulds according to variants I and II differ in respect of the ingate position in relation to sprue. In variant I the ingates are positioned at acute angle in relation to the sprue, and in variant II ingates are positioned at 90° angle in relation to the sprue.

In both variants the cavities in which balls are formed are connected through the ingate with the sprue and the sprue is connected with the pouring cup. Between the poring cup and the sprue a choke can be provided in form of ingate "bottleneck". At the end of the ingate which can be positioned at an acute or right angle, for horizontal pouring, at the contact of ingate and ball a tooth will be formed, tangential to the ball, whose role is to form a notch on ingates. This notch creates stresses and consequently initiates separation of balls from the gating system.

The gating system which is formed in the insert has the role to introduce metal to the mould cavity in which balls are formed,and at the same time it serves as a "riser". Material used for the gating system insert must be of lower heat conductivity compared to metal from which mould is produced. Because of that the gating system inserts are made from moulding sand i.e. from the mixture of sand and binder which may be of organic or inorganic nature. The gating system insert is 3 to 5 mm thick.

BEST MODE FOR CARRYING OUT THE INVENTION

For casting mill balls and other crushing elements in permanent mouldith gating system insert it is necessary to design and prepare:

- core box for gating system, and
- metal mould.

The core box is to be made from grey or nodular cast adjusted to the machine for cores production after some modern process

which uses a mixture of resins of organic nature as the binder. The most appropriate is Shell process for which coated sand is used.

The metal mould is most appropriately made in three parts: cooling chamber, mould body and crystallizers.

The cooling chamber can be of welded or cast structure, with suitable holes for connecting the mould to the cooling chamber and with connections for water inlet and outlet.

The mould body is to be cast from grey or nodular cast. In the mould cavities for gating system inserts and cristallizers should be provided. For connecting the mould body to the cooling chamber a flange is provided with eyelets for centering pieces mounting.

Crystallizers are the most sensitive and most loaded parts of the permanent mould. Because of that they are made from such material which has good heat conductivity and which allows cooling with water or with some other fluid.

At the contact crystallizer-mould body a seal based on asbestos and graphite is used. The crystallizer is connected to the mould body by means of bolts or special nuts.

The operational life of such a permanent mould will depend to a large extent on the operational conditions. The conditions for proper operation of a permanent mould are:

- before operation with the permanent mould it must be preheated at a temperature of 40 to 50°C..
- After heating the mould to the above temperature, the mould cavities should be coated with acetylenic soot. This soot coating procedure should be repeated after every third run.
- Before casting, the cooling chamber must be filled with water. During casting process the mould must be intensively cooled, taking care that the temperature variation between input and output water does not exceed 15°C.
- Other technological parameters such as temperature of

casting, rate of casting, cooling period in the mould etc will depend on ball size.

C L A I M S:

1. What is claimed is PERMANENT MOULD WITH INSERT FOR CASTING MILL BALLS secured on plates for cooling chamber closing whereby centering pieces are provided for proper closing, which mould consists of the body (1) characterized by a chamber (7) connected from outside to the body, or characterized by cooling pipes serving for cooling the body from inside, in which body (1) cavity (6) is provided for forming balls and which cavity is connected with cavities (6') in which cavities insert (2) is provided made frome core mixture for inserting, with pouring cup (3) on top of the insert (2) and oblique or straight ingates (5) connecting cavities (6) for forming balls to the sprue (4) which is provided in the middle of the insert (2) and which connects the pouring cup (3) with ingates (5).

2. Permanent mould with insert for casting mill balls and other crushing elements according to Variant I and Claim 1, which mould consists of the body (1) characterized by a cavity(14')in which crystallizer (14)is installed having a cavity (6) for forming balls which cavity (6) is connected with cavity (6') whereby insert (2) is provided in cavity (6') for inserting, and in which insert the insert ingates (5) are positioned at an acute angle in relation to sprue (4).

3. Permanent mould with insert for casting mill balls and other crushing elements according to Variant II and Claim(2) whereby ingates (5) are positioned at right angle in relation to sprue (4).

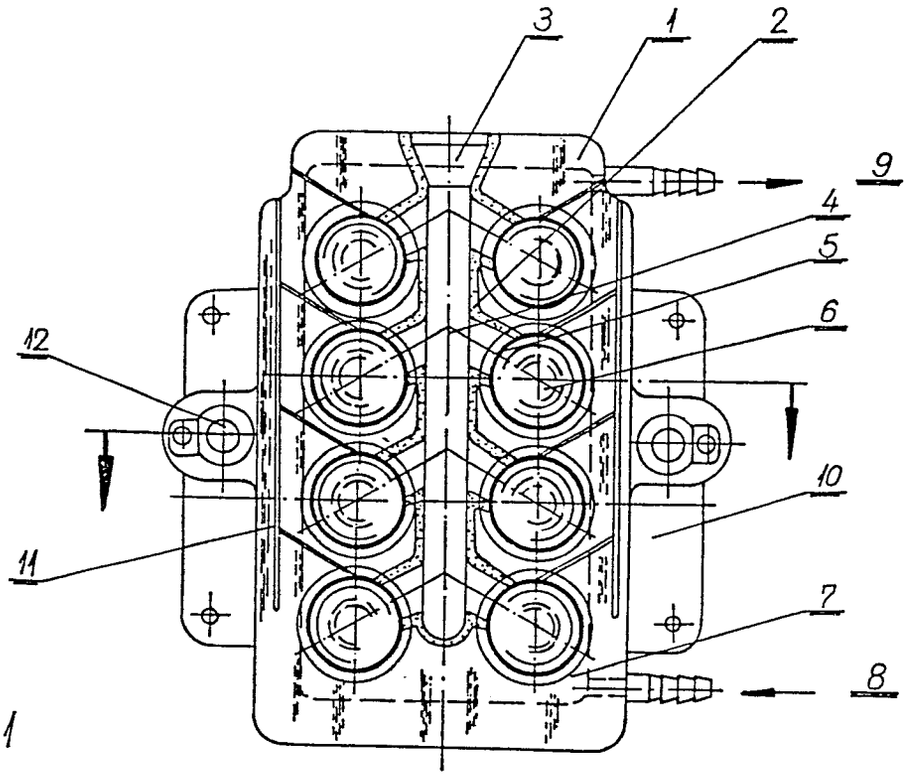

Fig. 1

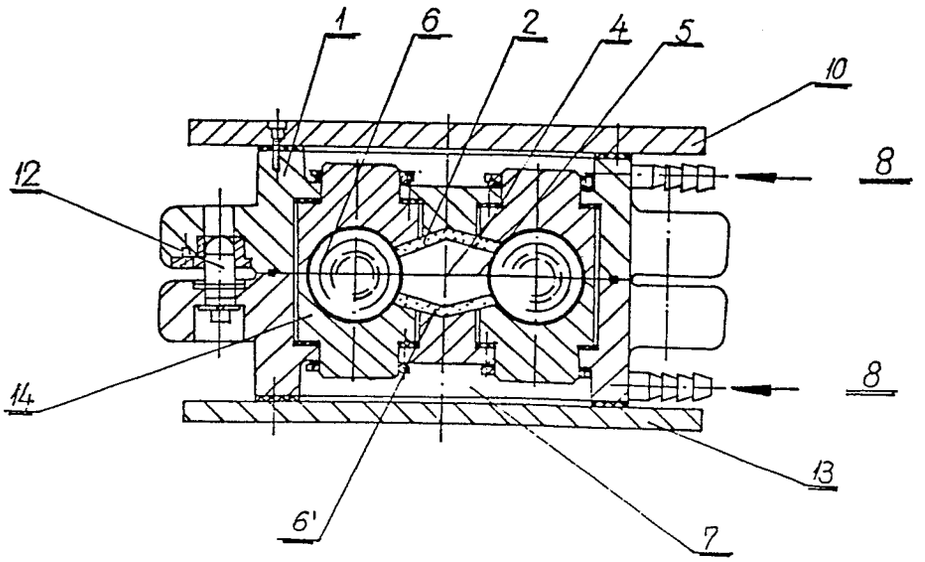

Fig. 2

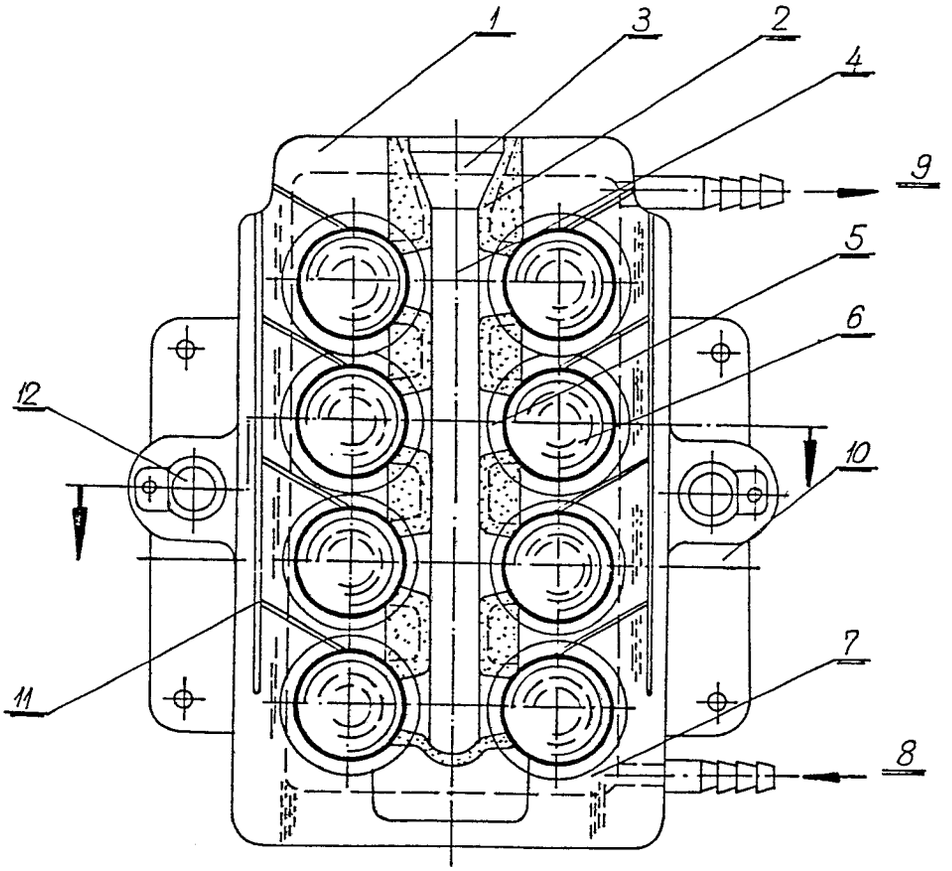

Fig. 3

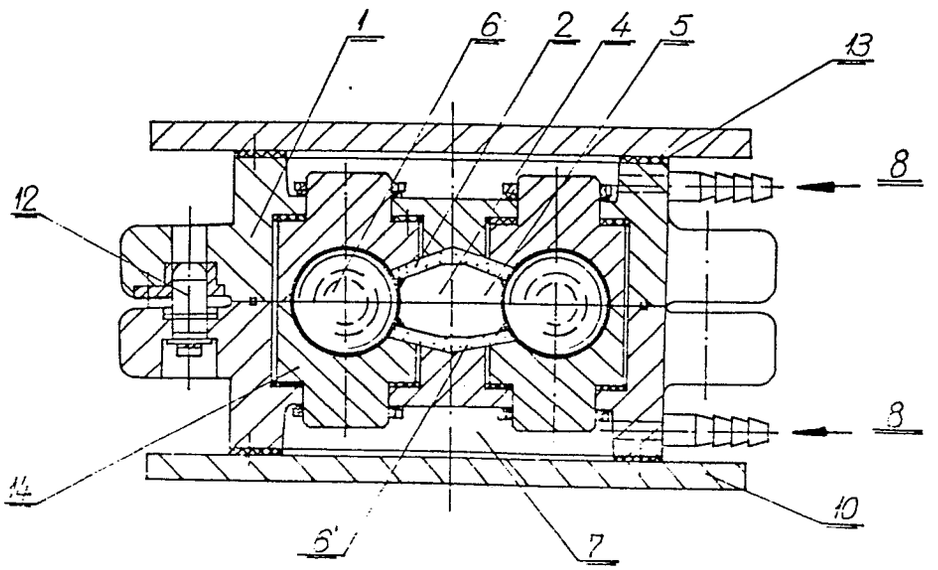

Fig. 4