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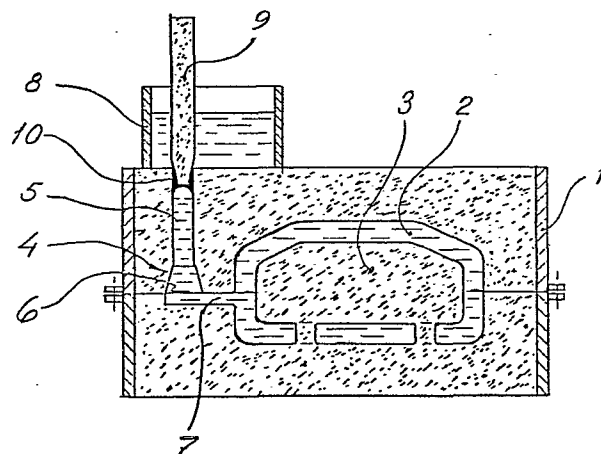
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⑤④ **Method of casting melts of materials, the course of solidification of which comprises an expansion followed by a contraction.**

⑤⑦ The invention relates to a method of casting such melts of materials, the course of solidification of which comprises an expansion followed by a contraction, for example grey iron alloys, nodular iron, etc. The molten material is supplied to the mould cavity (2) in a mould (1) via one or more sprues (5) with following inlets (7) in direct communication with the mould cavity (2), after which the connection of the mould cavity (2) to the environment is blocked at a moment selected so that at least some of said expansion and following contraction takes place in the space closed by said blocking. What is characteristic of the inventions is that the blocking is brought about by cooling a portion of the spure (5) so that a solidified plug of material (10) is formed in the spure (5) before the material present in the inlet (7) solidifies.



METHOD OF CASTING SELTS OF MATERIALS, THE COURSE OF
SOLIDIFICATION OF WHICH COMPRISES AN EXPANSION FOLLOWED
BY A CONTRACTION

5 The present invention relates to the casting of
melts of materials, the course of solidification of
which comprises an expansion followed by a contraction,
for example grey iron alloys or nodular iron.

10 The changes in volume which materials of the said
kind undergo during cooling of a melt of the material,
follow a common pattern to a greater or lesser extent.
If the initial temperature of the melt is sufficiently
high, a contraction of the material in the liquid phase
is first obtained during cooling. Then an expansion
15 follows, after which a secondary contraction occurs down
to the specific volume of the material in the solidified
state. Casting of melts of materials of the said kind
takes place in certain cases under such temperature
conditions that during the course of the cooling, the
20 casting melt undergoes both said initial contraction and
the following expansion and secondary contraction. In
other cases, the casting takes place with a temperature
of the melt selected so that only an expansion followed
by a contraction is obtained during the course of the
25 cooling and solidification. The changes in volume which
occur during the course of solidification make it
necessary, in both cases, to take precautions to prevent
the formation of cavities, so-called pipes in the
finished casting.

30 The method most commonly used to prevent the forma-
tion of cavities in the castings caused by the shrinkage
during the course of solidification is to form the cast-
ing system with a feed system, that is to say to connect
the mould cavity in the mould to one or more feeders
35 from which melt is supplied at the rate and in the amount

which is required to compensate for contraction which occurs during the course of solidification. Forming the casting system with a feed system involves a complication. The design and placing of the feeders requires
5 careful consideration; the dimensions of the mould increase; output is lower and cleaning and after-treatment of the casting involve more labour.

According to another known method, the expansion of the melt during the course of the solidification is
10 used to compensate for the following contraction. According to the known method, this is achieved by dimensioning the inlet to the mould cavity so that this solidifies at a moment selected so that the expansion of the melt during the course of solidification takes place
15 in the mould cavity closed by means of the solidified inlet. In this case, the expansion leads to an increase in pressure which causes a resilient compression of the mould walls. Since the deformation of the mould walls lies within the resilient range, the mould tends to
20 return to its original shape, which means that the casting is also compressed, which prevents the formation of cavities in the casting. In certain cases, the method means that the need for feeders is completely eliminated, in other cases that feeders are required only to a
25 limited extent. The method described above is practised in some different modifications, three of which will be discussed in more detail below.

One form of carrying out the known method is practised with castings with thin material and where the
30 initial temperature of the melt is so high that the course of the cooling begins with a contraction in the melt. The inlet to the mould cavity is dimensioned so that the inlet is caused to solidify first at such a temperature of the melt that its initial contraction
35 ceases and the course of the expansion begins during the

continued solidification. This means that a certain feed from the casting system takes place during the initial stage of the course of casting to compensate for the initial contraction of the melt. As a result of said dimensioning of the inlet, the connection between the casting system and the mould cavity is blocked as a result of the fact that the melt solidifies in the inlet at the moment when the expansion begins, which leads to an increase in pressure in the mould cavity as a result of which the resilient changes in shape of the mould walls, mentioned earlier, take place.

A second form of carrying out the known method is practised with larger castings and where the initial temperature of the melt is selected so that continued cooling of the melt takes place with expansion followed by a contraction. The inlet to the mould cavity is dimensioned so that the inlet solidifies or "freezes" as soon as the mould cavity is filled with melt. The continued course of the solidification thus begins with an expansion followed by a contraction. With this form of execution of the method, the need for feeders is completely avoided.

A third form of execution of the known method is practised when casting in moulds where the mould sand is only able to take up a limited increase in pressure through resilient compression of the mould walls. The inlet to the mould cavity is dimensioned so that a certain further feeding of melt to the casting system takes place during the expansion phase of the melt, the inlet being caused to solidify at such a temperature that the continued expansion during the course of the solidification leads to such an increase in pressure in the mould cavity that the following compression of the mould walls lies within the elastic range. The diffi-

culties in finding the correct dimension of the inlet when practising this modification are greater than with the modifications mentioned earlier and generally presuppose the carrying out of practical tests to find a
5 suitable dimension.

As can be seen from the description given above of the methods whereby the expansion during the course of solidification is used to compensate for the following contraction, the methods are based on an accurate and
10 correct dimensioning of the inlet to the mould cavity so that the melt in the inlet solidifies or "freezes" at the right moment. As a consequence of this, the inlet determines the dimensions for the whole casting system, since the dimensions of the sprue and runner
15 must be in a certain relationship to the area of the inlet. This is an important disadvantage of the methods in question and restricts the possibilities for the optimum dimensioning of the casting system. It is actually a desideratum to be able to dimension the casting
20 system so that the most rapid filling possible of the mould cavity is obtained. If the filling of the mould cavity with melt takes place too slowly, then apart from undesirable temperature variations in the melt, there is also the risk that the gas generation
25 which takes place on contact of the melt with the core may go out into the mould cavity instead of leaving through passages specially provided for the purpose in the core. The requirement of rapid filling of the mould cavity with melt while at the same time the dimensions
30 of the inlet should be adapted for solidification at the correct moment can lead to a very large number of inlets having to be provided. This involves increased work during finishing of the completed casting. The dimensions of the inlet may sometimes lead to the fact that
35 the melt is supplied to the mould cavity in the form of

jets of liquid which can have an eroding effect on the core with defects in the finished casting as a result. A further disadvantage of the said known method is the difficulty of determining precisely, by dimensioning
5 of the inlet, the moment at which the solidification should take place. Even if the inlet is dimensioned correctly, variations in the mould sand and varying temperature conditions in different parts of the mould may lead to unwanted variations in the moment of solid-
10 ification for the various inlets.

The present invention, which also utilizes the expansion during the course of solidification of the material melt to compensate for the following contraction, has as its object to indicate a method whereby
15 the above-mentioned disadvantages of the known method are avoided and which thus permits full freedom with regard to the dimensioning of the casting system, renders possible the use of fewer inlets and permits a precise determination of the moment at which blocking
20 of the casting system shall take place to utilize the expansion of the melt for the purpose of compensating for shrinkage.

According to the invention, this object is achieved by the characterizing features given in the following
25 patent claims.

The invention is described below, on the one hand in its general application and on the other hand as applied to three modifications corresponding to the three modifications described in connection with the
30 known method, and finally in connection with a concrete example of embodiment, illustrated diagrammatically in the accompanying figure which shows a section through a mould with mould cavity, core and casting system with pouring gate.

35 As can be seen from the preamble to patent claim 1,

the invention is intended to be used during the casting of melts of materials which, during the course of solidification, undergo an expansion followed by a contraction, for example grey iron alloys, nodular iron, etc. The molten material is supplied to the mould cavity in the mould via one or more sprues with following inlets in direct communication with the mould cavity. The connection of the mould cavity to the environment is then blocked at a moment selected so that at least some of said expansion and following contraction takes place in the space closed by said blocking. What is characteristic of the invention is that the blocking is brought about by cooling of a portion of the sprue so that a solidified plug of material is formed in the sprue before the material present in the inlet solidifies. According to a preferred form of execution of the invention, this cooling is brought about by inserting a plug of sand in the sprue. The consequence of this is that the melt immediately begins to solidify adjacent to the sand plug so that a solidified plug of material, closing the sprue, is quickly formed. The course of solidification and formation of the plug of material closing the sprue are accelerated by forming the plug of sand with an end narrowing in a taper. The casting system is thus separated from the environment and the increase in pressure which is obtained on expansion of the melt during the course of solidification is caused to act in the whole casting system, including the mould cavity. In this, the method according to the invention differs from the method previously known. Since the blocking takes place in the sprue instead of in the inlet, this can be formed with such optimum dimensions as are required to obtain a rapid and suitable filling of the mould cavity. Since a solidified plug of material is

formed in practice immediately after the plug of sand is inserted in the sprue, the moment at which the blocking of the casting system shall take place so that the expansion of the melt during the course of solidification can be used in the optimum manner, can be selected with great accuracy.

During the casting of melts of materials, the initial temperature of which is so high that the course of cooling begins with a contraction, it is necessary to wait before inserting the plug of sand in the sprue until the temperature of the melt, after filling of the mould cavity, has sunk to the value at which the initial contraction ceases. The moment for this can easily be determined by observing the level of the melt in the pouring gate. Because of the contraction of the melt, the level of the melt in the pouring gate drops even after the mould cavity is filled. When the temperature of the melt has dropped to the value at which the initial contraction ceases, the level of the melt in the pouring gate ceases to drop. The correct moment for inserting the plug of sand in the sprue is therefore, in this case, the moment when the level of the melt in the pouring gate ceases to drop.

During the casting of melts of materials, the initial temperature of which is selected so that cooling of the melt begins with an expansion, the plug of sand must be inserted in the sprue as soon as the mould cavity is filled with melt. This moment can also be determined by observing the level of the melt in the pouring gate. When the mould cavity is filled with melt, the sinking of the level in the pouring gate ceases, and the plug should be inserted in the sprue.

Also when applying the method according to the invention to casting in those moulds in which the mould sand is only able to take up a limited increase in

pressure by elastic compression of the mould walls, the correct moment for inserting the plug of sand in the sprue can be determined by observing the level of the melt in the pouring gate. With this modification
5 of the casting method, a certain after-feed of melt to the casting system should take place during the expansion of the melt during solidification. The after-feed is expressed by a rise in the level of the melt in the pouring gate. The magnitude of the rise in level at
10 which the plug of sand should be inserted in the sprue must be determined experimentally.

The application of the method according to the invention is described below with reference to an example of embodiment, illustrated diagrammatically in
15 the accompanying figure. In the figure, a vertical section is shown through a mould 1, with a mould cavity 2 and a core 3 inserted in this. The casting system 4 comprises a sprue 5, a runner 6 and a number of inlets 7 in direct communication with the mould
20 cavity 2. The sprue 5 is fed with melt through a pouring basin 8 situated above the mould 1. Inserted in the mouth of the sprue 5 there is shown a plug 9 of sand round the tapered end of which a solidified plug 10 of material is indicated. Thus the figure illustrates
25 that stage of the course of casting when the mould cavity 2 is filled with melt and blocking of the connection with the environment is effected, so that the expansion during the course of solidification takes place in the space closed by means of the plug of
30 material 10.

In the initial stage of casting, the mouth of the sprue 5 is covered by a stopper not shown in the figure. After the temperature of the melt poured into a pouring ladle and intended for casting, has been checked, the
35 pouring basin 8 is filled with melt. When the level of

the melt in the pouring basin has reached a certain level, the stopper is removed, whereupon the melt flows via the sprue 5, the runner 6 and the inlet 7 into the mould cavity 2 to fill this. Parallel with this, the pouring basin 8 is filled with the rest of the melt. If the composition of the melt and its temperature are selected so that the course of cooling begins with an expansion, the plug of sand 9 is inserted in the mouth of the sprue 5 as soon as the filling of the mould cavity 2 is terminated. This leads practically immediately to a solidified plug of material 10 being formed round the tapered end of the plug of sand 9. Continued expansion during the course of solidification thus leads to the increase in pressure in the space closed by means of the plug of material, leading to the elastic compression of the mould walls which prevents the formation of cavities in the casting during the continued solidification.

In the example of embodiment described above, the cooling of a portion of the sprue, necessary according to the invention, is brought about by inserting a plug of sand in the mouth of the sprue. The fact that the material sand is selected as a material for the plug in the preferred form of embodiment is because mould sand is easily available in foundries. The plug may, however, equally well consist of another material, for example graphite, brick, ceramic or even fibrous material or metal material. The selection of the material for the plug thus has no decisive importance. What is important is the rapid cooling of the melt to solidification which is obtained close to the plug inserted in the sprue. The plug may appropriately be shaped with a cross-section decreasing in the direction of insertion, for example tapered, so that a large cooling surface is obtained in relation to the amount of material melt adjacent to

the plug. Instead of inserting a plug, the necessary formation of a solidified plug of material of the melt can be brought about by adding an additive which accelerates the solidification to the sprue, for
5 example tellurium.

In the example of embodiment described, the casting is carried out using a pouring basin disposed on the mould. This is not, however, a prerequisite for application of the method according to the invention
10 which can equally well be used during casting without a pouring basin.

Should there be a need for very precise information regarding the temperature of the melt after filling of the mould to render possible precise determination of the moment at which "freezing" of the sprue
15 should take place, this can be effected by previously disposing temperature pick-offs at suitable places in the mould.

CLAIMS

1. A method of casting such melts of materials, the course of solidification of which comprises an expansion followed by a contraction, for example grey
5 iron alloys, nodular iron, etc., wherein the molten material is supplied to the mould cavity (2) in a mould (1) via one or more sprues (5) with following inlets (7) in direct communication with the mould cavity, after which the connection of the mould cavity
10 (2) to the environment is blocked at a moment selected so that at least some of said expansion and following contraction take place in the space closed by said blocking, c h a r a c t e r i z e d in that the blocking is brought about by cooling a portion of the
15 sprue so that a solidified plug of material (10) is formed in the sprue (5) before the material present in said inlet (7) solidifies.

2. A method as claimed in claim 1, c h a r a c -
t e r i z e d in that the upper end of the sprue (5)
20 is cooled.

3. A method as claimed in claim 2, c h a r a c -
t e r i z e d in that the cooling is brought about by inserting a plug (9) in the mouth of the sprue, preferably a plug with a cross-section decreasing in
25 the direction of insertion.

4. A method as claimed in claims 1 to 3, c h a r a c t e r i z e d in that said cooling of a portion of the sprue is carried out at such a temperature of the melt present in the mould that continued cooling
30 of the melt takes place with expansion followed by contraction.

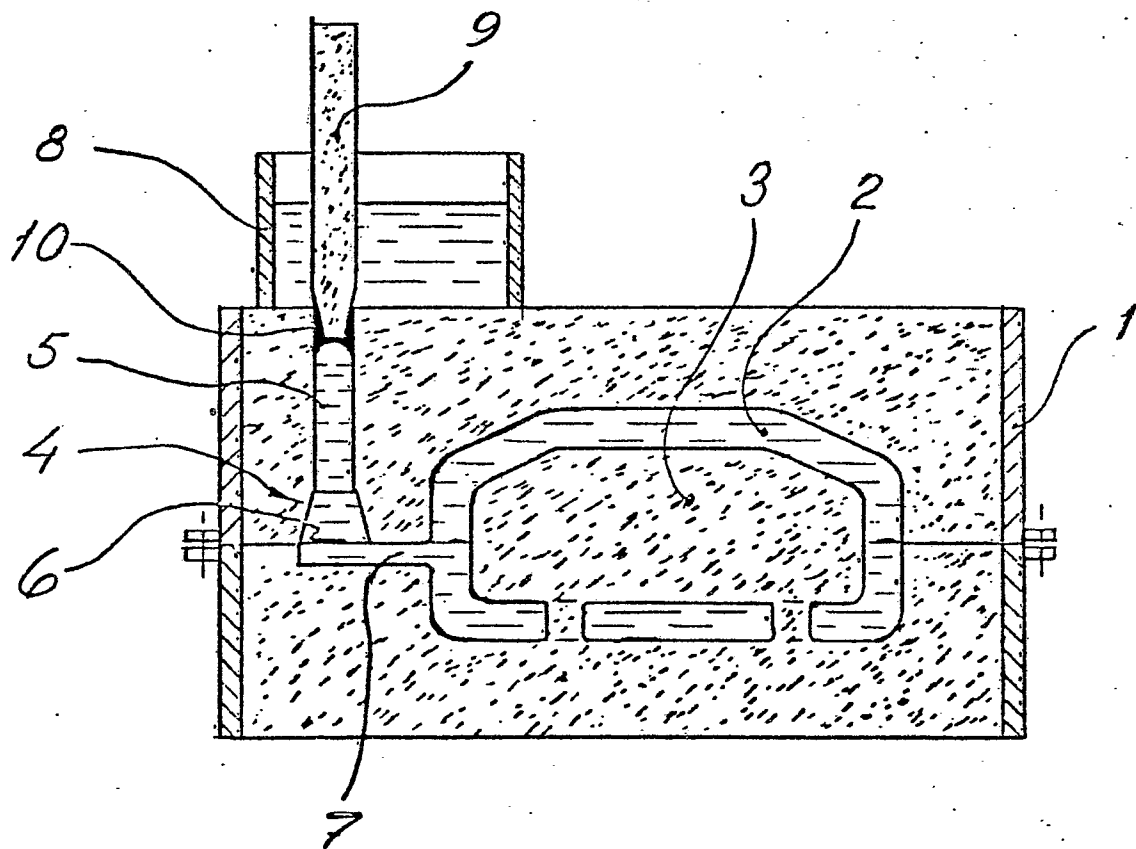
5. A method as claimed in claim 1 to 3, c h a r a c t e r i z e d in that said cooling of a portion of the sprue is carried out at a moment after
35 the mould has been filled with melt, selected so that

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a certain expansion has already taken place during the course of cooling.

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European Patent
Office

EUROPEAN SEARCH REPORT

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Application number

EP 81 85 0179

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	FR - A - 2 384 568 (PONT-A-MOUSSON) * Figures 1-4; claim 2 * --	1	B 22 D 27/09 23/02
A	US - A - 4 133 370 (PONT-A-MOUSSON) * Abstract; figure 1 * --	1	
A	US - A - 3 628 598 (S.G. MACNEILL) * Abstract; figures 5-7; column 4, lines 18-23 * --	1	TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
A	US - A - 3 771 588 (J.R. CAVANAGH) * Figure 8; column 9, lines 21-47 * --	1	B 22 D
A	GB - A - 909 538 (R. THOMAS) * Whole document * --		
A	FR - A - 2 081 888 (INLAND STEEL) * Claim 1; figures 1,2 * ----		CATEGORY OF CITED DOCUMENTS
			X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	14-01-1982	MAILLIARD	