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(54) **Mould for continous casting of long or flat products, cooling jacket designed to cooperate with such a mould and assembly comprising such a mould and such cooling jacket**

(57) The invention concerns a mould for continuous casting of long or flat products extending along an axis (z), and comprising an internal and an external surface delimiting mould thicknesses (e), the internal surface defining a mould cavity, **characterized in that** the thickness (e, e', e3, e4) of at least one part of the mould (10) varies depending on measured or simulated temperature gradients of a mould in use.

The invention also concerns a cooling jacket design to cooperate with such a mould and an assembly comprising such a mould and such a cooling jacket.

FIG 3A

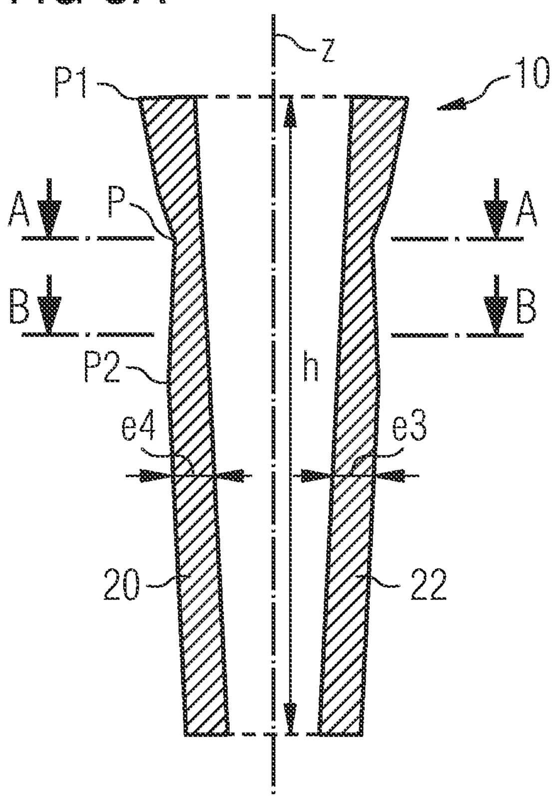

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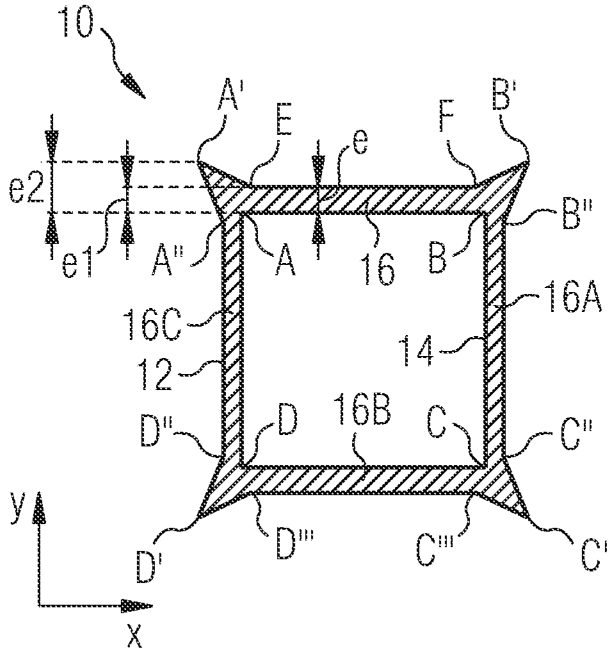
FIG 3B A-A



Description

[0001] The invention relates to a mould for the continuous casting of long or flat products such as billets or blooms.

[0002] Moulds for the continuous casting of long products define a continuous sizing passage for the cast metal which enters it in the molten state via the top of the mould and leaves it via the bottom of the mould in the form of a solid shell deriving from the peripheral solidification of the cast metal on contact with the cold wall of the mould body and which contains a still-liquid core. Solidification then continues to its conclusion in the lower part of the casting machine by means of spray units. These kinds of moulds are also called "mould tube" and can have a square, rectangular, circular, or polygonal cross-section. The tubes can be straight or curved along a so called "casting radius", and the internal cavity is characterized by a progressive decrease in dimension in order to follow the natural shrinkage of steel during solidification process.

[0003] Moulds for continuous casting of long products, particularly billets cast in open stream casting, must withstand high temperatures load during casting. In particular, the top part of the mould is subject to a heat transfer profile which could be characterized by isotherm at different temperatures. Such conditions, which are also enhanced by higher casting speed and oil lubrication, induce high thermal gradients in longitudinal and also in transversal direction of the mould, with additional high gradients, and therefore high internal temperature, across the thickness of mould. Such temperature differences between different points of the mould, and the high temperature reached inside the mould, induce thermal distortion, recrystalization, cracking and detachment of internal chromium plating. Additionally, especially when oil is used for lubrication, the high temperature of internal side of the mould causes partial evaporation of oil, with defective lubrication and higher oil consumption rate. Moreover, such uneven mould wall temperature and corresponding heat extraction are generating negative effect on product quality.

[0004] In the past several trials have been made, reducing the mould thickness generally in a uniform way transversally and longitudinally. In other applications the mould thickness has been reduced by grooves applied vertically in the top part of the mould, or eventually along all the mould length, with the aim to increase heat transfer in that area and reduce mould temperature. Other applications were applying a differentiate cooling based on separate circuits for different parts of the mould tube itself.

[0005] However, if in one hand the decrease of mould thickness improves the temperature gradient between internal and external side of the mould, on the other hand, this decrease reduces mechanical characteristics of the mould.

[0006] The object of the invention is to solve the above mentioned problems and more specifically to increase heat transfer, decrease temperature gradients in longitudinal and transversal directions of a mould, as well as decrease the internal temperature of a mould for continuous casting of long products and at the same time keeping the mechanical characteristics of said mould when used.

[0007] For this purpose, the subject of the invention according to a first aspect is a mould for continuous casting of long or flat products extending along an axis and comprising an internal and an external surface delimiting mould thicknesses, the internal surface defining a mould cavity, **characterized in that** the thickness of at least one part of the mould varies depending on measured or simulated temperature gradients of a mould in use.

[0008] The invention increases heat transfers, decreases temperature gradients in longitudinal and transversal direction, and decreases the internal temperature of the mould, creating the preconditions for a more homogeneous shell growth.

[0009] Advantageously when the mould has a plurality of longitudinal elements extending along the axis, said elements forming a transverse polygonal cross-section of the mould, a thickness of at least one mould element contained in a mould transversal cross-section continuously varies between a first and a second value depending on measured or simulated transversal temperature gradients of a mould in use.

[0010] Advantageously the thickness varies continuously from the middle of a segment of said mould element in the direction of one of the internal corners of the mould.

[0011] According to the invention, the thickness of each mould element varies from the middle of a segment of each mould element in the direction of an internal corner of the mould.

[0012] According to another feature of the invention, in at least one transversal cross section, at least one portion of a the mould element is symmetrical with respect to a plan passing by the central segment of said transversal mould element and being perpendicular to said transversal mould element.

[0013] Advantageously the variation of the thickness extends only on a portion of the height of the mould.

[0014] Furthermore, the variation is an increase. In one embodiment of the invention, the maximal thicknesses are equal.

[0015] According to another feature of the invention, a thickness of at least a longitudinal element of the mould contained in a longitudinal cross-section of the mould, varies depending on measured or simulated temperature gradients of a mould in use.

[0016] Advantageouly, the variation is function of longitudinal temperature gradients measured or simulated on a mould in use.

[0017] Advantageouly, the thickness contained in a longitudinal cross-section of each longitudinal element increases, at least on a portion of the mould, from a point of minimum thickness in both directions defined by the longitudinal axis. Advantageouly, the point of minimum thickness is located depending on the location of the point of maximum longitudinal temperature previously measured on said other mould in use or previously determined by simulation.

[0018] According to a second aspect, the subject of the invention is a cooling jacket designed to cooperate with a mould as above defined, the cooling jacket comprising a body defining a plurality of cooling ducts for guiding a cooling agent along external surfaces of the mould, the cooling jacket being designed to receive and at least partially longitudinally surround said mould, a thickness of the cooling jacket varies depending on measured or simulated temperatures gradients of a mould in use.

[0019] Advantageouly, the thickness of the cooling jacket at a predefined height of the cooling jacket is inversely proportional to the thickness of the mould at the same height.

[0020] According to another aspect, the subject of the invention is an assembly comprising a mould as above defined and a cooling jacket as above defined.

[0021] Due to this particular design of the external part of the mould and of the water cooling channels, higher stability and improved centring of the mould itself is achieved, preventing uneven cooling effects due to possible mould misalignment inside the cooling jacket.

[0022] The invention will be clearly understood and other aspects and advantages will be more clearly apparent in light of the following description given by way of embodiments with reference to the appended drawings, in which:

- figure 1 shows measured or simulated longitudinal temperature isotherms of a mould in use,
- figure 2 is a view of internal and external temperatures profiles of a mould in use according figure 1 conditions,
- figures 3A, 3B and 3C show schematic longitudinal and transversal cross-sections of a mould according to the invention.
- figures 4A, 4B, 4C, 4D show schematic longitudinal and transversal cross sections of a cooling jacket according to the invention.
- figures 5A 5B 5C show schematic longitudinal and transversal cross sections of the assembly of a mould and of a cooling jacket according to the invention.

[0023] It has to be noted that on the drawings the view are not at the same scale.

[0024] When metal in liquid form is poured into a mould, the top part of this mould is subject to a heat transfer profile which could be characterized by isotherm at different temperatures. Figure 1 is a graphic giving the isotherms measured or simulated along the longitudinal direction and the longitudinal thickness of a mould for continuous casting of long products in use, the liquid metal entering the mould being at a temperature comprises between approximately 1450°C and 1600°C, depending on the chemical composition of the cast product and on the casting mode, section and speed. The mould represented in the figures is 900mm long, has a thickness of 13mm and has a squared cross section.

[0025] Figure 2 is a view of internal and external temperatures profiles of a mould in use according to figure 1 conditions. In other words, figure 2 gives temperatures, measured or simulated, along the internal and the external faces of a mould in use in figure 1 conditions. The temperatures T°out are the temperatures of the external face of the mould and the temperatures T°in are the temperatures of the internal face of the mould. These two curves give the difference of temperature across the thickness of the mould for a given altitude of the known mould. For example, the difference of temperature between an internal and an external point of the known mould situated at 200mm from the top of the known mould is about 100°C. As above mentioned, this difference causes cracking of the mould and other problems.

[0026] The aims of the invention are to minimize the differences of temperature between two points of the mould. In other words, to have more uniform temperature distribution of the mould and at the same time increase heat extraction and decrease internal mould wall temperature.

[0027] In this purpose an object of the invention is a mould for continuous casting of long products comprising an internal and an external surface delimiting a thickness of the mould, the internal surfaces defining a mould cavity. The main feature of the invention is that the thickness of at least one portion of the mould varies depending on measured or simulated temperature gradients of another mould in use. The other mould may be a known mould having known features.

[0028] Figure 3A, is a longitudinal cross-sectional view of one embodiment of a mould 10 according to the invention and figures 3B and 3C are transversal cross-sectional views of figure 3A at two different heights or altitudes of said mould 10. For a better understanding figures 3B and 3C are provided with an orthogonal two dimensional coordinate system defined by two orthogonal half straight line x and y. The mould 10 comprises an external longitudinal surface 12 and an internal longitudinal surface 14 and can be made of copper or of an alloy including cooper. This kind of mould is also called a mould tube. Furthermore, the mould 10 comprises a plurality of longitudinal elements 16 to 16C extending along an axis z. The elements 16 to 16C may have a plate shape.

[0029] In this particular embodiment and as can be seen on figure 3B and 3C, the mould 10 has a transverse polygonal cross-section and comprises a plurality of internal corners A, B C, D and a plurality of external corners A',E, F, B', B'', C'', C', C''', D''', D', D'' and A'''. In the transversal cross-section of the mould 10 of figure 3B, the mould element 16 is delimited by two consecutive internal corners A and B and by four consecutive external corners

A', B', E, F. The vertical thickness e of said transversal mould element 16, which is the projection of the thickness e on the vertical axis y, continuously varies from one point of said element 16 of the mould 10 between a first vertical thickness *e1* and a second thickness *e2.* For this particular mould element 16 the first thickness *e1* of the element 16 is the vertical distance between point A and point E and the second thickness e2 of the element 16 is the vertical distance between point A and point A'. Of course the thickness of each of the tree other mould elements 16A to 16C respectively delimited by the corners BB'B"C"C'C, CC'C"'D"' D"D'D and DD'D"A"A'A are also varied as above mentioned for the thickness e but in the corresponding horizontal or vertical direction.

[0030] The figure 3C is a cross-sectional view of figure 3A at another height or altitude of mould 10. In this view, the transversal cross-section of the mould 10 has a different shape.

[0031] In the transversal cross-section of the mould 10 of figure 3C, a closed transversal element 18 of the mould 10 is delimited by two consecutive internal corners G and J and by four consecutive external corners G', K, L, J'. The horizontal thickness e' of said transversal mould element 18, which is the projection of the thickness e' on the axis horizontal x, continuously varies from one point of said mould element 18 between a first horizontal thickness e1' and a second thickness horizontal e2'. For this particular mould element 18 the first thickness e1' is the horizontal distance between point L and point J and the second thickness is the horizontal distance between point J and point J'. Of course the thickness of each the tree other closed transversal mould element 18A to 18C in this cross-section of the mould 10 respectively delimited by the corners GG'G"H"' H'H, HH'H"I'I"I and II'I"J"J'J is also varied as above mentioned for the thickness *e*' but in the corresponding horizontal or vertical direction.

[0032] Furthermore, in the embodiment of figures 3 each transversal mould element is symmetrical with respect to a plan passing by the central segment of said transversal mould face and being perpendicular to said transversal mould face. In other words the thickness (*e* or *e*') as above defined, of a mould face has the same value for two points situated at the same distance with respect to and in both side of the central segment of said mould face.

[0033] In another embodiment not shown on the figures, the thickness e varies continuously from the middle of a segment AB, BC, CD or DA of one mould element 16 in the direction of one of the internal corners A, B, C or D of the mould.

[0034] Moreover, the variation of the transversal thicknesses of a mould can be limited to the top portion of this mould, the other part of the mould having a constant transversal thickness. For example, the variation of the transversal thickness of a mould can extends longitudinally only between the first 300 and 400 mm of the mould height.

[0035] Furthermore, in the embodiment of figure 3B and 3C wherein the mould 10 has a general squared transversal cross-section, the thicknesses in the areas of the corners are equal. In other words, the distances AA', BB', CC', DD' are equal to each others and the distances GG,'HH', II', JJ' are also equal to each others. In other words, the maximal horizontal and vertical thicknesses of the mould 10 contained in a transversal cross-section of the mould at a given height or altitude of the mould may have the same value.

[0036] Moreover, the variation above mentioned is an increase and e2 is greater than e1 whereas e2' is greater than e1'.

[0037] Moreover, in the case of a rectangular cross-section mould it may happen that the thicknesses contained in a transversal cross-section of the mould at a given height or altitude of the mould are the same only for the two opposite elements, while the maximal thicknesses in the area of the corners, as above defined have the same value.

[0038] The principle of varying the thickness of a mould also applies in the longitudinal direction of the mould 10 according to the invention. Figure 3A is a longitudinal cross-section of the mould 10. Each mould 10 element 16A and 16C comprise respectively longitudinal surfaces 20 and 22 each one having a respective thickness *e3* and *e4.* As above mentioned the variation of the thickness *e3* and *e4* is function of a longitudinal temperature gradient previously measured on another mould in use or is function of a simulated longitudinal temperature gradient of a mould as presented in figures 1 and 2. More precisely, the longitudinal thicknesses *e3* and *e4* of each longitudinal element 16A,16C increases, at least on a portion of the mould, from a point of minimum thickness in both directions defined by a longitudinal axis z. More precisely, in the embodiment of figure 3A while moving vertically from the top point P1 of the mould 10, the thicknesses *e3* and *e4* progressively decrease up to the point P where the thickness is minimum. Then, the thicknesses *e3* and *e4* increase up to the point P2. After the point P2 the thicknesses *e3* and *e4* are constant. As way of example the distance between point P1 and P can be comprises between 300 and 400mm for a mould having a height of 900mm. The thickness of the element 16B and 16C in a longitudinal cross section of the mould varies also as above mentioned.

[0039] This variation of thicknesses *e3* and *e4* allows a more uniform temperature distribution in the mould 10 and at the same time increases heat extraction and decreases internal mould wall temperature.

[0040] The point P of minimum thickness of the mould 10 is placed approximately between 50 to 100mm from the point of maximum longitudinal temperature previously measured on said other mould in use or previously determined by simulation. This point and the curves of figure 1 and 2 are obtained by experimental measurement based on thermocouples or other measuring systems installed on known moulds in order to find the real temperature profile, or are calculated with proper simulation programs.

[0041] In order to obtain the mould according to the present invention, mould having the same geometrical features than the known mould used to determine the curves of figures 1 and to 2 is machined until the shapes as above mentioned described and shown on the figures are obtained.

[0042] Moulds for continuous casting of long products are cooled during casting process by mean of a cooling agent, flowing trough an external guided channel surrounding the mould, in order to avoid problems with mechanical distortion and to additionally improve the heat extraction, increase water turbulence and helping in centring the mould inside the water jacket. Another aspect of the invention is then a cooling jacket designed to receive and at least partially longitudinally surround mould 10.

[0043] Figure 4A is a longitudinal cross-sectional view of a cooling jacket according to the invention and figures 4B to 4D are transversal cross-sectional views of figure 4A at different height or altitude of the cooling jacket.

[0044] The cooling jacket 30 for a mould as previously defined comprises internal 32 and external faces 34 delimiting two longitudinal cross-sectional cooling jacket faces 36 and 38. The cooling jacket 30 defines a plurality of cooling ducts 36 for guiding a cooling agent along external surfaces of a mould according to the present invention. The cooling ducts extend at least on a portion of the height of the cooled jacket 30. The cooling jacket 30 is designed to receive and at least partially longitudinally surround said mould 10 and has a complementary form with respect to the mould. In particular, as can be seen on figure 4A, the thicknesses i and i" of the cooling jacket varies along the height of the cooling jacket 30.

[0045] In the embodiment shown on the figures, the cooling jacket 30 has squared cross-sectional shape comprising a plurality of portions 30A to 30 D. The thicknesses i, and i' of the cooling jacket 30 delimited by internal 32 and external faces 34 at a predefined height of the cooling jacket 30 are inversely proportional to the thickness e3 or e4 of a cross sectional longitudinal face 20 or 22 of the mould at the same height of the cooling jacket 30.

[0046] As can be seen on the figures 4A to 4D the thicknesses i and i' increase in the top part of the water jacket 30 up to a maximum value and then diminish up to a minimum value and remain constant in the last part of the water jacket 30.

[0047] Figure 5A is a longitudinal cross-sectional view of an assembly comprising a cooling jacket 30 and a mould 10' according to the invention and figures 5B and 5C are transversal cross-section of figure 5A at different heights or altitudes of the cooling jacket.

[0048] The cooling jacket 30 has a longitudinal profile and a transversal profile which follows the different thicknesses e3' and e4' of the external faces(s) of the mould 10' and then has also thicknesses i and i' which depend, at least on a portion of the cooling jacket 30, on a temperature gradient previously measured on another mould in use or on a previously simulated temperature gradient of a mould in use.

[0049] Moreover, in order to keep the total thickness of the assembly 40 at a constant value, at given height of the cooling jacket 30, the more the thicknesses e3' and e4' of the mould 10' are high the less thicknesses i and i' of the cooling jacket are important.

[0050] Besides, the cooling jacket 30 comprises to parts which that can be assembled around the mould 10, the assembly being made in a factory.

[0051] Moreover the casting mould above described may also be curved extending along a curved radius and may have different length and/or thickness, depending on the cast product size and chemical composition and depending on the required productivity.

[0052] The particular design of the assembly mould/cooling jacket prevents mould deformation, and grant higher casting speed, longer mould life and better product quality due to a more uniform heat extraction not only along the mould perimeter but also in longitudinal direction.

[0053] The uniformity of cooling in billet perimeter allows a more uniform shell growth, preventing possible shape deformations due to differentiate cooling and resulting thermal tensions, while the extension of the mould decreased thickness in the longitudinal direction will increase the heat extraction capability of the mould itself, granting a faster shell growth with related possibility of increased casting speed and productivity.

[0054] All of these advantages give a benefit in term of reduction of machine costs, i.e. more productivity with the same number of strands or reduced number of strands with same productivity. Moreover it is also possible to install the invention on existing machines exchanging old systems with a mould and a mould cooling jacket according to the invention.

Claims

1. Mould for continuous casting of long or flat products, said mould extending along an axis (z) and comprising an internal and an external surface delimiting mould thicknesses (e, e', e3, e4), the internal surface defining a mould cavity, **characterized in that** the thickness (e, e', e3, e4) of at least one part of the mould (10) varies depending on measured or simulated temperature gradients of a mould in use.

2. Mould according to claim 1 having a plurality of longitudinal elements (16, 16A, 16B, 16C) extending along the axis (z), said elements forming a transverse polygonal cross-section of the mould **characterized in that** a thickness (e, e') of at least one mould element contained in a mould transversal cross-section continuously varies between a first (e1, e'1) and a second value (e2, e'2) depending on

measured or simulated transversal temperature gradients of a mould in use.

3. Mould according to claim 2 **characterized in that** the thickness (e,e') varies continuously from the middle of a segment (AB,BC,CD,DA) of said mould element (16) in the direction of one of the internal corners (A,B,C,D) of the mould.

4. Mould according to one of the claims 2 to 4 **characterized in that** the thickness of each mould element (16,16A, 16B, 16C) varies from the middle of a segment of each mould element (16,16A,16B,16C) in the direction of an internal corner (A,B,C,D,G,H,I,J) of the mould (10).

5. Mould according to the previous claim **characterized in that** at least one mould element (16, 16A, 16B, 16C,18,18A18B18C) is symmetrical with respect to a plan passing by the central segment of said transversal mould element (16, 16A, 16B, 16C) and being perpendicular to said transversal mould element.

6. Mould according to one of claims 2 to 5 **characterized in that** the variation of the thickness (e) extend only on a portion of the height (h) of the mould (10).

7. Mould according anyone of the previous claims **characterized in that** the variation is an increase.

8. Mould according to the previous claim **characterized in that** the maximal thicknesses (e2, e2') are equal.

9. Mould according to anyone of the previous claims **characterized in that** a thickness (e3, e4) of at least a longitudinal element (16A, 16C) of the mould contained in a longitudinal cross-section of the mould (10) varies depending on a measured or simulated temperature gradients of a mould in use.

10. Mould according to the previous claim **characterized in that** the variation of the thickness (e3, e4) is function of a longitudinal temperature gradient measured or simulated on a mould in use.

11. Mould according anyone of claims 9 or 10 **characterized in that** the thickness (e3, e4) contained in a longitudinal cross-section of each longitudinal element (16, 16A, 16B, 16C, 18, 18A, 18B, 18C) increases, at least on a portion of the mould (10), from a point (P) of minimum thickness in both directions defined by the longitudinal axis (z).

12. Mould according to the previous claim **characterized in that** the point (P) of minimum thickness is located depending on the location of the point of maximum longitudinal temperature previously measured on said other mould in use or previously determined by simulation.

13. Cooling jacket (30) designed to cooperate with a mould (10) according to one of the previous claims, the cooling jacket comprising a body defining a plurality of cooling ducts (6) for guiding a cooling agent along external surfaces (12) of the mould (10) the cooling jacket (30) being designed to receive and at least partially longitudinally surround said mould **characterized in that**, a thickness (i, i') of the cooling jacket (36,38) varies depending on measured or simulated temperatures gradients of a mould in use.

14. Cooling jacket according to claim 13 **characterized in that** the thickness (i, i') of the cooling jacket (30) at a predefined height of the cooling jacket (30) is inversely proportional to the thickness (e3,e4) of the mould (10) at the same height.

15. Assembly comprising a mould according to anyone of the claims 1 to 11 and a cooling jacket according to anyone of the claims 12 to 14.

FIG 1

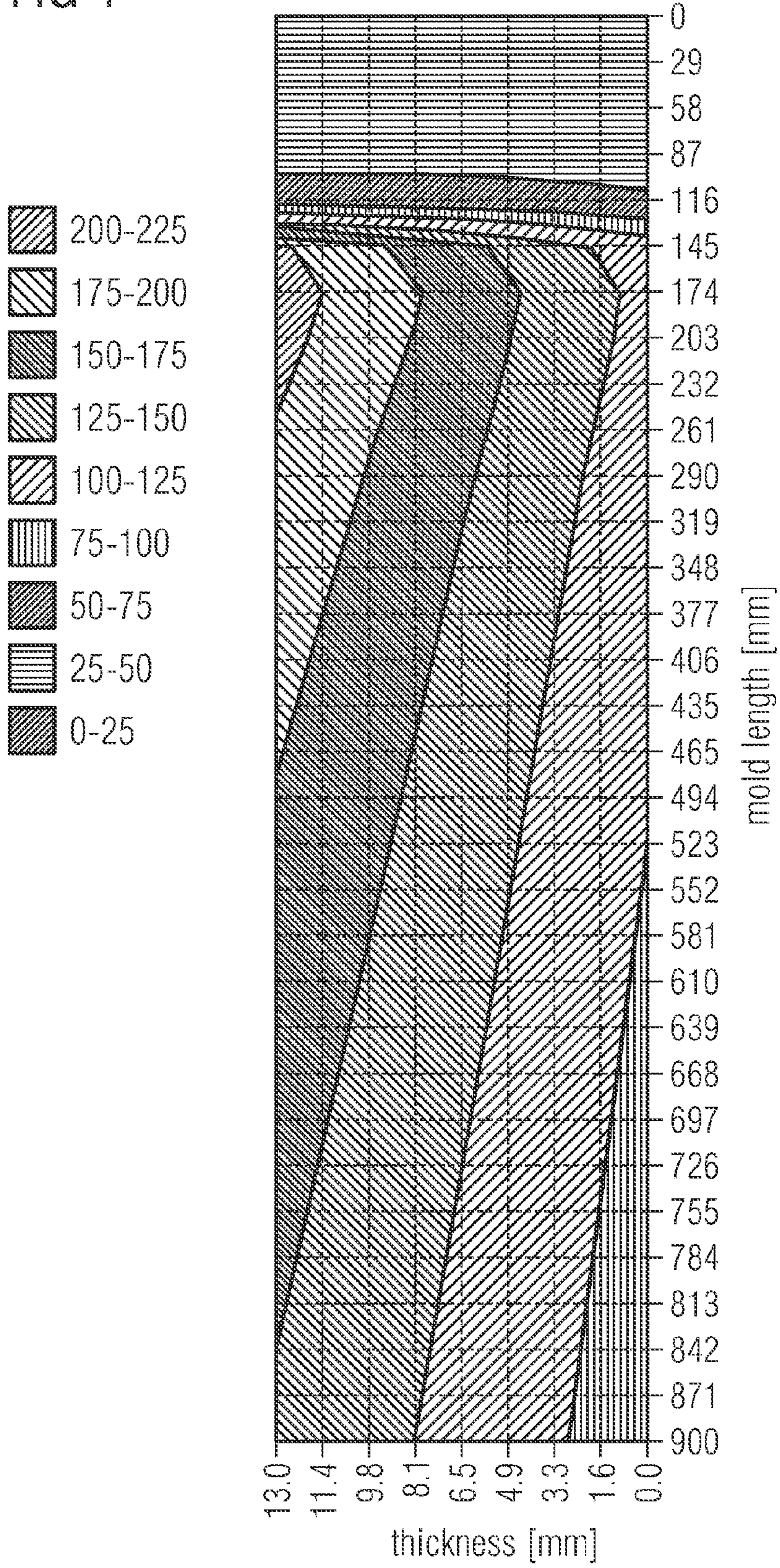

200-225
175-200
150-175
125-150
100-125
75-100
50-75
25-50
0-25
0
29
58
87
116
145
174
203
232
261
290
319
348
377
406
435
465
494
523
552
581
610
639
668
697
726
755
784
813
842
871
900
mold length [mm]
13.0
11.4
9.8
8.1
6.5
4.9
3.3
1.6
0.0
thickness [mm]

FIG 2

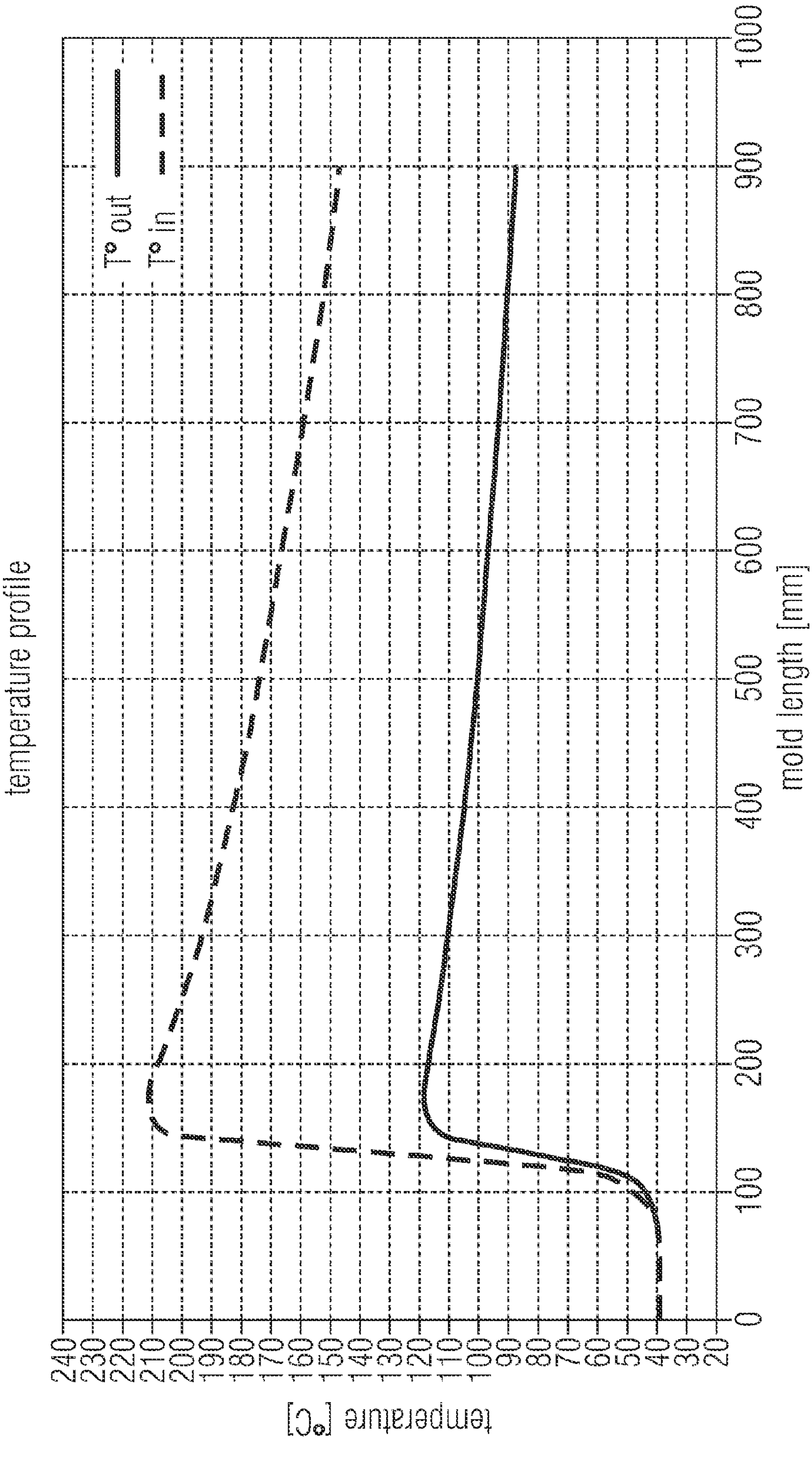

temperature profile
temperature [°C]
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
0
100
200
300
400
500
600
700
800
900
1000
mold length [mm]
T° out
T° in

FIG 3A

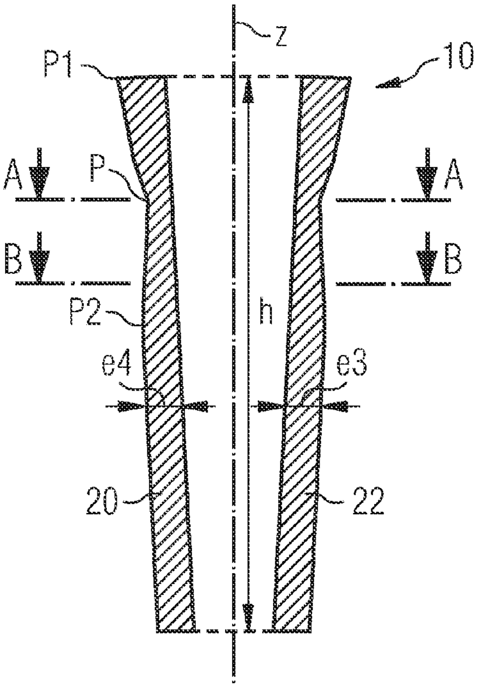


FIG 3B A-A

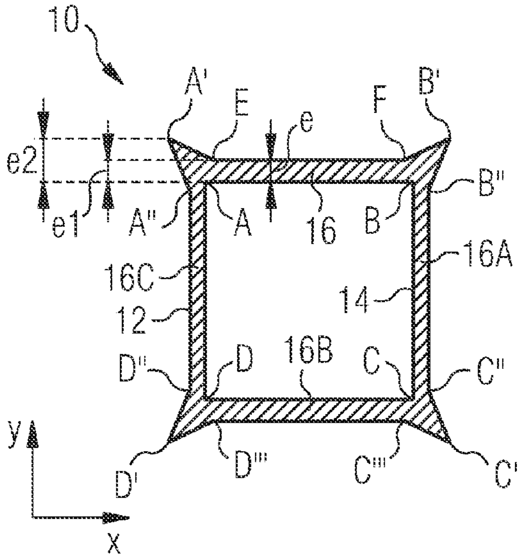


FIG 3C B-B

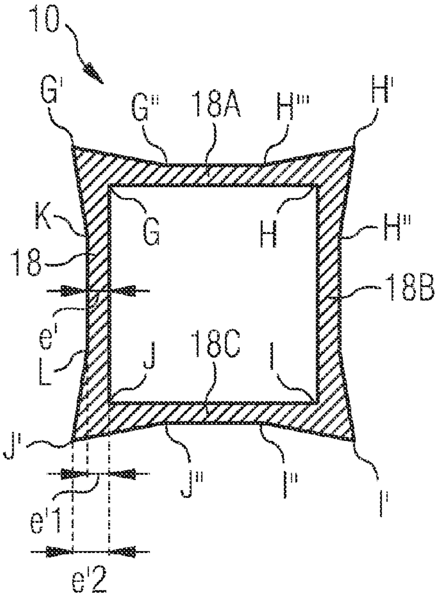


FIG 4A

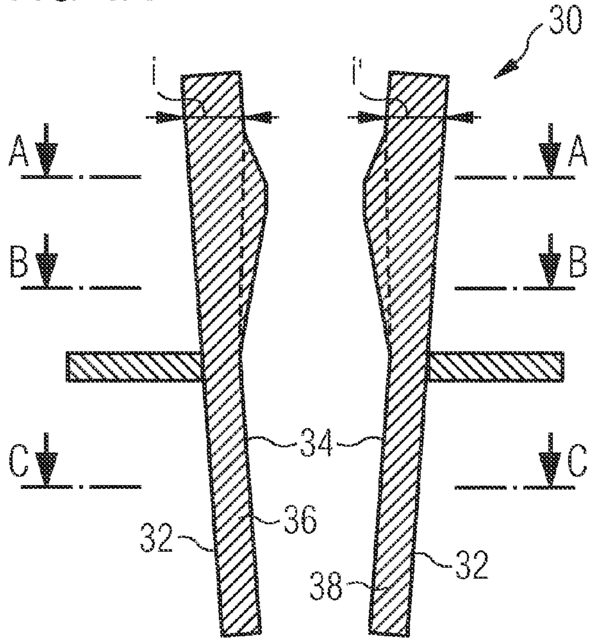


FIG 4B A-A

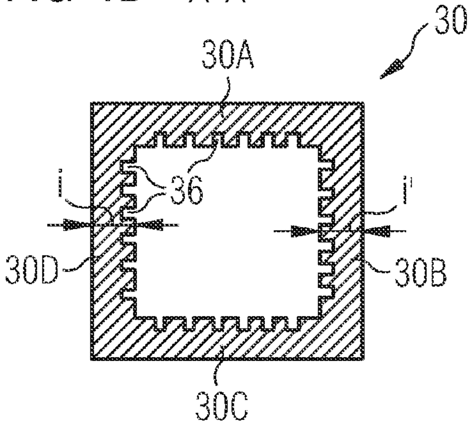


FIG 4C B-B

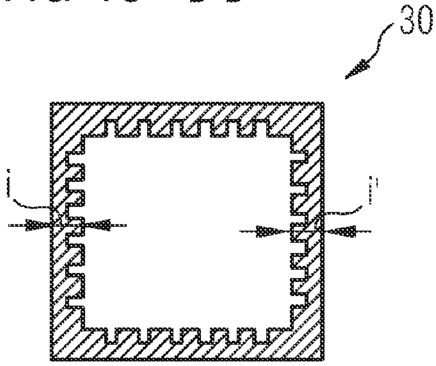


FIG 4D C-C

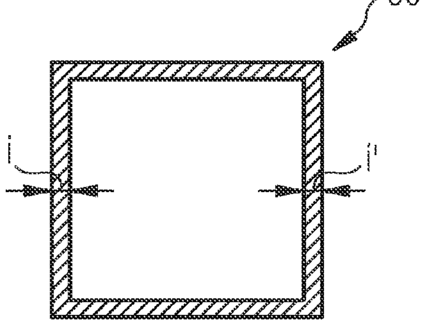


FIG 5A

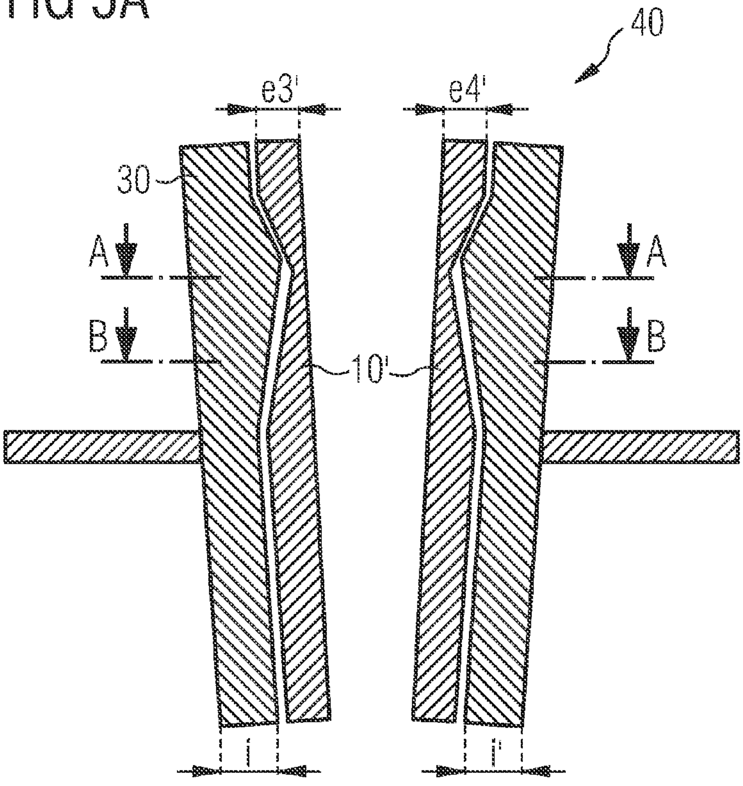


FIG 5B

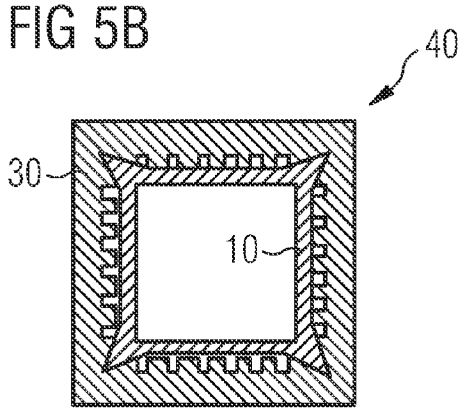
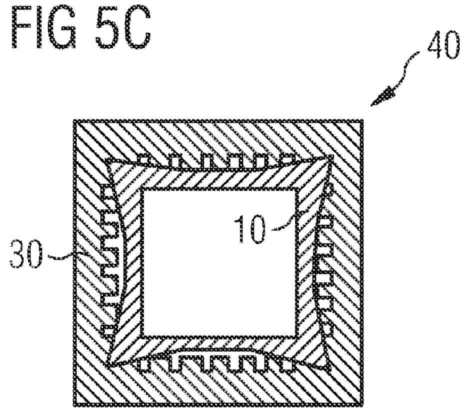


FIG 5C



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Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 42 5320

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 03/092930 A2 (SMS DEMAG AG [DE]; PLESCHIUTSCHNIGG FRITZ-PETER [DE]; LETZEL DIRK [DE]) 13 November 2003 (2003-11-13) * page 1, line 9 - line 28 * * page 2, line 5 - line 28 * * page 4, line 5 - page 8, line 26 * * figures 3-5 *	1-5,7,8, 13-15	INV. B22D11/04 B22D7/06
X	EP 0 958 871 A1 (CONCAST STANDARD AG [CH]) 24 November 1999 (1999-11-24) * figures 1,2 * * paragraph [0012] - paragraph [0040] *	1,2, 5-10, 13-15	
X	WO 96/35533 A1 (SANDVIK AB [SE]; METALLFORSKNING INST [SE]; ROGBERG BO [SE]; BROLUND B) 14 November 1996 (1996-11-14) * figures 1,2 * * page 4, line 13 - page 8, line 23 *	1-8, 13-15	TECHNICAL FIELDS SEARCHED (IPC)
X	JP 61 049751 A (NIPPON STEEL CORP) 11 March 1986 (1986-03-11) * abstract *	9,10, 13-15	B22D
X	FR 2 300 640 A1 (ROSSI IRVING [US]) 10 September 1976 (1976-09-10) * figure 2 *	9,10, 13-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 May 2010	Zimmermann, Frank

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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

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Application Number
EP 09 42 5320

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

- [ ] Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

- [ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- [X] All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- [ ] As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- [ ] Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- [ ] None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

- [ ] The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 09 42 5320

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-8, 13-15

    Continuous casting mold with mould element having a varying thickness in a transverse cross-section, water-jacket for this mould and assembly of such a mould and a water-jacket

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2. claims: 9-15

    Continuous casting mould with mould element having a varying thickness in a longitudinal cross-section, water-jacket for this mould and assembly of such a mould and a water-jacket.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 42 5320

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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03-05-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03092930 A2	13-11-2003	AU 2003239808 A1	17-11-2003
		DE 10218957 A1	04-12-2003
EP 0958871 A1	24-11-1999	AT 261787 T	15-04-2004
		CH 693130 A5	14-03-2003
		DE 59908842 D1	22-04-2004
		ES 2218901 T3	16-11-2004
WO 9635533 A1	14-11-1996	AU 5709296 A	29-11-1996
		BR 9608283 A	08-06-1999
		CA 2219910 A1	14-11-1996
		JP 11504864 T	11-05-1999
		SE 516076 C2	12-11-2001
		SE 9501709 A	10-11-1996
JP 61049751 A	11-03-1986	JP 1627015 C	28-11-1991
		JP 2052580 B	14-11-1990
FR 2300640 A1	10-09-1976	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82