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(54) CONTINUOUS CASTING MOLD

(57) According to the present invention, a continuous casting mold which is tapered downwards, comprises: two long-side molds and two short-side molds and have protrusions at both side ends so as to form a chamfered surface at the edges of a slab, wherein the protrusions of the short-side molds gradually decrease downwards to compensate for the shrinkage amount of the slab.

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Description

[Technical Field]

[0001] The present invention relates to a continuous casting mold for preventing corner cracks in a slab.

[Background Art]

[0002] FIG. 1 is a perspective view of a general continuous casting apparatus, and FIG. 2 is a perspective view of a mold 3 of the continuous casting apparatus of FIG. 1.

[0003] Also, FIG. 3 illustrates a front view, a top view, and a side view of the mold 3 of FIG. 2, and FIG. 4 is a graph illustrating a brittle area of steel according to a temperature.

[0004] Referring to FIGS. 1 to 4, liquid molten steel passes from a ladle 1 to a tundish 2 and is injected into the mold 3, thereby forming a solidified layer at a surface of a slab. The solidification of the liquid molten steel is completed while the slab is passing through a second cooling zone 4 including a plurality of guide rolls, thereby allowing slabs to be continuously produced.

[0005] Herein, since cracks formed in slabs may not be removed in a following rolling process and may remain as product defects, it is necessary to remove cracks through a scraping before the rolling process. However, in such a case, since it is necessary to add a process of inspecting slabs and removing cracks, it is impossible to directly insert slabs into a rolling-heating furnace and additional human resources and costs may be required.

[0006] In detail, molten steel is injected into the mold 3 through a soak nozzle 2a and a solidified layer is formed from a surface of the molten steel at a short side of a mold 3a and a long side of a mold 3b and grows and becomes thicker.

[0007] The solidified layer, progressing downwardly, decreases in temperature and becomes contracts. Herein, when the mold 3 does not compensate for such contraction, tension occurs in the solidified layer and cracks are formed therein.

[0008] To prevent such cracks, as illustrated in the drawings, a bottom width is reduced in comparison with a top width, thereby allowing the mold 3 to incline. A shrinkage rate of long sides of the solidified layer is compensated by allowing the short side mold 3a to incline by reducing a bottom width W_{1B} of the long sides in comparison with a top width W_{1T} of the long sides. A shrinkage rate of short sides of the solidified layer is compensated by allowing the long side mold 3b to incline by reducing a bottom width W_{2B} of the short side mold 3a in comparison with a top width W_{2T} thereof.

[0009] Corner cracks formed in slabs are closely related with a brittle area of steel.

[0010] As shown in FIG. 4, generally, the steel has three brittle areas according to a temperature. Herein, since malleability is small in an area among these areas, in which a surface temperature of a slab is from about 700°C to about 800°C (hereinafter, referred to as a third area brittle section), although a strain speed is low, cracks easily develop.

[0011] Generally, in case of a rectangular slab, since heat escapes from corners in both directions from the long sides and short sides of the solidified layer, a surface temperature decreases more rapidly therein than in other portions of the slab, corners may be easily included in the third area brittle section in the continuous casting apparatus during a casting process.

[0012] Accordingly, while the slab is being bent or leveled by the continuous casting apparatus, stress is exerted on the slab and a temperature of corners of the slab in the section is included in the third area brittle section, thereby easily developing corner cracks.

[0013] To overcome this, the slab is cast to allow corners to be chamfered to restrict the temperature at the corners from being more rapidly reduced than other portions of the slab, thereby allowing the temperature of corners to be outside of a brittle section while the slab is being bent or leveled by the continuous casting apparatus. To cast a slab having chamfered corners as described above, prior art inventions for modifying a continuous casting mold, as shown in FIGS. 5A to 5D, are disclosed in Patent Nos. EP0776714 and EP0409708, Japanese Patent Laid-Open Publication No. hei 11-290995, and Korean Patent Application No. KR2002-0084914.

[0014] Patent No. EP0776714, as shown in FIG. 5A, discloses a method of reducing inner cracks of a slab occurring while reducing an unsolidified portion of the slab, by allowing short sides of the slab to have a projecting shape using a short-side mold 5 . Herein, since a chamfer of the slab includes a surface perpendicular to long sides instead of a flat incline, an effect of preventing a reduction in a temperature caused by chamfering is reduced in this portion and a corner is folded during a process of rolling the slab. Also, since a shape and a size of the projection 5a is identical at top and bottom thereof, a shrinkage rate of the chamfer is not compensated, thereby developing cracks.

[0015] Patent No. EP0409708, as shown in FIG. 5B, may provide effects of preventing a folded groove in rolled steel by allowing a chamfer of a slab to be a flat incline by inserting a short-side mold 6 into a long side groove 7a and simultaneously with increasing durability by allowing a thickness of corners of a projection 6a to be great. However, since it is impossible to modify a width of the short-side mold 6 and the top and the bottom have the same shape and size, a shrinkage rate of the slab at an incline surface of a chamfer is not compensated, thereby developing cracks in the chamfer.

[0016] Japanese Patent Laid-Open Publication No. hei 11-290995, as shown in FIG. 5C, discloses a mold, in which both ends of a short-side mold 8 is processed as an arc to form a corner of a slab to have an arc shape. It is impossible to modify a width of the mold. The corner may be effective for preventing a reduction in a temperature of the corner and for increasing durability of a metal plate of the corner due to the arc shape thereof. However, since the corner of the slab having the arc shape has the same shape at top and bottom, a shrinkage rate of a solidified layer of an arc is not compensated, thereby developing cracks between surfaces.

[0017] Korean Patent Application No. KR2002-0084915, as shown in FIG. 5D, discloses a short-side mold 9 provided with a projection 9a forming a chamfer at corners of a slab, which increases in size at a lower portion to prevent corner cracks of the slab and cracks between surfaces. Since the projection 9a increases downwards, a length of the short-side mold 9 except the projection 9a is reduced at a lower portion thereof, thereby compensating for a shrinkage rate of the slab. However, since a length of an incline surface of the projection 9a increases at a lower portion at a chamfer of the slab, the shrinkage rate of the slab is not compensated, thereby developing cracks between surfaces at the chamfer.

[Disclosure]

[Technical Problem]

[0018] An aspect of the present invention provides a continuous casting mold for compensating for a shrinkage rate of a slab and reducing the abrasion of the mold.

[Technical Solution]

[0019] According to an aspect of the present invention, there is provided a continuous casting mold tapered downwards including two long-side molds and two short-side molds sealing a space between the two long-side molds and formed with projections on both ends thereof to form chamfers at corners of a slab, in which the projection of the short-side mold 40 is reduced downwards to compensate a shrinkage amount of the slab.

[0020] Herein, the short-side mold, toward a bottom thereof, may decrease in a width of an incline surface of the projection 42 and a width of a central surface 44a not projecting.

[0021] In addition, the short-side mold, toward a bottom thereof, decreases in an incline angle of the incline surface of the projection.

[0022] Herein, an incline angle of an incline surface of the projection is from about 20° to about 70°.

[0023] Additionally, a difference between a top angle and a bottom angle at the incline angle of the incline surface of the projection may be 10° or less.

[Advantageous Effects]

[0024] According to embodiments of the present invention, since a short-side mold is formed with projections, chamfers are formed on corners of a slab, thereby preventing a rapid decrease in a temperature at the corners during a continuous-casting process. Also, a brittle section of a third area is avoided during a process of bending or leveling the slab, thereby reducing an occurrence rate of the corner cracks.

[0025] Also, the slab in the mold becomes solidified as progressing downwards, thereby being contracted. Corresponding thereto, widths of an incline surface and a central surface not projecting, in contact with the chamfers of the slab, become smaller, thereby compensating for a shrinkage amount of a short-side solidified layer of the slab to prevent cracks between surfaces at the chamfers.

[0026] In addition, an incline angle of the projection is reduced toward a bottom of the short-side mold, thereby compensating for a shrinkage rate of a long-side solidified layer of the slab, which is more reduced than a tapered incline rate of the short-side mold downwards. Accordingly, it is possible to significantly reduce a degree of abrasion of the short-side mold.

[Description of Drawings]

[0027] The above and other aspects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view of a general continuous casting apparatus;
FIG. 2 is a perspective view of a mold of the continuous casting apparatus of FIG. 1;
FIG. 3 illustrates a front view, a top view, and a side view of the mold of FIG. 2;
FIG. 4 is a graph illustrating a brittle area of steel according to a temperature;
FIGS. 5A to 5D are views of general short-side molds;
FIG. 6 is a perspective view of a short-side mold of a continuous casting mold according to an embodiment of the present invention;
FIG. 7 is a top view of the short-side mold of FIG. 6;
FIGS. 8A, 8B, and 8C are views of a short-side mold having a bottom angle smaller than a top angle at an incline surface of a projection of the short-side mold of FIG. 7 according to another embodiment of the present invention; and
FIG. 9A is a table related to a condition of a short-side mold in a continuous casting process, and FIG. 9B illustrates a result of measuring a temperature at a corner of a slab in accordance with the condition of the short-side mold of in FIG. 9A.

[Best Mode]

[0028] Exemplary embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

[0029] FIG. 6 is a perspective view illustrating a short-side mold 40 of a continuous casting mold according to an embodiment of the present invention, and FIG. 7 is a top view of the short-side mold 40.

[0030] Referring to FIGS. 6 and 7, the continuous casting mold includes two long-side molds spaced corresponding to a thickness of a slab and two short-side molds 40 spaced corresponding to a width of the slab.

[0031] Herein, two long-side molds are disposed to be spaced from each other corresponding to the thickness of the slab formed while molten steel is being solidified.

[0032] Also, two short-side molds 40 seal a space between the two long-side molds and are fastened to the long-side mold while being spaced from each other corresponding to the width of slab.

[0033] The continuous casting mold formed of the long-side molds and the short-side molds 40 has a downward-tapered structure with open top and bottom.

[0034] In detail, the short-side mold 40 is formed with projections 42 at both ends thereof to chamfer corners of the slab.

[0035] That is, in order to chamfer the corners of the slab, the both ends of the short-side mold 40 project to be shaped corresponding to chamfers on the corners and incline toward a central surface 44a, thereby forming the projections 42 having an incline surface 42a corresponding to the chamfer of the slab.

[0036] As an example, when the slab has a rectangular shape, since heat escapes in both directions from long sides and short sides of a solidified layer at corners, a surface temperature more rapidly decreases than other portions of the slab. According thereto, since it is easy a temperature around the corners of the slab is included in a third area brittle section during a casting process, corner cracks easily develop while stress is being put on the slab during a process of bending or leveling the slab.

[0037] However, since the short-side mold 40 is formed with the projections 42, the chamfers are formed on the corners of the slab, thereby preventing a rapid decrease in the temperature at the corners during a continuous-casting process. Also, a brittle section of a third area is avoided during the process of bending or leveling the slab, thereby reducing the corner cracks.

[0038] Herein, to obtain effects described above, a size of the projection 42 may be 15 mm or more in a thickness direction and a width direction of the short-side mold 40.

[0039] Also, the size of the projection 42 decreases toward a bottom of the projection 42 to compensate a shrinkage amount of a long-side solidified layer in the slab.

[0040] In detail, toward a bottom of the short-side mold 40, a width of the incline surface 42a of the projection 42 is reduced and a width of the central surface 44a not projecting also is reduced.

[0041] Referring to FIGS. 6 and 7, the width of the incline surface 42a becomes gradually narrower downwards and the width of the central surface 44a not projecting also becomes gradually smaller downwards.

[0042] In addition, the short-side mold 40 is not limited thereto. However, a bottom width IW_B of the incline surface 42a may be smaller than a top width IW_T thereof and a bottom width CW_B of the central surface 44a may be smaller than a top CW_T thereof.

[0043] The slab in the mold becomes solidified as progressing downwards, thereby being contracted. Corresponding thereto, the widths of the incline surface 42a and the central surface 44a not projecting, in contact with the chamfers of the slab, become smaller, thereby compensating for a shrinkage amount of a short-side solidified layer to prevent cracks between surfaces at the chamfers.

[0044] As a reference, referring to FIGS. 6 and 7, a horizontal difference $\frac{W_{2T} - W_{2B}}{2}$ (refer to FIG. 3 for W_{2T} and W_{2B}) between top and bottom lateral edges of the projection 42, is formed to be greater than 0, thereby compensating the shrinkage amount of the short-side solidified layer. Also, a horizontal difference $\frac{W_{1T} - W_{1B}}{2}$ (refer to FIG. 3 for W_{1T} and W_{1B}) between top and bottom of the central surfaces 44a is formed to be greater than 0, thereby compensating the shrinkage amount of the long-side solidified layer.

[0045] That is, the long-side molds inclines with an incline surface amount of $d_1(d_1>0)$ to compensate the shrinkage amount of the short-side solidified layer and the short-side mold 40 has an incline surface amount of $d_2(d_2>0)$ to compensate the shrinkage amount of the long-side solidified layer. Herein, d_1 and d_2, as those of a general mold, have a value of from about 0.5% to about 1.5% (refer to FIG. 2 for W_{1T}, W_{1B}, W_{2T}, W_{2B}, d_1, and d_2).

[0046] Additionally, to compensate the shrinkage amount of the long-side solidified layer, S shown in FIG. 7 may have a value greater than 0.

[0047] Also, the short-side mold 40 is formed to allow an incline angle of the incline surface 42a of the projection 42 to become smaller, as progressing downwards.

[0048] With respect to this, as shown in FIGS. 8A, 8B, and 8C, the incline angle of the incline surface 42a of the projection 42 toward the central surface 44a not projecting gradually is reduced downwards.

[0049] More preferably, a bottom angle θB may be smaller than a top angle θT at the incline surface 42a of the projection 42 of short-side molds 40', 40", and 40'''.

[0050] Since a shrinkage rate of a slab is more reduced than a tapered incline rate toward a bottom of a short-side mold, in comparison with a top of the short-side mold, the bottom increases with frictional force of the slab. Due to an increase in frictional force, a large amount of abrasion occurs.

[0051] That is, since frictional force between the short-side mold and the slab more increases at the projection 42, in which solidified layers are in contact with one another, than a portion of the solidified layer, supported by an unsolidified portion, the abrasion is great on the portion.

[0052] Accordingly, an incline angle of the projection 42 is reduced as progressing toward bottoms of the short-side molds 40', 40'', and 40''', thereby compensating for the shrinkage rate of the slab, which is more reduced than the tapered incline rate of the short-side mold downwards. Accordingly, it is possible to greatly reduce a degree of abrasion of the short-side mold.

[0053] Also, the bottom angle is smaller than the top angle, thereby forming another incline 42a on the incline surface 42a of the projection 42. Herein, a height of the other incline 42a on a bottom is designated as 'h'. Not limited thereto, the incline surface 42a of the projection 42 may be further formed with a plurality of inclines 42a.

[0054] In addition, an incline angle of the incline surface 42a of the projection 42 may be from about 20° to about 70°.

[0055] The incline angle of the incline surface 42a of the projection 42 is determined within a range of from about 0 to about 90°. When the incline angle is too small, that is, is reduced than 20°, an effect of chamfering a corner of the slab is reduced, thereby developing corner cracks.

[0056] Also, when the incline angle becomes too great, a degree of projection becomes steep, sticking to the slab becomes greater, thereby increasing abrasion. Accordingly, corners of the projection 42 become deteriorated in durability, thereby being damaged.

[0057] In addition, a difference between the top angle θT and the bottom angle θB at the incline angle of the incline surface 42a of the projection 42 may be 10° or less.

[0058] That is, when the difference between an incline angle at a top surface and an incline surface at a bottom surface of the projection 42 becomes greater, a chamfer of the slab is distorted. To prevent this, the difference between the top angle θT and the bottom angle θB may be determined to be 10° or less.

[0059] FIG. 9A is a table related to a condition of a short side mold in a continuous casting process, and FIG. 9B illustrates a result of measuring a temperature at a corner of a slab in accordance with the condition of the short side mold of in FIG. 9A.

[0060] Herein, Test 1 is performed using a general mold, Test 2 is performed using the short-side mold 40, and Test 3 is performed using the short-side mold 40'.

[0061] Low carbon steel and medium carbon steel were produced as slabs having a width of from about 1000 to about 2000 mm and a thickness of about 250 mm through these molds and a crack occurrence rate of the slabs and a degree of abrasion of metal plates were shown.

[0062] An incline surface amount of the short-side mold is allowed to vary within a range of from about 1.0 to about 1.3% according to the composition of steel and a width of a mold.

[0063] The surface temperature of the corner of the slab is measured by a pyrometer horizontally moving on a top surface of the slab in a width direction in a position, in which the slab enters a leveling section in a continuous casting apparatus in a continuous casting process, which is shown in FIG. 9B.

[0064] Referring to FIG. 9B, a temperature highly increases outwards from the corner of the slab. This is because a portion projected due to bulging at a short side of the slab is measured and shown by the pyrometer disposed perpendicularly to the top surface of the slab.

[0065] Comparing temperatures of the corners, in case of Test 1, that is, a slab having a rectangular corner produced using the general mold, the temperature of the corner is measured as 740°C. On the contrary, in case of slabs produced using the molds according to the embodiments, a temperature of an outer corner of a chamfer, that is, a corner of a short side is measured as about 890°C and a temperature of an inner corner, that is, a corner of a long side is measured as about 860°C, which is effective for avoiding a third area brittle section.

[0066] As a result, an occurrence rate of corner cracks of the slab is about 4.1% when using the general mold but those of the Tests 2 and 3 are reduced to about 0.7%

[0067] On the other hand, in Test 2, a degree of abrasion of the projection 42 of the short-side mold 40 is greater three times than a degree of abrasion of the general mold.

[0068] However, when using the metal plate of Test 3, a degree of abrasion is reduced to a degree identical to the general mold.

[0069] That is, when the incline angle of the incline surface 42a of the projection 42 decreases toward the bottom of the short-side mold 40, the degree of abrasion is significantly reduced.

[0070] As a result, since the short-side mold 40 is formed with the projections 42, chamfers are formed on the corners of the slab, thereby preventing a rapid decrease in the temperature at the corners during the continuous-casting process. Also, a brittle section of a third area is avoided during a process of bending or leveling the slab, thereby reducing the corner cracks.

[0071] Also, the slab in the mold becomes solidified as progressing downwards, thereby being contracted. Corresponding thereto, widths of the incline surface 42a and the central surface 44a not projecting, in contact with the chamfers of the slab, become smaller, thereby compensating for a shrinkage amount of a short-side solidified layer to prevent cracks between surfaces at the chamfers.

[0072] Accordingly, an incline angle of the projection 42 is reduced as progressing toward the bottom of the short-side mold 40, thereby appropriately compensating for a shrinkage rate of a long-side solidified layer of the slab, which is more reduced than the tapered incline rate of the short-side mold 40 downwards. Accordingly, it is possible to greatly reduce the degree of abrasion of the short-side mold 40.

[0073] While the present invention has been shown and described in connection with the exemplary embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the spirit and scope of the invention as defined by the appended claims.

Claims

1. A continuous casting mold tapered downwards comprising:

   two long-side molds; and
   two short-side molds 40 sealing a space between the two long-side molds and formed with projections 42 on both ends thereof to form chamfers at corners of a slab,
   wherein the projection 42 of the short-side mold 40 is reduced downwards to compensate a shrinkage amount of the slab.

2. The continuous casting mold of claim 1, wherein the short-side mold 40, toward a bottom thereof, decreases in a width of an incline surface 42a of the projection 42 and a width of a central surface 44a not projecting.

3. The continuous casting mold of claim 1, wherein the short-side mold 40, toward a bottom thereof, decreases in an incline angle of the incline surface 42a of the projection 42.

4. The continuous casting mold of claim 1, wherein an incline angle of an incline surface 42a of the projection 42 is from about 20° to about 70°.

5. The continuous casting mold of claim 4, wherein a difference between a top angle θT and a bottom angle θB the incline angle of the incline surface 42a of the projection 42 is 10° or less.

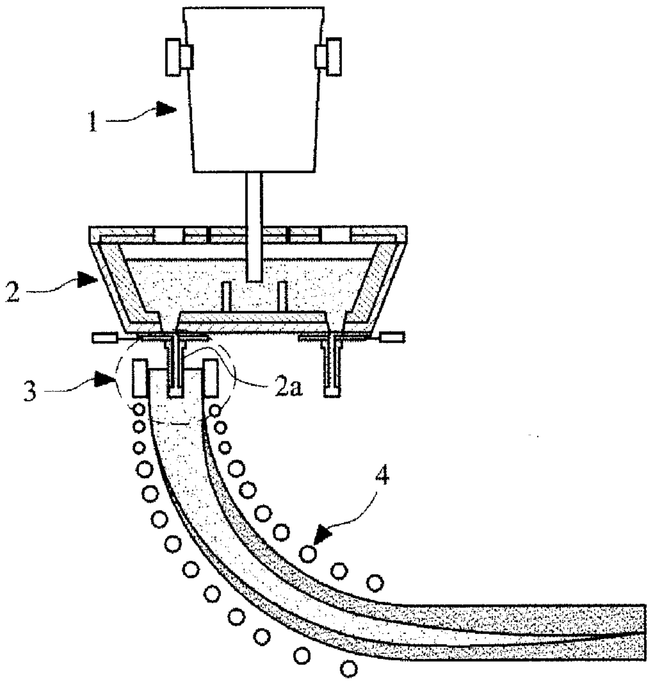


FIG. 1

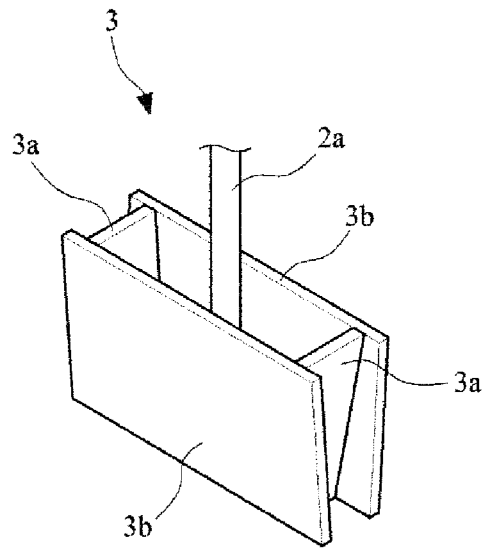
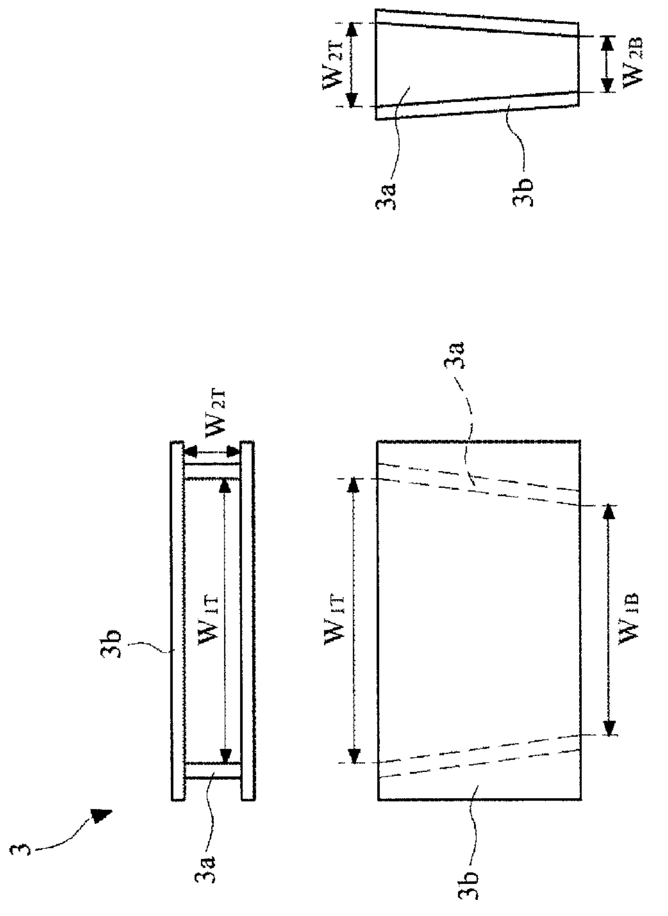


FIG. 2



d_1=(incline amount of long side) = $(W_{1T}-W_{1B})/W_{1B} \times 100$

d_2=(incline amount of short side) = $(W_{2T}-W_{2B})/W_{2B} \times 100$

FIG. 3

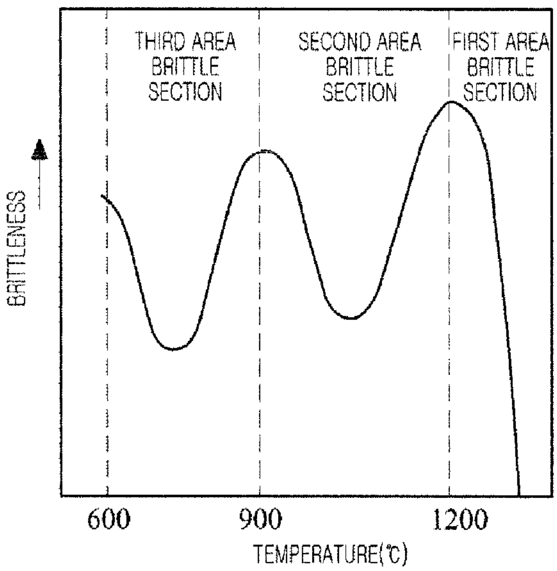

THIRD AREA
BRITTLE
SECTION
SECOND AREA
BRITTLE
SECTION
FIRST AREA
BRITTLE
SECTION
BRITTLENESS
600
900
1200
TEMPERATURE(℃)

FIG. 4

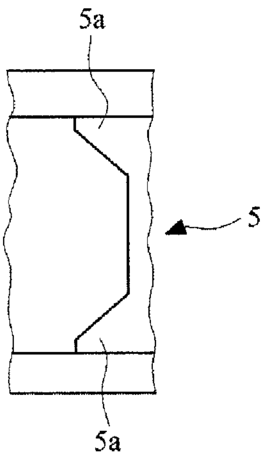


FIG. 5A

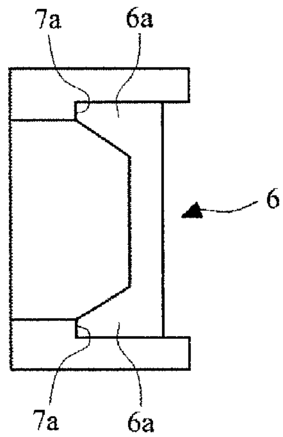


FIG. 5B

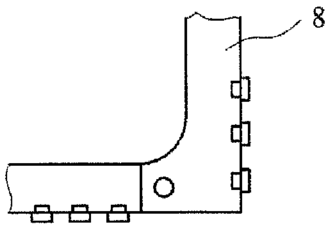


FIG. 5C

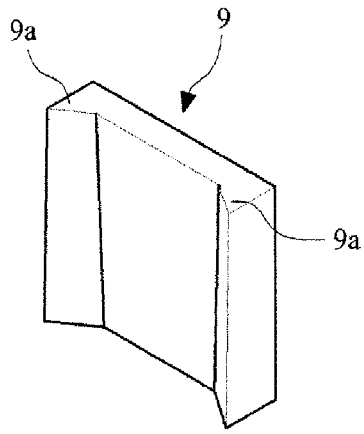


FIG. 5D

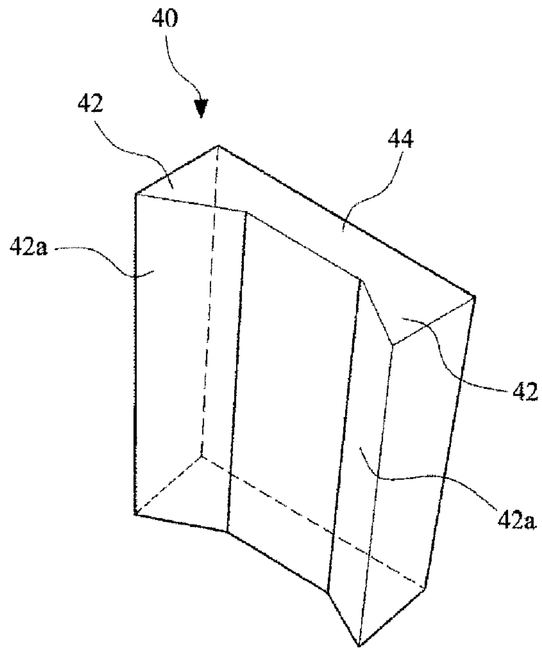


FIG. 6

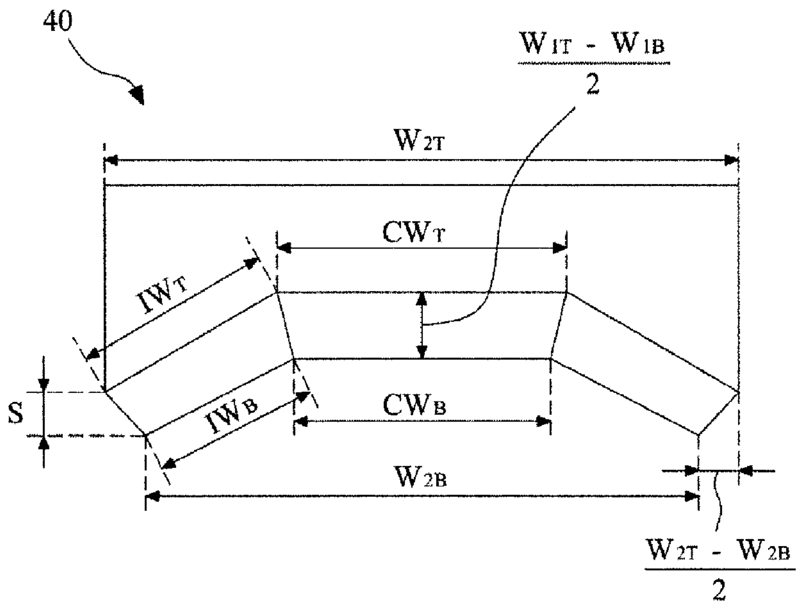


FIG. 7

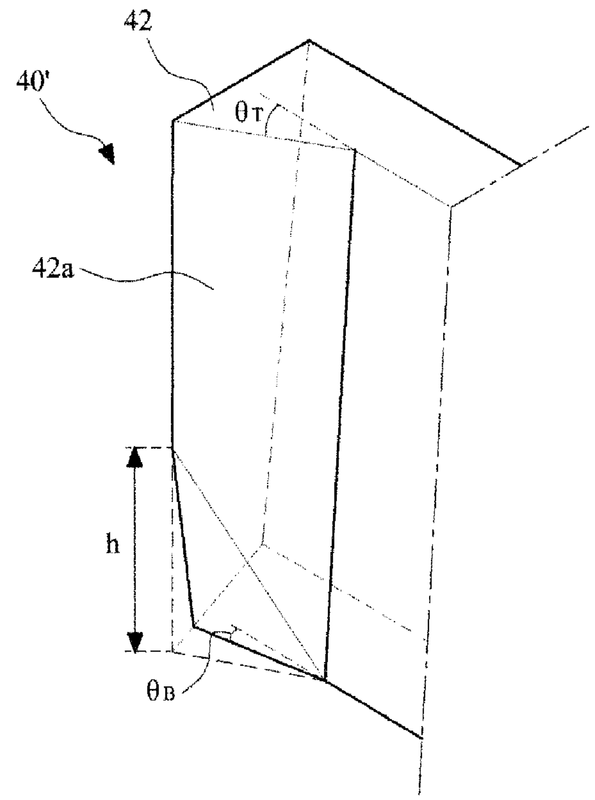


FIG. 8A

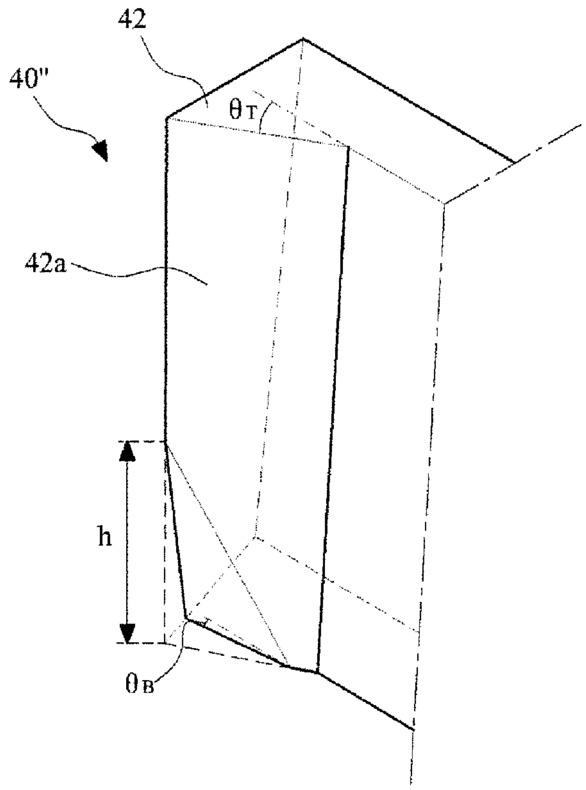


FIG. 8B

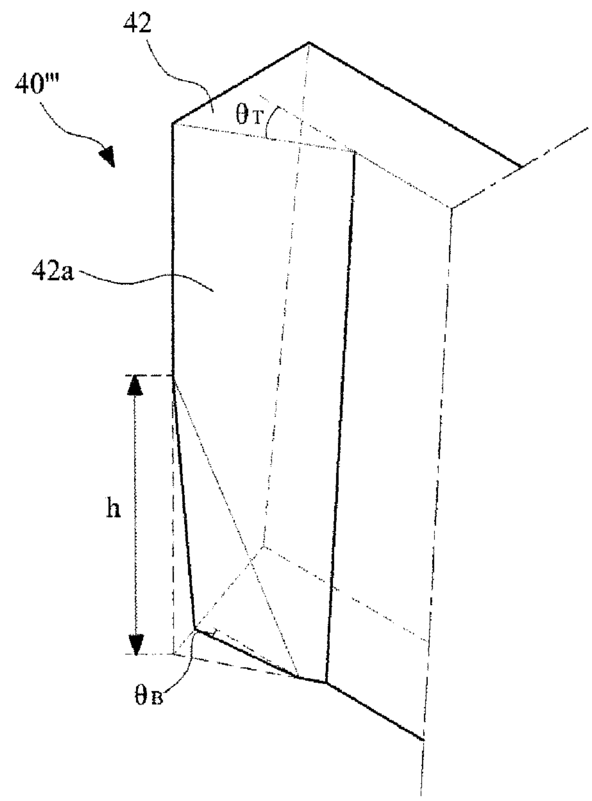


FIG. 8C

TEST	TOP WIDTH OF MOLD (mm)		d_1 (%)	d_2 (%)	W_{3T} (mm)	W_{3B} (mm)	θ_T (°)	θ_B (°)	h (mm)	CORNER CRACK OCCURRENCE RATE(%)	DEGREE OF ABRASION OF METAL PLATE
	LONG SIDE (W_{1T})	SHORT SIDE (W_{1T})									
1	1000 ~ 2000	267	1 ~ 1.3	0.755	267	265	0	0	0	4.11%	1
2		267			207	205.8	33.69	33.65	0	0.65%	2.5
3		267			207	205.8	33.69	32.01	300	0.74%	0.8

FIG. 9A

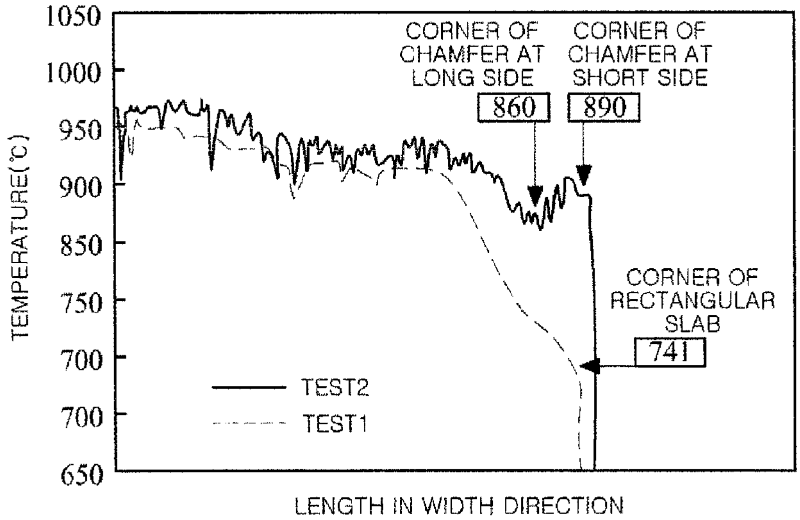

1050
1000
950
900
850
750
700
700
650
TEMPERATURE(℃)
CORNER OF CHAMFER AT LONG SIDE
860
CORNER OF CHAMFER AT SHORT SIDE
890
CORNER OF RECTANGULAR SLAB
741
TEST2
TEST1
LENGTH IN WIDTH DIRECTION

FIG. 9B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2012/011290

A. CLASSIFICATION OF SUBJECT MATTER

B22D 11/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22D 11/04; B22D 11/057; B22D 11/00; B22D 11/041; B22D 11/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: continuous casting, narrow face mold, chamfering surface, inclined plane, shrinkage amount

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-0685474 B1 (KIM, YONG HO) 26 February 2007 See abstract, claims 1,4 and figures 3,4.	1-5
A	KR 10-0775091 B1 (POSCO) 08 November 2007 See abstract, claims 1,2 and figures 3-5.	1-5
A	JP 08-150440 A (DANIELI & C OFF MECC SPA) 11 June 1996 See abstract, claim 1 and figures 1-4.	1-5
A	KR 10-2004-0059083 A (POSCO) 05 July 2004 See abstract and figure 8.	1-5
A	KR 10-2007-0056923 A (KME GERMANY AG) 04 June 2007 See abstract, claims 1-3 and figures 1-6.	1-5

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 MARCH 2013 (18.03.2013)	**19 MARCH 2013 (19.03.2013)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2012/011290

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-0685474 B1	26.02.2007	NONE	
KR 10-0775091 B1	08.11.2007	NONE	
JP 08-150440 A	11.06.1996	BR 9502158 A	07.11.1995
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		US 7455098 B2	25.11.2008

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- JP HEI11290995 B **[0013] [0016]**
- KR 20020084914 **[0013]**
- KR 20020084915 **[0017]**