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(54) **COOLED CONTINUOUS CASTING MOLD**

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(57) **ABSTRACT**

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The invention relates to a cooled continuous casting mold (1) for casting metal, especially steel, which has a casting format (GF) that is defined by respective two opposite broad faces (2, 3) and small faces (4, 5). The broad faces (2, 3) have a cooling area (6) which is designed for the maximum casting width and comprises a plurality of cooling channels (7) extending in the direction of casting and being connected to a coolant circuit. The small faces (4, 5) can be adjusted to a predetermined casting format having a corresponding casting width. The aim of the invention is to provide a continuous casting mold for slab formats, especially thin slabs, which allows to adjust an even working end temperature of the broad sides and especially to reduce a considerable temperature drop in the neighborhood of the small faces while at the same time allowing to adjust different casting formats, especially smaller casting formats as compared to the maximum casting format. For this purpose, the cooling channels (7) and/or the inlet and/or outlet channels (8) of the mold cooling system can be at least partially blocked in the area of the adjustable small faces (4, 5).

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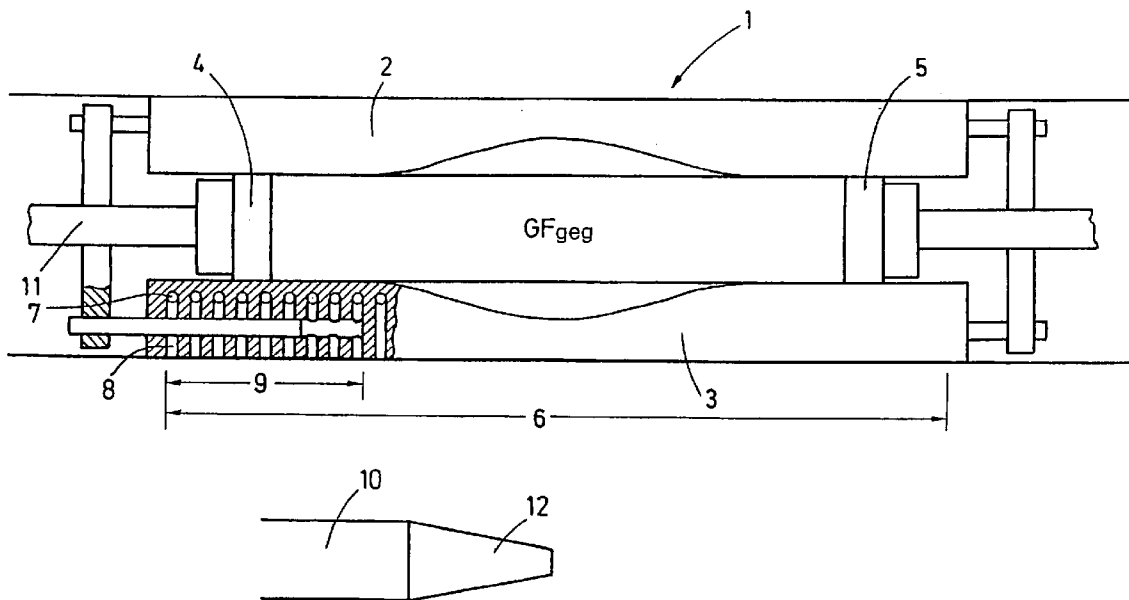


Fig. 1

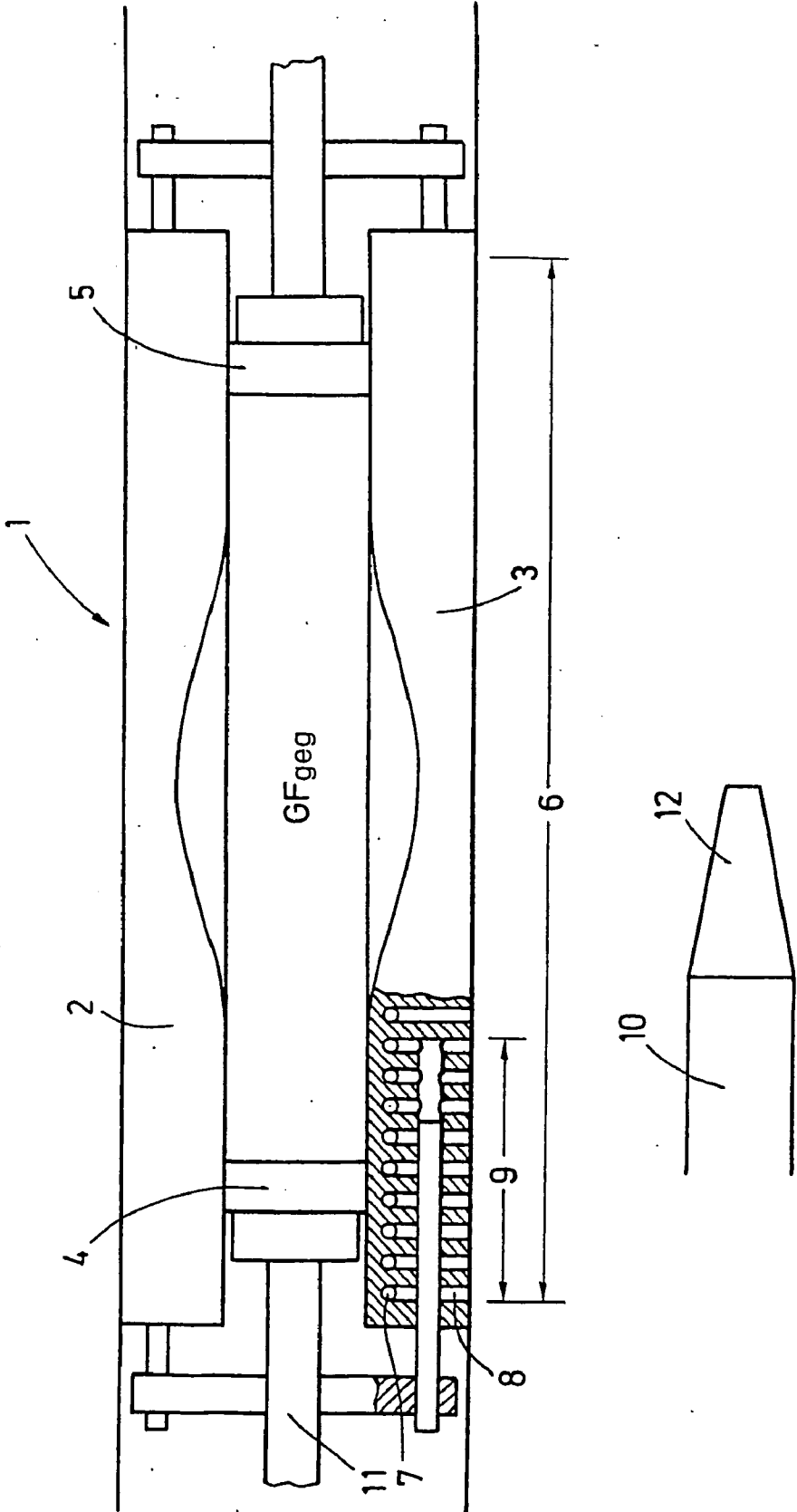
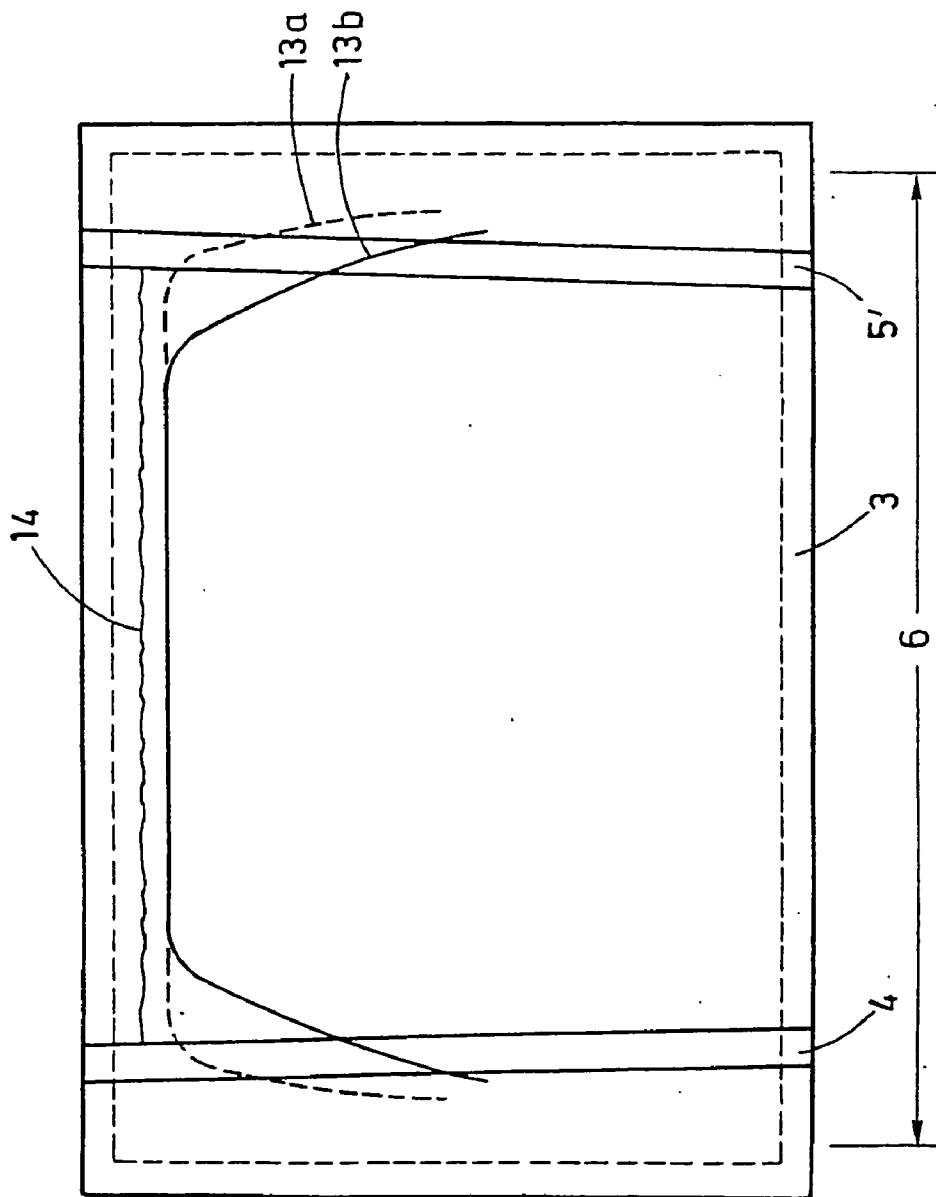


Fig. 2



### COOLED CONTINUOUS CASTING MOLD

**[0001]** The invention concerns a cooled continuous casting mold for casting metal, especially steel, with a casting format formed by two opposite wide sides and two opposite narrow sides. The wide sides have a cooling zone designed for the maximum casting width with several cooling channels which extend in the direction of casting, are connected to a coolant circuit, and have inlet and outlet channels. The narrow sides can be adjusted to set up the desired casting width.

**[0002]** In all slab molds (thin slabs, intermediate slabs, and thick slabs), the cooling system for the wide sides of the mold is designed for the maximum casting width. During the casting of a slab with a casting width that is smaller than the maximum casting width, the intensive mold cooling is also active outside the adjustable narrow side. The cooling zone is thus wider than the actual casting width. Consequently, intensive cooling also occurs where there is no heat evolved by the strand.

**[0003]** As a result of the two-dimensional heat flow, the temperature along the wide sides can drop significantly in the vicinity of the narrow sides. Depending on the temperature level on the wide sides and the wall thickness of the wide sides between the working face and the cooling channels (the mold plates being made of a copper material), the temperature drop in the immediate vicinity of the narrow sides can be up to 200° C. or more.

**[0004]** As a result of temperature drops of this magnitude, uniform melting conditions for the casting flux powder are no longer present. However, uniform melting conditions are necessary to achieve good, uniform surface quality of the continuously cast product.

**[0005]** Since the same amounts of water are used for small casting formats as for the maximum format width, unnecessarily large amounts of water are needed in this type of operation. These large amounts of water are ultimately not needed for cooling the strand, and they also have an adverse effect on the uniform melting of the casting flux powder.

**[0006]** The Japanese document JP 09 04 7848 discloses a continuous strip casting mold with narrow sides which can be moved back and forth along with blocking elements for cooling channels.

**[0007]** DE 41 27 333 C2 discloses a steel continuous casting mold with walls provided with several cooling channels that extend from top to bottom and are connected to a coolant water circuit, thereby forming a cooling zone that extends all the way across the wide sides. Here it is proposed that the open cross section of the cooling channels be reduced by displacement rods in the region of the highest thermal stress of the mold, i.e., in the heating zone, in order to increase the flow rate of the cooling water and thus the rate of heat removal in these places.

**[0008]** The goal of the invention is to create a continuous casting mold for slab formats, especially thin slabs, in which, despite the setting of different casting formats, especially casting formats that are smaller than the maximum casting format, the temperature of the working face of the wide sides can be made more uniform, and the significant temperature drop in the vicinity of the narrow sides can be reduced. The amount of cooling water needed is also to be reduced.

**[0009]** This goal is achieved by the continuous casting mold with the features of claim 1. Advantageous refinements are described in the dependent claims.

**[0010]** In accordance with the invention, it is proposed that, to set up a cooling zone that is dependent on the casting width or to set up a water-cooled width that is dependent on the format width, the cooling channels and/or the inlet and/or outlet channels of the wide sides of the mold can be completely or at least partially blocked in the region within which the narrow sides can be adjusted and also in a region within which the narrow sides can be adjusted and also in a region which extends into the casting format. The blocking can take place in the mold plate, in the steel intermediate plate of a cassette mold, and/or in the water box. The blocking can take place in the negative strip or the positive strip of the mold.

**[0011]** The blocking is meant to be possible between the region of the narrow side plates and the maximum cooling width. Blocking is also possible between a region close to the narrow side, which can extend beyond the actual narrow side into the casting format itself, and the maximum cooling width.

**[0012]** Because the flow of cooling medium, especially cooling water, is blocked or greatly reduced in the region of the narrow side and in the region outside the casting format, the temperature of the working face of the wide sides is evened out in the area of the narrow sides. Because of the more even temperature distribution on the working face of the wide sides in the region of the liquid steel level, the melting of the casting flux powder and thus the surface quality of the cast product are improved.

**[0013]** An advantage is obtained especially in the casting of small casting formats. Because the width cooled by water can be adjusted as a function of the format width, the amount of cooling medium required, especially the amount of water required, can be reduced and/or the water flow rate can be increased. This is important, especially at constant casting output, since higher water flow rates are possible at small casting widths and higher casting speeds. With the higher water flow rates, the heat transfer can be increased, and thus the temperature increase of the working face due to the higher casting speed can be at least partially compensated.

**[0014]** As discussed above, the cooling channels that extend at least over the region within which the narrow sides can be adjusted can be completely or partially blocked. Moreover, calculations have shown that, in order to even out the temperature gradients of the wide sides more effectively, it should also be possible to block cooling channels which extend beyond the narrow sides and into the casting format itself by up to 100 mm per side.

**[0015]** A uniform temperature distribution on the working face of the wide sides is obtained when the degree of blocking of the coolant flow decreases towards the center of the mold, i.e., when the blocking of the cooling channels decreases towards the center of the mold. This can be achieved if suitable blocking elements in the region near the narrow sides and/or in the casting format taper towards the center of the mold.

**[0016]** Water is the preferred coolant. The most uniform temperature distribution is obtained when the water flow rate in the region of the cooling channels that can be partially blocked is a maximum of 25 m/s and a minimum of 0.5 m/s.

**[0017]** In addition, it is advisable for the water flow rate of the cooling channels in the cooling zone with cooling channels that are not blocked to be a minimum of 0.5 m/s. This is achieved by suitably configured blocking elements.

**[0018]** In a preferred embodiment, the blocking of the individual cooling channels is achieved by blocking elements

installed on the narrow-side support. The blocking elements are preferably designed as pins that control the inlet or outlet of the individual cooling channels. The blocking elements can be moved back and forth along with the associated narrow side or narrow-side support. First, the positions of the narrow sides are adjusted to obtain the desired casting format or casting width. Once the narrow sides are in their proper positions, the wide-side cooling channels in the vicinity of the narrow sides are at least partially blocked. This prevents these areas of the wide sides from being overcooled, which has an advantageous effect on the melting behavior of the casting flux powder and thus on the surface quality of the continuously cast product.

[0019] Further details and advantages of the invention are specified in the dependent claims and in the following description, in which the specific embodiment of the invention illustrated in the drawings is explained in greater detail.

[0020] FIG. 1 shows a top view of a mold with wide sides and narrow sides and with means for adjusting the water-cooled width.

[0021] FIG. 2 shows a side view of a mold and a representation of the average working face temperature gradient below the liquid steel level in a mold with and without adjustment of the water-cooled width.

[0022] FIG. 1 shows a top view of a continuous casting mold 1 that consists of two opposite wide sides 2, 3 and two opposite narrow sides 4, 5, which form the casting format for the given slab between them. The positions of the narrow sides 4, 5 between the wide sides 2, 3 can be adjusted to set up a predetermined or desired casting format  $GF_{geg}$  or a casting width. So that casting formats of maximum width can also be cast reliably, the cooling zone 6 of the wide sides 2, 3 is designed to correspond to the maximum casting width. The wide sides 2, 3 have vertical cooling channels 7 in the form of bores, each of which is connected to a cooling water circuit by an inlet 8 and an outlet.

[0023] When a casting format  $GF_{max}$  with the maximum casting width is being cast, cooling water flows through all of the cooling channels 7, and the wide sides 2, 3 are cooled over the entire cooling zone 6.

[0024] When a casting format  $GF_{geg}$  with a smaller casting width is set up, the cooling channels 7 and the inlets 8 are at least partially blocked in the region 9.

[0025] It is also shown that the region of influence 9 can be made to extend beyond the positions to which the narrow sides have been adjusted and into the casting format itself. In this case, cooling channels which are located beyond the actual narrow side plate and thus in the casting format itself are also blocked. It was determined that the partial blocking of the cooling channels can extend up to 100 mm per side into the casting format.

[0026] In accordance with a preferred embodiment, the cooling channels are at least partially blocked by blocking elements 10, which are in the form of pins mounted on the support 11 of the narrow sides 4, 5 and which thus can move back and forth along with the narrow side. They taper toward the center of the mold. As a result of this tapering end 12, the blocking effect on the inlets of the channels decreases toward the center of the mold.

[0027] FIG. 2 shows a side view of a mold with the two narrow sides 4, 5 and a representation of the average working face temperature gradient below the liquid steel level in a mold with (13a) and without (13b) adjustment of the cooling water width in accordance with the invention. The liquid steel

level is labeled 14. Although the cooling zone 6 extends over the entire wide side of the mold, the cooling action can be reduced or completely blocked in certain areas depending on the positions of the narrow sides. Reducing or blocking the cooling in the area between the maximum casting format and the displaced narrow sides 4, 5 has the positive effect of evening out the temperature of the working face below the level of the liquid steel. The working face temperature thus remains constant as far as the narrow sides, whereas, without the inventive influence on the cooling action, the working face temperature drops sharply as it approaches the narrow sides.

#### LIST OF REFERENCE NUMBERS

|        |  |
|--------|--|
| [0028] | 1 continuous casting mold  |
| [0029] | 2 wide side  |
| [0030] | 3 wide side  |
| [0031] | 4 narrow side  |
| [0032] | 5 narrow side  |
| [0033] | 6 cooling zone   |
| [0034] | 7 vertical cooling channels  |
| [0035] | 8 coolant inlet  |
| [0036] | 9 zone with at least partially blocked cooling channels  |
| [0037] | 10 blocking element  |
| [0038] | 11 narrow-side support   |
| [0039] | 12 tapering end of the blocking element  |
| [0040] | 13a average working face temperature gradient below the liquid steel level in a mold with adjustment of the cooling water width    |
| [0041] | 13b average working face temperature gradient below the liquid steel level in a mold without adjustment of the cooling water width |
| [0042] | 14 liquid steel level  |

1. Cooled continuous casting mold (1) for casting metal, especially steel, with a casting format (GF) formed by two opposite wide sides (2, 3) and two opposite narrow sides (4, 5), where the wide sides (2, 3) have a cooling zone designed for the maximum casting width with several cooling channels (7) that extend in the direction of casting, are connected to a coolant circuit, and comprise inlet and outlet channels (8), and where, in the area of the narrow sides (4, 5), the cooling channels (7) can be at least partially blocked by blocking elements, wherein the narrow sides (4, 5) can be adjusted to set up a predetermined casting format with the desired casting width; in that the blocking elements are designed to block, at least partially, the cooling channels (7), and, alternatively or additionally, to block the inlet and/or outlet channels (8) in the adjustment region; and in that the cooling channels and/or the inlet and/or outlet channels are blocked in such a way that the blocking action decreases from the narrow side into the casting format.

2. Continuous casting mold according to claim 1, wherein the blocking starts from the maximum cooling width and extends beyond the narrow sides into the casting format by a maximum of 100 mm.

3. Continuous casting mold according to claim 1, wherein the at least partial blocking takes place in the mold plate, in the steel intermediate plate of a cassette mold, and/or in the water box.

4. Continuous casting mold according to claim 1, wherein, to realize the decreasing blocking action, the blocking elements (10) have a form (12) which tapers toward the center of the mold.

5. Continuous casting mold according to claim 1, wherein the coolant is water, and in that the water flow rate in the region of the cooling channels and/or inlet and/or outlet channels that can be at least partially blocked is a maximum of 25 m/s and a minimum of 0.5 m/s.

6. Continuous casting mold according to claim 1, wherein the water flow rate of the cooling channels in the cooling zone with cooling channels that are not blocked is a minimum of 0.5 m/s.

7. Continuous casting mold according to claim 6, wherein the blocking elements (10) can be moved back and forth along with the associated narrow side (4, 5).

8. Continuous casting mold according to claim 1, wherein the blocking elements (10) in the form of pins are mounted on a narrow side support (11).

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