CONTINUOUS CASTING DEVICE AND METHOD FOR USING SAME

A continuous casting machine includes: a mold; a dummy bar curved at a uniform curvature in a longitudinal direction and configured to be inserted into the mold to receive molten steel when casting is started; guide rolls configured to guide, downward along a circular path, the dummy bar and a cast piece that have been drawn out of the mold, the circular path passing through the mold and having the curvature radius; a delivery portion configured to deliver, in a tangential direction of the circular path, the cast piece separated from the dummy bar at a bottom portion of the circular path; and a guide mechanism configured to allow the dummy bar separated from the cast piece to move along the circular path and configured to insert the dummy bar into the mold from above the mold.

FIG. 1
Description

[Technical Field]

[0001] The present invention relates to a continuous casting machine having a cast-piece path curved at a uniform curvature radius, and a method of using the same. More specifically, the present invention relates to a continuous casting machine, in which a dummy bar is also curved at a uniform curvature radius, and a method of using the same.

[Background Art]

[0002] In a continuous casting machine for casting steel, the molten steel transferred from a converter by a ladle is temporarily transferred to a tundish by pouring the molten steel into the tundish through the bottom of the ladle, and is continuously poured from the tundish into a rectangular or cylindrical mold. A dummy bar is inserted into the mold from below and the molten steel poured into the mold is brought into contact with the inner surface of the dummy bar and the mold and is thus cooled. The periphery of the molten steel is cooled by the inner surface of the mold and is thus solidified. A cast piece is drawn from the mold downward by drawing the dummy bar downward in a state where part of the molten steel not yet solidified remains in the cast piece. The cast piece is guided by pinch rolls arranged below the mold and is drawn downward along a curved path formed by the pinch rolls, in the course of which the cast piece is completely solidified. The dummy bar at the leading end is separated from the cast piece at the bottom of the curved movement path. The cast piece is straightened from the curved shape into a flat shape and then, the cast piece is cut to predetermined dimensions and sent to a downstream process.

[0003] FIGS. 7(a) and 7(b) are diagrams showing an operation of a conventional continuous casting machine described in Patent Document 1. A dummy bar 1 having a uniform curvature radius is inserted into a mold 8 from below the mold 8 and molten steel is poured from a tundish (not shown) into the mold for casting so as to cover the trailing end of the dummy bar 1. Thereafter, the dummy bar 1 is drawn downward, so that the cast piece 2, part of which is in contact with the mold 8 and is therefore solidified in the mold 8, is drawn downward through the bottom of the mold 8. Straightening rolls 3 and 4 are disposed at a bottom portion of the movement range of the dummy bar 1 and the cast piece 2. The straightening rolls 4 move upward and wait, so that the dummy bar 1 can move along the guide rolls 7 and move upward along the same circular path. The straightening rolls 4 descend and press the leading end portion of the cast piece 2, so that the leading end of the cast piece 2 is separated from the trailing end of the dummy bar 1. The cast piece 2 is pressed downward by the straightening rolls 3 and 4 and thereby straightened from a curved shape into a flat, straight shape. The cast piece 2 is then cut to appropriate dimensions and discharged from the continuous casting machine.

[0004] As shown in FIG. 7(b), the dummy bar 1 waits at a higher position. When the molten steel has been poured from the ladle into the tundish and has been poured from the tundish into the mold 8, and the trailing end of the cast piece 2 has passed the straightening rolls 3 and 4, the dummy bar 1 is reversed along the circular path and the trailing end thereof (the leading end in the reversing direction) is inserted into the mold 8 through the bottom of the mold 8. The next casting operation is then started. Similar continuous casting machines are also described in Patent Documents 2 to 4.

[0005] Patent Document 5 describes a continuous casting machine, in which the curvature of the course for drawing the cast piece is not uniform and the cast piece receives straightening force so that the curvature radius gradually increases in the course of drawing the cast piece from the mold by the pinch rolls. In the continuous casting machine, the dummy bar is formed by connecting a plurality of units in the form of a chain. The dummy bar moves downward between the pinch rolls while relative angles between the units are gradually changed, which causes the dummy bar to change its form so that the curvature radius is gradually increased. The dummy bar is separated from the leading end of the cast piece and is then inserted into the mold from above the mold to be used in the next casting operation. In the continuous casting machine described in Patent Document 5, the dummy bar separated from the cast piece at the cast piece separation position, which is a bottom portion of the continuous casting machine, is raised to the casting floor by a dummy bar-hoisting winch. Thereafter, the dummy bar is placed on a mover frame that runs on guide rails installed on the casting floor, and is carried to the vicinity of the mold. The mover frame is tilted at the vicinity of the mold, so that the dummy bar is slid and inserted into the mold from the lower end of the tilted mover frame.

[Prior Art Document]

[Patent Document]

[0006]

[Patent Document 1]

[Patent Document 2]

[Patent Document 3]
US Patent No. 5131453

US Patent No. 4043383

[Summary of Invention]

[Problems to be Solved by the Invention]

In the above-described, conventional continuous casting machine, however, after the pouring of molten steel from the tundish into the mold 8 is completed and the trailing end of the cast piece 2 has passed the pinch rolls (not shown), the dummy bar 1 is reversed and inserted into the mold 8 through the bottom of the mold 8 to complete preparation for the next casting operation. As such, there has been a problem that the operation rate of the continuous casting machine is low because waiting time is long, that is, the time taken from when the preceding casting operation is completed to when it becomes possible to start the next casting operation.

Patent Document 5 describes a continuous casting machine, in which the dummy bar is inserted into the mold from the top of the mold. In order to insert the dummy bar into the mold from the top of this mold, it is necessary that the dummy bar be made up of a plurality of units connected like a chain and be able to be bent at the connections between the units so that the shape of the dummy bar is changeable. Moreover, it is also required to install a hoisting winch for hoisting the dummy bar on the casting floor and install a mover for further carrying the dummy bar from the hoisting position to the vicinity of the mold. As such, a large-scale casting machine is required. Furthermore, since it is required to install such a hoisting winch and a mover on the casting floor and a casting control room, etc. are installed on the casting floor as described in Patent Document 5, a large space for installation is required in order to avoid interference with these facilities in installing the hoisting winch and the mover.

The present invention has been made in consideration of the above problem and an object of the present invention is to provide a continuous casting machine and a method of using the same, with which it is possible to achieve a high operation rate and improve productivity by reducing the waiting time between a preceding casting operation and the next casting operation, without increase in size and complication of the machine.

[Means for Solving the Problems]

A continuous casting machine according to the present invention is characterized by including:

- a mold;
- a dummy bar curved at a uniform curvature in a longitudinal direction and configured to be inserted into the mold to receive molten steel when casting is started;
- guide rolls configured to guide, downward along a circular path, the dummy bar and a cast piece that have been drawn out of the mold, the circular path passing through the mold and having the curvature radius;
- a delivery portion configured to deliver, in a tangential direction of the circular path, the cast piece separated from the dummy bar at a bottom portion of the circular path; and
- a guide mechanism configured to allow the dummy bar separated from the cast piece to move along the circular path and configured to insert the dummy bar into the mold from above the mold.

In the continuous casting machine, the guide mechanism may have:

a first pinch roll portion disposed on the circular path and configured to apply a drawing force to the dummy bar and the cast piece, the first pinch roll portion having at least two pairs of pinch rolls; and
a second pinch roll portion disposed on the circular path and configured to apply a driving force to the dummy bar to move the dummy bar along the circular path, the second pinch roll portion having at least two pairs of pinch rolls.

In the continuous casting machine, the first pinch roll portion may be provided at the delivery portion, and
the second pinch roll portion may be provided at each of two or more locations on the circular path.

In the continuous casting machine, the second pinch roll portion may be provided at each of two or more locations on the circular path that include locations positioned on both sides of a top of the circular path, and
the guide mechanism may have a support roll disposed above the second pinch roll portions and configured to roll on an inner surface of the dummy bar with respect to a radial direction of the circular path to support the dummy bar.

In the continuous casting machine, the guide mechanism may have:

an underside roll configured to roll on an outer surface of the dummy bar with respect to the radial direction of the circular path to support the dummy bar; and
a side roll configured to roll on a side surface of the dummy bar to support the dummy bar.

[0015] A method of using the continuous casting machine according to the present invention is characterized by including the steps of:

preparing for a casting operation by inserting the dummy bar into the mold from above the mold and placing the dummy bar at a bottom portion of the mold;
According to the present invention, since the present invention achieves very high productivity. Moreover, the dummy bar DB has a length equal to or greater than one third of the circumference of the circular path. A mold 10 is disposed at a middle position of the movement path 20 in the vertical direction. The mold 10 is curved at the curvature radius D along the movement path 20. Guide rolls 11 that guide the dummy bar DB and a cast piece C downward along the curved track are disposed below the mold 10. Five pairs of pinch rolls 12 (first pinch roll portion), for example, are disposed at an end portion (lower end portion) of the guide rolls 11. Second pinch roll portions 21 and 22 that roll on and deliver the dummy bar DB while supporting the dummy bar DB from both sides of the dummy bar DB are provided at two upper locations on the movement path 20. Moreover, a support roll 23 that supports a lower surface of the dummy bar DB (inner surface of the arch) from below is disposed at a top portion on the movement path 20. The mold 10, the guide rolls 11, the first pinch roll portion 12, the second pinch roll portion 21, the support roll 23, and the second pinch roll portion 22 are arranged along the movement path 20 of the dummy bar DB. In this embodiment, the second pinch roll portions 21 and 22 are disposed at the two locations on the circular movement path 20. Each of the second pinch roll portions 21 and 22 includes two pairs of rolls.

At a delivery portion, in which the first pinch roll portion 12 is provided, the dummy bar DB and the cast piece C are separated from each other and the cast piece C deviates from the movement path 20. After the cast piece C is straightened from a curved shape into a flat shape by the first pinch roll portion 12, the cast piece C is delivered in a horizontal direction by the first pinch roll portion 12. The cast piece C is conveyed on conveyor rollers 17, cut to predetermined dimensions by a shear...
A tundish 14 is positioned above the mold 10 and the second pinch roll portions 21 and 22. Such that the dummy bar DB is always caught by at least two pairs of the pinch rolls included in the first pinch roll portion 12 and the second pinch roll portions 21 and 22. A tundish 14 is positioned above the mold 10 and a ladle 16 is positioned above the tundish 14. The tundish 14 is placed on a tundish car (not shown) that moves on an operation floor, so that the tundish 14 is moved between a position over the mold 10 and a position away from the position over the mold 10. The ladle 16 receives, from a converter (not shown), molten steel refined in the converter and is carried by a suitable crane to a turning machine 15. The ladle 16 is turned or pivoted by the turning machine 15 and positioned over the tundish 14 that is positioned over the mold 10. The molten steel in the ladle 16 is poured into and stored in the tundish 14 and then, the molten steel is poured from the tundish 14 into the mold 10. One casting operation is completed when all the molten steel in the ladle 16 is supplied to the mold 10 via the tundish 14 and solidified in the mold 10, and the trailing end of the cast piece is drawn out of the mold 10. The tundish 14 is then moved from the position over the mold 10 to a standby position by the tundish car and the inner refractory lining of the tundish 14 is restored at the standby position.

As shown in FIG. 2, the molten steel poured into the mold 10 is cooled in the mold 10, a peripheral portion of the molten steel that is in contact with the mold 10 is solidified to form a solidified shell, and the cast piece C is drawn out of the mold 10 downward in a state where the molten steel not yet solidified remains in the cast piece C. The dummy bar DB is joined to a leading end portion of the cast piece C. The dummy bar DB and the cast piece C are moved downward while the same curvature radius thereof is kept by the guide rolls 11. The dummy bar DB reaches the position, at which the downstream direction of the cast piece C joined to the trailing end of the dummy bar DB reaches the position, at which the downstream direction of the cast piece C is separated from the leading end of the cast piece C. The cast piece C is then delivered forward and conveyed on the conveyor rollers 17 by the rotating rolls of the first pinch roll portion 12 while being straightened into a flat shape by being sandwiched between the lowered upper roll 12b and the lower roll 12b on the lower side and at the same time sandwiched between the adjacent rolls 12a to keep the vertical position of the cast piece C. The dummy bar DB is constrained and supported by the guide mechanism installed on supports 31 and 35 that are installed in a standing manner on the floor, so that the dummy bar DB is moved upward while the curvature radius D of the dummy bar DB is maintained. A horizontal base 32 is installed on the top of the supports 31 and a vertically extending support 33 is installed in a standing manner on the base 32. In this embodiment, the guide mechanism includes: side rolls 25 and underside rolls 24 provided on the support 35 near the first pinch roll portion 12; and side rolls 25, an outside roll 42, and side rolls 44 provided on the supports 31 to 33 for installing the second pinch roll portion 21. The side rolls 25 roll on the side surfaces of the dummy bar DB to restrict the horizontal position of the dummy bar so as to prevent the dummy bar DB from deviating from the predetermined movement path 20. The underside rolls 24 roll on the lower side of the dummy bar DB to bear the weight of the dummy bar DB and restrict the position of the dummy bar DB so as to prevent the dummy bar DB from
ally from the movement path 20. The outside roll 42 rolls on the outer side of the dummy bar DB and also restricts the position of the dummy bar DB so as to prevent the dummy bar DB from deviating laterally from the movement path 20.

[0025] The second pinch roll portion 21 is provided on the horizontal base 32 and the support 33 provided on the base 32 in a standing manner. The second pinch roll portion 21 includes two pairs of rolls, which are a pinch roll 21a having rolls 41a and 42a and a pinch roll 21b having rolls 41b and 42b. The rolls 41a and 41b roll on the inner side of the curved dummy bar DB and the rolls 42a and 42b roll on the outer side of the dummy bar DB. The rolls 42a and 42b are provided on the support 33 and move with the outer surface of the dummy bar DB to bear the lateral stress caused by the dummy bar DB. Meanwhile, the rolls 41a and 41b are driven by a motor 43 and sandwich the dummy bar DB between the rolls 41a and 41b and the opposing rolls 42a and 42b while pressing the inner side of the dummy bar DB, so that the dummy bar DB is moved along the circular movement path 20 by the driving force of the motor 43. The rolls 21a and 21b and the motor 43 are disposed on the base 32 so that the whole of the rolls 21a and 21b and the motor 43 is pivotable about a horizontal rotation shaft 45. The second pinch roll portion 22 is similar in structure to the second pinch roll portion 21. As described above, the second pinch roll portions 21 and 22 are disposed at two locations on the movement path 20 of the dummy bar DB in this embodiment. The second pinch roll portion 21 has the two pairs of rolls 21a and 21b and the dummy bar DB moves while being sandwiched between the rolls 41a and 41b of the roll pair 21a and between the rolls 41b and 42b of the roll pair 21b. This also applies to the second pinch roll portion 22. In the present invention, however, each of the second pinch roll portions 21 and 22 may include one roll pair instead of providing two roll pairs for each of the second pinch roll portions 21 and 22.

[0026] As shown in FIG. 1, the second pinch roll portion 22 similar in structure to the second pinch roll portion 21 is disposed at the position opposite to the position of the second pinch roll portion 21 in the upper part of the circular movement path 20. Also in the second pinch roll portion 22, the dummy bar DB is drawn and moved forward along the predetermined movement path 20 by the roll pairs.

[0027] Next, operation of the continuous casting machine of this embodiment configured as described above will be described. The dummy bar DB is curved so that the curvature radius D of the dummy bar DB is the same as the curvature radius of the predetermined movement path 20 as described above. The dummy bar DB is rigid as a whole. The curvature radius of the dummy bar DB is adjustable by adjusting the relative angles between the units DB1, ... as described above. The length of the dummy bar DB is greater than the length of the section of the circumference from the mold 10 to the first pinch roll portion 12. It is necessary that the length of the dummy bar DB be greater than the length of the section of the circumference between the first pinch roll portion 12 and the second pinch roll portion 21 and greater than the length of the section of the circumference between the second pinch roll portion 21 and the second pinch roll portion 22.

[0028] After the ladle 16 is turned and carried to the position for casting by the turning machine 15 and the tundish 14 on the tundish car is moved to the standby position away from the position over the mold 10, the second pinch roll portion 21 and the second pinch roll portion 22 are then driven to advance the dummy bar DB in the direction indicated by the arrow in FIG. 1 to insert the dummy bar DB into the mold 10 from above the mold 10. The leading end of the dummy bar DB first enters the mold 10. The dummy bar DB passes through the mold downward and is stopped while the lower end of the dummy bar DB remains in a lower part of the mold 10. In this way, a casting space is formed, which is formed by the side walls of the mold 10 and the top surface of the dummy bar DB. When this is performed, the dummy bar DB is moved forward by the rotating rolls of the second pinch roll portion 22 while being guided by the mold 10 and the guide rolls 11, with the dummy bar DB being sandwiched by the second pinch roll portion 22. When the trailing end of the dummy bar DB is positioned in the mold 10, the leading end of the dummy bar DB is already sandwiched by the rolls of the first pinch roll portion 12 and the dummy bar DB is thereafter drawn by the first pinch roll portion 12.

[0029] The tundish car is then driven to position the restored tundish 14 over the mold 10. The ladle 16, by which molten steel is transferred from the converter, is positioned over the tundish 14 by driving the turning machine 15, the molten steel is poured from the ladle 16 into the tundish 14, and the molten steel is then poured into the mold 10 through a tundish nozzle. The molten steel contacts the mold 10 and is thus cooled, so that the peripheral portion and the bottom portion of the molten steel are solidified and form a solidified shell, and a cast piece C is formed, in which molten steel not yet solidified remains. The dummy bar DB is then drawn by the first pinch roll portion 12 to draw the cast piece C joined to the dummy bar DB out of the mold 10 downward, and the cast piece C is guided downward along the guide rolls 11. In this way, the cast piece C is cooled by the cooling water sprayed from spray nozzles and the cast piece C, including the inner part thereof, is completely solidified while the cast piece moves downward, guided by the guide rolls arranged below the mold 10.

[0030] As shown in FIG. 4, the leading end of the dummy bar DB passes the pairs of rolls 12a and 12b of the first pinch roll portion 12 and moves upward with the outer
surface of the dummy bar DB supported by the underside rolls 24 and the outside roll 42, because the dummy bar DB is rigid. Since the side surfaces of the dummy bar DB are supported by the side rolls 25, the dummy bar DB is prevented from deviating from the predetermined movement path 20. When the trailing end of the dummy bar DB reaches the position, at which the rolls 12b of the first pinch roll portion 12 are disposed, the upper roll 12b is lowered to press down the cast piece C joined to the trailing end of the dummy bar DB and separate the cast piece C from the dummy bar DB immediately after the trailing end of the dummy bar DB passes the upper roll 12b. Since the cast piece C is sandwiched between the lowered upper roll 12b and the lower roll 12b and at the same time sandwiched between the adjacent pair of rolls 12a, the cast piece C is flattened by the roll pairs in the first pinch roll portion 12, transported on the conveyor rollers 17, and cut to predetermined dimensions by the shear 13 during transportation.

[0031] The dummy bar DB is further advanced by the first pinch roll portion 12. The front portion of the dummy bar DB is guided by the guide mechanism, moves upward, and is caught between the rolls 21a and between the rolls 21b of the second pinch roll portion 21. The dummy bar DB is then driven and advanced by the second pinch roll portion 21.

[0032] As shown in FIG. 1, the dummy bar DB then leaves the first pinch roll portion 12 and is driven only by the second pinch roll portion 21, so that the dummy bar DB moves toward the second pinch roll portion 22 along the movement path 20. The dummy bar DB is supported by the support roll 23 in the course. The leading end of the dummy bar DB is then caught by the second pinch roll portion 22, so that the dummy bar DB is driven by the second pinch roll portions 21 and 22. Thereafter, the trailing end of the dummy bar DB leaves the second pinch roll portion 21 and is driven by the second pinch roll portion 22 only. Until completion of the casting operation, the movement of the dummy bar DB is stopped in a state where the leading end of the dummy bar DB is caught by the second pinch roll portion 22.

[0033] The first pinch roll portion 12 continues delivering the cast piece C onto the conveyor rollers 17. After the molten steel in the ladle 16 runs out and substantially all of the molten steel in the tundish 14 is poured into the mold 10, the surface level of the molten steel in the mold 10 descends, and the trailing end of the cast piece C is drawn out of the mold 10.

[0034] The tundish 14 used is then moved from the position over the mold 10 to the standby position by the tundish car. The second pinch roll portion 22 then drives the dummy bar DB and delivers the dummy bar DB into the mold 10. The second pinch roll portion 12 stops driving the dummy bar DB in a state where the trailing end of the dummy bar DB is positioned at the bottom of the mold 10. A restored, new tundish 14 is then moved to the position over the mold 10 by the tundish car. Refined molten steel is then transferred from the converter by the ladle 16. The ladle 16 is mounted on the turning machine 15 and positioned over the tundish 14 by driving the turning machine 15. The next casting operation is then started.

[0035] In this way, the dummy bar DB moves in one direction along the circular movement path 20 having the uniform curvature radius D in this embodiment. Since the placement of the dummy bar DB in the mold and the casting operations are performed by moving the dummy bar DB along the movement path 20 in this way, it is possible to replace the tundish 14 with a new one and start the next casting operation as soon as possible, that is, with substantially no waiting time, after the completion of pouring molten steel from the tundish 14 into the mold 10. For this reason, the continuous casting machine of this embodiment achieves a high operation rate and therefore achieves a very high productivity.

[0036] Moreover, as compared to the conventional continuous casting machines described in Patent Documents 1 to 4, in the case of the continuous casting machine according to this embodiment, it suffices that a guide mechanism configured to move the dummy bar DB separated from the cast piece at the delivery portion along the circular path passing through the mold and insert the dummy bar DB from above the mold is additionally installed. Such a guide mechanism does not require the conventional, complicated structure. Accordingly, it is possible to improve the casting operation rate without the increase in size and complication of the machine and without the need for a large space unlike the apparatus described in Patent Document 5.

[0037] As described above, it is necessary that the dummy bar move on a circular path in the present invention. Of the continuous casting machines for continuously casting steel, the continuous casting machine for making cast pieces having small, rectangular or circular cross sections, such as blooms and billets, or the continuous casting machine for making beam blanks, such as H-beam having an H-shaped cross section is provided with a mold and guide rolls for guiding the cast pieces, the mold and the guide rolls being arranged so as to be curved at a uniform curvature radius. Such a configuration is adopted in order to smoothly draw the cast piece, of which the peripheral portion of the molten steel is solidified in the mold, by guiding the cast piece until the cast piece reaches the end of the guide rolls with the curvature radius kept unchanged. For this reason, the dummy bar is also curved at a uniform curvature radius similarly to the mold and the pinch rolls, so that the dummy bar moves and passes the guide rolls without deformation while the dummy bar moves, guided by the guide rolls, with the curved form kept unchanged.

[0038] It suffices that, when the dummy bar is long, the second pinch roll portion to be used solely for driving the dummy bar is installed at one location (a top portion of the movement path) opposite to the position of the first pinch roll portion to be used basically for driving the cast piece. However, when the length of the dummy bar DB
is not so long, it is required to provide two or more second pinch roll portions at two or more locations. In order to further simplify the structure to achieve a greater reduction in costs, it is preferable to provide the second pinch roll portions at two locations only. The guide mechanism may include the underside rolls that bear the weight of the dummy bar DB, the side rolls that support the dummy bar DB so as to prevent the dummy bar from deviating in the lateral direction, etc. Nevertheless, it is unnecessary to use a large-scale installation for the means for moving the dummy bar along the circular movement path. In the above-described embodiment, two pairs of rolls are provided for each of the second pinch roll portions 21 and 22, which allows each of the second pinch roll portions 21 and 22 to support the dummy bar DB reliably. However, it is possible to use one pair of rolls for each of the second pinch roll portions when the guide mechanism, which includes the side rolls and the underside rolls, is constructed so as to support the dummy bar sufficiently.

[0039] In the above-described embodiment, the first pinch roll portion 12 and the second pinch roll portions 21 and 22 are configured to move the dummy bar DB in one direction along the circular movement path and drive the dummy bar DB so that the dummy bar DB is inserted into the mold 10 from above the mold 10. However, it is also possible to insert the dummy bar DB into the mold 10 from below the mold 10 with the use of the continuous casting machine of this embodiment.

[Industrial Applicability]

[0040] The present invention significantly improves the operation rate and the productivity of the continuous casting machine while reducing the manufacturing costs.

[Description of Reference Numerals]

[0041]

10: mold
11: guide roll
12: first pinch roll portion
13: shear
14: tundish
15: turning machine
16: ladle
17: conveyor roller
20: movement path
21, 22: second pinch roll portion

Claims

1. A continuous casting machine characterized by comprising:

   a mold;

   a dummy bar curved at a uniform curvature in a longitudinal direction and configured to be inserted into the mold to receive molten steel when casting is started;

   guide rolls configured to guide, downward along a circular path, the dummy bar and a cast piece that have been drawn out of the mold, the circular path passing through the mold and having the curvature radius;

   a delivery portion configured to deliver, in a tangential direction of the circular path, the cast piece separated from the dummy bar at a bottom portion of the circular path; and

   a guide mechanism configured to allow the dummy bar separated from the cast piece to move along the circular path and configured to insert the dummy bar into the mold from above the mold.

2. The continuous casting machine according to claim 1, characterized in that

   the guide mechanism includes:

   a first pinch roll portion disposed on the circular path and configured to apply a drawing force to the dummy bar and the cast piece, the first pinch roll portion having at least two pairs of pinch rolls;

   and

   a second pinch roll portion disposed on the circular path and configured to apply a driving force to the dummy bar to move the dummy bar along the circular path, the second pinch roll portion having at least two pairs of pinch rolls.

3. The continuous casting machine according to claim 2, characterized in that

   the first pinch roll portion is provided at the delivery portion, and

   the second pinch roll portion is provided at each of two or more locations on the circular path.

4. The continuous casting machine according to claim 2 or 3, characterized in that

   the second pinch roll portion is provided at each of two or more locations on the circular path that include locations positioned on both sides of a top of the circular path, and

   the guide mechanism includes a support roll disposed above the second pinch roll portions and configured to roll on an inner surface of the dummy bar with respect to a radial direction of the circular path to support the dummy bar.

5. The continuous casting machine according to any one of claims 2 to 4, characterized in that

   the guide mechanism includes:

   an underside roll configured to roll on an outer
surface of the dummy bar with respect to the radial direction of the circular path to support the dummy bar; and
a side roll configured to roll on a side surface of the dummy bar to support the dummy bar.

6. A method of using the continuous casting machine according to any one of claims 1 to 5, the method being characterized by comprising the steps of:

preparing for a casting operation by inserting the dummy bar into the mold from above the mold and placing the dummy bar at a bottom portion of the mold;
drawing the cast piece joined to the dummy bar out of the mold by starting drawing the dummy bar after the molten steel is poured into the mold from a tundish positioned over the mold and a solidified shell is formed in the mold;
continuing the pouring of the molten steel from the tundish into the mold and the drawing of the dummy bar and the cast piece;
after a leading end of the cast piece reaches a position of the delivery portion and the dummy bar and the cast piece are separated from each other, causing the guide mechanism to guide and drive the dummy bar so that the dummy bar moves along the circular path and sending the separated cast piece to a downstream process;
and
preparing for a next casting operation by removing the tundish from a position over the mold after the casting of the molten steel from the tundish to the mold is completed, and inserting the dummy bar into the mold from above the mold before the cast piece formed by the molten steel supplied from the tundish reaches the delivery portion.
FIG. 4
**INTERNATIONAL SEARCH REPORT**

**INTERNATIONAL APPLICATION NO.**

PCT/JP2013/066973

**A. CLASSIFICATION OF SUBJECT MATTER**

B22D11/043(2006.01)

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)

B22D11/043

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
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<td>X</td>
<td>JP 2011-515226 A (SMS Sienag AG), 19 May 2011 (19.05.2011), paragraphs [0002], [0020]</td>
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<td>WO 2009/121492 A1 &amp; DE 102008016759 A</td>
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<td>CN 101983112 A</td>
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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
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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

04 July, 2013 (04.07.13)

Date of mailing of the international search report

16 July, 2013 (16.07.13)

Name and mailing address of the ISA/

Japanese Patent Office

Authorized officer

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