ABSTRACT

A continuous casting apparatus has a series of rolling stands for lightly rolling a continuously cast strand while the core of the strand is liquid. Each of the rolling stands has a lower module which contains an idler roll disposed at a fixed location. Each of the rolling stands further has an upper module containing a driven roll as well as a hydraulic unit for moving the driven roll towards and away from the idler roll. The upper modules are mounted on pairs of columns where the columns of each pair are located directly across from one another on opposite sides of the strand. The upper modules of two neighboring rolling stands share a pair of columns thereby allowing the distance between such rolling stands to be reduced.
BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

The invention relates to continuous casting.

[0002] 2. Description of the Prior Art

Apparatus for the continuous casting of steel typically include a mold having a generally vertical casting passage. The casting passage is open at the top and bottom, and a stream of molten steel is directed into the top of the passage. The molten steel partially solidifies in the mold to form a continuously cast strand consisting of a solidified outer shell and a molten core. The strand is withdrawn from the bottom of the casting passage and conveyed along a path which curves to the horizontal. As the strand travels along such path, the strand is cooled and the molten core solidifies progressively. Once the strand has solidified throughout the cross section thereof, the strand is cut into sections.

[0005] It has been found that the internal quality of a fully solidified strand is improved when the strand undergoes a small amount of rolling before solidification is complete. This rolling, which is referred to as soft reduction, is carried out while the cross section of the strand has a solid fraction of 20 percent to 85 percent.

[0006] The term “solid fraction” arises from the fact that steel generally does not undergo a direct transformation from liquid to solid when cooled. Instead, there is a temperature range between liquids and solids where the steel is in a so-called “mushy” state. In this state, the steel is neither completely solid nor completely liquid but is a mixture of solid and liquid. The proportion of solid in the mixture is indicated by a percentage referred to as the “solid fraction”.

[0007] Rolling of the strand during soft reduction takes place in a series of rolling stands or assemblies which are located next to one another along the path of the strand. Each of the rolling stands includes an upper module containing a movable roller, and a hydraulic unit for moving the roller towards and away from a second roller in a lower module. The upper module of each rolling stand is supported on four columns of its own, and two of the columns face one another across the path of the strand at a first location of the path while two face one another across the path of the strand at a second location of the path.

[0008] The rollers of neighboring rolling stands are spaced from each other by a relatively large distance which typically is at least 1 meter. Although it is desirable for the rollers to be closer to one another, the adjoining columns of two neighboring rolling stands prevent the distance between the stands from being reduced.

[0009] The solidification rate of a continuously cast strand can vary significantly depending upon a number of factors such as the type of steel being cast, the degree of superheat and the casting speed. When the distance between neighboring rolling stands is large, this can result in a situation where only one of the rolling stands, or possibly none of the rolling stands, acts on the portion of the strand having a solid fraction of 20 percent to 85 percent, i.e., on the portion of the strand which is suitable for soft reduction. In this case, little or none of the benefit of soft reduction is achieved.

SUMMARY OF THE INVENTION

[0010] It is an object of the invention to reduce the spacing between reduction devices.

[0011] The preceding object, as well as others which will become apparent as the description proceeds, are achieved by the invention.

[0012] One aspect of the invention resides in a continuous casting apparatus. The apparatus comprises a mold designed to form a continuously cast strand from molten material, at least one support and at least two assemblies operable substantially independently of one another to effect a dimensional reduction of a strand formed in the mold. Each of the assemblies includes a supporting part which rests on the support, and each of the assemblies further includes another part which extends downward from the respective supporting part and comprises at least one reducing member for effecting a dimensional reduction of a strand formed in the mold. By way of example, the support can constitute or resemble a column while the reduction assemblies can constitute rolling stands.

[0013] In accordance with the invention, two assemblies for effecting a dimensional reduction of a continuously cast strand share a support thereby allowing a second support between the assemblies to be eliminated. This enables the assemblies to be placed closer to one another than before.

[0014] Another aspect of the invention resides in a method of operating a continuous casting apparatus. The method comprises the steps of providing a mold designed to form a continuously cast strand from molten material, installing the mold at a casting location and providing two assemblies operable substantially independently of one another to effect a dimensional reduction of a continuously cast strand. The method further comprises the step of placing the assemblies on a support at a reduction location spaced from the casting location so that a supporting part of each assembly rests on the support and a second part of each assembly extends downward from the respective supporting part. The second part of each assembly includes a reducing member for effecting a dimensional reduction of a strand formed in the mold. Each of the assemblies is preferably placed on the support substantially independently of the other assembly.

[0015] The method can additionally comprise the step of fixing the assemblies to the support with a fixing element which urges both of the assemblies towards the support.

[0016] The method may also include the steps of forming a partially solidified continuously cast strand in the mold, and subjecting the partially solidified strand to a dimensional reduction in at least one of the assemblies. The reducing member of this assembly can comprise a roll and the subjecting step can then involve rolling the partially solidified strand.

[0017] At least one of the reducing assemblies can include an additional reducing member which is arranged to cooperate with the other reducing member of such assembly to effect a dimensional reduction of a strand formed in said mold. The method can here comprise the step of anchoring the additional reducing member to the support for the reducing assemblies.
The method may further comprise the steps of providing a hollow anchoring member having an upper side and a lower side separated by a gap, passing the support through the upper side, and resting the support on the lower side.

The method may further comprise the steps of providing an additional support, bridging the two supports with a pipe, and introducing a cooling fluid into the supports from the pipe.

Additional features and advantages of the invention will be forthcoming from the following detailed description of preferred embodiments when read in conjunction with the accompanying drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**[0021]** FIG. 1 is a schematic sectional side view of a continuous casting apparatus in accordance with the invention.

**[0022]** FIG. 2 is a side view showing certain details of rolling stands constituting part of the apparatus of FIG. 1.

**[0023]** FIG. 3 is a sectional view in the direction of the arrows III-III of FIG. 2.

**[0024]** FIG. 4 is a fragmentary sectional view in the direction of the arrows IV-IV of FIG. 2 but without counterweights and drive units forming part of the rolling stands.

**[0025]** FIG. 5 is a fragmentary sectional view in the direction of the arrows V-V of FIG. 4.

**[0026]** FIG. 6 is a fragmentary sectional view in the direction of the arrows VI-VI of FIG. 4.

**DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Referring to FIG. 1, the numeral 10 generally identifies a continuous caster or casting apparatus according to the invention. The caster 10 is of the type typically used to cast steel, and this type of apparatus is generally designed to produce billets, blooms or slabs which are square or rectangular products differing primarily in cross-sectional size. The caster 10 is assumed to be capable of casting steel into multiple product types and product sizes, and the products generated by the caster 10 can be converted into special bar quality and/or rails. Examples of products which can be made by the caster 10 are blooms, billets and rounds.

The caster 10 includes a cooled, generally vertical continuous casting mold 12 having a generally vertical casting passage 14. The casting passage 14, which is here curved but could also be straight, has an open upper end 14a and an open lower end 14b. The upper end 14a constitutes an inlet end of the casting passage 14 while the lower end 14b constitutes an outlet end of the casting passage 14.

Below the mold 12 is a curved roller apron 16 which includes a row of rollers 16a and another row of rollers 16b situated opposite the roller row 16a. At the end of the roller apron 16 remote from the mold 12 is a series of rolling stands or reduction assemblies 18 each of which comprises an upper roller or reducing member 18a and a lower roller or reducing member 18b. The lower rollers 18b are mounted for rotation at fixed locations while the upper rollers 18a are movable towards and away from the respective lower rollers 18b by individual hydraulic units 20 forming part of the rolling stands 18. The rolling stands 18 are designed to subject the strand 18 to soft reduction.

Following the rolling stands 18, as considered in a direction away from the mold 12, is a pinch roll and final straightening mechanism 22 with an upper roller 22a and two lower rollers 22b and 22c. The lower rollers 22b, 22c are mounted for rotation at fixed locations whereas the upper roller 22a, which is situated opposite the lower roller 22c, is movable towards and away from the roller 22c by a hydraulic unit not shown in FIG. 1. The rolling stands 18, together with the pinch roll and final straightening mechanism 22, constitute a straightener/withdrawal unit with soft reduction capability. The straightener/withdrawal unit 18, 22 is followed by a runout table 24 which includes a row of rollers 24a.

The pinch roll and final straightening mechanism 22 can be eliminated. Thus, it is possible to design the caster 10 such that the rolling stands 18 carry out withdrawal and straightening as well as soft reduction.

The mold 12, roller apron 16, rolling stands 18, pinch roll and final straightening mechanism 22 and runout table 24 define a path, indicated by the arrow P, which curves from the mold 12 to the pinch roll and final straightening mechanism 22 and then becomes straight and horizontal. The portion of the path P from the mold 12 to the rolling stands 18 constitutes a segment of a circle, and this portion of the path P has an inner radius which is tangent to the roller apron rollers 16a and an outer radius which is tangent to the roller apron rollers 16b.

At the start of a casting operation, the outlet end 14b of the casting passage 14 is closed by a non-illustrated dummy bar which is gripped by the pinch roll and final straightening mechanism 22. A stream or jet 26 of molten material is then teemed into the inlet end 14a of the casting passage 14. The molten material, which is here assumed to be steel, solidifies partially in the casting passage 14 to establish a connection with the dummy bar and to form a continuously cast strand 28 which is releasably attached to the dummy bar. The strand 28 comprises a shell or skin 28a of solidified steel and a core 28b of molten steel confined within the shell 28a.

The dummy bar is withdrawn from the casting passage 14 along the path P by the pinch roll and final straightening mechanism 22. The dummy bar, which pulls the strand 28 behind it, is disconnected from the strand 28 and stored once the strand 28 reaches the pinch roll and final straightening mechanism 22. Thereafter, the pinch roll and final straightening mechanism 22 acts directly on the strand 28 to convey the latter along the path P.

The strand 28 is conveyed continuously along the path P at a predetermined rate commonly referred to as the casting speed. The molten steel from the ladle and tundish is teemed continuously into the casting passage 14 at a rate matched to the casting speed.

As the strand 28 travels through the roller apron 16, the strand 28 is cooled by non-illustrated water sprays. Consequently, the strand 28 solidifies progressively along the roller apron 16 with the shell 28a increasing in thickness and the core 28b decreasing in thickness. Upon reaching the rolling stands 18, the strand 28 is subjected to a soft
reduction which can involve a reduction of 1 mm to 5 mm in the thickness of the strand 28 in each rolling stand 18. The cross section of the strand 28 preferably has a solid fraction of at least 20 percent and, depending upon the operator of the caster 10, no more than 70 percent or 85 percent when undergoing soft reduction.

[0037] After leaving the rolling stands 18, the strand 28 passes through the pinch roll and final straightening mechanism 22 which straightens the strand 28. The strand 28, which has now solidified throughout, then moves onto the runout table 24 where the strand 28 is cut into sections by non-illustrated traveling cutting torches.

[0038] The soft reduction of the strand 28 improves the quality of the strand 28. For example, it has been found that soft reduction decreases segregation and porosity.

[0039] Referring to FIGS. 2 and 3, each of the rolling stands 18 includes an upper module 30 containing the respective upper roller 18a and a lower module 32 containing the respective lower roller 18b. The lower modules 32 are fixed to a bottom frame 34 which sits on a subbase 36 and is connected thereto by clamping bolts 38. The subbase 36, in turn, sits on a foundation 40. The subbase 36 is provided with anchoring elements 42 which penetrate the foundation 40 and help to prevent shifting of the subbase 36 relative to the same. Foundation bolts 44 serve to secure the subbase 36 to the foundation 40.

[0040] In addition to the respective upper roller 18a, each upper module 30 further contains a counterweight 46, a drive unit 48 for rotating the upper roller 18a, and the respective hydraulic unit 20 for moving the upper roller 18a towards and away from the lower roller 18b. Every drive unit 48 comprises a motor 48a and a gear box 48b.

[0041] Each upper module 30 includes a main carrier or supporting part 50 and an auxiliary carrier 52 below the main carrier 50. The counterweight 46 and the drive unit 48 are fixed to opposite sides of the auxiliary carrier 52 while the upper roller 18a is suspended therefrom. The main carrier 50 and auxiliary carrier 52 can be in the form of box beams.

[0042] Considering FIG. 4 in conjunction with FIGS. 2 and 3, each upper module 30 is provided with a vertical central passage 54. The hydraulic unit 20 of each upper module 30 comprises a cylinder 56 and a cylinder rod 58 which projects from the cylinder 56. The cylinder 56 of each hydraulic unit 20 rests on top of the respective main carrier 50 and is secured to the carrier 50 by four threaded bolts or fastening elements 60 which screw into square nuts 62. The cylinder rod 58 of each hydraulic unit 20 extends downward from the cylinder 56 through the respective central passage 54, and the end of the cylinder rod 58 remote from the cylinder 56 is threaded.

[0043] A coupling device 64 is fixed to the top of each auxiliary carrier 52, and each coupling device 64 is formed with a blind bore which is aligned with the respective central passage 54. The blind bore is threaded, and the threaded end of the cylinder rod 58 of the respective hydraulic unit 20 is screwed into the blind bore. Consequently, as the cylinder rod 58 of an upper module 30 is extended, the corresponding auxiliary carrier 52 and upper roller 18a move away from the respective main carrier 50 and towards the respective lower roller 18b. Conversely, as the cylinder rod 58 is retracted, the corresponding auxiliary carrier 52 and upper roller 18a move towards the respective main carrier 50 and away from the respective lower roller 18b.

[0044] In conventional continuous casting apparatus, the upper module of each rolling stand is supported on four columns of its own. Two of the columns face one another across the path of the strand at a first location of the path and two face one another across the path of the strand at a second location of the path. The rollers of neighboring rolling stands are spaced from each other by a relatively large distance, which is typically at least 1 meter, and the adjoining columns of two neighboring rolling stands prevent the distance between the rolling stands from being reduced.

[0045] With widely spaced rolling stands, there is a good likelihood that little or none of the advantage of soft reduction will be achieved. The reason is that the solidification rate of a continuously cast strand can vary significantly depending upon a number of factors such as the type of steel being cast, the degree of superheat and the casting speed. Thus, when the distance between neighboring rolling stands is large, this variation in solidification rate can result in a situation where only one of the rolling stands, or possibly none of the rolling stands, acts on the portion of the strand having a solid fraction of 20 percent to 85 percent, i.e., on the portion of the strand which is suitable for soft reduction.

[0046] One object of the invention is to position the rolling stands 18 closer to one another. To this end, the upper modules 30 of two neighboring rolling stands 18 rest on and are fixed to a common pair of columns or carrying members 66.

[0047] The columns 66 are mounted on the bottom frame 34 of the continuous casting apparatus 10. As seen in FIG. 3, the bottom frame 34 includes parallel box beams or anchoring members 68 each having two side plates 68a and 68b which are separated by a gap. Each of the box beams 68 further has an upper plate 68c and a lower plate 68d which are likewise separated by a gap and bridge the respective side plates 68a,68b. The side plates 68a of the box beams 68 face the path P of the strand 28. The columns 66 pass through the upper plates 68c and rest on the lower plates 68d, and the columns 66 are secured to the upper plates 68c and the lower plates 68d, e.g., by welding.

[0048] As illustrated in FIG. 5, the columns 66 are hollow to permit circulation of cooling water therethrough and can be in the form of circular tubing. A plate 70 is located inside each column 66 a short distance below the top of the respective column 66 and closes the column 66. The plates 70 prevent the cooling water flowing in the columns 66 from escaping through the tops of the columns 66.

[0049] The columns 66 are arranged in pairs with the columns 66 of each pair being situated directly opposite one another on opposite sides of the path P of the strand 28. As shown in FIG. 3, the columns 66 of each pair are connected to each other by a lower pipe 72a disposed near the bottoms of the columns 66 and by an upper pipe 72b disposed near the tops of the columns 66. The lower pipes 72a are located between the box beams 68 of the bottom frame 34 and connect to the columns 66 through openings in the side plates 68a. The pipes 72a,72b function to distribute a cooling fluid, typically water, to the columns 66 and also to stiffen the columns 66.
As seen in FIGS. 2-6, a plate 74 is fixed to the top of each column 66, e.g., by welding, and the main carriers 50 of the upper modules 30 rest on the plates 74. Two columns 66 disposed directly opposite one another on opposite sides of the path P of the strand 28 are situated between neighboring ones of the rolling stands 18, and the upper modules 30 of neighboring rolling stands 18 are both carried by the two columns 66 between such rolling stands 18. In other words, the upper modules 30 of neighboring rolling stands 18 share the columns 66 located between these rolling stands 18.

FIG. 6 shows the main carrier 50 of an upper module 30 resting on two columns 66 located directly opposite each other on opposite sides of the path P of the strand 28. As illustrated in FIG. 6, the plate 74 at the top of each column 66 has a portion 74a which projects laterally from the respective column 66 towards the other of the two columns 66. The main carrier 50 is fixed to each of the two columns 66 by a bolt or fastening element 76 which passes through the main carrier 50 and through the projecting portion 74a of the respective plate 74. Each of the bolts 76 has a head 76a which bears against the upper side of the respective main carrier 50, and each of the bolts 76 further has a threaded end which projects from the respective plate 74. A nut 78 is screwed onto the threaded end of each of the bolts 76.

Referring to FIG. 4 together with FIG. 6, each of the main carriers 50 is provided with two parallel pipe sections 80a and two parallel pipe sections 80b. The pipe sections 80a are disposed side-by-side as are the pipe sections 80b. The pipe sections 80a, 80b run in the direction of the path P of the strand 28, and the pipe sections 80a in each main carrier 50 are located upstream of the central passage 54 for the respective hydraulic unit 20 while the pipe sections 80b are located downstream of the central passage 54. In each of the main carriers 50, the axis of each pipe section 80a lies on a line with the axis of one of the pipe sections 80b.

Each of the pipe sections 80a, 80b has an open end 82 to allow access to the interior of the respective pipe section 80a, 80b. The square nuts 83, which screw onto the bolts 60 holding the hydraulic units 20 on the main carriers 50, are located inside the pipe sections 80a, 80b.

As seen in FIG. 4, cooling fluid is supplied to each of the main carriers 50 by way of an inlet pipe 84. After circulating through the respective main carrier 50, the cooling fluid flows out of the main carrier 50 via an outlet pipe 86. FIG. 6 shows that flow passages 88 for the cooling fluid are machined into the pipe sections 80a, 80b.

As outlined earlier, each of the two main carriers 50 resting on a column 66 is secured to such column 66 by a discrete bolt 76. FIGS. 2, 4 and 5 illustrate that, in addition, the two main carriers 50 resting on a column 66 are secured to such column 66 by a common thread bolt or fastening element 90, i.e., a bolt or fastening element 90 acting on both of the main carriers 50.

Considering FIGS. 4 and 5, the two main carriers 50 resting on a column 66 define two gaps 92 which are disposed directly opposite one another on opposite sides of the path P of the strand 28. The main carriers 50 have outer sides 94 which face away from the path P, and each of the gaps 92 has an open end at the outer sides 94 of the respective main carriers 50. The gaps 92, which are located above and centered with reference to the respective columns 66, extend inward from the outer sides 94 to locations overlying the plates 70 inside the columns 66.

The widths of the gaps 92 are slightly larger than the diameters of the bolts 90, and the bolts 90 extend through the gaps 92 and pass through the plates 74 fixed to the tops of the columns 66. This is shown in FIG. 5 which further shows that the bolts 90 have heads 90a disposed above the main carriers 50. The ends of the bolts 90 remote from the heads 90a are located in the spaces between the plates 74 on the tops of the columns 66 and the plates 70 inside the columns 66. Nuts 96 are screwed onto these ends of the bolts 90.

With reference still to FIG. 5, the heads 90a of the bolts 90 bear against nuts 98 screwed onto the bolts 90. Each of the nuts 98, in turn, bears against the tops of the two main carriers 50 defining the gap 92 which receives the respective bolt 90. Hence, each bolt 90 functions to secure the two main carriers 50 resting on a column 66 to the respective column 66.

Turning to FIG. 4 again, the plates 74 fixed to the tops of the columns 66 have outer edges 100 which face away from the main carriers 50. Each of the plates 74 is provided with a slot or cutout 102 which is in alignment with, and can have the same width as, the respective gap 92. The slots 102 extend inward from the respective outer edges 100 and terminate at the same locations as the gaps 92, that is, at locations overlying the plates 70 inside the columns 66. The wall of each column 66 is formed with a non-illustrated opening which is in register with the respective slot 102 and extends downward from the slot 102 to the level of the plate 70 inside the respective column 66.

To fix two neighboring main carriers 50 to a column 66, the nut 98 is screwed onto the respective bolt 90 followed by the nut 96. With reference to FIG. 5 once more, the distance between the nuts 96, 98 is adjusted so that it exceeds the distance between the bottom surface of the respective plate 74 and the top surfaces of the respective main carriers 50. The bolt 90 is then inserted in the respective slot 102 and moved inward through the aligned gap 92 and the non-illustrated opening in the column 66 so that the nut 96 enters the space between the plate 74 on top of the column 66 and the plate 70 inside the column 66. Once the bolt 90 has arrived at its desired position, the nut 98 is tightened.

As illustrated in FIG. 3, a guide plate 104 for the strand 28 is mounted on each of the columns 66. The guide plates 104 face the path P of the strand 28 and prevent excessive sideways shifting of the latter.

Referring to FIG. 2 in conjunction with FIG. 3, two additional guide plates 106 are fixed to each of the columns 66. While the guide plates 104 for the strand 28 project from the respective columns 66 at right angles to the path P of the strand 28, the additional guide plates 106 project from the respective columns 66 parallel to the path P. Two additional guide plates 106 are mounted on each column 66, and one of the additional guide plates 106 extends upstream of the path P from the column 66 whereas the second of the additional guide plates 106 extends downstream of the path P.
Each of the auxiliary carriers 52 is located between four of the columns 66 and, hence, between four of the additional guide plates 106. The main function of the additional guide plates 106 is to guide the auxiliary carriers 52 and the upper rollers 18a as they move towards and away from the lower rollers 18b. To this end, each of the auxiliary carriers 52 is equipped with four guide members 108, and each guide member 108 includes a pair of wear plates which embrace a respective additional guide plate 106.

FIG. 2 shows that each of the additional guide plates 106 has a relatively narrow upper portion 106a, a wider lower portion 106b and a portion 106c of variable width between the upper portion 106a and the lower portion 106b. The auxiliary carriers 52 and upper rollers 18a move along the upper portions 106a while the lower modules 32 containing the lower rollers 18b sit at the levels of the lower portions 106b.

Each of the lower modules 32 is located between four of the columns 66 and, therefore, between the lower portions 106b of four of the additional guide plates 106. Each of the lower modules 32 is equipped with four extensions 110 in the form of plates (only two of the extensions 110 are visible for each lower module 32), and each extension 110 projects towards and overlaps a respective lower portion 106b. The extensions 110 lie against the lower portions 106b of the additional guide plates 106 and are fixed to the lower portions 106b by bolts or fastening elements 112. This arrangement enables stiffness to be increased.

Each of the rolling stands 18 can be withdrawn from the apparatus 10 and mounted in the apparatus 10 independently of the other rolling stands 18, that is, without moving the other rolling stands 18. To withdraw a rolling stand 18 from the apparatus 10, the bolts 90 and the bolts 76 holding the respective main carrier 50 on the respective columns 66 are removed. The upper module 30 of the rolling stand 18 is then lifted off the columns 66. The bolts 112 connecting the lower module 32 of the respective rolling stand 18 to such columns 66 are likewise removed, and the lower module 32 is then upon lifted from the bottom frame 34. It is possible to tie a lower module 32 to the respective upper module 30 by way of straps or the like so that the lower module 32 can be lifted from the apparatus 10 together with the upper module 30.

When a rolling stand 18 is to be mounted in the apparatus 10, the respective lower module 32 is lowered onto the bottom frame 34 and attached to the respective columns 66 by the bolts 112. Subsequently, the upper module 30 of the rolling stand 18 is lowered into the apparatus 10 so that the respective main carrier 50 comes to rest on the columns 66. Once the main carrier 50 has been properly positioned on the columns 66, the main carrier 50 is secured to the columns 66 via the bolts 76 and 90.

It is possible to tie a lower module 32 to the respective upper module 30 by way of straps or the like so that the lower module 32 can be lifted from or placed in the apparatus 10 together with the upper module 30.

Although the apparatus 10 is shown as having six rolling stands 18, the number of rolling stands 18 may be smaller or larger than six. It is preferred for the apparatus 10 to have 3 to 9 rolling stands 18.

By mounting the upper modules 30 of two neighboring rolling stands 18 on a common pair of columns 66, it becomes possible to reduce the distance between the rolling stands 18 from 1 meter or more to 500 millimeters or less. This decreases the likelihood that none of the rolling stands 18 will act on the portion of the strand 28 which is suitable for soft reduction, i.e., the portion of the strand 28 having a solid fraction of 20 percent to 85 percent. Moreover, if the nature of the strand 28 is such that a certain number of rolling stands of a prior art apparatus would act on the portion of the strand 28 suitable for soft reduction, the smaller rolling stand spacing in the apparatus 10 of the invention may allow a greater number of the rolling stands 18 to act on such portion of the strand 28.

The use of hollow or tubular columns 66 makes it possible to circulate a cooling fluid through the columns 66. Furthermore, as opposed to columns of solid cross section, the tubular columns 66 permit the weight of the apparatus 10 to be reduced.

By employing box beams 68 for the bottom frame 34 and passing the columns 66 through the upper plates 68c of the box beams 68 so that the columns 66 rest on the lower plates 68d, the stiffness of the rolling stands 18 may be increased. The pipes 72a, 72b connecting two opposite columns 66 to one another allow the stiffness to be enhanced while, at the same time, providing a means for supplying a cooling fluid to and/or removing a cooling fluid from the columns 66. A further increase in stiffness can be achieved by the attachment of the lower modules 32 to the columns 66 via the extensions 110 and the bolts 112.

The bolts 90 make it possible to simplify mounting of the main carriers 50 on and removal of the main carriers 50 from the columns 66. Thus, since each bolt 90 holds two neighboring main carriers 50 on a column 66, the number of bolts which must be tightened or removed to assemble or disassemble the rolling stands 18 can be reduced.

Various modifications are possible within the meaning and range of equivalence of the appended claims.

I claim:

1. A continuous casting apparatus comprising:
   a mold designed to form a continuously cast strand from mollen material;
   at least one support; and
   at least two assemblies operable substantially independently of one another to effect a dimensional reduction of a strand formed in said mold, each of said assemblies including a supporting part which rests on said one support, and each of said assemblies further including another part which extends downward from the respective supporting part and comprises at least one reducing member for effecting a dimensional reduction of a strand formed in said mold.

2. The apparatus of claim 1, further comprising means for fixing said supporting parts to said one support, said fixing means including a fixing element which urges both of said supporting parts towards said one support.

3. The apparatus of claim 2, wherein said fixing element comprises a threaded shaft.

4. The apparatus of claim 1, wherein said supporting part and said other part of one of said assemblies are removable.
from said one support substantially independently of said supporting part and said other part of the other of said assemblies.

5. The apparatus of claim 1, wherein said one support comprises at least one carrying member which resembles or constitutes a column.

6. The apparatus of claim 1, wherein said one support is hollow.

7. The apparatus of claim 6, further comprising means for introducing cooling fluid into said one support.

8. The apparatus of claim 7, further comprising an additional hollow support, said introducing means including a pipe which bridges and opens into said supports.

9. The apparatus of claim 1, wherein said one reducing member of at least one of said assemblies comprises a roll.

10. The apparatus of claim 9, wherein said supporting part and said other part of said one assembly comprise means for driving said roll in rotation.

11. The apparatus of claim 1, wherein at least one of said assemblies further comprises an additional reducing member arranged to cooperate with said one reducing member of said one assembly to effect a dimensional reduction of a strand formed in said mold, said supporting part and said other part of said one assembly including means for moving said one reducing member of said one assembly towards and away from said additional reducing member.

12. The apparatus of claim 11, wherein said additional reducing member is anchored to said one support.

13. The apparatus of claim 1, further comprising a hollow anchoring member for said one support, said anchoring member having an upper side and a lower side separated by a gap, and said one support passing through said upper side and resting on said lower side.

14. A method of operating a continuous casting apparatus comprising the steps of:

providing a mold designed to form a continuously cast strand from molten material;

installing said mold at a casting location;

providing two assemblies operable substantially independently of one another to effect a dimensional reduction of a strand formed in said mold; and

placing said assemblies on at least one support at a reducing location spaced from said casting location, said assemblies being placed on said support so that a supporting part of each assembly rests on said support and another part of each assembly extends downward from the respective supporting part, said other part of each of said assemblies including at least one reducing member for effecting a dimensional reduction of a strand formed in said mold.

15. The method of claim 14, further comprising the step of fixing said assemblies to said one support with a fixing element which urges both of said assemblies towards said one support.

16. The method of claim 14, wherein each of said assemblies is placed on said support substantially independently of the other assembly.

17. The method of claim 14, further comprising the steps of forming a partially solidified continuously cast strand in said mold, and subjecting said partially solidified strand to a dimensional reduction in at least one of said assemblies.

18. The method of claim 17, wherein said one reducing member of said one assembly comprises a roll and the subjecting step comprises rolling said partially solidified strand.

19. The method of claim 14, further comprising the steps of providing an additional support, bridging said supports with a pipe, and introducing a cooling fluid into said supports from said pipe.

20. The method of claim 14, wherein at least one of said assemblies comprises an additional reducing member which is arranged to cooperate with said one reducing member of said one assembly to effect a dimensional reduction of a strand formed in said mold; and further comprising the step of anchoring said additional reducing member to said one support.

21. The method of claim 14, further comprising the steps of providing a hollow anchoring member having an upper side and a lower side separated by a gap, passing said one support through said upper side, and resting said one support on said lower side.

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