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(54) METHOD FOR THE CONTINUOUS ROLLING OF A METAL BAR, PARTICULARLY A STEEL BAR, WHICH IS PRODUCED AT A CASTING SPEED AND THE CROSS SECTION OF WHICH IS CONFIGURED AS A THIN SLAB, AND CORRESPONDING CONTINUOUS CASTING MACHINE

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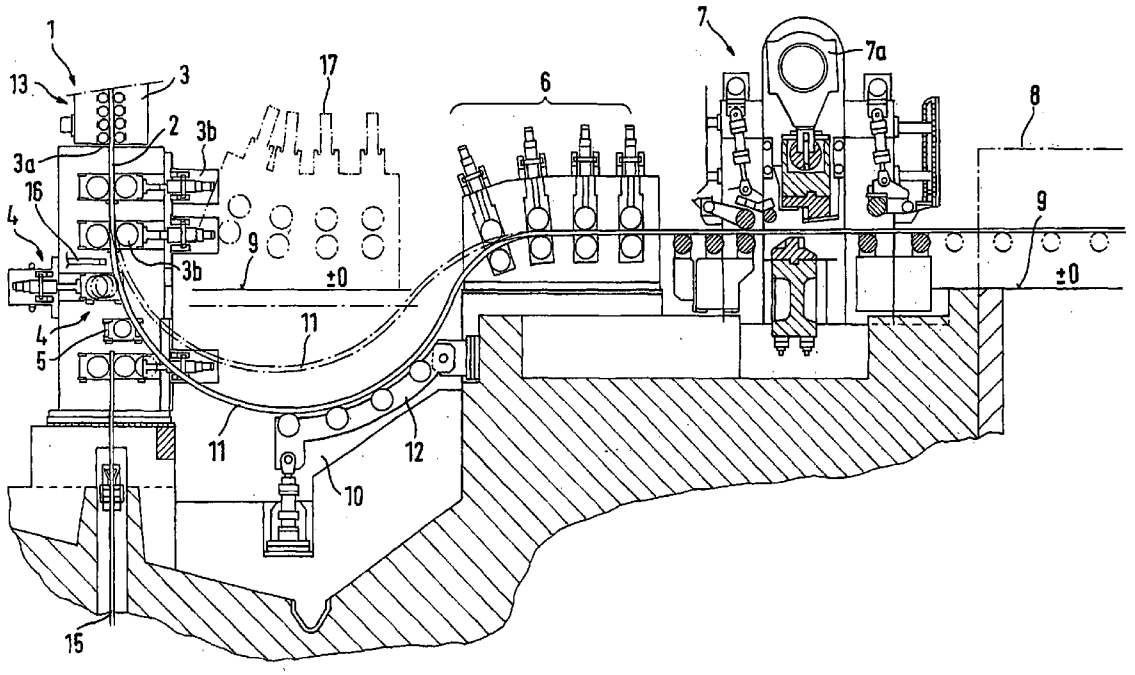
(57) **ABSTRACT**

Disclosed are a method and a corresponding continuous casting machine **(1)** for continuously rolling a metal bar, particularly a steel bar, which is produced at a casting speed and the cross section of which is configured as a thin slab. Said metal bar is bent, dressed, and cut to length as required during cooling and is fed into a first roll stand for rolling once the temperature has been equalized. Optionally the metal bar can still be fed by modifying the casting machine by supporting **(3)** a vertically cast continuous slab **(2)** having a guide length that is adjusted to the casting rate. One or several segments of said continuous slab **(2)** is/are then dressed by bending and straightening, whereupon the continuous slab **(2)** is guided by a sling **(11)**, which is supported from below, into a straightening driver **(6)** that is positioned at a distance approximately equivalent to the length of the sling before being cut to length **(7)**.



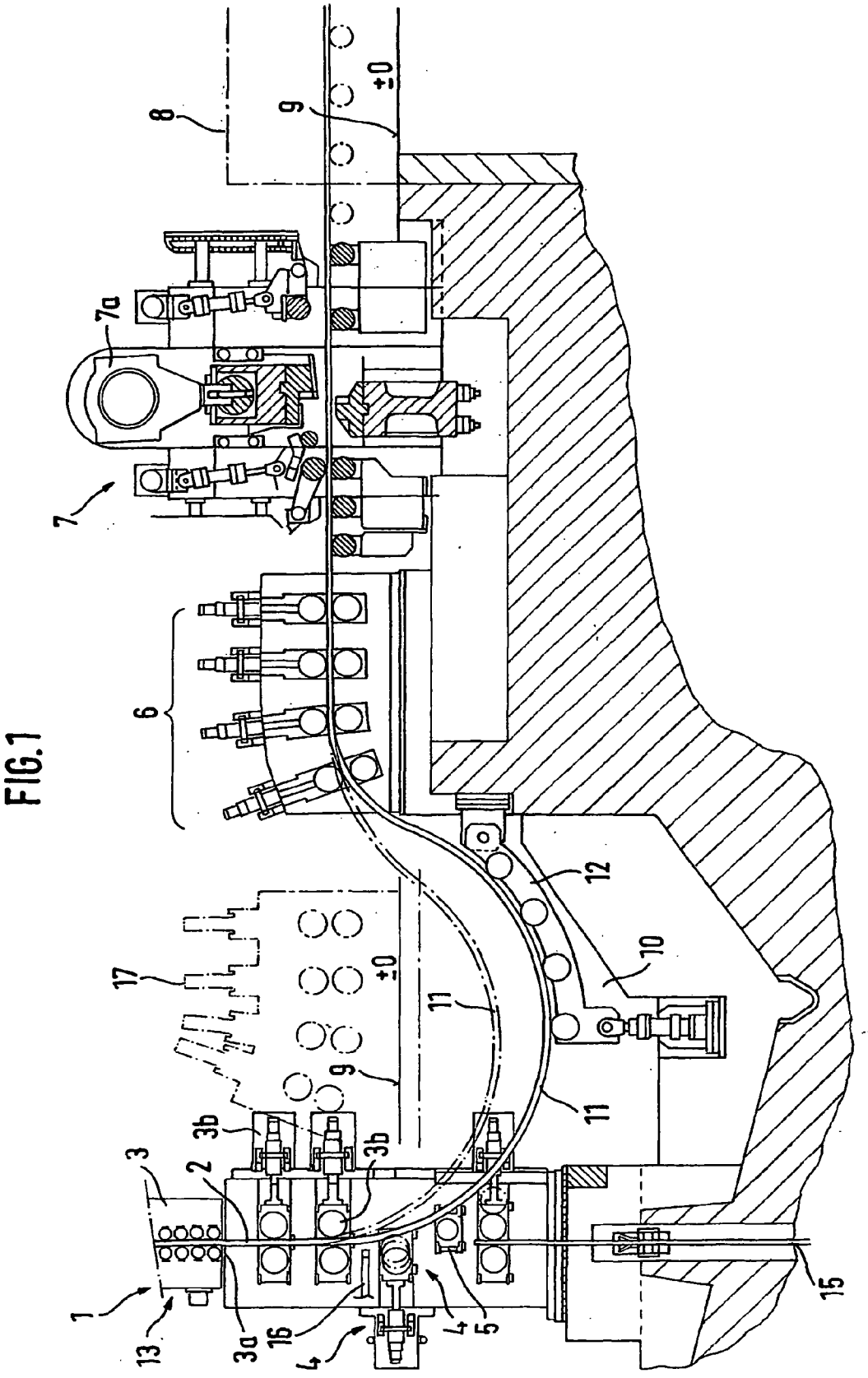


FIG.1

FIG. 2

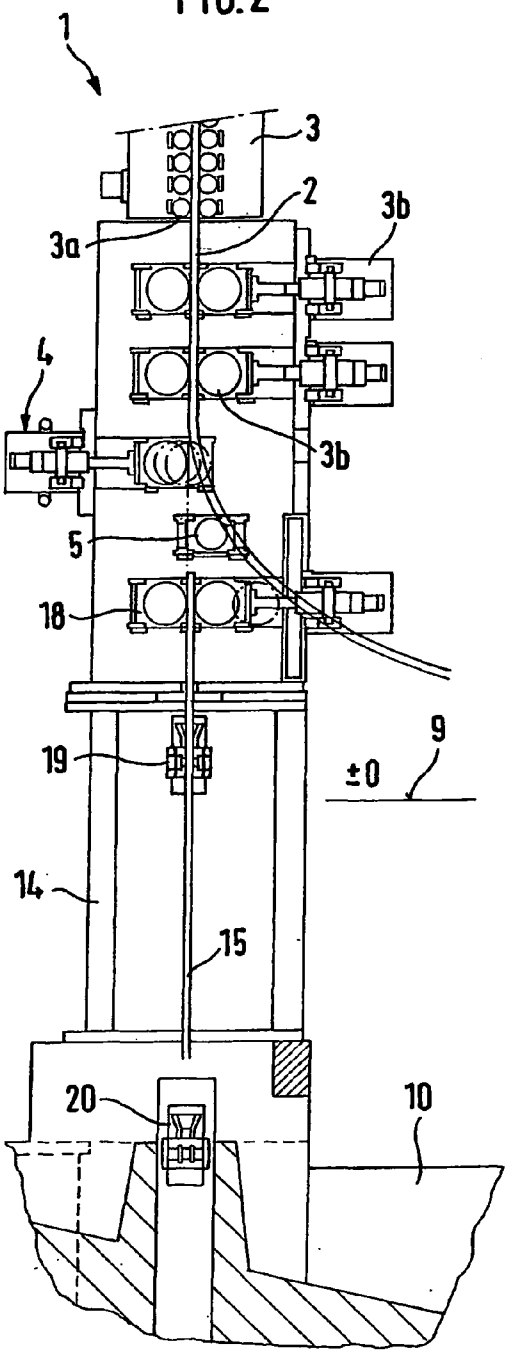
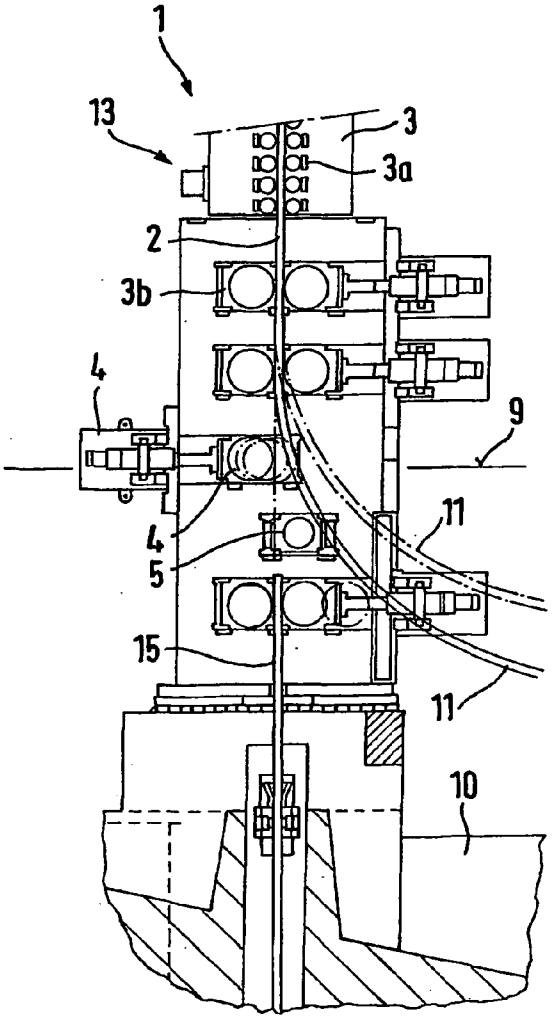


FIG. 3



METHOD FOR THE CONTINUOUS ROLLING OF A METAL BAR, PARTICULARLY A STEEL BAR, WHICH IS PRODUCED AT A CASTING SPEED AND THE CROSS SECTION OF WHICH IS CONFIGURED AS A THIN SLAB, AND CORRESPONDING CONTINUOUS CASTING MACHINE

[0001] The invention concerns a method for the continuous rolling of a metal strand, especially a steel strand, which is produced at casting speed, has the cross-sectional dimensions of a thin slab, is bent during cooling, straightened, cut to length as required, and after homogenization of the temperature, introduced into a first rolling stand to be rolled. The invention also concerns a corresponding continuous casting machine.

[0002] A method of this type is used for so-called thin slabs, which have a cast thickness of about 50-90 mm and are rolled out into strips. Compared to conventional continuous casting plants and rolling trains, significant amounts of energy and labor can be saved. Two different methods are preferably used for this purpose, but they are both aimed at the same result. In one method, a thin slab with a thickness of 90 mm is cast and then reduced to a thickness of 15 mm in several rolling stages. The cooling that occurs during the thickness reduction is compensated by a suitably long induction heating station. The thin slab is then coiled and placed in a holding furnace. A coil can then be uncoiled and rolled in a hot rolling mill. In a second method, a funnel mold is used, which forms a thin slab of about 50 mm. The outlet of the so-called CSP process (=compact strip production) is a cut-to-length unit, in which the cast slabs are cut to length, after which the individual lengths are placed in a soaking furnace for homogenization of the slab temperature. A temporary shutdown of the rolling train is compensated by the soaking furnace, in which the individual lengths remain. Furthermore, the slabs can be moved at a higher speed than the casting speed, so that spaces are present between the slabs. In addition, an additional furnace length is provided as a buffer interval. During a shutdown of the rolling mill, the casting machine can continue to operate until these gaps are filled.

[0003] The demand is determined, e.g., by the roll service life or, when the casting speed differs from the rolling speed, by the furnace length (so-called semi continuous rolling).

[0004] The design of the casting machine must be adapted to the rolling principle. Subsequent modifications, such as changing over to continuous rolling, otherwise necessitate large structural changes in the casting machine that extend all the way down to the foundation of the installation.

[0005] The objective of the invention is to design the continuous casting plant right from the start in such a way that the rolling method can also be subsequently changed. The goal is thus to be able later to also use continuous rolling with the existing continuous casting machine.

[0006] In accordance with the invention, this objective is achieved by a method in which a vertically cast and solidifying strand with a guide length that is adjusted to the casting speed is supported, bent, and straightened in one or more segments and guided in a loop, which is supported from below, into a straightening driver, which is positioned at a distance approximately equal to the length of the loop, before being cut to length. The advantage of such a loop is that it serves as a buffer, which makes it possible to compensate speed differences between the continuous casting and the rolling in a continuous rolling process. In the vertical strand guide, provisions are made for the addition of a segment to lengthen the strand support for higher casting speeds.

[0007] The loop can be controlled according to the required rolling speed.

[0008] In accordance with other features, casting can be carried out at casting speeds of about 8-12 m/min due to the greater supported length.

[0009] The indicated method makes it possible to produce a thin slab with a solidified thickness of 50-70 mm.

[0010] It is also advantageous that the cast strand is bent and straightened at the outlet of the loop. This takes into account variable slack of the loop on the basis of a changing entry angle.

[0011] In this regard, it is also advantageous that when the casting speed is raised to the rolling feed speed of the first rolling stand, the thin slab is subjected to an initial pass down to a thickness of about 50 mm.

[0012] In accordance with another alternative, continuous rolling can also be practiced in such a way that at a casting thickness greater than 50 mm, e.g., 60 to 70 mm, the desired rolling thickness is reduced by LCR (liquid core reduction) to such an extent that complete solidification is-completed in the existing strand support without lengthening. In this case as well, measures can be taken for a suitable loop for casting/rolling speed equalization.

[0013] The corresponding continuous casting machine, which is connected in front of a rolling train for continuous rolling and on which a metal strand, especially a steel strand, with the cross-sectional dimensions of a thin slab can be cast., wherein a vertical strand support is provided, which is adjusted to the casting speed and is followed by at least a bending driver, a straightening driver, a cut-to-length line, a continuous-type furnace, and the first rolling stand, is designed for continuous rolling by providing a free space that extends downward approximately from the zero level between the bending driver and the straightening driver, and by installing a roller section in this free space, which can be raised and lowered and which is provided in a lowest position for a maximum loop of the cast strand. The advantages of purely vertical, symmetrical solidification are preserved, and the use of the dummy bar system is retained.

[0014] Additional features provide that the formation of the loop and thus the casting/rolling speed equalization are controlled by the straightening driver.

[0015] It is also advantageous for the continuous casting mold that is used to be a CSP funnel mold.

[0016] The continuous casting machine can be prepared for higher casting speeds by making it possible to install at least one additional support segment with increasing casting speed.

[0017] In the event of a subsequent change in the rolling strategy, it is advantageous if the bending driver is initially installed on a separate support structure.

[0018] The dummy bar system can be used in existing plants. Thus, it is advantageous in vertical casting machines to be able to withdraw a dummy bar vertically downward.

[0019] Depending on the type of plant, an alternative consists in being able to withdraw the dummy bar upward to the zero level behind the straightening driver.

[0020] To this end, it is also advantageous to provide a transversely movable auxiliary roller table for the dummy bar and the dummy bar head at the zero level.

[0021] Additional features are derived from the provision, in the area of the bending driver, of a cutting torch, which can be moved out for emergency cutting.

[0022] Embodiments of the invention are illustrated in the drawings and described in greater detail below.

[0023] **FIG. 1** shows a longitudinal-section through a casting-rolling plant for continuous rolling.

[0024] **FIG. 2** shows a partial view of a vertical continuous casting machine with short strand support for single-slab operation, in which the bending driver is supported.

[0025] **FIG. 3** shows the same partial view for the continuous operation with lengthened strand guide and the driver on the foundation.

[0026] The continuous casting machine **1** is a vertical casting machine, from which the cast strand **2** is drawn off vertically from the continuous casting mold (not shown) and is completely cooled in a strand support **3** between a series of pairs of strand containment rolls **3***a,* and during this process the cast strand **1** completely solidifies. Driving power is transmitted to the cast strand by at least two pairs of drive rolls **3***b.* Below the pairs of drive rolls **3***b,* there is a bending roll **4**, which bends the cast slab **2** from the vertical, thereby uncoupling the slab **2** and the dummy bar **15**. The support roll **5** acts to-steady and support the strand during uncoupling and later serves as a support point or unrolling point of the cast slab **2** in the bend. In the further course of the strand, a free space **10** is formed in the foundation. At the end of the free space in the direction of flow of the cast strand, there is a straightening driver **6**, which takes up the cast strand **2** and straightens it horizontally. The straightening driver **6** is followed by a cut-to-length line **7**, which, as shown, can consist of a shear **7***a,* and thereafter the cast slab strand **2** or the cut lengths of cast strand travel into a continuous-type furnace **8** for temperature homogenization and adjustment of the rolling temperature. For continuous rolling, the straightening driver **6** stands on the zero level **9**, on which it also stands for rolling of single slabs, position **17**. During the changeover to continuous rolling, the straightening driver **6** can be moved to create the free space **10** for the loop **11**.

[0027] Between the straightening driver **6** and the continuous casting machine **1**, the cast slab **2** forms a loop **11** during continuous rolling to allow speed equalization between the casting speed and the rolling speed. The loop **11** is supported by means of a roller section **12** that can be raised and lowered. Another support segment **13** has been installed for high casting speeds of, for example 8-12 m/min.

[0028] To allow subsequent lengthening of the strand support **3**, the bending driver **3***b,* **4** is initially placed on a special support structure **14**. In this regard, in a design that has proven effective, the dummy bar **15** is driven vertically past the bending roll **5** and held by dummy bar drive rolls **18** and brought out of the casting line through dummy bar guides **19** and **20** (**FIG. 2**).

[0029] In a standard CSP plant (see **FIG. 2**), in which the free space **10** is already included in the plan, the strand support **3** is set for the presently customary casting speed of, e.g., 6 m/min, at a height of, e.g., 10 m. The bending driver **4** which follows is located, together with the drive rolls **3***b,* on the support structure **14**. An additional support segment **13** is installed for the conversion to continuous rolling in order to operate at higher casting speeds. The-bending driver **3***b,* **4**, the support roll **5**, and the dummy bar withdrawal system are shifted downward and then rest on the foundation, as shown in **FIG. 3**. The straightening driver **6** is moved out of position **17**, which is shown with broken lines (**FIG. 1**), towards the cut-to-length line **7**. This creates the space for the loop **11**, which makes it possible to equalize the speed difference between casting and rolling.

[0030] Below the pairs of drive rolls **3***b,* in the area of the bending driver **4**, a cutting torch **16** can be installed for emergency cutting.

LIST OF REFERENCES NUMBERS

[0031] **1** continuous casting machine

[0032] **2** cast slab/cast strand

[0033] **3** strand support

[0034] **3***a* pairs of strand containment rolls

[0035] **3***b* drive rolls

[0036] **4** bending roll

[0037] **5** support roll

[0038] **6** straightening driver

[0039] **7** cut-to-length line

[0040] **7***a* shear

[0041] **8** continuous-type furnace

[0042] **9** zero level

[0043] **10** free space

[0044] **11** loop

[0045] **12** roller section that can be raised and lowered

[0046] **13** support segment

[0047] **14** support structure

[0048] **15** dummy bar

[0049] **16** cutting torch

[0050] **17** earlier position of the straightening driver

[0051] **18** dummy bar drive rolls

[0052] **19** dummy bar guide

[0053] **20** dummy bar rest position

1. Method for the continuous rolling of a metal strand, especially a steel strand, which is produced at casting speed, has the cross-sectional dimensions of a thin slab, is bent during cooling, straightened, cut to length as required, and

after homogenization of the temperature, introduced into a first rolling stand to be rolled, wherein a vertically cast and solidifying strand with a guide length that is adjusted to the casting speed is supported, bent, and straightened in one or more segments and guided in a loop, which is supported from below, into a straightening driver, which is positioned at a distance approximately equal to the length of the loop, before being cut to length.

2. Method in accordance with claim 1, wherein the loop is controlled in the straightening section or sections.

3. Method in accordance with claim 1, wherein the strand is cast at a casting speed of 8-12 m/min.

4. Method in accordance with claim 1, wherein a thin slab with a solidified thickness of 50-70 mm is produced.

5. Method in accordance with claim 1, wherein the cast strand is bent and straightened at the outlet of the loop,

6. Method in accordance with claim 1, wherein, when the casting speed is raised to the rolling feed speed of the first rolling stand, the thin slab is subjected to an initial pass down to a thickness of about 50 mm.

7. Method in accordance with claim 1, wherein, at a casting thickness greater than 50 mm, the desired rolling thickness is reduced by liquid core reduction to such an extent that complete solidification is completed in the existing strand support without lengthening.

8. Continuous casting machine which is connected in front of a rolling train and on which a metal strand, especially a steel strand, with the cross-sectional dimensions of a thin slab can be cast, wherein a vertical strand support is provided, which is adjusted to the casting speed and is followed by at least a bending driver, a straightening driver, a cut-to-length line, a continuous-type furnace, and the first rolling stand, wherein a free space **(10)** that extends downward approximately from the zero level **(9)** is provided between the bending driver **(4)** and the straightening driver **(6)**, and a roller section **(12)**, which can be raised and lowered and which is provided in a lowest position for a maximum loop **(11)** of the cast strand **(2)**, is installed in this free space.

9. Continuous casting machine in accordance with claim 8, wherein the formation of the loop **(11)** and thus the casting/rolling speed equalization are controlled by the straightening driver **(6)**.

10. Continuous casting machine in accordance with claim 8, wherein the continuous casting mold that is used is a CSP funnel mold.

11. Continuous casting machine in accordance with claim 8, wherein at least one additional support segment **(13)** can be installed with increasing casting speed.

12. Continuous casting machine in accordance with claim 8, wherein the bending driver **(4)** is initially installed on a separate support structure **(14)**.

13. Continuous casting machine in accordance with claim 8, wherein a dummy bar **(1S)** can be withdrawn vertically downward.

14. Continuous casting machine in accordance with claim 8, wherein the dummy bar **(15)** can be withdrawn upward to the zero level **(9)** behind the straightening driver **(6)**.

15. Continuous casting machine in accordance with claim 8, wherein a transversely movable auxiliary roller table for the dummy bar **(15)** and the dummy bar head is provided at the zero level.

16. Continuous casting machine in accordance with claim 8, wherein a cutting torch **(16)**, which can be moved out for emergency cutting, is provided in the area of the bending driver **(4)**.

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