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(54) APPARATUS FOR MANUFACTURING METAL MATERIAL BY ROLLING

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(57) **ABSTRACT**

A method and roll segment (**1**) for determining core solidification and/or the liquid crater tip in the continuous casting of metals, particularly steel materials, inside a roll segment (**1**) of a support roller gantry (**2**), wherein the upper frame (**3**) thereof supporting the upper rollers (**4**) can be drivingly adjusted via hydraulic piston-cylinder units (**6**), which are arranged in the corners (**5***a*-**5***d*) of a polygon, counter to the lower rollers (**8**) of a lower frame (**7**), according to the thickness of the billet, working in a more accurate manner, using an independent pair (**14**) of piston-cylinder units (**6**) with an external or internal measuring device (**13***a*,**13**) in order to adjust a rotationally driven, individual upper roller (**4**), taking into account the measuring values for positional adjustment or force adjustment in order to determine the position of core solidification and/or the liquid crater tip in the cast billet.

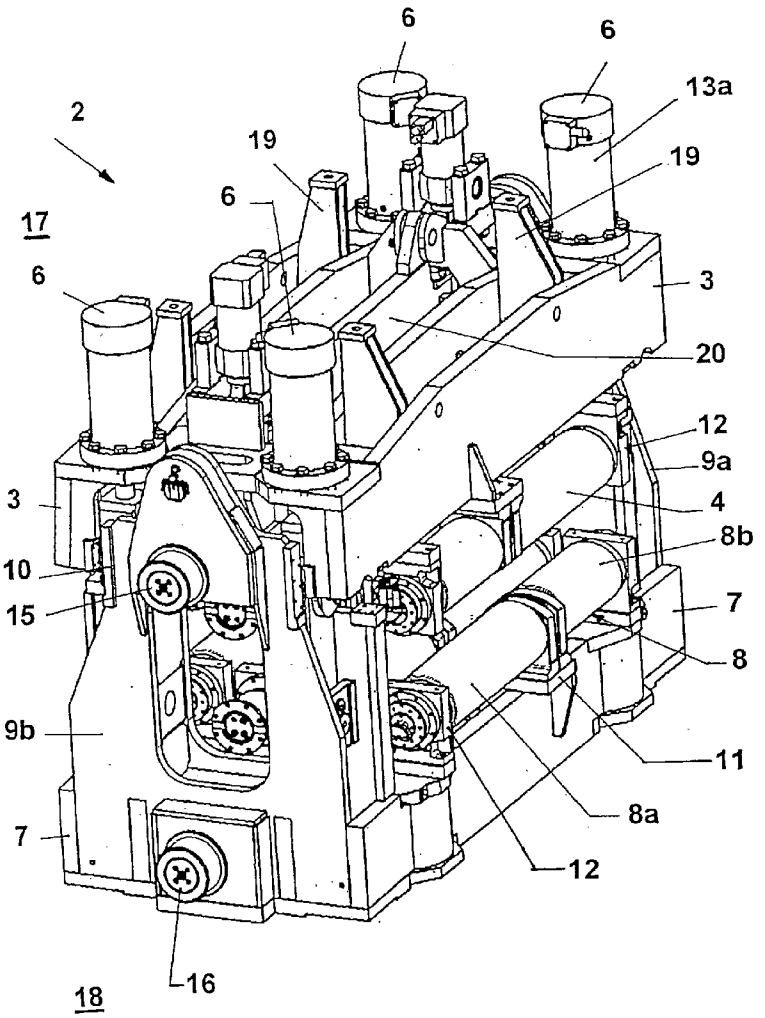


FIG. 1

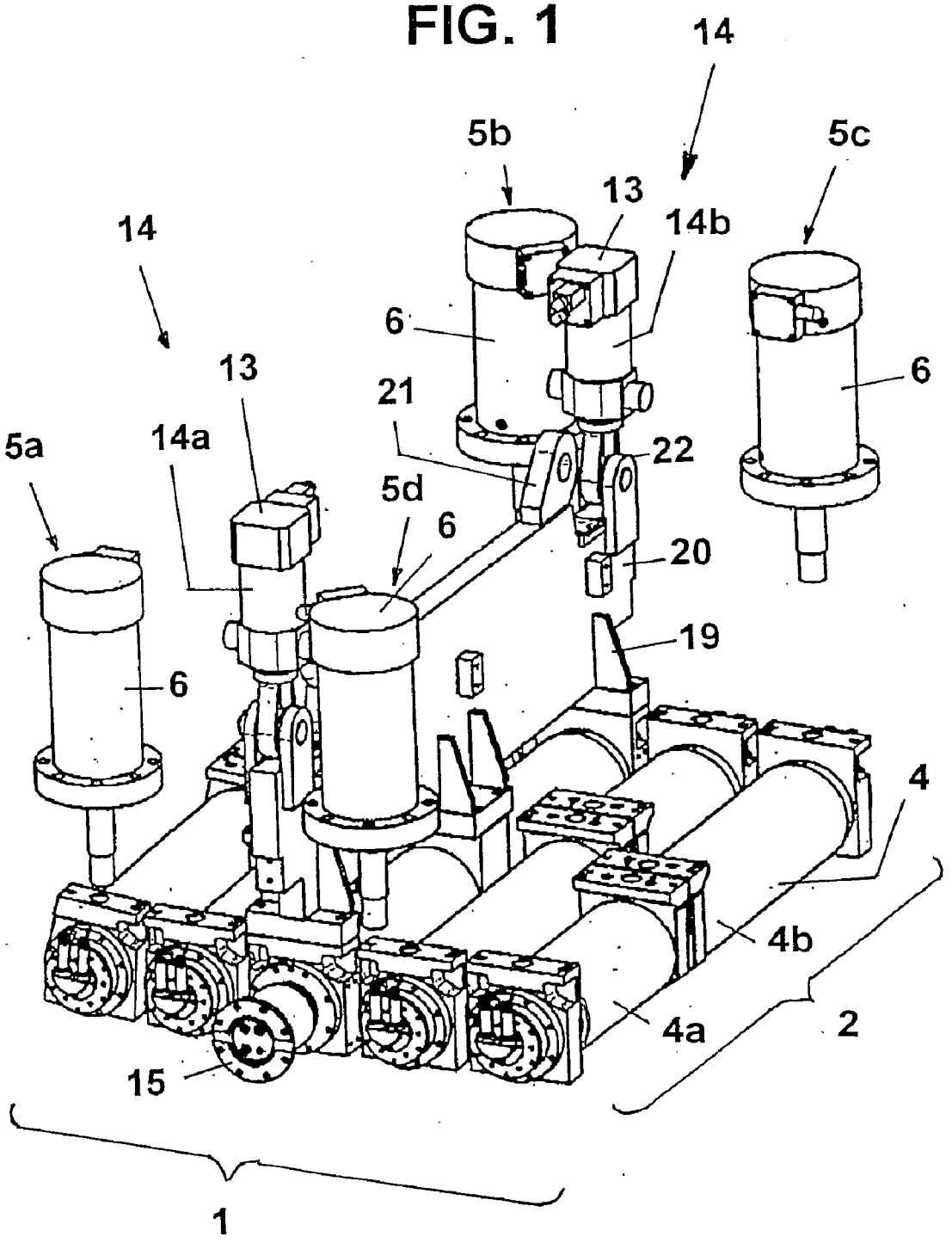
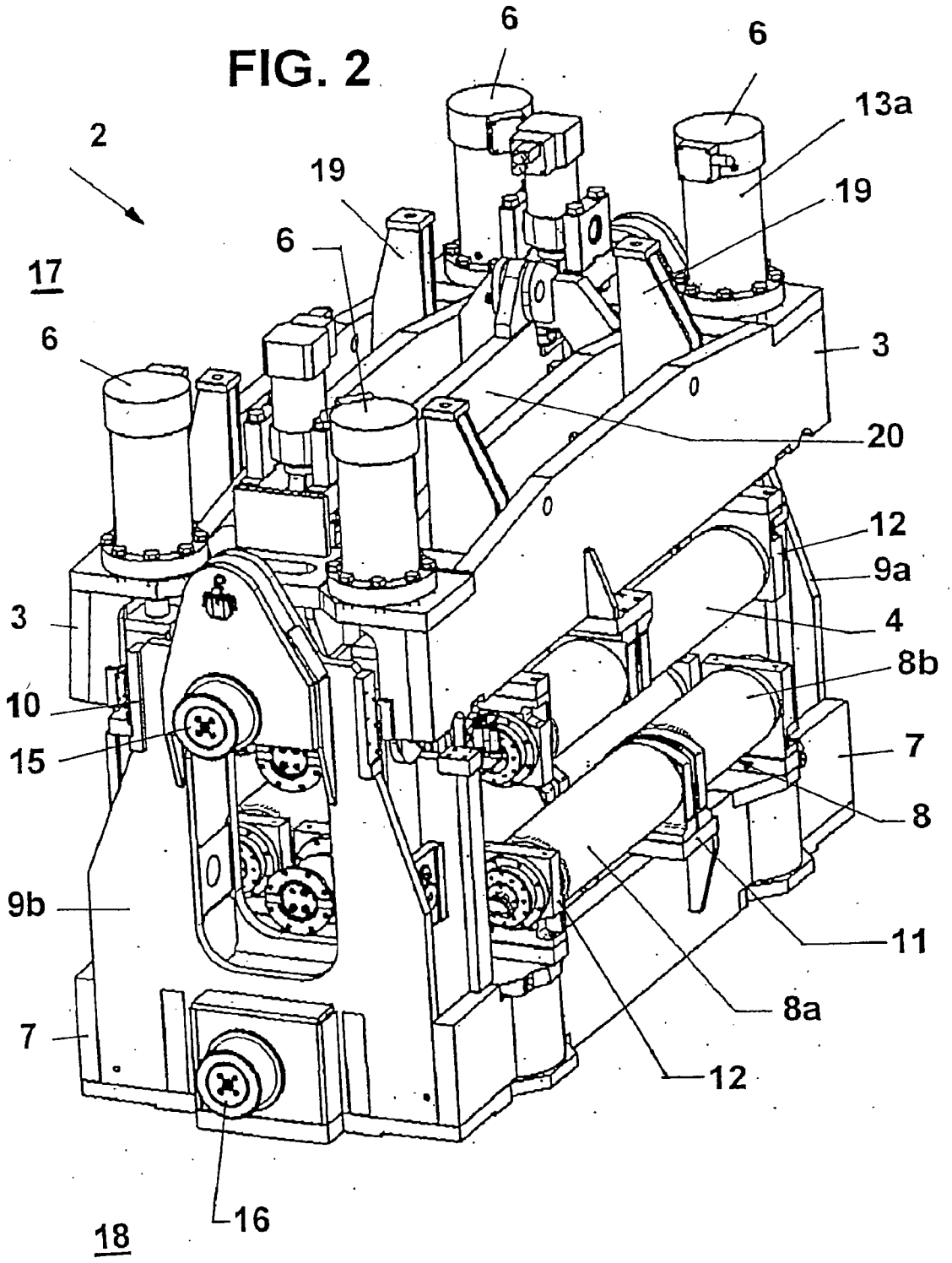


FIG. 2



APPARATUS FOR MANUFACTURING METAL MATERIAL BY ROLLING

[0001] The invention concerns a method and a roll segment for determining the core solidification and/or the tip of the liquid crater in the continuous casting of metals, especially steel materials, within a roll segment of a support roll frame, whose upper frame, which supports the upper rolls, is driven towards the lower rolls of a lower frame by hydraulic piston-cylinder units installed at the vertices of a polygon to adjust to the given strand thickness.

[0002] EP 0 908 256 B1 discloses a method and a device for producing slabs in a continuous casting plant, whose strand guide consists of roll segments downstream of the continuous casting mold. Each segment frame is divided into two sections, and the frame sections are braced together by means of piston-cylinder units. To this end, each roll segment has four hydraulic cylinders, which brace pairs of opposing rolls for supporting and conveying the solidifying continuously cast strand. At least one of these rolls, which acts as a drive roll, is pressed with a well-defined contact force against the continuously cast strand to transmit the strand-conveying forces. In this regard, the roll gap between the roll conveyor of the stationary side and the roll conveyor of the movable side is determined, measured, and, if necessary, automatically controlled by hydraulic cylinders with integrated electronic displacement sensors and position sensors relative to one another. The position of the tip of the liquid crater inside the continuously cast strand is determined via the movement of the entire upper frame and/or an evaluation of the four position values in conjunction with the resulting force values of the four hydraulic cylinders.

[0003] It was found that this method for determining the tip of the liquid crater and the preceding regions is not sufficiently accurate. In addition, the expense for non-position-controlled roll segments is very high.

[0004] In accordance with the invention, the stated objective is achieved by taking into consideration the measured values in the automatic position or force control for determining the position of the core solidification and/or the position of the tip of the liquid crater in the cast strand by means of an independent pair of piston-cylinder units with an external measuring device or an internal measuring device for adjusting a single, rotationally driven upper roll. The measurement results that are obtained are advantageously used as the basis for expanded process-engineering sequences and functions for the operation and optimization of the adjustment parameters of the continuous casting and the continuous casting plant. The selection of a position value with subsequent evaluation of the resulting force or the selection of the force values with subsequent evaluation of the resulting position can be used as process-engineering feedback of the state of the strand or the position of the tip of the liquid crater. The accuracy of the determination of the precise position of the tip of the liquid crater can be improved compared to the previously known procedure of using the entire upper frame for the measurement. The application is related to automatically position-controlled segments and an independent installation for segments without automatic position control. The equipment can be less expensively designed.

[0005] In accordance with additional features of the invention, increased accuracy can be preadjusted by simultaneously measuring the measured values in several (selected) roll segments with at least one pair of independent piston-cylinder units in each case and processing all of the measured data to obtain a mean value.

[0006] The mechanical solution of the problem of the invention is achieved by providing the upper frame with an independent crossbeam, which serves the purpose of mounting an external measuring device or at least a pair of hydraulic piston-cylinder units and has a single, rotationally driven upper roll for measuring the data for the dummy bar force or the cast strand force. The crossbeam can be equipped with one or two hydraulic piston-cylinder units. The position of the piston-cylinder units is automatically controlled. For this purpose, position sensors are integrated in the cylinders, or an external measuring device is mounted on the crossbeam. An automatic control system receives the determined position values and automatically controls the cylinder set position by a hydraulic valve. The contact force of the single roll can be automatically controlled in similar fashion. For this purpose, pressure sensors are integrated in the hydraulic cylinders (in both cylinder chambers) or in connecting lines (between the control valve and cylinder). The cylinder set forces are automatically controlled by the hydraulic control valve.

[0007] In a refinement of the invention, for an odd total number of upper rolls and lower rolls, at least a middle upper roll and the opposite lower roll are driven.

[0008] It is then advantageous to arrange the roll segment with the features of the invention as the last roll segment of the support roll frame in the direction of casting. When the automatically position-controlled crossbeam is placed in this way as the last stand of a support roll frame, it is possible to optimize the casting speed with maximum utilization of the continuous casting plant and maximum throughput. This prevents a hazard due to bulging of the strand downstream of the continuous casting machine when the casting speed at which the liquid crater leaves the strand guide is set too high.

[0009] Specific embodiments are illustrated in the drawings and explained in greater detail below.

[0010] FIG. **1** shows an exploded perspective view of an upper roll segment

[0011] FIG. **2** shows a perspective view of a unit consisting of an upper frame and lower frame, several of which can be arranged in succession to form a support roll frame.

[0012] FIGS. **1** and **2** show a roll segment **1**, and FIG. **2** shows the roll segment **1** in its installed state in a section of the support roll frame **2**. An upper frame **3** supports the upper rolls **4**. Hydraulic piston-cylinder units **6** are mounted at the vertices **5***a*, **5***b*, **5***c*, **5***d* of a polygon and are connected with a lower frame **7** by the pistons. The lower frame **7** supports the lower roll **8**. To allow adjustment of the upper rolls **4** towards each corresponding lower roll **8**, the upper frame **3** is slidingly supported on lateral uprights **9***a*, **9***b* in guides **10**, so that the upper frame **3** with its upper rolls **4** can move in a suitable manner when the cast strand undergoes a change in thickness (e.g., bulging).

[0013] The upper rolls **4** and the lower rolls **8** are realized in partial lengths **4***a*, **4***b* and **8***a*, **8***b*, respectively, and are rotatably supported by inner bearings **11** and outer bearings **12** and internally cooled.

[0014] The method for determining the core solidification and/or the position of the tip of the liquid crater during the continuous casting of metals, especially steel materials, is carried out in such a way that the measured values in the automatic position or force control for determining the position of the core solidification and/or the position-of the tip of the liquid crater in the cast strand are taken into consideration by means of an external measuring device **13** that is independent of the upper rolls **4** and lower rolls **8** or by means of at least a pair **14** of additional piston-cylinder units **14***a*, **14***b*, which is independent of the other piston-cylinder units **6** and has an internal measuring device **13***a* for adjusting a single, rotationally driven upper roll **4**. The single, rotationally driven upper roll **4** has an upper shaft end **15**, and the opposite unadjustable lower roll **8** has a lower shaft end **16**, to which the respective rotational drives (not shown) are connected.

[0015] It is also possible, depending on the process, simultaneously to obtain the measured values in several roll segments **1** with at least one pair **14** of independent piston-cylinder units **14***a*, **14***b* in each case, and to process all of the measured data to obtain a mean value.

[0016] In accordance with FIG. **2** (see also FIG. **1**), the upper frame **3** supports, in addition to the polygonal piston-cylinder units **6** on the movable side **17** (the stationary-mounted lower frame **7** on the stationary side **18** corresponds to the upper frame **3**), a crossbeam **20** between paired transverse walls **19**. The single, driven upper roll **4** is mounted and rotatably supported on the crossbeam **20**. The crossbeam **20** is provided with jack rings **21**, so that a unit consisting of the single upper roll **4**, the independent pair **14** of piston-cylinder units **6**, and the measuring device **13** can be listed out or lowered into position with a crane. The pair **14** of piston-cylinder units **6** is connected by joints **22**.

[0017] In the illustrated embodiment, for an odd total number of upper rolls **4** and lower rolls **8**, at least the middle upper roll **4** is driven via the shaft end **15**. The opposite lower roll **8** is also driven, and the lower shaft end **16** synchronously transmits a drive force.

LIST OF REFERENCE NUMBERS

[0018] **1** roll segment

[0019] **2** support roll frame

[0020] **3** upper frame

[0021] **4** upper roll

[0022] **4***a* partial length

[0023] **4***b* partial length

[0024] **5***a* vertex of a polygon

[0025] **5***b* vertex of a polygon

[0026] **5***c* vertex of a polygon

[0027] **5***d* vertex of a polygon

[0028] **6** piston-cylinder unit

[0029] **7** lower frame

[0030] **8** lower roll

[0031] **8***a* partial length

[0032] **8***b* partial length

[0033] **9***a* upright member

[0034] **9***b* upright member

[0035] **10** guide

[0036] **11** inner bearing

[0037] **12** outer bearing

[0038] **13** measuring device

[0039] **13***a* internal measuring device

[0040] **14** independent pair of piston-cylinder units

[0041] **14***a* piston-cylinder unit

[0042] **14***b* piston-cylinder unit

[0043] **15** upper shaft end

[0044] **16** lower shaft end

[0045] **17** movable side

[0046] **18** stationary side

[0047] **19** transverse wall

[0048] **20** crossbeam

[0049] **21** jack ring

[0050] **22** joint

1. Method for determining the core solidification and/or the tip of the liquid crater in the continuous casting of metals, especially steel, in a roll segment (**1**) of a support roll frame (**2**), whose upper frame (**3**), which supports the upper rolls (**4**), is driven towards the lower rolls (**8**) of a lower frame (**7**) by hydraulic piston-cylinder units (**6**) installed at the vertices (**6***a*, **6***b*, **6***c*, **6***d*) of a polygon to adjust to the given strand thickness, wherein the measured values for determining the position of the core solidification and/or the position of the tip of the liquid crater in the cast strand are determined by means of an independent pair (**14**) of piston-cylinder units (**6**) with a measuring device (**13**, **13***a*) for adjusting a crossbeam (**20**), on which a single, rotationally driven upper roll (**4**) is provided, by means of the movement of the upper frame and/or an evaluation of the four position values in conjunction with the resulting force values of the four hydraulic cylinders (**6**), wherein the selection of a position value of the single upper roll (**4**) with subsequent evaluation of the resulting position or the selection of the force values of the single upper roll (**4**) of a roll segment (**1**) with subsequent evaluation of the resulting position in several selected roll segments (**1**) is evaluated for determining the core solidification or the tip of the liquid crater, and the position of the tip of the liquid crater is used as process-engineering feedback to automatically position-control roll segments (**1**) and to an independent installation for roll segments (**1**) without automatic position control.

2. Method in accordance with claim 1, wherein the measured values are simultaneously measured in several roll segments (**1**) with at least one pair (**14**) of independent piston-cylinder units (**14***a*, **14***b*) in each case, and all of the measured data is processed to obtain a mean value.

3. Support and drive roll frame (**2**) consisting of several roll segments (**1**) in continuous casting installations for metals, especially steel materials, with hydraulic piston-cylinder units (**6**) arranged polygonally in pairs, in which the

roll separations, which are set to the given strand thickness, are adjusted on the movable side (**17**) of an adjustable upper frame (**3**), which supports the upper rolls (**4**), towards the lower rolls (**8**) of the lower frame (**7**), which constitutes the stationary side (**18**), wherein an independent pair (**14**) of piston-cylinder units (**6**) for adjusting a crossbeam (**20**), on which are provided a single, rotationally driven upper roll (**4**), which rests on the cast strand, and a measuring device (**13**) for measured values for determining the position of the core solidification and/or the position of the tip of the liquid crater, wherein the measuring device (**13**) is formed as an external or internal measuring device (**13***a*) of the independent pair (**14**) of piston-cylinder units for measured values based on the automatic position or force control, and a unit is formed which consists of the individual upper roll (**4**), the independent pair (**14**) of piston cylinder units (**6**), the crossbeam (**20**), and the measuring device (**13**).

4. Support and drive roll frame in accordance with claim 3, wherein, for an odd total number of upper rolls (**4**) and lower rolls (**8**), at least a middle upper roll (**4**) and the opposite lower roll (**8**) are driven.

5. Support and drive roll frame in accordance with claim 3, wherein a roll segment (**1**) with the measuring device (**13**, **13***a*) is arranged as the last roll segment (**1**) in the direction of casting.

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