



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.01.2013 Bulletin 2013/02

(51) Int Cl.:
B22D 11/12 ^(2006.01) **B22D 11/128** ^(2006.01)
B22D 11/14 ^(2006.01)

(21) Application number: **11425182.0**

(22) Date of filing: **08.07.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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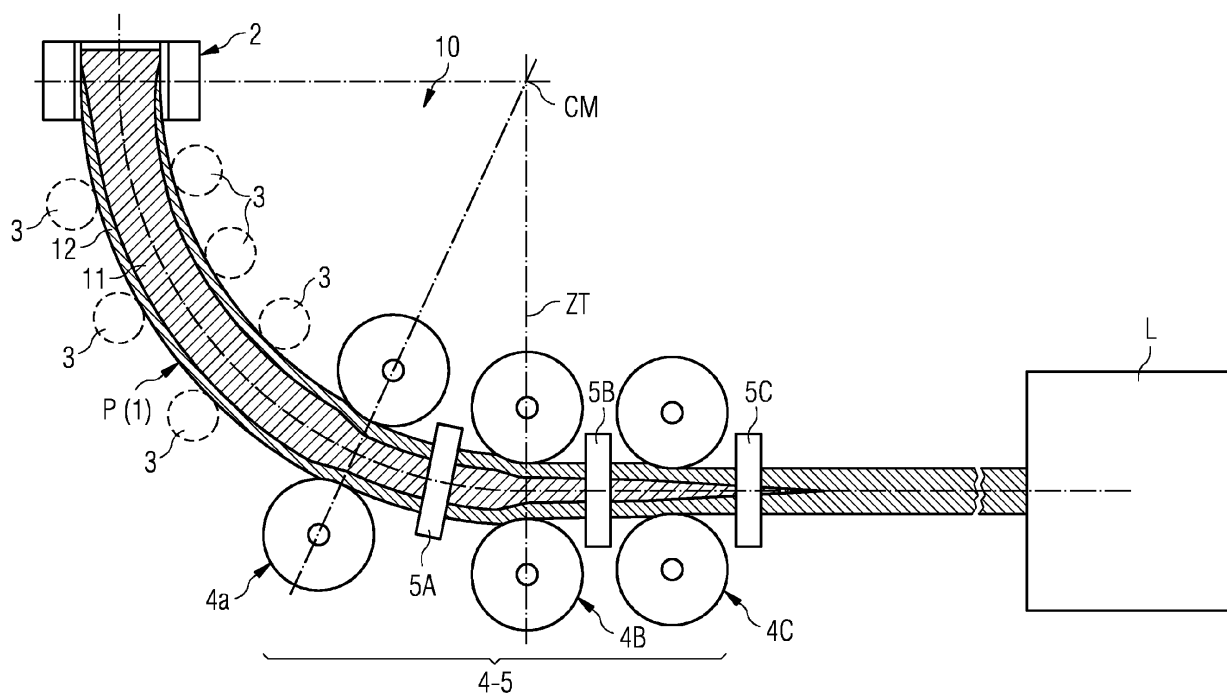
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(54) **Process and apparatus for the manufacturing of long steel products in a continuous casting**

(57) An apparatus for continuous casting comprising a withdrawal/straightening unit (4,5) with pairs of rolls (4A,4B,4C) wherein the distances between two rolls of

each pair (4A,4B,4C) decrease to create a deformation of a long metallic product (1) poured from a mould (2), in particular a reduction of the section on one direction, preferably a vertical direction.

FIG 3



Description

[0001] The present invention relates to a process and apparatus for the manufacturing of long products in a continuous casting plant.

[0002] The term "long products" relates herein to blooms, billets or generally to all products in their physical form in which they exit from the mould of a continuous casting machine fed by a steelworks furnace, such as an arc furnace (EAF) or the like.

[0003] In order to maximize the yield of a steelworks plant, the use of the continuous casting principle, with a direct connection to the mills downstream, is known.

[0004] The creation of this type of plant, however, has considerable problems due to the difference in velocity with which the long products leave the mould (usually less than 5 m/min) and the velocity at which they must be fed to the breaking mills, or the first of the series of rolling stands (usually at least 6 m/min).

[0005] If, on the one hand, it is not possible to follow the strategy of increasing the casting speed over certain limits (so as not to risk having a faulty product), it is not even conceivable, on the other hand, to lower the feeding speed of the mills below certain values (mainly due to the excessive heating to which they would be subjected and to the excessive plant expenses for every single laminated product).

[0006] Various techniques have been prepared for overcoming these drawbacks: in the case of thin flat laminates (strips), for example, resort is made to the presence of two winding stations which, situated upstream of the breaking mill, create an expansion effect which allows the two different velocities to be respected.

[0007] Even if this solution is functional, it has the disadvantage, however, of requiring a significant installation cost.

[0008] Another solution which is conceptually similar to that described above but applied to the field of blooms and billets, is that described in the document EP1187686: a main feeding line to the mill exits from the continuous casting together with one or more parallel auxiliary lines from which the rough products of the feeding are transferred to the main line to be processed; in short, these auxiliary lines again merely act as a "buffer" for the feeding of the mill.

[0009] A first drawback of this solution relates to the fact that in order to effect the passage from an auxiliary line to the main line, appropriate transversal transfer systems must be set up.

[0010] Furthermore, the control of the transfer rates of the rough products in the feeding (different for the main line and the auxiliary line) must be particularly precise in order to allow the regular continuous feeding of the mill.

[0011] There are also known processings, such as that described in the patent EP0603330 or in the patent application US2009/0056906, which are capable of slightly increasing the velocity of the elongated product from when it leaves the mould to when it enters the withdrawal/straightening unit (often indicated with the acronym W.S.U).

[0012] It should be immediately noted that the increase in the rate of the rough products is a necessary consequence of the process which is described herein, but not the main objective of this process, which has been conceived for other purposes.

[0013] Before entering into the details of the description of these solutions, it should be pointed out that in these types of plant, the product P leaves the ingot mould vertically and is then deformed along a section of circumference until it acquires a horizontal position and straight trajectory, in order to limit the vertical encumbrances of the plant.

[0014] As a result, in all of these plants, the trajectory followed by the product P comprises a first portion, immediately downstream of the mould section, which develops according to a circular section with an opening of about 90° (from vertical to horizontal) and a second portion which develops horizontally: the joining section of the two trajectories (curved and straight line) is indicated with the term "transition area".

[0015] The W.S.U. (Withdrawal Straightening Unit) is typically positioned in correspondence with this area, which straightens the product P from a curved form to a straight form and allows the withdrawal speed to be controlled.

[0016] The W.S.U. obviously acts with its rolls in the sections of trajectory situated immediately upstream and downstream of the transition area.

[0017] In order to understand the processing described in the document EP0603330, reference should be made to figure 1: this shows the terminal part of the mould L of a continuous casting from which a product P exits.

[0018] According to the teachings of EP0603330, the plant must be modified and dimensioned so that the "metallurgical length" of the product P is totally included within the curved section (from the ingot mould to the W.S.U. rolls), i.e. upstream of the transition area, shown in fig.1 with the reference ZT.

[0019] "Metallurgical length" indicates the portion of product P in which there is a central nucleus, not yet completely solidified (solid grains in suspension coexist in the nucleus, in a liquid matrix).

[0020] Also in this case, the W.S.U. is not a traditional unit, but is specifically produced so that it acts only on the straight portion, downstream of the transition area ZT: this special W.S.U. in fact comprises a series of rolls, all positioned downstream of the transition area ZT and having rotational axes parallel to each other and substantially positioned at the same distance from the product P.

[0021] The product P, immediately downstream of the mould, passes through the rolling stands R, which are structured so as to generate a deformation of the product which creates a sectional variation obtained by maintaining the perimeter

of the product P constant.

[0022] This deformation is often defined in the technical field as "soft core reduction" and has the primary objective of improving the quality of the finished product.

[0023] Under certain conditions, the sectional variation of the product P could obviously be useful for increasing the advance speed of the product.

[0024] By following the teachings provided by the patent EP0603330, however, this increase in rate is too limited to allow a direct feeding to the mill RM without using expedients described above (i.e. the "buffer" solutions).

[0025] Furthermore, in addition to not being able to be used for these purposes, the solution illustrated in EP0603330 has various drawbacks.

[0026] First of all, the plant set-up is extremely expensive, as the rolling stands R must be produced with "nipper" shells suitable for being opened and closed to allow the passage of the so-called "head of the dummy bar" in the initial start-up phase of the plant, which has a fixed section, equal to that of the outlet mouth of the mould.

[0027] In order to allow the passage of the head of the dummy bar, the rolling stands R must not have a conical passage section, otherwise the head (with a fixed dimension) would not be able to pass.

[0028] This solution, moreover, is quite complex to effect and is mainly suitable for products P having small dimensions: maintaining the metallurgic length within the curved section, in fact, alternatively requires either an extremely reduced advance speed (which consequently does not help to reach the feeding rate of the mills) or an extremely wide curvature radius (with negative consequences in terms of vertical encumbrance of the plant with relative costs).

[0029] Yet another drawback is linked to the fact that the W.S.U. must be specifically designed and produced for this plant.

[0030] The disclosure of US2009/0056906 is based on the basic teachings of EP0603330 discussed so far, and even if there is apparently an assembly in line with the lamination stations, the latter (for the reasons discussed above) are presumably fed at a low speed, with the drawbacks presented above.

[0031] From what is specified above, it appears evident that it is necessary to avail of a process and apparatus for the manufacturing of long products in a continuous casting plant, wherein the mills can be fed in a simple and inexpensive manner.

[0032] In particular, an objective of the present invention is to solve the above-mentioned drawbacks by providing a process and apparatus for the manufacturing of products in a continuous casting plant in which it is possible to obtain an acceleration of the product downstream of the ingot mould so that the advance rate of the product can be increased from the initial casting rate to the feeding rate of the mills, without having to apply costly modifications to the known plants and maintaining relatively limited encumbrances.

[0033] These objectives are achieved according to a first aspect of the invention by a process for the manufacturing of a long metallic product in a continuous casting plant, wherein said product follows a trajectory comprising a curvilinear section and a straight section. The process comprises at least a first and a second deformation phase, each of said phases comprising a contemporaneous deformation of the perimeter and of the transversal section of said product, the first deformation phase being effected in said curvilinear section and the second deformation phase being effected in said straight section, the first and the second deformation phase being effected in an area where liquid metal is still present in the product and at a location where each deformation provokes an increase in the speed of the product.

[0034] The process according to the invention may also comprise the following steps:

- a further deformation of said perimeter and said transversal section of said product occurs in a transition area located between the first and the second deformation,
- said deformation phases create a deformation of the section of said product in one direction, preferably a vertical direction,
- there are further deformation phases along said deformation line (LD)
- said deformation phases create a deformation of the section of said product in two directions perpendicular to each other, preferably in an alternating horizontal and vertical direction.

[0035] The process according to the invention may also comprise the following steps:

- a- casting a long metallic product with a square section, the product advancing along a trajectory comprising a curvilinear section and a straight section, the extremity of a metallurgical line of said product being upstream and downstream of a transition area located between said curvilinear section and said straight section;
- b-deforming said product upstream of said transition area to reduce said section in a first direction, preferably vertical, so as to obtain a rectangular section;
- c- deforming said product in said transition area to further reduce said section in said first direction, thus obtaining a rectangular section;
- d- further deforming said product downstream of said transition area to further reducing said section in said first

direction, thus obtaining a rectangular section;

[0036] The process according to the invention may also comprise the following steps:

- a1- casting a long metallic product with a mould, the product advancing along a trajectory comprising a first curvilinear section and a second straight section, the extremities of a metallurgical line of said product being upstream and downstream of a transition area located between said curvilinear section and said straight section;
- b1- deforming of said product upstream of said transition area to reduce said section in a first direction, preferably vertical, so as to obtain a rectangular section;
- c1- deforming said product upstream of said transition area to reduce said section in a second direction perpendicular to said first direction, preferably horizontal, so as to obtain a square section;
- d1- deforming said product in said transition area to further reduce said section in said first direction, thus obtaining a rectangular section;
- e1- deforming of said product in said transition area to further reduce said section in said second direction;
- f1- deforming said product downstream of said transition area to further reduce said section in said first direction, thus obtaining a rectangular section;
- g1- deforming said product downstream of said transition area, to further reduce said section in said second direction.

[0037] In one embodiment the reduction of said section in said first or said second direction which is obtained as a whole between the section upstream of the first deformation and that downstream of a last deformation ranges from 14% to 16.8%, and is preferably equal to 15.4% of the initial dimension.

[0038] In one embodiment the advance speed of said product downstream of said ingot mould is equal to about 5 m/min.

[0039] In one embodiment said deformations are created in a withdrawal/straightening unit of said product.

[0040] According to a second aspect, the invention also relates to an apparatus for manufacturing a metallic long product which effects the above mentioned process.

[0041] The apparatus may comprise:

- means for guiding the product along a trajectory comprising a curvilinear section and a straight section;
- a withdrawal/straightening unit comprising a plurality of pairs of rolls wherein at least a first pair of rolls is located in said curvilinear section and at least a second pair of rolls is located in the straight section, the first and the second pair of rolls being further located in an area where liquid metal is still present in the product and at a location where the rolls provoke an increase in the speed of the product.

[0042] In one embodiment the distances between two consecutive rolls of two consecutive pairs decrease to create a deformation of a long metallic product poured from a mould, in particular a reduction of the section in one direction, preferably a vertical direction.

[0043] The withdrawal/straightening unit may comprise alternating pairs of rolls having perpendicular rotation axes between rolls of adjacent pairs, in particular alternating horizontal and vertical axes, wherein the distances between two rolls of each pair decrease to create a deformation of a long metallic product poured from a mould, in particular a reduction of the section on two directions, preferably a vertical direction and a horizontal direction.

[0044] In short, the Applicant has observed that the above mentioned objective can be achieved by reducing the section and perimeter of the product, by acting in both the area prior to and subsequent to the transition area from the curved form to the linear form of the product, said reductions in the section and perimeter being effected under conditions of the product having a nucleus not completely solidified and at a location where the product can be significantly accelerated.

[0045] In this case, the section and perimeter are modified in the development of the metallurgical length, which extends beyond the transition area of the product from curvilinear to rectilinear.

[0046] In this way, without the casting speed exceeding 5 m/min, it is possible to increase the advance speed of the product to the feeding speed of the mills, i.e. 6 m/min.

[0047] The structural and functional characteristics of the invention and its advantages with respect to the known art, can be clearly understood from the following description, referring to the enclosed drawings, which show a possible embodiment of the invention.

[0048] In the drawings:

- figure 1 shows a solution of the known art;
- figure 2 shows a scheme of a first embodiment of the present invention;
- figure 3 shows a scheme of a second embodiment of the present invention;

- figure 4 shows a plurality of transversal sections of a product during different operating phases of the process according to the present invention.

[0049] With reference to figure 2, this shows a scheme relating to the process and apparatus according to a first embodiment of the present invention.

[0050] In general the process for manufacturing an elongated metal product 1 in a continuous casting plant according to the present invention, envisages that the product 1 follow a trajectory comprising a curvilinear section and a straight section and that it comprises at least a first and a second deformation phase, each of said phases including a contemporaneous deformation of the perimeter and transversal section of said product 1.

[0051] According to the teachings provided herein, the first and second phase are respectively effected, one in the curvilinear section and the other in the straight section.

[0052] The first and second deformation phases respectively define two extremities of a deformation line indicated by LD and located on a barycentric axis of the product 1.

[0053] This deformation line LD is included within a metallurgical line (also called metallurgical length) LM measured on the same barycentric axis of said product 1 and delimited by a first extreme point in which overheated liquid metal is present in the product 1, and a second extreme point in which said product 1 is completely solidified; this aspect will be dealt with further on.

[0054] In a first basic version, the process envisages the deformation of the section and perimeter of the product, by acting in a single direction, preferably a vertical direction.

[0055] A more developed variant of the process and relative apparatus envisages that the deformation be effected by acting in two perpendicular directions, horizontal and vertical.

[0056] With respect to fig. 2, reference 1 indicates the elongated product which vertically leaves the ingot mould 2, whereas reference 10 indicates the apparatus as a whole.

[0057] The product 1 is preferably steel in the form of a billet or bloom or similar sections.

[0058] Downstream of the ingot mould 2, the product 1 is guided by guiding rolls 3 (dotted line) as far as the straightening/withdrawal unit (W.S.U.) indicated as a whole by reference 4.

[0059] The W.S.U. includes at least three pairs of rolls 4A, 4B, 4C, situated, with reference to the transition area ZT (point or region in which the product 1 passes from a curved to a flat configuration) upstream (rolls 4A) of the area ZT, in correspondence with the area ZT (rolls 4B) and downstream of the area ZT (rolls 4C).

[0060] The rolls 4A, 4B and 4C all have a horizontal axis and at least one roll, preferably one for each pair, is motorized.

[0061] More specifically, for the rolls of the upstream pair 4A and in correspondence 4B with the area ZT, it can be observed that the rotation axes of the rolls of each pair 4A, 4B lie along the same radius connected to a single centre CM, i.e. the so-called "machine centre", which is the centre of the circumference with subtends the arc of magnitude 90° on which the curved trajectory of the product 1 is developed, downstream of the ingot mould and upstream of the transition area ZT.

[0062] The distance between the first pair of rolls 4A and the second pair of rolls 4B is greater than the distance between the second pair of rolls 4B and the third pair of rolls 4C, thus creating a deformation of the product 1, in particular a reduction in the section in one direction, in particular vertical.

[0063] More specifically, the decrease in the vertical dimension which is obtained as a whole between the section upstream of the first pair of rolls 4A and downstream of the third pair of rolls 4C ranges from 14% to 16.8%, preferably equal to 15.4%.

[0064] According to the conservation of mass principle, under these conditions, the speed downstream of the third pair of rolls 4C is increased by a value equal to about 18.7%.

[0065] It can therefore be said that the process effected comprises the following steps:

- a- preparing a metallic product 1 with a square section, preferably with a side of 130 mm, poured from a mould 2 and suitable for advancing with an advance speed preferably equal to 5 m/min along a trajectory comprising a first curvilinear section and a second straight section, the extremities of a metallurgical line LM of said product 1 being upstream and downstream of a transition area ZT between said curvilinear section and said straight section;
- b- deforming said product 1 upstream of said transition area ZT to reduce said section in a first direction, preferably vertical, so as to obtain a rectangular section preferably having sides of 130 mm and 122 mm;
- c- deforming of said product 1 in said transition area ZT to further reduce said section in said first direction, thus obtaining a rectangular section preferably having sides of 130 mm and 116 mm;
- d- further deforming said product 1 downstream of said transition area ZT, to further reduce said section in said first direction, thus obtaining a rectangular section preferably having sides of 130 mm and 110 mm.

[0066] Under operative conditions, the best results are obtained in fact when the product 1, downstream of the ingot mould 2, has a substantially square section, with a side of 130 mm and an advance speed equal to about 5 m/min.

[0067] Under these conditions, the following steps are effected:

- a first deformation realized by the first pair of rolls 4A so as to allow the product 1 to acquire a substantially rectangular section with sides of 130 mm and 122 mm.
- a second deformation realized by the second pair of rolls 4B so as to allow the product 1 to acquire a substantially rectangular section with sides of 130 mm and 116 mm.
- a third deformation realized by the third pair of rolls 4C so as to allow the product 1 to acquire a substantially rectangular section with sides of 130 mm and 110 mm.

[0068] It should be noted that the section to which reference is made above is indicated as "substantially" rectangular as, in reality, it has rounded edges which normally derive from the deformation of the product 1 in a dimension (vertical) and under these operative conditions.

[0069] Under these conditions, the speed downstream of the third pair of rolls 4C is equal to about 6 m/min, and therefore optimum for sending the product 1 directly to a mill L.

[0070] Optionally, before the mills L, the product 1 can be preheated in an induction furnace or similar.

[0071] It is fundamental to remember that, for the purposes of the present invention, the semi-solid core 11 of the product 1 extends in the deformation area between the first 4A and third 4C pair of rolls.

[0072] It would be convenient, at this point, to briefly explain how the solidification of the product 1 takes place downstream of the mould 2.

[0073] In the very first area downstream of the mould 2, the product 1 has a relatively reduced "skin thickness" (i.e. a thickness of the solid perimetric wall 12).

[0074] The central nucleus, or core 11, of the product 1, extends significantly in this area and approximately occupies a surface higher than 80% of the transversal section of the product 1.

[0075] The temperature of the nucleus 11 is obviously higher than that of the perimetric wall 12, so that both the liquid phase and metal grains already solidified co-exist in said nucleus 11.

[0076] Due to the progressive cooling, along the trajectory followed by the product 1, the skin thickness 12 tends to increase and the section of the nucleus 11 to progressively decrease.

[0077] According to the teachings provided herein, it is therefore necessary for the "metallurgical line" LM (referring to the length of the portion of product 1 measured on the barycentric axis of the product 1 and in which there is a central nucleus not yet completely solidified, in which solid grains and not overheated liquid metal co-exist, LM being measured from the exit of the mould 2), to extend beyond the last pair of rolls 4C of the W.S.U. machine 4.

[0078] The deformation line LD must therefore be included within the metallurgical length LM.

[0079] In short, the product 1 must reach the transition area ZT still provided with a semi-liquid core which continues to be present at least as far as the last roll 4C of the W.S.U. 4, as schematically illustrated in figure 4 enclosed. Furthermore the rolls, and in particular the first pair of rolls 4A, are located at a position where the solidified skin thickness 12 is important enough so that the deformation realized by the rolls also provokes an increase of the speed of the product in the advancing direction of the product. In other words the rolls should not be located too close to the mould 2 where the product is still too liquid and where the deformation would not provoke sufficient acceleration of the product.

[0080] This is dimensionally obtained, in a preferred solution, respecting these conditions:

Reduction phases	Dimensions of the sides L1, L2 of the transversal section of the product 1	Advance speed V
Initial measurement	L1=130 mm L2=130 mm	5 m/min
Final measurement	L1=130 mm L2=110 mm	5, 9 m/min

[0081] It should be immediately noted that variants can be applied in which there is a reduction in only two steps, for example only in correspondence with the first rolls 4A and third rolls 4C, all included in the scope of the present invention.

[0082] A further variant is shown in figure 3, in which the same parts are indicated with the same reference numbers and consequently no further reference will be made thereto.

[0083] In this case, the apparatus differs from the apparatus previously described in that the W.S.U. 45 comprises both the pairs of rolls 4A, 4B, 4C described above and also a plurality (for example three) of pairs of rolls 5A, 5B, 5C having a rotation axis perpendicular to that of the pairs of rolls 4A, 4B, 4C.

[0084] The pairs 4A, 4B, 4C for example, have a horizontal axis, whereas the pairs 5A, 5B, 5C have a vertical axis.

[0085] In particular, the W.S.U. machine 45 in this case comprises both series of rolls, the pairs with a horizontal axis 4A, 4B, 4C, and also those with a vertical axis 5A, 5B, 5C alternating, so that a pair of rolls with a horizontal axis is followed

by a pair with a vertical axis and vice versa.

[0086] The first pair of rolls 4A of the W.S.U. machine 45 which the product 1 encounters when leaving the mould 2 is preferably a pair of rolls with a horizontal axis.

[0087] In this case, the pairs of rolls 4A,4B,4C,5A,5B,5C are arranged and dimensioned so as to generate a deformation of the product 1 in two directions perpendicular to each other, preferably horizontal and vertical.

[0088] The arrangement of the pairs of rolls 4A, 4B, 4C, 5A, 5B, 5C is such that a deformation in a vertical direction is followed by a deformation in a horizontal direction and vice versa.

[0089] The advantages in this case are substantially analogous to those offered with the apparatus 1 and consequently no further mention will be made to this, except for pointing out that the deformation in two directions allows a much higher final speed (downstream of the rolls 5C) of the product 1 to be obtained.

[0090] Also in this case, the "metallurgical line" LM can extend beyond the last pair of rolls 5C of the W.S.U. machine 45 and the deformation length LD is included within the metallurgical line LM.

[0091] This is dimensionally obtained, in a preferred solution, respecting the following conditions:

Reduction phases	Dimensions of the sides L1,L2 of the transversal section of the product 1	Advance speed V
Initial measurement	L1=130 mm L2=130 mm	5 m/min
Final measurement	L1= 110 mm L2= 110 mm	7 m/min

[0092] It can therefore be said that in this variant, the process comprises the following steps:

a1- preparing a metallic product 1 with a square section, preferably with a side of 130 mm, poured from a mould 2 and suitable for advancing with an advance speed preferably equal to 5 m/min along a trajectory comprising a first curvilinear section and a second straight section, the extremities of a metallurgical line LM of said product 1 being upstream and downstream of a transition area ZT between said curvilinear section and said straight section;

b1- deforming said product 1 upstream of said transition area ZT to reduce said section in a first direction, preferably vertical, so as to obtain a rectangular section preferably having sides of 130 mm and 122 mm;

c1- further deforming said product 1 upstream of said transition area ZT to reduce said section in a second direction perpendicular to said first direction, preferably horizontal, so as to obtain a square section preferably having sides of 122 mm;

d1- further deforming said product 1 in said transition area ZT to further reduce said section in said first direction, thus obtaining a rectangular section preferably having sides of 122 mm and 116 mm;

e1- further deforming said product 1 in said transition area ZT to further reduce said section in said second direction, thus obtaining a square section preferably having sides of 116 mm;

f1- further deforming said product 1 downstream of said transition area ZT, to further reduce said section in said first direction, thus obtaining a rectangular section preferably having sides of 116 mm and 110 mm;

g1- further deforming said product 1 downstream of said transition area ZT, to further reduce said section in said second direction, thus obtaining a square section preferably having sides of 110 mm.

[0093] A further advantage obtained with the present invention is that the W.S.U. machine 4 can be a machine, in which there is the expedient of positioning the pairs of rolls 4A,4B,4C at suitable distances in order to effect the method described above.

[0094] Alternatively, a W.S.U. machine can be modified by adding two, three or more pairs of rolls 5A,5B,5C with a horizontal axis to cause a reduction in the section of the product 1 in more than one direction.

[0095] Numerous modifications to what has been described so far can obviously be applied, for example the reduction percentages can vary from one pair of rolls to the subsequent pair, or the sections can be different from square or rectangular.

[0096] The objectives indicated in the preamble of the description have therefore been achieved.

[0097] The scope of the invention is defined by the following claims.

Claims

1. A process for the manufacturing of a long metallic product (1) in a continuous casting plant, wherein said product (1) follows a trajectory comprising a curvilinear section and a straight section,

characterized in that it comprises at least a first and a second deformation phase, each of said phases comprising a contemporaneous deformation of the perimeter and of the transversal section of said product (1), the first deformation phase being effected in said curvilinear section and the second deformation phase being effected in said straight section, the first and the second deformation phase being effected in an area where liquid metal is still present in the product (1), and at a location where each deformation provokes an increase of the speed of the product.

2. The process according to claim 1, wherein a further deformation of said perimeter and said transversal section of said product occurs (1) in a transition area (ZT) located between the first and the second deformation.

3. The process according to claim 1 or 2, wherein said deformation phases create a deformation of the section of said product in one direction, preferably a vertical direction.

4. The process according to any of the previous claims, wherein there are further deformation phases along said deformation line (LD).

5. The process according to any of the previous claims, wherein said deformation phases create a deformation of the section of said product in two directions perpendicular to each other, preferably in an alternating horizontal and vertical direction.

6. The process according to any of the previous claims, comprising the following steps:

a- casting a long metallic product (1) with a square section, the product advancing along a trajectory comprising a curvilinear section and a straight section, the extremity of a metallurgical line (LM) of said product (1) being upstream and downstream of a transition area (ZT) located between said curvilinear section and said straight section;

b-deforming said product (1) upstream of said transition area (ZT) to reduce said section in a first direction, preferably vertical, so as to obtain a rectangular section;

c- deforming said product (1) in said transition area (ZT) to further reduce said section in said first direction, thus obtaining a rectangular section;

d- further deforming said product (1) downstream of said transition area (ZT) to further reducing said section in said first direction, thus obtaining a rectangular section.

7. The process according to any of the claims from 1 to 5, comprising the following steps:

a1- casting a long metallic product (1) with a mould (2), the product advancing along a trajectory comprising a first curvilinear section and a second straight section, the extremities of a metallurgical line (LM) of said product (1) being upstream and downstream of a transition area (ZT) located between said curvilinear section and said straight section;

b1- deforming of said product (1) upstream of said transition area (ZT) to reduce said section in a first direction, preferably vertical, so as to obtain a rectangular section;

c1- deforming said product (1) upstream of said transition area (ZT) to reduce said section in a second direction perpendicular to said first direction, preferably horizontal, so as to obtain a square section;

d1- deforming said product (1) in said transition area (ZT) to further reduce said section in said first direction, thus obtaining a rectangular section;

e1- deforming of said product (1) in said transition area (ZT) to further reduce said section in said second direction;

f1- deforming said product (1) downstream of said transition area (ZT) to further reduce said section in said first direction, thus obtaining a rectangular section;

g1- deforming said product (1) downstream of said transition area (ZT), to further reduce said section in said second direction.

8. The process according to claims 6 or 7, wherein the reduction of said section in said first or said second direction which is obtained as a whole between the section upstream of the first deformation and that downstream of a last deformation ranges from 14% to 16.8%, and is preferably equal to 15.4% of the initial dimension.

9. The process according to any of the previous claims, wherein the advance speed of said product (1) downstream of said ingot mould (2) is equal to about 5 m/min.

10. The process according to any of the previous claims, wherein said deformations are created in a withdrawal/straightening unit (4) of said product (1).

11. An apparatus for manufacturing a metallic long product **characterized in that** it effects the process according to anyone of the previous claims.

12. The apparatus according to claim 11, **characterized in that** it comprises:

- means for guiding the product along a trajectory comprising a curvilinear section and a straight section;
- a withdrawal/straightening unit (45) comprising a plurality of pairs of rolls (4A,4B,4C) wherein at least a first pair of rolls is located in said curvilinear section and at least a second pair of rolls is located in the straight section, the first and the second pair of rolls being further located in an area where liquid metal is still present in the product (1) and at a location where the rolls provoke an increase in the speed of the product.

13. The apparatus according to claim 12 wherein the distances between two consecutive rolls of two consecutive pairs (4A,4B,4C) decrease to create a deformation of a long metallic product (1) poured from a mould (2), in particular a reduction of the section in one direction, preferably a vertical direction.

14. The apparatus according to claim 12 or 13, **characterized in that** the withdrawal/straightening unit (45) comprises alternating pairs of rolls (4A,4B,4C,5A,5B,5C) having perpendicular rotation axes between rolls of adjacent pairs, in particular alternating horizontal and vertical axes, wherein the distances between two rolls of each pair (4A,4B,4C,5A,5B,5C) decrease to create a deformation of a long metallic product (1) poured from a mould (2), in particular a reduction of the section on two directions, preferably a vertical direction and a horizontal direction.

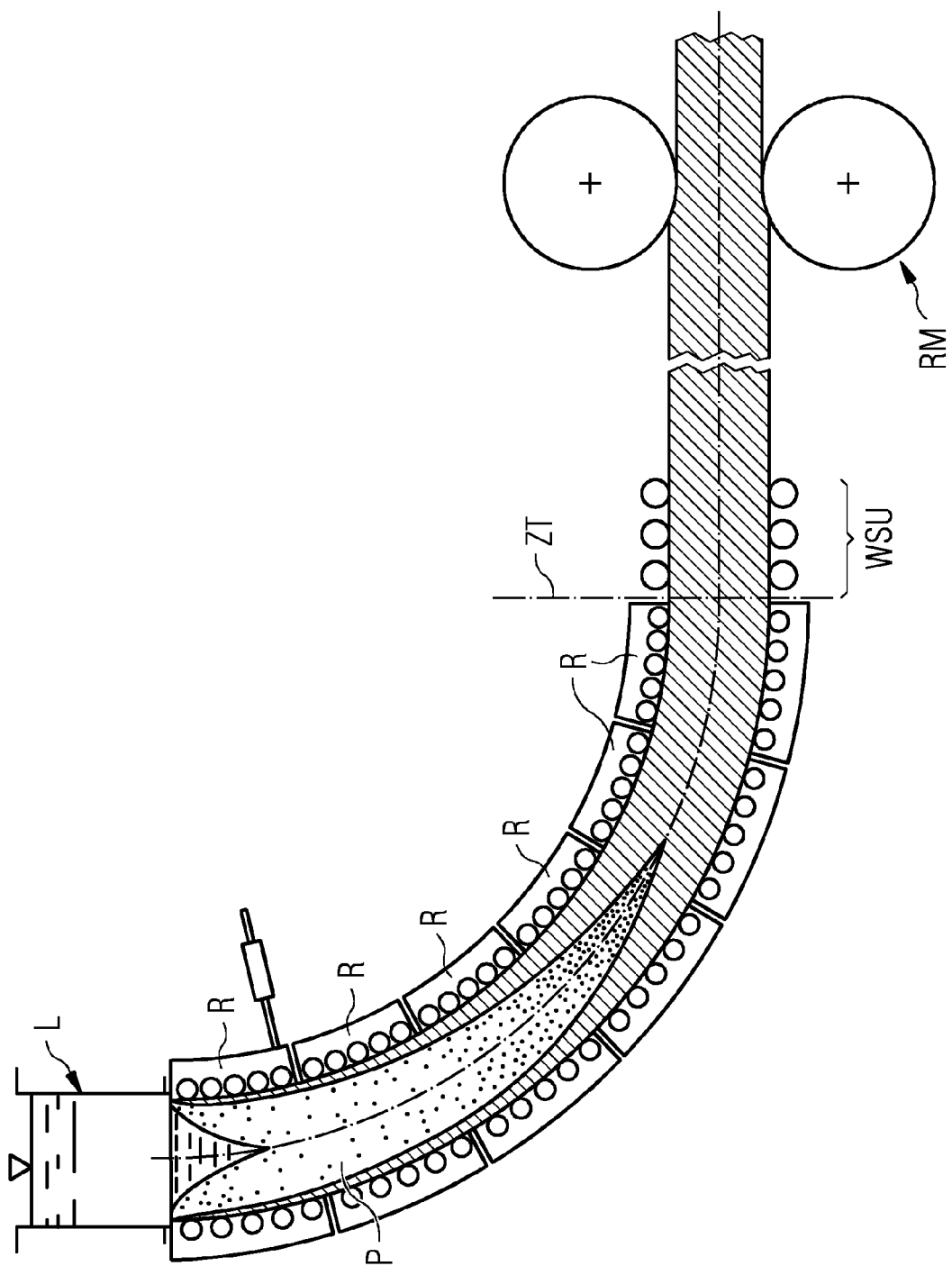
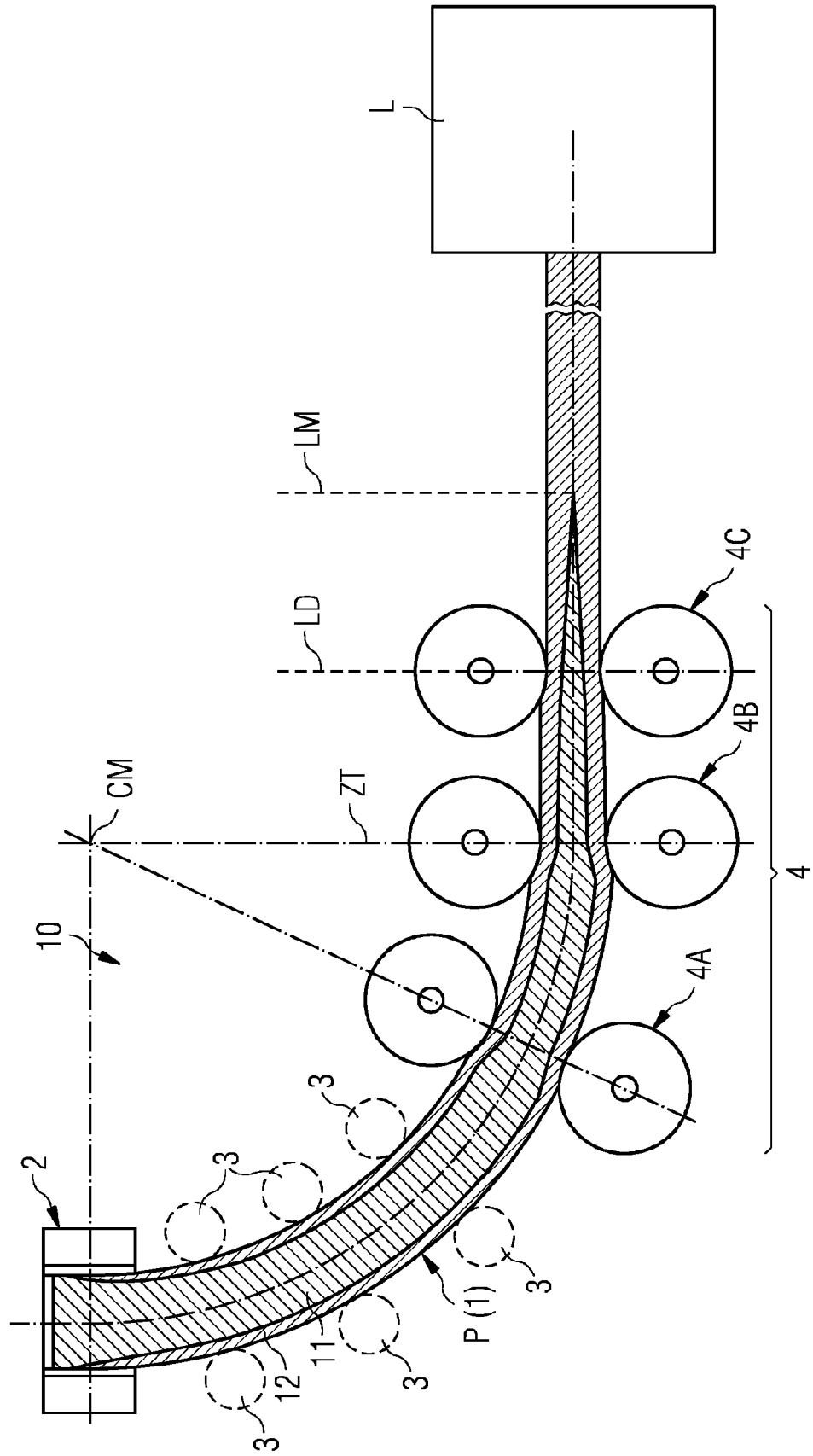


FIG 1
PRIOR ART

FIG 2



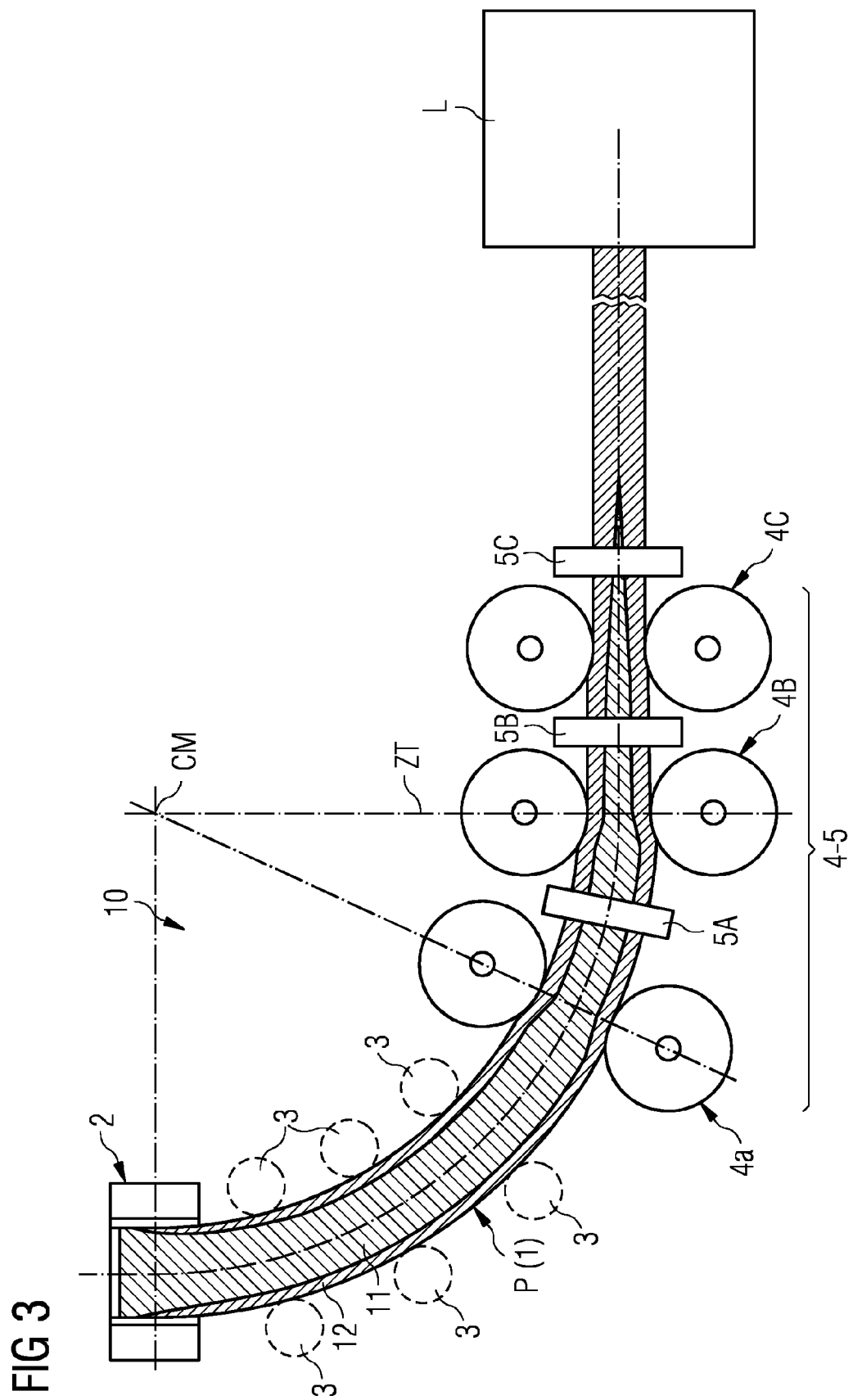
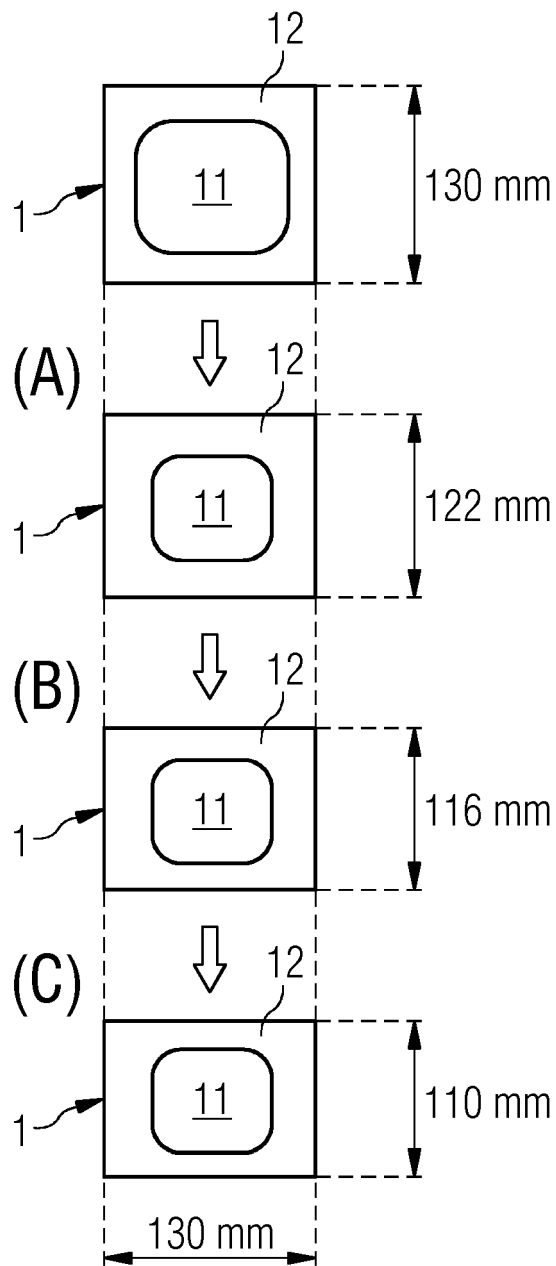


FIG 4





EUROPEAN SEARCH REPORT

Application Number
EP 11 42 5182

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