CONTINUOUS CASTING PLANT

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Field of Search 164/274, 282, 271, 272, 164/283 R, 283 M, 283 MS, 87, 276

References Cited
UNITED STATES PATENTS
3,442,322 5/1969 Lemper 164/274
3,765,470 10/1973 Huber 164/274
3,773,102 11/1973 Gerding 164/283 MS X

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ABSTRACT

The invention relates to a continuous casting plant comprising a water-cooled mould, a supporting and guiding structure for the cast bar joining the mould, and a lateral guiding structure for a dummy bar which is connectable at one end with a dummy head closing the mould at its inside. The dummy bar is exclusively composed of a flexible, elastically shapeable steel tape whose thickness is substantially smaller than the thickness of the smallest continuous bar to be cast on the plant, whose width is preferably greater than the width of the guiding and supporting structure for the cast bar, and whose margins immediately engage with the lateral guiding structure for the dummy bar and are enclosed by it at least at one side.

8 Claims, 3 Drawing Figures
CONTINUOUS CASTING PLANT

The invention relates to a continuous casting plant comprising a water-cooled mould, a supporting and guiding structure for the cast bar joining the mould and being provided preferably with rollers, and a lateral guiding structure for a dummy bar which is connectable at one end with a dummy head closing the inner space of the mould.

In such continuous casting plants, it is attempted to make the dummy bar as simple and light as possible, which dummy bar serves for closing the mould at the onset of casting and for drawing out the cast bar. In continuous casting plants comprising an arcuate bar guiding structure joining the mould for deflecting the cast bar from a substantially vertical direction into horizontal direction, dummy bars composed of several parts similar to a link chain are used. They have the disadvantage that because of the necessary play in the joints on the one hand and because of the play between the dummy bar and the supporting and guiding structure for the cast bar on the other hand, push-like movements occur. When these movements are conveyed to the cast bar, they cause a so-called falling through of the bar in the mould and may lead to casting disturbances. It is another disadvantage of known dummy bars that they are considerably thick, i.e. their thickness corresponds to at least the thickness of the smallest bar cross section that may be cast on the plant, so that the drawing out means for the cast bar may engage the dummy bar.

In order to partly overcome these disadvantages, it has already been proposed to use a dummy bar comprising a flexible band member and a multiplicity of gage block elements, the thickness of these gage block elements arranged movably on the flexible band member being equal to the thickness of the continuous body to be cast (Canadian Pat. No. 733,026). It is complicated to construct this dummy bar which is as wide as the bar to be cast. The drawing out means engages the gage block elements so that a considerable number of these block elements have to be distributed over the total starting length. Such a dummy bar is therefore very heavy and necessitates careful servicing.

According to another known proposal, a beam is joined to the dummy head which is insertable into the mould. This beam is wider than the supporting and guiding rollers for the cast bar, and on both sides of this beam, ropes or tapes are fixed which are guided in U-shaped guides, by means of which the cast bar may be drawn out (German provisional publication No. 2,114,936). As the ropes or tapes are relatively thin or narrow, respectively, the bar may be drawn out, but it is not possible to guide or push the dummy head from below through the supporting and guiding means for the cast bar. In this case, the ropes or tapes would buckle. Another disadvantage of this invention is that the bar is drawn out obliquely when the tension elements expand irregularly, which may lead to ruptures in the bar shell.

The invention is aimed at avoiding the described disadvantages and at creating a dummy bar which is considerably simpler and cheaper in construction and production and which affords a high operational safety and guarantees simple handling. In a continuous casting plant of the kind defined in the introduction, the invention resides in that the dummy bar comprises merely a flexible, elastically shapeable steel tape whose thickness is substantially smaller than the thickness of the smallest continuous bar to be cast on the plant, whose width is preferably greater than the width of the guiding and supporting structure for the cast bar, and whose margins immediately engage with the lateral guiding structure for the dummy bar and are enclosed by it at least at one side.

A relatively thin dummy bar which is guided laterally in guiding rails is known from the German printed application No. 1,583,586, but this dummy bar comprises elements which are articularly joined to one another. It is provided with individual lateral pin-shaped projections or bolts which engage with the guiding rails. The link chain thus contacts the rails only at points, which fact entails the disadvantage that the pin-shaped projections or bolts are excessively stressed at the articulations of the dummy bar, subjected to a strong wear and frequently have to be renewed. The disadvantages inherent with member bars, in particular the push-like movement of the cast bar, are also present.

Preferably the thickness of the steel tape of the invention amounts to only 3 to 20 mm. In continuous casting plants, as a rule, the smallest bar thickness amounts to about 80 mm in plants for billets and to about 150 mm in plants for slabs. In plants for casting broad slabs, in particular for bars having a width of 1,000 to 2,000 mm, particularly great advantages are obtained when according to the invention a thin steel tape is used as dummy bar. It is possible to make do with a tape of 5 to 6 mm thickness without having to fear that the dummy bar will "buckle out" during guiding. The tensile strength of such a steel tape is big enough so that also the cast bar may be drawn out without plastic deformation.

According to a further feature of the invention, it is advantageous to use a steel tape made of a hardened and tempered spring steel whose composition lies within the following limits:

- 0.35 to 0.75 % C
- 0.15 to 1.80 % Si
- 0.40 to 1.20 % Mn
- up to 0.050 % P at the most
- up to 0.050 % S at the most
- up to 1.2 % Cr
- up to 0.12 % V

Balance iron and impurities caused by melting.

It may also be made of steel resistant to wear containing about 1.2 % C and about 12 % Mn.

In an arcuate supporting and guiding structure for the cast bar, it is advantageous to arrange the lateral guiding structure for the dummy bar along the supporting and guiding elements lying on the inner side of the arch, the central part of the steel tape being supported, guided and bent by these supporting and guiding elements.

In a further particularly advantageous embodiment of the invention in which steel tapes of up to 6 mm thickness are used, the end of the guiding structure for the dummy bar remote from the mould may be guided out of the supporting and guiding structure for the cast bar along an arcuate path and joined to a reeling means. The rotation direction of the reeling means is reversible and the drive output of the motor or of the motors respectively, is such that it is possible not only to bend and straighten the steel tape, but also to draw out the cast bar from the mould. It is particularly suitable to arrange the reeling means laterally or of above
3,889,740

or below the bar guiding structure in continuous casting plants comprising a means for direct shaping the cast bar including grooved rolls which function at the same time as drawing out means. These grooved rolls, as a rule, are arranged in pairs, a vertically arranged pair of rolls being followed by a horizontally arranged pair of rolls. In the known continuous casting plants, it is therefore impossible to make do with a single dummy bar when the pass design is changed. For example, a rectangular standard dummy bar, in which, when the form is changed, only the dummy head need be exchanged, cannot be engaged by the grooved rolls. It is therefore of advantage in such continuous casting plants to dispose the reeling means and their drive such that the dummy bar may be introduced and the cast bar may be drawn out without having to make use of the roller pairs destined for drawing out the bar. In addition, when reeling means are used, space is saved and the known arrangement of long boxes for sheltering the dummy bar after its separation from the cast bar is no longer necessary.

In order that the invention may be more fully understood, two embodiments thereof shall now be explained with reference to the accompanying drawings.

FIG. 1 is a simplified representation of a vertical sectional view of a continuous casting plant for slabs.

FIG. 2 is a vertical sectional view of a bar guiding structure.

FIG. 3 is a similar representation as FIG. 1 but of a continuous casting plant for billets with bar shaping rolls.

In FIG. 1, numeral 1 denotes a water-cooled mould which oscillates in a vertical direction. This mould is followed by a supporting and guiding structure for the continuously cast bar, which comprises non-driven rollers 2, 3. Between these rollers, cooling means for the secondary cooling of the continuously cast bar are arranged. The cooling means are not shown in the drawing. Numerals 4, 5, 6, and 7 denote driven pairs of rolls for drawing out the bar having a still-liquid core. The rolls may be adjusted to the bar. When it is completely solidified, the bar is engaged by a further pair of rolls 8 and may be deformed up to e.g. 20 percent. Numeral 9 denotes a roller table on which the bar is transported to a separating means, not illustrated. As may be derived from the drawing, the supporting and guiding structure for the cast bar is arcuate below the mould 1. The rollers 2 at the inner side of the arch are adjustable to different bar thicknesses and arch radii. Along the rollers 2, on the inner side of the arch, a guiding structure of a thin, e.g. 5 mm thick, spring steel tape 11 is provided. This structure is formed of laterally arranged U-shaped carriers or rails 10 lying opposite to each other. The margins of the spring steel tape are surrounded by this guiding structure (FIG. 2). The width of the steel tape 11 is greater than the maximum bar width, which corresponds to about the length of the rollers 2, 3. At its mould side end, the steel tape 11 is connected with a hook-shaped dummy head 12, which is shown in FIG. 2 in a dot and dash line and whose width corresponds to the maximum bar width. The hook-shaped dummy head 12 is preferably releasably connected with the steel tape 11, so that it may easily be exchanged when the mould is exchanged. Suitably, the dummy head is articularly connectable with the solidified end of the cast bar so that later, by a rotatory movement, the dummy head may easily be separated from the cast bar, as this is described e.g. in Swiss Pat. No. 475,049. About in the area of the driven pair of rolls 5, the end 10" of the lateral guiding structure for the steel tape 11 is guided out of the supporting and guiding structure along an arcuate path, preferably with a bending radius R corresponding to the roller path 2, so that the end 11' of the steel tape 11 may be guided into a reeling plant. The reeling plant is composed substantially of the following parts: individually driven bending and drawing out rollers 13, 14, 15, an arcuate guiding part 17 and the idle supporting rollers 16. While the steel tape 11 is reeled to form a coil, whose contour 18 is drawn in a broken line, the guiding part 17 may be slenw or rotated around a horizontal axis 19 in direction of the arrow into a position 17', shown in a dash-dot-line, by means of a cylinder, which is not shown in the drawing and which may be actuated pneumatically, for example. Such a reeling means or three roller coiling machine, respectively, is described in "Maschinelle Ausrüstung von Walzwerken," by Kulatschky, I.G., VEB Verlag Technik Berlin, 1954, page 972/982. By reeling the steel tape 11, the dummy head 12 gets into its end position 12' shown in a broken line.

In order to be able to coil up the tape, the upper roll 5 and some of the following rollers 2 for a short period have to be lifted from their normal positions, shown in broken lines, into positions 5' and 2', shown in full, or to be slenw or rotated out until the dummy head 12 is released from the cast bar and has passed this place. Then the upper roll 5 and the rollers 2 are adjusted to the bar and the bar is further drawn out by the pairs of rolls 4, 5 or 6, 7, 8, respectively. The use of a lateral guiding structure 10 with a substantially circular arch shape and the radius R has the advantage that the steel tape 11 need be bent only slightly so that no strong bending forces will occur. The bending forces necessary for coiling up and coiling off, respectively, are practically exclusively supplied by the bending and drawing out rollers 13, 14, 15. The arrangement of the reeling means within the area of the supporting and guiding structure for the cast bar has the advantage that a short dummy bar may be used and the idling time passing before the next cast bar may be started may be shortened because the dummy bar may already be driven into the mould 1 before the cast bar issues from the horizontal bar guiding structure. The reeling means may, of course, also be built in below the bar guiding structure.

FIG. 2 illustrates how the carriers or guiding rails 10 may be designed. They have a C- or U-shaped cross section and may be connected integrally with the supporting means 21 for the rollers 2. Their upper margins 22 are in alignment with the inner side of the roller path so that the rollers 2 support the central part of the steel tape 11 when the bar is drawn out, and may help when it is bent. The rails 10 may also be designed in several parts or as independent, exchangeable structural parts. Numeral 23 denotes a supporting means for the outer rollers 3.

In FIG. 3, numeral 24 denotes a coil which is driven by a pole changing motor. The coil is provided with a clamping slot 25 for fixing one end of the steel tape 11. The other end of the steel tape 11 reeled on the coil 24 is again fixed to a dummy head 12", which may be driven into the mould through driven pairs of grooved rolls 26, 27 and independently of them. Numeral 10" denotes the arcuate guiding structure which
leads out of the supporting and guiding structure including the rollers 2, 3 and is arranged behind the pairs of grooved rolls 26, 27 forming the drawing out means for the cast bar, and is joined to the reel 24.

In a continuous casting plant for billets with a bar cross section of 140 × 140 mm, it is, for example, possible to use a uniaxial elastic steel tape with a cross section of 240 × 12 mm made of an unalloyed carbon steel with 0.25 % C. When thick tapes are used, i.e. tapes of more than 6 mm width, the dummy bar is moved by the drawing out rolls for the cast bar, although basically it is also possible to coil up thicker tapes, whereby, however, the bending forces are increased and the reeling means must be designed heavily. Tapes with a thickness of 3 to 6 mm may be reeled with advantage. Instead of a compact steel tape, it is also possible to use a continuous woven steel tape produced from a plurality of thin wires or strips which is particularly well bendable and yet provided with the buckling resistance necessary for guiding in the dummy bar.

For the production of compact, bendable, elastically shapeable steel tapes, for example, the following steels may be used according to the invention:

<table>
<thead>
<tr>
<th>%</th>
<th>Steel A</th>
<th>Steel B</th>
<th>Steel C</th>
<th>Steel D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.42/0.5</td>
<td>0.02/0.05</td>
<td>0.55/0.62</td>
<td>1.10/1.30</td>
</tr>
<tr>
<td>Si</td>
<td>1.50/1.8</td>
<td>1.20/1.40</td>
<td>0.15/0.35</td>
<td>0.30/0.50</td>
</tr>
<tr>
<td>Mn</td>
<td>0.50/0.80</td>
<td>0.40/0.60</td>
<td>0.30/1.10</td>
<td>12.0/15.0</td>
</tr>
<tr>
<td>P</td>
<td>max. 0.05</td>
<td>max. 0.035</td>
<td>max. 0.03</td>
<td>max. 0.035</td>
</tr>
<tr>
<td>S</td>
<td>max. 0.05</td>
<td>max. 0.035</td>
<td>max. 0.03</td>
<td>max. 0.035</td>
</tr>
<tr>
<td>Cr</td>
<td>—</td>
<td>0.40/0.60</td>
<td>0.90/1.20</td>
<td>max. 1.50</td>
</tr>
<tr>
<td>V</td>
<td>—</td>
<td>—</td>
<td>0.07/0.12</td>
<td>—</td>
</tr>
</tbody>
</table>

The steels A and B are hot rolled spring steels, steel C is a cold-rolled strip steel and the steel D is a manganese steel resistant to wear.

What we claim is:

1. A continuous casting plant comprising:
   a. a water-cooled mould;
   b. means extending from the mould for supporting and guiding a cast bar;
   c. a dummy bar adapted to be connected at one end to a dummy head that is insertable into the mould to close an end of the mould, the dummy bar being composed exclusively of a flexible, elastically shapeable steel tape without articulated joints and having a thickness that is generally constant along the length of the dummy bar and that is substantially smaller than the thickness of the smallest continuous bar to be cast in the plant; and
   d. means extending from the mould for guiding the dummy bar, the guiding means being adapted to engage side margins of the dummy bar and to enclose at least one of said side margins.

2. The continuous casting plant set forth in claim 1, wherein the width of said steel tape is greater than the width of the guiding and supporting means for the cast bar.

3. The continuous casting plant set forth in claim 1, wherein the supporting and guiding means for the cast bar includes a plurality of rollers.

4. The continuous casting plant set forth in claim 1, wherein the thickness of the steel tape amounts to from 3 to 20 mm.

5. The continuous casting plant set forth in claim 1, wherein the steel tape is made of a hardened and tempered spring steel whose composition lies within the following limits:
   0.35 to 0.75 % C
   0.15 to 1.80 % Si
   0.40 to 1.20 % Mn
   up to 0.050 % P at the most
   up to 0.050 % S at the most
   up to 1.2 % Cr
   up to 0.12 % V
   balance iron and impurities cause by melting.

6. The continuous casting plant set forth in claim 1, wherein the steel tape is made of steel resistant to wear containing about 1.2 % C and about 12 % Mn.

7. The continuous casting plant set forth in claim 1, wherein the supporting and guiding means for the cast bar includes supporting and guiding elements arranged along an arc, the guiding means for the dummy bar is arranged along the supporting and guiding elements that lie on a radially inward side of the arc, and the steel tape at its central part is supported, guided and bent by said radially inward supporting and guiding elements.

8. The continuous casting plant set forth in claim 1, also comprising means for reeling up the dummy bar and at least one motor for reversibly driving the reeling means, and wherein the steel tape has a thickness of up to 6 mm and an end of the guiding means for the dummy bar remote from the mould is adapted to be moved away from the supporting and guiding means for the cast bar to define a path leading to the reeling means, the motor for the reeling means having a drive output sufficient to bend and straighten the steel tape and also the draw out a cast bar from the mould.
UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,889,740
DATED : June 17, 1975
INVENTOR(S) : Bruno Tarmann et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 6, line 26, "cause" should read --caused--; and
Col. 6, line 49, "the draw" should read --to draw--.

Signed and Sealed this
second Day of September 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks