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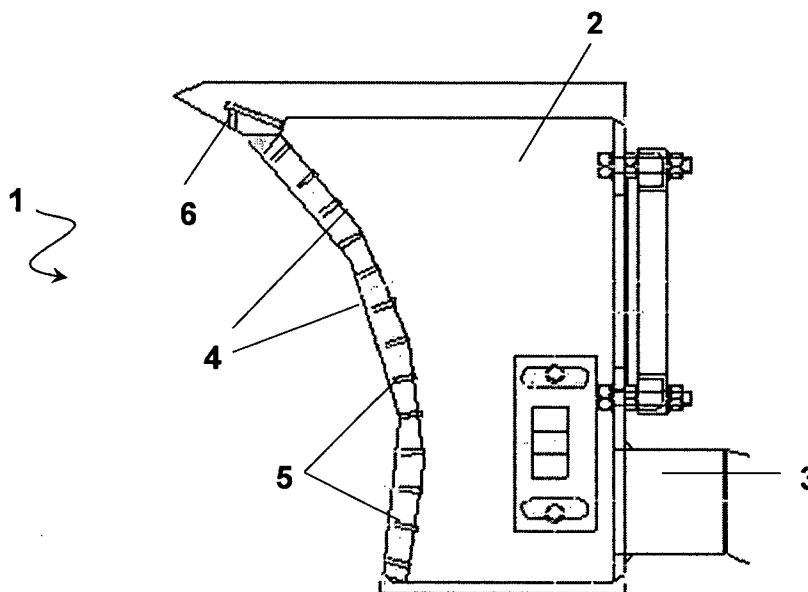
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(54) Title: ROLLING MILL WITH COOLING DEVICE AND ROLLING PROCESS

Fig. 1



(57) Abstract: The invention deals with a rolling mill (1) for metallic products comprising at least one pair of work rolls and at least one cooling device (2) projecting a plurality of cooling jets under pressure on at least one work roll, the cooling device projecting also at least one scraper jet between the cooling jets and the metallic product to be rolled, the scraper jets being oriented in the desired flow direction following a re-entrant angle towards the perpendicular to the surface of the work roll, as well as with a rolling process using said rolling mill (1).

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Rolling mill with cooling device and rolling process

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The present invention deals with a rolling mill integrating a cooling device, which can be used for hot rolling of metallic products, like steel sheets, without being limited to such use and products.

Such a hot rolling consists in heating a metallic product and making it
10 pass through pairs of rotating work rolls, so as to reduce the thickness of the heated metallic product under the pressure exerted by the top and the bottom work rolls.

The work rolls are heated through contact with the heated metallic products but also through their rolling action, and require to be cooled
15 continuously, in the most uniform way. Cooling devices consisting in boxes drilled with a plurality of holes can be used to project a cooling fluid under pressure onto the work rolls during rolling.

In order to prevent that cooling fluid that is employed for roll cooling comes into contact with the metallic product that is being rolled, a mechanical
20 scraper is being used. The mechanical scraper is a device which is in contact with the roll and mechanically blocks the flow of the cooling fluid. This scraper is closing the passage for the cooling fluid coming from the roll cooling device, avoiding the fluid to come into contact with the metallic product, which could be detrimental for said product.

25 However, such mechanical scraper undergoes a lot of thermal and mechanical constraints and must be very often replaced, imposing to interrupt the rolling production.

The purpose of the present invention is therefore to put at disposal a rolling mill with an improved cooling device, free of the above mentioned
30 drawbacks, allowing an improved service life of said cooling device without production stops.

According to this, a first object of the present invention is a rolling mill for metallic products comprising at least one pair of work rolls and at least one cooling device projecting a plurality of cooling jets under pressure on at least one of said work roll, said cooling device projecting also at least one scraper jet between said cooling jets and the metallic product to be rolled, said scraper jets being oriented in the desired flow direction following a re-entrant angle towards the perpendicular to the surface of said work roll.

The rolling mill according to the invention can also comprise several other characteristics, alone or in combination, such as:

- the cooling jets are perpendicular to the surface of said work roll,
- the cooling jets are arranged in horizontal rows, each adjacent row being laterally shifted so as to form a quincunx disposition,
- the exits of said cooling jets are arranged along a curved surface, which curvature radius is higher than the radius of said work roll,
- the cooling device comprises a plurality of nozzles through which said cooling jets and scraper jets are projected on said work roll,
- the cooling device consists in a box fed with a cooling fluid under pressure, provided on one of its external surface with said cooling and scraper nozzles disposed on a curved plate,
- the cooling device is a water pillow cooling device including side guides for the formation of said water pillow,
- the cooled work roll can be a bottom work roll, and/or a top work roll,
- the rolling mill comprises at least two rolling stands, wherein said cooling device is implemented in the first and/or the second rolling stands, for example.

A second object of the invention is a cooling device as described above.

A third object of the present invention is a process of rolling metallic products using a rolling mill or a cooling device according to the invention, wherein said pressure of cooling and scraper jets is lower than 4 bar, preferably lower than 3 bar.

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The process according to the invention can also comprise several other embodiments, taken alone or in combination, such as:

- the cooling fluid consists in water,
- the metallic product is a steel sheet,
- 10 - the rolling mill is a hot rolling mill.

Other characteristics and advantages of the invention will appear through the detailed description which will follow, only given as a mere example and referring to the following figures:

- 15 ▪ Figure 1: representing a sectional view of a cooling device according to the invention,
- Figure 2: showing a picture of the cooling device of figure 1 during operation.

20 As can be seen on figure 1, a cooling device 1 according in the invention consists in a box 2 connected through a feeding pipe 3 to a cooling fluid container and to a pump (not represented). Said cooling fluid can, for example, be water or an emulsion of water and oil stabilised or not with surfactants.

25 Opposite to the fluid feeding pipe 3, the box 2 comprises a pair of curved plates 4 provided with a plurality of internal nozzles 5 forming and directing cooling fluid jets from the box 2 towards the roll surface. As can be better seen on figure 2, those nozzles 5 preferably have an orientation perpendicular to the work roll surface so as to cool it in a uniform way.

30 Above those cooling nozzles 5, scraper nozzles 6 are provided and connected to the inside of the box 2 which feeds them with cooling fluid under pressure. The orientation of those scraper nozzles 6 is different from the

orientation of the cooling nozzles 5 and presents a re-entrant angle of approximately 45° towards the perpendicular to the work roll.

The operating pressure of the cooling is preferably under 4 bar and most preferably under 3 bar. Those pressures have proven to be sufficient to reach a good cooling action and help in limiting the bouncing of cooling fluid on the work roll surface.

The cooling nozzles 5 and the scraping nozzles 6 can have various section shapes and/or sizes. They are preferably disposed in parallel rows, each row being laterally shifted from the adjacent rows, so as to create a quincunx disposition. They can also be replaced by transversal slits extending along all or part of the cooling device, parallel to the ground, generating flat jets.

As can be better seen on figure 2, the scraper nozzles 6 guide the cooling fluid fluxes towards the ground, in the desired flow direction, tangentially to the roll R. They generate a kind of water curtain avoiding having any cooling fluid projection towards the metallic product to be rolled.

In the case where the scraper function would be applied to the top work roll, the scraper nozzles would, of course, guide the cooling fluid fluxes towards the top.

As can be seen on figure 2, the curved plates 4 have a higher curvature radius than the work roll radius, which is advantageous. The distance between the exit of the scraper nozzles 6 and the work roll R surface is determined in order to avoid any direct interaction between the scraper jets and the adjacent cooling jets so as not to reduce the cooling efficiency of the device. It is also important not to place the exit of the scraper jets too close to the work roll R surface to avoid any cooling fluid projection on the metallic product which would be due to the impact of the scraping jets themselves. As a matter of example, a distance under 20 mm has proven to be suited for a work roll diameter of 745 mm.

The design shown on figure 1 can of course be modified depending on the particular implementation to be performed. Thus, the external curved plate 4 can be omitted, which would let only the internal plate 4 provided with external protruding nozzles.

The curved plates 4 and internal nozzles 5 could also be replaced by a massive plate drilled with a plurality of through holes, playing the same role as the internal nozzles 5.

To improve the efficiency of the scraper action, the nozzles 6 or holes
5 can have an increased density compared to the cooling nozzles 5. It is also of course possible to have more than one row of scraper jets placed at the top of the cooling device, to improve the scraper efficiency whenever required.

The cooling device with integrated scraper function according to the
10 invention can be used to implement several types of cooling processes. Among those processes, it can advantageously be used to carry out a water pillow cooling process, where a water cushion is formed between the cooling device external surface and the roll through the use of side plates retaining the projected water.

15 Other processes are however suited to such a scraper function, like, for example, high turbulence roll cooling.

This cooling device can be installed on any rolling stands that needs to be efficiently cooled, but is preferably installed on the first rolling and/or second stands where the processing conditions are the most difficult.

20 It has been described for implementation on a bottom work roll but could also be implemented for a top work roll or both bottom and top work rolls at the same time.

The metallic products which can be processed by the rolling mill according to the invention are of various kinds. Steel products, like carbon
25 steels or stainless steel, can be cited, together with ferrous alloys or aluminium products.

CLAIMS

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1. Rolling mill (1) for metallic products comprising at least one pair of work rolls and at least one cooling device (2) projecting a plurality of cooling jets under pressure on at least one of said work roll (R), said cooling device (2) projecting also at least one scraper jet between said cooling jets and the metallic product to be rolled, said scraper jet being oriented in the desired flow direction following a re-entrant angle towards the perpendicular to the surface of said work roll (R).
 2. Rolling mill (1) according to claim 1, wherein said cooling jets are perpendicular to the surface of said work roll (R).
 3. Rolling mill (1) according to anyone of claims 1 or 2, wherein said cooling jets are arranged in horizontal rows, each adjacent row being laterally shifted so as to form a quincunx disposition.
 4. Rolling mill (1) according to anyone of claims 1 to 3, wherein the exits of said cooling jets are arranged along a curved surface, which curvature radius is higher than the radius of said work roll.
 5. Rolling mill (1) according to anyone of claims 1 to 4, wherein said cooling device (2) comprises a plurality of nozzles (5,6) through which said cooling jets and scraper jets are projected on said work roll (R).
 6. Rolling mill (1) according to claim 5, wherein said cooling device (2) consists in a box fed with a cooling fluid under pressure, provided on one of its external surface with said cooling and scraper nozzles (5,6) disposed on a curved plate (4).
 7. Rolling mill (1) according to anyone of claims 1 to 6, wherein said cooling device (2) is a water pillow cooling device including side guides for the formation of said water pillow.

8. Rolling mill (1) according to anyone of claims 1 to 7, wherein said work roll (R) is a bottom work roll.
- 5 9. Rolling mill (1) according to anyone of claims 1 to 7, wherein said work roll is a top work roll.
10. Cooling device (2) according to anyone of claims 1 to 9.
- 10 11. Process of rolling metallic products using a rolling mill (1) according to anyone of claims 1 to 9 or a cooling device according to claim 10, wherein said pressure of cooling and scraper jets is lower than 4 bar.
- 15 12. Process according to claim 11, wherein said cooling fluid consists in water.
13. Process according to anyone of claims 11 or 12, wherein said metallic product is a steel sheet.
- 20 14. Process according to anyone of claims 11 to 13, wherein said rolling mill is a hot rolling mill.

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Fig. 1

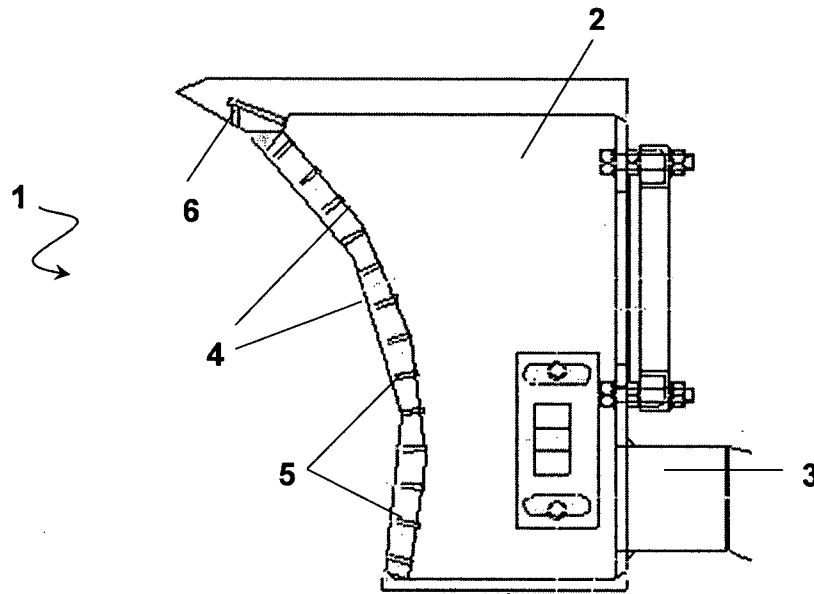
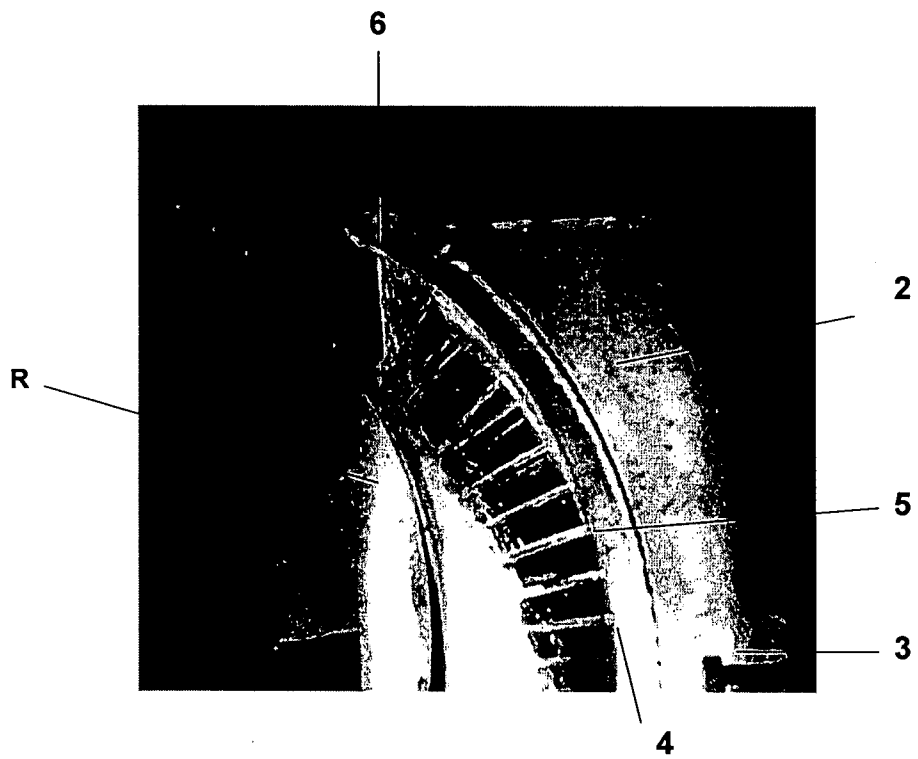


Fig. 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2008/001403A. CLASSIFICATION OF SUBJECT MATTER
INV. B21B27/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 313 516 A1 (LAUENER ENG AG [CH]) 26 April 1989 (1989-04-26) column 5, line 9 - line 55; figures 2-4	1-14
A	EP 0 899 030 A2 (SCHLOEMANN SIEMAG AG [DE]) SMS DEMAG AG [DE] 3 March 1999 (1999-03-03) column 5, line 18 - column 6, line 11; figures 1,2	1-14
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A	JP 55 109508 A (NIPPON STEEL CORP) 23 August 1980 (1980-08-23) abstract	1,11

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

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Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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