(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 289 522 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.12.2023 Bulletin 2023/50

(21) Application number: **23460020.3**

(22) Date of filing: **22.05.2023**

(51) International Patent Classification (IPC):
B21B 1/085 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B21B 1/085

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **09.06.2022 PL 44142822**

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(54) **ROLLING MILL ROLL FOR ROLLING RAILWAY AND TRAM RAILS**

(57) The subject-matter of the invention is a rolling mill roll used for rolling railway and/or tramway rails, especially of leading roll and finishing roll, wherein a pass of the working surface of the roll forming the bottom surface of rail foot is convex, while the lines forming the roll pass convexity are rounded with a radius at their contact point, and the size (S) of convexity of roll passes calculated from the straight line joining the ends of the roll pass intended to form the rail foot is in the range of 0.5 mm to 2.0 mm for the leading roll pass and in the range of 0.2 mm to 0.75 mm for the finishing roll pass.

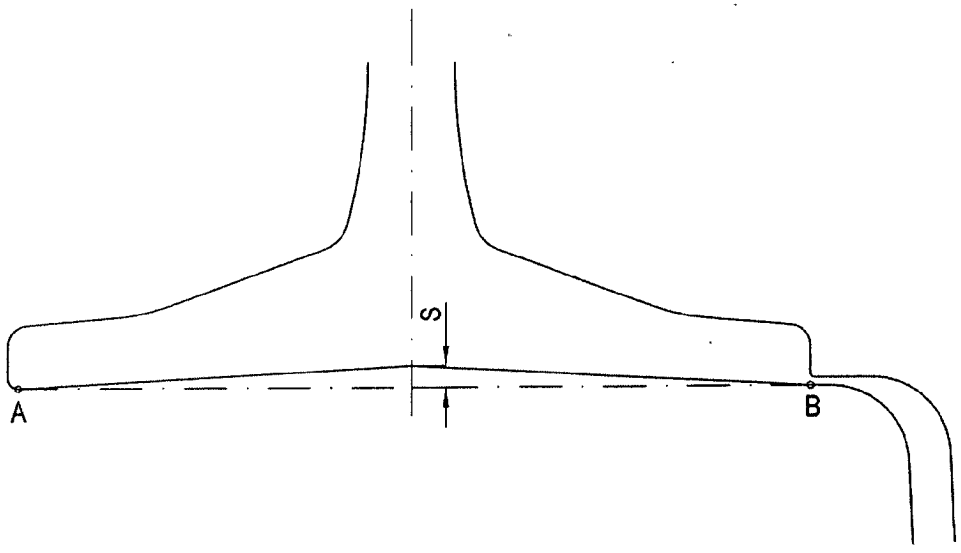

Fig. 1

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Description

[0001] The subject of the invention is a roll intended for use in rolling mills in the process of rolling railway and tram rails (grooved rail).

[0002] Patent description CN110180889B covering steel rolling processes and disclosing rail rolling production line and rail rolling process with its application is known in the state of the art. The rail rolling production line comprises a pre-rolling unit; the pre-rolling unit comprises the first pre-rolling mill, the second pre-rolling mill, finishing unit and saw for hot cutting strip ends; the first and the second pre-rolling mills are arranged in a removable manner; the finishing unit is located downstream the second pre-rolling mill and comprises at least four finishing mills which are arranged successively; the saw for hot cutting strip ends is located separately between the second pre-rolling mill and the finishing unit, where the first pre-rolling mill and the second pre-rolling mill are arranged to allow tandem rolling process, and at least two finishing mills of at least four finishing mills are arranged to allow continuous rolling.

[0003] The basic element of rail-rolling technology for achieving the required rail shape is the roll pass design. The technological arrangement and type of rolling stands used in the rolling mill have a decisive influence on the choice of roll and pass design method. Currently, rails are rolled, depending on the type and equipment of the rolling mill, as follows:

- in newer tandem mills with two-high rolling stands and in older line rolling mills with two-high or three-high stands according to technology based on Battscherer's roll pass design.
- in rolling mills equipped with universal four-high (minimum three-high) stands according to technology based on Stammbach's roll pass design,
- in the latest generation of rolling mills equipped with three-stand tandem mill unit according to technology based on X-H roll pass design.

[0004] All the above roll pass designs ensure flat rail foot. In case of Bartscherer's roll pass design, finishing passes, i.e. leading and finishing passes, regardless of the degree of inclination relative to the roll axis, are always designed so that the surface of the rail foot is smooth when leaving them during rolling. The activities associated with designing passes and their reasonable arrangement in roll assemblies are referred to as roll pass design. Roll pass design is one of the basic elements of plastic working technology by means of rolling.

[0005] Roll passes prepared according to Stammbach and X-H designs can only be used for universal four-high mills, so they are not suitable for two-high and three-high mills.

[0006] The present invention refers to roll pass designs suitable for two-high and three-high mills.

[0007] The aim of the invention was to develop the shape of rolling mill rolls intended for rolling railway and tramway rails, which would make it possible to reduce the level of residual stresses of rolled rails, while maintaining the required dimensions of rails resulting from the applicable standards, without having to interfere with the structure of the rolling mill used in the state of the art.

[0008] The essence of invention is a rolling mill roll used for rolling railway and/or tramway rails, especially of leading roll and finishing roll, characterised in that pass of the working surface of the roll is convex, while the lines forming the roll pass convexity are rounded with a radius at their contact point, and the size of convexity of roll pass calculated from the straight line joining the ends of the roll pass intended to form the rail foot is in the range of 0.5 mm to 2.0 mm for the leading roll pass and in the range of 0.2 mm to 0.75 mm for the finishing roll pass.

[0009] Roll characterized by roll pass according to the invention makes it possible to obtain - after the hot-rolling process - concavity in the rail foot in its axis of symmetry in the range of 0.1-0.3 mm.

[0010] The concavity of rail foot surface is achieved by a different design of roll passes than previously used. The subject of the invention in the example an embodiment is shown in the drawing, where Fig. 1 shows a fragment of roll according to invention characterised by roll pass, fig. 2 shows the entire roll characterized by roll pass which illustrates the forming of the entire rail surface during rolling, fig. 3 shows the assembly of two rolls #1 and #2

[0011] The finishing roll according to the invention is characterised by roll pass describing the rail foot by two lines inclined towards each other at an obtuse angle, instead of a straight line used so far, resulting in the convexity of the roll pass indicated in fig. 1. Lines that form the convexity of roll pass are rounded with a radius at their contact point. The size of convexity (S) of roll passes, calculated from the theoretical straight line (designated in fig. 1 by a dotted line) joining the ends of the roll pass forming the rail foot marked as points A and B, varies according to the type of pass. The subject of the invention in the example an embodiment is shown in the drawing, where Fig. 1 shows a fragment of roll characterised by roll pass with S convexity, which forms the rail foot so as to give it concavity between 0.1 and 0.3 mm. Whereas Fig. 2 shows the entire roll characterized by roll pass, which illustrates the forming of the entire rail surface during rolling, where S defines the convexity of roll pass. On the other hand, fig. 3 shows the assembly of two rolls #1 and #2 with the arrangement of sample roll passes #11 and #21 on the roll face (usually several passes are placed along the roll length).

[0012] The shape of roll passes according to the invention in the area of the rail foot makes it possible to achieve a concavity of the foot during rolling, resulting in reduction of contact pressure of foot rollers in a vertical straightener acting on the rail foot surface.

[0013] The assumptions made were conditioned by the limited possibility of changing the shape of passes in the area of rail foot, since achieving the shape and dimen-

sions of rail as specified in the standard is the necessary requirement. Modification of roll pass design according to the invention was carried out in such a way as to obtain a suitable shape of the rail foot, which would be the most preferable in terms of reducing the level of internal stresses in the rail foot after completing all technological operations of rail production.

[0014] Making the rail foot concave, and therefore modifying its shape as a result of the altered roll pass design according to the invention, results in a reduction of the level of residual stresses in the rail foot after the straightening process in roller straighteners using both flat and profile rollers.

[0015] The use of rails with foot concavity given during rolling results in a change in the level of stress in the near-surface layer in the tested foot region during rail straightening. It is modified in such a way that there is a reduction in the level of residual tensile stresses in the concavity region of the foot surface resulting in a reduction in the total residual tensile stresses across the foot volume. According to the invention, roll pass, especially leading and finishing, has been designed in such a way as to make it possible to straighten rails using both the standard, previously used flat straightening rollers and profile rollers, while maintaining the correctness of all cross-section parameters. The solution does not adversely affect the rail straightness, providing an effective reduction in the residual stresses in the rail foot. After using rolls according to the invention, a 40% reduction in the average level of residual tensile stresses in the rail foot was observed for rails straightened with conventional flat rollers and even about 65% reduction in the level of residual stresses - for rails straightened with profile rollers in relation to the level of maximum allowable residual stresses in the rail foot of 250 MPa as required by the EN13674-1:2011+A1:2017 standard. Comparing the residual stress reduction to the standard level of residual stresses normally obtained in rolling mills, i.e. approx. 190 MPa to 230 MPa in the rail foot (based on available data in the literature), application of the invention results in a reduction of residual stresses by more than 20% when using conventional flat straightening rollers and even by more than 50% when using profile rollers. Furthermore, the use of roll according to the invention does not require a change in the rolling line structure used in the state of the art.

[0016] It is also possible to re-turn the existing rolls of mills known in the state-of-the-art in order to give them proper shape (roll pass design) of working surface.

Claims

1. A rolling mill roll used for rolling railway and/or tramway rails, especially of leading roll and finishing roll, **characterized in that** a pass of the working surface of the roll forming the bottom surface of rail foot is convex, while the lines forming the roll pass convexity are rounded with a radius at their contact point, and the size of convexity of roll passes calculated from the straight line joining the ends of the roll pass intended to form the rail foot is in the range of 0.5 mm to 2.0 mm for the leading roll pass and in the range of 0.2 mm to 0.75 mm for the finishing roll pass.

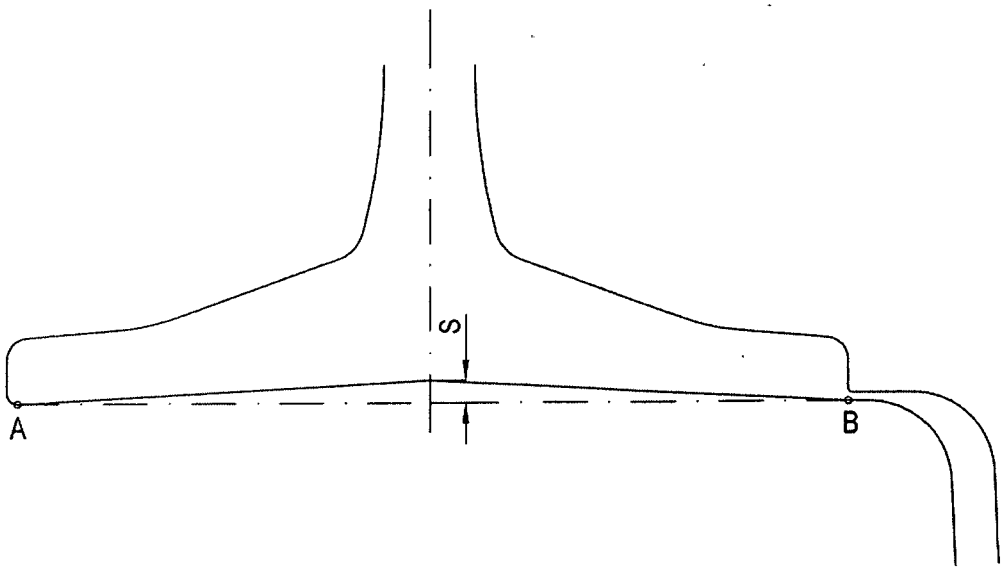

Fig. 1

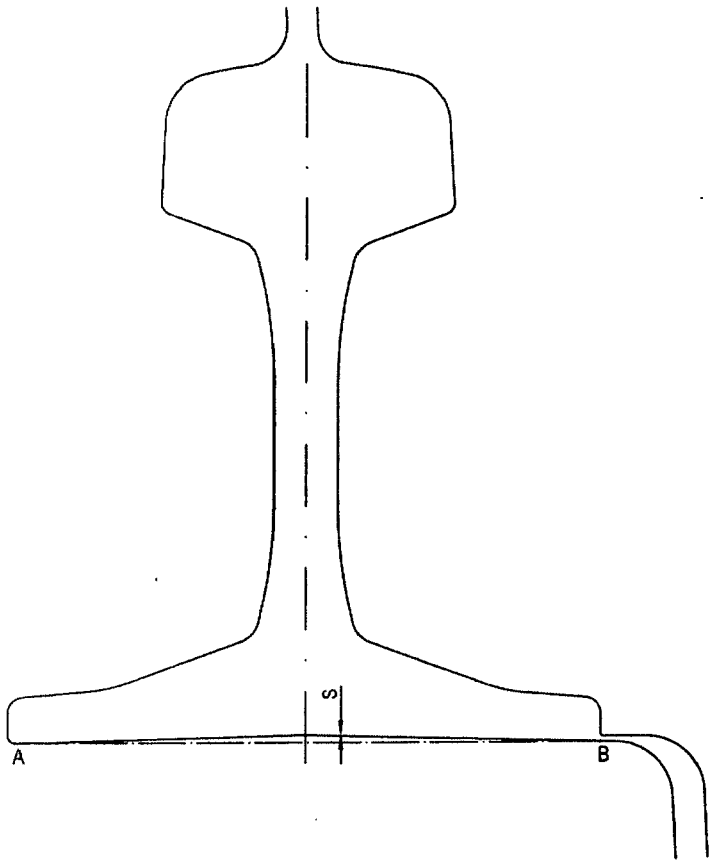

Fig. 2

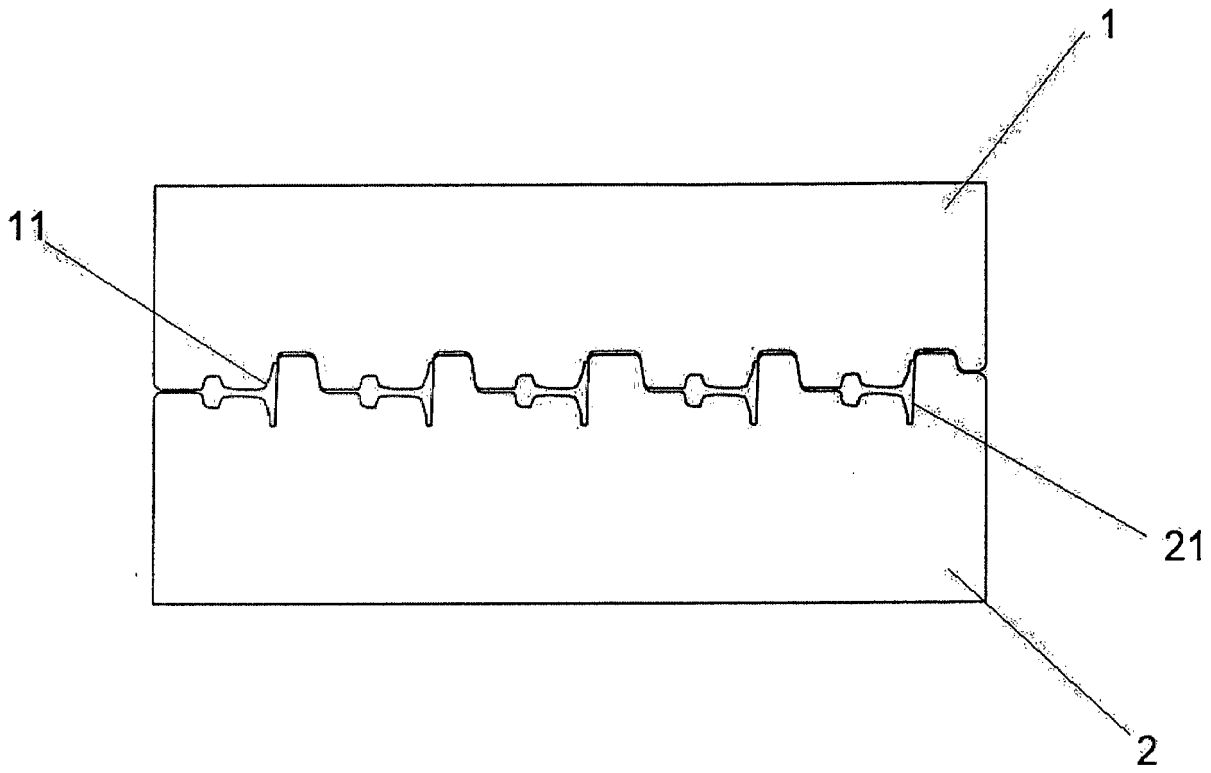

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 46 0020

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			B21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 September 2023	Forciniti, Marco

CATEGORY OF CITED DOCUMENTS

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01-09-2023

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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