



(11)

EP 4 338 861 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:

20.03.2024 Bulletin 2024/12

(51) International Patent Classification (IPC):

B21B 1/08 (2006.01) B21B 27/02 (2006.01)

(21) Application number: **21938839.4**

(86) International application number:

PCT/CN2021/118826

(22) Date of filing: **16.09.2021**

(87) International publication number:

WO 2022/227375 (03.11.2022 Gazette 2022/44)

(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**

(30) Priority: **25.04.2021 CN 202110450379**

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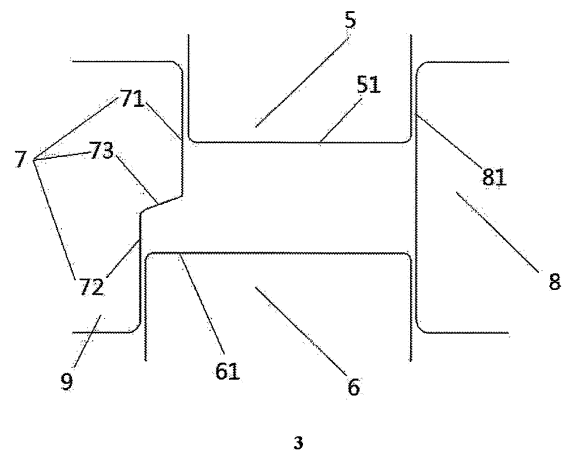
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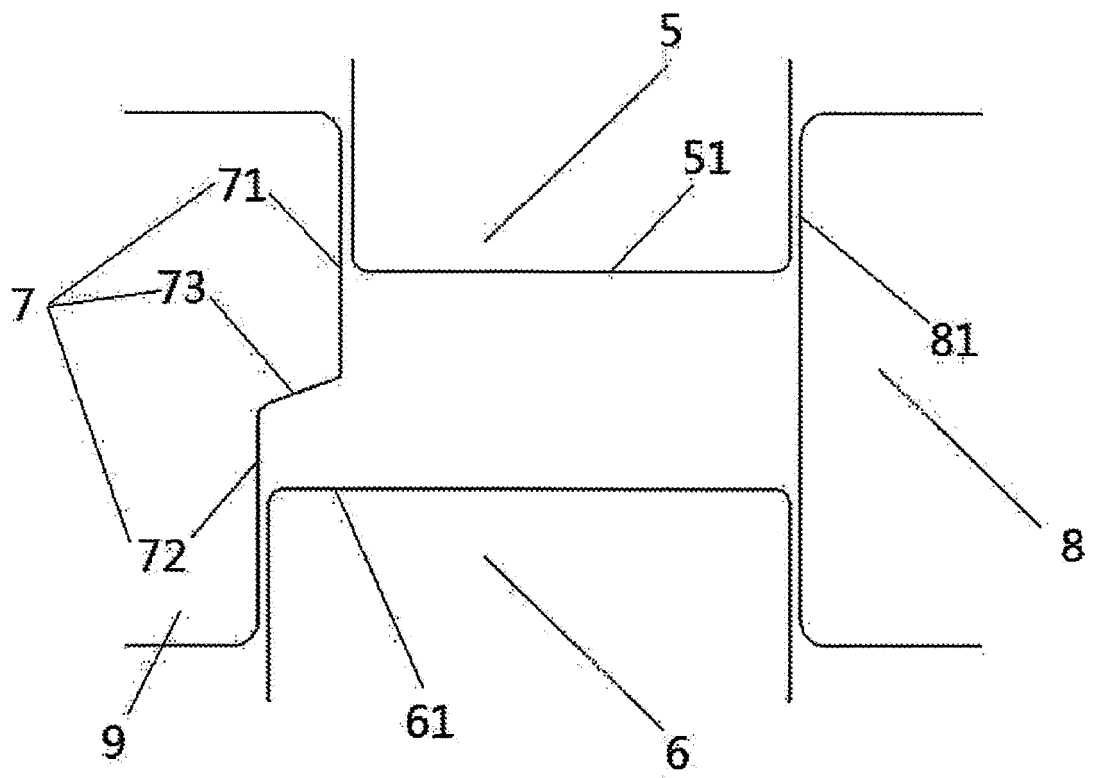
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(54) **ROLL ASSEMBLY FOR ROLLING SPECIAL-SHAPED STEEL AND A ROLLING MILL TRAIN**

(57) A roll assembly for rolling special-shaped steel, comprising: an upper roll (5), a lower roll (6), a left roll (9), and a right roll (8). The left roll has a left forming surface (7), the right roll has a right forming surface (81), the upper roll has an upper forming surface (51), and the lower roll has a lower forming surface (61); the left forming surface, the right forming surface, the upper forming surface and the lower forming surface together enclose a cavity; the upper roll and the lower roll can respectively move in an up-down direction; the left roll and the right roll can respectively move in a left-right direction. Also disclosed is a rolling mill train. The rolling mill train comprises at least two rolling mills; each rolling mill comprises a stand and a roll assembly provided on the stand; the roll assembly can be applicable to special-shaped steel similar in shape but different in size; moreover, when a cavity wall of the cavity is worn, on-line compensation can be implemented without stopping production and disassembling rolls. Thus, the production efficiency is ensured, and the purchase cost of rolls is saved.



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Description

FIELD OF INVENTION

[0001] The invention belongs to the technical field of a hot-rolled section steel, and in particular relates to a roll assembly for rolling a special-shaped steel and a rolling mill train.

BACKGROUND OF THE INVENTION

[0002] At present, the rolling process often used for a special-shaped steel is: using rectangular billets or square billets to pass through multiple box passes, slit passes, preformcavities and final product passes, and finally rolling into the special-shaped steel of the target shape.

[0003] Take the forklift beam section steel as an example to illustrate. The forklift beam section steel is the steel used to make the fork arm carrier beam of the forklift and is supported on the load-bearing member of the forklift, therefore, for the forklift beam section steel, the requirements for the performance, the dimensional accuracy and the surface quality are relatively high. As shown in Figure 1, the section of the forklift beam section steel is composed of a right-angled trapezoid area 1 and a rectangular area 2, which is the special-shaped steel. The width of the right-angled trapezoid region 1 is H1, the thickness is B1, the width of the rectangular area 2 is H, and the thickness is B. As shown in Figure 2, the rolling steel component of the special-shaped steel rolling mill in the prior art includes an upper rolled roller 3 and a lower rolled roller 4, the upper rolled roller 3 and the lower rolled roller 4 are formed into a cavity to match the shape of the target special-shaped steel, the steel is rolled into the desired shape when passing through the aforesaid cavity.

[0004] The thickness B1 of the right-angled trapezoid area 1 is the same as its width H1 in most forklift beam section steels with different specifications., therefore, the special-shaped steel rolling mill only needs to make the width H and the thickness B of the rectangular area 2 of the forklift beam section steel adjustable, which means the special-shaped steel rolling mill can be universally used for most forklift beam section steels with different specifications. However, in the prior art, the forklift beam section steel rolled by the special-shaped steel rolling mill using the aforesaid upper rolled roller 3 and lower rolled roller 4 has a small adjustment range for the width H and thickness B of the rectangular area, which leads to the low production efficiency and the large roll investment in the production of the multi-specification forklift beam section steel in the workshop. And when the rolls are worn, the rolls can only be replaced, the consumption of the rolls is large, which further increases the cost.

[0005] Therefore, it is necessary to provide an improved technical solution against the deficiencies of the above-mentioned prior art.

SUMMARY

[0006] The purpose of the present invention is to overcome the problems of the low production efficiency and the high cost of the special-shaped steel rolling mill train in the aforesaid prior art.

[0007] In order to achieve the above object, the present invention provides the following technical solutions: a roll assembly for rolling a special-shaped steel, including:

an upper roll, a lower roll, a left roll and a right roll, the left roll has a left forming surface, the right roll has a right forming surface, the upper roll has an upper forming surface, the lower roll has a lower forming surface. The left forming surface, the right forming surface, the upper forming surface and the lower forming surface together enclose a cavity; the upper roll and the lower roll can respectively move along an up-down direction; the left roll and the right roll can respectively move along a left-right direction. Furthermore, at least one of the left forming surface and the right forming surface is a non-planar surface.

[0008] Furthermore, the left forming surface is a non-planar surface, the left forming surface includes a first plane, a second plane and an inclined plane; The first plane and the second plane are parallel and extend along the up-down direction, the inclined plane connects the first plane and the second plane. Furthermore, a movement space is formed between the left roll and the right roll, the upper roll and the lower roll move up and down in the movement space.

[0009] Furthermore, the second plane is located at the lower left of the first plane, the lower roll moves in the space between the second plane and the right roll. a rolling mill train, the rolling mill train comprises at least two rolling mills, the rolling mill comprises a stand and a roll assembly provided on the stand; including: an upper roll, a lower roll, a left roll and a right roll, the left roll has a left forming surface, the right roll has a right forming surface, the upper roll has an upper forming surface, and the lower roll has a lower forming surface. The left forming surface, the right forming surface, the upper forming surface and the lower forming surface together enclose a cavity;

The upper roll and the lower roll can respectively move along the up-down direction;

[0010] The left roll and the right roll can respectively move along the left-right direction. Furthermore, at least one of the left forming surface and the right forming surface is a non-planar surface.

[0011] Furthermore, the left forming surface is a non-planar surface, the left forming surface includes a first plane, a second plane and an inclined plane; The first plane and the second plane are parallel and extend along the up-down direction, the inclined plane

connects the first plane and the second plane. Furthermore, a movement space is formed between the left roll and the right roll, the upper roll and the lower roll move up and down in the movement space.

[0012] Furthermore, the second plane is located at the lower left of the first plane, the lower roll moves in the space between the second plane and the right roll.

[0013] Furthermore, the rolling mills are arranged in sequence on the rolling production line; There is a difference in the distance between the left forming surface and the right forming surface of the roll assemblies of each of the rolling mills, and one of the rolling mills is selected to be put into the rolling work during the steel rolling.

[0014] Furthermore, the number of the rolling mills in the rolling mill train is no more than five.

Compared with the closest prior art, the technical solution provided by the present invention has at least the following excellent effects:

[0015]

- 1) Can be applied to the special-shaped steels with similar shapes but different sizes, and when the cavity wall of the cavity is worn, it can be replenished online, without the need of stopping production and disassembling the rolls, which ensures the production efficiency and saves the purchasing expense of the rolls.
- 2) At least one of the left forming surface and the right forming surface is a non-planar surface, which can be better adapted to the rolling of the special-shaped steel.
- 3) Can be adapted to the rolling of the forklift beam section steel.
- 4) When the inclined surface is worn, it can be adjusted online too.
- 5) The support force received by the special-shaped steel is dispersed to the lower forming surface with a larger area, which reduces the wear speed of the lower forming surface.
- 6) When rolling different shapes of special-shaped steels, it is required to switch the rolling mill instead of the rolling mill production line, which has a smaller floor space, fast switching speed and high production efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a structural schematic diagram of the forklift beam section steel;
FIG. 2 is a structural schematic diagram of a roll assembly of a rolling mill train in the prior art;
FIG. 3 is a structural schematic diagram of a roll assembly in a specific embodiment of the rolling mill

train of the present invention.

[0017] In the figures: 1, right-angled trapezoidal part; 2, rectangular part; 3, upper rolled roller; 4, lower rolled roller; 5, upper roll; 51, upper forming surface; 6, lower roll; 61, lower forming surface; 7, left forming surface; 71, first plane; 72, second plane; 73, inclined plane; 8, right roll; 81, right forming face; 9, left roll.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] The technical solutions in the embodiments of the present invention will be clearly and completely described below. Obviously, the described embodiments are only a part of the embodiments of the present invention, rather than the all embodiments. Based on the embodiments in the present invention, all other embodiments obtained by those of ordinary skill in the art fall within the protection scope of the present invention.

[0019] The present invention will be described in detail below with reference to the attached drawings and in conjunction with the embodiments. It should be noted that the embodiments of the present invention and the features of the embodiments may be combined with each other in the absence of conflict.

[0020] The specific embodiment of the rolling mill train of the present invention: the rolling mill train is used for the rolling of a special-shaped steel, includes at least two rolling mills, the number of the rolling mills can be adjusted according to the type and the specification of the special-shaped steel to be rolled through the rolling production line, it is preferable to set up three to five rolling mills in each rolling mill train. There is difference in the distance between the left forming surface 7 and the right forming surface 81 in the roll assembly of each rolling mill, one of the rolling mills is selected to be put into the rolling work during steel rolling.

[0021] The rolling mill includes a stand and a roll assembly provided on the stand for rolling a special-shaped steel (hereinafter referred to as a roll assembly). The roll assembly includes an upper roll 5, a lower roll 6, a left roll 9 and a right roll 8, the left roll 9 has a left forming surface 7, the right roll 8 has a right forming surface 81, the upper roll 5 has an upper forming surface 51, the lower roll 6 has a lower forming surface 61, the left molding surface 7, the right molding surface 81, the upper molding surface 51 and the lower molding surface 61 together enclose a cavity; the upper roll 5, the lower roll 6 can respectively move along an up-down direction, the left roll 9 and the right roll 8 can respectively move along a the left-right direction. According to the different shapes of the target special-shaped steel, the roll assemblies with different forming surfaces are selected, the cavities enclosed by different roll assemblies are different, that is, the shapes of the forming surfaces of the upper roll 5, the lower roll 6, the left roll 9 and the right roll 8 are different, there are as many sets of roll assemblies as there are many shapes of special-shaped steels, the present

invention cannot give examples one by one, the rolling steel assembly for rolling a forklift beam section steel is taken as an example for description.

[0022] As shown in FIG. 3, a movement space is formed between the left roll 9 and the right roll 8, the upper roll 5 and the lower roll 6 move up and down in the movement space. The left forming surface 7 is a non-planar surface, the left forming surface 7 includes a first plane 71, a second plane 72 and an inclined plane 73; the first plane 71 and the second plane 72 are parallel and extend along the up-down direction, the inclined plane 73 connects the first plane 71 and the second plane 72. The second plane 72 is located at the lower left of the first plane 71, the lower roll 6 moves in the space between the second plane 72 and the right roll 8, that is, the cavity wall of the cavity has a roll groove, the shape of the roll groove is a right-angled trapezium, which is enclosed by the inclined plane 73, a part of the second plane 72 and a part of the lower forming surface 61.

[0023] The cross-sectional shape of the cavity corresponds to that of the forklift beam section steel, includes a right-angled trapezoid area and a rectangular area, the boundary of the right-angled trapezoidal area is defined by a part of the second plane 72, the inclined plane 73 and a part of the lower forming surface 61. The boundary of the rectangular area is defined by the upper forming surface 51, a part of the lower forming surface 61, the left forming surface 7 and a part of the first plane 71.

[0024] When the roll assembly is worn, it can be compensated online, in particularly:

if the upper forming surface 51 is worn by 1mm, the upper forming surface 51 will be caused to move up by 1mm, the thickness B of the final rolled product will be 1mm thicker than the standard, at this time, the 1mm wear of the upper forming surface 51 can be compensated just by moving the upper roll 5 downward by 1mm, the thickness B of the rectangular part 2 of the forklift beam section steel is controlled to return to the standard size, so that there is no need to stop rolling and remove the roll assembly for cavity repair, rather, the roll assembly can be adjusted online without affecting the subsequent continuous rolling. When the size of the rolled piece exceeds the standard due to the wear of the cavity, the position of the upper roll 5 can be adjusted again to compensate the wear.

if the lower forming surface 61 is worn by 1mm, the lower forming surface 61 will be caused to move down by 1mm, the thicknesses B and B_1 of the final rolled products will be 1mm thicker than the standard, at this time, the 1mm wear of the lower forming surface 61 can be compensated just by moving the lower horizontal roll 1 upward by 1mm, the thickness B of the rectangular part 2 and B_1 of the right-angled trapezoid part 1 of the forklift beam section steel are controlled to return to the standard size, so that there is no need to stop rolling and remove the roll assembly

for cavity repair, rather, the roll assembly can be adjusted online without affecting the subsequent continuous rolling. When the size of the rolled piece exceeds the standard again due to the wear of the cavity, the position of the lower roll can be adjusted again to compensate the wear.

if the right forming surface 81 is worn by 1mm, the width H of the final rolled product will be 1mm larger than the standard, at this time, the 1mm wear of the right roll 8 can be compensated just by moving the right roll 8 to the left by 1mm (or by moving the left roll 9 to the right by 1mm), the width H of the rectangular part 2 of the forklift beam section steel is controlled to return to the standard size, so that there is no need to stop rolling and remove the roll assembly for cavity repair, rather, the roll assembly can be adjusted online without affecting the subsequent continuous rolling. When the size of the rolled piece exceeds the standard again due to the wear of the cavity, the position of the right roll 8 or the left roll 9 can be adjusted again to compensate the wear.

if the first plane 71, the second plane 72 and the inclined plane 73 are all worn by 1mm, the width H of the final rolled product will be 1mm larger than the standard, at this time, the 1mm wear of the first plane 71, the second plane 72 and the inclined plane 73 can be compensated just by moving the left roll 9 to the right by 1mm (or by moving the right roll 8 to the left by 1mm), the width H of the rectangular part 2 of the forklift beam section steel is controlled to return to the standard size, so that there is no need to stop rolling and remove the roll assembly for cavity repair, but the roll assembly can be adjusted online without affecting the subsequent continuous rolling. When the size of the rolled piece exceeds the standard again due to the wear of the cavity, the position of the left roll 9 or the right roll 8 can be adjusted again to compensate the wear.

if the inclined plane 73 is worn by 1mm, the thickness B_1 of the final rolled product will be 1mm larger than the standard, at this time, the 1mm wear of the inclined plane 73 can be compensated just by moving the upper roll 5 and the lower roll 6 upward by 1mm simultaneously, the thickness B_1 of the right-angled trapezoid part 1 of the forklift beam section steel is controlled to return to the standard size, so that there is no need to stop rolling and remove the roll assembly for cavity repair, rather, the roll assembly can be adjusted online without affecting the subsequent continuous rolling. When the B_1 size of the rolled piece exceeds the standard again due to the wear of the cavity, the positions of the upper roll 5 and the lower roll 6 can be adjusted again simultaneously to compensate the wear of the inclined plane 73.

[0025] At the same time, when it is necessary to roll forklift beam section steels with the same size of the right-angled trapezoid areas and different widths H and thick-

nesses B of the rectangular areas, the rolling production can be realized by the intervention of replacing with other rolling mills in the rolling mill train (the upper forming surface 51 and the lower forming surface 61 of the roll assembly of the replaced rolling mill match with the width H of the target forklift beam section steel), which has a simple structure and a low cost. When rolling several types of forklift beam section steels with little difference in size, the size of the corresponding part of the cavity can be adjusted by controlling the positions of the upper roll 5, the lower roll 6, the left roll 9 and the right roll 8, so as to be adapted to the target dimensions of each part of the forklift beam section steel. The upper roll 5 is moved downward, the lower roll 6 is moved upward, or both actions are performed simultaneously (the adjustment range is larger when the two actions are performed simultaneously) to reduce the thickness B of the rectangular area. The upper roll 5 moves upward, the lower roll 6 moves downward, or both actions are performed simultaneously (the adjustment range is larger when the two actions are performed simultaneously) to increase the thickness B of the rectangular area, wherein, the upward and downward movement of the lower roll 6 not only affect the thickness B of the rectangular area but also affect the thickness B₁ of the right-angled trapezoid area. The left roll 9 is moved to the right, the right roll 8 is moved to the left, or both actions are performed simultaneously to reduce the width H of the rectangular area. The left roll 9 is moved to the left, the right roll 8 is moved to the right, or both actions are performed simultaneously to increase the width of the rectangular area. The upper roll 5 and the lower roll 6 may move up simultaneously by a same stroke to reduce the thickness B₁ of the rectangular area, without changing the thickness B of the rectangular area. The upper roll 5 and the lower roll 6 may move down simultaneously by a same stroke to increase the thickness B₁ of the rectangular area, without changing the thickness B of the rectangular area.

[0026] The specific embodiment of the roll assembly for rolling the special-shaped steel of the present invention has the same structure as that in the specific embodiment of the above-mentioned rolling mill train, and will not be repeated again.

[0027] Conclusively, in comparison with the prior art, the roll assembly and the steel rolling stand for rolling the special-shaped steel adopted in the present invention have the following technical effects:

- 1) Can be applied to the special-shaped steels with similar shapes but different sizes, and when the cavity wall of the cavity is worn, it can be compensated online, without the need to stop production and disassemble the rolls, which ensures the production efficiency and saves the purchase cost of the roll.
- 2) At least one of the left forming surface and the right forming surface is a non-planar surface, which can be better adapted to the rolling of the special-shaped steel.

3) Can be adapted to the rolling of the forklift beam section steel.

4) When the inclined surface is worn, it can be adjusted online too.

5) The support force received by the special-shaped steel is dispersed to the lower forming surface with a larger area, which reduces the wear speed of the lower forming surface.

6) When rolling different shapes of special-shaped steels, it is required to switch the rolling mill instead of the rolling mill production line, which has a smaller floor space, fast switching speed and high production efficiency.

[0028] The above contents are only preferred embodiments of the present invention, and are not intended to limit the present invention. Any modifications, equivalent replacements, improvements, etc. made within the spirit and principles of the present invention fall within the protection scope of the pending claims of the present invention.

Claims

1. A roll assembly for rolling a special-shaped steel, its characteristic is that, including:

an upper roll, a lower roll, a left roll and a right roll, the left roll has a left forming surface, the right roll has a right forming surface, the upper roll has an upper forming surface, the lower roll has a lower forming surface, the left forming surface, the right forming surface, and the upper forming surface and the lower forming surface together enclose a cavity;
the upper roll and the lower roll can respectively move along an up-down direction;
the left roll and the right roll can respectively move along a left-right direction.

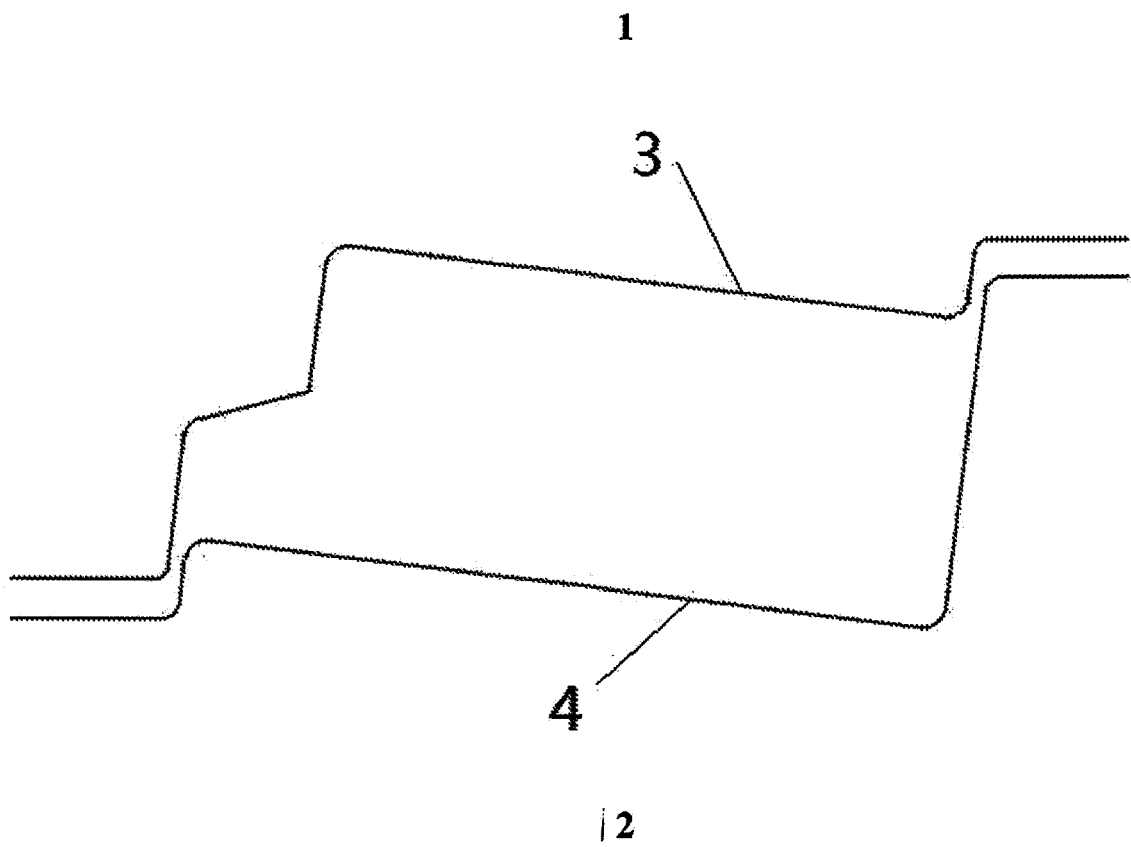
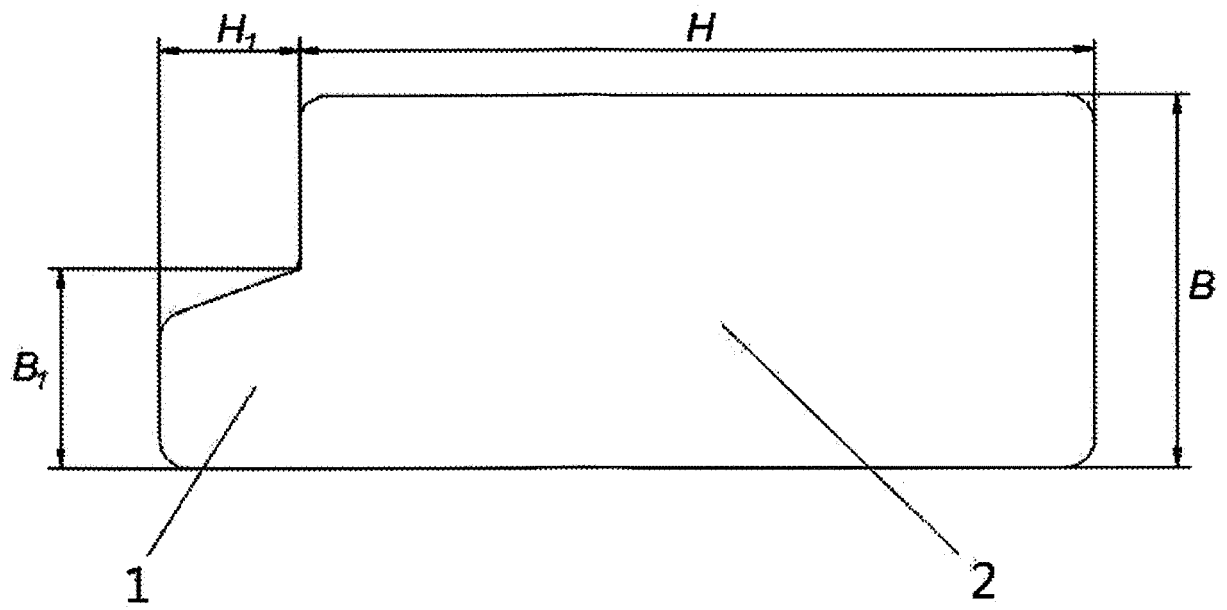
2. The roll assembly for rolling a special-shaped steel according to claim 1, its characteristic is that, at least one of the left forming surface and the right forming surface is a non-planar surface.

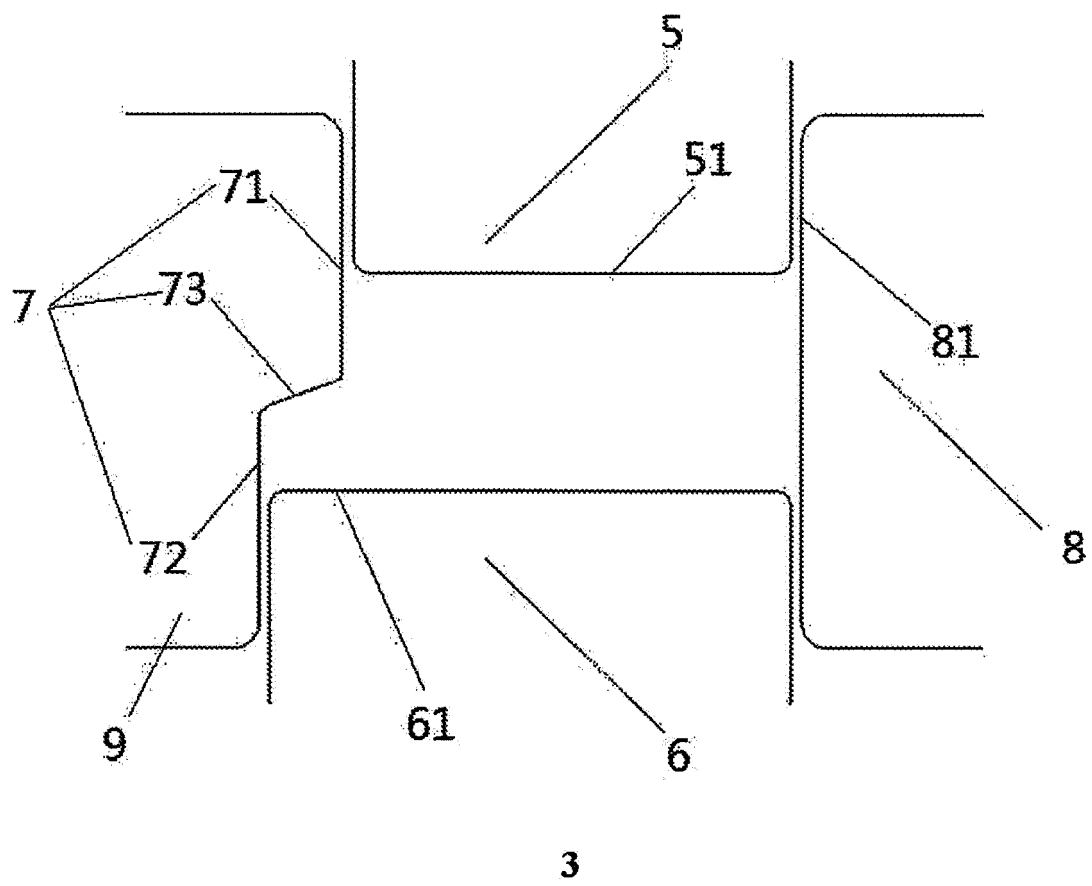
3. The roll assembly for a rolling special-shaped steel according to claim 2, its characteristic is that, the left forming surface is a non-planar surface, the left forming surface includes a first plane, a second plane and an inclined plane;
the first plane and the second plane are parallel and extend along the up-down direction, the inclined plane connects the first plane and the second plane.

4. The roll assembly for rolling a special-shaped steel according to claim 3, its characteristic is that, a movement space is formed between the left roll and the

right roll, the upper roll and the lower roll move up and down in the movement space.

5. The roll assembly for rolling a special-shaped steel according to claim 4, its characteristic is that, the second plane is located at the lower left of the first plane, the lower roll moves in the space between the second plane and the right roll. 5
6. A rolling mill train, its characteristic is that, the rolling mill train comprises at least two rolling mills, the rolling mill comprises a stand and a roll assembly provided on the stand; the roll assembly is that for rolling a special-shaped steel according to any of claims 1-5. 10 15
7. The rolling mill train according to claim 6, its characteristic is that, the rolling mills are arranged in sequence on the rolling production line; there is a difference in the distance between the left forming surface and the right forming surface in the roll assembly of each of the rolling mills, one of the rolling mills is selected to be put into the rolling work during the steel rolling. 20 25
8. The rolling mill train according to claim 6, its characteristic is that, the number of the rolling mills in the rolling mill train is no more than five. 30 35 40 45 50 55





INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/118826

A. CLASSIFICATION OF SUBJECT MATTER

B21B 1/08(2006.01)i; B21B 27/02(2006.01)i

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 practicable, search terms used)

CNABS, CNKI, DWPI, SIPOABS: 异型钢, 轧辊, 四辊, 轧制, 叉车横梁, deformed, shaped, section, steel, roller?, roll+, four, forklift, beam

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 113042524 A (SHANDONG IRON AND STEEL COMPANY LTD.) 29 June 2021 (2021-06-29) see description, paragraphs [0006]-[0060], and figures 1-3	1-8
E	CN 214767783 U (SHANDONG IRON AND STEEL COMPANY LTD.) 19 November 2021 (2021-11-19) see description, paragraphs [0006]-[0060], and figures 1-3	1-8
E	CN 113560341 A (SHANDONG IRON AND STEEL CO., LTD.) 29 October 2021 (2021-10-29) see description, paragraphs [0005]-[0061], and figure 1	1-2
X	CN 107824613 A (SHANDONG IRON AND STEEL CO., LTD.) 23 March 2018 (2018-03-23) see description, paragraphs [0005]-[0026], and figure 1	1-8
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A	CN 1986089 A (HUAQIANG RAILWAY EQUIPMENT CO.) 27 June 2007 (2007-06-27) see entire document	1-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

23 December 2021

Date of mailing of the international search report

26 January 2022

Name and mailing address of the ISA/CN

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100088, China

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/118826

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2619520 A1 (UNIMETAL SA) 24 February 1989 (1989-02-24) see entire document	1-8

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/118826

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CN 113042524 A	29 June 2021	None	
CN 214767783 U	19 November 2021	None	
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