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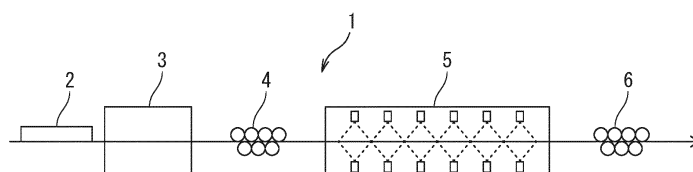
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(54) **MANUFACTURING EQUIPMENT AND MANUFACTURING METHOD FOR STEEL PLATE**

(57) To provide manufacturing equipment and a manufacturing method for a steel plate capable of performing more uniform cooling during heat treatment of the steel plate and manufacturing a flat and homogeneous steel plate. Manufacturing equipment (heat treatment equipment (1)) for a steel plate (2) according to an aspect of the present invention is manufacturing equipment for a steel plate (2), in which the steel plate (2) is

heat-treated, the equipment including a heating furnace (3) configured to heat the steel plate (2) having a temperature of 100°C or lower, a first flattening device (4) configured to flatten the heated steel plate (2), a quenching device (5) configured to quench the flattened steel plate (2), and a second flattening device (6) configured to flatten the quenched steel plate (2).

FIG. 1



Description

Technical Field

5 **[0001]** The present invention relates to manufacturing equipment and a manufacturing method for a steel plate.

Background Art

10 **[0002]** In manufacturing a steel plate, cooling from a high temperature is often performed to adjust mechanical properties such as strength. Cooling is roughly divided into an online water cooling method and an offline water cooling method. In the online water cooling method, the steel plate after hot rolling is water-cooled by using a water cooling device connected online. In the offline water cooling method, the rolled material is once cooled to room temperature, and then heated and water-cooled again in a heat treatment furnace connected offline. In terms of energy cost, the online water cooling method is advantageous, but since the steel plate is likely to warp or the like during rolling, it is not possible to dispose a cooling device near the rolling mill. As a result, since the temperature drops during transportation to the cooling device after rolling, there is a problem that water cooling cannot be performed at an appropriate temperature.

15 **[0003]** On the other hand, the offline water cooling method is advantageous for adjusting the mechanical properties because the cooling device is disposed on the outlet side of the heating furnace and quenching can be performed from a temperature substantially equal to the heating temperature.

20 **[0004]** In general, a hot-rolled steel plate is likely to have temperature unevenness during cooling due to differences in the temperature distribution, shape, or surface condition of the steel plate immediately after rolling. Furthermore, the temperature unevenness of the steel plate may be caused by the performance of the cooling device. When the temperature unevenness of the steel plate occurs, deformation of the steel plate, residual stress, material variation, and the like occur after cooling. As a countermeasure, various cooling devices capable of uniform cooling have been developed. However, 25 the method developed is only an improvement of the cooling device, and in particular, flattening of the steel plate after cooling is not completely achieved. Poor shape of the steel plate after cooling causes operational troubles such as a plate passage failure in the manufacturing line, and requires a precision treatment by a press or a flattening device in a subsequent step, resulting in high cost.

30 **[0005]** There are two types of temperature unevenness of the steel plate, one is due to the design of the cooling nozzle and the other is due to the shape of the steel plate during rolling. Depending on the design of a cooling nozzle, temperature deviation on the upper and lower surfaces and temperature non-uniformity in the width direction may occur. On the other hand, when the shape of the steel plate during rolling is poor, the cooling water does not flow evenly on the steel plate, and the cooling capacity changes depending on the location, resulting in temperature unevenness.

35 **[0006]** Here, many technologies are known as a method for suppressing temperature unevenness caused by a cooling nozzle such as temperature deviation on the upper and lower surfaces and uniformity in the width direction. On the other hand, there are not so many technologies for suppressing the temperature unevenness generated from the shape defect generated during rolling, and as a corresponding technology, a method of performing flattening in front of an accelerated cooling device to flatten the shape and ensure uniformity during cooling (PTLs 1 and 2) is known. In PTLs 1 and 2, it is an object of a first flattening device to flatten the shape of a steel plate to such an extent that draining can be sufficiently 40 performed by a draining roll in a cooling device.

Citation List

Patent Literature

45 **[0007]**

PTL 1: JP 2002-11515 A

50 PTL 2: JP 2005-74480 A

Summary of Invention

Technical Problem

55 **[0008]** Incidentally, in recent years, an increasing number of manufacturing lines are actually operating technologies such as those described in PTLs 1 and 2 in which an online flattening device is installed in front of a cooling device. However, in the first place, in hot rolling, the temperature deviation is large in principle due to descaling during rolling

and water cooling for temperature adjustment, and the temperature deviation generated in the plate surface is a difference in the heat shrinkage amount. Therefore, even when the shape is flattened in hot rolling, there is a problem that the shape is deformed again when the temperature drops.

[0009] Furthermore, PTLs 1 and 2 propose an online process of flattening with a first flattening device, accelerated cooling, and then final flattening with a second flattening device. However, no matter which technology is used alone, a large effect cannot be obtained on the generation of temperature unevenness caused by the cooling nozzle and the cooling strain caused by the temperature unevenness, such as the temperature deviation on the upper and lower surfaces and the uniformity in the width direction described above.

[0010] The offline heat treatment equipment in the related art is disposed in the order of a heating furnace, a quenching device, and a flattening device. The quenching device cools to 100°C or less, and even when the cooling uniformity is not ensured, the final cooling stop temperature of the steel plate is constant because it is cooled to a low temperature close to the water temperature of the cooling water. Therefore, the uniformity of cooling was not considered. In recent years, there is an increasing need to reduce the variation in cooling rate within the plate surface during quenching from the viewpoint of quality improvement, and it is important to perform uniform cooling by offline heat treatment that can ensure temperature uniformity before quenching. Furthermore, even in the offline heat treatment, cooling may be completed at a temperature higher than room temperature such as 100°C or higher. In that case, when the cooling is not uniform, since the temperature of the steel plate after cooling also varies, not only the predetermined quality cannot be ensured, but also the steel plate is distorted due to the difference in thermal expansion in the plane of the steel plate temperature.

[0011] The present invention has been made in view of such circumstances, and it is an object of the present invention to provide manufacturing equipment and a manufacturing method for a steel plate capable of performing more uniform cooling during heat treatment of the steel plate and manufacturing a flat and homogeneous steel plate.

Solution to Problem

[0012] According to an aspect of the present invention, there is provided manufacturing equipment for a steel plate, in which the steel plate is heat-treated, the equipment including a heating furnace configured to heat the steel plate having a temperature of 100°C or lower, a first flattening device configured to flatten the heated steel plate, a quenching device configured to quench the flattened steel plate, and a second flattening device configured to flatten the quenched steel plate.

[0013] According to another aspect of the present invention, there is provided a manufacturing method for a steel plate, in which the steel plate is heat-treated, the method including a heating step of heating the steel plate having a temperature of 100°C or lower, a first flattening step of flattening the steel plate after the heating, a quenching step of quenching the steel plate after the first flattening step, and a second flattening step of flattening the steel plate after the quenching.

Advantageous Effects of Invention

[0014] According to an aspect of the present invention, there is provided manufacturing equipment and a manufacturing method for a steel plate capable of performing more uniform cooling during heat treatment of the steel plate and manufacturing a flat and homogeneous steel plate.

Brief Description of Drawings

[0015]

FIG. 1 is a schematic configuration diagram of heat treatment equipment which is manufacturing equipment for a steel plate according to an embodiment of the present invention; and

FIG. 2 is a perspective view illustrating a detailed configuration of a first flattening device and a quenching device.

Description of Embodiments

[0016] Hereinafter, an embodiment of the present invention will now be described with reference to the drawings. The embodiment illustrated below exemplifies a device and a method for embodying the technical idea of the present invention, and the technical idea of the present invention does not specify the material, shape, structure, arrangement, and the like of the component parts in the following embodiment. In addition, the drawings are schematic. Therefore, it is required to be noted that a relationship, ratio, and the like between a thickness and a plane dimension are different from the actual ones, and there are parts where the relationship and ratio of the dimensions are different between the drawings.

(Manufacturing Equipment for Steel Plate)

[0017] FIG. 1 illustrates a schematic configuration of heat treatment equipment 1 for a steel plate 2, which is manufacturing equipment for a steel plate according to an embodiment of the present invention, and FIG. 2 illustrates a detailed configuration of each of a first flattening device 4 and a quenching device 5 in the present embodiment. In the present embodiment, to secure a uniform temperature and shape, the main focus is on adjusting the mechanical properties of the material with offline heat treatment equipment that is not directly connected to a rolling line, and the heat treatment equipment 1 is not directly connected to the rolling line. The heat treatment equipment 1 is equipment for heat-treating the steel plate 2, and is provided with a heating furnace 3, the first flattening device 4, the quenching device 5, and a second flattening device 6. In addition, as illustrated in FIG. 1, in the heat treatment equipment 1, the heating furnace 3, the first flattening device 4, the quenching device 5, and the second flattening device 6 are disposed in this order from the upstream side in the transport direction of the steel plate 2. Furthermore, a transport roller (not illustrated) for transporting the steel plate 2 is provided between each of the heating furnace 3, the first flattening device 4, the quenching device 5, and the second flattening device 6.

[0018] The heating furnace 3 heats the steel plate 2 having a temperature of 100°C or lower after hot rolling to the austenite temperature range. The steel plate 2 has a plate thickness of 4.0 mm or more.

[0019] The first flattening device 4 is a device for flattening the steel plate 2 heated in the heating furnace 3, and is provided between the heating furnace 3 and the quenching device 5. As the first flattening device 4, a reduction type skin pass flattening device or a repeatedly bending type roller leveler flattening device can be used. In addition, for the reason described later, it is preferable to use the roller leveler flattening device for the first flattening device 4. Furthermore, for the reason described later, in a case where the roller leveler flattening device is used, it is more preferable to further provide a press type flattening mechanism or the like capable of correcting the warp of a tip tail end portion of the steel plate 2.

[0020] Here, the temperature of the steel plate 2 drops from the time when the steel plate 2 is extracted from the heating furnace 3 to the time when the steel plate 2 reaches the first flattening device 4. The smaller the temperature drop, the smaller the increase in the deformation resistance of the steel plate 2, and the shape can be flattened with a small flattening force. Therefore, it is preferable that the distance from the heating furnace 3 to the first flattening device 4 is 4 m or less. Furthermore, the first flattening device 4 is preferably small in size and has a small installation space to shorten the transport time from the heating furnace 3 to the quenching device 5. In addition, in the first flattening device 4, it is preferable to use a flattening device having a lower load capacity than that of the second flattening device 6 to flatten the steel plate 2 having a relatively low deformation resistance during heat. The first flattening device 4 may have a load capacity of at least 500 tons, and preferably approximately 3000 tons. In the present embodiment, ton indicates metric ton.

[0021] The quenching device 5 is a device for quenching the steel plate 2 shape-flattened by the first flattening device 4 by water cooling. As illustrated in FIG. 2, the quenching device 5 includes an upper cooling nozzle 51 and a lower cooling nozzle 52 as a device for rapidly cooling the steel plate 2 after flattening. A plurality of upper cooling nozzles 51 and a plurality of lower cooling nozzles 52 are provided in the width direction of the steel plate 2 in pairs in the vertical direction with respect to the transport line, and are arranged at a plurality of locations side by side at a predetermined pitch along the transport direction of the steel plate 2. Cooling water 53 is sprayed toward the steel plate 2 from each of the cooling nozzles of the upper cooling nozzles 51 and the lower cooling nozzles 52. In addition, in the quenching device 5, each of restraint rolls 50 may be installed before and after the upper cooling nozzle 51 and the lower cooling nozzle 52. By providing the restraint roll 50, even when the steel plate 2 is distorted due to cooling unevenness or the like, since the steel plate 2 can be restrained to some extent, out-of-plane deformation can be prevented.

[0022] The second flattening device 6 is a device for flattening the steel plate 2 quenched by the quenching device 5, and is provided on the outlet side of the quenching device 5 (downstream side in the transport direction of the steel plate 2). As the second flattening device 6, a reduction type skin pass flattening device, a repeatedly bending type roller leveler flattening device, or a press type flattening device can be used. In addition, for the same reason as the first flattening device 4, it is preferable to use a roller leveler flattening device for the second flattening device 6. Furthermore, for the same reason as that of the first flattening device 4, in a case where the roller leveler flattening device is used, it is more preferable to further provide a press type flattening mechanism or the like capable of correcting the warp of the tip tail end portion of the steel plate 2. In addition, the second flattening device 6 preferably has a high flattening reaction force in terms of performing flattening of the steel plate 2 near room temperature, and preferably has a load capacity of at least 2000 tons.

(Manufacturing Method for Steel Plate)

[0023] In the manufacturing method for a steel plate according to the present embodiment, first, a steel plate 2 having a predetermined thickness (for example, 30 mm) and width (for example, 2000 mm) is manufactured by hot rolling using

a slab or the like as a material in a hot rolling line (not illustrated) different from the heat treatment equipment 1. Next, the hot-rolled steel plate 2 is cooled to room temperature, and then the scale is removed by a surface scale removing device (not illustrated).

[0024] Furthermore, the steel plate 2 from which the scale is removed is charged into the heating furnace 3 and heated to an austenite temperature range (for example, approximately 910°C) (heating step).

[0025] Thereafter, the steel plate 2 is extracted from the heating furnace 3, is transported to the first flattening device 4 by a plurality of table rolls (not illustrated) installed on the outlet side of the heating furnace 3, and is flattened by the first flattening device 4 (first flattening step).

[0026] Here, the reason for installing the first flattening device 4 in front of the quenching device 5 (on the upstream side in the transport direction of the steel plate 2) will be described below. As described above, the steel plate 2 is hot-rolled in advance to a predetermined thickness and width on a hot rolling line different from the heat treatment equipment 1. At this time, in a case where there is a temperature deviation in the steel plate 2 during rolling, since the degree of heat shrinkage in the process of cooling to room temperature differs depending on the portion of the steel plate 2, a shape defect occurs after cooling. In the heat treatment equipment 1, since the steel plate 2 is inserted into the heating furnace 3 with the shape defect occurring, the shape defect remains even when the steel plate 2 is uniformly heated in the heating furnace 3. Even when such a steel plate 2 is extracted from the heating furnace 3 and heat-treated by the quenching device 5, the shape defect does not disappear, but rather the way the cooling water is applied is not uniform, and thus non-uniformity in temperature is promoted. Therefore, after heating in the heating furnace 3 that guarantees uniform heating, by flattening the steel plate 2 with the first flattening device 4 and cooling the steel plate 2 with the quenching device 5, it is possible to manufacture the steel plate 2 with high flatness. That is, it is necessary to flatten the shape (initial shape) of the steel plate 2 before entering the quenching device 5 to obtain the effect of the present invention.

[0027] In addition, in a case where the tip end portion of the steel plate 2 is warped, there is a risk that the steel plate 2 collides with the nozzle or the like of the quenching device 5. Therefore, the first flattening device 4 is preferably a roller leveler flattening device capable of repeated bending than a skin pass flattening device having a low flattening ability for the warp in the longitudinal direction generated at the tip tail end portion of the steel plate 2. The roller leveler flattening device is a flattening machine that repeatedly bends with a plurality of rolls (for example, four on the upper surface and three on the lower surface), and the flattening effect is relatively low at a distance corresponding to the roll pitch. Therefore, in a case where a roller leveler flattening device is used, it is more preferable to further provide a press type flattening mechanism or the like capable of correcting the warp of the tip tail end portion of the steel plate 2.

[0028] Furthermore, the temperature of the steel plate 2 when flattening the shape by the first flattening device 4 is preferably in the range of the temperature A_{r3} temperature $\pm 150^\circ\text{C}$ at which the austenite of the steel plate 2 is transformed into ferrite. By setting such a temperature, the yield stress of the steel plate 2 is sufficiently low, and the reaction force when flattening the shape can be reduced.

[0029] After the first flattening step, the steel plate 2 is quenched by the quenching device 5 (quenching step).

[0030] After the quenching step, the steel plate 2 is flattened by the second flattening device 6 (second flattening step). In quenching (cooling) by the quenching device 5, it is difficult to control the flow rates of the cooling water 53 ejected from the upper cooling nozzle 51 and the lower cooling nozzle 52 to be completely matched in the width direction. Therefore, there remains a risk of slight warpage due to temperature unevenness during quenching, and thus it is necessary to further flatten the steel plate 2 with the second flattening device 6. In addition, it is preferable that the temperature of the steel plate 2 is 100°C or lower when flattening by the second flattening device 6.

<Modification Example>

[0031] Hereinbefore, the present invention is described with reference to a specific embodiment, but it is not intended to limit the invention by these descriptions. By reference to the description of the invention, other embodiments of the present invention including various modification examples are apparent to those skilled in the art as well as the disclosed embodiment. Therefore, it is required to be understood that the embodiment of the invention described in the claims also covers embodiments including these modification examples described in the present specification alone or in combination.

[0032] For example, in the above embodiment, the steel plate 2 has a plate thickness of 4.0 mm or more, and the present invention is not limited to this example. The steel plate may have a plate thickness of less than 4.0 mm. The present invention is suitable for a steel plate having a plate thickness of 4.0 mm or more, and is more suitable for a steel plate having a plate thickness of 6.0 mm or more.

<Effect of Embodiment>

[0033] (1) Manufacturing equipment (heat treatment equipment 1) for a steel plate according to an aspect of the present

invention is manufacturing equipment for a steel plate, in which the steel plate is heat-treated, and includes the heating furnace 3 configured to heat the steel plate having a temperature of 100°C or lower, the first flattening device 4 configured to flatten the heated steel plate, the quenching device 5 configured to quench the flattened steel plate, and the second flattening device 6 configured to flatten the quenched steel plate.

[0034] According to the above configuration of (1), by flattening the steel plate with the first flattening device 4, cooling when quenching can be made uniform. Therefore, the steel plate can be made flat and homogeneous. In addition, by flattening the steel plate with the second flattening device 6 after quenching, the finally manufactured steel plate can be flattened even in a case where the cooling of the quenching device 5 is uneven.

[0035] (2) In the above configuration of (1), the load capacity of the first flattening device 4 is lower than the load capacity of the second flattening device 6.

[0036] According to the above configuration of (2), the load capacity can be optimized according to the difference in deformation resistance due to the difference in the temperature of the steel plate, and since the first flattening device 4 does not use a flattening device with a high load capacity, the initial equipment introduction cost is low.

[0037] (3) In the above configuration of (1) or (2), the temperature of the steel plate is in the range of Ar₃ temperature $\pm 150^\circ\text{C}$ when the steel plate is flattened by the first flattening device 4.

[0038] According to the above configuration of (3), the yield stress of the steel plate is sufficiently low, and the reaction force when flattening the shape can be reduced.

[0039] (4) In any one of the above configurations (1) to (3), a temperature of the steel plate is 100°C or lower when the steel plate is flattened by the second flattening device 6.

[0040] According to the above configuration of (4), since the flattening temperature is substantially room temperature, and after flattening, re-deformation due to heat shrinkage due to a further temperature drop does not occur, a good shape can be obtained.

[0041] (5) In any one of the above configurations (1) to (4), the first flattening device 4 and the second flattening device 6 are roller leveler flattening devices.

[0042] According to the above configuration of (5), it is possible to flatten the warp at the tip tail end portion of the steel plate. Therefore, it is possible not only to suppress the warp of the steel plate itself, but also to prevent contact with equipment such as a cooling nozzle constituting the quenching device 5 when quenching.

[0043] (6) In any one of the above configurations (1) to (5), the quenching device quenches the steel plate by water cooling.

[0044] (7) A method for manufacturing a steel plate according to another aspect of the present invention is a manufacturing method for a steel plate, in which the steel plate is heat-treated, and includes a heating step of heating the steel plate 2 having a temperature of 100°C or lower, a first flattening step of flattening the steel plate after the heating, a quenching step of quenching the steel plate after the first flattening step, and a second flattening step of flattening the steel plate after the quenching.

[0045] (8) In the above configuration of (7), in the first flattening step, a temperature of the steel plate when flattening is in the range of Ar₃ temperature $\pm 150^\circ\text{C}$.

[0046] (9) In the above configuration of (7) or (8), in the second flattening step, a temperature of the steel plate is 100°C or lower.

[0047] According to the above configurations (7) to (9), the same effects as those of the above configurations (1), (3), and (4) can be obtained.

Example

[0048] The examples performed by the present inventors will be described. In the examples, in the heat treatment equipment 1 illustrated in FIG. 1, a steel plate 2 (plate thickness 6 mm, 12 mm, 25 mm, 40 mm x plate width 3500 mm x plate length 7 m) in a room temperature state from which scale was removed by shot blasting in advance was heated in the heating furnace 3 to 900°C in a nitrogen atmosphere. Next, the heated steel plate 2 was extracted, the steel plate 2 was flattened by the first flattening device 4 (roller leveler type), and quenched to 100°C or lower by the quenching device 5. The quenched steel plate 2 was shape-flattened again by the second flattening device 6. The quenching device 5 used a spray nozzle as the cooling nozzles 51 and 52. The temperature of Ar₃ of this material was 800°C, and the temperature of the steel plate 2 when extracted from the heating furnace 3 and flattened by the first flattening device 4 was approximately 860°C.

[0049] In the examples, the shape of the steel plate when the heat treatment of the steel plate 2 was performed with the above equipment arrangement was investigated. In the investigation, when the steel plate 2 was placed on the surface plate and the amount obtained by subtracting the plate thickness from the maximum height of the steel plate 2 with respect to the surface plate surface (referred to as the amount of warpage) was measured, the results were as illustrated in Examples 1 to 4 in Table 1. The allowable value of the amount of warpage of the steel plate 2 is 5 mm or less. For all the steel plates 2 having a plate thickness of 6 mm, 12 mm, 25 mm, and 40 mm, the amount of warpage

was 5 mm or less, and the shape was good (evaluation: o).

[0050] As comparative examples, the heat treatment was performed under the condition that neither the first flattening device 4 nor the second flattening device 6 was used (Comparative Examples 1 to 4), the condition that only the second flattening device 6 was used for flattening without using the first flattening device 4 (Comparative Examples 5 to 8), and the condition that only the first flattening device 4 was used for flattening without using the second flattening device 6 (Comparative Examples 9 to 12). The shape of the steel plate for the heat-treated steel plate 2 was investigated in the same manner as in the examples. Except for the above conditions, the heat treatment was performed under the same conditions as in the examples. As illustrated in Table 1, in Comparative Examples 1 to 12, the amount of warpage was larger than 5 mm under any of the conditions, and sufficient flatness could not be obtained as a product (evaluation: ×).

[Table 1]

	Plate thickness	First flattening device	Second flattening device	Warpage height	Evaluation
	mm			mm	
Ex. 1	6	Used	Used	4	o
Ex. 2	12	Used	Used	5	o
Ex.3	24	Used	Used	3	o
Ex.4	40	Used	Used	4	o
Comp. Ex. 1	6	Not used	Not used	25	×
Comp. Ex. 2	12	Not used	Not used	20	×
Comp. Ex. 3	24	Not used	Not used	18	×
Comp. Ex. 4	40	Not used	Not used	12	×
Comp. Ex. 5	6	Not used	Used	10	×
Comp. Ex. 6	12	Not used	Used	7	×
Comp. Ex. 7	24	Not used	Used	6	×
Comp. Ex. 8	40	Not used	Used	8	×
Comp. Ex. 9	6	Used	Not used	12	×
Comp. Ex. 10	12	Used	Not used	10	×
Comp. Ex. 11	24	Used	Not used	12	×
Comp. Ex. 12	40	Used	Not used	15	×

Reference Signs List

[0051]

- 1 heat treatment equipment
- 2 steel plate
- 3 heating furnace
- 4 first flattening device
- 5 quenching device
- 50 restraint roll
- 51 upper cooling nozzle
- 52 lower cooling nozzle
- 53 cooling water
- 6 second flattening device

Claims

1. Manufacturing equipment for a steel plate, in which the steel plate is heat-treated, the equipment comprising:

a heating furnace configured to heat the steel plate having a temperature of 100°C or lower;
a first flattening device configured to flatten the heated steel plate;
a quenching device configured to quench the flattened steel plate; and
a second flattening device configured to flatten the quenched steel plate.

2. The manufacturing equipment for a steel plate according to claim 1, wherein a load capacity of the first flattening device is lower than a load capacity of the second flattening device.
3. The manufacturing equipment for a steel plate according to claim 1 or 2, wherein a temperature of the steel plate is in a range of Ar_3 temperature $\pm 150^\circ\text{C}$ when the steel plate is flattened by the first flattening device.
4. The manufacturing equipment for a steel plate according to any one of claims 1 to 3, wherein a temperature of the steel plate is 100°C or lower when the steel plate is flattened by the second flattening device.
5. The manufacturing equipment for a steel plate according to any one of claims 1 to 4, wherein the first flattening device and the second flattening device are roller leveler flattening devices.
6. The manufacturing equipment for a steel plate according to any one of claims 1 to 5, wherein the quenching device quenches the steel plate by water cooling.
7. A manufacturing method for a steel plate, in which the steel plate is heat-treated, the method comprising:
 - a heating step of heating the steel plate having a temperature of 100°C or lower;
 - a first flattening step of flattening the steel plate after the heating;
 - a quenching step of quenching the steel plate after the first flattening step; and
 - a second flattening step of flattening the steel plate after the quenching.
8. The manufacturing method for a steel plate according to claim 7, wherein in the first flattening step, a temperature of the steel plate when flattening is in a range of Ar_3 temperature $\pm 150^\circ\text{C}$.
9. The manufacturing method for a steel plate according to claim 7 or 8, wherein in the second flattening step, a temperature of the steel plate is 100°C or lower.

FIG. 1

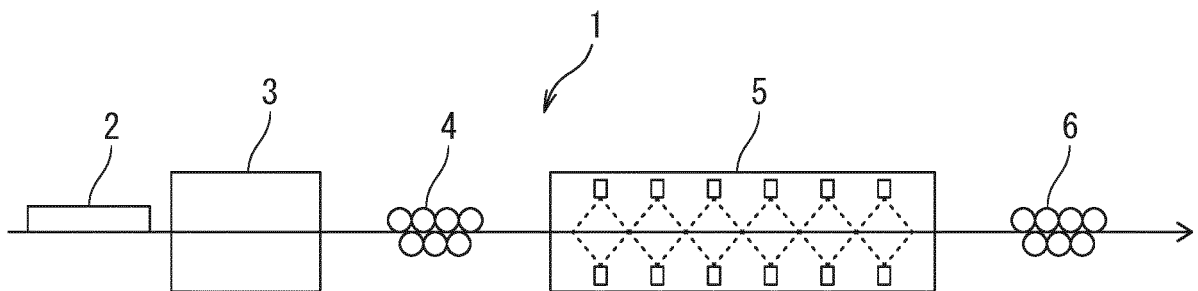
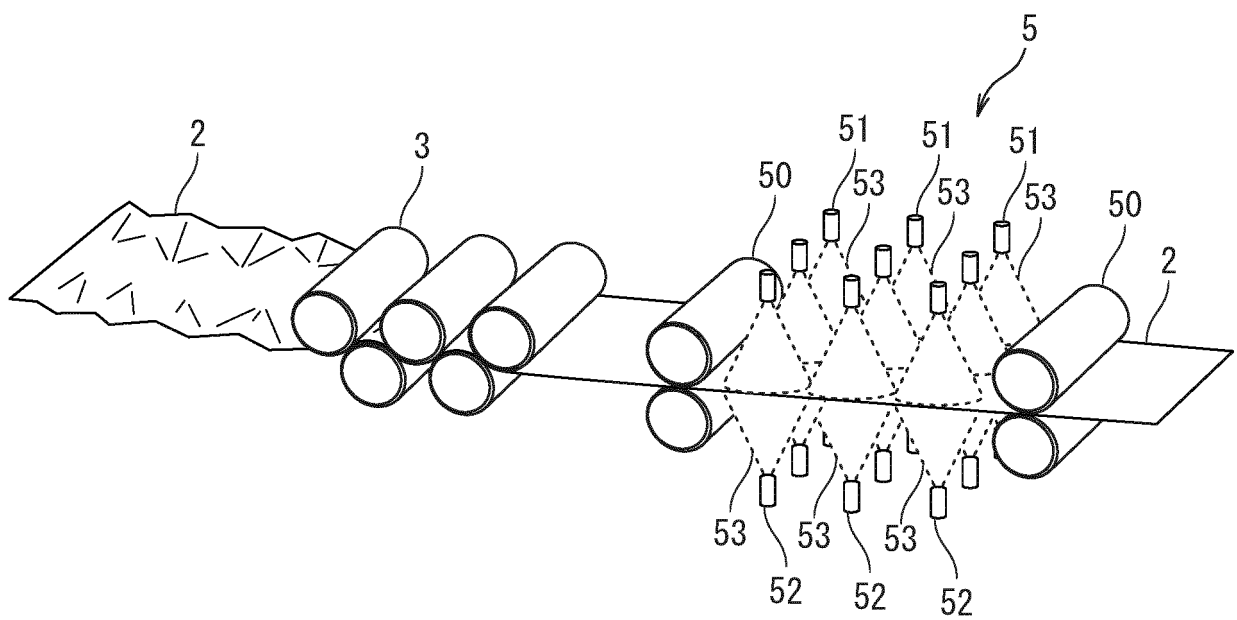


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/043061

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. B21D1/05(2006.01)i, B21B1/22(2006.01)i, B21B45/02(2006.01)i
 FI: B21D1/05A, B21B1/22H, B21D1/05G, B21B45/02320R

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)

Int.Cl. B21D1/05, B21B1/22, B21B45/02

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61-126909 A (SUMITOMO METAL INDUSTRIES, LTD.) 14 June 1986 (1986-06-14), page 1, left column, line 1 to page 5, left column, line 10, fig. 2	1-9
Y	JP 2002-11515 A (NKK CORP.) 15 January 2002 (2002- 01-15), paragraphs [0001]-[0030], fig. 1	1-9
A	JP 61-262418 A (SUMITOMO METAL INDUSTRIES, LTD.) 20 November 1986 (1986-11-20), fig. 3	1-9
A	JP 62-72430 A (SUMITOMO METAL INDUSTRIES, LTD.) 03 April 1987 (1987-04-03), fig. 1	1-9
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Further documents are listed in the continuation of Box C.



See patent family annex.

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15 December 2020

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/043061

JP 61-126909 A 14 June 1986 (Family: none)

JP 2002-11515 A 15 January 2002 (Family: none)

JP 61-262418 A 20 November 1986 (Family: none)

JP 62-72430 A 03 April 1987 (Family: none)

JP 57-116732 A 20 July 1982 (Family: none)

REFERENCES CITED IN THE DESCRIPTION

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