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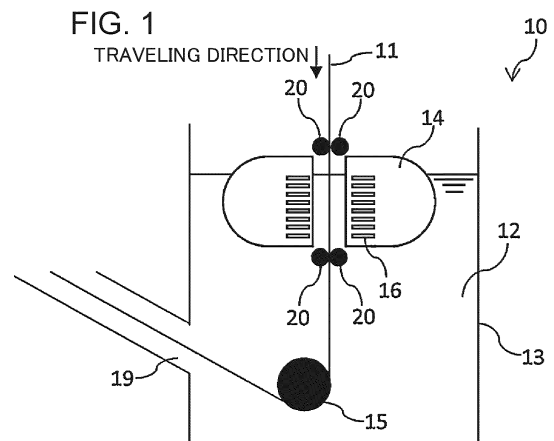
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(54) **QUENCHING DEVICE AND METAL SHEET MANUFACTURING METHOD**

(57) Provided are a quenching apparatus for a metal sheet with which it is possible to achieve sufficient cooling rate of the metal sheet when the metal sheet passes through a water-blowing device and to prevent a cooling rate from varying in accordance with the position in the metal sheet and a method for manufacturing a metal sheet by using the quenching apparatus for a metal sheet. The quenching apparatus according to the present invention is a quenching apparatus for dipping a high-temperature metal sheet in a liquid and for thereby cooling the metal sheet, the apparatus including a dipping tank for containing the liquid in which the metal sheet is dipped, a liquid-blowing device having plural nozzles for blowing a cooling liquid onto the metal sheet from both sides of the metal sheet, at least part of the liquid-blowing device being placed in the liquid contained in the dipping tank, and pairs of restraining rolls for restraining the metal sheet, each of the pairs of the restraining rolls being placed on a corresponding one of an upstream side and a downstream side in a traveling direction of the liquid-blowing device.



Description

Technical Field

5 **[0001]** The present invention relates to a quenching apparatus used to dip a high-temperature metal sheet in a liquid and thereby cool the metal sheet and to a method for manufacturing a metal sheet by using the quenching apparatus.

Background Art

10 **[0002]** When a metal sheet such as a steel sheet is manufactured, material properties are imparted by, for example, allowing phase transformation to occur by cooling the metal sheet after having heated the metal sheet in continuous annealing equipment. Nowadays, there is a growing trend in the automobile industry toward using a high tension steel sheet to simultaneously achieve weight reduction and satisfactory crash safety in automobile bodies. To address such a demand trend, there is an increase in the importance of a rapid quenching (rapid cooling) technique, which is advantageous for manufacturing a high tension steel sheet. Examples of a common water quenching method, which realizes the highest cooling rate, include a method in which cooling water is blown onto a steel sheet from quenching nozzles placed in water to perform rapid cooling when the heated hot steel sheet is dipped in water. However, when such rapid cooling is performed, there is a problem in that shape defects due to out-of-plane deformation such as warpage and wavelike deformation occur in the steel sheet.

20 **[0003]** In response to such a problem, Patent Literature 1 proposes a method in which out-of-plane deformation is inhibited by arranging a pair of restraining rolls in a quenching apparatus to restrain a metal sheet having a temperature almost within a temperature range for martensite transformation on the front- and back-surface sides of the metal sheet by using the restraining rolls.

25 **[0004]** Patent Literature 2 discloses a quenching apparatus in which a problem of a decrease in the cooling rate of a metal sheet caused by a pair of restraining rolls, which are arranged in a quenching apparatus as proposed in Patent Literature 1, is solved by using nozzles which are inclined from a horizontal plane.

[0005] Patent Literature 3 proposes a quenching apparatus in which a problem of a decrease in cooling rate in the vicinity of rolls is solved by using rolls having grooves along which cooling water is allowed to flow to eliminate stagnation of cooling water in the vicinity of the rolls.

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Citation List

Patent Literature

35 **[0006]**

PTL 1: Japanese Patent No. 6094722

PTL 2: Japanese Unexamined Patent Application Publication No. 2017-119912

PTL 3: Japanese Unexamined Patent Application Publication No. 2018-135552

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Summary of Invention

Technical Problem

45 **[0007]** However, in the case where the quenching apparatus described in Patent Literature 1 is used, although it is possible to prevent the deformation of a metal sheet from occurring when quenching is performed, it was found that there is a problem of a deterioration in the properties of the metal sheet, because, when the metal sheet passes through the restraining rolls arranged in a water-blowing device, there is a temporary decrease in the cooling rate of the metal sheet. Specifically, due to a decrease in the cooling rate of the metal sheet, there may be a case where it is not possible to achieve desired material properties of the metal sheet, and for example, it is not possible to obtain a metal sheet having desired tensile strength.

50 **[0008]** In addition, in the method described in Patent Literature 2, since the nozzles are inclined, there is an increase in the area in the traveling direction occupied by each of the nozzles, and there is a problem of a decrease in cooling rate due to a decrease in the number of nozzles arranged per unit length in the traveling direction. Also in this case, as in the case described above, there may be a case where it is not possible to obtain a metal sheet having desired material properties.

55 **[0009]** In addition, in Patent Literature 3, a problem of stagnant cooling water in the vicinity of the restraining rolls due to the restraining rolls being arranged as described in Patent Literature 1 is solved by forming grooves in the restraining

rolls. However, in the method disclosed in Patent Literature 3, since cooling water is inhibited from flowing through or over parts other than the grooves while the cooling water flows preferentially along the grooves, the cooling rate of the metal sheet has a non-uniform distribution in the width direction of the metal sheet corresponding to the period of the groove interval. As a result, the material properties of the metal sheet such as tensile strength have non-uniform distribution corresponding to the period of the groove interval. Non-uniformity in the material properties causes various problems when working such as pressing or bending is performed on the metal sheet. Examples of the problems include a problem in which there is a deterioration in dimensional accuracy due to non-uniform deformation of the metal sheet when the metal sheet is subjected to working and a problem in which a striped pattern is formed on the surface of the metal sheet depending on the working method.

[0010] The present invention has been completed in view of the situation described above, and an object of the present invention is to provide a quenching apparatus for a metal sheet with which it is possible to achieve a sufficient cooling rate of the metal sheet when the metal sheet passes through a water-blowing device and to prevent a cooling rate from varying in accordance with the position in the metal sheet and to provide a method for manufacturing a metal sheet by using the quenching apparatus for a metal sheet. Solution to Problem

[0011] The present inventors diligently conducted investigations to solve the problems described above and, as a result, obtained the following knowledge. When a steel sheet is manufactured, there may be a case where microstructure control is performed by allowing martensite transformation to occur in the steel sheet when a high-temperature steel sheet is subjected to rapid cooling by dipping the steel sheet in water and by blowing cooling water. At this time, since rapid volume swelling occurs in the microstructure due to martensite transformation, there may be a case where the steel sheet has a complex, non-uniform recessed and projected shape. When a high tension steel sheet (high strength steel sheet) having a martensite microstructure is subjected to quenching, since the largest stress is applied to the steel sheet at a temperature almost within a temperature range from the Ms temperature to the Mf temperature, in which transformation swelling occurs along with thermal shrinkage, there is a deterioration in the shape of the steel sheet. Here, the term "Ms temperature" denotes the temperature at which martensite transformation starts, and the term "Mf temperature" denotes the temperature at which martensite transformation finishes.

[0012] Moreover, it was found that, in the case where a cooling rate has a non-uniform distribution in the width direction and the thickness direction of the steel sheet at this time, since stress which is generated in a region where martensite transformation occurs is released in a region where transformation has not yet finished, significantly large out-of-plane deformation occurs. Examples of the reasons for non-uniformity in cooling rate include the fact that the position of the metal sheet is shifted in the out-of-plane direction during cooling. Specifically, since the metal sheet is pushed by the blown cooling water in the out-of-plane direction (a direction perpendicular to the surface of the metal sheet), the pass line of the metal sheet is shifted. Although it is preferable that the metal sheet pass the central position in the out-of-plane direction, which is located at a position equidistant from both nozzles arranged on the front-surface side of the metal sheet and nozzles arranged on the back-surface side of the metal sheet, there may be a case where the pass line of the metal sheet is shifted due to the cooling water in the out-of-plane direction from the central position in the out-of-plane direction. In particular, in the case where restraining rolls are not placed in the water-blowing device in order that the rolls do not cause a decrease in cooling rate in the vicinity of the rolls as described above, since there is a decrease in the tension applied to the metal sheet in the water-blowing device, the pass line of the metal sheet tends to be shifted.

[0013] Due to the pass line of the metal sheet being shifted, since the distances between the nozzles and the metal sheet vary between the front surface and the back surface of the metal sheet and in accordance with the position in the width direction of the metal sheet, the cooling rate has a non-uniform distribution. The present inventors found that holding the pass line of the metal sheet at the central position in the out-of-plane direction is effective for realizing uniformity in cooling rate and for thereby inhibiting the shape defect of the metal sheet.

[0014] The means of the present invention is as follows.

[1] A quenching apparatus for dipping a high-temperature metal sheet in a liquid and for thereby cooling the metal sheet, the apparatus comprising:

- a dipping tank for containing the liquid in which the metal sheet is dipped;
- a liquid-blowing device having plural nozzles for blowing a cooling liquid onto the metal sheet from both sides of the metal sheet, at least part of the liquid-blowing device being placed in the liquid contained in the dipping tank; and
- pairs of restraining rolls for restraining the metal sheet, one pair of the restraining rolls being placed on an upstream side of the liquid-blowing device and another pair of the restraining rolls being placed on a downstream side in a traveling direction of the metal sheet.

[2] The quenching apparatus according to item [1], in which each of the pairs of the restraining rolls is arranged in

a traveling direction with a distance being provided between central axes of the pair of the restraining rolls.

[3] The quenching apparatus according to item [1] or [2], in which each of the pairs of the restraining rolls is placed at a position within a range of 0 m to 1.2 m from a corresponding one of a cooling start point of the nozzles and a cooling stop point of the nozzles of the liquid-blowing device.

[4] A method for manufacturing a metal sheet, the method including performing an annealing treatment on a metal sheet by using a continuous annealing furnace and performing quenching on the annealed metal sheet by using a quenching apparatus, in which the quenching apparatus includes a dipping tank for containing a liquid in which the metal sheet is dipped, a liquid-blowing device having plural nozzles for blowing a cooling liquid onto the metal sheet from both sides of the metal sheet, at least part of the liquid-blowing device being placed in the liquid contained in the dipping tank, and pairs of restraining rolls, each of which is placed on a corresponding one of an upstream side and a downstream side in a traveling direction of the liquid-blowing device, and in which, when the metal sheet passes through the liquid-blowing device, the pairs of restraining rolls restrain the metal sheet to hold a pass line of the metal sheet at a central position in an out-of-plane direction.

[5] The method for manufacturing a metal sheet according to item [4], in which each of the pairs of the restraining rolls is arranged in the traveling direction with a distance being provided between central axes of the pair of the restraining rolls.

[6] The method for manufacturing a metal sheet according to item [4] or [5], in which each of the pairs of the restraining rolls is placed at a position within a range of 0 m to 1.2 m from a corresponding one of a cooling start point of the nozzles and a cooling stop point of the nozzles of the liquid-blowing device.

Advantageous Effects of Invention

[0015] According to the present invention, it is possible to prevent a decrease in the cooling rate of a metal sheet, to prevent the cooling rate from varying in accordance with the position in the metal sheet when the metal sheet passes through a water-blowing device, and to thereby manufacture a metal sheet having desired uniform material properties.

Brief Description of Drawings

[0016]

[Fig. 1] Fig. 1 is a schematic diagram illustrating an example of a quenching apparatus according to the present invention.

[Fig. 2] Fig. 2 is an enlarged diagram illustrating part in the vicinity of a water-blowing device of the quenching apparatus illustrated in Fig. 1.

[Fig. 3] Fig. 3 is a schematic diagram illustrating another example of a quenching apparatus according to the present invention.

Description of Embodiments

[0017] An example of a quenching apparatus according to the present invention will be described in accordance with Fig. 1 and Fig. 2. Fig. 1 is a schematic diagram illustrating a quenching apparatus 10. Fig. 2 is an enlarged diagram illustrating part in the vicinity of a water-blowing device 14 of the quenching apparatus 10 illustrated in Fig. 1. The quenching apparatus 10 is used for cooling equipment placed on the exit side of a soaking zone in a continuous annealing furnace. Hereinafter, although description will be made by using a steel sheet 11 as a specific example of a metal sheet, water 12 as an example of a liquid (cooling liquid), a water tank 13 as an example of a dipping tank, and a water-blowing device 14 as an example of a liquid-blowing device, the present invention is not limited to such examples.

[0018] In the quenching apparatus 10 in Fig. 1, the water 12 is contained in the water tank 13 in such a manner that at least part of the water-blowing device 14 is placed in the water 12. The steel sheet 11 having a high temperature is discharged from the soaking zone in the continuous annealing furnace, in which a series of treatments for annealing involving heating, soaking, cooling, and reheating is performed, and is then transported into the water 12 from above the water tank 13. In addition, cooling water is blown from nozzles 16 of the water-blowing device 14 onto both surfaces of the steel sheet 11 so that the steel sheet 11 is subjected to quenching. After the steel sheet 11 has been rapidly cooled, for example, to a temperature equal to the temperature of the cooling water through dipping in the water 12 and blowing of the cooling water, the steel sheet 11 is discharged through the exit 19 of the water tank 13 and transported to a subsequent process.

[0019] As illustrated in Fig. 1, the quenching apparatus 10 has the water tank (dipping tank) 13 containing water 12, in which the steel sheet (steel strip) 11 is dipped, and the water-blowing device 14, which blows cooling water onto the steel sheet 11. In addition, the quenching apparatus 10 has a sink roll 15 which is placed in the water 12 contained in

the water tank 13 and which changes the transporting direction (traveling direction) of the steel sheet 11.

[0020] In addition, the water-blowing device 14 is arranged in such a manner that at least part thereof is in the water 12 contained in the water tank 13, and, in Fig. 1, the water-blowing device 14 is arranged to straddle the steel sheet threading line, on which the steel sheet 11 passes, in such a manner that the devices face each other with a predetermined gap being provided therebetween. In addition, the water-blowing device 14 has plural nozzles 16 which extend in the width direction of the steel sheet 11 and which blow cooling water onto the steel sheet 11 from both surface sides of the steel sheet 11. The nozzles 16 are arranged on both sides of the pass line, on which the steel sheet 11 passes, in such a manner that, in Fig. 1, eight nozzles 16 are arranged on each side at predetermined intervals in the transporting direction of the steel sheet 11. In addition, in Fig. 1, all of the nozzles 16 are arranged in the water 12 contained in the water tank 13.

[0021] Since the steel sheet 11 is rapidly cooled by the cooling water blown from the nozzles 16 of the water-blowing device 14 in the water 12 contained in the water tank 13, that is, below the water surface of the water tank 13, thermal shrinkage occurs in the steel sheet 11. In particular, in the case where the steel sheet 11 is a material in which martensite transformation occurs, when the temperature of the steel sheet 11 changes from the Ms temperature, at which martensite transformation starts, to the Mf temperature, at which martensite transformation finishes, since rapid thermal shrinkage and transformation swelling occur in the steel sheet 11 at the same time, stress applied to the steel sheet 11 peaks, which results in a deterioration in the shape of the steel sheet 11. At this time, in the case where the pass line of the steel sheet 11 is shifted from the central position in the out-of-plane direction, since the distances between the nozzles and the steel sheet vary in accordance with the position in the width direction and between the front surface and the back surface, the cooling rate has a non-uniform distribution in the width direction and the thickness direction, which results in significantly large out-of-plane deformation occurring.

[0022] In the quenching apparatus 10 according to the present invention, each of pairs of restraining rolls 20 is placed on a corresponding one of an upstream side and a downstream side in the traveling direction of the water-blowing device 14. The restraining rolls 20 keep the steel sheet 11 flat when the steel sheet 11 passes through the water-blowing device 14 and hold the pass line of the steel sheet 11. More specifically, as a result of each of the two pairs of pinch rolls being placed on a predetermined and corresponding one of the upstream side and the downstream side in the traveling direction of the water-blowing device 14 to restrain the steel sheet 11, which has been deformed due to rolling and annealing, from both sides of the steel sheet 11, the steel sheet 11 is kept flat in the water-blowing device 14, and the pass line of the steel sheet 11 is held at the central position in the out-of-plane direction. By keeping the steel sheet 11 flat, and by preventing the position of the steel sheet 11 from being shifted in the out-of-plane direction to stabilize the pass line, it is possible to prevent non-uniformity in cooling from occurring due to the positional shift of the steel sheet 11 in the water-blowing device 14. Therefore, it is possible to manufacture the steel sheet 11 having the desired uniform material properties by using the quenching apparatus according to the present invention in a method for manufacturing a metal sheet (steel sheet). Although there is no particular limitation on the diameter of the restraining rolls 20, it is preferable that the diameter be 100 mm to 200 mm from the viewpoint of applying a sufficient restraining force to the steel sheet 11.

[0023] The term "out-of-plane direction" denotes a direction perpendicular to the front and back surfaces of the steel sheet 11. The expression "shifted in the out-of-plane direction" denotes a case where the pass line of the steel sheet 11 is shifted in a direction perpendicular to the front and back surfaces of the steel sheet (in Fig. 1, the left-right direction) from the ideal position. In the case of the ideal pass line, in the side view viewed in the width direction of the steel sheet 11 as illustrated in Fig. 1, the central position in the thickness direction of the steel sheet 11 passes through a straight line passing through the central positions in the out-of-plane direction, where each of the central positions is equidistant from a pair of the nozzles 16 facing each other. It is acceptable that the pass line of the metal sheet (steel sheet) be shifted a slight amount from the central position in the out-of-plane direction as long as the effect of the present invention is realized. Specifically, in the side view as illustrated in Fig. 1, it is acceptable that the central position in the thickness direction of the steel sheet be shifted, from the central position in the out-of-plane direction, an amount of 8% or less of the distance between the nozzle and the surface of the steel sheet.

[0024] In the present invention, it is not necessary that rolls be placed in the water-blowing device 14, or more specifically, between the pass line of the steel sheet 11 and the nozzles 16. Therefore, in the present invention, since there is no temporary decrease in the cooling rate of the steel sheet 11 that may occur when the steel sheet 11 passes through the position in the vicinity of the rolls between the pass line of the steel sheet 11 and the nozzles 16, it is possible to solve the problem of a deterioration in the properties of the steel sheet 11.

[0025] In the present invention, it is possible to arrange each of the nozzles 16 horizontally, or more specifically, approximately parallel to the out-of-plane direction of the steel sheet 11. Therefore, since it is possible to inhibit an increase in the area in the traveling direction occupied by each of the nozzles, it is possible to inhibit a decrease in the number of nozzles arranged per unit length in the traveling direction, which results in a high cooling capacity being realized.

[0026] In the case of Fig. 1 and Fig. 2, although a pair of restraining rolls is arranged in such a manner that the positions of the central axes of two rolls constituting the pair in the traveling direction are the same, it is also possible to realize the effect of the present invention by using other embodiments as long as the steel sheet 11 is held at the central position

in the out-of-plane direction of the water-blowing device 14. For example, as illustrated in Fig. 3, each pair of restraining rolls may be arranged in the traveling direction with a distance being provided between the central axes thereof, that is, such that one roll is offset in the traveling direction with respect to the other roll.

[0027] By arranging each pair of restraining rolls such that one roll is offset in the traveling direction with respect to the other roll as illustrated in Fig. 3, it is possible to increase the effect of keeping the steel sheet 11 flat. More specifically, arranging one of the restraining rolls 20 constituting the pair which is farther than the other from the water-blowing device 14 at a position so that the restraining roll pushes the steel sheet 11 increases such an effect.

[0028] It is preferable that one restraining roll farther than the other from the water-blowing device 14 is at a position with a distance of about 1 mm to 5 mm toward the steel sheet 11 from a base position. In the base position, the restraining rolls contact to the steel sheet 11 with a distance of 0 mm and a winding angle between the steel sheet 11 and the restraining rolls 20 of 0°.

[0029] With an increase in the distance between the restraining rolls 20 on the upstream side of the water-blowing device 14 and the restraining rolls 20 on the downstream side of the water-blowing device 14, the effect of keeping the steel sheet 11 flat decreases, and the capability to hold the pass line of the steel sheet 11 at the central position in the out-of-plane direction decreases. Therefore, it is preferable that the distance between the restraining rolls 20 on the upstream side and the restraining rolls 20 on the downstream side be as small as possible. On the other hand, as in the quenching apparatuses disclosed in Patent Literature 1 to Patent Literature 3, in the case where the restraining rolls are arranged at positions where the restraining rolls interfere with the nozzles 16 of the water-blowing device 14, there is a problem in that it is not possible to achieve sufficient cooling capacity or in that the flow of the cooling water is inhibited in the vicinity of the restraining rolls. Therefore, in the present invention, it is preferable that the distance between the restraining rolls on the upstream side and the restraining rolls on the downstream side be as small as possible within a range in which the restraining rolls do not interfere with the flow of the cooling water from the nozzles 16.

[0030] Specifically, it is preferable that each pair of the restraining rolls 20 be placed at a position within a range of 0 m to 1.2 m from a corresponding one of a cooling start point of the nozzles and a cooling stop point of the nozzles of the water-blowing device 14. In the case where the restraining rolls are placed at positions within such a range, it is possible to keep the steel sheet 11 flat at a sufficient level without causing interference with the flow of the cooling water. The expression "cooling start point of the nozzles" denotes a position at which the upper end of the water flow blown from the most upstream nozzle and the front surface (or back surface) of the steel sheet 11 come into contact, and the expression "cooling stop point of the nozzles" denotes a position at which the lower end of the water flow blown from the most downstream nozzle and the front surface (or back surface) of the steel sheet 11 come into contact. In addition, when the distance between the restraining rolls 20 and the cooling start point of the nozzles or the cooling stop point of the nozzles is determined, it is sufficient that the upper end or lower end of the roll which is nearer to the water-blowing device 14 be the starting point of determination.

[0031] It is preferable that the present invention be applied to an apparatus for manufacturing a steel sheet having a tensile strength of 590 MPa or more.

EXAMPLES

[0032] Although examples will be described hereafter for further understanding of the present invention, the present invention is not limited to the examples in any way.

[0033] By using the quenching apparatus 10 illustrated in Fig. 1, a high strength cold rolled steel sheet having a thickness of 1.0 mm, a width of 1 m, and a tensile strength of a 1470 MPa class was manufactured at a threading speed of 100 mpm. The quenching start temperature (at which dipping in the water tank 13 was started) of the steel sheet 11 was 750°C, and cooling was performed to a water temperature of 30°C. Each of two pairs of pinch rolls was arranged as the restraining rolls 20 on a corresponding one of the upstream side and the downstream side in the traveling direction of the water-blowing device 14, that is, at a position 20 mm from a corresponding one of the cooling start point of the nozzles and the cooling stop point of the nozzles (Example 1). The diameter of the restraining rolls 20 was 150 mm. On the other hand, in Comparative example 1, as described in Patent Literature 1, an experiment was performed in such a manner that a pair of restraining rolls were arranged in a water-blowing device. In Comparative example 2, as described in Patent Literature 3, an experiment was performed in such a manner that a pair of restraining rolls having grooves was arranged in a water-blowing device.

[0034] The tensile strength, tensile strength variation, and steel sheet shape of the steel sheets manufactured in the example and the comparative examples were evaluated. The evaluation results are given in Table 1. After the tensile strength had been obtained by performing a tensile test in accordance with JIS Z 2241 on a JIS No. 5 tensile test specimen taken so that the tensile direction was the rolling direction, a tensile strength of lower than 1470 MPa was judged as ×, and a tensile strength of 1470 MPa or higher was judged as ○. In addition, after the tensile test described above had been performed on test specimens taken at intervals of 40 mm in the width direction of the steel sheet, a tensile strength variation ratio was defined as the ratio of a tensile strength variation, which is the difference between

the maximum tensile strength and the minimum tensile strength, to an average tensile strength across the whole width, a tensile strength variation ratio of less than 4% was judged as ○, and a tensile strength variation ratio of 4% or more was judged as ×. In addition, regarding the evaluation of the steel sheet shape, a warpage quantity of the steel sheet of 10 mm or less was judged as ○, and a warpage quantity of the steel sheet of more than 10 mm was judged as ×.

The warpage quantity of the steel sheet was defined as the height of the highest point of the steel sheet when the steel sheet was placed on a horizontal plane.

[0035] In the case of Example 1 where there were no rolls inhibiting the flow of the cooling water in the water-blowing device 14, it was clarified that the steel sheet had a good shape and high tensile strength with no variation in strength in accordance with the position in the width direction. On the other hand, in the case of Comparative example 1 where restraining rolls having no groove were used in the water-blowing device 14, although the steel sheet had a good shape, since there was a decrease in cooling rate compared with the case of Example 1 and Comparative example 2, the tensile strength did not reach the predetermined value. In addition, in the case of Comparative example 2 where restraining rolls having grooves were arranged in the water-blowing device 14, although the steel sheet had a good shape and tensile strength of equal to or higher than the predetermined value, since there was an increased difference in cooling rate between the grooves and parts other than the grooves, there was an increased variation in tensile strength.

[Table 1]

	Groove	Groove Width w (mm)	Groove Depth d (mm)	Groove Pitch p (mm)	Steel Sheet Shape	Steel Sheet Tensile Strength	Tensile Strength Variation	Tensile Strength (MPa)
Comparative Example 1	not Formed	-	-	-	○	×	○	1410
Comparative Example 2	Formed	10	10	15	○	○	×	1536
Example 1	Formed	-	-	-	○	○	○	1540

Reference Signs List

[0036]

10 quenching apparatus

11 steel sheet

12 water

13 water tank

14 water-blowing device

15 sink roll

16 nozzle

19 exit

20 restraining roll

Claims

1. A quenching apparatus for dipping a high-temperature metal sheet in a liquid and for thereby cooling the metal sheet, the apparatus comprising:

a dipping tank for containing the liquid in which the metal sheet is dipped;
a liquid-blowing device having plural nozzles for blowing a cooling liquid onto the metal sheet from both sides of the metal sheet, at least part of the liquid-blowing device being placed in the liquid contained in the dipping tank; and

pairs of restraining rolls for restraining the metal sheet, one pair of the restraining rolls being placed on an upstream side of the liquid-blowing device and another pair of the restraining rolls being placed on a downstream side in a traveling direction of the metal sheet.

2. The quenching apparatus according to Claim 1, wherein in each of the pairs of the restraining rolls, central axes of one restraining roll and another restraining roll are arranged with a distance in the traveling direction of the metal sheet.

3. The quenching apparatus according to Claim 1 or 2, wherein the pair of the restraining rolls in the upstream is placed at a position within a range of 0 m to 1.2 m from a cooling start point of the nozzles of the liquid-blowing device and the pair of the restraining rolls in the downstream is placed at a position within a range of 0 m to 1.2 m from a cooling stop point of the nozzles of the liquid-blowing device.

4. A method for manufacturing a metal sheet, the method comprising performing an annealing treatment on a metal sheet by using a continuous annealing furnace and performing quenching on the annealed metal sheet by using a quenching apparatus,

wherein the quenching apparatus includes a dipping tank for containing a liquid in which the metal sheet is dipped, a liquid-blowing device having plural nozzles for blowing a cooling liquid onto the metal sheet from both sides of the metal sheet, at least part of the liquid-blowing device being placed in the liquid contained in the dipping tank, and pairs of restraining rolls, one pair of the restraining rolls being placed on an upstream side of the liquid-blowing device and another pair of the restraining rolls being placed on a downstream side in a traveling direction of the metal sheet, and

wherein, when the metal sheet passes through the liquid-blowing device, the pairs of restraining rolls restrain the metal sheet to hold a pass line of the metal sheet at a central position in an out-of-plane direction.

5. The method for manufacturing a metal sheet according to Claim 4, in each of the pairs of the restraining rolls, central axes of one restraining roll and another restraining roll are arranged with a distance in the traveling direction of the metal sheet.

6. The method for manufacturing a metal sheet according to Claim 4 or 5, wherein the pair of the restraining rolls in the upstream is placed at a position within a range of 0 m to 1.2 m from a corresponding one of a cooling start point of the nozzles of the liquid-blowing device and the pair of the restraining rolls in the downstream is placed at a position within a range of 0 m to 1.2 m from a cooling stop point of the nozzles of the liquid-blowing device.

FIG. 1

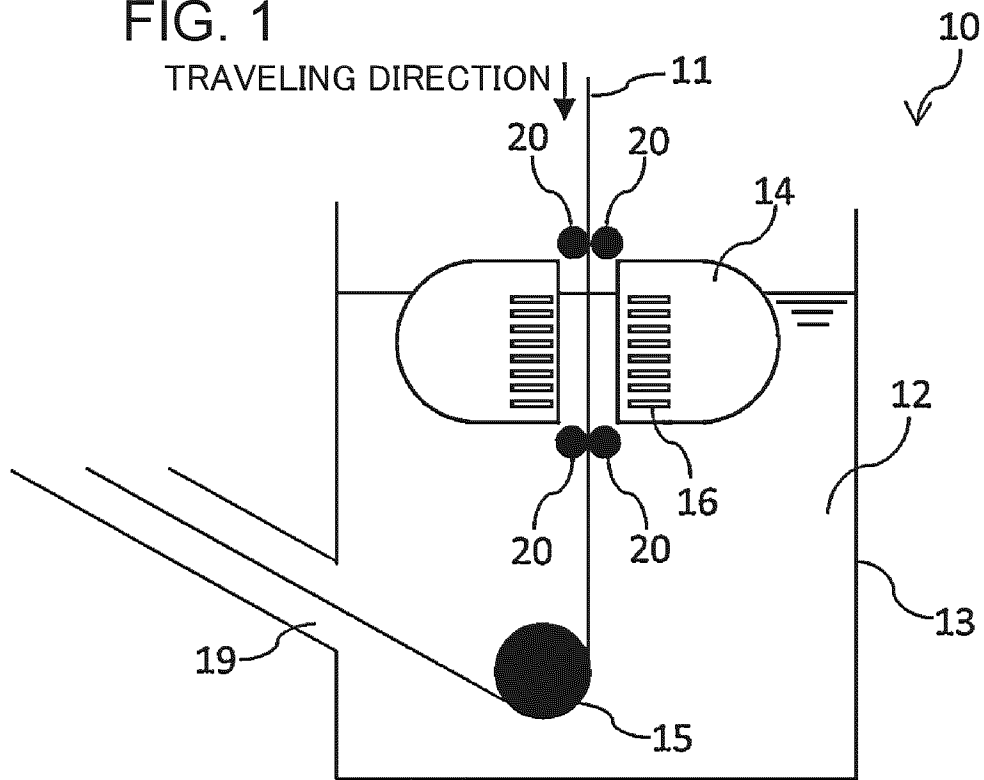


FIG. 2

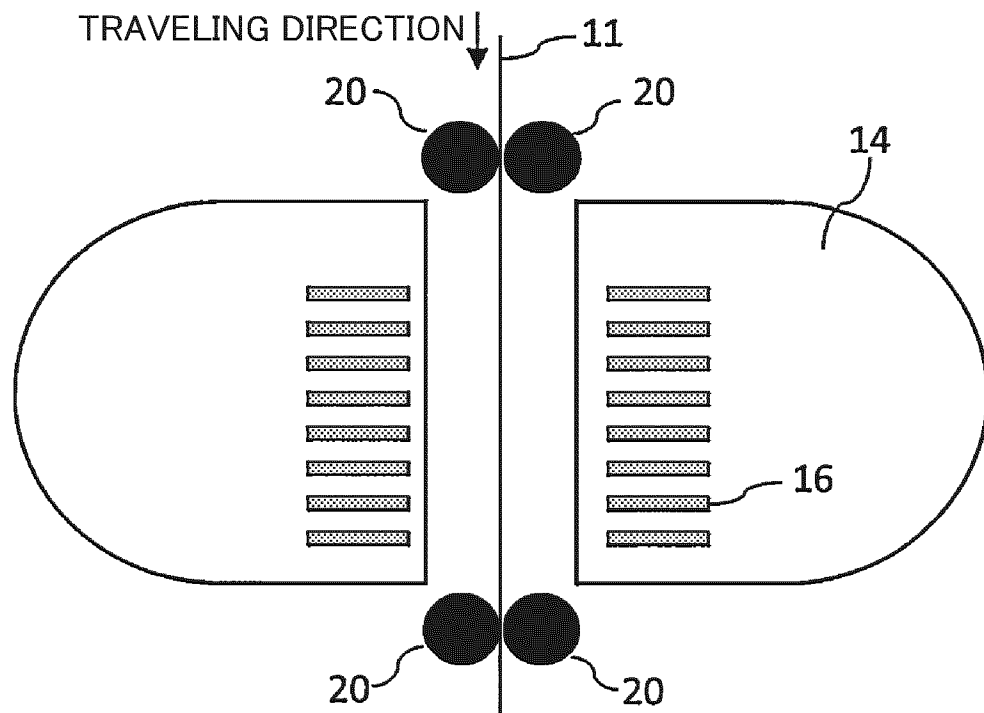
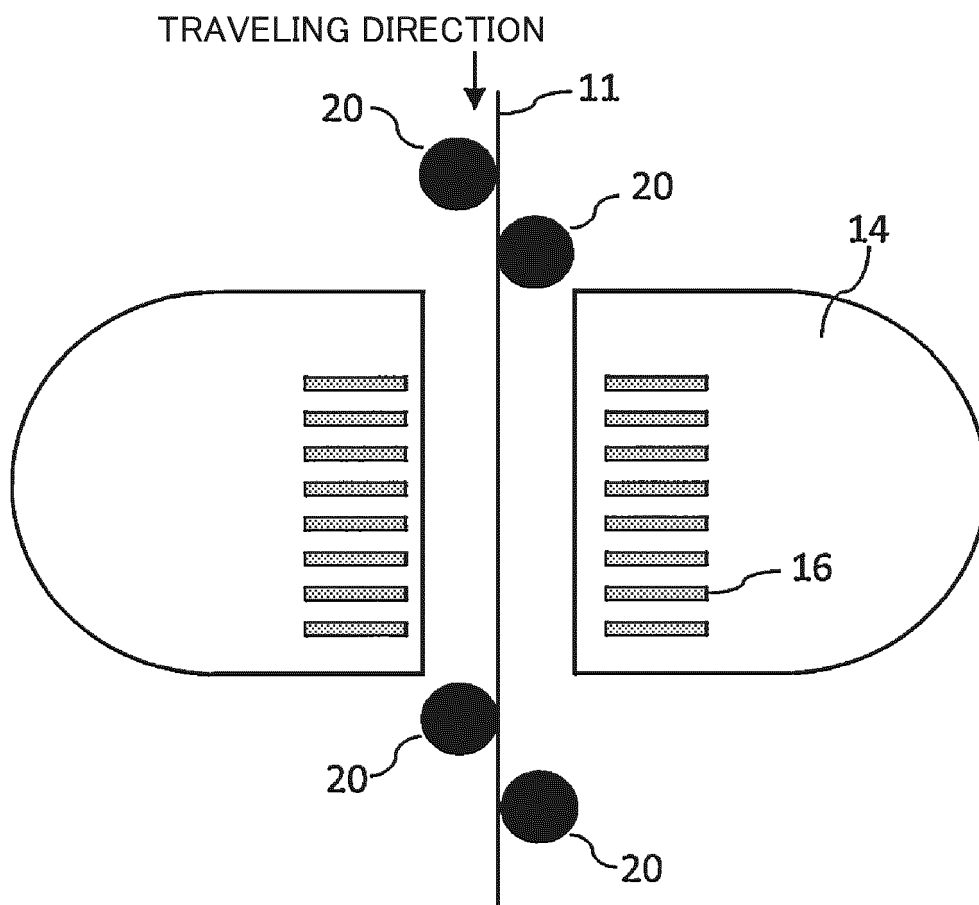


FIG. 3



5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/011751

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. C21D1/63(2006.01)i, C21D1/18(2006.01)i, C21D9/573(2006.01)i
 FI: C21D1/63, C21D1/18A, C21D1/18D, C21D9/573101Z

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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. C21D1/63, C21D1/18, C21D9/52-9/66

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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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101993995 A (CAPITAL STEEL GENERAL COMPANY)	1, 3-4, 6
Y	30.03.2011 (2011-03-30), paragraphs [0006], [0026]-[0045], [0048], fig. 1, 2	2, 5
X	JP 2017-119912 A (JFE STEEL CORPORATION)	1-6
Y	06.07.2017 (2017-07-06), paragraphs [0015]-[0019], fig. 3	2, 5
X	JP 58-107424 A (KAWASAKI STEEL CORP.) 27.06.1983 (1983-06-27), page 2, upper right column, line 20 to page 3, upper left column, line 19, fig. 1, 2	1, 3-4, 6
Y	JP 2011-184773 A (KOBE STEEL, LTD.) 22.09.2011 (2011-09-22), paragraphs [0028]-[0033], fig. 5	1-6
Y	JP 58-135725 A (NIPPON KINZOKU CO., LTD.) 12.08.1983 (1983-08-12), page 2, upper left column, lines 3-18, fig. 1, 2	1-6

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

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* Special categories of cited documents:	"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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Date of the actual completion of the international search
 04.06.2020

Date of mailing of the international search report
 16.06.2020

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Name and mailing address of the ISA/
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 3-4-3, Kasumigaseki, Chiyoda-ku,
 Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2020/011751

CN 101993995 A	30.03.2011	(Family: none)
JP 2017-119912 A	06.07.2017	US 2019/0010564 A1 paragraphs [0036]-[0040], fig. 3 EP 3399056 A1 KR 10-2018-0085788 A CN 108474052 A MX 2018007971 A
JP 58-107424 A	27.06.1983	US 4575052 A column 16, line 12 to column 17, line 8, fig. 1, 18 EP 80322 A2 AU 9007282 A FI 823965 L
JP 2011-184773 A	22.09.2011	(Family: none)
JP 58-135725 A	12.08.1983	(Family: none)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6094722 B [0006]
- JP 2017119912 A [0006]
- JP 2018135552 A [0006]