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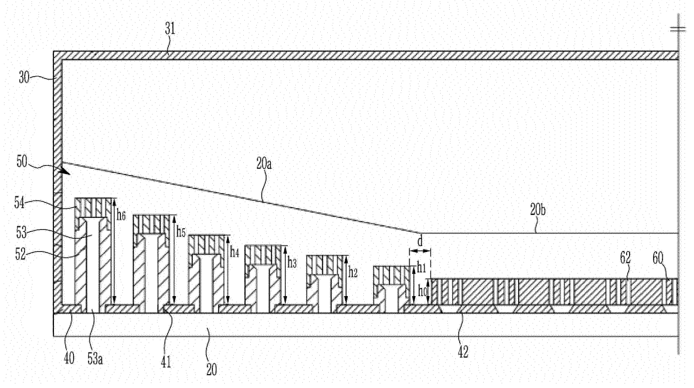
(54) **COOLING DEVICE**

(57) An exemplary embodiment of the present invention provides a cooling device including: a tub which is disposed above a cooling target and has an accommodation space that accommodates a coolant supplied from the outside; and spray nozzles which are installed in the accommodation space, each of the spray nozzles having one or more coolant inlet ports into which the coolant flows, the spray nozzles being disposed to be spaced apart from a central portion of the accommodation space toward an edge portion of the accommodation space, and the spray nozzles spraying the coolant, which flows in through the coolant inlet port, toward the cooling target, in which heights of the coolant inlet ports are in proportion to distances at which the spray nozzles are spaced apart from the central portion of the accommodation space.

FIG. 5



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Description

[Technical Field]

[0001] The present invention relates to a cooling device, and more particularly, to a cooling device which feeds a coolant to a predetermined width of a cooling target in accordance with a level of the coolant in a tub installed above the cooling target.

[Background Art]

[0002] In general, in a hot rolling process that produces a rolled strip, a slab, which is heated in a heating furnace to a predetermined temperature, is rolled in the form of a bar by a primary rough rolling and then finally rolled in the form of a strip by a finish rolling machine. While the strip passes through a run-out table including multiple rollers, a coolant is fed to the strip from above and below the strip to ensure a winding temperature, and then a winding machine winds the strip in the form of a roll to produce a hot coil.

[0003] The run-out table performs a process of conveying a material, that is, the strip which has passed through the heating furnace and has subjected to the rough rolling and the finish rolling, before the winding machine finally winds the strip. This process cools the material to a target temperature to determine quality and strength of a product. During the process of cooling the strip, the remaining coolant, which has fallen to a central portion in a width direction of the strip, flows outward through edge portions of strip, such that a temperature at both edge portions typically becomes lower than a temperature at the central portion. In this process, the edge portions, which are cooled or excessively cooled, shrink in volume first, and then the central portion, which is subsequently cooled, shrinks in volume. With this temperature deviation, there occurs a difference in timing of shrinkage in volume, which causes the strip to have a wave shape.

[0004] In particular, during the cooling process in the hot rolling process, the strip is cooled typically in a high-temperature state at a temperature of about 600 or more, and as a result, the strip expands in volume in a transformation section that occurs during the process of cooling the strip in accordance with types of steel. The expansion in volume occurs at the edge portions of the strip which are cooled before the central portion of the strip is cooled. Therefore, when the edge portions begin to be transformed in a predetermined section, the edge portions, which are cooled first, expand in volume, but the high-temperature central portion, which does not yet go into the transformation section, shrinks in volume while being cooled, and this process is a typical mechanism that causes the edge portions to have waves.

[DISCLOSURE]

[Technical Problem]

[0005] The present invention has been made in an effort to prevent an edge wave generated during a process of cooling a cooling target to a winding temperature. The present invention has also been made in an effort to provide a cooling target cooling device capable of feeding a coolant with quick responsiveness and stability. Other objects of the present invention will be more apparent from the following detailed description and the drawings.

[Technical Solution]

[0006] An exemplary embodiment of the present invention provides a cooling device including: a tub which is disposed above a cooling target and has an accommodation space that accommodates a coolant supplied from the outside; and spray nozzles which are installed in the accommodation space, each of the spray nozzles having one or more outer inlet ports into which the coolant flows, the spray nozzles being disposed to be spaced apart from a central portion of the accommodation space toward an edge portion of the accommodation space, and the spray nozzles spraying the coolant, which flows in through the outer inlet port, toward the cooling target, in which heights of the outer inlet ports are in proportion to distances at which the spray nozzles are spaced apart from the central portion of the accommodation space.

[0007] The tub may have a spray plate having multiple installation holes which are disposed to be spaced apart from one another while penetrating one surface facing the cooling target and each have internal screw threads formed on an inner circumferential surface thereof, and the spray nozzle may have an external screw thread which is formed on an outer circumferential surface of the spray nozzle and fastened to the internal screw thread of the installation hole by a threaded connection, such that a position of the spray nozzle is adjusted by a rotation of the spray nozzle.

[0008] The spray nozzles may be arranged in a direction in parallel with a width direction of the cooling target.

[0009] The spray nozzle may include: a nozzle body which has the external screw thread, is disposed to be approximately perpendicular to the spray plate, and has a spray flow path formed therein and a spray port formed at a lower end of the spray flow path; and a nozzle cap which is fastened to an upper portion of the nozzle body and has the multiple outer inlet ports.

[0010] The nozzle cap may be fastened to the nozzle body by a threaded connection, such that a height of the outer inlet port is adjustable by a rotation of the nozzle cap.

[0011] The spray plate may have auxiliary installation holes which are disposed to be spaced apart from one another while penetrating one surface facing the cooling target and positioned at a central portion of the accommodation space, and the cooling device may further include an auxiliary spray nozzle having auxiliary inlet ports which are in communication with the auxiliary installation holes and disposed to be lower than a height of the outer inlet port.

[0012] The tub may include: an inner tub which has side plates disposed in parallel with a direction in which the spray nozzles are spaced apart from one another; and a supply pipe which supplies the coolant into the inner tub, and the side plate may have a central portion and an edge portion having an upper end higher than an upper end of the central portion.

[0013] A height of the upper end of the edge portion may be gradually increased toward an edge portion of the accommodation space.

[0014] The cooling device may further include meshes which are fixedly installed on an inner circumferential surface of the inner tub and disposed in parallel with a direction in which the spray nozzles are spaced apart from one another.

[0015] The meshes may have an upper mesh and a lower mesh positioned below the upper mesh.

[0016] The supply pipe may be installed at a center of the accommodation space, and the meshes may be disposed at both sides of the supply pipe and in contact with the supply pipe.

[0017] The tub may include: an inner tub which has side plates disposed in parallel with a direction in which the accommodation space and the spray nozzles are spaced apart from one another; and an outer tub which is disposed outside the inner tub and surrounds the inner tub, and the spray plate may be disposed between the inner tub and the outer tub and disposed to be higher than a lower end of the inner tub and a lower end of the outer tub.

[0018] The tub may further have an auxiliary accommodation space which is positioned between the inner tub and the outer tub and formed above the spray plate.

[0019] Another exemplary embodiment of the present invention provides a cooling device including: a tub which is disposed above a cooling target and has an accommodation space that accommodates a coolant supplied from the outside; and spray nozzles which are installed in the accommodation space and have outer inlet ports into which the coolant selectively flows in accordance with a level of the coolant, and spray ports through which the coolant is sprayed toward the cooling target.

[0020] Heights of the outer inlet port may be gradually increased in a width direction of the cooling target.

[0021] The tub may have an inner accommodation space into which the coolant is supplied, and an outer accommodation space into which the coolant overflowing from the inner accommodation space flows, and the spray nozzles may be installed in the outer accommodation space.

[0022] The tub may have a side plate which defines the inner accommodation space and the outer accommodation space, and a height of a central portion of the side plate may be lower than heights of edge portions positioned at both sides of the central portion.

[0023] A height of the side plate in the width direction of the cooling target may be higher than heights of the spray nozzles.

[0024] The cooling device may further include: an auxiliary spray nozzle which is installed at a center of the accommodation space and has auxiliary inlet ports disposed to be lower than heights of the outer inlet ports, in which the spray nozzles are disposed at both sides of the auxiliary spray nozzle.

[Advantageous Effects]

[0025] According to the exemplary embodiment of the present invention, it is possible to solve the problems of high installation costs, complicated structures and materials in use, and frequent breakdowns caused by poor working environments that occur in the cooling device using the edge mask in the related art, and as a result, it is possible to make it easy to manufacture the cooling device and improve stability and responsiveness when feeding the coolant. Therefore, it is possible to easily change the amount of coolant in the width direction, thereby preventing edge portions of a steel plate from being excessively cooled, and improving productivity and quality of final products.

[Description of the Drawings]

[0026]

FIG. 1 is a view schematically illustrating a general hot rolling apparatus.

FIG. 2 is a view for explaining a cause that generates an edge wave during a cooling process.

FIG. 3 is a view illustrating a cooling device using an edge mask.

FIG. 4 is a view schematically illustrating a cooling device according to an exemplary embodiment of the present invention.

FIGS. 5 to 8 are views illustrating the cooling device illustrated in FIG. 4.

FIGS. 9 and 10 are views illustrating a state in which the cooling device illustrated in FIGS. 5 and 8 operates.

FIGS. 11 and 12 are views illustrating a process of adjusting a height of a spray nozzle illustrated in FIG. 5.

FIG. 13 is a view illustrating a modified example of the cooling device illustrated in FIG. 5.

[Mode for Invention]

[0027] Hereinafter, an exemplary embodiment of the present invention will be described in more detail with reference to FIGS. 1 to 10. The exemplary embodiments of the present invention may be modified in various forms, and the scope of the present invention should not be interpreted as being limited to the following exemplary embodiment. The exemplary embodiments of the present invention are provided to more completely explain the present invention to those skilled in the art. Therefore, the shapes of the respective elements illustrated in the drawings may be exaggerated to emphasize a clearer description.

[0028] FIG. 1 is a view schematically illustrating a general hot rolling apparatus. As illustrated in FIG. 1, the hot rolling apparatus includes a heating furnace 11 which heats a slab 1, a rough rolling machine 12 which performs rough rolling on a rolling target material heated in the heating furnace 11, a finish rolling machine 13 which performs finish rolling on the rolling target material (e.g., a bar) which has been subjected to the rough rolling, a run-out table 14 which conveys the rolling target material (e.g., a strip) which has been subjected to the finish rolling, and a winding machine 15 which winds the conveyed rolling target material in the form of a coil.

[0029] The slab 1 sequentially passes through the heating furnace 11, the rough rolling machine 12, the finish rolling machine 13, the run-out table 14, and the winding machine 15, and then is wound in the form of a coil. When the slab (or bar 1), which has been subjected to the rough rolling, travels to the finish rolling machine 13, the rolling target material is subjected to the finish rolling while individually controlling rolling speeds of multiple rollers provided in the finish rolling machine 13. As described above, the process including all of the overall operations of heating the rolling target material 1 in the heating furnace 11 and then winding the rolling target material 1 in the form of a coil by the winding machine 15 is typically called "hot rolling".

[0030] During the hot rolling process, the run-out table 14 performs the process of conveying the rolling target material 1, that is, the strip 1, which has passed through the heating furnace 11 and has been subjected to the rough rolling and the finish rolling, before the winding machine 15 finally winds the strip 1, and in this process, the strip 1 is cooled to a target temperature to determine quality and strength of a product. In this case, a strip wave, which is a shape defect caused by a cooling deviation in the width direction of the strip, is generated as a troublesome problem, and a generation mechanism is as follows.

[0031] FIG. 2 is a view for explaining a cause that generates an edge wave during a cooling process. As illustrated in FIG. 2, during the process of cooling the strip 1 by the run-out table 14, a coolant, which has fallen at the central portion in the width direction of the strip 1, flows outward through the edge portions of the strip 1, such that a temperature at the edge portions of the strip 1 typically becomes lower than a temperature at the central portion thereof.

[0032] In this process, the edge portions of the strip 1, which are cooled or excessively cooled, shrink in volume first, and then the central portion of the strip 1, which is subsequently cooled, shrinks in volume. With this temperature deviation, there occurs a difference in timing of shrinkage in volume, which causes the strip 1 to have a wave shape.

[0033] In particular, during the cooling process in the hot rolling process, the strip 1 is cooled typically in a high-temperature state at a temperature of about 600 or more, and as a result, the strip expands in volume in a transformation section that occurs during the process of cooling the strip in accordance with types of steel. As described above, this phenomenon occurs first at the edge portions of the strip 1 which are cooled before the central portion of the strip 1 is cooled. Therefore, when the edge portions begin to be transformed in a predetermined section, the edge portions, which are cooled first, expand in volume, but the high-temperature central portion, which does not yet go into the transformation section, shrinks in volume while being cooled. This phenomenon is a typical mechanism that causes the edge portions to have waves.

[0034] FIG. 3 is a view illustrating a strip cooling device using an edge mask in the related art. As illustrated in FIG. 3, as a method in the related art which prevents the waves generated in the edge portions of the strip 1, the strip cooling device serves to prevent the edge portions from being excessively cooled. That is, to reduce the cooling deviation occurring in the width direction of the strip 1 while the strip 1 is cooled on the run-out table 14, edge mask devices 18 are mounted and operated at both end portions of a laminar bank 20.

[0035] The edge masks 18 are installed to solve the problem that the coolant, which has fallen at the central portion in the width direction of the strip 1, flows outward through the edge portions of the strip 1 during the process of cooling the strip 1, such that the temperature at the edge portions is controlled to be lower than the temperature at the central portion, which causes the cooling deviation in the width direction. The edge masks 18 serve to prevent the coolant fed from the laminar bank 20 from being fed to both end portions of the strip 1, and positions of the edge masks 18 are automatically controlled to prevent the coolant from being fed to the edge portions of the hot rolling strip 1 having an overall width of maximum 300 mm, and maximum 150 mm at a single side.

[0036] However, the aforementioned method of preventing the edge portion from being excessively cooled still has a problem of high costs required to install facilities and a problem of difficulty in maintenance of the facilities. In addition, power of a motor is transmitted to driving shafts of the edge masks 18 through chains, and the edge masks 18 are attached to the driving shafts and move in the width direction. In the hot rolling process, the strip at a high temperature of 600°C or more typically moves in the section of the run-out table 14, such that moisture vapor is generated by the coolant and the generated moisture vapor carries scale generated by a reaction with oxygen in the atmosphere. The scale is formed on a motor unit which is corroded by being exposed to a high temperature, the driving shaft, and a bearing of a connecting unit that connects the driving shaft and the chain, which causes frequent breakdowns of the facilities due to an overload of the motor.

[0037] In addition, a sensor (not illustrated), which detects a position of the strip 1, does not smoothly detect the position of the strip 1 due to the generated high-temperature moisture vapor, and as a result, a defect frequently occurs when controlling the strip 1 in the width direction. Because the scale enters and adheres to the driving shaft and a chain connecting unit, and as a result, a large amount of time is required to remove the adhering scale at the time of maintaining the edge masks 18. Due to the difficulty in maintenance, the important function of preventing the edge portions from being excessively cooled is frequently incompletely performed.

[0038] FIG. 4 is a view schematically illustrating a cooling device according to an exemplary embodiment of the present invention, and FIGS. 5 to 8 are views illustrating the cooling device illustrated in FIG. 4. The cooling device is installed above the roller table 14 that conveys the strip 1 rolled by the finish rolling machine 13.

[0039] As illustrated in FIGS. 5 and 8, the cooling device includes an inner tub 20 and an outer tub 30. The inner tub 20 has an inner accommodation space that may accommodate a coolant, and a supply pipe 35 is installed inside the inner accommodation space and supplies the coolant into the inner accommodation space. The supply pipe 35 is disposed approximately in parallel with the width direction of the strip 1. The supply pipe 35 has multiple supply holes 35a, and the coolant supplied from the outside is accommodated in the inner accommodation space through the supply holes 35a. Meanwhile, unlike the present exemplary embodiment, the supply pipe 35 may be installed outside the inner accommodation space and supply the coolant into the inner accommodation space.

[0040] Mesh members are fixedly installed on an inner circumferential surface of the inner tub 20 and supported by an outer circumferential surface of the supply pipe 35. The mesh members include an upper mesh 62 and a lower mesh 64, and the mesh member has a quadrangular cylinder shape disposed approximately in parallel with the supply pipe 35.

[0041] The outer tub 30 is installed outside the inner tub 20 and surrounds the inner tub 20, and a cover 31 closes an opened upper side of the outer tub 30 from the outside. As illustrated in FIG. 8, a front side plate and a rear side plate of the outer tub 30 are spaced apart from a front side plate and a rear side plate of the inner tub 20.

[0042] Spray plates 40 are installed between the front side plate of the inner tub 20 and the front side plate of the outer tub 30 and between the rear side plate of the inner tub 20 and the rear side plate of the outer tub 30, respectively, and as a result, outer accommodation spaces positioned outside the inner accommodation space are formed at upper portions of the spray plate 40, respectively.

[0043] The inner accommodation space and the outer accommodation spaces are divided by the front side plate and the rear side plate of the inner tub 20, and as illustrated in FIG. 5, each of the front side plate and the rear side plate has an edge upper end 20a which is positioned above spray nozzles 50, and a central upper end 20b which is positioned above an auxiliary spray nozzle 60. In this case, the central upper end 20b is disposed horizontally, and the edge upper end 20a is disposed to be inclined upward from one end (or both ends) of the central upper end 20b.

[0044] As illustrated in FIG. 5, the spray plate 40 has multiple installation holes 41 and multiple auxiliary installation holes 42, and the spray plate 40 is disposed approximately in parallel with the width direction of the strip 1 and positioned above the strip 1. In particular, a central portion (or center) of the spray plate 40 corresponds to a central portion (or center) of the strip 1, and edge portions of the spray plate 40 correspond to the edge portions of the strip 1.

[0045] The auxiliary installation holes 42 are formed at the central portion of the spray plate 40, and the installation holes 41 are formed at both sides based on the auxiliary installation holes 42 (FIG. 5 illustrates only one side). The auxiliary installation hole 42 has a tapered shape having a cross-sectional area decreasing downward, and the installation hole 41 has a straight shape having a screw thread formed on an inner circumferential surface thereof.

[0046] The spray nozzles 50 are installed on the installation holes 41 and disposed to be spaced apart from one another in the width direction of the strip 1. As illustrated in FIG. 6, the spray nozzle 50 has a nozzle body 52 and a nozzle cap 54, the nozzle cap 54 is fastened to the nozzle body 52 by a threaded connection, and the nozzle body 52 is fastened to the installation hole 41 by a threaded connection.

[0047] The nozzle cap 54 has one or more coolant inlet ports 54a which penetrate the nozzle cap 54 in a vertical direction, and the coolant inlet port 54a is in communication with a flow path 53 of the nozzle body 52 in a state in which the nozzle cap 54 is fastened to the nozzle body 52. The nozzle cap 54 has a screw thread formed on an inner circumferential surface thereof, and the nozzle cap 54 is fastened to an upper end portion 57 of the nozzle body 52 by a threaded connection.

[0048] The nozzle body 52 has stepped portions formed as a diameter of the upper end portion 57 and a diameter of a lower end portion 55 are decreased. The nozzle body 52 has a screw thread formed on an outer circumferential surface of the upper end portion 57, and the nozzle body 52 is fastened to the screw thread of the nozzle cap 54 by a threaded connection. In addition, the nozzle body 52 has a screw thread formed on an outer circumferential surface of the lower end portion 55, and the nozzle body 52 is fastened to the screw thread formed on the inner circumferential surface of the installation hole 41 by a threaded connection. Therefore, it is possible to adjust a height of the spray nozzle 50 by rotating the nozzle body 52, and it is possible to adjust a height of the coolant inlet port 54a by rotating the nozzle cap 54.

[0049] The nozzle body 52 has the flow path 53 formed in the nozzle body 52, and a spray port 53a formed at a lower end of the flow path 53, and the flow path 53 is in communication with the coolant inlet port 54a. An upper end of the flow path 53 has a tapered shape having a cross-sectional area increasing upward, such that the coolant may smoothly flow into the flow path 53 through the coolant inlet port 54a.

[0050] The auxiliary spray nozzle 60 is installed on the auxiliary installation holes 42, and the auxiliary spray nozzle 60 has coolant inlet ports 62 which are in communication with the auxiliary installation holes 42. The auxiliary installation hole 42 has a tapered shape having a cross-sectional area increasing downward, such that the coolant may smoothly flow into the auxiliary installation hole 42 through the coolant inlet port 62.

[0051] As illustrated in FIG. 5, the spray nozzles 50 are installed at both sides based on the auxiliary spray nozzle 60 (FIG. 5 illustrates only one side), and heights h1 to h6 of the upper ends of the spray nozzles 50 are increased in proportion to distances d at which the spray nozzles 50 are spaced apart from the auxiliary spray nozzle 60 (or the central portion of the inner accommodation space). Therefore, the heights h1 to h6 of the coolant inlet ports 54a are increased in proportion to a separation distance. In addition, a height h0 of the upper end of the auxiliary spray nozzle 60 is lower than the heights h1 to h6 of the upper ends of the spray nozzles 50.

[0052] FIGS. 9 and 10 are views illustrating a state in which the cooling device illustrated in FIGS. 5 and 8 operates. Hereinafter, a method of operating the cooling device will be described below with reference to FIGS. 9 and 10. As described above, the coolant is supplied into the inner accommodation space of the cooling device (specifically, the inner tub 20) through the supply pipe 35. The coolant is supplied into the inner accommodation space through the supply holes 35a, and foreign substances may be filtered out by mesh holes 64a of the lower mesh 64 and mesh holes 62a of the upper mesh 62. In this case, a diameter of the mesh hole 64a may be larger than a diameter of the mesh hole 62a.

[0053] As illustrated in FIG. 10, the coolant flows into the outer accommodation space while flowing over the front side plate and the rear side plate of the inner tub 20. Thereafter, as illustrated in FIG. 9, in accordance with a level of the coolant accommodated in the outer accommodation space, the coolant flows into the auxiliary spray nozzle 60 through the coolant inlet ports 62 and then is sprayed toward the strip 1, and the coolant flows into the spray nozzles 50 through the coolant inlet ports 54a and then is sprayed toward the strip 1.

[0054] That is, as the level of the coolant is increased, the coolant is sprayed first through the coolant inlet ports 62, and then the coolant is sprayed sequentially through the coolant inlet ports 54a in the order from the coolant inlet port 54a positioned at a lowest position to the coolant inlet port 54a positioned at a highest position. Therefore, when an operator intends to adjust a width of the coolant to be fed, the operator adjusts the level of the coolant in the outer accommodation space, such that whether the coolant is supplied into the spray nozzles 50 is determined based on the level of the coolant, and as a result, it is possible to adjust a cooling range for the strip 1.

[0055] In this case, as illustrated in FIG. 9, the spray plate 40 is installed to be higher than a lower end of the inner tub 20 and a lower end of the outer tub 30, and the coolant sprayed from the spray plate 40 is guided by a lower portion of the inner tub 20 and a lower portion of the outer tub 30 which protrude toward a lower portion of the spray plate 40, thereby preventing the coolant from being sprayed toward an unnecessary portion.

[0056] While the present invention has been described in detail with reference to the exemplary embodiment, other exemplary embodiments may be made in other forms. Accordingly, the technical spirit and the scope of the appended claims are not limited to the exemplary embodiment.

[Mode for Invention]

[0057] Hereinafter, exemplary embodiments of the present invention will be described in more detail with reference to FIGS. 11 to 13. The exemplary embodiments of the present invention may be modified in various forms, and the scope of the present invention should not be interpreted as being limited to the following exemplary embodiment. The exemplary embodiments of the present invention are provided to more completely explain the present invention to those skilled in the art. Therefore, the shapes of the respective elements illustrated in the drawings may be exaggerated to emphasize a clearer description.

[0058] FIGS. 11 and 12 are views illustrating a process of adjusting a height of the spray nozzle illustrated in FIG. 5. As described above, it is possible to adjust a height of the spray nozzle 50 by rotating the nozzle body 52, and it is possible to adjust a height of the coolant inlet port 54a by rotating the nozzle cap 54.

[0059] As illustrated in FIG. 11, when the nozzle cap 54 is rotated, the height of the coolant inlet port 54a is increased, and as a result, it is possible to prevent the coolant from flowing into the spray nozzle 50 through the coolant inlet port 54a (compared to FIG. 9). On the contrary, when the nozzle cap 54 is rotated and the height of the coolant inlet port 54a is decreased, the coolant may flow into the spray nozzle 50 through the coolant inlet port 54a. That is, a user may determine, for each spray nozzle 50, whether to spray the coolant through the spray nozzle 50 by rotating the nozzle cap 54 regardless of the level of the coolant (because an operation of adjusting the level of the coolant requires a large amount of time and affects all of the spray nozzles 50), and as a result, it is possible to spray the coolant asymmetrically based on the center of the strip 1.

[0060] As illustrated in FIG. 12, when the nozzle body 52 is rotated, the height of the coolant inlet port 54a is increased, and as a result, it is possible to prevent the coolant from flowing into the spray nozzle 50 through the coolant inlet port 54a (compared to FIG. 9). On the contrary, when the nozzle body 52 is rotated and the height of the coolant inlet port 54a is decreased, the coolant may flow into the spray nozzle 50 through the coolant inlet port 54a. That is, it is possible to determine, for each spray nozzle 50, whether to spray the coolant through the spray nozzle 50 by rotating the nozzle body 52, and as a result, it is possible to spray the coolant asymmetrically based on the center of the strip 1.

[0061] Meanwhile, the present exemplary embodiment has described that the height of the coolant inlet port 54a is adjusted by rotating the nozzle cap 54 or the nozzle body 52, but the scope of the present invention is not limited thereto, and it is possible to adjust the height of the coolant inlet port 54a through another exemplary embodiment. In addition, the nozzle cap 54 or the nozzle body 52 may be rotated by a driving device such as a motor.

[0062] FIG. 13 is a view illustrating a modified example of the cooling device illustrated in FIG. 5. Unlike FIG. 5 described above, a coolant inlet port 52a may be formed at a lateral side of the spray nozzle 50. As illustrated in FIG. 13, the spray nozzles 50 are installed at both sides based on the auxiliary spray nozzle 60 (FIG. 5 illustrates only one side), and heights h1 to h6 of the coolant inlet ports 54a are increased in proportion to distances d at which the spray nozzles 50 are spaced apart from the auxiliary spray nozzle 60 (or the central portion of the inner accommodation space).

[0063] While the present invention has been described in detail with reference to the exemplary embodiments, other exemplary embodiments may be made in other forms. Accordingly, the technical spirit and the scope of the appended claims are not limited to the exemplary embodiments.

[Industrial Applicability]

[0064] The present invention may be applied to various types of cooling devices.

Claims

1. A cooling device comprising:

   a tub which is disposed above a cooling target and has an accommodation space that accommodates a coolant; and
   spray nozzles which are installed in the accommodation space, each of the spray nozzles having one or more coolant inlet ports into which the coolant flows, the spray nozzles being disposed to be spaced apart from a central portion of the accommodation space toward an edge portion of the accommodation space, and the spray nozzles spraying the coolant toward the cooling target,
   wherein heights of the coolant inlet ports are in proportion to distances at which the spray nozzles are spaced apart from the central portion of the accommodation space.

2. The cooling device of claim 1, wherein:

   the tub has a spray plate having multiple installation holes which are disposed to be spaced apart from one another and each have an internal screw thread formed on an inner circumferential surface thereof, and
   the spray nozzle has an external screw thread which is formed on an outer circumferential surface of the spray nozzle and fastened to the internal screw thread of the installation hole by a threaded connection, such that a position of the spray nozzle is adjusted by a rotation of the spray nozzle.

3. The cooling device of claim 1 or claim 2, wherein:
   the spray nozzles are arranged in a direction in parallel with a width direction of the cooling target.

4. The cooling device of claim 2, wherein:
   the spray nozzle includes:

   a nozzle body which has the external screw thread, is disposed to be approximately perpendicular to the spray plate, and has a spray flow path formed therein and a spray port formed at a lower end of the spray flow path; and
   a nozzle cap which is fastened to an upper portion of the nozzle body and has the multiple coolant inlet ports.

5. The cooling device of claim 4, wherein:
   the nozzle cap is fastened to the nozzle body by a threaded connection, such that a height of the coolant inlet port is adjustable by a rotation of the nozzle cap.

6. The cooling device of claim 2, wherein:

   the spray plate has auxiliary installation holes which are disposed to be spaced apart from one another while penetrating one surface facing the cooling target and positioned at a central portion of the accommodation space, and
   the cooling device further includes an auxiliary spray nozzle having auxiliary inlet ports which are in communication with the auxiliary installation holes and disposed to be lower than a height

of the coolant inlet port.

7. The cooling device of claim 1, wherein: the tub includes:

an inner tub which has side plates disposed in parallel with a direction in which the spray nozzles are spaced apart from one another; and
a supply pipe which supplies the coolant into the inner tub, and
the side plate has a central portion and an edge portion having an upper end higher than an upper end of the central portion.

8. The cooling device of claim 7, wherein: a height of the upper end of the edge portion is gradually increased toward an edge portion of the accommodation space.

9. The cooling device of claim 7, further comprising: meshes which are fixedly installed on an inner circumferential surface of the inner tub and disposed in parallel with a direction in which the spray nozzles are spaced apart from one another.

10. The cooling device of claim 9, wherein: the meshes have an upper mesh and a lower mesh positioned below the upper mesh.

11. The cooling device of claim 9, wherein: the supply pipe is installed at a center of the accommodation space, and the meshes are disposed at both sides of the supply pipe and in contact with the supply pipe.

12. The cooling device of claim 2, wherein: the tub includes:

an inner tub which has side plates disposed in parallel with a direction in which the accommodation space and the spray nozzles are spaced apart from one another; and
an outer tub which is disposed outside the inner tub and surrounds the inner tub, and
the spray plate is disposed between the inner tub and the outer tub and disposed to be higher than a lower end of the inner tub and a lower end of the outer tub.

13. The cooling device of claim 12, wherein: the tub further has an auxiliary accommodation space which is positioned between the inner tub and the outer tub and formed above the spray plate.

14. A cooling device comprising:

a tub which is disposed above a cooling target and has an accommodation space that accommodates a coolant supplied from the outside; and
spray nozzles which are installed in the accommodation space and have coolant inlet ports into which the coolant selectively flows in accordance with a level of the coolant, and spray ports through which the coolant is sprayed toward the cooling target.

15. The cooling device of claim 14, wherein: heights of the coolant inlet port are gradually increased in a width direction of the cooling target.

16. The cooling device of claim 14, wherein: the tub has an inner accommodation space into which the coolant is supplied, and an outer accommodation space into which the coolant overflowing from the inner accommodation space flows, and the spray nozzles are installed in the outer accommodation space.

17. The cooling device of claim 16, wherein: the tub has a side plate which defines the inner accommodation space and the outer accommodation space, and a height of a central portion of the side plate is lower than heights of edge portions positioned at both sides of the central portion.

18. The cooling device of claim 17, wherein: a height of the side plate in the width direction of the cooling target is higher than heights of the spray nozzles.

19. The cooling device of claim 14, further comprising:

an auxiliary spray nozzle which is installed at a center of the accommodation space and has auxiliary inlet ports disposed to be lower than heights of the coolant inlet ports,
wherein the spray nozzles are disposed at both sides of the auxiliary spray nozzle.

FIG. 1

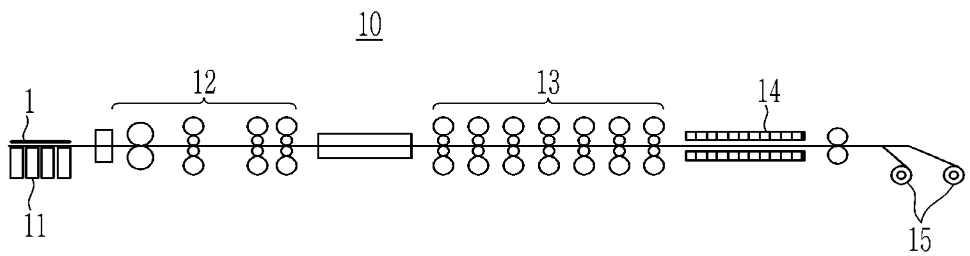
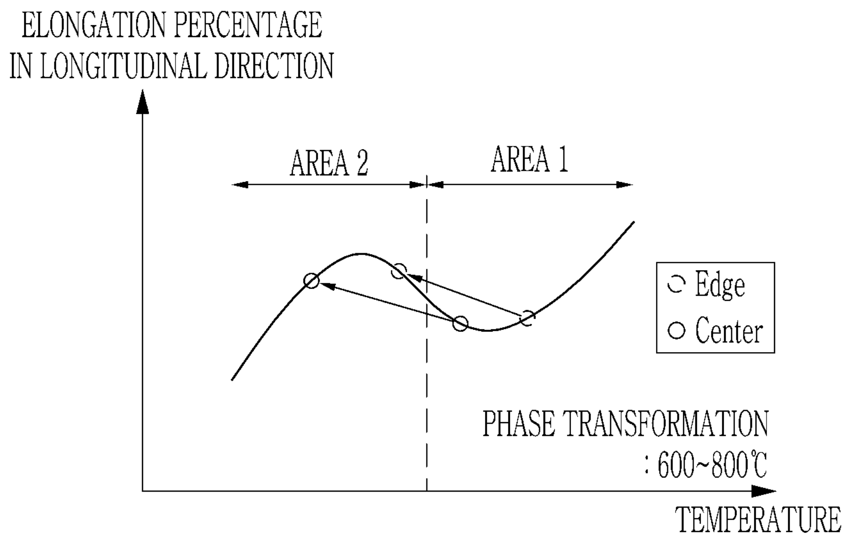


FIG. 2



[CURVE OF PHASE TRANSFORMATION OF MATERIAL CAUSED BY COOLING]

CLASSIFICATION	AREA 1		AREA 2	
	CHANGE IN LENGTH	CHANGE IN STRESS	CHANGE IN LENGTH	CHANGE IN STRESS
Edge	EXPANSION	COMPRESSIVE STRESS (HIGH)	SHRINKAGE	TENSILE STRESS (HIGH)
Center	SHRINKAGE	TENSILE STRESS (LOW)	EXPANSION	COMPRESSIVE STRESS (LOW)

→ OCCURRENCE OF PLASTIC DEFORMATION → Wave

FIG. 3

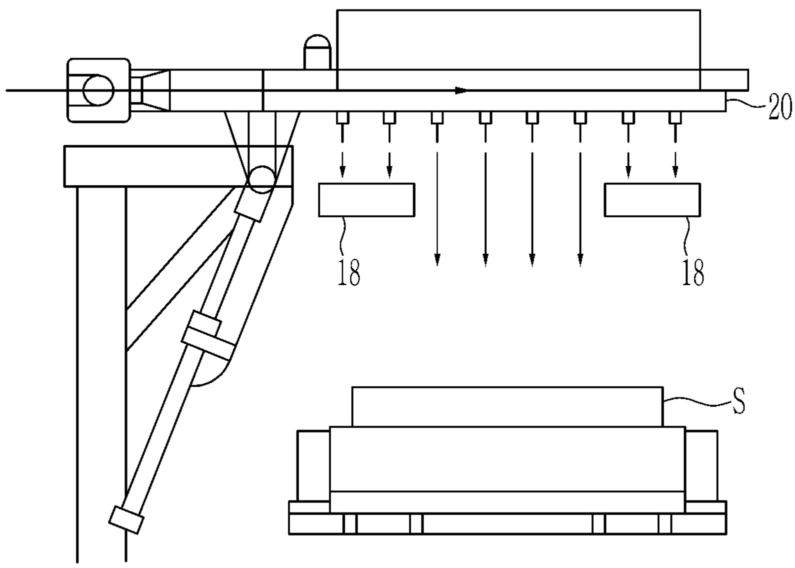


FIG. 4

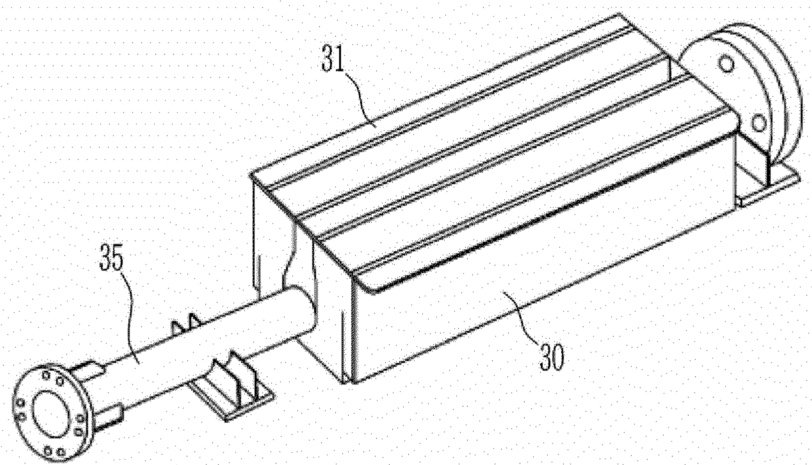


FIG. 5

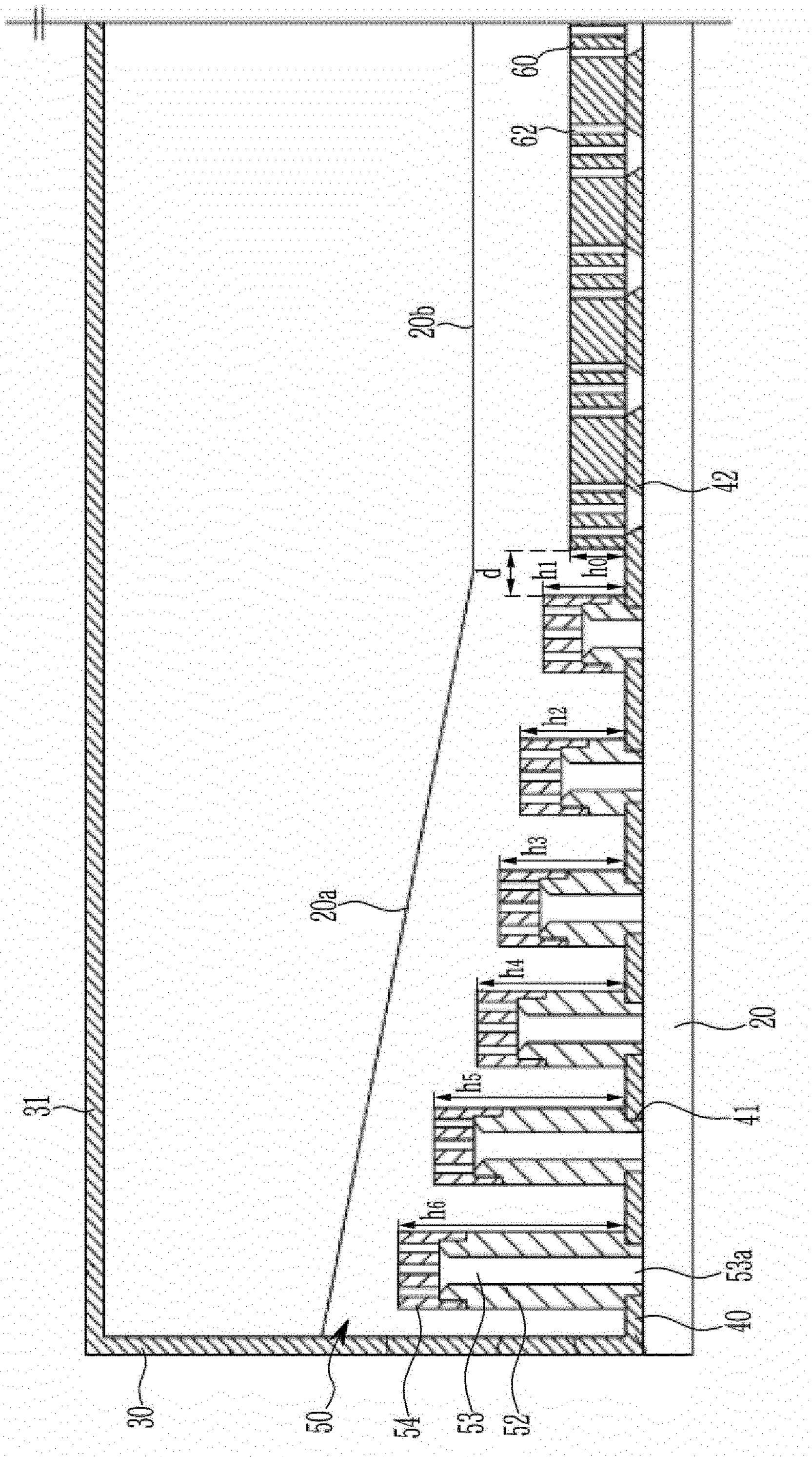


FIG. 6

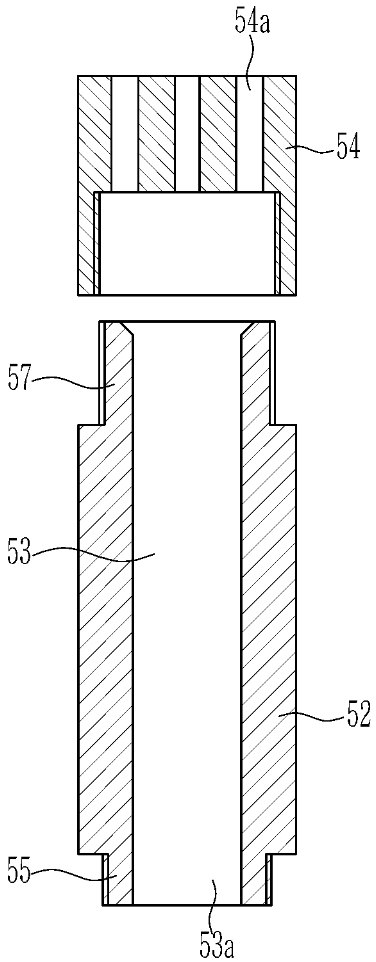


FIG. 7

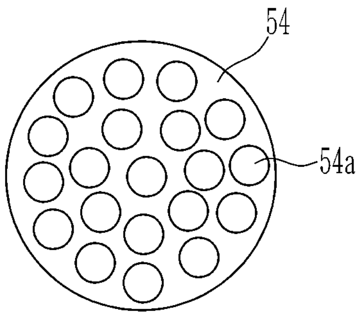


FIG. 8

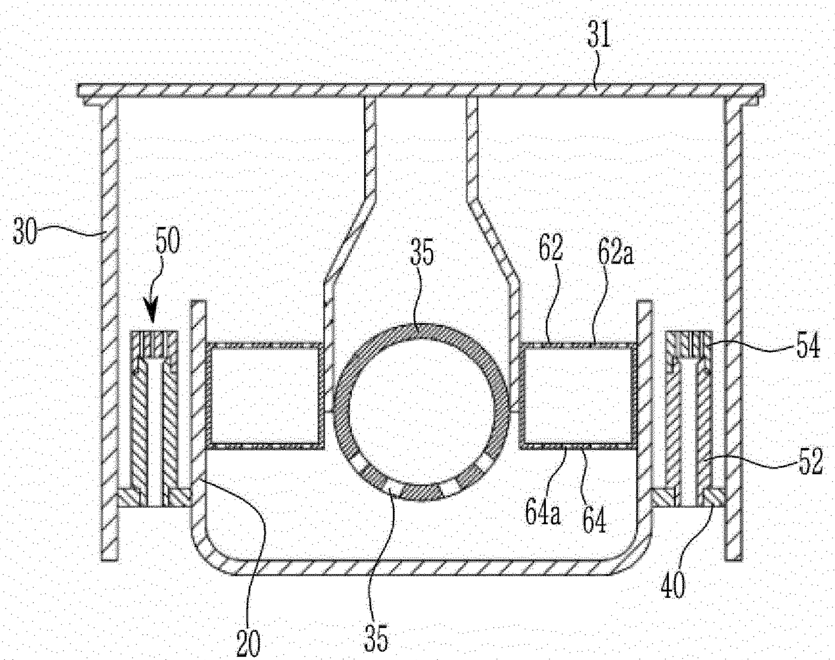


FIG. 9

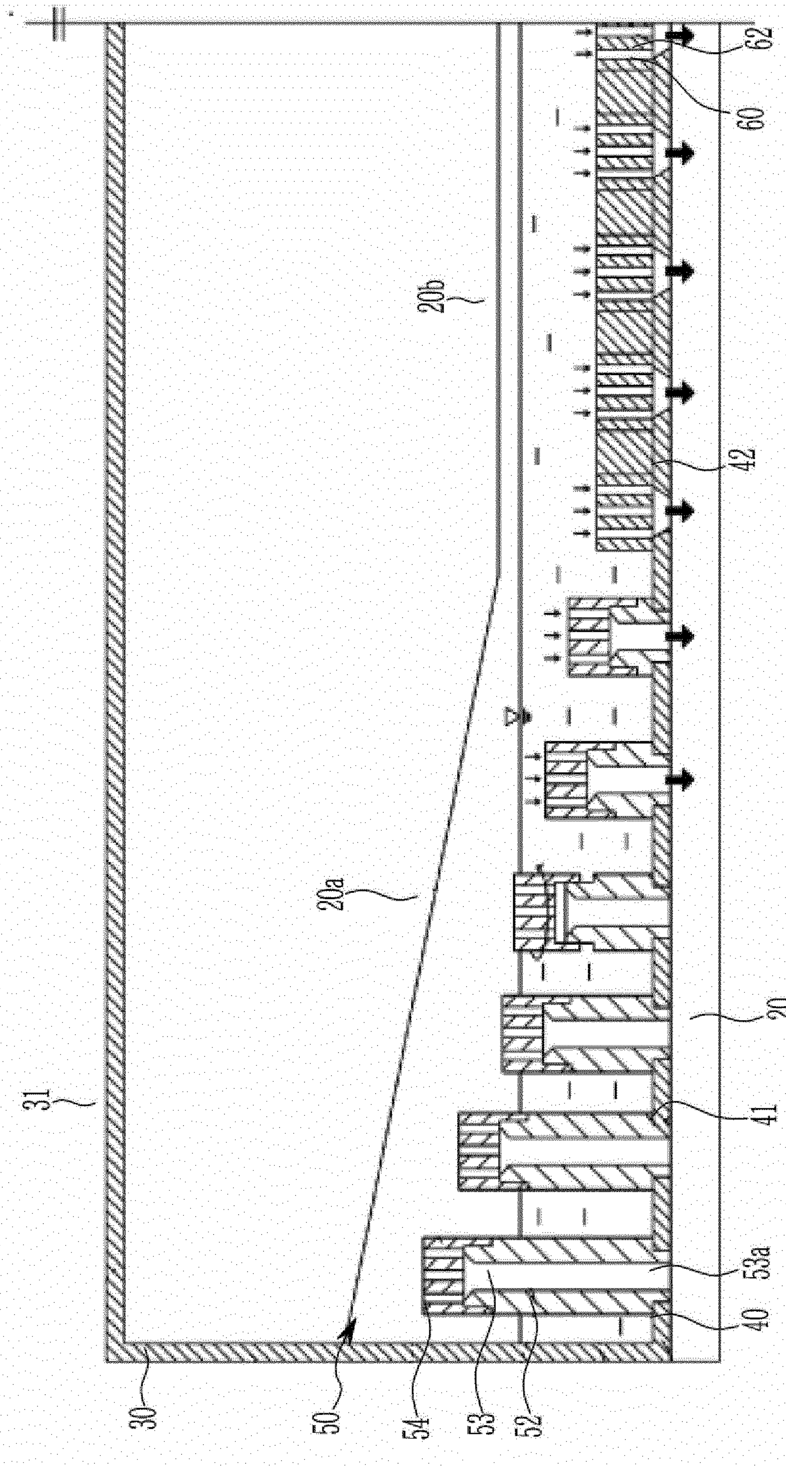


FIG. 10

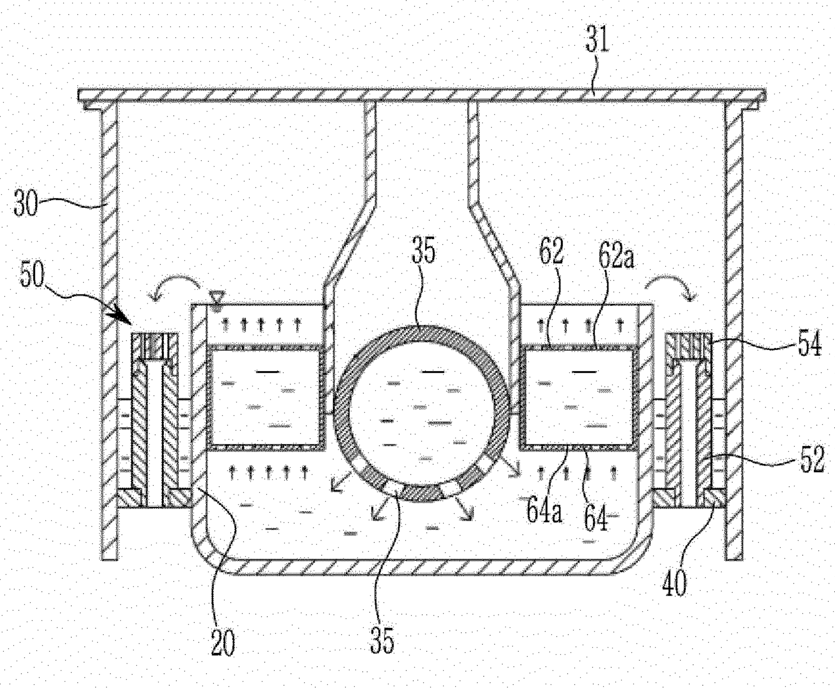


FIG. 11

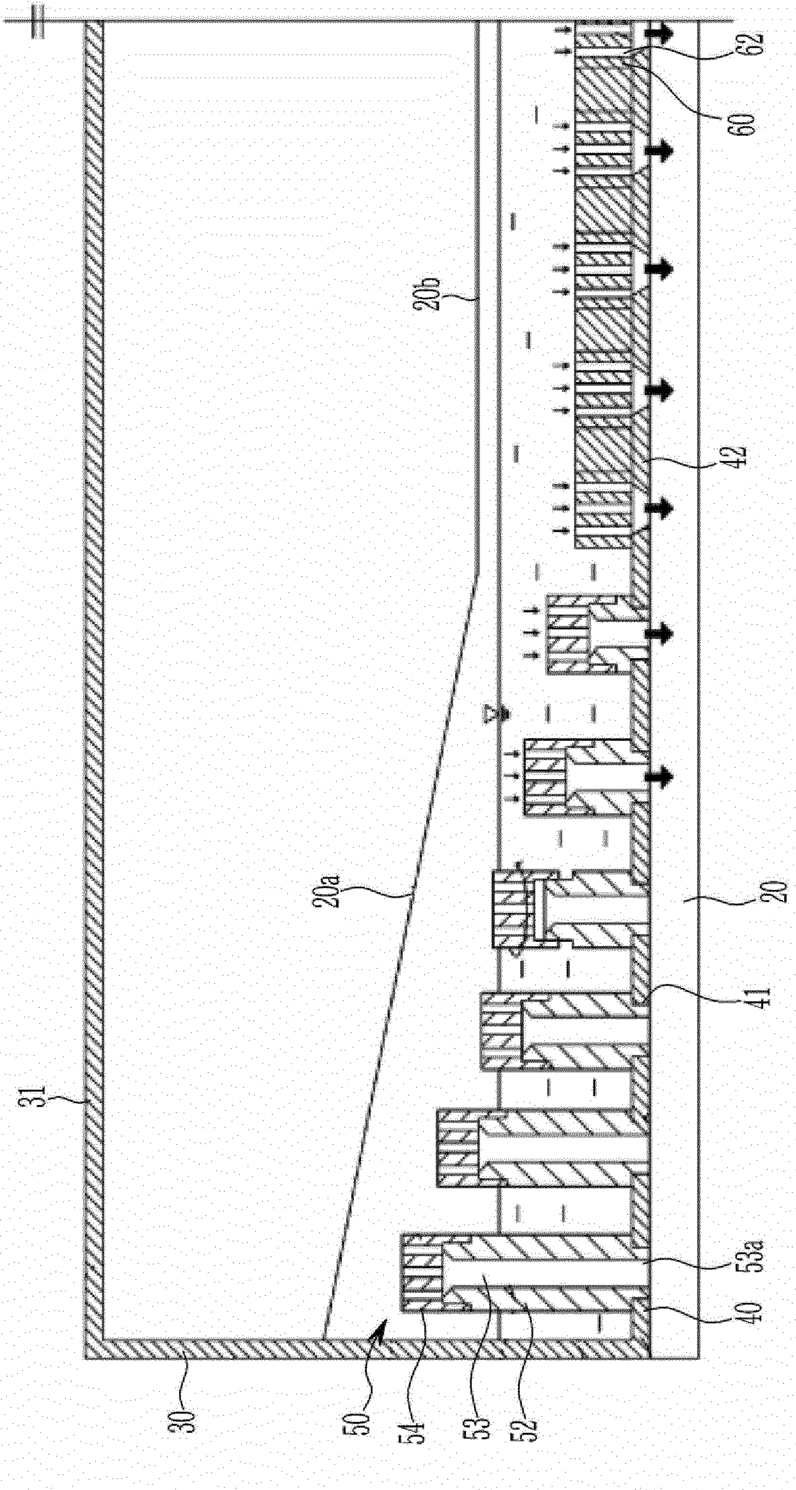


FIG. 12

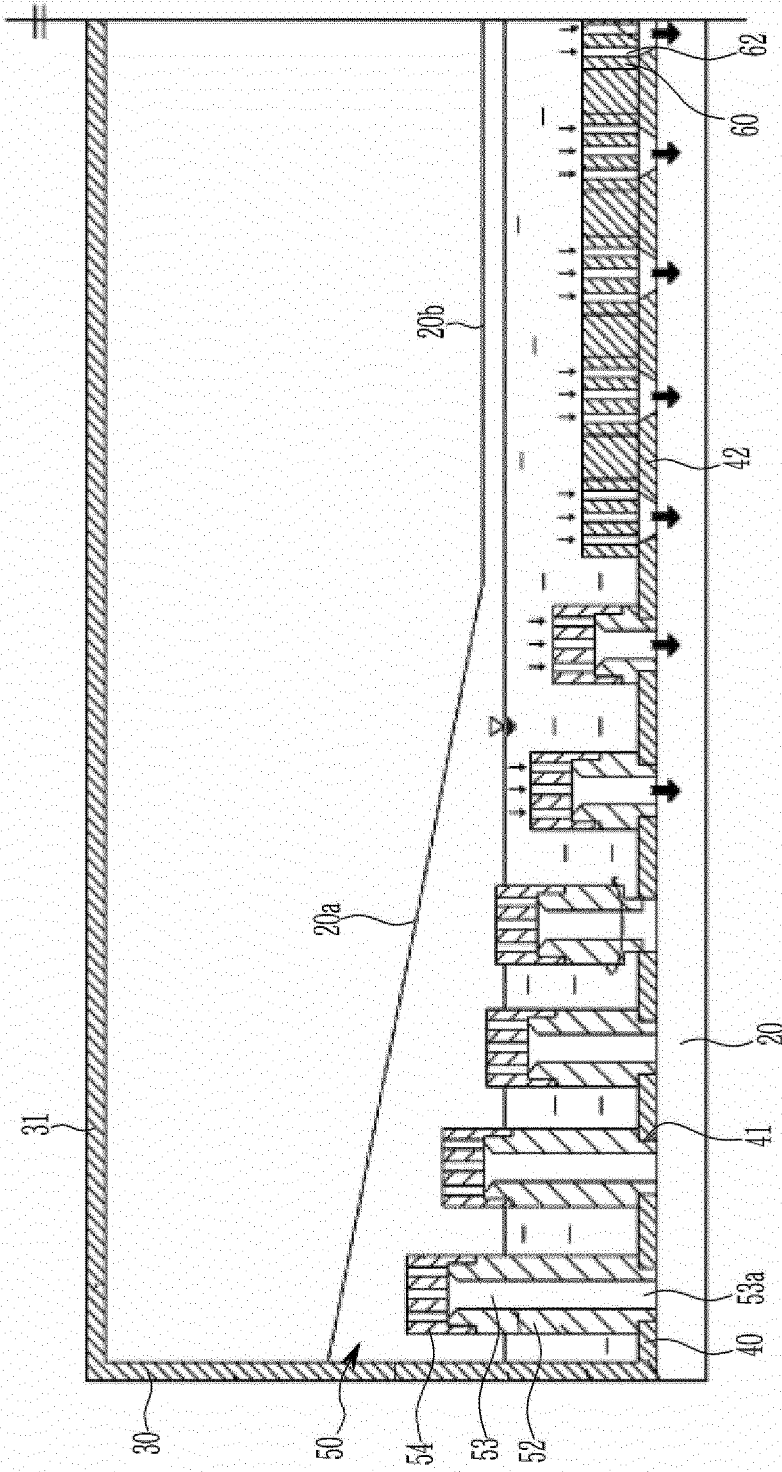
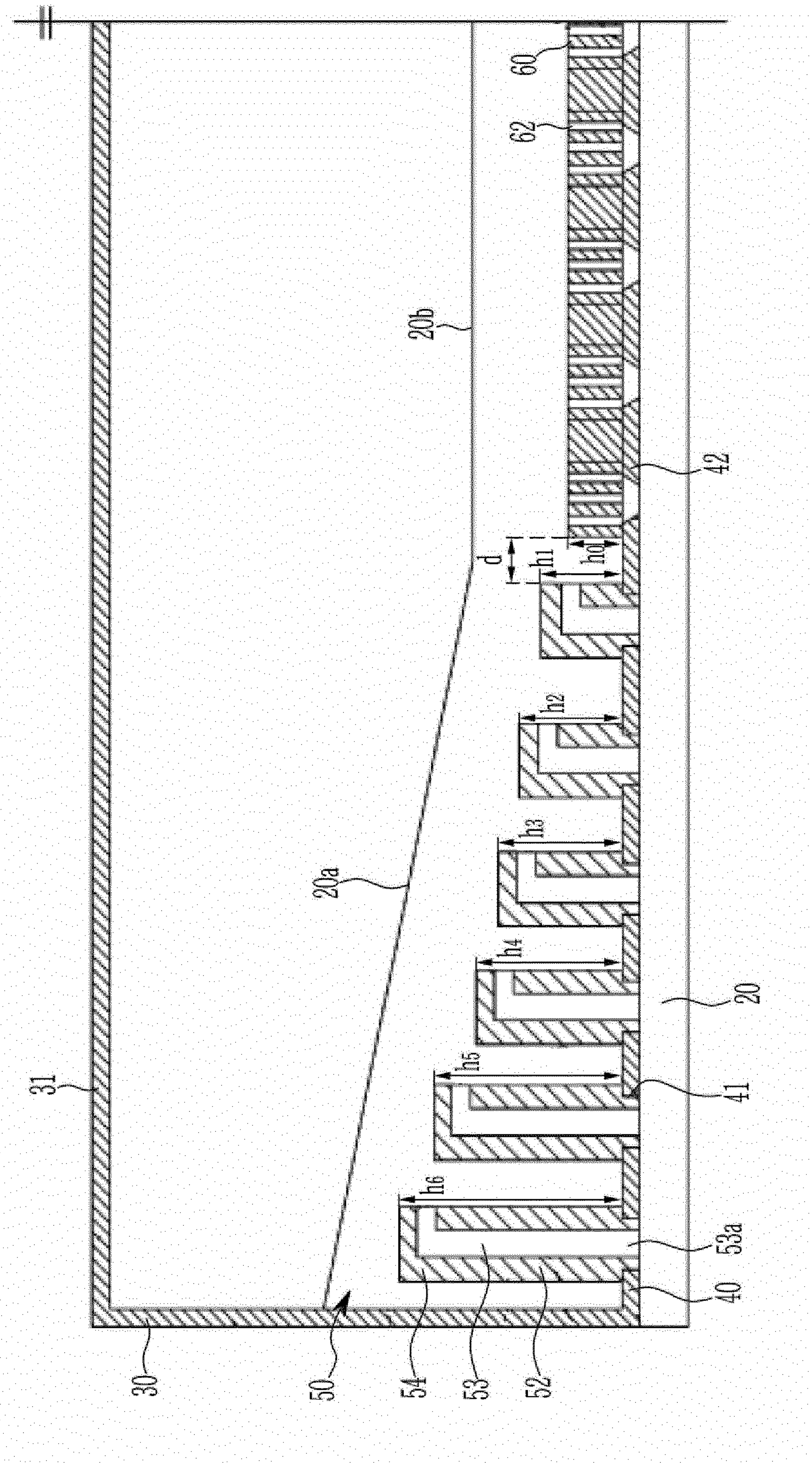


FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/013995

A. CLASSIFICATION OF SUBJECT MATTER

B21B 45/02(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 45/02; B21B 45/00; B21B 37/74

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: rolling, cooling device, nozzle, water tank, slope, width direction, size and filter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-1481616 B1 (POSCO) 12 January 2015 See paragraphs [0009], [0030]-[0032], [0035]-[0036] and figures 2-3.	1-3,6-11,14-16,19
A		4-5,12-13,17-18
A	KR 10-1008071 B1 (POSCO) 13 January 2011 See abstract, paragraphs [0037]-[0038], [0040]-[0042], [0047], [0050], [0053] and figure 3.	1-19
A	KR 10-1998-0014639 A (POHANG IRON AND STEEL CO., LTD. et al.) 25 May 1998 See abstract, page 2, lines 1-38 and figures 3b-3c.	1-19
A	KR 10-0560805 B1 (POSCO) 14 March 2006 See abstract, claims 1, 3-4 and figure 5.	1-19
A	KR 10-1330871 B1 (HYUNDAI STEEL COMPANY) 18 November 2013 See abstract, paragraphs [0026]-[0042] and figures 1-2.	1-19

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

* Special categories of cited documents:
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"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
"T" 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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 SEPTEMBER 2016 (02.09.2016)	**02 SEPTEMBER 2016 (02.09.2016)**

Name and mailing address of the ISA/KR	Authorized officer
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Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2015/013995

Patent document cited in search report	Publication date	Patent family member	Publication date
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KR 10-1998-0014639 A	25/05/1998	KR 10-0311782 B1	17/12/2001
KR 10-0560805 B1	14/03/2006	KR 10-2003-0002548 A	09/01/2003
KR 10-1330871 B1	18/11/2013	KR 10-2013-0046938 A	08/05/2013

Form PCT/ISA/210 (patent family annex) (January 2015)