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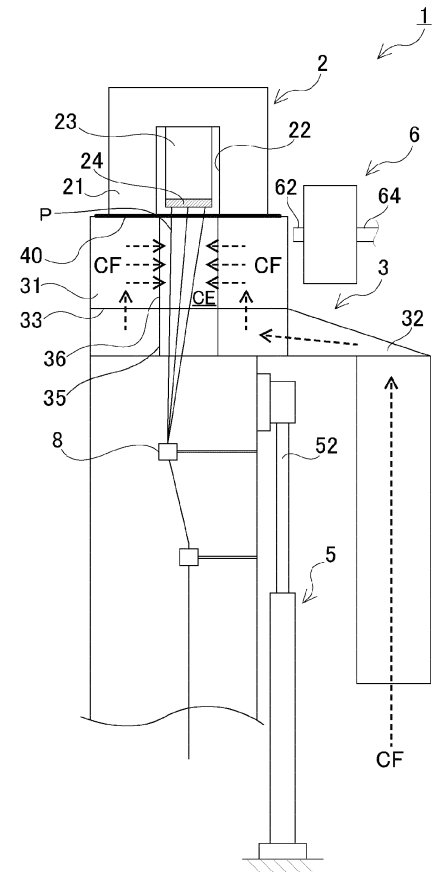
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(54) **SPINNING SYSTEM AND METHOD OF CONTROLLING A SPINNING SYSTEM**

(57) A spinning system configured such that decrease in temperature at a spinneret and in ambient temperature around the spinneret can be suppressed is provided. Such a spinning system includes: a spinning beam 21 having a spinning pack 23 inserted therein including a spinneret 24 for allowing molten polymer P to be spun downward; a cooling unit 3 arranged below the spinning beam 21, including a spinning cylinder 31 extending in an up-and-down direction so as to surround the molten polymer P spun from the spinneret 24, configured to cool the molten polymer P through the use of cooling air CF supplied from a periphery of the spinning cylinder 31; an air cylinder 5 for causing the cooling unit 3 to move downward with respect to the spinning beam 21 so as to form a working space between the cooling unit 3 and the spinning beam 21; and a blower 6 configured to, at least when the cooling unit 3 having been caused to move downward with respect to the spinning beam 21, blow air toward between the spinning beam 21 and the cooling unit 3 in a direction intersecting a yarn path of the molten polymer P spun from the spinneret 24.

FIG. 1



Description**BACKGROUND OF THE INVENTION****FIELD OF THE INVENTION**

[0001] The present invention relates to a spinning system and a controlling method thereof.

DESCRIPTION OF THE BACKGROUND ART

[0002] Conventionally, a spinning system has been provided with a cooling unit arranged below a spinning beam having a spinning pack inserted therein including a spinneret for allowing high-temperature molten polymer to be spun therefrom. The cooling unit includes a spinning cylinder surrounding the high-temperature molten polymer spun from the spinneret. The cooling unit is configured to supply cooling air to the spinning cylinder to blow the cooling air on the high-temperature molten polymer so that the molten polymer can be cooled to be solidified, and thereby yarn is formed.

[0003] In order to maintain yarn productivity and quality, the above sort of spinning system has undergone maintenance on a regular basis for cleaning a spinneret surface (hereinafter referred to as "surface cleaning") or exchanging a spinning pack. Patent Document 1, e.g., discloses maintenance on a spinning system conducted while a cooling unit is lowered to ensure a working space between the cooling unit and a spinning beam (see paragraph 0026 in particular). Further, Patent Document 2, e.g., discloses a filament cooling unit elevated and lowered for exchanging a spinning pack or performing surface cleaning (see paragraph 0023 in particular).

(Prior Art Documents)

(Patent Documents)

[0004]

Patent Document 1: Japanese Patent Application Publication No. 2014-145132

Patent Document 2: Japanese Patent Application Publication No. 2005-42227

(Problems to be Solved)

[0005] By such a technique as described in Patent Documents 1, 2, however, there has been a probability that, in lowering and elevating the cooling unit, a temperature at the spinneret and an ambient temperature around the spinneret would decrease significantly due to an upward air flow from the spinning cylinder. For a temperature at the spinneret and an ambient temperature around the spinneret decreasing significantly, a time has been taken to return to their respective original levels from the production started after completion of the main-

tenance. The physical properties of yarn produced in a state of decrease in temperature at the spinneret and in ambient temperature around the spinneret have been degraded to cause technical problems of increase in yarn to be disposed of.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in view of the above-described technical problems. It is the objective of the present invention to provide a spinning system configured such that decrease in temperature at a spinneret and in ambient temperature around the spinneret can be suppressed.

(Means for Solving Problems)

[0007] A first aspect of the present invention is a spinning system comprising:

a spinning beam having a spinning pack inserted therein including a spinneret for allowing molten polymer to be spun downward;

a cooling unit arranged below the spinning beam, including a spinning cylinder extending in an up-and-down direction so as to surround the molten polymer spun from the spinneret, configured to cool the molten polymer through the use of cooling air supplied from a periphery of the spinning cylinder;

a moving mechanism configured to cause the cooling unit to move downward with respect to the spinning beam so as to form a gap between the cooling unit and the spinning beam; and

a blower configured to, at least when the cooling unit having been caused to move downward with respect to the spinning beam, blow air toward between the spinning beam and the cooling unit in a direction intersecting a yarn path of the molten polymer spun from the spinneret.

[0008] According to the above-described first aspect of the spinning system, when the cooling unit having been caused to move for maintenance, air can be blown toward between the spinning beam and the cooling unit in a direction intersecting a yarn path of the molten polymer spun from the spinneret. As a result, air flowing toward the spinneret can be blocked. In other words, as a result of blowing air toward a direction intersecting a yarn path of the molten polymer spun from the spinneret, the flowing of air toward the spinneret can be interrupted or an amount of air flowing toward the spinneret can be reduced. As a consequence, decrease in temperature at the spinneret and in ambient temperature around the spinneret can be suppressed, and therefore a time taken for a temperature at the spinneret and an ambient temperature around the spinneret to return to their respective original levels can be shortened. Eventually, a time taken for yarn to be stabilized in physical properties can be

shortened, and therefore an amount of yarn to be disposed of can be reduced.

[0009] A second aspect of the spinning system in the above-described first aspect is characterized in that the blower stops operation when the spinning beam and the cooling unit abut each other.

[0010] According to the above-described second aspect of the spinning system, the abutting between the spinning beam and the cooling unit closes an upper opening of the spinning cylinder. The closed upper opening of the spinning cylinder causes the cooling air supplied from the cooling unit to mostly flow downward, and therefore decrease in temperature at the spinneret and in ambient temperature around the spinneret can be suppressed. As a result, a time taken for a temperature at the spinneret and an ambient temperature around the spinneret to return to their respective original levels can be shortened, and eventually, a time taken for yarn to be stabilized in physical properties can be shortened.

[0011] A third aspect of the spinning system in the above-described first aspect or second aspect is characterized in that the blower is further configured such that a direction of cooling air blown toward the spinneret out of cooling air supplied to the spinning cylinder is changeable.

[0012] According to the above-described third aspect of the spinning system, a changeable direction of cooling air toward the spinneret can reduce an amount of air flowing toward the spinneret and an area around the spinneret, or can interrupt the flowing of air, thereby capable of suppressing decrease in temperature at the spinneret and in ambient temperature around the spinneret. Even without stopping of cooling air supplied to the spinning cylinder, decrease in temperature at the spinneret and in ambient temperature around the spinneret can be suppressed by changing a direction of cooling air toward the spinneret. As a result, it becomes possible to reduce time loss to be caused by stopping cooling air and then restarting the flowing of cooling air, and work burden to be required for cooling air and then restarting the flowing of cooling air.

[0013] A fourth aspect of the present invention is a method of controlling a spinning system comprising:

a spinning beam having a spinning pack inserted therein including a spinneret for allowing molten polymer to be spun downward; and
a cooling unit arranged below the spinning beam, including a spinning cylinder extending in an up-and-down direction so as to surround the molten polymer spun from the spinneret, configured to cool the molten polymer through the use of cooling air supplied from a periphery of the spinning cylinder, wherein said spinning system performs:

a preparation step of causing the cooling unit to move downward with respect to the spinning beam so as to form a gap between the cooling

unit and the spinning beam;

a temperature decrease suppression step of suppressing decrease in temperature at the spinneret at least when the cooling unit having been caused to move downward with respect to the spinning beam; and

a restoration step of causing the cooling unit to move upward with respect to the spinning beam while suppressing decrease in temperature at the spinneret after the cooling unit having been caused to move downward with respect to the spinning beam so as to undergo maintenance, and

wherein the temperature decrease suppression step includes:

an air blowing step of blowing air toward between the spinning beam and the cooling unit in a direction intersecting a yarn path of the molten polymer spun from the spinneret.

[0014] According to the above-described fourth aspect of the controlling method, when the cooling unit having been caused to move down for maintenance, air can be blown toward between the spinning beam and the cooling unit in a direction intersecting a yarn path of the molten polymer spun from the spinneret, and therefore air flowing toward the spinneret can be blocked while its amount being reduced. As a result, decrease in temperature at the spinneret and in ambient temperature around the spinneret can be suppressed, and therefore a time taken for a temperature at the spinneret and an ambient temperature around the spinneret to return to their respective original levels can be shortened. Eventually, a time taken for yarn to be stabilized in physical properties can be shortened, and therefore an amount of yarn to be disposed of can be reduced.

[0015] A fifth aspect of the controlling method in the above-described fourth aspect is characterized in that, in the air blowing step, blowing air is finished, during performance of the restoration step, after having undergone maintenance, or when the restoration step having been finished.

[0016] According to the above-described fifth aspect of the controlling method, when the restoration step having been finished, an upper opening of the spinning cylinder is closed. The closed upper opening of the spinning cylinder causes the cooling air supplied from the cooling unit to mostly flow downward, and therefore decrease in temperature at the spinneret and in ambient temperature around the spinneret can be suppressed. As a result, a time taken for a temperature at the spinneret and an ambient temperature around the spinneret to return to their respective original levels can be shortened, and eventually, a time taken for yarn to be stabilized in physical properties can be shortened.

[0017] A sixth aspect of the controlling method in the above-described fourth aspect or five aspect is characterized in that, in the air blowing step, a direction of cooling

air blown toward the spinneret out of cooling air supplied to the spinning cylinder is changeable.

[0018] According to the above-described sixth aspect of the controlling method, a changeable direction of cooling air toward the spinneret can reduce an amount of air flowing toward the spinneret and an area around the spinneret, or can interrupt the flowing of air, thereby capable of suppressing decrease in temperature at the spinneret and in ambient temperature around the spinneret. Even without stopping of cooling air supplied to the spinning cylinder, decrease in temperature at the spinneret and in ambient temperature around the spinneret can be suppressed by changing a direction of cooling air toward the spinneret. As a result, it becomes possible to reduce time loss to be caused by stopping cooling air and then restarting the flowing of cooling air, and work burden to be required for cooling air and then restarting the flowing of cooling air.

[0019] The spinning system according to the present invention does not necessarily include all the above-described first aspect to third aspect. The invention in the above-described first aspect, e.g., does not need to encompass both of the invention in the above-described second aspect and the invention in the above-described third aspect. The present invention may be obtained by arbitrarily combining the first aspect and at least a part of the second aspect, or by arbitrarily combining the first aspect and at least a part of the third aspect, or by arbitrarily combining the first aspect, at least a part of the second aspect, and at least a part of the third aspect, to such an extent that consistency can be achieved. In a similar manner, the controlling method according to the present invention does not necessarily include all the above-described fourth aspect to sixth aspect. The invention in the above-described fourth aspect, e.g., does not need to encompass both of the invention in the above-described fifth aspect and the invention in the above-described sixth aspect. The present invention may be obtained by arbitrarily combining the fourth aspect and at least a part of the fifth aspect, or by arbitrarily combining the fourth aspect and at least a part of the sixth aspect, or by arbitrarily combining the fourth aspect, at least a part of the fifth aspect, and at least a part of the sixth aspect, to such an extent that consistency can be achieved.

(Advantageous Effects of the Invention)

[0020] According to the present invention, it is possible to provide a spinning system configured such that decrease in temperature at a spinneret and in ambient temperature around the spinneret can be suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

FIG. 1 depicts an example of side view taken sche-

matically from a right side with respect to a part of a spinning system according to an embodiment of the present invention;

FIG. 2 depicts an example of front view taken schematically from a forward side with respect to a part of the spinning system shown in FIG. 1;

FIG. 3 depicts an example of schematic view of the spinning system in a state of having caused a cooling unit to move down in the spinning system shown in FIG. 1;

FIG. 4 depicts an example of function block diagram schematically showing an electrically-connected configuration of the spinning system;

FIG. 5 depicts an example of explanatory view of a maintenance step of a conventional spinning system schematically showing a part thereof in an operational state;

FIG. 6 depicts an example of explanatory view of a maintenance step of the conventional spinning system schematically showing a part thereof in a state of stopping the spinning of molten polymer;

FIG. 7 depicts an exemplary view of a maintenance step of the conventional spinning system schematically showing a part thereof in a state of having caused a cooling unit to move down to a lower end with respect to a spinning beam;

FIG. 8 depicts an example of explanatory view of a maintenance step of the conventional spinning system schematically showing a part thereof in a state of allowing a spinning pack to be exchanged;

FIG. 9 depicts an example of explanatory view of a maintenance step of the conventional spinning system schematically showing a part thereof in a state of restarting the spinning of molten polymer;

FIG. 10 depicts an example of explanatory view of a maintenance step of the conventional spinning system schematically showing a part thereof in a state of allowing a cover for covering an upper opening of a spinning cylinder to be detached;

FIG. 11 depicts an example of explanatory view of a maintenance step of the conventional spinning system schematically showing a part thereof in a state of allowing a spinning cylinder to have yarn threaded therethrough in yarn threading work;

FIG. 12 depicts an example of schematic diagram showing a result of circular knit staining evaluation changed with the passage of time from the restoration to an operational state after the maintenance in a conventional maintenance step;

FIG. 13 depicts a graph showing a result of thermal stress and de-twisting tension on yarn changed with the passage of time from the restoration to an operational state after the maintenance in a conventional maintenance step;

FIG. 14 depicts a graph showing a surface temperature of a spinneret changed with the passage of time from the starting of maintenance in a conventional maintenance step;

FIG. 15 depicts an example of explanatory view of a maintenance step according to an embodiment of the present invention schematically showing a part of a spinning system in a state of stopping the spinning of molten polymer;

FIG. 16 depicts an example of explanatory view of a maintenance step according to an embodiment of the present invention schematically showing a part of the spinning system in a state of having caused a cooling unit to move down to a lower end with respect to a spinning beam;

FIG. 17 depicts an example of explanatory view of a maintenance step according to an embodiment of the present invention schematically showing a part of the spinning system in a state of restarting the spinning of molten polymer;

FIG. 18 depicts an example of explanatory view of a maintenance step according to an embodiment of the present invention schematically showing a part of the spinning system in a state of allowing a cover for covering an upper opening of a spinning cylinder to be detached;

FIG. 19 depicts an example of explanatory view of a maintenance step according to an embodiment of the present invention schematically showing a part of the spinning system in a state of allowing the spinning cylinder to have yarn threaded therethrough in yarn threading work;

FIG. 20 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing a part of the spinning system in a state of stopping the spinning of molten polymer;

FIG. 21 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing a part of the spinning system in a state of having caused the cooling unit to move down to a lower end with respect to the spinning beam;

FIG. 22 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing a part of the spinning system in a state of restarting the spinning of molten polymer;

FIG. 23 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing a part of the spinning system in a state of causing a blower to start operation;

FIG. 24 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing a part of the spinning system in a state of allowing the spinning cylinder to have yarn threaded therethrough in yarn threading work;

FIG. 25 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing

a part of the spinning system in a state of having caused the cooling unit to move up to an upper end with respect to the spinning beam;

FIG. 26 depicts an example of explanatory view of a maintenance step according to a modified embodiment of the present invention schematically showing a part of the spinning system in a state of being restored to an operational state;

FIG. 27 depicts an example of schematic diagram showing a result of circular knit staining evaluation changed with the passage of time from the restoration to an operational state after the maintenance step according to an embodiment of the present invention;

FIG. 28 depicts an example of graph showing results of thermal stress and de-twisting tension on yarn changed with the passage of time from the restoration to an operational state after the maintenance in their respective steps of conventional maintenance and maintenance according to a modified embodiment of the present invention; and

FIG. 29 depicts an example of graph showing levels of surface temperature of a spinneret changed with the passage of time from the starting of maintenance in their respective steps of: conventional maintenance; maintenance according to an embodiment of the present invention; and maintenance according to a modified embodiment of the present invention.

DESCRIPTIONS OF EMBODIMENTS OF THE INVENTION

[0022] An embodiment of the present invention will be described with reference to the drawings hereinafter. For the convenience of description, an up-and-down direction, a left-and-right direction, and a forward-and-backward direction are as shown in their respective drawings to be described later.

[1. Outline of Spinning System]

[0023] First, an outline of a spinning system 1 according to an embodiment of the present invention will be described. FIG. 1 depicts an example of side view taken schematically from a right side with respect to a part of the spinning system 1 according to an embodiment of the present invention. FIG. 2 depicts an example of front view taken schematically from a forward side with respect to a part of the spinning system 1 shown in FIG. 1. FIG. 3 depicts an example of schematic view of the spinning system in a state of having caused a cooling unit 3 to move down in the spinning system 1 shown in FIG. 1. The illustrations of a polymer tank 25 and a polymer pipe 26 shown in FIG. 2 are omitted from FIGS. 1 and 3. While illustrations of molten polymer P and a yarn Y are omitted from FIG. 3 for the sake of convenience, the yarn Y may be formed as a result of spinning the molten polymer P from a spinneret 24, when the cooling unit 3 is caused

to move down, so that the spun molten polymer P is cooled to be solidified through the use of the cooling unit 3 or under other conditions.

[0024] The spinning system 1 according to an embodiment of the present invention is a system for producing a yarn Y made of synthetic fibers. As shown in FIG. 1, e.g., the spinning system 1 includes a spinning unit 2, a cooling unit 3, a moving mechanism 5, a blower 6, and a controller 7 (see FIG. 4 to be described later). In addition to these structures, the spinning system 1 includes an oil-agent application unit 8, a take-up unit (not shown), a winder (not shown), and the like. Descriptions of such structures are however omitted here.

[Spinning Unit]

[0025] As shown in FIG. 1 or 2, the spinning unit 2 is a melt spinning unit configured to spin molten polymer P as material of a yarn Y. The spinning unit 2 includes a spinning beam 21 having a substantially rectangular-solid shape, a plurality of pack housings 22 formed in the spinning beam 21, a plurality of spinning packs 23 (whose number is the same as, e.g., the number of the plurality of pack housings 22) arranged respectively in the plurality of pack housings 22, a polymer tank 25 having polymer stored therein, and a plurality of polymer pipes 26 connecting between their respective spinning packs 23 and the polymer tank 25.

[0026] For the sake of convenience, three pack housings 22 and three spinning packs 23 are shown in FIG. 2. However, the invention is not limited to such a configuration. A larger number of pack housings 22 and a larger number of spinning packs 23 (e.g., twelve) may be provided.

[0027] Polymer in the polymer tank 25 is fed through the plurality of polymer pipes 26 to the plurality of spinning packs 23. In feeding the polymer from the polymer tank 25 to the spinning pack 23, the polymer in the polymer tank 25 and in the polymer pipe 26 is heated by the spinning beam 21 to a predetermined temperature (e.g., 300 °C) to become molten polymer.

[0028] High-temperature heated molten polymer in a liquid state is supplied through the polymer pipe 26 to each spinning pack 23. A spinneret 24 is arranged at a lower end portion of each spinning pack 23. That is, the number of the spinnerets 24 is the same as that of the spinning packs 23. The spinneret 24 has, e.g., a plurality of nozzles (not shown). The spinning pack 23 ejects molten polymer P through the plurality of nozzles of the spinneret 24 (in other words, spins a plurality of yarns Y). The molten polymer P ejected through the plurality of nozzles is cooled by the cooling unit 3 to become the plurality of yarns Y having a plurality of filaments. Specifically, one yarn Y is spun from one spinneret 24. Each spinneret 24 is not necessarily required to have a plurality of nozzles but may have only one nozzle. In such a case, the yarn Y is produced as monofilament yarn.

[Cooling Unit]

[0029] As shown in FIG. 1, the cooling unit 3 includes a spinning cylinder 31 arranged below the spinning unit 2, a duct 32 connected to the spinning cylinder 31, and a first compressed-air source 37 (see FIG. 4 to be described later) configured to supply cooling air CF to the spinning cylinder 31 through the duct 32. In an embodiment of the present invention, a cyclic yarn cooling unit, e.g., is used as the cooling unit 3. The spinning cylinder 31 is e.g. a hollow box body, and extends in an up-and-down direction so as to surround the molten polymer spun from the spinneret 24 (so as to locate the molten polymer P in a hollow area CE). The spinning cylinder 31 includes a flow straightening plate 33 provided therein. Air for cooling (the air will be called "cooling air CF") supplied from the first compressed-air source 37 passes through the inside of the duct 32 and is supplied into lower space (space under the flow straightening plate 33) of the spinning cylinder 31. The cooling air CF having flowed into the lower space of the spinning cylinder 31 passes through the flow straightening plate 33 to be straightened upward, and then flows into upper space (space over the flow straightening plate 33) of the spinning cylinder 31. A plurality of partitioning cylinders 35 is arranged at a position directly below a filter member 36. The partitioning cylinder 35 is configured to prevent transmission of the cooling air CF in a radial direction of the partitioning cylinder 35, thereby preventing the cooling air CF from flowing from the lower space of the spinning cylinder 31 directly into the hollow area CE. The cooling air CF having flowed into the upper space of the spinning cylinder 31 is straightened in passing through the filter member 36 having, e.g., a punching filter and a cooling filter, and then flows into the hollow area CE. In such a manner, the cooling air CF is blown on a yarn material from a periphery of the filter member 36, more specifically, from an entire outer perimeter of the filter member 36. As a result, the yarn material is cooled to become the yarn Y. A sealing member 40 is provided at a place where the spinning beam 21 and the spinning cylinder 31 are in abutting contact with each other. The sealing member 40 can be used for preventing leakage from a surface of the abutting contact between the spinning beam 21 and the spinning cylinder 31.

[Moving Mechanism]

[0030] The moving mechanism 5 having e.g. an air cylinder (the moving mechanism 5 will be called an air cylinder 5) is configured to cause the cooling unit 3 to move up and down. More specifically, the air cylinder 5 is standing upright on, e.g., a floor surface of a factory. The air cylinder 5 has a piston rod 52 extending longitudinally in an up-and-down direction arranged so as to be expandable/contractible in an up-and-down direction. The spinning cylinder 31 has a lower end fixed with a wall member 10 extending downward. The wall member 10 has a side

surface fixed with a tip of the piston rod 52. In such a configuration, the cooling unit 3 is entirely movable by the actuation of the air cylinder 5 between a first position (see FIG. 1) corresponding to an operational state where the spinning system 1 is in an operational state and a second position (see FIG. 3) below the first position. The cooling unit 3 is caused to move up in response to the actuation of the piston rod 52 of the air cylinder 5 in an expanding direction (upward direction in FIG. 1) and is caused to move down in response to the actuation of the piston rod 52 in a contracting direction (downward direction in FIG. 1). The production of the yarn Y is feasible when the cooling unit 3 is at the first position. When the cooling unit 3 is at the first position, a force acting upward (toward the spinning beam 21) is applied to the cooling unit 3 by the air cylinder 5. When the cooling unit 3 is at the second position, a gap is formed as a working space Sw between the spinning unit 2 (more specifically, the spinning beam 21) and the cooling unit 3 as viewed in an up-and-down direction. Hereinafter, for the sake of convenience, the foregoing "first position" will be called an "upper end" and the foregoing "second position" will be called a "lower end." However, the "first position" is not limited to the upper end, and the "second position" is not limited to the lower end.

[Blower]

[0031] As shown in FIG. 3, the blower 6 is a device configured to blow side air SF such that the side air SF flows in a substantially horizontal direction in a working space Sw when the cooling unit 3 is at the lower end. In this specification, "blowing" of air may also be called "release."

[0032] The blower 6 includes, e.g., a second compressed-air source 66 (see FIG. 4 to be described later), a plurality of air nozzles 62 through which air (e.g., compressed air) supplied from the second compressed-air source 66 is releasable as the side air SF, an air pipe 64 connecting the second compressed-air source 66 and each air nozzle 62, and the like. The plurality of air nozzles 62 corresponding to the plurality of spinning packs 23, respectively, are arranged side by side in a left-and-right direction. In an embodiment of the present invention, the plurality of air nozzles 62 are arranged so as to cause the side air SF released from the air nozzle 62 to flow in one direction from a backward side toward a forward side in a working space Sw formed between the spinning unit 2 and the cooling unit 3 as viewed in an up-and-down direction. The reason for causing the side air SF released from the plurality of air nozzles 62 to flow in one direction is to prevent flows of the cooling air CF directed in different directions from interfering with each other.

[0033] It is not necessarily required to arrange the plurality of air nozzles 62 so as to cause side air SF to flow from a backward side toward a forward side. The air nozzles 62 may be arranged so as to, e.g., cause the side air SF to flow from a forward side toward a background

side. The plurality of air nozzles 62 may alternatively be arranged so as to cause the side air SF to flow from a left side toward a right side. In consideration of attenuation of the flow rate of the side air SF with a greater distance from the air nozzle 62, however, the plurality of air nozzles 62 are preferably arranged so as to cause the side air SF to flow from a backward side toward a forward side, and vice versa.

[0034] It is not necessarily required to provide the plurality of air nozzles 62 corresponding to the plurality of spinning packs 23, respectively. The plurality of air nozzles 62 may be replaced, e.g., with a single flat nozzle having a greater width than a length in a left-and-right direction from a spinning pack 23 at the left end to a spinning pack 23 at the right end.

[0035] The reason for causing the side air SF released from the air nozzle 62 to flow in a substantially horizontal direction in a working space Sw is to prevent the side air SF released from the air nozzle 62 from going toward the spinneret 24 and toward a place around the spinneret 24. Thus, as long as compressed air released from the air nozzle 62 does not go toward the spinneret 24 and toward a place around the spinneret 24, the air nozzles 62 are not necessarily required to be arranged so as to cause the compressed air released from the air nozzles 62 to flow as the side air SF in a substantially horizontal direction. The air nozzles 62 may be arranged so as to, e.g., cause the compressed air released from the air nozzles 62 to flow diagonally downward. In another case, the air nozzles 62 may be arranged so as to cause the compressed air released from the air nozzles 62 to flow diagonally upward.

[0036] In an embodiment of the present invention, the second compressed-air source 66 for supplying compressed air to the air nozzle 62 and the first compressed-air source 37 for supplying the cooling air CF to the spinning cylinder 31 are provided separately. However, the invention is not limited to such a configuration. A common compressed-air source may be provided for supplying compressed air to both of the air nozzle 62 and the spinning cylinder 31. Further, it is not necessarily required to connect the second compressed-air source 66 and each air nozzle 62 through the air pipe 64. An air hose, e.g., may be used for the connection.

[Controller]

[0037] FIG. 4 depicts an example of function block diagram schematically showing an electrically-connected configuration of the spinning system 1. The controller 7 is configured to perform processing relating to operation of the spinning system 1. The controller 7 is responsible for controls such as operation and stop of the spinning of molten polymer P from the spinneret 24, actuation and stop of the air cylinder 5, regulation of the flow rate of cooling air CF supplied to the spinning cylinder 31, i.e., into the hollow area CE, and regulation of the flow rate of compressed air released from the air nozzle 62 forming

the blower 6.

[0038] The controller 7 includes a CPU, ROM, RAM, and the like. The controller 7 is connected electrically to units including an operation unit 72 having buttons and the like operable by an operator, an upper end detection sensor 76 for determining that the cooling unit 3 is at the upper end, and a lower end detection sensor 78 for determining that the cooling unit 3 is at the lower end. The controller 7 is configured to receive signals from the units including the operation unit 72, the upper end detection sensor 76, and the lower end detection sensor 78.

[0039] The controller 7 is further connected electrically to units including a gear pump 28 capable of causing the spinning of the molten polymer P from the spinneret 24, the first compressed-air source 37, the second compressed-air source 66, and a solenoid 74 configured to actuate the air cylinder. On the basis of receipt of various sorts of signals from the units including the operation unit 72, the upper end detection sensor 76, and the lower end detection sensor 78, the controller 7 controls the units including the gear pump 28, the first compressed-air source 37, the second compressed-air source 66, and the solenoid 74. The controller 7 controls the solenoid 74 to control actuation of the air cylinder 5.

[0040] In response to control over the first compressed-air source 37, the flow rate of the cooling air CF (hereinafter referred to as "air volume") supplied to the spinning cylinder 31 is controlled. In response to control over the second compressed-air source 66, the flow rate of the side air SF (hereinafter referred to as "air volume" like the cooling air CF) released from the air nozzle 62 is controlled.

[0041] The cooling air CF supplied to the spinning cylinder 31 may be controlled by an automatic valve arranged upstream from the duct 32 instead of operation or stop of the first compressed-air source 37. The air volume of the side air SF released from the air nozzle 62 may be controlled by an automatic valve arranged upstream from the air nozzle 62.

[2. Maintenance Step]

[0042] Second, a maintenance step to be undergone by a spinning system will be described. Before description of such a maintenance step according to an embodiment of the present invention conducted for the spinning system 1, a conventional maintenance step will be described by referring to FIGS. 5 to 11. In describing the conventional maintenance step, signs given to various structures forming the spinning system 1 according to an embodiment of the present invention are applied as they are to the corresponding structures (including a spinning unit and a cooling unit) forming a conventional spinning system 100. Meanwhile, the conventional spinning system 100 does not include the above-described blower 6.

[2-1. Conventional maintenance step in conventional spinning system]

[0043] FIG. 5 depicts an example of explanatory view of a maintenance step of the conventional spinning system 100 schematically showing a part thereof in an operational state. While the spinning system 100 is in an operational state, the spinning beam 21 and the cooling unit 3 are in abutting contact with each other. While the spinning system 100 is in operation, the molten polymer P is spun from the spinneret 24 and the cooling air CF is supplied from the first compressed-air source 37 to the spinning cylinder 31 through the duct 32. The cooling air CF supplied to the spinning cylinder 31 flows in a substantially horizontal direction into the hollow area CE to cool the molten polymer P spun from the spinneret 24.

[2-1-1. Preparation step]

[0044] FIG. 6 depicts an example of explanatory view of a maintenance step of the conventional spinning step schematically showing a part thereof in a state of stopping the spinning of molten polymer 100 in a state where the spinning of the molten polymer P. For the maintenance on the spinning system 100, the spinning of the molten polymer P from the spinneret 24 is stopped first, as shown in FIG. 6. The spinning of the molten polymer P is stopped by the controller 7 in response to the operation by, e.g., an operator. During the maintenance, supply of the cooling air CF by the cooling unit 3 is continued. In the present specification, the maintenance corresponds to, e.g., surface cleaning of the spinneret 24 or exchange of the spinning pack 23.

[0045] FIG. 7 depicts an exemplary view of a maintenance step of the conventional spinning system 100 schematically showing a part thereof in a state of having caused the cooling unit 3 to move down to the lower end with respect to the spinning beam 21. After stopping the spinning of the molten polymer P, the controller 7 actuates the air cylinder 5 in a contracting direction to lower the cooling unit 3 with respect to the spinning beam 21, as shown in FIG. 7. Causing the cooling unit 3 to move down with respect to the spinning beam 21 forms the working space Sw between the spinning unit 2 and the cooling unit 3 as viewed in the up-and-down direction. When the cooling unit 3 is caused to move down with respect to the spinning beam 21, the operator immediately conducts work of covering an upper opening of the spinning cylinder 31 with a cover 42. Covering the upper opening of the spinning cylinder 31 with the cover 42 makes it possible to stop an upward air flow (namely, the cooling air CF) from the upper opening of the spinning cylinder 31.

[2-1-2. Maintenance main step]

[0046] After covering the upper opening of the spinning cylinder 31 with the cover 42, the operator conducts the

maintenance. The detail of the maintenance includes surface cleaning of the spinneret 24 and exchange of the spinning pack 23. While a time required for the maintenance is determined in a manner depending upon a detail of the maintenance, it is generally 10 minutes. The operator conducts surface cleaning of the spinneret 24 or exchange of the spinning pack 23 in response to purpose. FIG. 8 depicts an example of explanatory view of a maintenance step of the conventional spinning system 100 schematically showing a part thereof in a state of allowing the spinning pack 23 to be exchanged.

[2-1-3. Molten polymer spinning restarting step]

[0047] FIG. 9 depicts an example of explanatory view of a maintenance step of the conventional spinning system showing a part of the spinning system 100 in a state where the spinning of the molten polymer P is restarted. After implementation of the maintenance, in response to operation by the operator, e.g., the controller 7 starts (re-starts) the spinning of the molten polymer P from the spinneret 24, as shown in FIG. 9.

[2-1-4. Cover detaching step]

[0048] FIG. 10 depicts an example of explanatory view of the maintenance step of the spinning system 100 schematically showing a part thereof in a state of allowing the cover 42 for covering the upper opening of the spinning cylinder 31 to be detached. As shown in FIG. 10, when the spinning of the molten polymer P is restarted, the operator conducts work of detaching the cover 42 covering the upper opening of the spinning cylinder 31.

[2-1-5. Yarn threading step]

[0049] FIG. 11 depicts an example of explanatory view of the maintenance step of the spinning system 100 schematically showing a part thereof in a state of allowing the spinning cylinder 31 to have yarn threaded therethrough in yarn threading work. As shown in FIG. 11, after implementation of the work of detaching the cover 42 covering the upper opening of the spinning cylinder 31, the operator conducts yarn threading work of threading the molten polymer P spun from the spinneret 24 (or cooled and solidified yarn Y) through the spinning cylinder 31.

[2-1-6. Restoration step]

[0050] After implementation of the yarn threading work, in response to operation by the operator, e.g., the controller 7 actuates the air cylinder 5 in an expanding direction to cause the cooling unit 3 to move up so as to make the cooling unit 3 get closer to the spinning beam 21. When the upper end detection sensor 76 (see FIG. 4) determines that the cooling unit 3 is at the upper end, the controller 7 stops actuation of the air cylinder 5, thereby stopping elevation of the cooling unit 3. When the cool-

ing unit 3 stops at the upper end, the spinning beam 21 and the cooling unit 3 abut each other across the sealing member 40. While other preparations for starting production are made in the restoration step, illustrations of these other preparations are omitted.

[0051] After implementation of the restoration step, the spinning system 100 works normally to be in a state of production. The maintenance on the spinning system 100 has conventionally been conducted through the above-described steps.

[2-1-7. Problems in conventional maintenance step or the like]

[0052] If restoration is made to a working state after implementation of the maintenance through the above-described conventional maintenance step, the physical properties of yarn are degraded. As shown in FIGS. 12 and 13, e.g., considerable time is required to recover normal physical properties of the yarn (specifically, for the yarn to be determined to be normal). FIG. 12 depicts an example of schematic diagram showing a result of circular knit staining evaluation changed with the passage of time from the restoration to an operational state after the maintenance in the conventional maintenance step. FIG. 13 depicts a graph showing a result of thermal stress and de-twisting tension on yarn changed with the passage of time from the restoration to an operational state after the maintenance in the conventional maintenance step.

[0053] As shown in FIG. 12, the result about circular knit staining evaluation is such that, even after passage of about 60 minutes from restoration to a working state, a color is still lighter than a benchmark as a reference (hereinafter called "B. M") so the yarn is not determined to be normal. After passage of about 70 minutes from the restoration to the working state, a color approximate to the B. M is obtained so the yarn is determined to be normal.

[0054] As shown in FIG. 13, both the de-twisting tension and the thermal stress take values approximate to reference values after passage of about 80 to 90 minutes from restoration to a working state. As shown in FIG. 13, while B. M as a reference value for the de-twisting tension is about 30.8 [cN], e.g., and B. M as a reference value for the thermal stress is about 83.1 [cN], e.g., the B. M changes in response to the sort of yarn, and the like.

[0055] As described above, after maintenance is conducted by the conventional maintenance step and then restoration is made to a working state, considerable time is required to recover normal physical properties of yarn. Hence, producing the yarn continuously merely results in increased amount of the yarn to be disposed of. In a case where maintenance is conducted by the conventional maintenance step and then restoration is made to a working state, possible reason for requiring considerable time to recover normal physical properties of the yarn is that temperature at the spinneret 24 and ambient

temperature around the spinneret 24 decrease seriously in the maintenance step so it takes time for temperature at the spinneret 24 and ambient temperature around the spinneret 24 to recover their original temperatures.

[0056] FIG. 14 depicts a graph showing a surface temperature of the spinneret 24 changed with the passage of time from the starting of maintenance in the conventional maintenance step. As shown in FIG. 14, when the cooling unit 3 is caused to move down with respect to the spinning beam 21, surface temperature on the spinneret 24 decreases nearly continuously to cause serious decrease of surface temperature on the spinneret 24 at a time when the maintenance is finished. When the maintenance is finished and the cooling unit 3 is caused to move up so as to get closer to the spinning beam 21, surface temperature on the spinneret 24 is recovered gradually. As shown in FIG. 14, in order for surface temperature on the spinneret 24 to recover its original temperature (e.g., temperature before implementation of the maintenance), a duration of about 2000 s or more is required from start of the elevation of the cooling unit 3.

[0057] Possible reason for the serious decrease of surface temperature on the spinneret 24 occurring in the conventional maintenance step is that the cooling air CF supplied to the spinning cylinder 31 goes upward from the upper opening of the spinning cylinder 31. During implementation of the yarn threading work of threading the molten polymer P spun from the spinneret 24 (or cooled and solidified yarn Y) through the spinning cylinder 31, the molten polymer P is cooled and solidified by the cooling air CF (see, e.g., FIG. 11) flowing upward from the upper opening of the spinning cylinder 31. In this case, while the operator is allowed to conduct the yarn threading work without using a tool, temperature at the spinneret 24 and ambient temperature around the spinneret 24 are unintentionally decreased by the cooling air CF flowing upward from the upper opening of the spinning cylinder 31. This causes serious decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24. Hence, it is considered that, after restoration to a working state, it takes time for temperature at the spinneret 24 and ambient temperature around the spinneret 24 to recover their original temperatures.

[0058] To solve the above-described problem revealed in the conventional maintenance step, maintenance is conducted on the spinning system 1 according to the embodiment of the present invention by a maintenance step described below. The following describes the maintenance step conducted on the spinning system 1 according to the embodiment of the present invention.

[2-2. Maintenance step according to embodiment of present invention]

[0059] The maintenance step according to the present invention will be described by referring to FIGS. 1 and 15 to 19. The spinning system 1 according to the embod-

iment of the present invention largely differs from the conventional spinning system 100 in that it includes the blower 6.

[0060] As shown in FIG. 1, while the spinning system 1 is working, the lower end of the spinning beam 21 and the upper end of the cooling unit 3 are in abutting contact with each other. While the spinning system 1 is working, the molten polymer P is spun from the spinneret 24 and the cooling air CF is supplied from the first compressed-air source 37 (see FIG. 4 and the same applies to the following cases) to the spinning cylinder 31 through the duct 32. The cooling air CF supplied to the spinning cylinder 31 flows in a substantially horizontal direction into the hollow area CE to cool the molten polymer P spun from the spinneret 24. While the spinning system 1 is working, the side air SF is not released from the air nozzle 62.

[2-2-1. Preparation step]

[0061] FIG. 15 depicts an example of view schematically showing a part of the spinning system 1 in a state of stopping the spinning of molten polymer P. For implementation of maintenance on the spinning system 1, the spinning of the molten polymer P from the spinneret 24 is stopped first, as shown in FIG. 15. The spinning of the molten polymer P is stopped by the controller 7 in response to operation by, e.g., an operator. During implementation of the maintenance, supply of the cooling air CF by the cooling unit 3 is continued. At this time, the blower 6 stops its operation so the side air SF is not released from the air nozzle 62.

[0062] FIG. 16 depicts an example of view schematically showing a part of the spinning system 1 in a state of having caused the cooling unit 3 to move down to a lower end with respect to the spinning beam 1. After stopping the spinning of the molten polymer P, the controller 7 actuates the air cylinder 5 in a contracting direction to lower the cooling unit 3 with respect to the spinning beam 21, as shown in FIG. 16. Causing the cooling unit 3 to move down with respect to the spinning beam 21 forms the working space Sw between the spinning unit 2 and the cooling unit 3 as viewed in an up-and-down direction. When the cooling unit 3 starts to be caused to move down with respect to the spinning beam 21, the operator immediately conducts work of covering the upper opening of the spinning cylinder 31 with the cover 42. Covering the upper opening of the spinning cylinder 31 with the cover 42 immediately after starting causing the cooling unit 3 to move down with respect to the spinning beam 21 makes it possible to stop an upward flow of the cooling air CF from the upper opening of the spinning cylinder 31, thereby preventing the spinneret 24 from being cooled by this cooling air CF. At this time, the blower 6 stops its operation so the side air SF is not released from the air nozzle 62.

[0063] Preferably, timing of stopping the spinning of the molten polymer P coincides with a moment before

start of causing the cooling unit 3 to move down with respect to the spinning beam 21. However, this is not the only timing but the spinning may be stopped during causing the cooling unit 3 to move down with respect to the spinning beam 21 or after causing the cooling unit 3 to move down to the lower end with respect to the spinning beam 21.

[2-2-2. Maintenance main step]

[0064] After covering the upper opening of the spinning cylinder 31 with the cover 42, the operator conducts the maintenance. The detail of the maintenance includes surface cleaning of the spinneret 24 and exchange of the spinning pack 23. While time required for the maintenance is determined in a manner that depends on the detail of the maintenance, it is generally 10 minutes. The operator conducts surface cleaning of the spinneret 24 or exchange of the spinning pack 23 in response to purpose.

[2-2-3. Molten polymer spinning restarting step]

[0065] FIG. 17 depicts an example of view schematically showing a part of the spinning system 1 in a state of restarting the spinning of molten polymer P. After implementation of the maintenance, in response to operation by the operator, e.g., the controller 7 starts (restarts) the spinning of the molten polymer P from the spinneret 24, as shown in FIG. 17.

[2-2-4. Temperature decrease suppression step]

[0066] When the spinning of the molten polymer P is restarted, the controller 7 starts operation of the blower 6, as shown in FIG. 17. As shown in FIG. 17, when the operation of the blower 6 is started, the side air SF is released in the working space Sw between the spinning unit 2 and the cooling unit 3 as viewed in the up-and-down direction from the air nozzle 62 in a substantially horizontal direction toward the molten polymer P spun from the spinneret 24. Thus, a temperature decrease limiting step includes a blowing step of releasing the side air SF in the working space Sw from the air nozzle 62 in a substantially horizontal direction toward the molten polymer P spun from the spinneret 24. Timing of starting releasing of the side air SF from the air nozzle 62 will be described later.

[2-2-5. Cover detaching step]

[0067] FIG. 18 depicts an example of view schematically showing a part of the spinning system 1 in a state of allowing the cover 42 for covering the upper opening of the spinning cylinder 31 to be detached. When the operation of the blower 6 is started (specifically, when release of the side air SF from the air nozzle 62 is started), the operator conducts work of detaching the cover 42

covering the upper opening of the spinning cylinder 31. When the cover 42 covering the upper opening of the spinning cylinder 31 is detached, part of the cooling air CF supplied to the spinning cylinder 31 goes upward from the upper opening of the spinning cylinder 31. However, a direction of this cooling air CF is changed by the side air SF. Specifically, the cooling air CF going upward can be prevented from reaching the spinneret 24 and a place around the spinneret 24. Preferably, the operation of the blower 6 is started at least before the cover 42 covering the upper opening of the spinning cylinder 31 is detached.

[0068] The size of an opening at the air nozzle 62, specifically, the area of the opening through which the side air SF is released is extremely smaller than the area of the upper opening of the spinning cylinder 31. Thus, the flow rate of the side air SF released from the air nozzle 62 is extremely higher than the flow rate of the cooling air CF going from the upper opening of the spinning cylinder 31 toward the spinneret 24. This makes it possible to change a direction of flow of the cooling air CF going upward from the upper opening of the spinning cylinder 31 using the side air SF released in a substantially horizontal direction from the air nozzle 62. In this way, the side air SF functions as a barrier to interrupt flow of the cooling air CF toward the spinneret 24 or to reduce the air volume of the cooling air CF going toward the spinneret 24. Furthermore, making the air volume of the side air SF per unit time released from the air nozzle 62 larger than the air volume of the cooling air CF per unit time going toward the spinneret 24 makes it possible to reduce the air volume of the cooling air CF going toward the spinneret 24. In this way, the cooling air CF going upward from the upper opening of the spinning cylinder 31 can be blocked from moving toward the spinneret 24 and a place around the spinneret 24. The side air SF released in a substantially horizontal direction from the air nozzle 62 further has the function of cooling and solidifying the molten polymer P spun from the spinneret 24. It becomes more difficult to cool the molten polymer P with a greater diameter of the molten polymer P. Thus, the blower 6 preferably has the function of changing the air volume of the side air SF per unit time released from the air nozzle 62.

[2-2-6. Yarn threading step]

[0069] FIG. 19 depicts an example of view schematically showing a part of the spinning system 1 in a state of allowing the spinning cylinder 31 to have yarn threaded therethrough in yarn threading work. As shown in FIG. 19, after implementation of the work of detaching the cover 42 covering the upper opening of the spinning cylinder 31, the operator conducts yarn threading work of threading the molten polymer P spun from the spinneret 24 (or cooled and solidified yarn Y) through the spinning cylinder 31. At this time, once the yarn Y is threaded through the spinning cylinder 31, the yarn Y is then carried by the cooling air CF flowing downward that is part of the cooling

air CF supplied to the spinning cylinder 31. The molten polymer P spun from the spinneret 24 is cooled and solidified by the side air SF or the cooling air CF, or by the side air SF and the cooling air CF. This allows the operator to conduct the yarn threading work without using a tool.

[2-2-7. Restoration step]

[0070] After implementation of the yarn threading work, in response to operation by the operator, e.g., the controller 7 actuates the air cylinder 5 in an expanding direction to cause the cooling unit 3 to move up so as to make the cooling unit 3 get closer to the spinning beam 21. When the spinning beam 21 and the cooling unit 3 abut each other, the controller 7 stops actuation of the air cylinder 5 to stop elevation of the cooling unit 3, and then makes restoration to a working state.

[0071] When the spinning beam 21 and the cooling unit 3 abut each other and elevation of the cooling unit 3 is stopped, the controller 7 stops operation of the blower 6 to stop release of the side air SF from the air nozzle 62, thereby finishing the blowing step. Preferably, timing of stopping release of the side air SF from the air nozzle 62 coincides with a moment when the spinning beam 21 and the cooling unit 3 abut each other and elevation of the cooling unit 3 is stopped or a moment after stop of the elevation. The reason for this is that, as the abutting contact between the spinning beam 21 and the cooling unit 3 closes the upper opening of the spinning cylinder 31 to cause the cooling air CF flowing into the hollow area CE to go downward entirely or mostly, it is still possible to limit decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24 even after the blowing step is finished. As a result, it becomes possible to shorten time for temperature at the spinneret 24 and ambient temperature around the spinneret 24 to recover their original temperatures, eventually, shorten time for stabilizing the physical properties of yarn. In another case, release of the side air SF from the air nozzle 62 may be stopped during elevation of the cooling unit 3 so as to make the cooling unit 3 get closer to the spinning beam 21, while this may reduce the effect of limiting decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24 compared to a case where release of the side air SF from the blower 6 is stopped when elevation of the cooling unit 3 is stopped.

[0072] After elevation of the cooling unit 3 with respect to the spinning beam 21 is stopped, the operator stretches the yarn around the oil applicator 8. Timing of stretching the yarn around the oil applicator 8 is not limited to a moment after the cooling unit 3 has been caused to move up with respect to the spinning beam 21 but may coincide with a moment before elevation of the cooling unit 3 with respect to the spinning beam 21 is started or with a period when the cooling unit 3 is being caused to move up with respect to the spinning beam 21. However, this timing preferably coincides with a moment after release of the

side air SF from the air nozzle 62 is stopped.

[0073] While other preparations for starting production are made in the restoration step, illustrations of these other preparations are omitted. After implementation of the restoration step, the spinning system 1 works normally to be in a state of production.

[2-2-8. Effects and the like]

[0074] As described above, in the maintenance step according to the present invention, the side air SF released from the air nozzle 62 functions as a barrier to interrupt flow of the cooling air CF toward the spinneret 24 or to reduce the air volume of the cooling air CF going toward the spinneret 24. This makes it possible to prevent serious decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24. Thus, time for temperature at the spinneret 24 and ambient temperature around the spinneret 24 to recover their original temperatures can be shortened after restoration to a working state to allow reduction in the amount of yarn to be disposed of.

[0075] As long as release of the side air SF from the air nozzle 62 is started at least before detachment of the cover 42 covering the upper opening of the spinning cylinder 31, this timing of the release may coincide with a moment either before or after the spinning of the molten polymer P is restarted.

[0076] While the maintenance step according to the present invention is as has been described above, this is not the only maintenance step for solving the problem revealed in the conventional maintenance step. The following describes a maintenance step according to a modification.

[2-3. Maintenance step according to modified embodiment of present invention]

[0077] The maintenance step according to the modification will be described by referring to FIGS. 20 to 26. The state of the spinning system 1 during production or in a working state is the same as that of FIG. 1, so that a drawing showing the state of the spinning system 1 in a working state is omitted.

[0078] The maintenance step according to the modification largely differs from the maintenance step according to the present invention in that supply of the cooling air CF to the spinning cylinder 31 is stopped in the maintenance step. Like the spinning system 1 according to the embodiment of the present invention, the spinning system 1 according to the modification includes the blower 6.

[2-3-1. Preparation step]

[0079] FIG. 20 depicts an example of view schematically showing a part of the spinning system 1 in a state of stopping the spinning of molten polymer P. For imple-

mentation of maintenance on the spinning system 1, the spinning of the molten polymer P from the spinneret 24 is stopped first, as shown in FIG. 20. The spinning of the molten polymer P is stopped by the controller 7 in response to operation by, e.g., an operator. The blower 6 stops its operation and air is not supplied from the second compressed-air source 66 to the air nozzle 62, so that the side air SF is not released from the air nozzle 62.

[0080] After stopping the spinning of the molten polymer P, the controller 7 stops operation of the first compressed-air source 37 to stop supply of the cooling air CF to the spinning cylinder 31. Stopping supply of the cooling air CF to the spinning cylinder 31 makes it possible to prevent the cooling air CF from going from the upper opening of the spinning cylinder 31 toward the spinneret 24, thereby preventing serious decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24.

[0081] FIG. 21 depicts an example of view schematically showing a part of the spinning system 1 in a state of having caused the cooling unit 3 to move down to a lower end with respect to the spinning beam 31. After stopping supply of the cooling air CF to the spinning cylinder 31, the controller 7 actuates the air cylinder 5 in a contracting direction to lower the cooling unit 3 with respect to the spinning beam 21, as shown in FIG. 21. Causing the cooling unit 3 to move down with respect to the spinning beam 21 forms the working space Sw between the spinning unit 2 and the cooling unit 3 as viewed in an up-and-down direction. When the cooling unit 3 is caused to move down with respect to the spinning beam 21, the operator conducts work of covering the upper opening of the spinning cylinder 31 with the cover 42. However, it is not necessarily required to conduct the work of covering the upper opening of the spinning cylinder 31 with the cover 42 as supply of the cooling air CF to the spinning cylinder 31 is stopped. The blower 6 stops its operation and compressed air is not supplied from the second compressed-air source 66 to the air nozzle 62, so that the side air SF is not released from the air nozzle 62.

[0082] Preferably, timing of stopping the spinning of the molten polymer P coincides with a moment before start of causing the cooling unit 3 to move down with respect to the spinning beam 21. However, this is not the only timing but the spinning may be stopped during causing the cooling unit 3 with respect to the spinning beam 21 or after causing the cooling unit 3 to move down to the lower end with respect to the spinning beam 21.

[0083] Timing of stopping supply of the cooling air CF to the spinning cylinder 31 is not limited to a moment after the spinning of the molten polymer P is stopped but may coincide with a moment before the spinning of the molten polymer P is stopped or with a moment substantially simultaneous with stop of the spinning of the molten polymer P.

[2-3-2. Maintenance main step]

[0084] After the cooling unit 3 has been caused to move down with respect to the spinning beam 21 and the upper opening of the spinning cylinder 31 is covered with the cover 42 while this covering is not absolute necessity, the operator conducts the maintenance such as surface cleaning of the spinneret 24 or exchange of the spinning pack 23 in response to purpose. While time required for the maintenance is determined in a manner that depends on the detail of the maintenance, it is generally 10 minutes.

[2-3-3. Molten polymer spinning restarting step]

[0085] FIG. 22 depicts an example of view schematically showing a part of the spinning system 1 in a state of restarting the spinning of molten polymer P. After implementation of the maintenance, in response to operation by the operator, e.g., the controller 7 starts (restarts) the spinning of the molten polymer P from the spinneret 24, as shown in FIG. 22. If the upper opening of the spinning cylinder 31 is covered with the cover 42, the operator conducts work of detaching the cover 42 covering the upper opening of the spinning cylinder 31.

[2-3-4. Temperature decrease suppression step]

[0086] The foregoing step of stopping supply of the cooling air CF to the spinning cylinder 31 is included in a temperature decrease limiting step. Timing of stopping supply of the cooling air CF to the spinning cylinder 31 is as has been described above. If the upper opening of the spinning cylinder 31 is covered with the cover 42, however, it is only required to stop supply of the cooling air CF to the spinning cylinder 31 at least before detachment of the cover 42. The reason for this is that, while the upper opening of the spinning cylinder 31 is covered with the cover 42, the cover 42 can function to prevent the cooling air CF from going from the upper opening of the spinning cylinder 31 toward the spinneret 24.

[0087] FIG. 23 depicts an example of view schematically showing a part of the spinning system 1 in a state of causing the blower 6 to start operation. After restarting the spinning of the molten polymer P, the controller 7 starts operation of the blower 6. When the operation of the blower 6 is started, the side air SF is released in the working space Sw between the spinning unit 2 and the cooling unit 3 as viewed in an up-and-down direction from the air nozzle 62 in a substantially horizontal direction toward the molten polymer P spun from the spinneret 24. A step of releasing the side air SF in the working space Sw from the air nozzle 62 is also included in the temperature decrease limiting step.

[0088] Operation of the blower 6 may be started after detachment of the cover 42 covering the upper opening of the spinning cylinder 31 or before detachment of the cover 42 covering the upper opening of the spinning cyl-

inder 31. The reason for this is that, as there is no supply of the cooling air CF to the spinning cylinder 31, serious decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24 is not caused by the cooling air CF going upward from the upper opening of the spinning cylinder 31.

[0089] Timing of starting operation of the blower 6 is not limited to a moment after the spinning of the molten polymer P is restarted but may coincide with a moment before the spinning of the molten polymer P from the spinneret 24 is restarted.

[0090] As described above, stopping supply of the cooling air CF to the spinning cylinder 31 makes it possible to limit decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24. On the other hand, stopping supply of the cooling air CF to the spinning cylinder 31 makes it impossible to cool and solidify the molten polymer P spun from the spinneret 24 using the cooling air CF supplied to the spinning cylinder 31. Not cooling and solidifying the molten polymer P spun from the spinneret 24 might impose difficulty in conducting yarn threading through the spinning cylinder 31 after the maintenance is finished. In this regard, releasing the side air SF in the working space Sw from the air nozzle 62 toward the molten polymer P spun from the spinneret 24 allows cooling and solidification of the molten polymer P spun from the spinneret 24. As a result, it becomes possible to facilitate yarn threading through the spinning cylinder 31 conducted after the maintenance is finished while limiting decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24.

[2-3-5. Yarn threading step]

[0091] FIG. 24 depicts an example of view schematically showing a part of the spinning system 1 in a state of allowing the spinning cylinder 31 to have yarn threaded therethrough in yarn threading work. As shown in FIG. 24, when release of the side air SF from the air nozzle 62 is started, the operator conducts yarn threading work of threading the molten polymer P spun from the spinneret 24 (or cooled and solidified yarn Y) through the spinning cylinder 31. At this time, the molten polymer P spun from the spinneret 24 is cooled and solidified by the side air SF released from the air nozzle 62. This allows the operator to conduct the yarn threading work without using a tool.

[2-3-6. Restoration step]

[0092] FIG. 25 depicts an example of view schematically showing a part of the spinning system 1 in a state of having caused the cooling unit 3 to move up to the upper end with respect to the spinning beam 21. As shown in FIG. 25, after implementation of the work of threading the yarn through the spinning cylinder 31, in response to operation by the operator, e.g., the controller 7 actuates the air cylinder 5 in an expanding direction to

cause the cooling unit 3 to move up so as to make the cooling unit 3 get closer to the spinning beam 21. When the spinning beam 21 and the cooling unit 3 abut each other, the controller 7 stops actuation of the air cylinder 5 to stop elevation of the cooling unit 3. Furthermore, when the spinning beam 21 and the cooling unit 3 abut each other and elevation of the cooling unit 3 is stopped, the controller 7 stops operation of the blower 6 to stop release of the side air SF from the air nozzle 62. Preferably, timing of stopping release of the side air SF from the air nozzle 62 coincides with a moment when the spinning beam 21 and the cooling unit 3 abut each other and elevation of the cooling unit 3 is stopped or a moment after stop of the elevation, as it allows cooling and solidification of the molten polymer P spun from the spinneret 24. In another case, release of the side air SF from the air nozzle 62 may be stopped before elevation of the cooling unit 3 with respect to the spinning beam 21 is started or during elevation of the cooling unit 3 so as to make the cooling unit 3 get closer to the spinning beam 21.

[0093] After elevation of the cooling unit 3 with respect to the spinning beam 21 is stopped, the operator stretches the yarn around the oil applicator 8. Timing of stretching the yarn around the oil applicator 8 is not limited to a moment after the cooling unit 3 has been caused to move up with respect to the spinning beam 21 but may coincide with a moment before elevation of the cooling unit 3 with respect to the spinning beam 21 is started or with a period when the cooling unit 3 is being caused to move up with respect to the spinning beam 21. However, this timing preferably coincides with a moment after release of the side air SF from the air nozzle 62 is stopped.

[0094] FIG. 26 depicts an example of view schematically showing a part of the spinning system 1 in a state of being restored to an operational state. When the lower end of the spinning beam 21 and the upper end of the cooling unit 3 abut each other and elevation of the cooling unit 3 is stopped, the controller 7 restarts operation of the first compressed-air source 37 to start supply of the cooling air CF to the spinning cylinder 31.

[0095] While other preparations for starting production are made in the restoration step, illustrations of these other preparations are omitted. After implementation of the restoration step, the spinning system 1 works normally to be in a state of production.

[0096] Timing of starting supply of the cooling air CF to the spinning cylinder 31 is not limited to a moment when the lower end of the spinning beam 21 and the upper end of the cooling unit 3 abut each other and elevation of the cooling unit 3 is stopped. For example, if the side air SF released from the air nozzle 62 flows between the spinning unit 2 and the cooling unit 3 as viewed in an up-and-down direction, supply of the cooling air CF to the spinning cylinder 31 may be started while the cooling unit 3 is at the lower end. Starting supply of the cooling air CF to the spinning cylinder 31 while the cooling unit 3 is at the lower end makes it likely that the cooling air

CF will flow from the upper opening of the spinning cylinder 31 toward the spinneret 24. However, as the side air SF released from the air nozzle 62 functions as a barrier, it is possible to limit decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24.

[2-3-7. Effects and the like]

[0097] In the maintenance step according to the modification described above, at least in a state where the cooling unit 3 has been moved downward with respect to the spinning beam 21, supply of the cooling air CF to the spinning cylinder 31 is stopped. This allows the cooling air CF to be stopped from flowing from the upper opening of the spinning cylinder 31 toward the spinneret 24. As a result, it is possible to limit decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24.

[0098] The foregoing maintenance step according to the modification has been described on the assumption that supply of the cooling air CF to the spinning cylinder 31 is stopped. However, instead of stopping supply of the cooling air CF to the spinning cylinder 31, the air volume of the cooling air CF to be supplied to the spinning cylinder 31 may be reduced. Reducing the air volume of the cooling air CF to be supplied to the spinning cylinder 31 reduces the air volume of the cooling air CF to flow from the upper opening of the spinning cylinder 31 toward the spinneret 24, making it possible to limit decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24. Regarding reduction in the air volume of the cooling air CF to be supplied to the spinning cylinder 31, this air volume may be reduced at least compared to an air volume during production, namely, before stop of the spinning of the molten polymer P.

[0099] Stopping supply of the cooling air CF to the spinning cylinder 31 or reducing the volume of supply of the cooling air CF during implementation of maintenance on the spinning system 1 might result in the failure to cool and solidify the molten polymer P spun from the spinneret 24 to impose difficulty in the work of threading yarn through the spinning cylinder 31 conducted after the maintenance is finished. However, as the side air SF released from the air nozzle 62 flows toward a direction intersecting a yarn path of the molten polymer P spun from the spinneret 24, it is possible to cool and solidify the molten polymer P spun from the spinneret 24. This allows yarn threading through the spinning cylinder to be conducted easily after the maintenance is finished while limiting decrease of temperature at the spinneret 24 and ambient temperature around the spinneret 24. As a result, after restoration is made to a working state, it becomes possible to shorten time for temperature at the spinneret 24 and ambient temperature around the spinneret 24 to recover their original temperatures to allow reduction in the amount of yarn to be disposed of.

[3. Verification Result of Maintenance Step of Present Invention and Modification]

[0100] As a result of implementation of maintenance by the maintenance step according to the present invention or implementation of maintenance by the maintenance step according to the modification described above, it was possible to shorten time required to recover normal physical properties of yarn after restoration to a working state. FIG. 27 is a schematic view showing result about circular knit staining evaluation that is changed with passage of time from restoration to a working state after implementation of maintenance by the maintenance step according to the present invention. FIG. 28 is a graph showing an example of result about thermal stress and de-twisting tension on yarn that are changed with passage of time from restoration to a working state in each of a case where maintenance is conducted by the conventional maintenance step and a case where maintenance is conducted by the maintenance step according to the modification.

[0101] As shown in FIG. 27, in the result about circular knit staining evaluation, a color approximate to B. M is obtained roughly after 15 minutes from restoration to a working state so the yarn is determined to be normal. In this way, it was possible to shorten time considerably required for the yarn to be determined to be normal, compared to implementation of the maintenance by the conventional maintenance step.

[0102] As clearly understood from FIG. 28, both the de-twisting tension and the thermal stress fulfill more favorable results in the case of implementation of maintenance by the maintenance step of the modification than in the case of implementation of maintenance by the conventional maintenance step.

[0103] FIG. 29 is a graph showing change in surface temperature on the spinneret 24 responsive to passage of time from when maintenance is started by each of the conventional maintenance step, the maintenance step of the present invention, and the maintenance step of the modification. In FIG. 29, (a) shows exemplary change in surface temperature on the spinneret 24 responsive to passage of time from when the maintenance is started by the conventional maintenance step. In FIG. 29, (b) shows exemplary change in surface temperature on the spinneret 24 responsive to passage of time from when the maintenance is started by the maintenance step according to the present invention. In FIG. 29, (c) shows exemplary change in surface temperature on the spinneret 24 responsive to passage of time from when the maintenance is started by the maintenance step according to the modification.

[0104] It is understood from FIG. 29 that surface temperature on the spinneret 24 decreases in response to cause the cooling unit 3 to move down with respect to the spinning beam 21 during implementation of each of the conventional maintenance step, the maintenance step of the present invention, and the maintenance step

of the modification. After the maintenance is finished and the cooling unit 3 is caused to move up, however, time required for surface temperature on the spinneret 24 to recover its original temperature is shorter in the case of implementation of each of the maintenance step of the present invention and the maintenance step of the modification than in the case of implementation of the conventional maintenance step. Possible reason for this is that, if the maintenance is conducted by the conventional maintenance step, temperature at the spinneret 24 and ambient temperature around the spinneret 24 decrease seriously with the cooling air CF going upward from the upper opening of the spinning cylinder 31 in causing the cooling unit 3 to move up. In this regard, according to the maintenance step of the present invention, while the cooling air CF supplied to the spinning cylinder 31 goes upward, this cooling air CF is blocked by the side air SF released from the air nozzle 62 of the cooling unit 3, thereby allowing limitation on decrease of surface temperature on the spinneret 24. Furthermore, according to the maintenance step of the modification, the cooling air CF is not supplied to the spinning cylinder 31. This results in the absence of the cooling air CF itself to go upward from the upper opening of the spinning cylinder 31 or reduces the air volume of the cooling air CF to go upward from the upper opening of the spinning cylinder 31, thereby allowing limitation on decrease of surface temperature on the spinneret 24.

(Reference Numerals)

[0105]

1	Spinning system
3	Cooling unit
5	Air cylinder
6	Blower
7	Controller
21	Spinning beam
23	Spinning pack
24	Spinneret
31	Spinning cylinder
P	Molten polymer
CF	Cooling air
Sw	Working space

Claims

1. A spinning system (1) comprising:
 - a spinning beam (21) having a spinning pack (23) inserted therein including a spinneret (24) for allowing molten polymer (P) to be spun downward;
 - a cooling unit (3) arranged below the spinning beam (21), including a spinning cylinder (31) extending in an up-and-down direction so as to sur-

round the molten polymer (P) spun from the spinneret (24), configured to cool the molten polymer (P) through the use of cooling air (CF) supplied from a periphery of the spinning cylinder (31);

a moving mechanism (5) configured to cause the cooling unit (3) to move downward with respect to the spinning beam (21) so as to form a gap between the cooling unit (3) and the spinning beam (21); and

a blower (6) configured to, at least when the cooling unit (3) having been caused to move downward with respect to the spinning beam (21), blow air toward between the spinning beam (21) and the cooling unit (3) in a direction intersecting a yarn path of the molten polymer (P) spun from the spinneret (24).

2. The spinning system (1) as claimed in claim 1, wherein the blower (6) stops operation when the spinning beam (21) and the cooling unit (3) abut each other.
3. The spinning system (1) as claimed in claim 1 or 2, wherein the blower (6) is further configured such that a direction of cooling air (CF) blown toward the spinneret (24) out of cooling air (CF) supplied to the spinning cylinder (31) is changeable.
4. A method of controlling a spinning system (1) comprising:

a spinning beam (21) having a spinning pack (23) inserted therein including a spinneret (24) for allowing molten polymer (P) to be spun downward; and

a cooling unit (3) arranged below the spinning beam (21), including a spinning cylinder (31) extending in an up-and-down direction so as to surround the molten polymer (P) spun from the spinneret (24), configured to cool the molten polymer (P) through the use of cooling air (CF) supplied from a periphery of the spinning cylinder (31),

wherein said spinning system (1) performs:

a preparation step of causing the cooling unit (3) to move downward with respect to the spinning beam (21) so as to form a gap between the cooling unit (3) and the spinning beam (21);

a temperature decrease suppression step of suppressing decrease in temperature at the spinneret (24) at least when the cooling unit (3) having been caused to move downward with respect to the spinning beam (21); and

a restoration step of causing the cooling unit (3) to move upward with respect to the spinning beam (21) while suppressing decrease in temperature at the spinneret (24) after the cooling unit (3) having been caused to move downward with respect to the spinning beam (21) so as to undergo maintenance, and
wherein the temperature decrease suppression step includes:
an air blowing step of blowing air toward between the spinning beam (21) and the cooling unit (3) in a direction intersecting a yarn path of the molten polymer (P) spun from the spinneret (24).

5. The method as claimed in claim 4, wherein, in the air blowing step, blowing air is finished, during performance of the restoration step, after having undergone maintenance, or when the restoration step having been finished.
6. The method as claimed in claim 4 or 5, wherein, in the air blowing step, a direction of cooling air (CF) blown toward the spinneret (24) out of cooling air (CF) supplied to the spinning cylinder (31) is changeable.

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FIG. 1

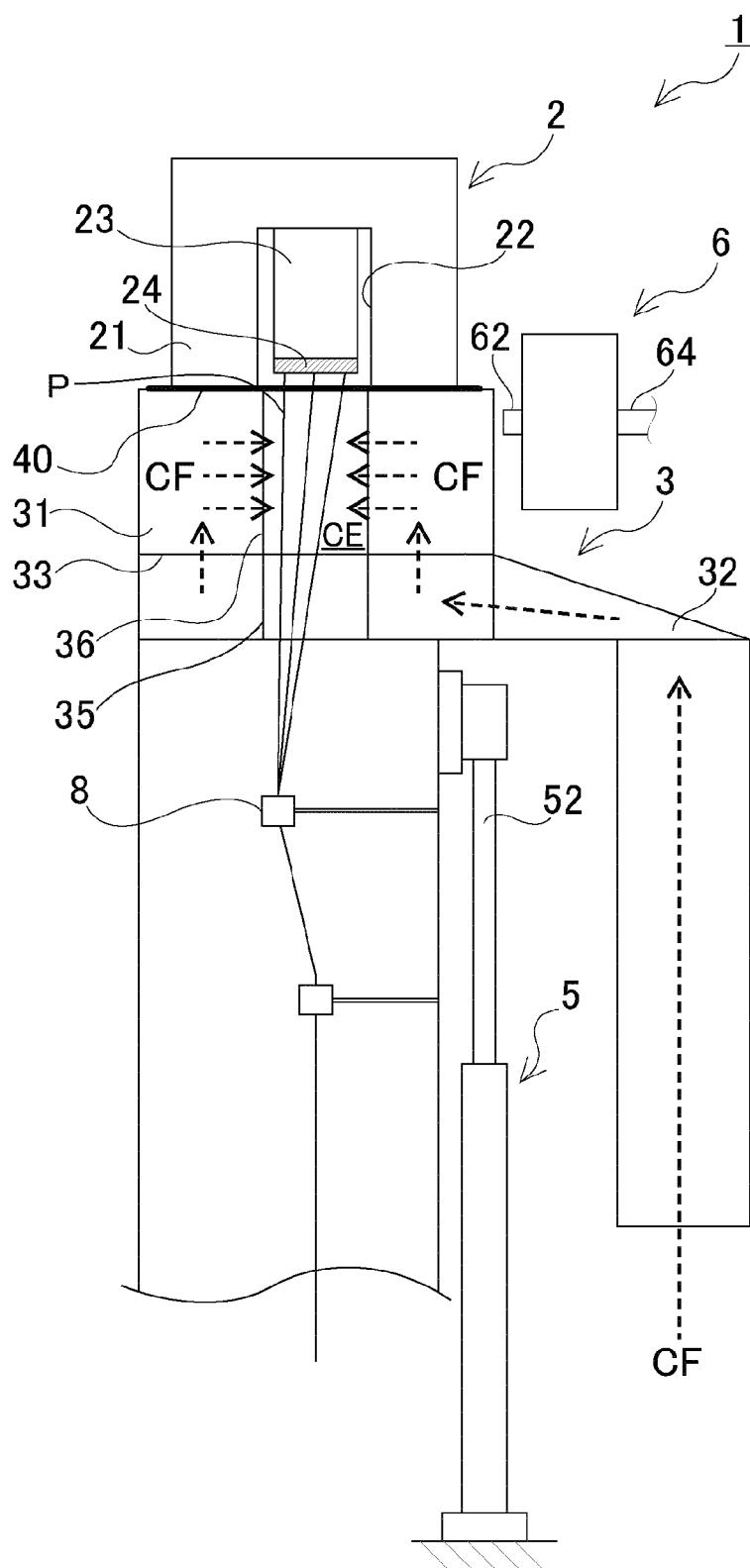


FIG. 2

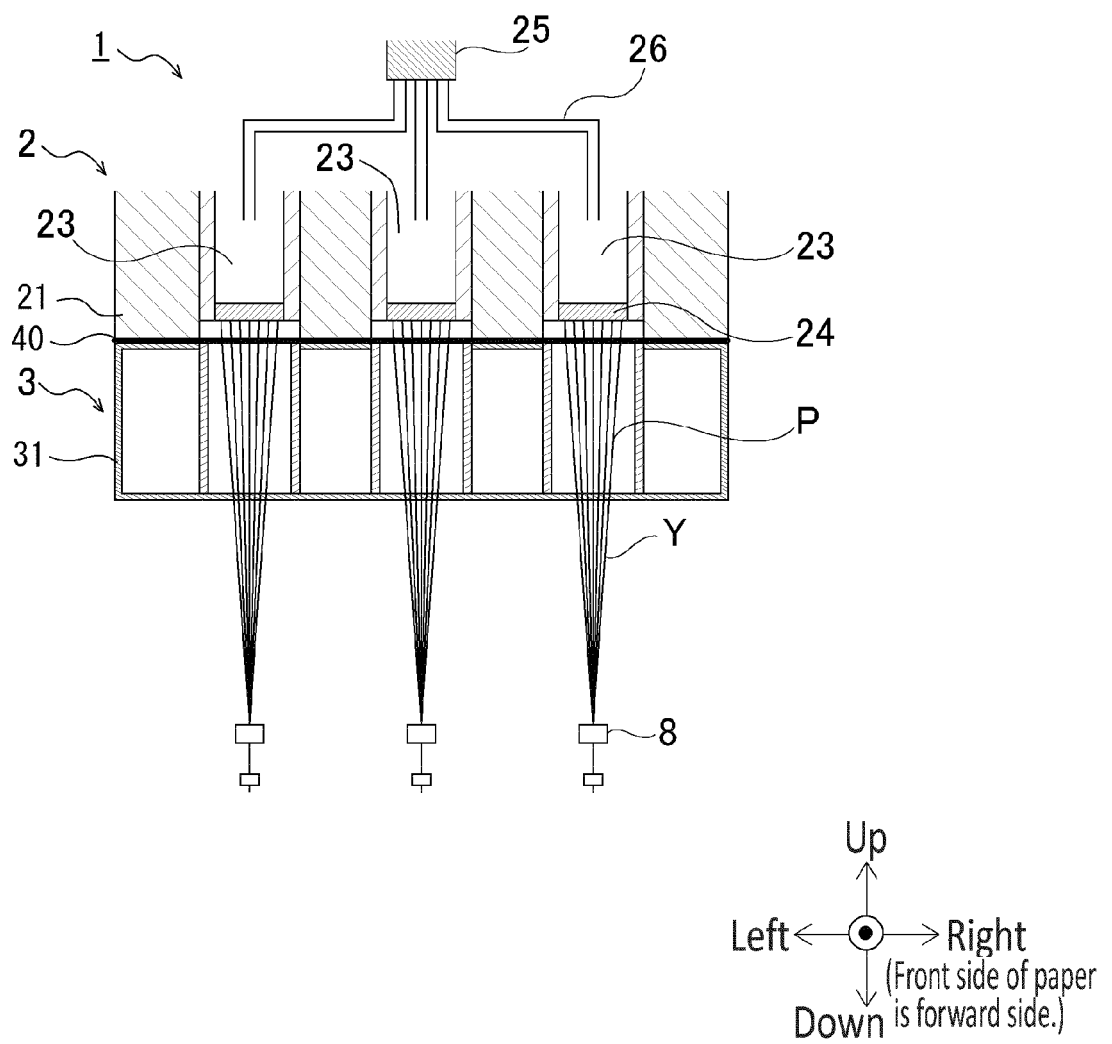


FIG. 3

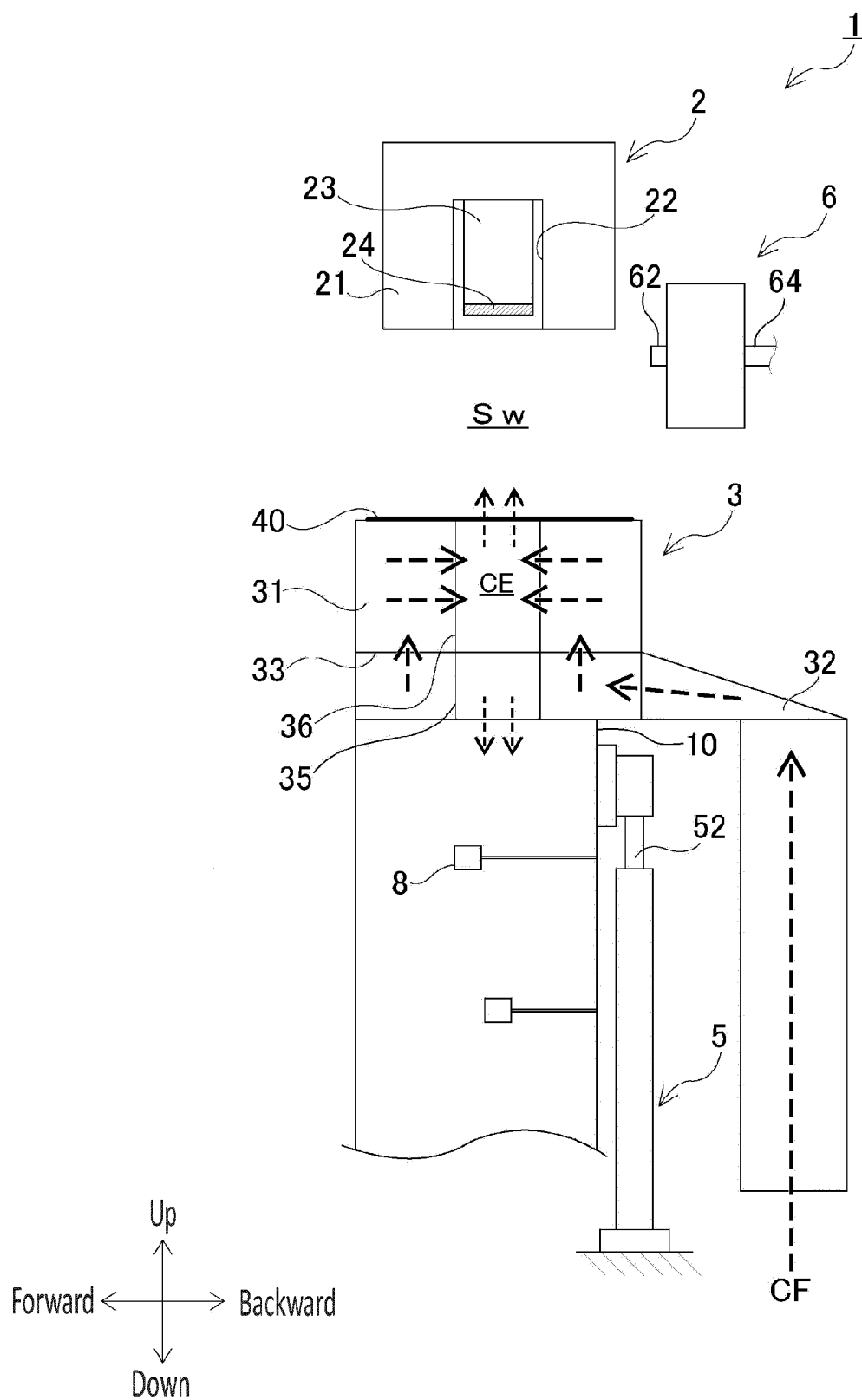


FIG. 4

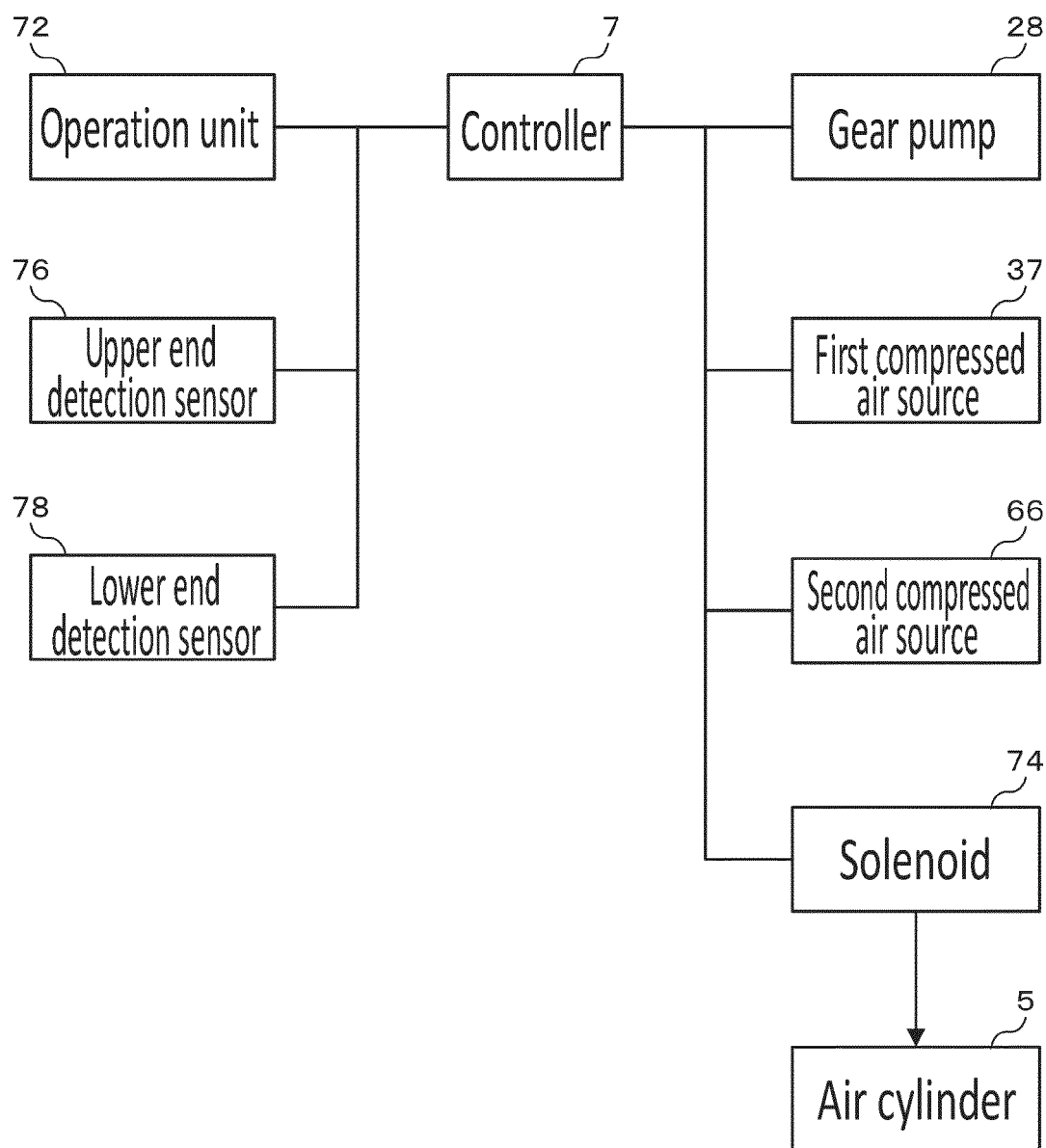


FIG. 5

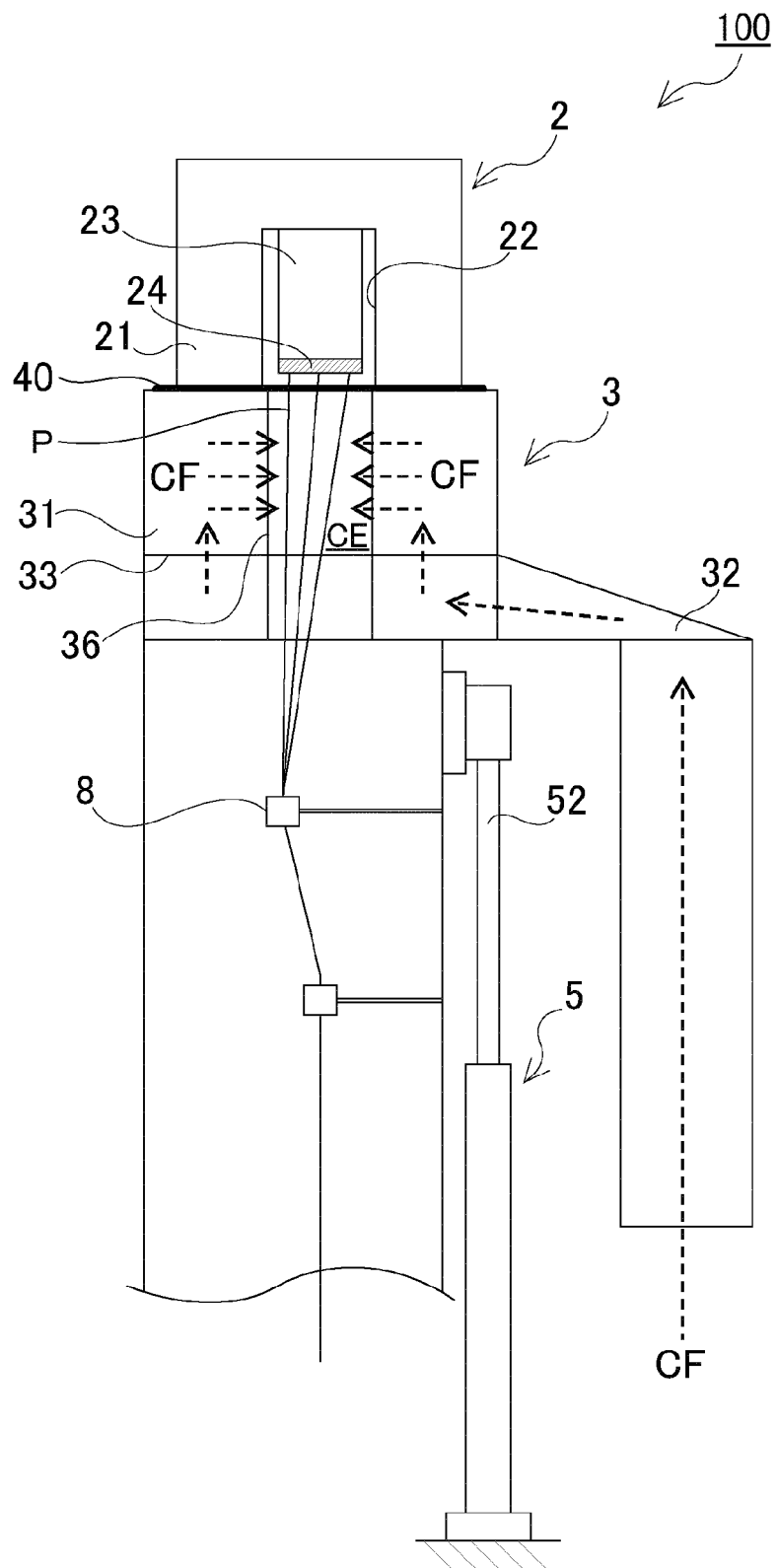


FIG. 6

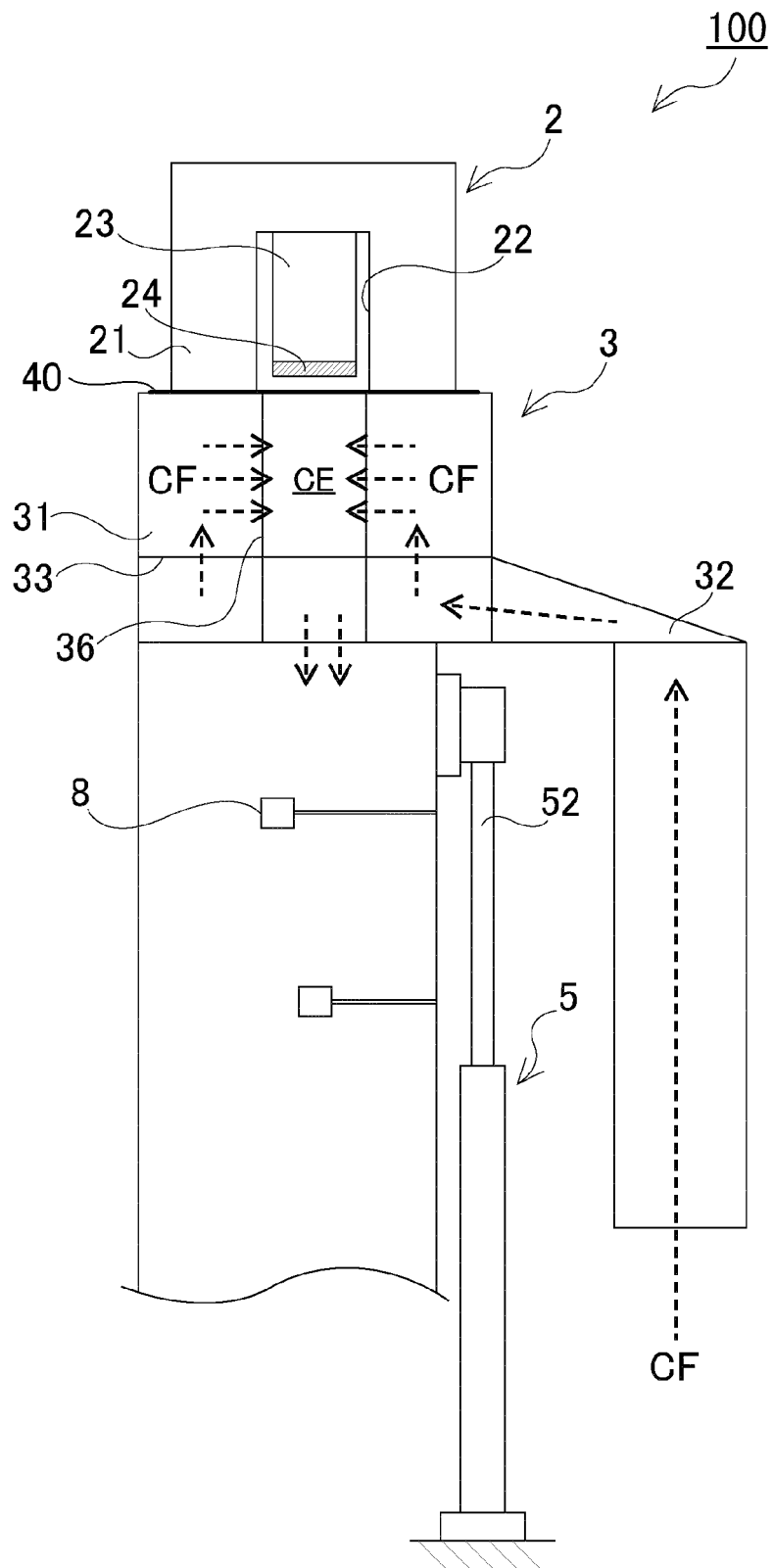


FIG. 7

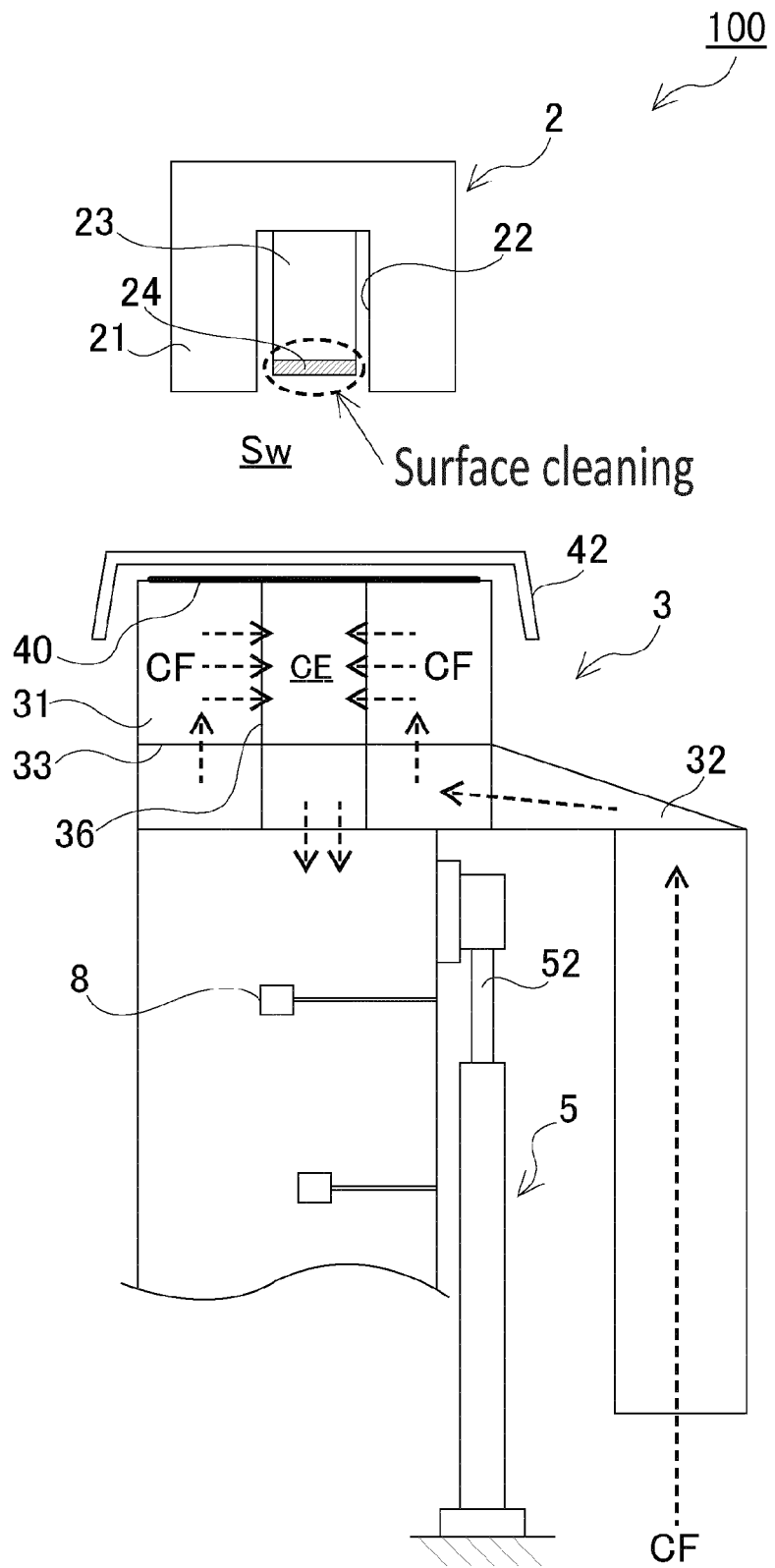


FIG. 8

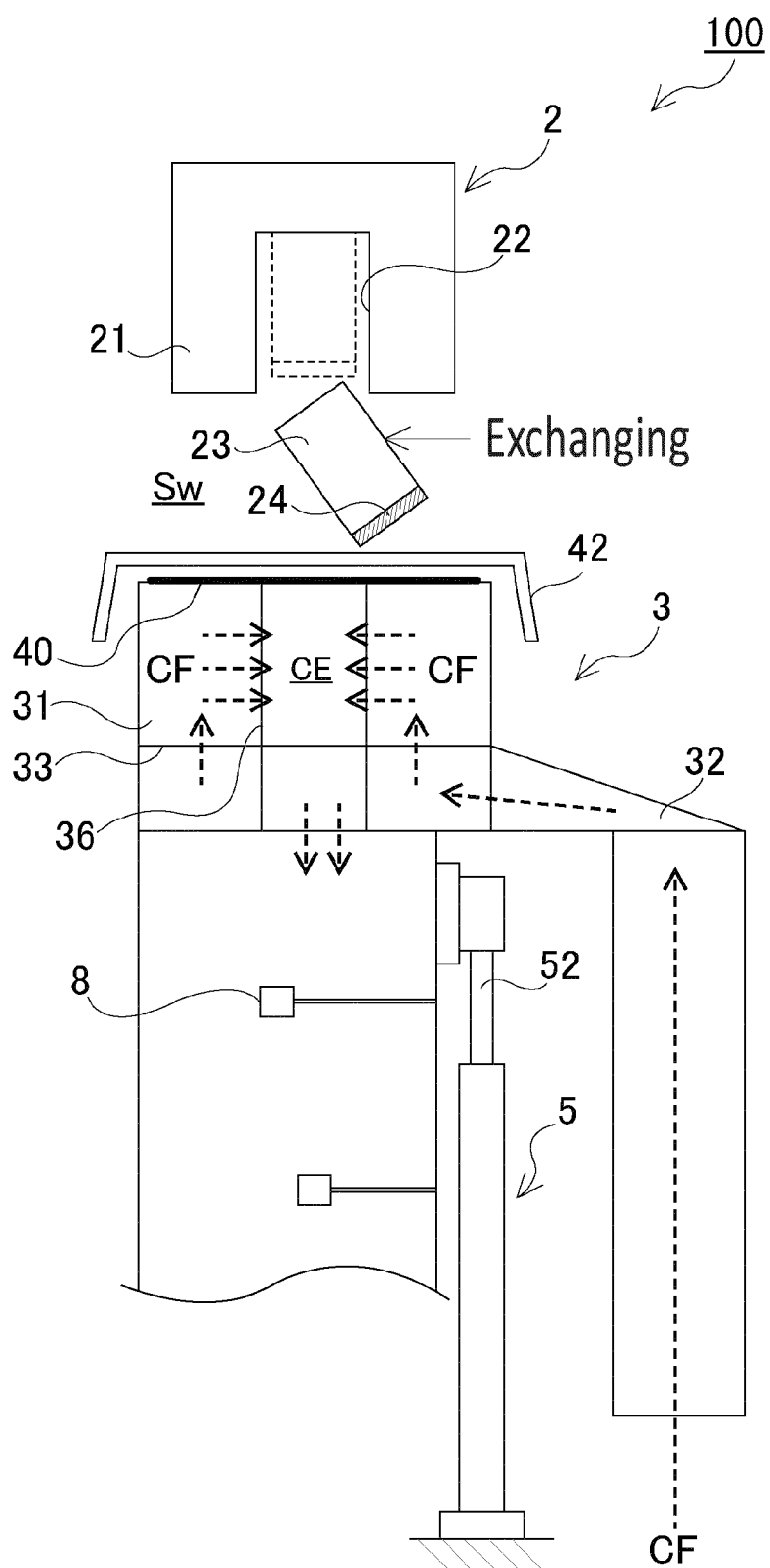


FIG. 9

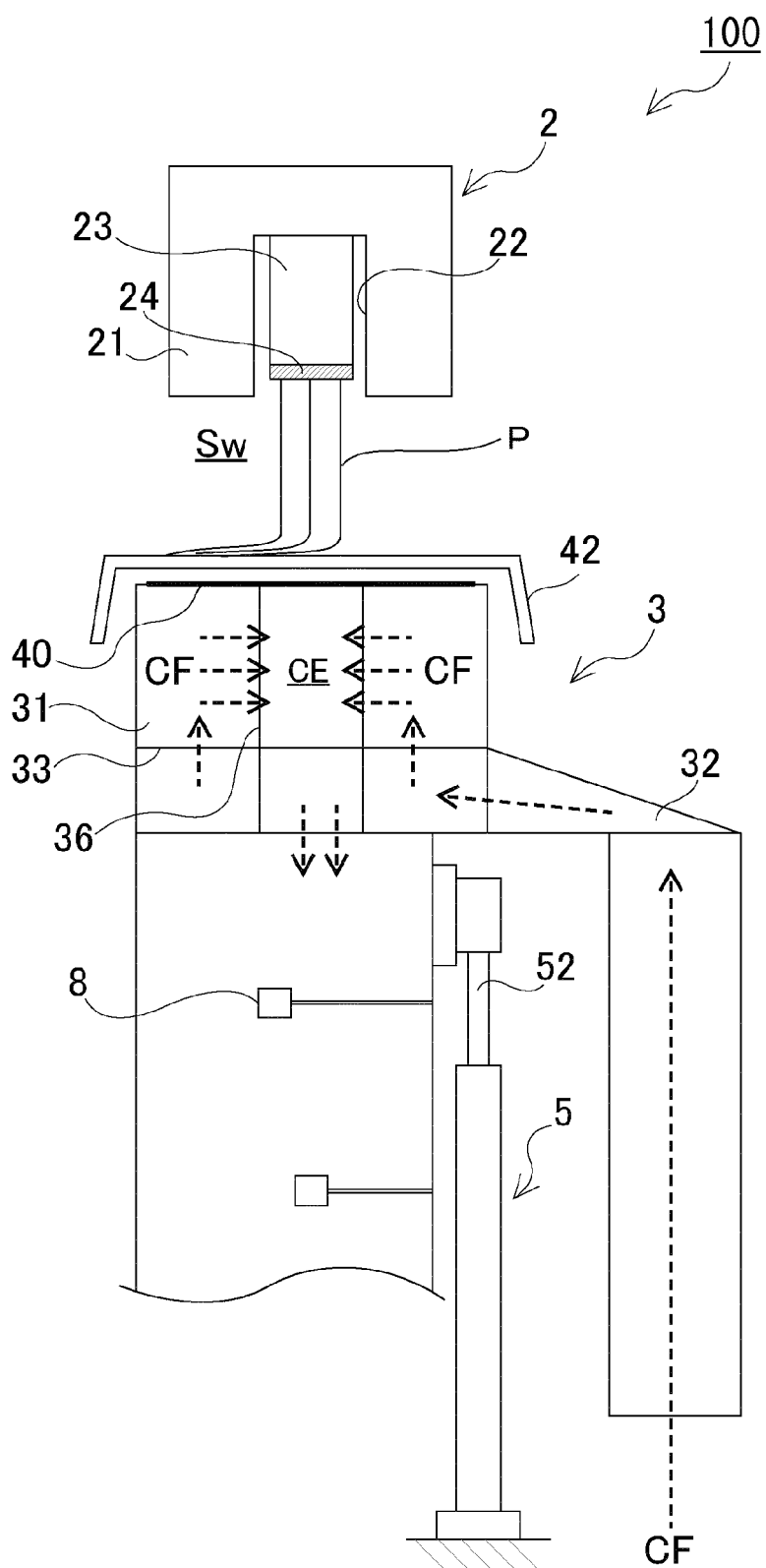


FIG. 10

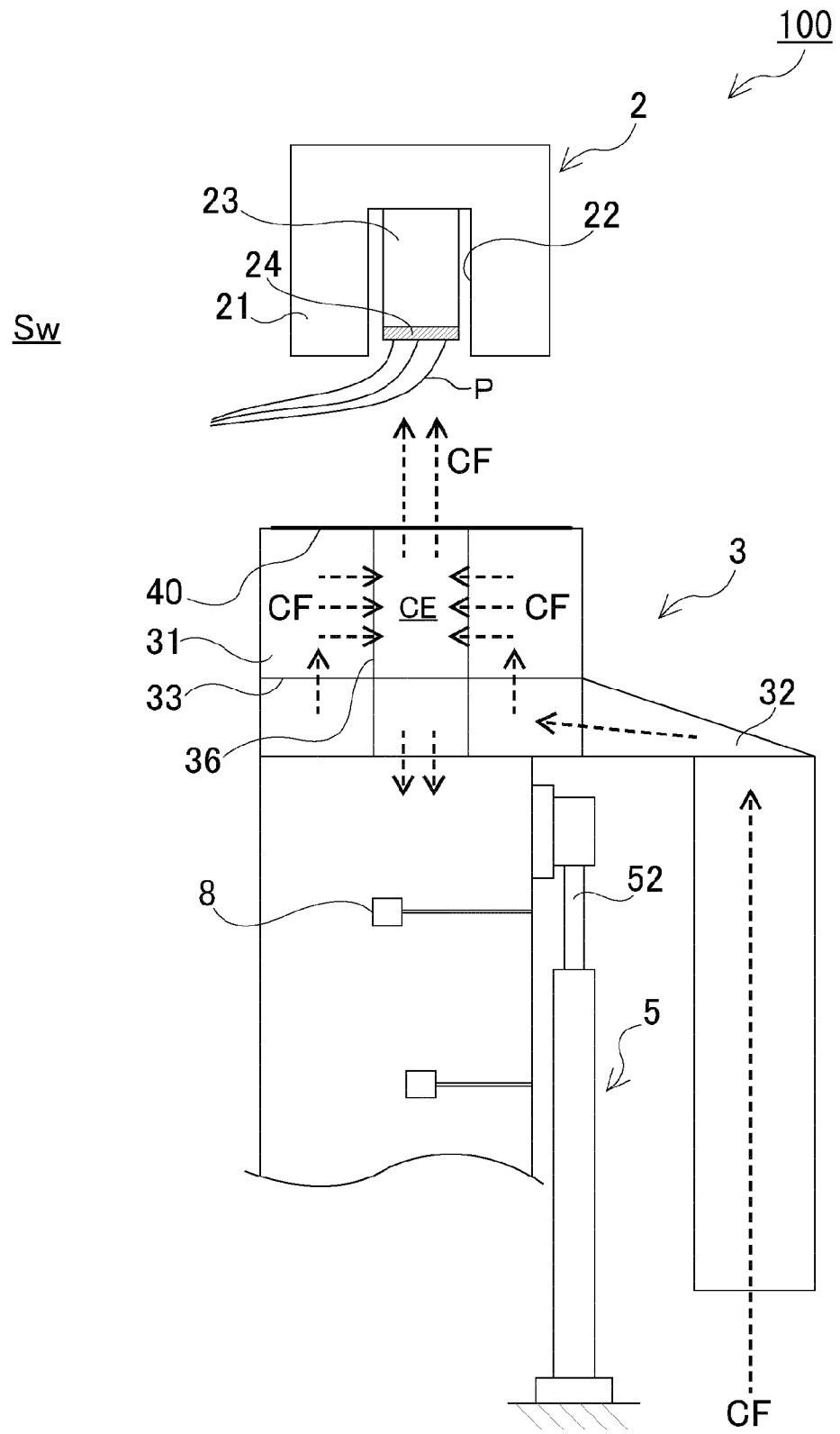


FIG. 11

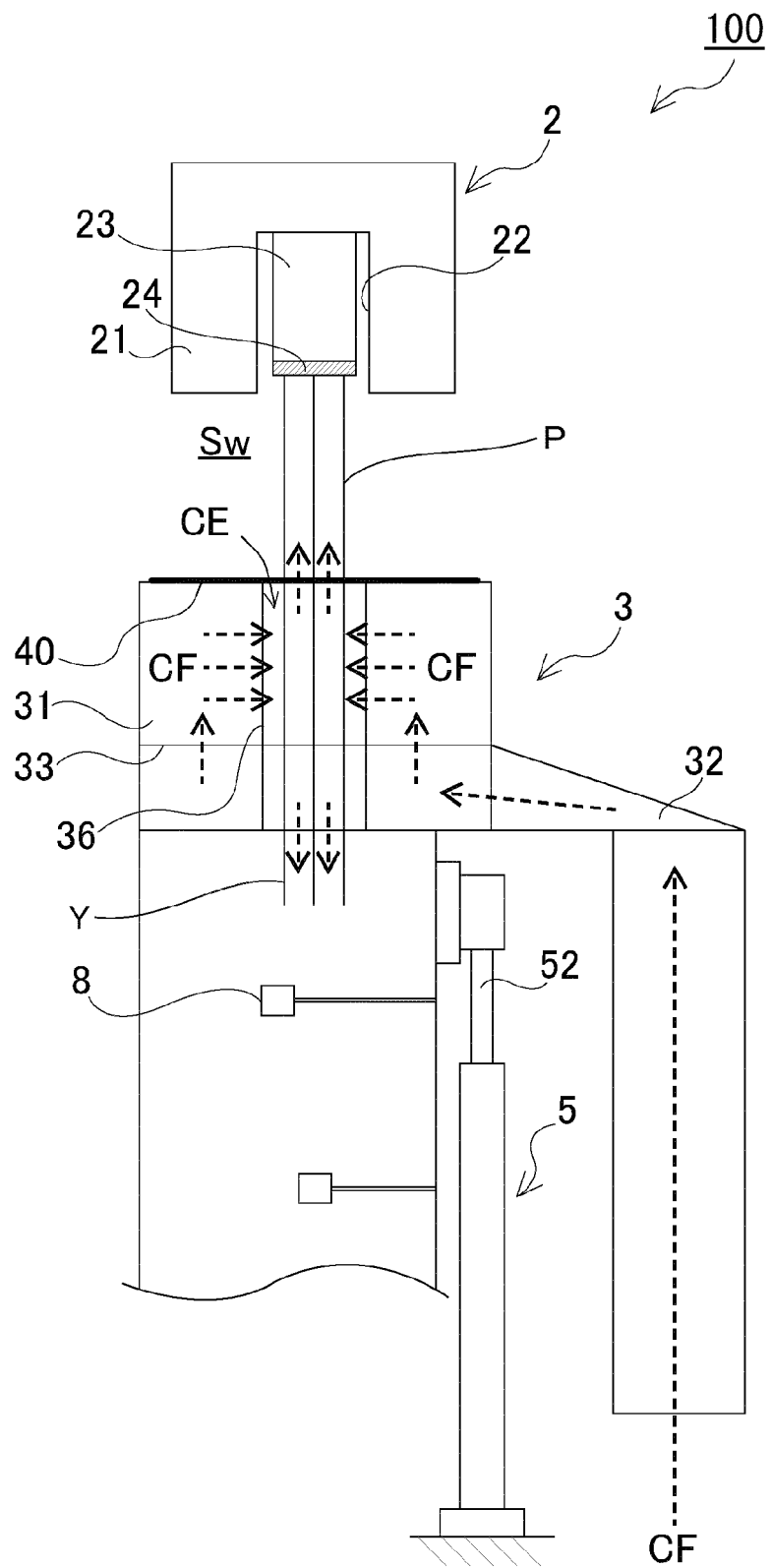


FIG. 12

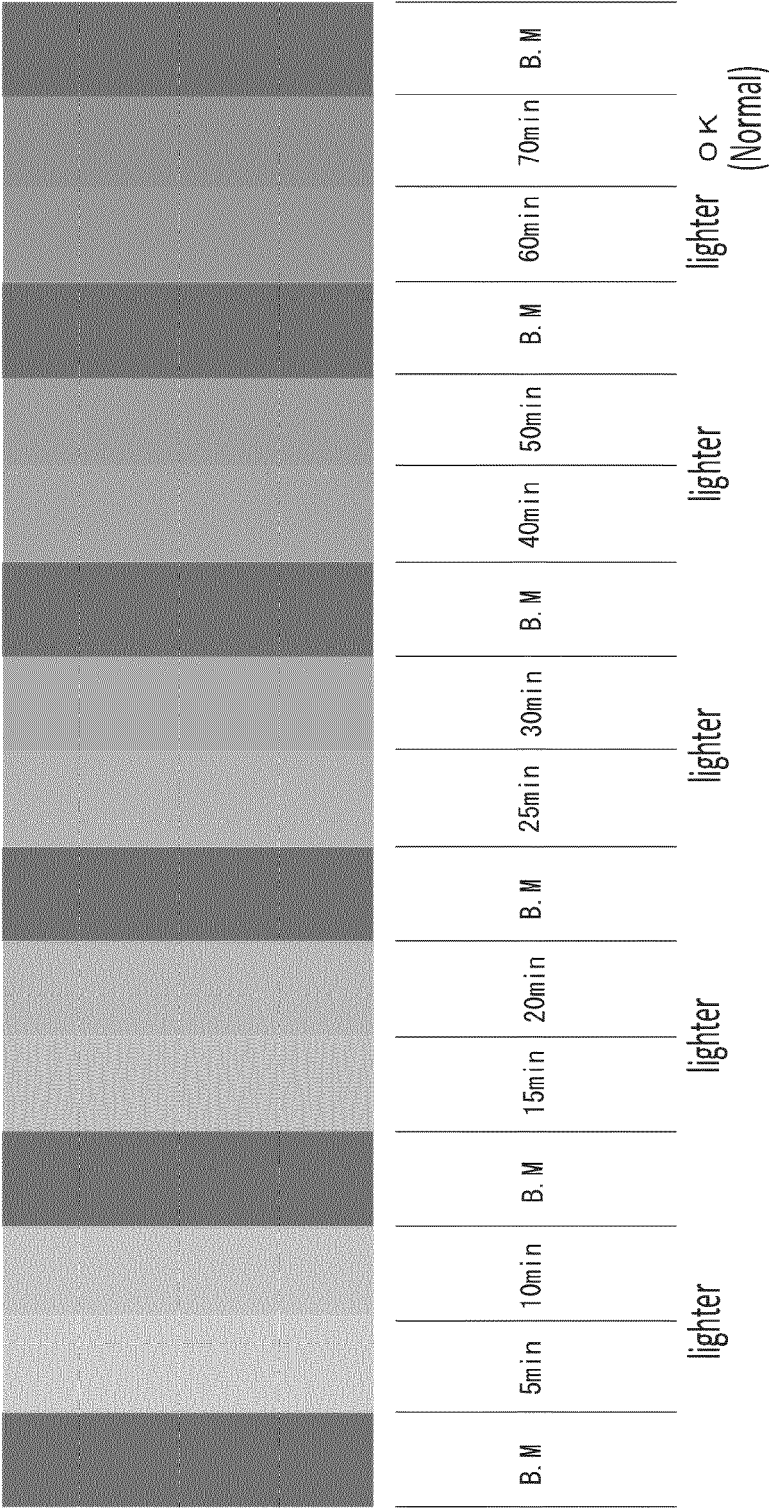


FIG. 13

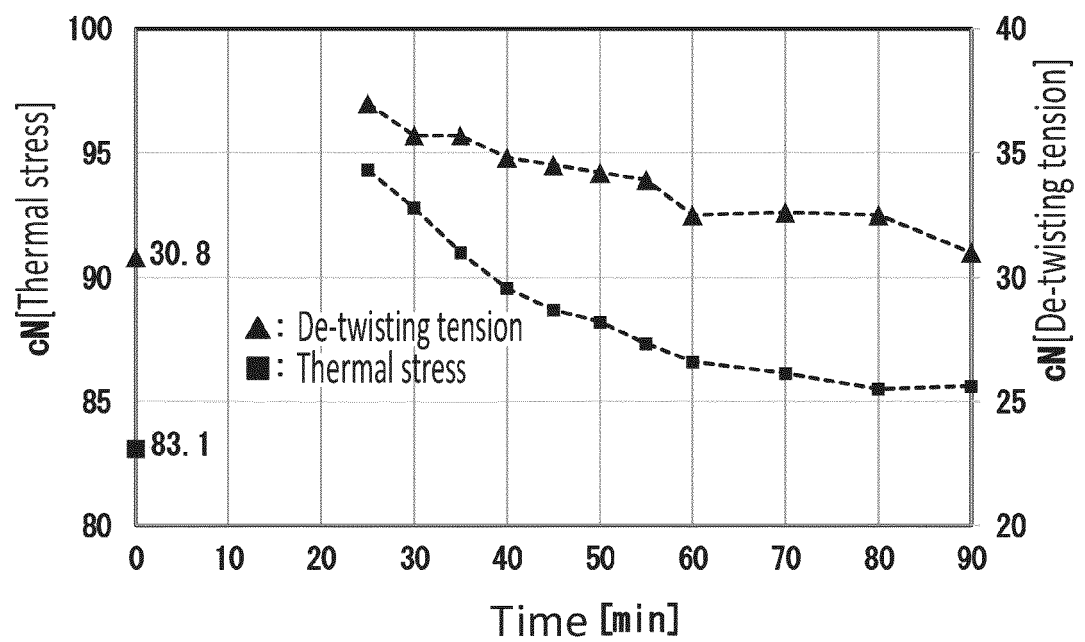


FIG. 14

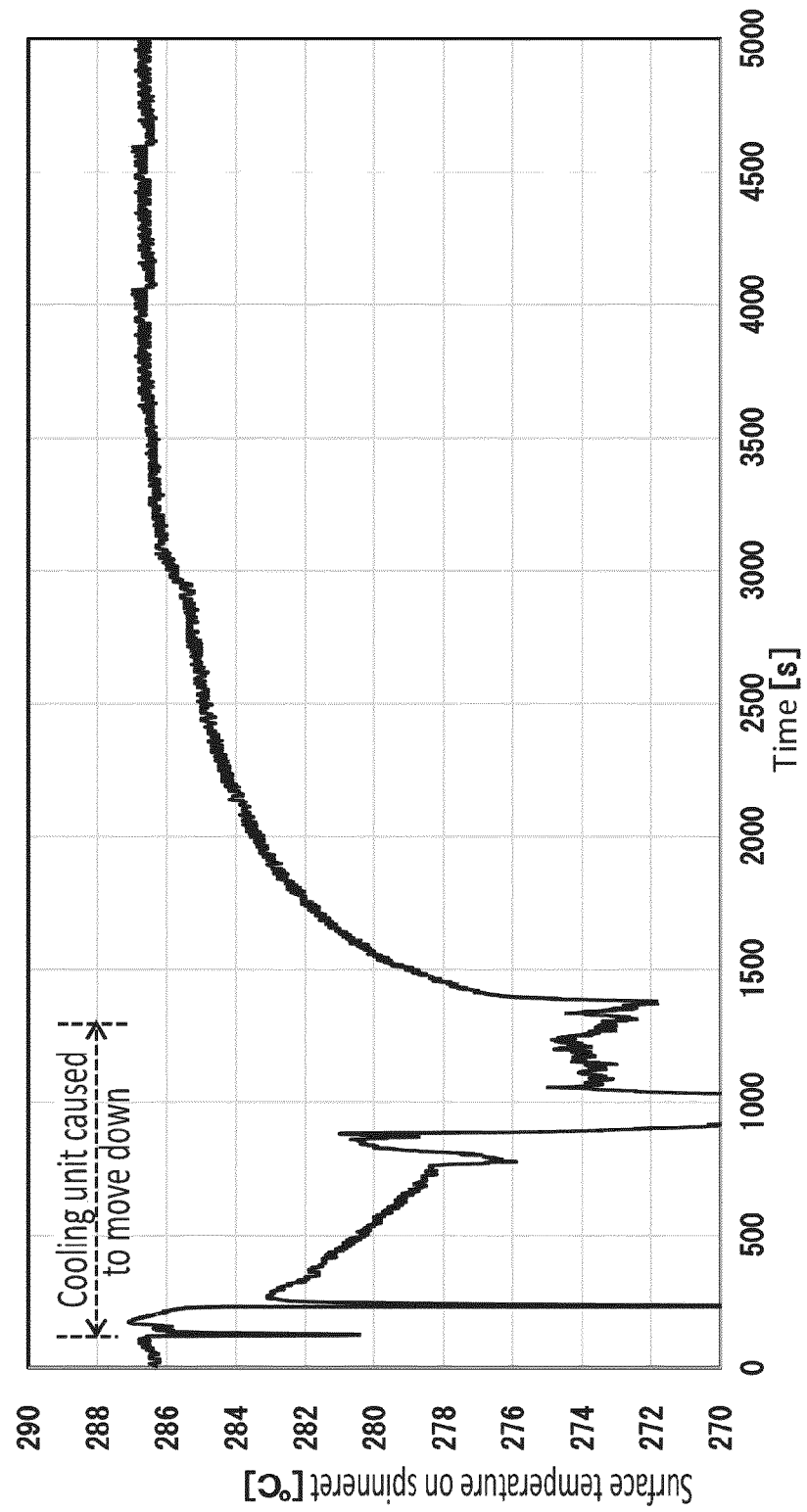


FIG. 15

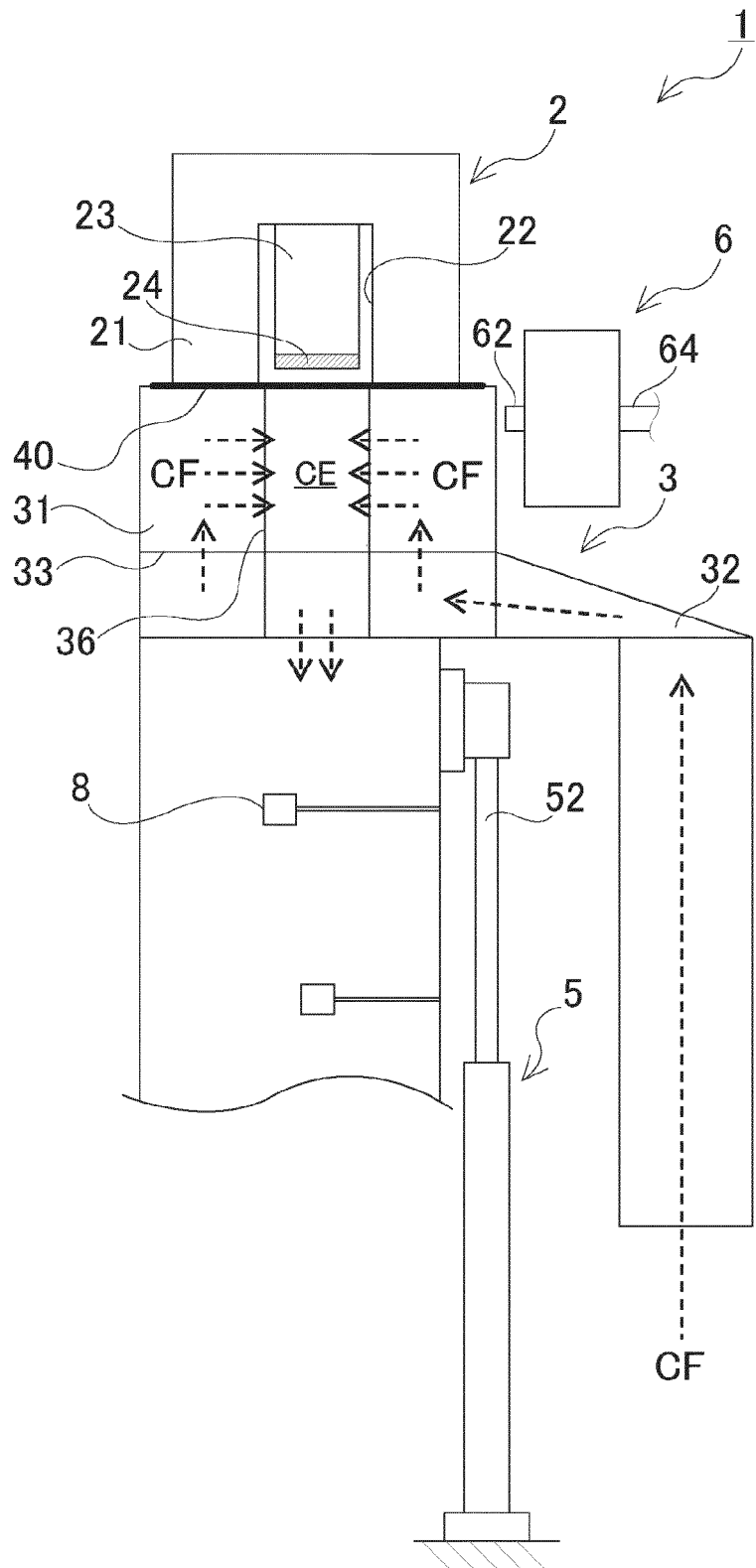


FIG. 16

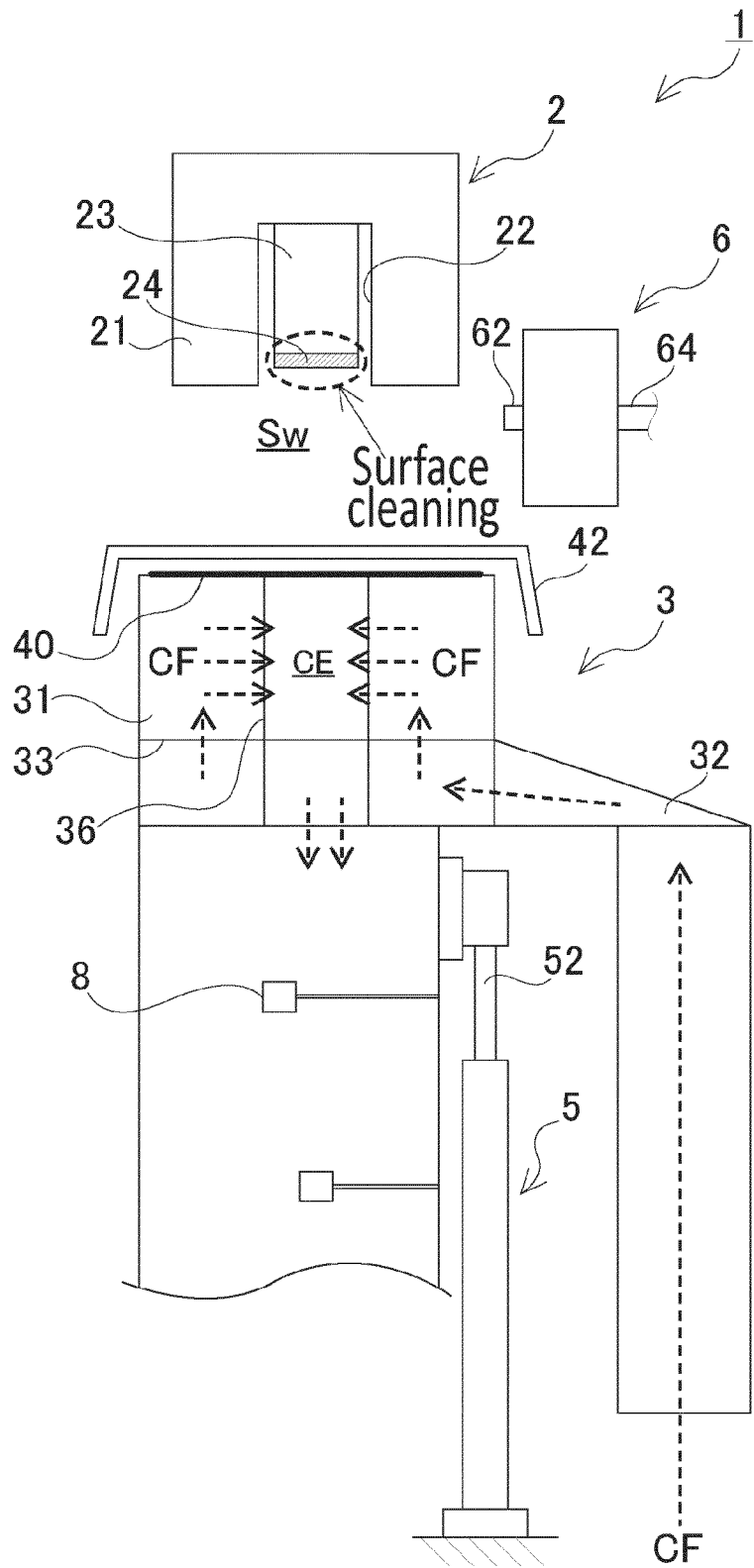


FIG. 17

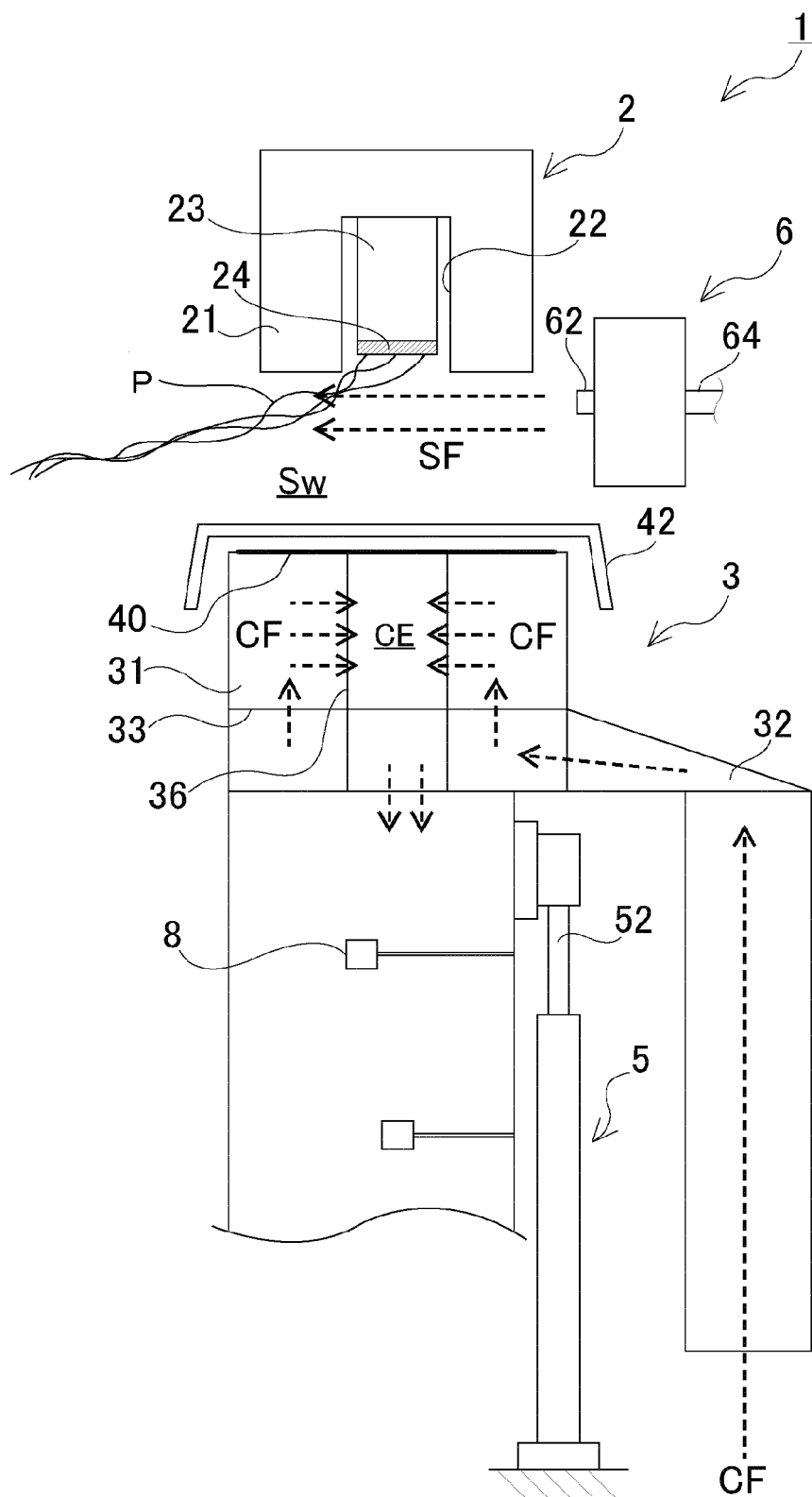


FIG. 18

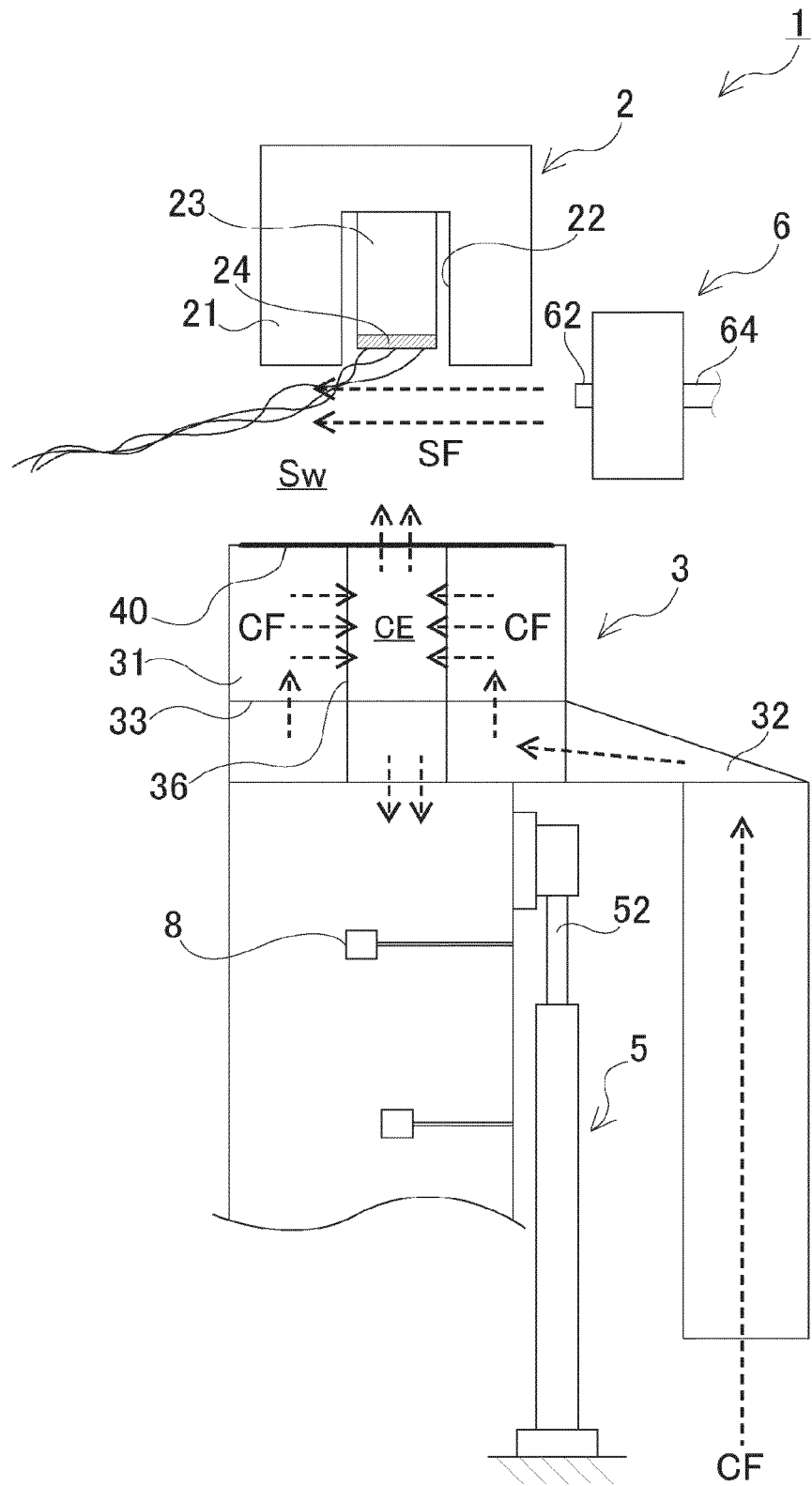


FIG. 19

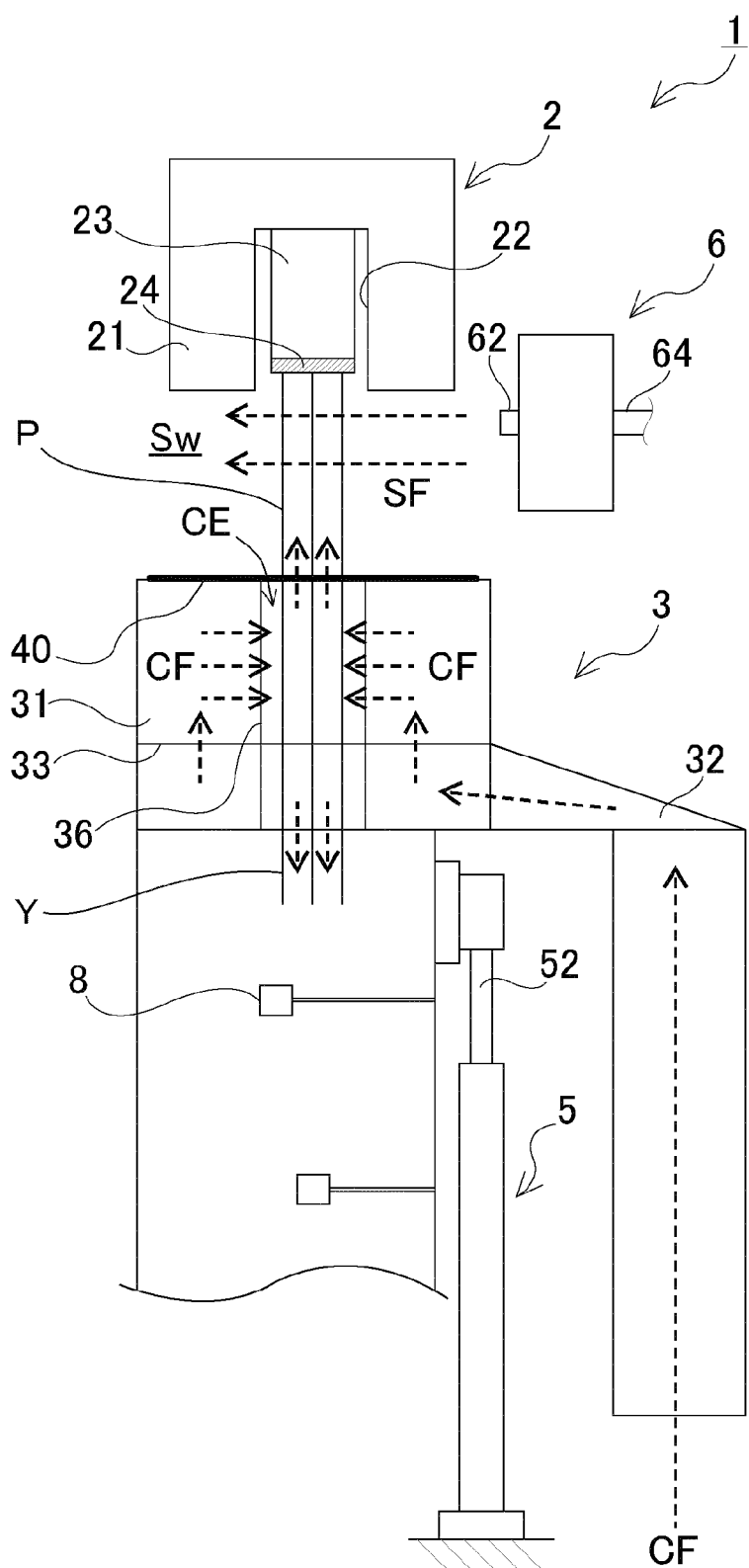


FIG. 20

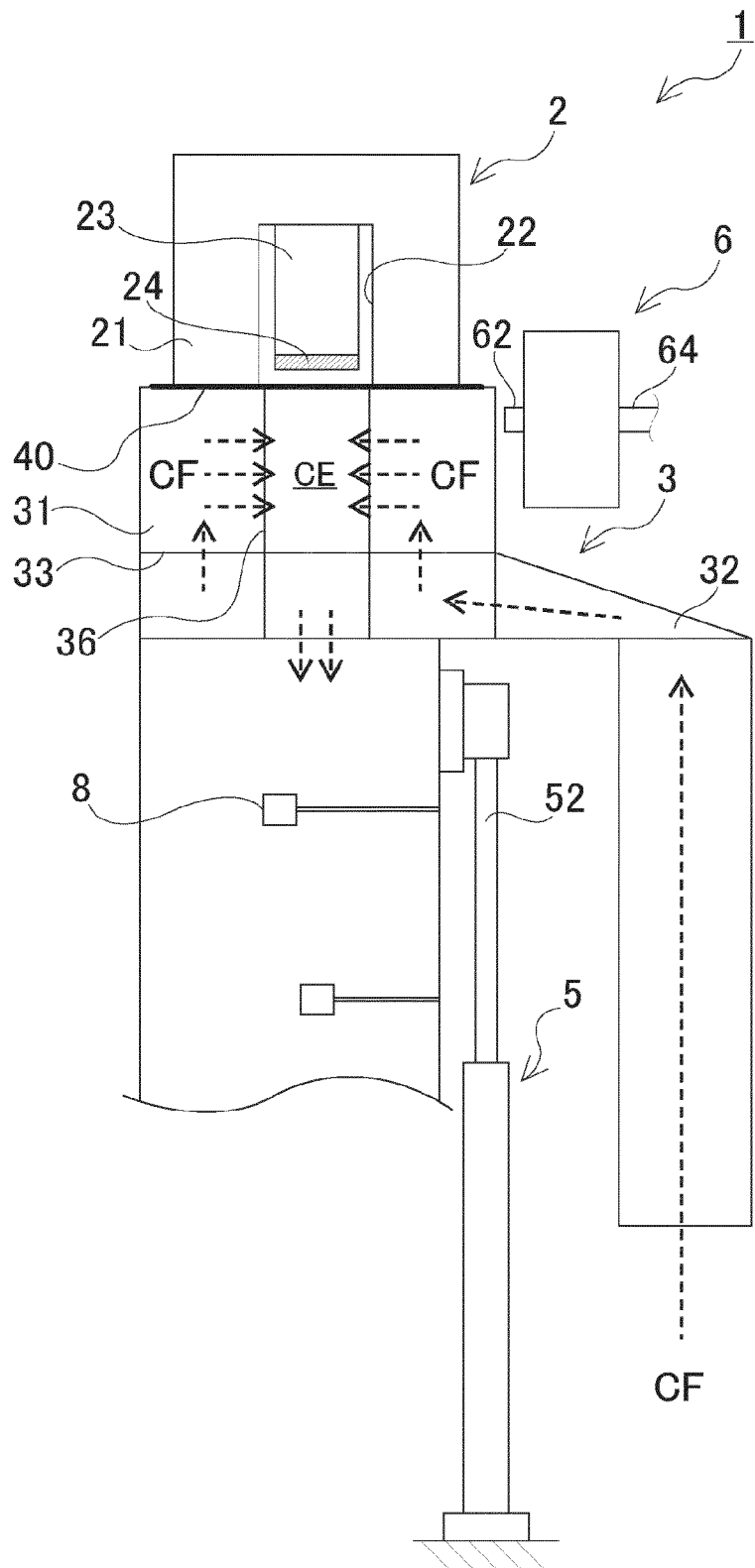


FIG. 21

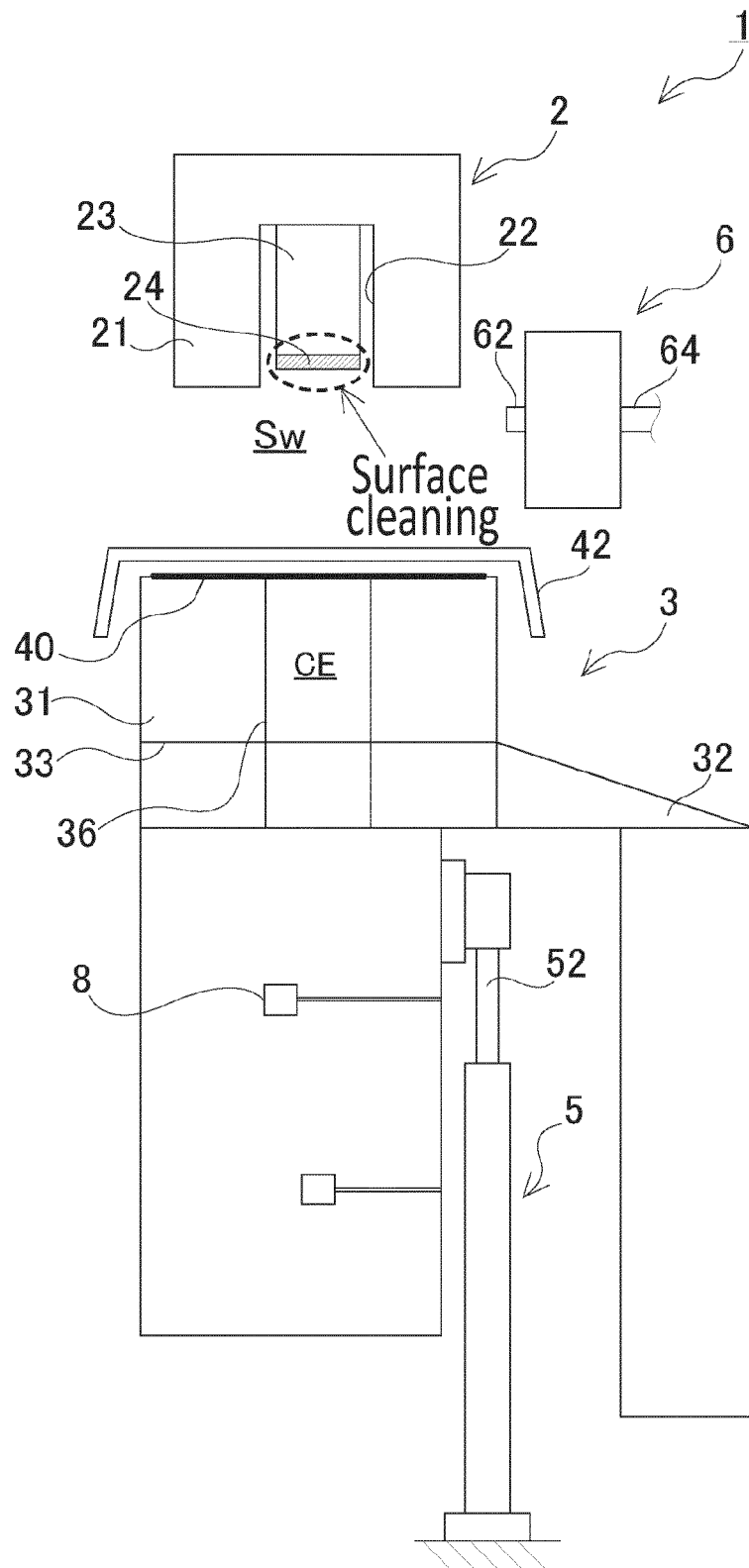


FIG. 22

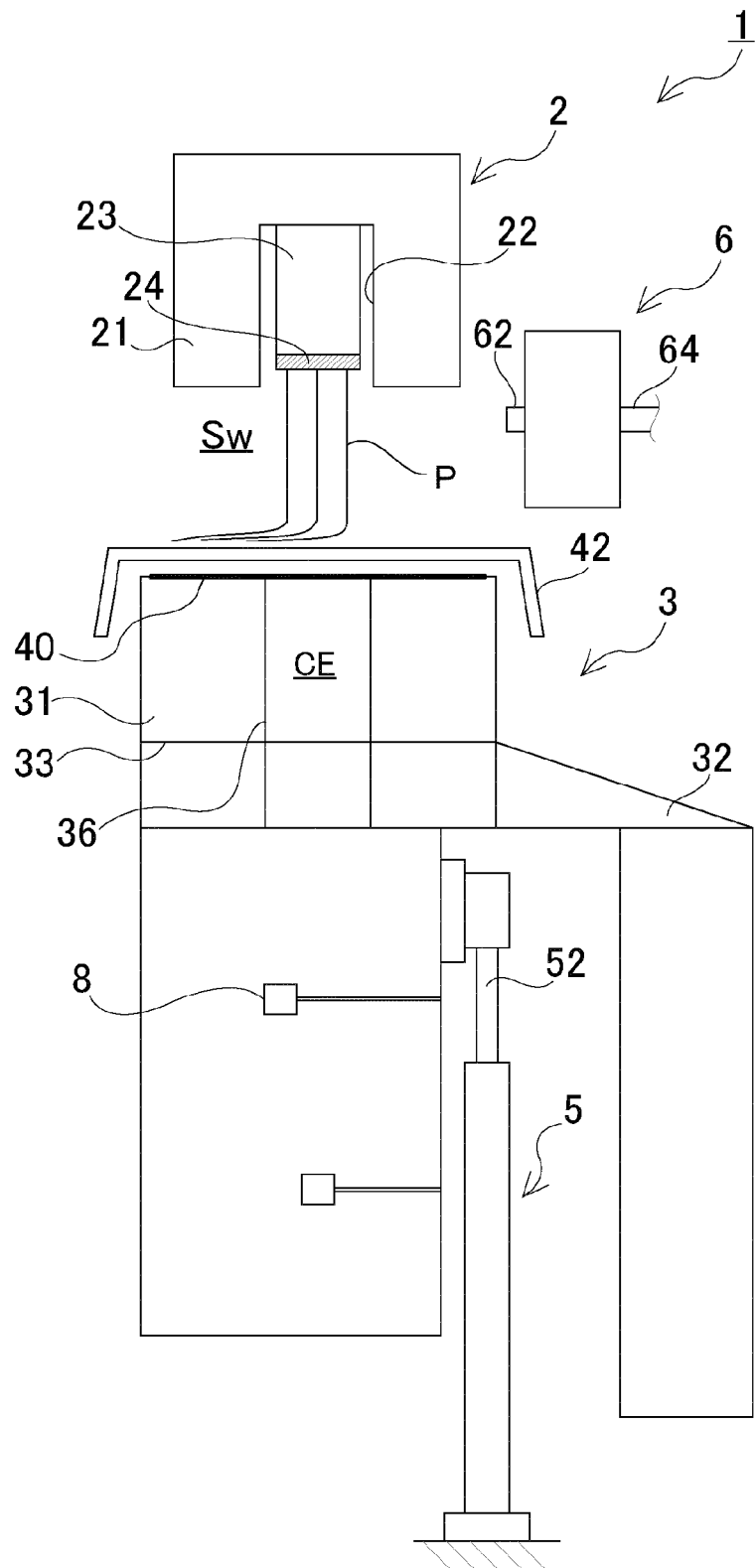


FIG. 23

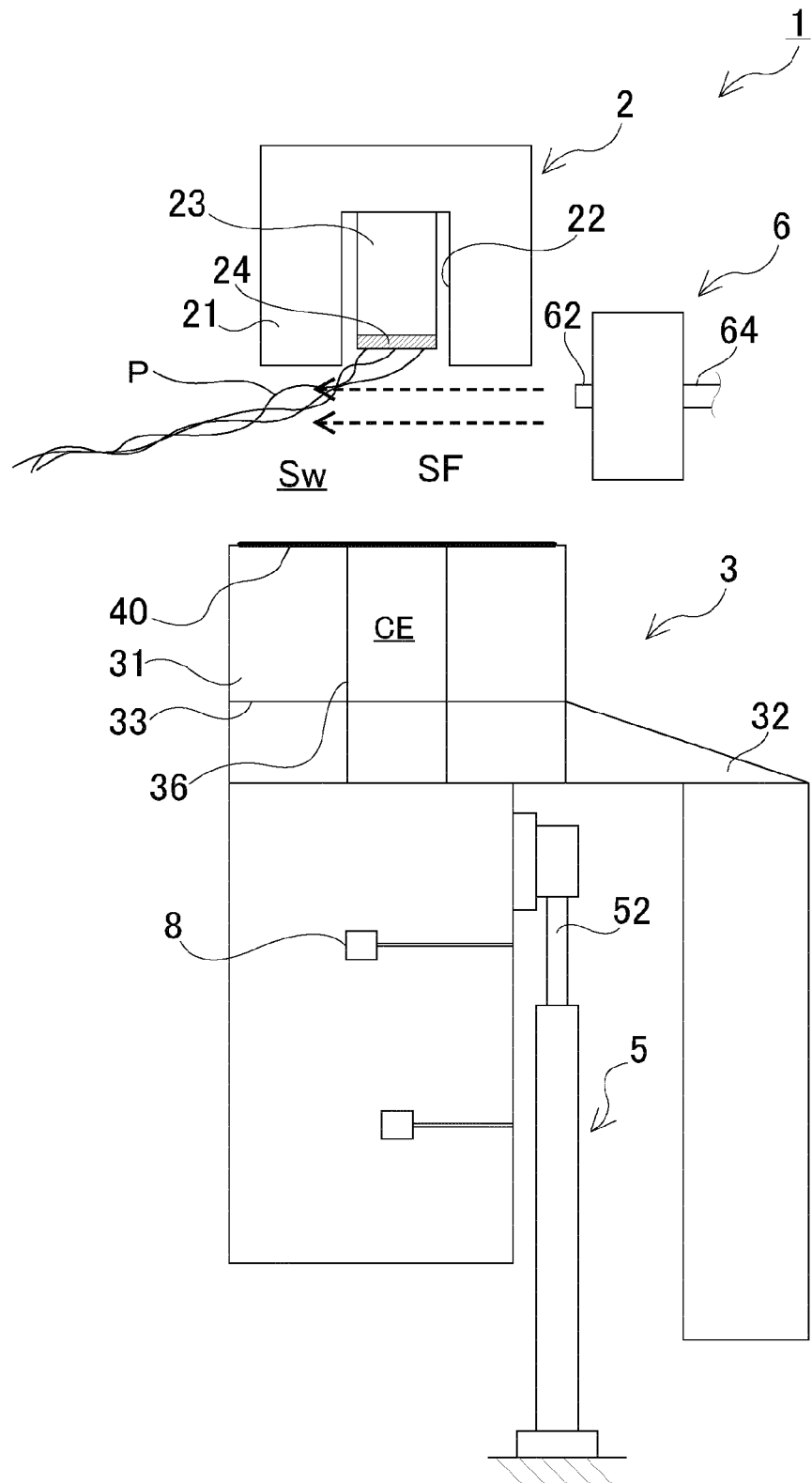


FIG. 24

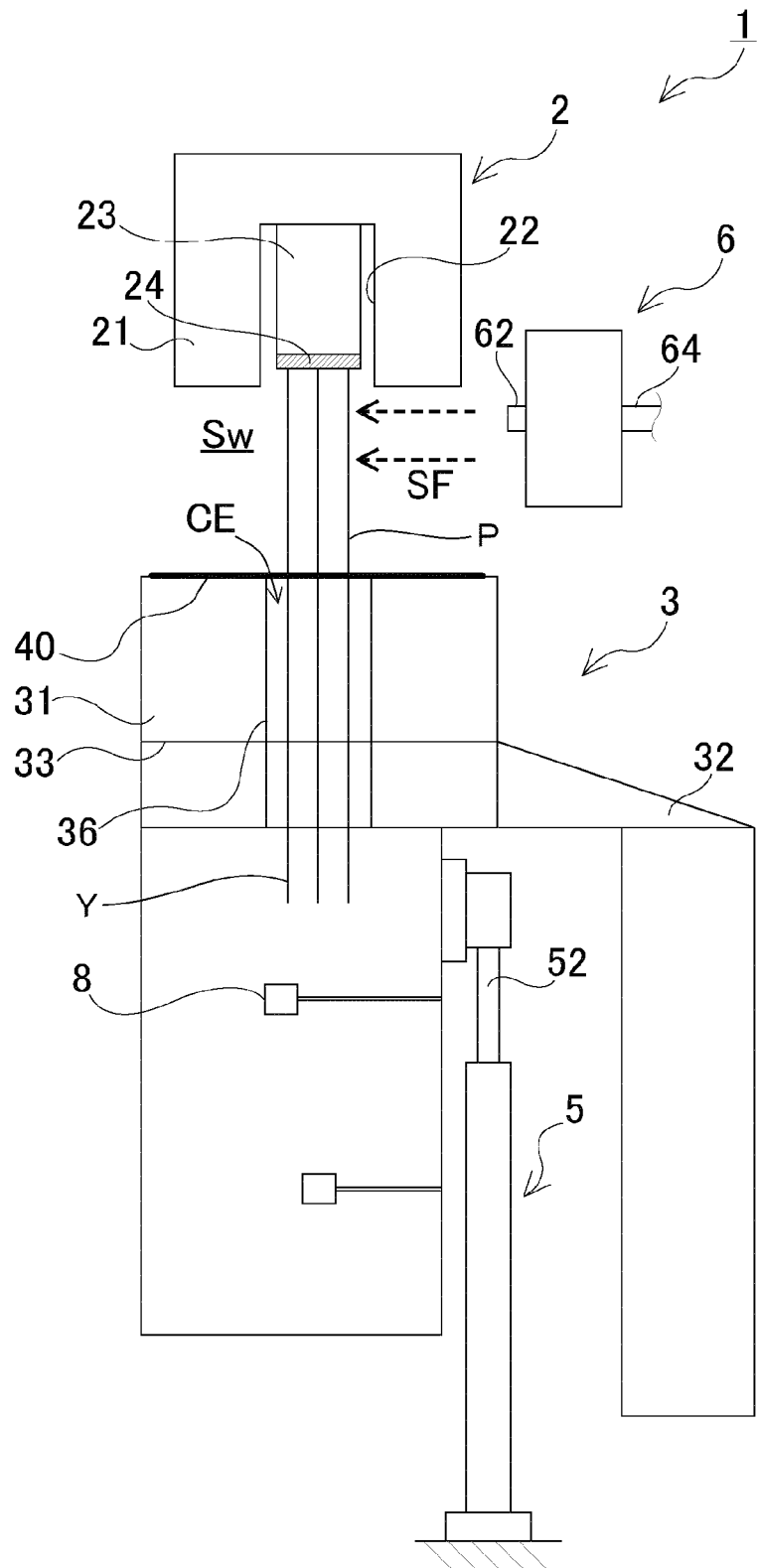


FIG. 25

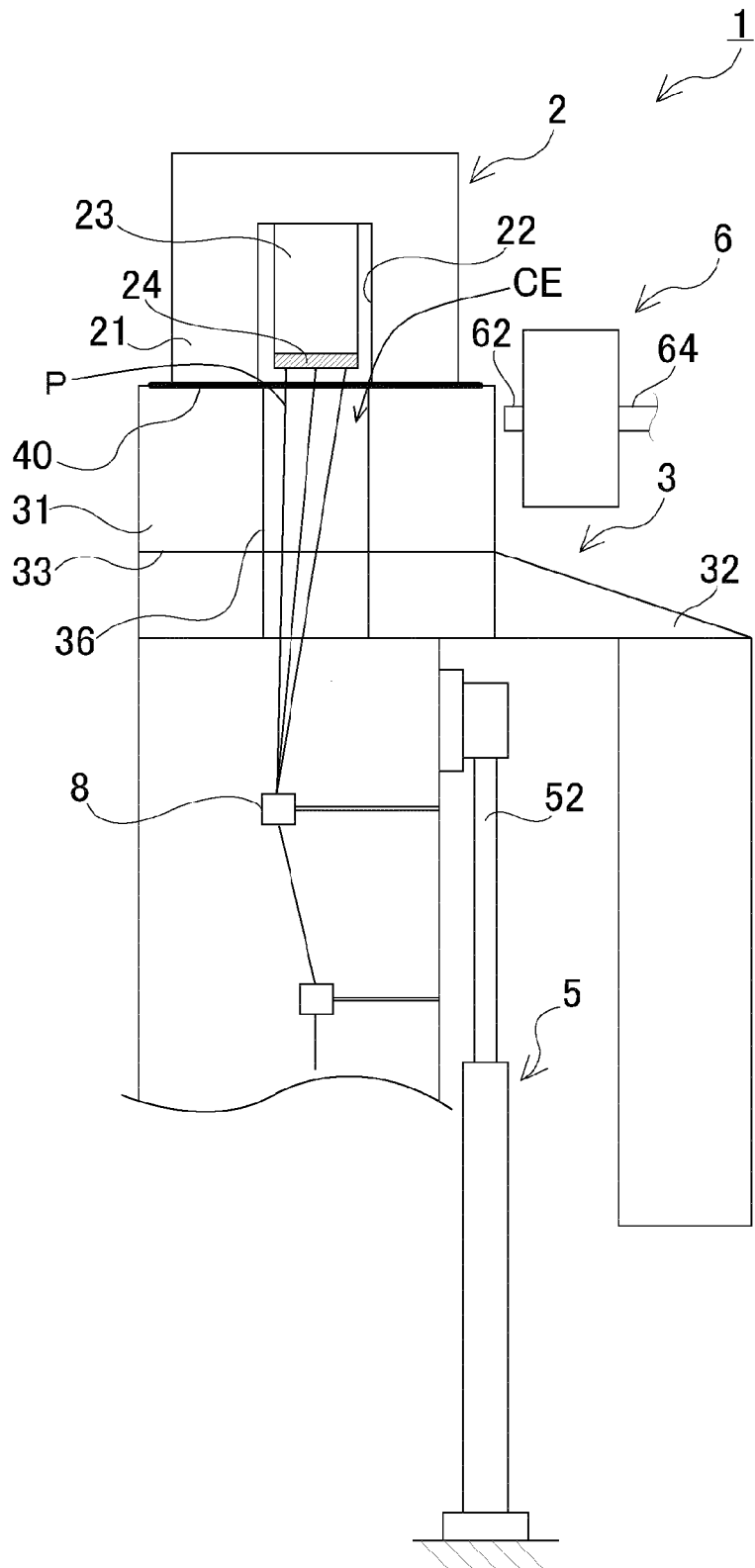


FIG. 26

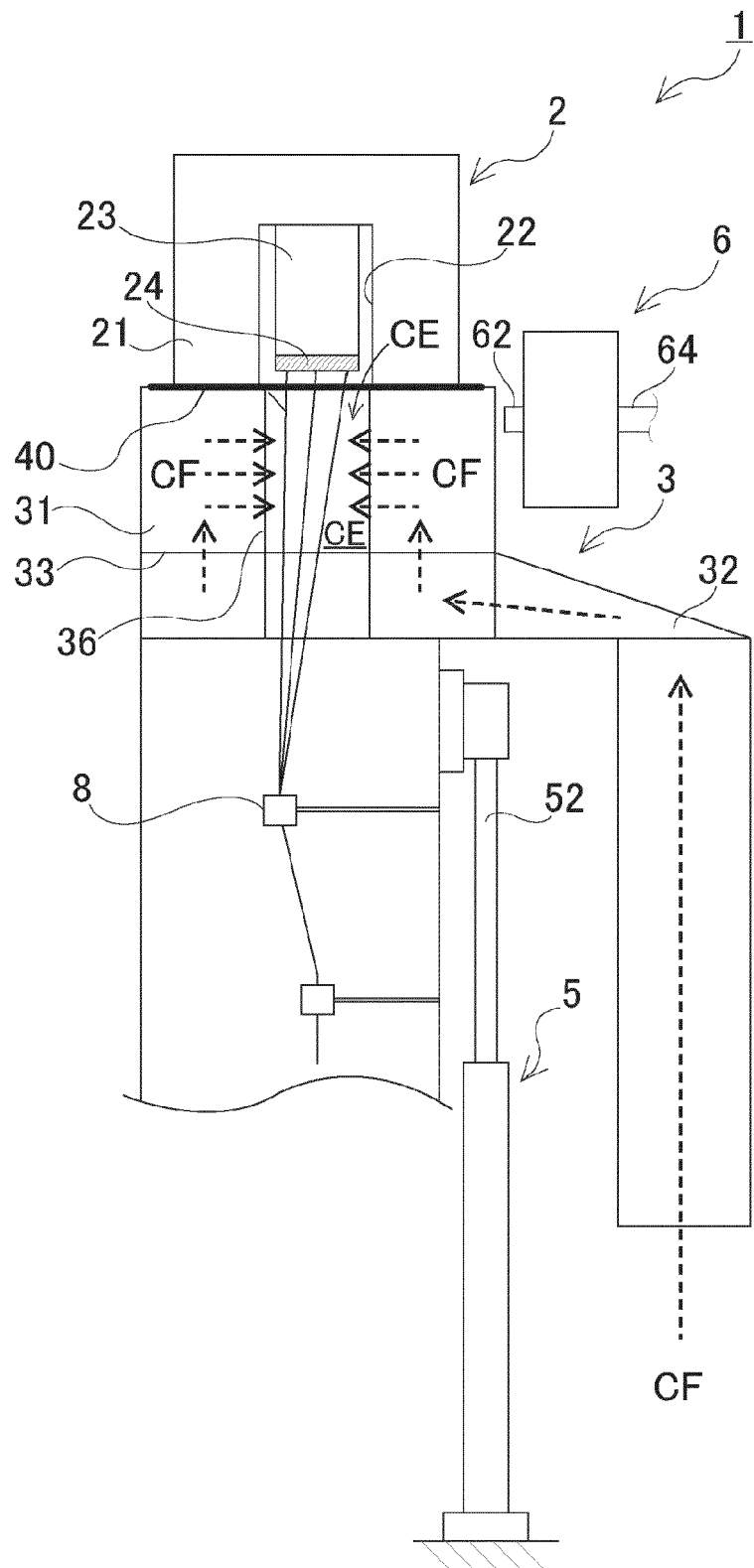


FIG. 27

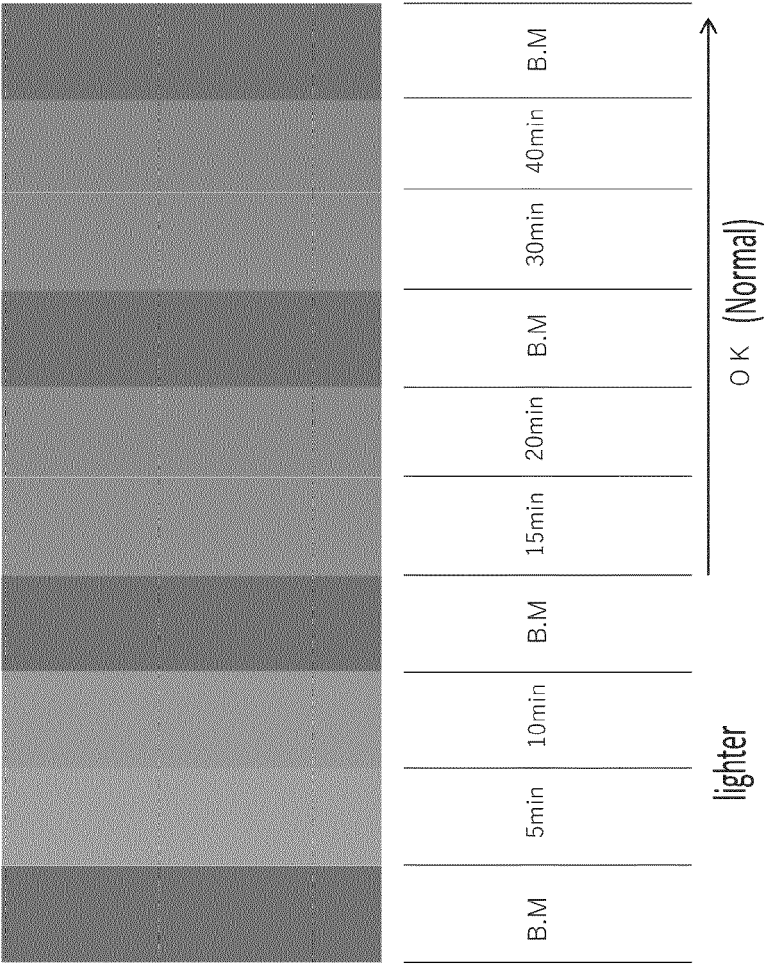


FIG. 28

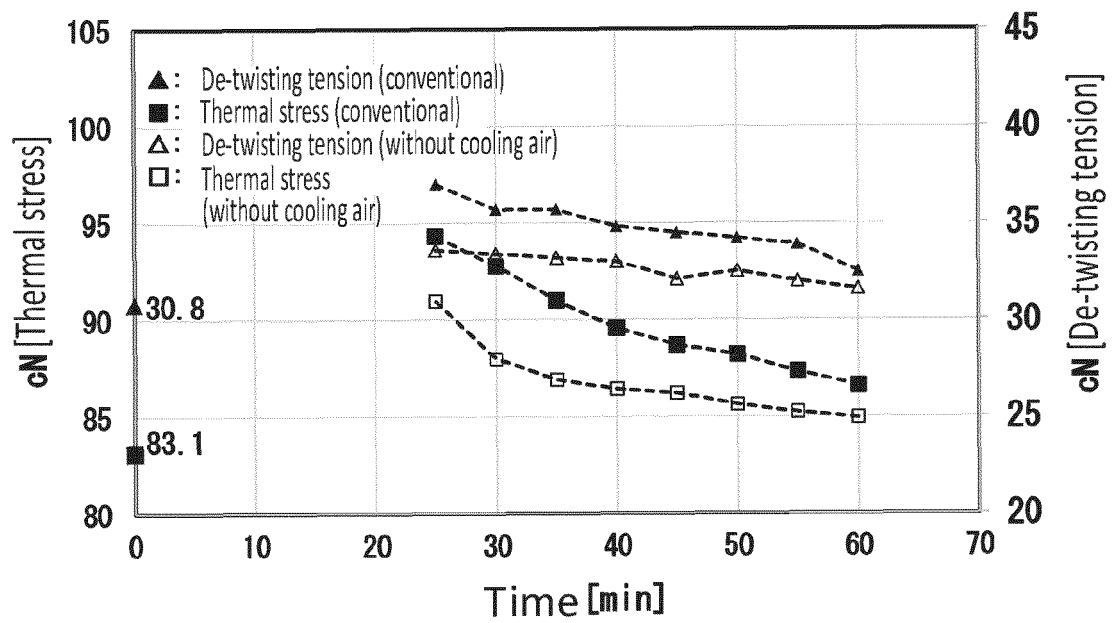
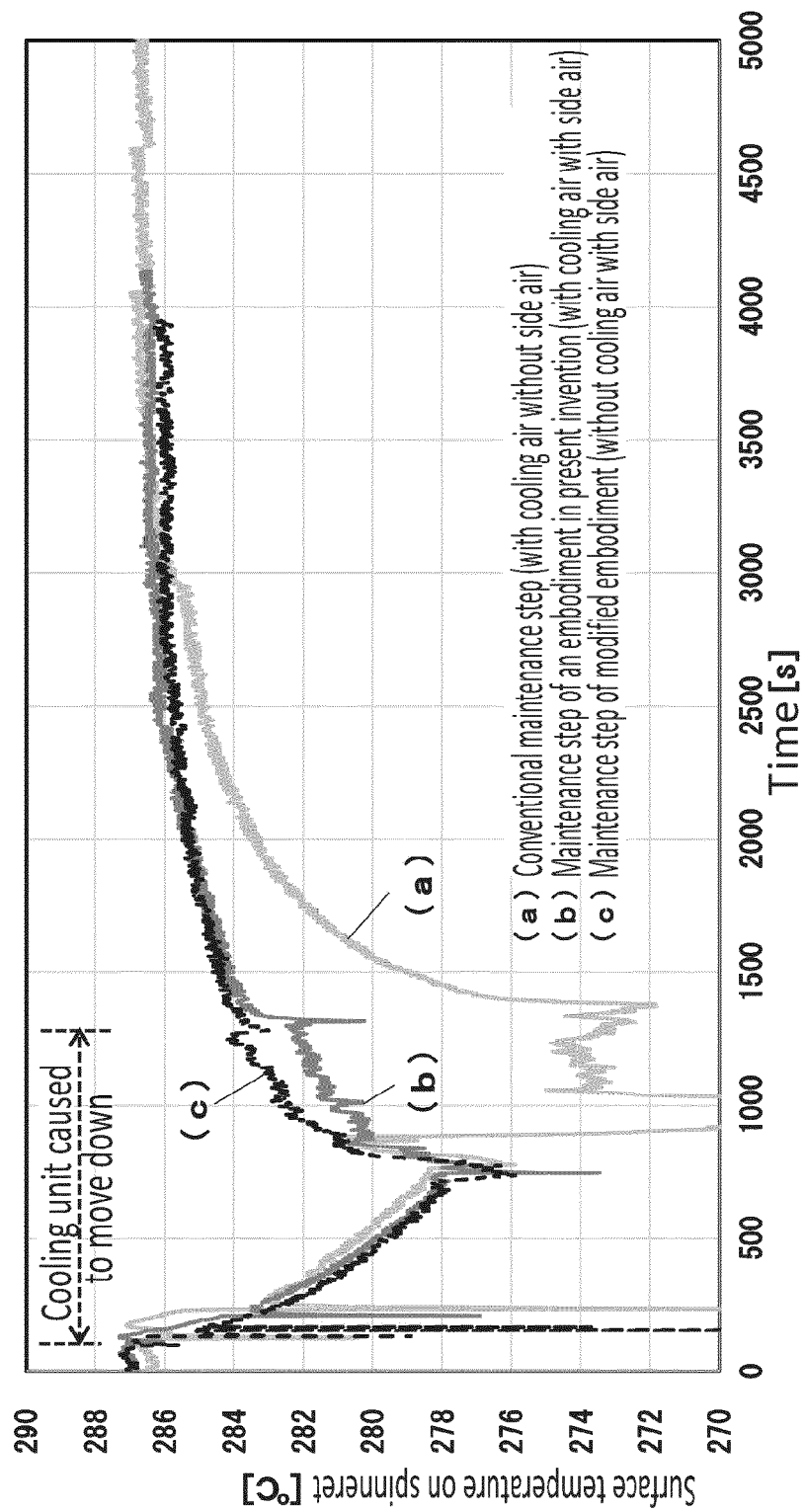


FIG. 29





EUROPEAN SEARCH REPORT

Application Number

EP 23 15 0242

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A, D	JP 2014 145132 A (TMT MACHINERY INC) 14 August 2014 (2014-08-14) * figures 1, 3, 4 * * paragraphs [0021] - [0022], [0026] * -----	1-6	INV. D01D5/092 D01D13/02 ADD. D01D4/04
A	JP S63 112378 A (TEIJIN LTD) 17 May 1988 (1988-05-17) * figures 1-4 * -----	1-6	
			TECHNICAL FIELDS SEARCHED (IPC)
			D01D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		17 July 2023	Verschuren, Jo
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 23 15 0242

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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17-07-2023

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		JP 2014145132 A	14-08-2014
JP S63112378 A	17-05-1988	NONE	

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- JP 2005042227 A [0004]