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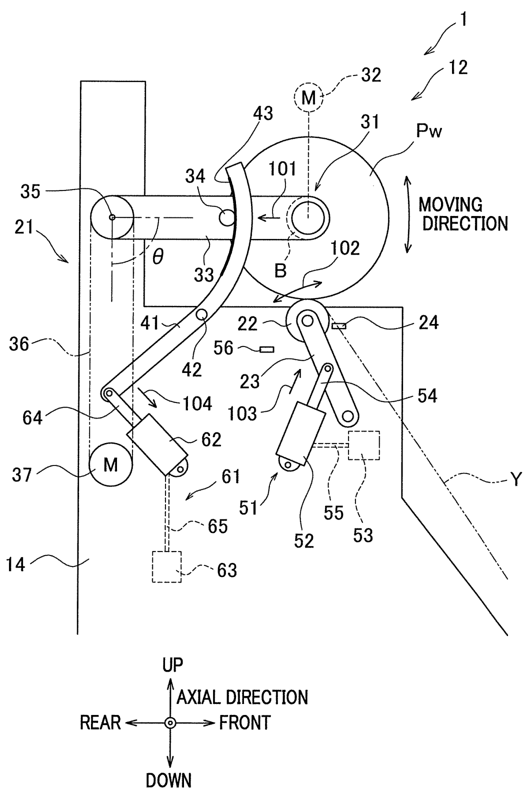
(54) **YARN WINDING MACHINE**

(57) In order to achieve both smooth movement of a support arm and suppression of package vibration, a rewinder 1 in the present invention is provided with:
a cradle device 21 which has a cradle arm 31 that rotatably supports a bobbin B and which is capable of moving the cradle arm 31 in a predetermined direction crossing the axial direction of the bobbin B; a vibration suppression lever 41 that is pressed against the cradle arm 31 and thereby suppresses the vibration of the cradle arm 31; and a pressing mechanism 61 that pushes the vibration suppression lever 41 against the cradle arm 31. The pressing mechanism 61 is capable of changing the magnitude of the pressing force during the winding operation of a yarn Y.

FIG.2



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Description

[Technical Field]

[0001] The present invention relates to a yarn winder configured to form a package by winding a yarn onto a bobbin.

[Background Art]

[0002] Patent Literature 1 discloses a yarn re-winder which is configured to re-wind a yarn supplied from a yarn supply package to a bobbin so as to form a wound package. To be more specific, the yarn re-winder includes a bobbin holding member (support arm) which is swingable and supports a bobbin to be rotatable, a friction roller which makes contact with a wound package and rotates the wound package, and a motor which rotationally drives the friction roller. As the friction roller is rotationally driven, the wound package passively rotates and a yarn is wound onto the wound package (winding operation). The support arm swings as the diameter of the wound package increases.

[0003] In the above-described yarn re-winder, the wound package may vibrate due to reasons such as deformation of the wound package (i.e., slight deviation from the optimal shape) . Such vibration may cause further deformation of the rotating wound package, and this may result in collapse in shape of the wound package. To solve this problem, for example, a vibration suppression mechanism shown in Patent Literature 2 may be provided in the above-described yarn re-winder. The vibration suppression mechanism includes a brake piece attached to a support arm, a brake body pressed onto the brake piece, and a spring biasing the brake body. With this arrangement, the vibration of the support arm is suppressed by friction force acting between the brake piece and the brake body, and hence the vibration of the package is suppressed.

[Citation List]

[Patent Literatures]

[0004]

[Patent Literature 1] Japanese Laid-Open Patent Publication No. 2004-107007

[Patent Literature 2] Japanese Examined Utility Model Publication No. S60-6048

[Summary of Invention]

[Technical Problem]

[0005] In the vibration suppression mechanism of Patent Literature 2, the biasing force of the spring is not actively changed in the winding operation. On this account, when the biasing force of the spring is set large in advance in order to ensure the suppression of vibration, the above-described friction force may become too large. When the friction force is too large, the swing of the support arm in accordance with the increase in diameter of the wound package may not be smoothly performed. Meanwhile, when the biasing force is set small in advance in order to ensure smooth swing of the support arm, the friction force may become too small. When the friction force is too small, the vibration of the wound package may not be sufficiently suppressed. Furthermore, when, for example, the biasing force required for sufficiently suppressing the vibration of the wound package is significantly larger than the biasing force which is sufficient to allow the support arm to smoothly swing, it may be impossible to achieve both the smooth swing of the support arm and the suppression of the vibration of the wound package.

[0006] An object of the present invention is to achieve both smooth movement of a support arm and suppression of vibration of a package.

[Solution to Problem]

[0007] A yarn winder of a first aspect of the invention, which forms a package by winding a yarn onto a bobbin, includes: a cradle device which includes a support arm supporting the bobbin to be rotatable and is capable of moving the support arm in a predetermined direction intersecting with an axial direction of the bobbin; a vibration suppression member which is pressed onto the support arm so as to suppress vibration of the support arm; and a pressing mechanism configured to press the vibration suppression member onto the support arm, the pressing mechanism being capable of changing the magnitude of pressing force during a winding operation of winding the yarn.

[0008] According to this aspect, as the vibration suppression member is pressed onto the support arm by the pressing mechanism, friction force acts between the vibration suppression member and the support arm. This friction force suppresses the vibration of the support arm, with the result that the vibration of the package is suppressed. Furthermore, the pressing mechanism is able to change the magnitude of the pressing force during the winding operation. In other words, the friction force is changeable during the winding operation. Therefore, when the support arm is moved in the predetermined direction, the support arm can be smoothly moved in a reliable manner as the friction force is decreased. Meanwhile, when the vibration of the package is suppressed, the suppression of the vibration of the support arm is ensured as the friction force is increased. As such, both the smooth movement of the support arm and the suppression of the vibration of the package are achieved.

[0009] According to a second aspect of the invention, the yarn winder of the first aspect is arranged such that the pressing mechanism includes a fluid pressure cylinder which changes the magnitude of the pressing force in accordance with t pressure of supplied fluid.

[0010] As the pressing mechanism, for example, a typical ball-screw mechanism or an electric actuator may be used. These mechanisms, however, essentially change the position of an object rather than the magnitude of pressing force. For this reason, it may be difficult to precisely control the magnitude of the pressing force by these mechanisms. Furthermore, the above-described mechanisms are typically unlikely to absorb vibration. That is to say, when, for example, the support arm slightly vibrates and the vibration is propagated to the vibration suppression member, repulsion to the vibration by the pressing mechanism tends to occur. This may cause the pressing force to be unstable. According to the aspect, the magnitude of the pressing force can be changed by changing the pressure of the supplied fluid. Furthermore, because the hydrostatic pressure cylinder typically has a cushioning property, even if the vibration suppression member vibrates, the vibration is absorbed and a change in the pressing force is suppressed. It is therefore possible to suppress the pressing force from becoming unstable.

[0011] According to a third aspect of the invention, the yarn winder of the first or second aspect further includes a contact pressure applying roller which applies contact pressure to the package which is rotating, the contact pressure applying roller being movable in accordance with a change in diameter of the package.

[0012] In the arrangement in which the package rotates while being in contact with the contact pressure applying roller, the package rotates in such a way that its surface is along the surface of the contact pressure applying roller. On this account, depending on, for example, the hardness (density) of the package, significant vibration may occur even if the package is only slightly deformed from the optimal shape. In such an arrangement, the pressing force is changeable, with the result that smooth movement of the support arm and suppression of vibration of the package are both achieved.

[0013] In addition to the above, when the support arm and the contact pressure applying roller are both movable, the movement of the support arm and the movement of the contact pressure applying roller may be unstable, and such instability may cause the package to easily vibrate. According to the aspect, because the magnitude of the pressing force is changeable during the winding operation, even if the movement of the support arm or the movement of the contact pressure applying roller becomes unstable, the vibration of the package is reliably suppressed by increasing the pressing force.

[0014] According to a fourth aspect of the invention, the yarn winder of the third aspect further includes a biasing mechanism which is configured to bias the contact pressure applying roller toward the package.

[0015] For example, in an arrangement in which contact pressure is applied to a package by biasing a support arm toward a contact pressure applying roller, the gravity acting on the package may influence on the magnitude of the contact pressure in addition to the biasing force, depending on the positional relationship between the package and the contact pressure applying roller. In this case, because it may be necessary to take into account of a change in the weight of the package during the winding operation, the contact pressure may not be easily controllable. According to the aspect, because the contact pressure applying roller is biased toward the package, the magnitude of the contact pressure is maintained to be constant by maintaining the biasing force to be constant, irrespective of the weight of the package. In other words, it is unnecessary to take into account of a change in weight of the package. The contact pressure is therefore easily controllable.

[0016] According to a fifth aspect of the invention, the yarn winder of the third or fourth aspect further includes: a tension applying mechanism which is configured to apply tension to the yarn wound onto the package and is capable of changing the magnitude of the tension; and a contact pressure changing mechanism which is capable of changing the magnitude of the contact pressure.

[0017] Typically, when the tension of the yarn to be wound is high and the contact pressure is high, the density (hardness) of the package is also high. For this reason, when the magnitude of the tension and the magnitude of the contact pressure are changeable as in the aspect, it is possible to wind the yarn with desired density. In this connection, the package rotates with its surface being along the surface of the contact pressure applying roller. On this account, when, for example, the hardness (density) of the package is increased, significant vibration may occur even when the package is only slightly deformed from the optimal shape. In such an arrangement, the pressing force is changeable during the winding operation, with the result that smooth movement of the support arm and suppression of vibration of the package are both achieved.

[0018] According to a sixth aspect of the invention, the yarn winder of any one of the first to fifth aspects is arranged such that a contact surface of the vibration suppression member, where the vibration suppression member makes contact with the support arm, extends along the predetermined direction.

[0019] When the contact surface is tilted with respect to the predetermined direction (moving direction of the support arm), the support arm may be pressed in the predetermined direction by the vibration suppression member, and hence the support arm may, for example, unintentionally move in the predetermined direction. According to the aspect, because the contact surface extends along the predetermined direction, it is possible to avoid the pressing of the support arm in the predetermined direction by, for example, pressing the vibration suppression member in the direction perpendicular to the contact surface. Therefore, for example, unintentional movement of the support arm in the predetermined direction is avoided.

[0020] According to a seventh aspect of the invention, the yarn winder of any one of the first to sixth aspects is arranged such that the vibration suppression member is rotatable about a rotation fulcrum which is fixed to a predetermined position.

[0021] According to the aspect, by utilizing the principle of leverage, the vibration suppression member can be strongly and stably pressed onto the support arm.

[0022] According to an eighth aspect of the invention, the yarn winder of any one of the first to seventh aspects is arranged such that the cradle device includes an arm driving unit which is configured to move the support arm in the predetermined direction.

[0023] According to the aspect, when the support arm is moved by the arm driving unit, the support arm can be smoothly moved as the pressing force is decreased (i.e., the friction force is decreased). Meanwhile, when the support arm is not moved, it is possible to increase the pressing force (i.e., increase the friction force) without any problems. On this account, it is possible to reliably suppress the vibration of the support arm by increasing the pressing force. As such, by changing the magnitude of the pressing force in accordance with the operation of the arm driving unit, it is possible to effectively achieve both the smooth movement of the support arm and the suppression of the vibration of the package.

[0024] According to a ninth aspect of the invention, the yarn winder of any one of the first to eighth aspects is arranged such that the support arm includes: an arm main body; and a contact target roller which is supported by the arm main body to be rotatable, the vibration suppression member making contact with the contact target roller.

[0025] For example, when a part of the support arm in contact with the vibration suppression member is fixed to the arm main body, the friction force may be too large and the movement of the support arm may not be smoothly done. According to the aspect, it is possible to facilitate smooth movement of the support arm by the rotatable contact target roller.

[0026] According to a tenth aspect of the invention, the yarn winder of any one of the first to ninth aspects is arranged such that the support arm is swingable about a swing fulcrum fixed to a predetermined position.

[0027] For example, in an arrangement in which the support arm moves in the predetermined direction in a parallel manner, a space or the like for allowing the support arm to perform the parallel movement is required, and this may cause the upsizing of the device. According to the aspect, the traveling range of the support arm is short at around the swing fulcrum, as compared to the arrangement in which the support arm moves in a parallel manner. It is therefore possible to avoid the increase in size of the device.

[0028] According to an eleventh aspect of the invention, the yarn winder of any one of the first to tenth aspects further includes a control unit, during the winding operation, the control unit changing the magnitude of the pressing force between first pressing force and second pressing force which is smaller than the first pressing force.

[0029] According to the aspect, the friction force is maintained to be large by pressing the vibration suppression member onto the support arm by the relatively large first pressing force, with the result that the vibration of the package is suppressed. Meanwhile, for example, the pressing force is decreased to the second pressing force at predetermined intervals, with the result that the friction force is temporarily decreased and the support arm is allowed to reliably move in the predetermined direction. For these reasons, the vibration of the package is reliably suppressed in the normal state, and the support arm is allowed to smoothly move in a reliable manner when the support arm moves.

[0030] According to a twelfth aspect of the invention, the yarn winder of the eleventh aspect further includes an arm driving unit which is configured to move the support arm in the predetermined direction, the control unit setting the magnitude of the pressing force at the first pressing force when the arm driving unit is not driven, and setting the magnitude of the pressing force at the second pressing force when the arm driving unit is driven.

[0031] According to this aspect, when the support arm is not moved, it is possible to increase the pressing force without any problems. On this account, it is possible to reliably suppress the vibration of the support arm by the large first pressing force. Meanwhile, when the support arm is moved, the magnitude of the pressing force is decreased to the second pressing force. It is therefore possible to smoothly move the support arm in a reliable manner. As such, both the smooth movement of the support arm and the suppression of the vibration of the package are effectively achieved.

[0032] According to a thirteenth aspect of the invention, the yarn winder of the twelfth aspect further includes a package diameter detection unit which is configured to detect a change in diameter of the package, the control unit controlling the arm driving unit based on a detection result of the package diameter detection unit.

[0033] According to this aspect, it is possible to allow the support arm to suitably move in accordance with a change in diameter of the package.

[0034] According to a fourteenth aspect of the invention, the yarn winder of the eleventh or twelfth aspect further includes a storage unit which stores a pattern regarding a change over time of the pressing force in advance, the control unit reading the patter before the start of the winding operation.

[0035] According to this aspect, with the simple control of causing the control unit to read the pattern before the start of the winding operation, it is possible achieve both the smooth movement of the support arm and the suppression of the vibration of the package.

[0036] According to a fifteenth aspect of the invention, the yarn winder of any one of the first to fourteenth aspects further includes: a vibration detection unit which is configured to detect vibration of the package; and a control unit, when the magnitude of the vibration of the package detected by the vibration detection unit is larger than a predetermined threshold, the control unit increasing the pressing force as compared to a case where the magnitude of the vibration is smaller than the threshold.

[0037] According to this aspect, because the pressing force is relatively small (i.e., the friction force is relatively small) when the magnitude of the vibration of the package is equal to or lower than a predetermined level, smooth movement of the support arm is facilitated. Meanwhile, because the pressing force is relatively large (i.e., the friction force is relatively large) when the magnitude of the vibration of the package is equal to or higher than the predetermined level, suppression of the vibration of the package is facilitated.

[Brief Description of Drawings]

[0038]

FIG. 1 is a schematic side view of a re-winder of an embodiment.
FIG. 2 shows a winding unit and its surroundings.
FIG. 3 shows an electric structure of the re-winder.
FIG. 4 (a) to FIG. 4 (c) show actions of a cradle arm and a contact roller during a winding operation.
FIG. 5 is a graph showing variations over time of an operation of an arm driving motor during the winding operation, a supply pressure of compressed air, and an angle of the cradle arm.
FIG. 6 is a side view of a re-winder of a modification.
FIG. 7 is a graph showing variations over time of an operation of an arm driving motor during the winding operation, a supply pressure of compressed air, and an angle of the cradle arm.
FIG. 8 relates to another modification and is a graph showing variations over time of a supply pressure of compressed air.
FIG. 9 is a side view of a yarn winding apparatus of a further modification.
FIG. 10 is a graph showing variations over time of a supply pressure of compressed air.

[Description of Embodiments]

[0039] The following will describe an embodiment of the present invention with reference to FIG. 1 to FIG. 5. An up-down direction and a front-rear direction shown in FIG. 1 will be used as an up-down direction and a front-rear direction of a re-winder 1. A direction orthogonal to both the up-down direction and the front-rear direction (i.e., a direction perpendicular to the plane of FIG. 1) is set as an axial direction of a bobbin B. A direction in which a yarn Y runs will be referred to as a yarn running direction.

(Structure of Re-Winder)

[0040] To begin with, the structure of a re-winder 1 (yarn winder of the present invention) of the present embodiment will be described with reference to FIG. 1. FIG. 1 is a schematic side view of the re-winder 1. As shown in FIG. 1, the re-winder 1 includes members such as a yarn supplying unit 11, a winding unit 12, a controller 13 (control unit of the present invention) . The re-winder 1 is configured to re-wind a yarn Y wound on a yarn supply package Ps supported by the yarn supplying unit 11 back to a bobbin B by the winding unit 12, so as to form a wound package Pw (package of the present invention). To be more specific, the re-winder 1 is used for, for example, re-winding a yarn Y wound on a yarn supply package Ps in a more beautiful manner, and for forming a wound package Pw with desired density. (Details will be given later.)

[0041] The yarn supplying unit 11 is, for example, attached to a front surface of a lower portion of a base 14 which vertically extends . The yarn supplying unit 11 is arranged to be able to support the yarn supply package Ps on which the yarn Y is wound. The yarn supplying unit 11 is therefore able to supply the yarn Y.

[0042] The winding unit 12 is configured to form the wound package Pw by winding a yarn Y onto a bobbin B. The winding unit 12 is provided at an upper portion of the base 14. The winding unit 12 includes members such as a cradle device 21 and a contact roller 22 (contact pressure applying roller of the present invention).

[0043] The cradle device 21 supports the bobbin B to be rotatable. The cradle device 21 includes a cradle arm 31 (support arm of the present invention) which is supported by the base 14 to be swingable and supports the bobbin B to be rotatable. At a leading end portion of the cradle arm 31, a bobbin holder (not illustrated) is attached to be rotatable and to hold the bobbin B. The bobbin holder is rotationally driven by a winding motor 32. The winding motor 32 is, for example, a typical AC motor in which the rotation number is variable. The winding motor 32 is therefore able to change the rotation speed of the bobbin B. The winding motor 32 is electrically connected to the controller 13 (see FIG. 3).

[0044] The contact roller 22 makes contact with the surface of the wound package Pw to adjust the shape of the wound package Pw by applying a contact pressure to the surface. The contact roller 22 is supported by a swinging boom 23 to be rotatable with the axial direction of the bobbin B functioning as the rotational axis. The swinging boom 23 is attached to the base 14 to be swingable with the axial direction of the bobbin B functioning as the swing axis. The contact roller 22 makes contact with the wound package Pw and is rotated by the rotation of the wound package Pw.

[0045] A traverse guide 24 is provided in the vicinity of the contact roller 22 (i.e., immediately upstream of the wound package Pw in the yarn running direction). The traverse guide 24 is reciprocated in the axial direction of the bobbin B by an unillustrated driving device, so as to traverse the yarn Y.

[0046] Between the yarn supplying unit 11 and the winding unit 12, a guide roller 15 and a tension sensor 16 are provided so that the guide roller 15 is upstream of the tension sensor 16 in the yarn running direction. The guide roller 15 guides the yarn Y unwound from the yarn supply package Ps to the downstream side in the yarn running direction. The guide roller 15 is provided on the front surface of the base 14 and above the yarn supplying unit 11. The guide roller 15 is rotationally driven by a roller driving motor 17, for example. The roller driving motor 17 is, for example, a typical AC motor in which the rotation number is variable. The roller driving motor 17 is therefore able to change the rotation speed of the guide roller 15. The roller driving motor 17 is electrically connected to the controller 13 (see FIG. 3).

[0047] The yarn Y running between the wound package Pw and the guide roller 15 in the yarn running direction receives a predetermined tension as the wound package Pw and the guide roller 15 are differentiated in circumferential speed (i.e., the wound package Pw is rotated at a higher speed than the guide roller 15). The tension varies in accordance with the difference in circumferential speed between the wound package Pw rotationally driven by the winding motor 32 and the guide roller 15 rotationally driven by the roller driving motor 17. (The larger the difference in circumferential speed is, the higher the tension is.) In this way, the tension applied to the yarn Y is changeable. The winding motor 32 and the roller driving motor 17 are equivalent to a tension applying mechanism of the present invention.

[0048] The tension sensor 16 is provided between the wound package Pw and the guide roller 15 in the yarn running direction and is configured to detect the tension applied to the yarn Y. The tension sensor 16 is electrically connected to the controller 13 (see FIG. 3) and sends a result of detection of the tension to the controller 13.

[0049] The controller 13 includes members such as CPU, a ROM, and a RAM (storage unit 18) . The storage unit 18 stores, for example, parameters such as an amount of the wound yarn Y, a winding speed, and the magnitude of tension applied to the yarn Y. The controller 13 controls components by using the CPU and a program stored in the ROM, based on the parameters stored in the RAM (storage unit 18), etc.

(Structure of Winding Unit)

[0050] The structure of the winding unit 12 will be further detailed with reference to FIG. 2. FIG. 2 shows the winding unit 12 and its surroundings. As described above, the winding unit 12 includes members such as the cradle device 21 and the contact roller 22. The cradle arm 31 of the cradle device 21 supports the bobbin B from the both sides in the axial direction to be rotatable, for example. Alternatively, the cradle arm 31 may support the bobbin B from one side in the axial direction. The cradle arm 31 includes an arm main body 33 and a contact target roller 34.

[0051] The arm main body 33 is a member extending in a direction orthogonal to the axial direction of the bobbin B. The arm main body 33 is supported to be swingable about a swing fulcrum 35 which is attached to a predetermined position of the base 14 (i.e., positionally fixed relative to the base 14). The direction of the swing axis of the arm main body 33 is, for example, substantially parallel to the axial direction of the bobbin B. The arm main body 33 is swung in a predetermined direction orthogonal to the axial direction of the bobbin B (i.e., in a moving direction shown in FIG. 2) by an arm driving motor 37 (arm driving unit of the present invention) via an endless belt 36, for example. In other words, when the arm main body 33 is viewed in the axial direction, if the angle between the vertical line and the center line of the arm main body 33 is an angle θ, the angle θ is changeable by the arm driving motor 37. The arm driving motor 37 is electrically connected to the controller 13 (see FIG. 3) . The moving direction of the arm main body 33 may not be orthogonal to the axial direction of the bobbin B, as long as the moving direction intersects with the axial direction of the bobbin B.

[0052] The contact target roller 34 is a roller member which is attached to an intermediate part of the arm main body 33 in its longitudinal direction so as to be rotatable. The rotational axis direction of the contact target roller 34 is substantially parallel to the axial direction of the bobbin B. The contact target roller 34 is in contact with a vibration suppression lever 41 (vibration suppression member of the present invention).

[0053] The vibration suppression lever 41 suppresses the vibration of the wound package Pw by suppressing the vibration of the cradle arm 31. The vibration of the wound package Pw occurs due to, for example, the vibration of the cradle arm 31 caused by the operation of the winding motor 32 and/or slight deformation of the wound package Pw (as compared to the optimal circular shape). When the wound package Pw vibrates, the deformation of the wound package Pw may be accelerated and the shape of the wound package Pw may be collapsed. For this reason, the vibration suppression lever 41 is provided to suppress the vibration of the wound package Pw. The vibration suppression lever 41 is a long and arc-shaped member. The vibration suppression lever 41 is supported to be rotatable about a rotation fulcrum 42 which is attached to a predetermined position of the base 14 (i.e. positionally fixed relative to the base 14. The direction of the rotation of the vibration suppression lever 41 is, for example, substantially parallel to the axial direction of the bobbin B. When viewed in the axial direction of the bobbin B, a contact surface 43 (indicated by a thick line) in contact with the cradle arm 31 of the vibration suppression lever 41 is a circular arc centered on the rotation fulcrum 42. To put it differently, the contact surface 43 extends along a predetermined direction (moving direction of the cradle arm 31).

[0054] The vibration suppression lever 41 is pressed onto the contact target roller 34 by a later-described pressing mechanism 61. Friction force therefore acts between the vibration suppression lever 41 and the contact target roller 34. This friction force suppresses the vibration of the cradle arm 31, with the result that the vibration of the wound package Pw is suppressed. The direction in which the vibration suppression lever 41 is pressed onto the contact target roller 34 (pressing direction) is perpendicular to the contact surface 43 (as indicated by an arrow 101 in FIG. 2) . This prevents the cradle arm 31 to be pressed in the predetermined direction. Therefore, for example, unintentional movement of the cradle arm 31 in the predetermined direction is avoided. Furthermore, on account of the principle of leverage with the rotation fulcrum 42 functioning as the fulcrum, the junction between the piston rod 64 and the vibration suppression lever 41 functioning as the force point, and the part where the vibration suppression lever 41 is in contact with the contact target roller 34 functioning as the action point, the vibration suppression lever 41 is strongly and stably pressed onto the contact target roller 34.

[0055] As described above, the contact roller 22 is supported by the swinging boom 23 to be rotatable. The swinging boom 23 is supported by the base 14 to be swingable (as indicated by an arrow 102 in FIG. 2). The contact roller 22 is swingable in accordance with a change in diameter of the wound package Pw. To be more specific, in accordance with the increase in diameter (thickening) of the wound package Pw on account of the winding of the yarn Y onto the bobbin B, the contact roller 22 swings away from the shaft center of the bobbin B in the radial direction of the wound package Pw. The swinging boom 23 is biased toward the wound package Pw (i.e., in the direction in which the contact roller 22 is pressed onto the wound package Pw) by a biasing mechanism 51.

[0056] The biasing mechanism 51 includes, for example, an air cylinder 52 and an electro-pneumatic regulator 53 (contact pressure changing mechanism of the present invention). The biasing mechanism 51 is able to change the contact pressure in accordance with the pressure of compressed air supplied to the air cylinder 52. The air cylinder 52 is, for example, a typical push-type cylinder. A piston rod 54 of the air cylinder 52 is connected to the swinging boom 23. The air cylinder 52 is connected, through pipes, to a supply port (not illustrated) connected to a source of compressed air and an exhaust port (not illustrated) through which air is discharged. The electro-pneumatic regulator 53 is provided between the supply and discharge ports and the air cylinder 52. For example, the electro-pneumatic regulator 53 includes plural electromagnetic valves, a pressure gauge, and a controller and is arranged to be able to adjust the pressure of compressed air supplied to the air cylinder 52. The electro-pneumatic regulator 53 is electrically connected to the controller 13 (see FIG. 3) . The compressed air with pressure adjusted by the electro-pneumatic regulator 53 is supplied to the air cylinder 52 through a supply tube 55. As a result, the swinging boom 23 is pressed by the piston rod 54 (as indicated by an arrow 103 in FIG. 2) and the contact roller 22 is biased toward the wound package Pw. In this way, the contact pressure is applied to the wound package Pw.

[0057] In the vicinity of the contact roller 22, a proximity sensor 56 (package diameter detection unit of the present invention) is provided to detect that the contact roller 22 is approaching. A non-limiting example of the proximity sensor 56 is an electrostatic capacitance contactless sensor. The proximity sensor 56 is provided outside the swing range of the contact roller 22 (behind the contact roller 22 in FIG. 2) . The proximity sensor 56 is electrically connected to the controller 13 (see FIG. 3). When the distance between the proximity sensor 56 and the contact roller 22 becomes equal to or shorter than a predetermined distance, the proximity sensor 56 detects that the contact roller 22 is approaching, and sends a detection signal to the controller 13.

(Winding Operation)

[0058] The following will describe a winding operation of winding the yarn Y by the re-winder 1 structured as described above, with reference to FIG. 4(a) to FIG. 4(c). FIG. 4(a) to FIG. 4(c) show actions of the cradle arm 31 and the contact roller 22 during the winding operation.

[0059] To begin with, in a state in which the yarn Y connects the yarn supply package Ps with the wound package Pw (see FIG. 1), the controller 13 (see FIG. 3) controls the winding motor 32 and the roller driving motor 17 to rotate the bobbin B and the guide roller 15. As a result, the yarn Y is wound onto the bobbin B (see FIG. 4 (a)) . The controller 13 controls the winding motor 32 and the roller driving motor 17 so that the circumferential speed of the wound package Pw is higher than the circumferential speed of the guide roller 15. The larger the difference in circumferential speed between the wound package Pw and the guide roller 15 is, the higher the tension of the yarn Y is. Furthermore, the controller 13 controls the electro-pneumatic regulator 53 to keep the pressure of the compressed air supplied to the air cylinder 52 to be constant at a predetermined level. As a result, the contact roller 22 is biased toward the wound package Pw with predetermined force, and contact pressure is applied from the contact roller 22 to the surface of the wound package Pw. Typically, when the tension of the yarn Y is high and the contact pressure is high, the density (hardness) of the wound package Pw is also high.

[0060] As the yarn Y is wound onto the bobbin B and the diameter of the wound package Pw increases (i.e., the wound package Pw thickens), the contact roller 22 is pressed by the surface of the wound package Pw and moves outward in the radial direction of the wound package Pw (as indicated by an arrow 105 in FIG. 4 (b)) . When the distance between the contact roller 22 and the contact roller 56 becomes equal to or shorter than a predetermined distance, the proximity sensor 56 detects that the contact roller 22 is approaching, and sends a detection signal to the controller 13. To put it differently, the proximity sensor 56 detects a change in diameter of the wound package Pw. When receiving the detection signal from the proximity sensor 56, the controller 13 controls the arm driving motor 37 to swing the cradle arm 31 by a predetermined angle. As a result, the shaft center of the bobbin B moves away from the shaft center of the contact roller 22 in the radial direction of the wound package Pw (as indicated by an arrow 106 in FIG. 4(c)). In accordance with the movement of the wound package Pw, the swinging boom 23 swings and the contact roller 22 moves away from the proximity sensor 56 (as indicated by an arrow 107 in FIG. 4(c)). As the wound package Pw further thickens, the contact roller 22 approaches the proximity sensor 56 again. In this way, the contact roller 22 reciprocally swings. As the operations above are repeated, the angle θ (see FIG. 2) increases in accordance with the thickening of the wound package Pw.

[0061] During the winding operation, as the vibration suppression lever 41 is pressed onto the contact target roller 34 by the pressing mechanism 61, friction force acts between the vibration suppression lever 41 and the contact target roller 34. This friction force suppresses the vibration of the cradle arm 31, with the result that the vibration of the wound package Pw is suppressed. In this regard, the vibration suppression lever 41 is biased by a spring in known arrangements, and the biasing force is not actively changed during the winding operation. On this account, when the biasing force of the spring is set large in advance in order to ensure the suppression of vibration, the friction force may become too large and the above-described swing of the cradle arm 31 may not be smoothly performed. Meanwhile, when the biasing force of the spring is set small in advance in order to ensure smooth swing of the cradle arm 31, the friction force may become too small and the vibration of the wound package Pw may not be sufficiently suppressed. In particular, because the vibration is highly likely to occur when the density (hardness) of the wound package Pw is arranged to be high, the pressing force of the pressing mechanism 61 is required to be large. In this case, however, the pressing force required to sufficiently suppress the vibration of the wound package Pw may be significantly larger than pressing force with which the cradle arm 31 is smoothly swung. In such a state, smooth swing of the cradle arm 31 and suppression of the vibration of the wound package Pw may not be concurrently achieved. Under this circumstance, in the present embodiment, the pressing mechanism 61 is arranged as described below, in order to concurrently achieve the smooth swing of the cradle arm 31 and the suppression of the vibration of the wound package Pw.

(Structure of Pressing Mechanism)

[0062] Referring back to FIG. 2, the structure of the pressing mechanism 61 will be described. The pressing mechanism 61 includes, for example, an air cylinder 62 (fluid pressure cylinder of the present invention) and an electro-pneumatic regulator 63. The air cylinder 62 is, for example, a typical pull-type cylinder. The air cylinder 62 is attached to the base 14. A leading end portion of a piston rod 64 of the air cylinder 62 is connected to an end portion of the vibration suppression lever 41. In the present embodiment, the junction between the vibration suppression lever 41 and the piston rod 64 is provided to oppose a part where the contact surface 43 is formed, over the rotation fulcrum 42. However, the disclosure is not limited to this arrangement. The air cylinder 62 is connected, through pipes, to a supply port (not illustrated) connected to a source of compressed air and an exhaust port (not illustrated) through which air is discharged. The air cylinder 62 typically has a cushioning property. On this account, even if the vibration suppression lever 41 vibrates, the vibration is absorbed and a change in the pressing force is suppressed.

[0063] The electro-pneumatic regulator 63 is provided between the supply and discharge ports and the air cylinder 62. For example, the electro-pneumatic regulator 63 includes plural electromagnetic valves, a pressure gauge, and a controller and is arranged to be able to adjust the pressure of compressed air supplied to the air cylinder 62. The electro-pneumatic regulator 63 is electrically connected to the controller 13 (see FIG. 3) . The compressed air with pressure adjusted by the electro-pneumatic regulator 63 is supplied to the air cylinder 62 through a supply tube 65. As a result, the vibration suppression lever 41 is pulled by the piston rod 64 (as indicated by an arrow 104 in FIG. 2) and the contact surface 43 is pressed onto the contact target roller 34. The magnitude of the pressing force is changed in accordance with the pressure of compressed air supplied to the air cylinder 62. In other words, the pressing force increases as the pressure of the supplied compressed air increases. As such, the pressing mechanism 61 is able to change the magnitude of the pressing force during the winding operation of winding the yarn Y.

(Control of Pressing Force During Winding Operation)

[0064] The following will describe the control of the pressing force during the winding operation with reference to FIG. 4(a) to FIG. 4(c) and FIG. 5. FIG. 5 is a graph showing variations over time of an operation of the arm driving motor 37 during the winding operation, the pressure of compressed air supplied to the air cylinder 62, and an angle of the cradle arm 31.

[0065] In an initial state, the winding operation is performed such that the controller 13 rotationally drives the winding motor 32 to wind the yarn Y into the bobbin B. The time point t is t0 (see FIG. 4(a) and FIG. 5). At this stage, the arm driving motor 37 is on standby (OFF in FIG. 5) and the cradle arm 31 is on standby at a predetermined position. In other words, the above-described angle θ is kept constant (θ=θ1 as shown in FIG. 4(a) and FIG. 5). Furthermore, the pressure of compressed air supplied to the air cylinder 62 is at a constant value (P1) (see FIG. 5), and the vibration suppression lever 41 is pressed onto the contact target roller 34 with predetermined first pressing force.

[0066] In this state, the yarn Y is wound onto the bobbin B and the wound package Pw increases in diameter as described above, and the contact roller 22 swings. As the proximity sensor 56 detects that the contact roller 22 is approaching, a detection signal is sent to the controller 13. The time point t is t1 at this stage (see FIG. 4 (b) and FIG. 5) . Based on the detection result of the proximity sensor 56, the controller 13 drives the arm driving motor 37 (ON in FIG. 5) to swing the cradle arm 31. At the same time, the controller 13 controls the electro-pneumatic regulator 63 (see FIG. 2) to lower the pressure of the compressed air supplied to the air cylinder 62 from P1 to P2 (<P1) (see FIG. 5) . As a result, the magnitude of the pressing force is changed to second pressing force which is smaller than the first pressing force. As such, the magnitude of the pressing force exerted by the pressing mechanism 61 is changed during the winding operation of winding the yarn Y. Consequently, the friction force acting between the vibration suppression lever 41 and the contact target roller 34 is temporarily decreased, with the result that the cradle arm 31 smoothly swings.

[0067] Thereafter, when the angle θ of the cradle arm 31 becomes θ2 (>θ1), the controller 13 stops the arm driving motor 37 (see FIG. 4(c) and FIG. 5). At this stage, the time point t is t2. At the same time, the controller 13 controls the electro-pneumatic regulator 63 to return the pressure of the compressed air supplied to the air cylinder 62 from P2 to P1. As a result, the magnitude of the pressing force returns from the second pressing force to the first pressing force, and hence the vibration of the cradle arm 31 is suppressed by large friction force again. In this way, the controller 13 controls the pressing mechanism 61 to change the magnitude of the pressing force between the first pressing force and the second pressing force. As the operations above are repeated, smooth swing of the cradle arm 31 and suppression of the vibration of the wound package Pw on account of suppression of the vibration of the cradle arm 31 are concurrently achieved during the winding operation of winding the yarn Y.

[0068] As described above, as the vibration suppression lever 41 is pressed onto the cradle arm 31 by the pressing mechanism 61, friction force acts between the vibration suppression lever 41 and the cradle arm 31. This friction force suppresses the vibration of the cradle arm 31, with the result that the vibration of the wound package Pw is suppressed. Furthermore, the pressing mechanism 61 is able to change the magnitude of the pressing force during the winding operation. In other words, the friction force is changeable during the winding operation. Therefore, when the cradle arm 31 is moved in the predetermined direction, the cradle arm 31 can be smoothly moved in a reliable manner as the friction force is decreased. Meanwhile, when the vibration of the wound package Pw is suppressed, the suppression of the vibration of the cradle arm 31 is ensured as the friction force is increased. As such, both the smooth movement of the cradle arm 31 and the suppression of the vibration of the wound package Pw are achieved.

[0069] Furthermore, because the pressing mechanism 61 includes the air cylinder 62, the magnitude of the pressing force can be changed by changing the supply pressure of the compressed air. Furthermore, because the air cylinder 62 typically has a cushioning property, even if the vibration suppression lever 41 vibrates, the vibration is absorbed and a change in the pressing force is suppressed. It is therefore possible to suppress the pressing force from becoming unstable.

[0070] In the arrangement in which the wound package Pw rotates while being in contact with the contact roller 22, the wound package Pw rotates in such a way that its surface is along the surface of the contact roller 22. On this account, depending on, for example, the hardness (density) of the wound package Pw, significant vibration may occur even when the wound package Pw is only slightly deformed from the optimal shape. In such an arrangement, changeable pressing force and coexistence of smooth movement of the cradle arm 31 and suppression of vibration of the wound package Pw are effective.

[0071] In addition to the above, when the cradle arm 31 and the contact roller 22 are both movable, the movement of the cradle arm 31 and the movement of the contact roller 22 may be unstable, and such instability may cause the wound package Pw to easily vibrate. In the present invention, because the magnitude of the pressing force is changeable during the winding operation, even if the movement of the cradle arm 31 or the movement of the contact roller 22 becomes unstable, the vibration of the wound package Pw is reliably suppressed by increasing the pressing force.

[0072] In addition to the above, because the contact roller 22 is biased toward the wound package Pw, the magnitude of the contact pressure is maintained to be constant by maintaining the biasing force to be constant, irrespective of the weight of the wound package Pw. In other words, it is unnecessary to take into account of a change in weight of the wound package Pw. The contact pressure is therefore easily controllable.

[0073] In addition to the above, when the magnitude of the tension and the magnitude of the contact pressure are changeable, it is possible to wind the yarn Y with desired density. In this connection, when, for example, the hardness (density) of the wound package Pw is increased, significant vibration may occur even when the wound package Pw is only slightly deformed from the optimal shape. In such an arrangement, changeable pressing force during the winding operation and coexistence of smooth movement of the cradle arm 31 and suppression of vibration of the wound package Pw are particularly effective.

[0074] In addition to the above, because the contact surface 43 of the vibration suppression lever 41 extends along the predetermined direction, it is possible to avoid the pressing of the cradle arm 31 in the predetermined direction by, for example, pressing the vibration suppression lever 41 in the direction perpendicular to the contact surface 43. Therefore, for example, unintentional movement of the cradle arm 31 in the predetermined direction is avoided.

[0075] In addition to the above, the vibration suppression lever 41 is rotatable about the rotation fulcrum 42. Therefore, by utilizing the principle of leverage, the vibration suppression lever 41 can be strongly and stably pressed onto the cradle arm 31.

[0076] In addition to the above, when the cradle arm 31 is moved by the arm driving motor 37, the cradle arm 31 can be smoothly moved as the pressing force is decreased (i.e., the friction force is decreased) . Meanwhile, when the cradle arm 31 is not moved, it is possible to increase the pressing force (i.e., increase the friction force) without any problems. On this account, it is possible to reliably suppress the vibration of the cradle arm 31 by increasing the pressing force. As such, by changing the magnitude of the pressing force in accordance with the operation of the arm driving motor 37, it is possible to effectively achieve both the smooth movement of the cradle arm 31 and the suppression of the vibration of the wound package Pw.

[0077] In addition to the above, it is possible to facilitate smooth movement of the cradle arm 31 by the rotatable contact target roller 34.

[0078] In addition to the above, the cradle arm 31 is swingable about the swing fulcrum 35. The traveling range of the cradle arm 31 is therefore short at around the swing fulcrum. It is therefore possible to suppress, for example, the apparatus from being upsized, as compared to an arrangement in which the cradle arm 31 is moved in a parallel manner.

[0079] In addition to the above, during the winding operation, the controller 13 changes the magnitude of the pressing force between the first pressing force and the second pressing force. In other words, when the cradle arm 31 does not swing, the vibration suppression lever 41 is pressed onto the cradle arm 31 with relatively large first pressing force, and hence the friction force is maintained to be large. The vibration of the wound package Pw is therefore suppressed. Meanwhile, when the cradle arm 31 swings, the pressing force is temporarily decreased to the second pressing force, with the result that the friction force is temporarily decreased and the cradle arm 31 is allowed to reliably swing in the predetermined direction. For these reasons, the vibration of the wound package Pw is reliably suppressed in the normal state, and the cradle arm 31 is allowed to smoothly move in a reliable manner when the cradle arm 31 swings. As such, both the smooth movement of the cradle arm 31 and the suppression of the vibration of the wound package Pw are effectively achieved.

[0080] In addition to the above, the controller 13 controls the operation of the arm driving motor 37 based on a detection result of the proximity sensor 56. It is therefore possible to allow the cradle arm 31 to suitably swing in accordance with a change in diameter of the wound package Pw.

[0081] The following will describe modifications of the above-described embodiment. The members identical with those in the embodiment above will be denoted by the same reference numerals and the explanations thereof are not repeated.

(1) In addition to the arrangement of the embodiment above, as shown in FIG. 6, for example, a cradle device 21a may include a vibration sensor 71 (vibration detection unit of the present invention) at a winding unit 12a of a re-winder 1a. A non-limiting example of the vibration sensor 71 is an electrostatic capacitance accelerometer attached to the cradle arm 31. The vibration sensor 71 is electrically connected to the controller 13 and, for example, sends a detection signal corresponding to the magnitude of vibration to the controller 13.
Control performed by the controller 13 in the re-winder 1a arranged as described above will be described with reference to a graph in FIG. 7. As shown in FIG. 7, when the magnitude of vibration detected by the vibration sensor 71 is smaller than a predetermined threshold, the controller 13 changes the pressure of compressed air supplied to the air cylinder 62 between P1 and P2 in the same manner as in the embodiment above. Meanwhile, when the magnitude of the vibration is larger than the threshold, the controller 13 controls the electro-pneumatic regulator 63 to arrange the pressure of the compressed air supplied to the air cylinder 62 to be P3 which is higher than P1. In other words, when the magnitude of the vibration is larger than the threshold, the above-described pressing force is arranged to be large as compared to a case where the magnitude of the vibration is smaller than the threshold. When the magnitude of the vibration becomes smaller than the threshold again, the controller 13 decreases the pressure of the compressed air again. With this arrangement, because the friction force is relatively small when the magnitude of the vibration of the wound package Pw is small, smooth movement of the cradle arm 31 is facilitated. Meanwhile, when the magnitude of the vibration of the wound package Pw become large, suppression of the vibration of the wound package Pw is facilitated by relatively large friction force.

(2) In the modification (1) above, the pressure of the supplied compressed air is changed both during the operation of the arm driving motor 37 and when the magnitude of the vibration becomes equal to or larger than the predetermined threshold. The disclosure, however, is not limited to this arrangement. As

shown in a graph in FIG. 8 when, for example, the magnitude of vibration is smaller than a threshold, the pressure of compressed air supplied to the air cylinder 62 may be maintained at P1a (which is, for example, lower than P1 described above) in order to facilitate smooth movement of the cradle arm 31. Only when the magnitude of the vibration becomes larger than the threshold, the pressure of the supplied compressed air may be changed to P2a which is higher than P1a in order to facilitate the suppression of the vibration of the wound package Pw.

(3) In the embodiment above, the cradle arm 31 is driven by the arm driving motor 37 to swing, and the contact roller 22 is arranged to be able to swing in a passive manner. The disclosure, however, is not limited to this arrangement. For example, as shown in FIG. 9, in a winding unit 12b of a re-winder 1b, a contact roller 81 may be positionally fixed relative to the base 14 and the cradle arm 31 may be able to swing in a passive manner in a cradle device 21b. To be more specific, the contact roller 81 may be supported by a supporting member 82 fixed to the base 14, so as to be rotatable. The contact roller 81 may be rotationally driven by a motor 83. In other words, the wound package Pw may be arranged to rotate in accordance with the rotation of the contact roller 22.

In the re-winder 1b arranged as described above, the controller 13 may perform control described below. For example, the storage unit 18 may store a pattern (see FIG. 10) regarding variations over time of the pressure of compressed air supplied to the air cylinder 62 in advance. To be more specific, this pattern is a pattern regarding variations over time of the pressure from the start to the end of formation of the wound package Pw. The controller 13 may read the pattern from the storage unit 18 before the start of the winding operation, and change the pressing force over time in accordance with the pattern. As such, both the smooth movement of the cradle arm 31 and the suppression of the vibration of the wound package Pw are achieved by the simple control.

(4) While in the embodiment above the cradle arm 31, etc. is arranged to be swingable, the disclosure is not limited to this arrangement. For example, the cradle arm 31 may be arranged to be movable in a parallel manner. To be more specific, parallel movement of the cradle arm 31 may be realized by using a typical ball-and-screw mechanism or a typical rack-and-pinion mechanism.

(5) While in the embodiment above the vibration suppression lever 41 is arranged to be rotatable, the disclosure is not limited to this arrangement. For example, a vibration suppression member (not illustrated) having a circular-arc-shaped contact surface may be simply pressed onto the cradle arm 31 by an air cylinder, etc.

(6) While in the embodiment above the vibration suppression lever 41 is pressed onto the contact target roller 34 of the cradle arm 31, the disclosure is not limited to this arrangement. For example, the cradle arm 31 may include a protrusion (not illustrated) protruding in the axial direction from the arm main body 33, and the vibration suppression lever 41 may be pressed onto the protrusion.

(7) While in the embodiment above the pressure of the compressed air supplied to the air cylinder 62 is adjusted by the electro-pneumatic regulator 63, the disclosure is not limited to this arrangement. In place of the electro-pneumatic regulator 63, for example, the pressure of the compressed air may be adjusted by using an adjustment valve (not illustrated) such as a typical globe valve and a pressure controller (not illustrated) . In other words, any arrangement may be employed as long as the pressing mechanism 61 is able to change the pressing force.

(8) While in the embodiment above the vibration suppression lever 41 is pressed onto the cradle arm 31 by the air cylinder 62, the disclosure is not limited to this arrangement. For example, gas such as nitrogen may be supplied to the air cylinder 62 instead of the compressed air. Furthermore, a hydraulic cylinder, etc. may be used in place of the air cylinder. In other words, a fluid pressure cylinder in which the magnitude of the pressing force changes in accordance with the pressure of fluid may be employed. Alternatively, in place of the fluid pressure cylinder, the vibration suppression lever 41 may be pressed onto the cradle arm 31 by means of a typical ball-and screw mechanism, or a motor-driven mechanism or device such as a linear actuator.

(9) In the embodiment above, the proximity sensor 56 detects the increase (thickening) in diameter of the wound package Pw. The disclosure, however, is not limited to this arrangement. For example, an image of the wound package Pw may be taken by an unillustrated camera unit, and the controller 13 may calculate the diameter of the wound package Pw by image analysis . In other words, any arrangement may be employed as long as a change in diameter of the wound package Pw can be detected.

(10) The guide roller 15 may not be rotationally driven by the roller driving motor 17. For example, a so-called torque limiter may be provided in the guide roller 15, and the guide roller 15 may be rotatable in a passive manner and the torque required for rotating the roller may be adjustable. In this case, the winding motor 32 and the guide roller 15 are equivalent to the tension applying mechanism of the present invention.

(11) The present invention can be applied to a yarn winder other than the re-winder. In other words, the present invention may be applied to various yarn winders each of which is configured to form a package by winding a yarn onto a bobbin. For example, the present invention may be applied to a winding

device of a draw texturing machine recited in, for example, Japanese Laid-Open Patent Publication No. 2016-223034. In this case, the winding device is equivalent to the yarn winder of the present invention.

[Reference Signs List]

[0082]

1 re-winder (yarn winder)
13 controller (control unit)
17 roller driving motor (tension applying mechanism)
18 storage unit
21 cradle device
22 contact roller (contact pressure applying roller)
31 cradle arm (support arm)
32 winding motor (tension applying mechanism)
33 arm main body
34 contact target roller
35 swing fulcrum
37 arm driving motor (arm driving unit)
41 vibration suppression lever (vibration suppression member)
42 rotation fulcrum
43 contact surface
51 biasing mechanism
53 electro-pneumatic regulator (contact pressure changing mechanism)
56 proximity sensor (package diameter detection unit)
61 pressing mechanism
62 air cylinder (fluid pressure cylinder)
71 vibration sensor (vibration detection unit)
B bobbin
Pw wound package (package)
Y yarn

Claims

1. A yarn winder forming a package by winding a yarn onto a bobbin, comprising:

   a cradle device which includes a support arm supporting the bobbin to be rotatable and is capable of moving the support arm in a predetermined direction intersecting with an axial direction of the bobbin;
   a vibration suppression member which is pressed onto the support arm so as to suppress vibration of the support arm; and
   a pressing mechanism configured to press the vibration suppression member onto the support arm,
   the pressing mechanism being capable of changing the magnitude of pressing force during a winding operation of winding the yarn.

2. The yarn winder according to claim 1, wherein, the pressing mechanism includes a fluid pressure cylinder which changes the magnitude of the pressing force in accordance with t pressure of supplied fluid.

3. The yarn winder according to claim 1 or 2, further comprising a contact pressure applying roller which applies contact pressure to the package which is rotating,
   the contact pressure applying roller being movable in accordance with a change in diameter of the package.

4. The yarn winder according to claim 3, further comprising a biasing mechanism which is configured to bias the contact pressure applying roller toward the package.

5. The yarn winding according to claim 3 or 4, further comprising;
   a tension applying mechanism which is configured to apply tension to the yarn wound onto the package and is capable of changing the magnitude of the tension; and
   a contact pressure changing mechanism which is capable of changing the magnitude of the contact pressure.

6. The yarn winder according to any one of claims 1 to 5, wherein, a contact surface of the vibration suppression member, where the vibration suppression member makes contact with the support arm, extends along the predetermined direction.

7. The yarn winder according to any one of claims 1 to 6, wherein, the vibration suppression member is rotatable about a rotation fulcrum which is fixed to a predetermined position.

8. The yarn winder according to any one of claims 1 to 7, wherein, the cradle device includes an arm driving unit which is configured to move the support arm in the predetermined direction.

9. The yarn winder according to any one of claims 1 to 8, wherein, the support arm includes:

   an arm main body; and
   a contact target roller which is supported by the arm main body to be rotatable, the vibration suppression member making contact with the contact target roller.

10. The yarn winder according to any one of claims 1 to 9, wherein, the support arm is swingable about a swing fulcrum fixed to a predetermined position.

11. The yarn winder according to any one of claims 1 to

9, further comprising a control unit, during the winding operation, the control unit changing the magnitude of the pressing force between first pressing force and second pressing force which is smaller than the first pressing force.

12. The yarn winder according to claim 11, further comprising an arm driving unit which is configured to move the support arm in the predetermined direction, the control unit setting the magnitude of the pressing force at the first pressing force when the arm driving unit is not driven, and setting the magnitude of the pressing force at the second pressing force when the arm driving unit is driven.

13. The yarn winder according to claim 12, further comprising a package diameter detection unit which is configured to detect a change in diameter of the package, the control unit controlling the arm driving unit based on a detection result of the package diameter detection unit.

14. The yarn winder according to claim 11 or 12, further comprising a storage unit which stores a pattern regarding a change over time of the pressing force in advance, the control unit reading the patter before the start of the winding operation.

15. The yarn winder according to any one of claims 1 to 14, further comprising a vibration detection unit which is configured to detect vibration of the package; and a control unit, when the magnitude of the vibration of the package detected by the vibration detection unit is larger than a predetermined threshold, the control unit increasing the pressing force as compared to a case where the magnitude of the vibration is smaller than the threshold.

FIG.1

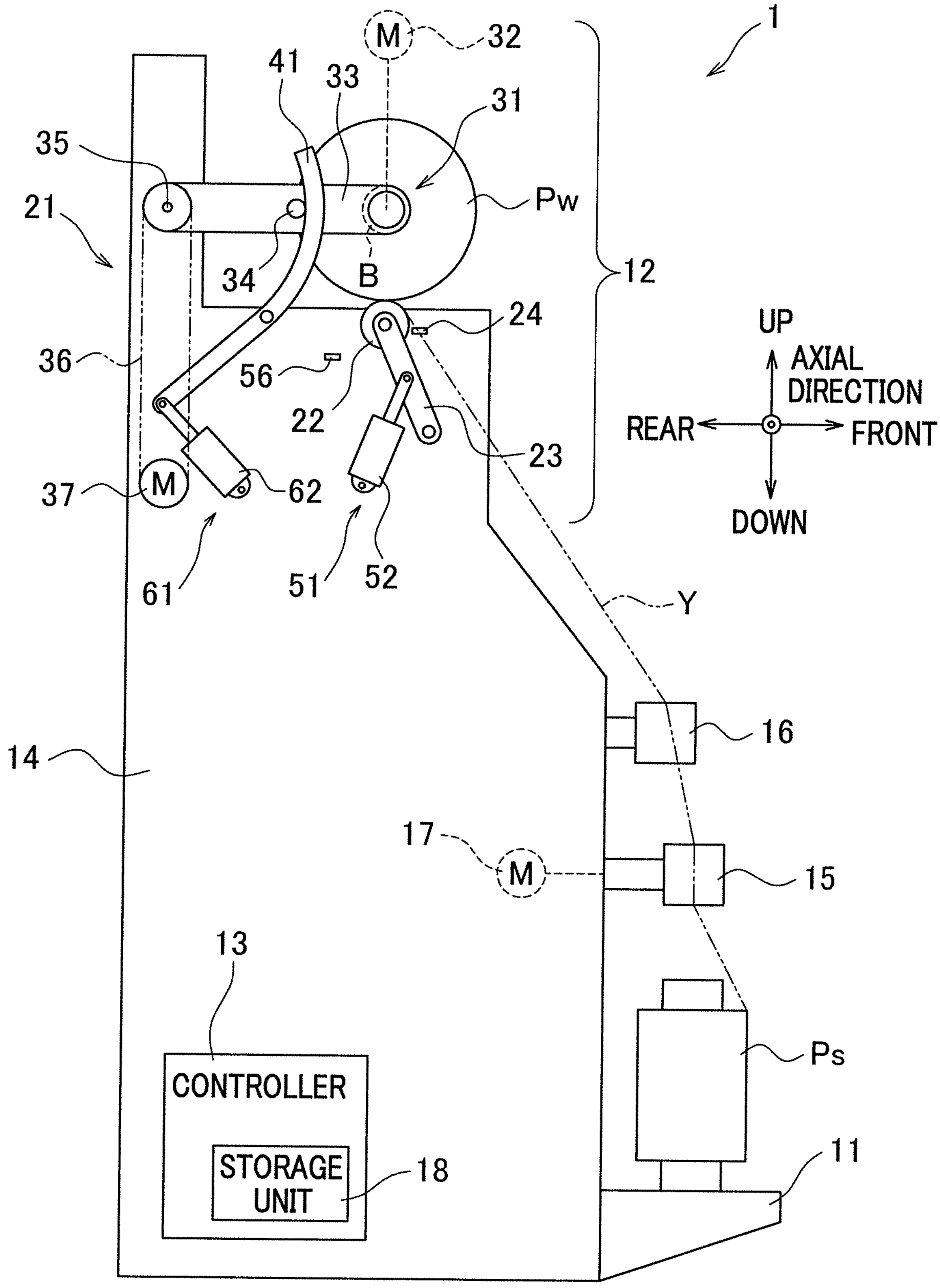

1
M
32
41
33
31
35
Pw
21
34
B
12
24
UP
AXIAL DIRECTION
36
56
REAR
FRONT
22
23
37
M
62
DOWN
61
51
52
Y
16
14
17
M
15
13
Ps
CONTROLLER
STORAGE UNIT
18
11

FIG.2

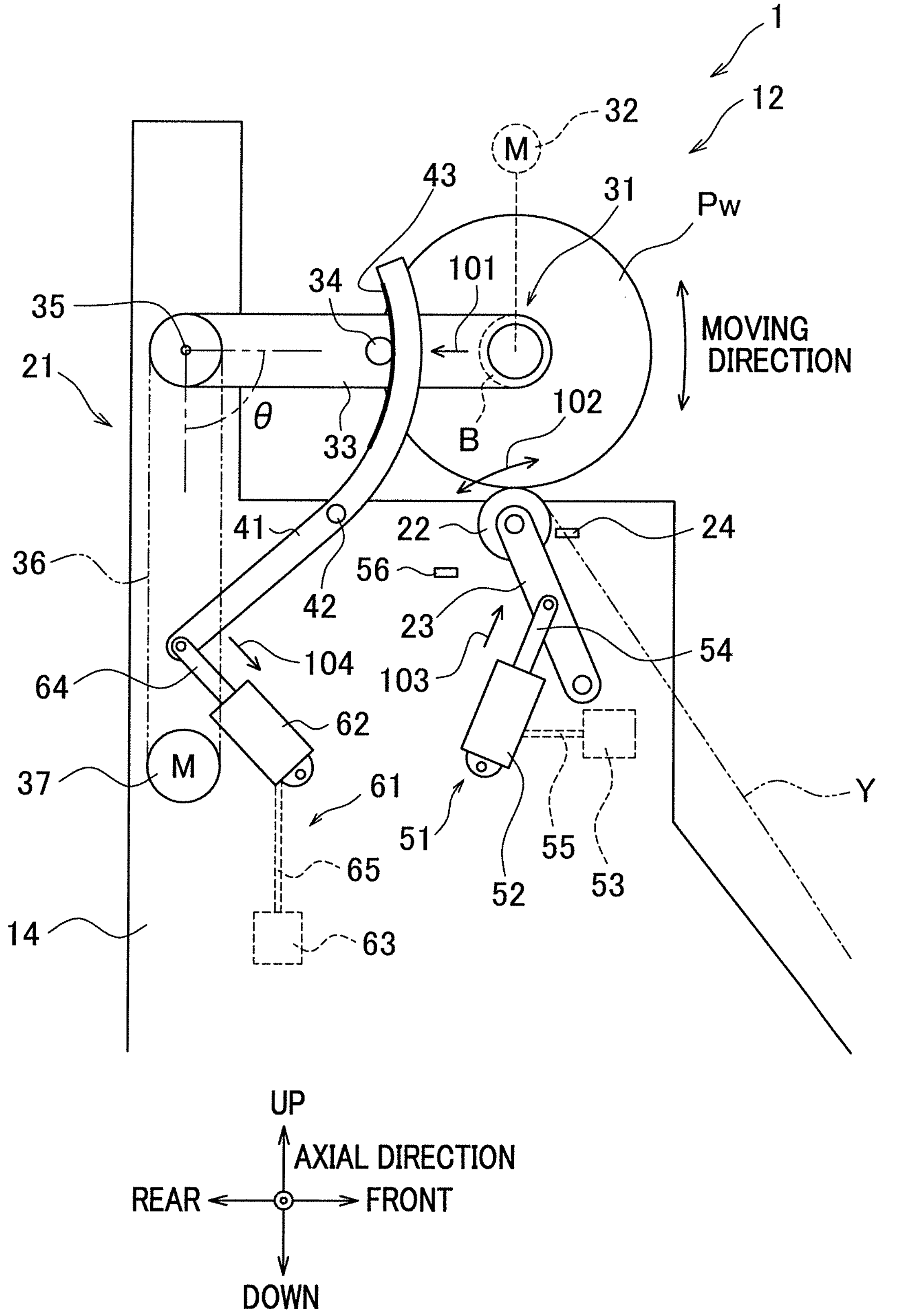

1
12
32
M
43
31
Pw
34
101
35
MOVING DIRECTION
21
θ
33
B
102
36
41
42
22
24
56
23
54
64
104
103
62
37
M
61
51
55
53
Y
65
52
14
63
UP
AXIAL DIRECTION
REAR
FRONT
DOWN

FIG.3

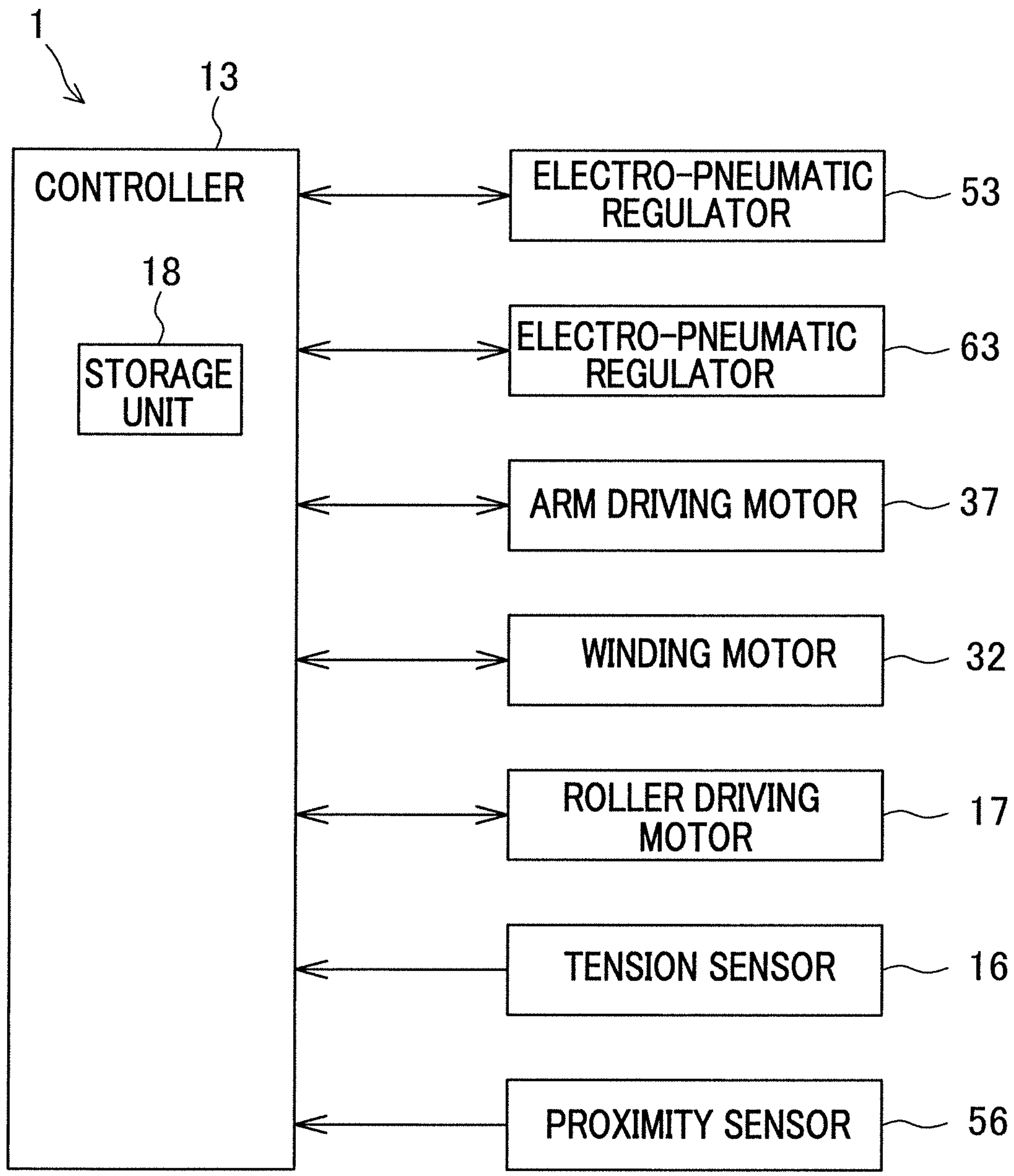

1
13
CONTROLLER
18
STORAGE UNIT
ELECTRO-PNEUMATIC REGULATOR
53
ELECTRO-PNEUMATIC REGULATOR
63
ARM DRIVING MOTOR
37
WINDING MOTOR
32
ROLLER DRIVING MOTOR
17
TENSION SENSOR
16
PROXIMITY SENSOR
56

FIG.4

(a) t = t0, θ = θ 1

(b) t = t1, θ = θ 1

(c) t = t2, θ = θ 2

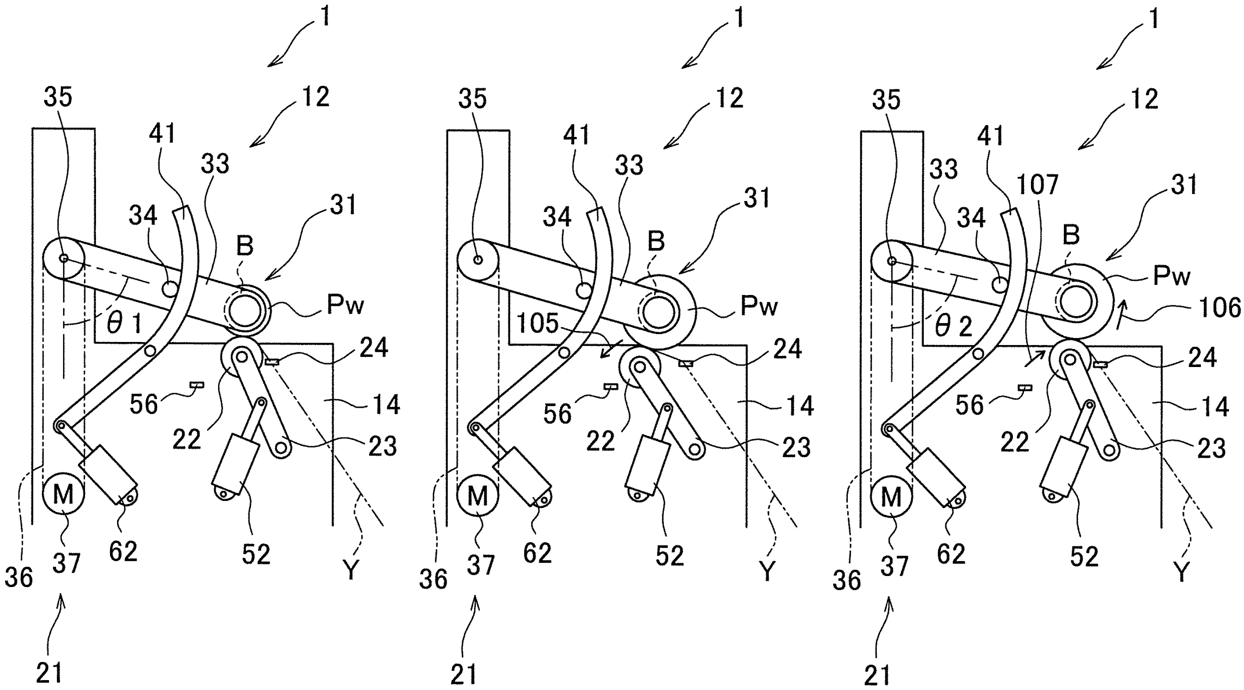


FIG.5

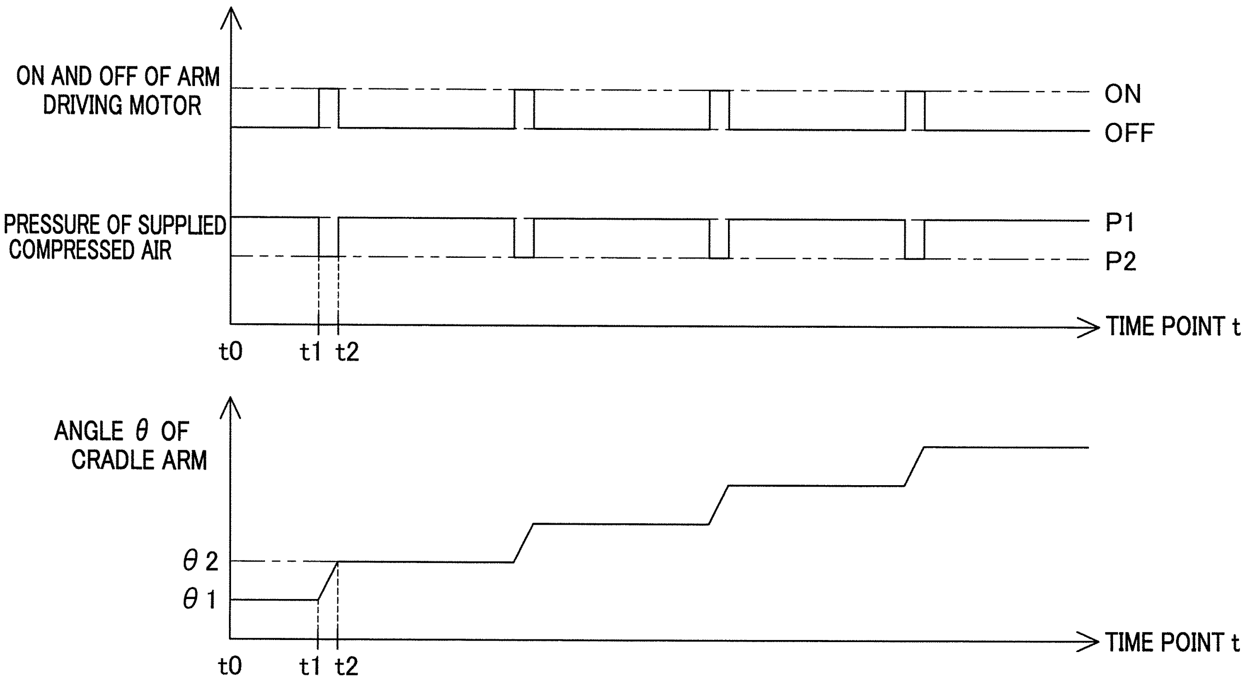

ON AND OFF OF ARM DRIVING MOTOR
ON
OFF
PRESSURE OF SUPPLIED COMPRESSED AIR
P1
P2
TIME POINT t
t0
t1
t2
ANGLE θ OF CRADLE ARM
θ2
θ1
TIME POINT t
t0
t1
t2

FIG.6

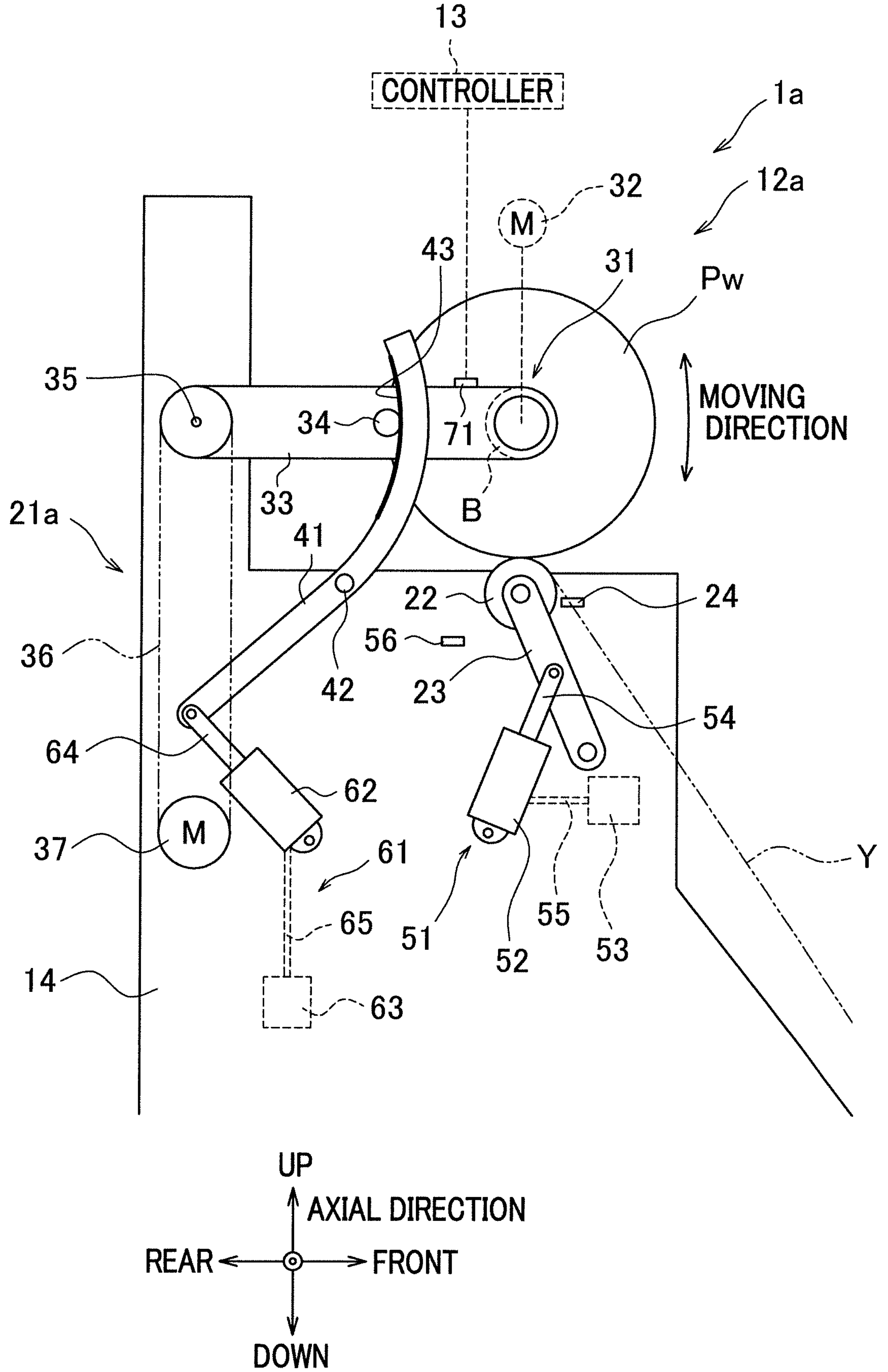

13
CONTROLLER
1a
12a
32
M
43
31
Pw
35
34
71
MOVING DIRECTION
33
B
21a
41
22
24
56
42
23
36
54
64
62
37
M
61
Y
65
51
55
52
53
14
63
UP
AXIAL DIRECTION
REAR
FRONT
DOWN

FIG.7

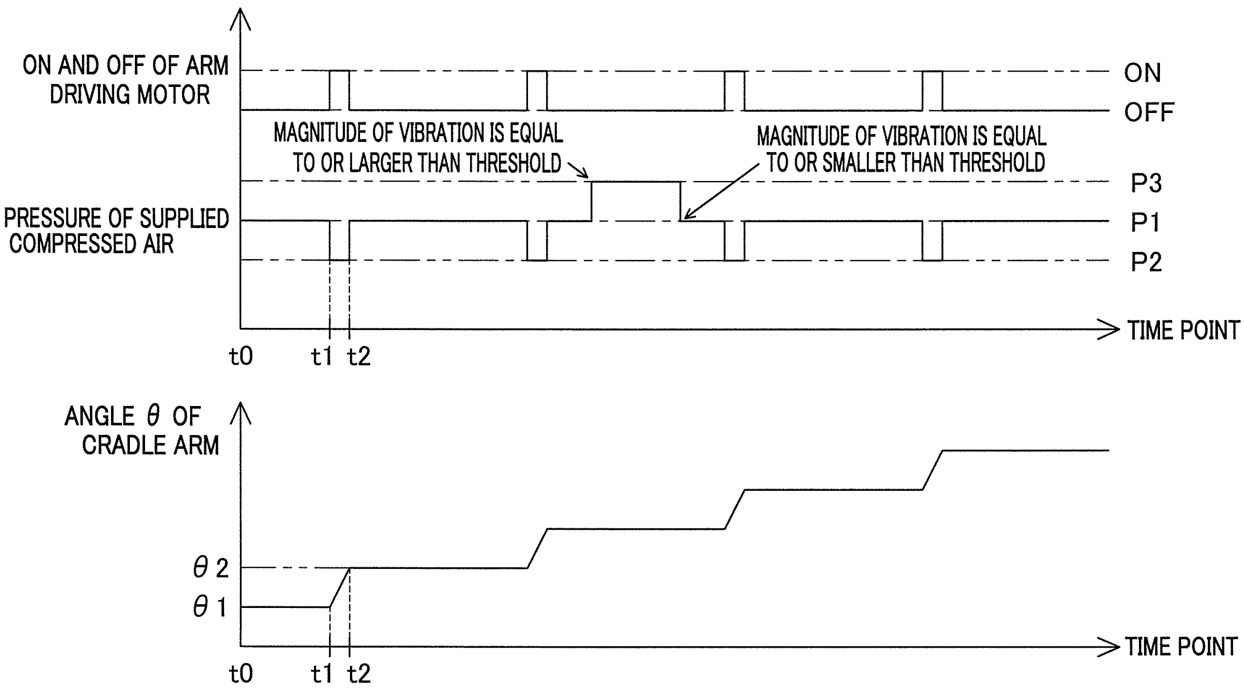

ON AND OFF OF ARM DRIVING MOTOR
ON
OFF
MAGNITUDE OF VIBRATION IS EQUAL TO OR LARGER THAN THRESHOLD
MAGNITUDE OF VIBRATION IS EQUAL TO OR SMALLER THAN THRESHOLD
P3
PRESSURE OF SUPPLIED COMPRESSED AIR
P1
P2
TIME POINT
t0
t1
t2
ANGLE θ OF CRADLE ARM
θ2
θ1
TIME POINT
t0
t1
t2

FIG.8

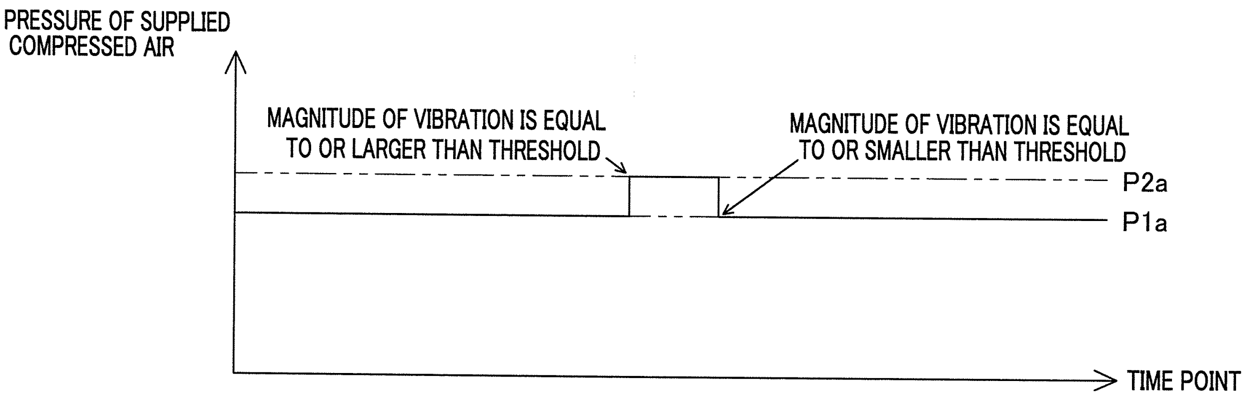

PRESSURE OF SUPPLIED COMPRESSED AIR
MAGNITUDE OF VIBRATION IS EQUAL TO OR LARGER THAN THRESHOLD
MAGNITUDE OF VIBRATION IS EQUAL TO OR SMALLER THAN THRESHOLD
P2a
P1a
TIME POINT

FIG.9

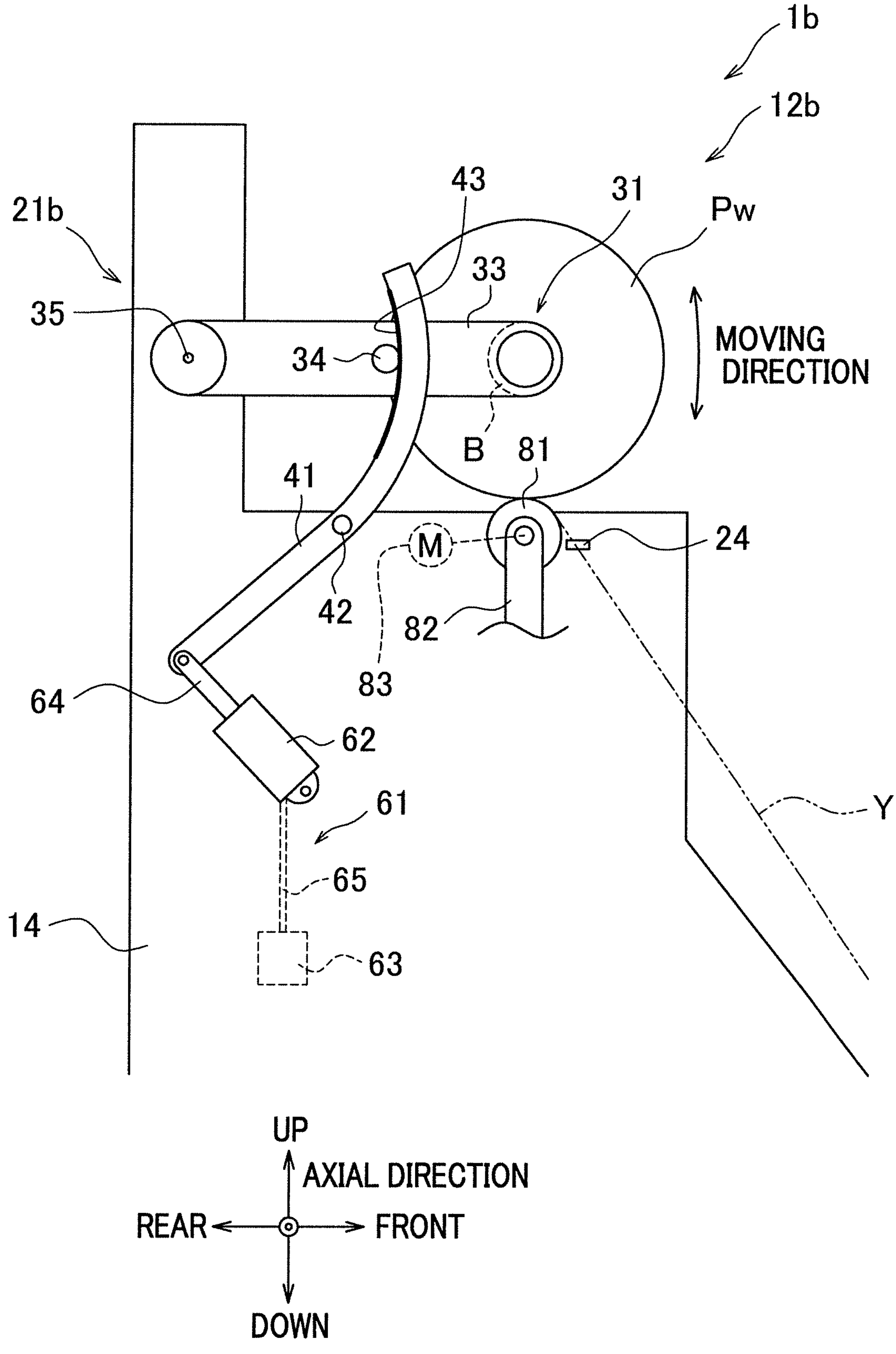
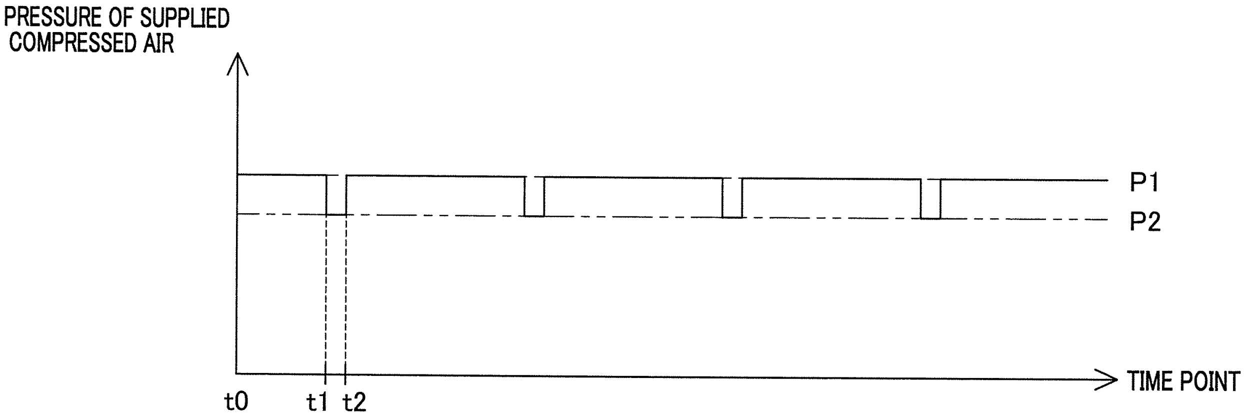

1b
12b
21b
43
31
Pw
33
35
34
MOVING
DIRECTION
B
81
41
M
24
42
82
83
64
62
61
Y
65
14
63
UP
AXIAL DIRECTION
REAR
FRONT
DOWN

FIG.10


PRESSURE OF SUPPLIED COMPRESSED AIR
P1
P2
TIME POINT
t0
t1
t2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/012201

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B65H54/52(2006.01)i, B65H54/553(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. B65H54/52, B65H54/553

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 8-225246 A (MURATA MACHINERY LTD.) 03 September 1996, paragraphs [0011]-[0026], fig. 1-3 (Family: none)	1-2, 7-8, 10-11, 14 3-6, 9, 12-13, 15
A	US 2009/0026298 A1 (METER et al.) 29 January 2009, & WO 2006/002704 A1	1-15
A	JP 62-31666 A (TEIJIN SEIKI CO., LTD.) 10 February 1987 (Family: none)	1-15
A	JP 11-286370 A (TORAY INDUSTRIES, INC.) 19 October 1999 (Family: none)	1-15

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14.05.2019	28.05.2019

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/012201

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2012/107646 A1 (METSO PAPER, INC.) 16 August 2012, & EP 2673227 A1	1-15
A	JP 2013-234047 A (TMT MACHINERY INC.) 21 November 2013, & EP 2662322 A2	1-15

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Patent documents cited in the description

- JP 2004107007 A **[0004]**
- JP S606048 B **[0004]**
- JP 2016223034 A **[0081]**