(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 902 108 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.03.1999 Bulletin 1999/11

(51) Int. Cl.[6]: **D01H 1/244**, D01H 1/32, D01H 13/16, B65H 63/02

(21) Application number: **98115916.3**

(22) Date of filing: **24.08.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **02.09.1997 JP 236383/97**

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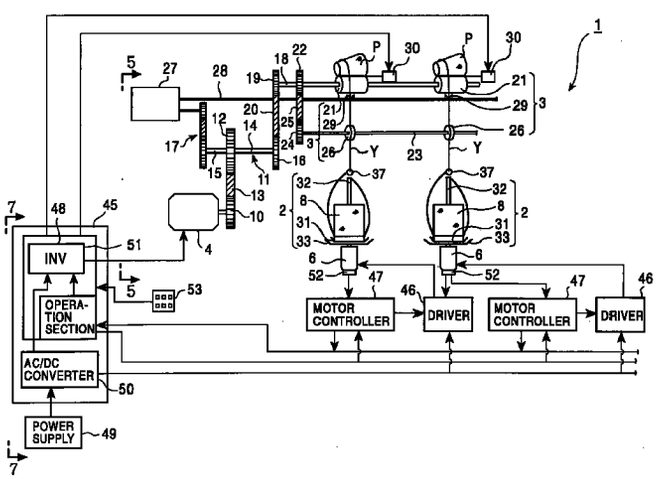
(54) Yarn winding machine

(57) To detect cut yarn without limiting the arrangement of the yarn winding machines. The present yarn winding machine installs in a row spindles, each of which has one yarn supply package 8, and rotates a spindle apparatus 2 of each spindle to twist and wind yarn Y released from the yarn supply package of each spindle while ballooned it. The yarn winding machine detects a load current through a driving motor 6 provided for a spindle apparatus 2 of each spindle, and compares the load current with a threshold value to determine that the yarn has been cut if the load current is lower than the threshold value.

FIG. 1



EP 0 902 108 A2

Description

Field of the Invention

[0001] The present invention relates to a yarn winding machine that twists and winds yarn released from a yarn supply package, and in particular, to a yarn winding machine including a function for detecting that wound yarn has been cut.

Background of the Invention

[0002] There are two types of conventional yarn winding machines; one type comprises spindles each having one yarn supply package 106 and installed in a row, as shown in Figure 7, and the other type comprises spindles that each have two double-ply yarn supply packages and are arranged in a row, as shown in Figure 8. In each of the yarn winding machines in Figures 7 and 8, a winding apparatus 103 is installed above a spindle apparatus 102 and two spindles are placed back-to-back in such a way that 80 to 304 spindles are arranged in parallel. The spindle apparatus 102 comprises a rotating disc 105 that is rotated at a high speed by a driving belt (not shown in the drawings), a stationary plate on which one or two yarn supply packages 106 are positioned, and a balloon guide 107 and so on. A yarn Y is released from the yarn supply package 106 and enters a tension apparatus 108 located in the center, where tension is applied to it. The yarn is then twisted twice by the rotating disc 105 rotating at a high speed and reaches the balloon guide 107 located above.

[0003] In addition, the winding apparatus 103 comprises guide rollers 109 and 110, a feed roller 111, a traverse guide 112, a winding drum 113 that is rotationally driven, and a cradle 114 that supports a winding package P. After passing through the guide rollers 109 and 110 and the feed roller 111, the twisted yarn is traversed by the traverse guide 112 and then rolls onto the winding drum 113 to become the winding package P.

[0004] A drop wire 115 is disposed between the spindle apparatus 102 and the winding apparatus 103. When the yarn supply package 106 becomes empty or the yarn Y is cut, the drop wire 115 turns in the direction (a) indicated in the figures, and a limit switch SW detects that the yarn is cut. When the cut yarn is detected, a controller 119 connected to the limit switch SW controls the opening and closing of a transfer valve 117 to operate an air cylinder 118 to rotate a link arm 119. The cradle 114 then turns to separate the winding package P from the winding drum 113 to stop winding. When the yarn Y is cut to turn the drop wire 115 due to the force of gravity, the drop wire 115 presses the upper end of the tension apparatus 108 to prevent the further yarn supply.

[0005] In the conventional yarn winding machines shown in Figures 7 and 8, however, the drop wire 115 that detects that the yarn Y is cut is placed in a yarn path between the spindle apparatus 102 and the winding apparatus 103, so the arrangement of the yarn winding machines is limited.

[0006] In addition, in the yarn winding machine shown in Figure 8, the yarns Y released from the two yarn supply packages are combined together and twisted twice, but if, for example, the drop wire 115 is provided in the yarn path for the yarn wound by the winding apparatus 103, it is difficult to detect that only one of the yarns from the yarn supply packages 106 has been cut. Although a sensor for detecting the thickness of yarn is often used to detect that a single yarn has been cut, when the sensor is located between the guide roller 109 and the feed roller 111 along which the yarn travels stably, the arrangement of the yarn winding machines is limited and the required costs are high.

[0007] A yarn winding machine according to this invention can detect cut yarn without limiting the arrangement of the yarn winding machines

Summary of the Invention

[0008] In claim 1, to solve the above problems, this invention provides a yarn winding machine including spindles each having one yarn supply package and installed in a row, with the winding machine rotating a spindle means of each spindle to twist and wind yarn released from the yarn supply package of each spindle while ballooning it around the yarn supply package, wherein the winding machine comprises a driving means for rotating the spindle means of each spindle, a detecting means for detecting the load on each driving means, and a determining means for determining that yarn has been cut based on the load detected by each detecting means.

[0009] This configuration enables variations in the load on the driving means due to the tension of the yarn to be detected to determine whether the yarn has been cut.

[0010] In claim 2, this invention provides a yarn winding machine including spindles each having a plurality of yarn supply packages and installed in a row, with the winding machine rotating a spindle means of each spindle to combine, twist, and wind yarns released from the plurality of yarn supply packages of each spindle while ballooning them around the plurality of yarn supply packages, characterized in that the winding machine comprises a driving means for rotating the spindle means of each spindle, a detecting means for detecting the load on each driving means, and a determining means for determining that yarn has been cut based on the load detected by each detecting means.

[0011] This configuration enables variations in the load on the driving means due to the tension of the yarn to be detected to determine whether the yarn has been cut. In particular, since the load on the driving means for each spindle is detected to determine whether the yarn has been cut, cutting of a single yarn, which is conven-

tionally difficult to detect, can be detected easily and accurately.

[0012] In claim 3, the determining means has a threshold value that is used to determine that yarn has been cut and that is set based on the load on the driving means when yarn is wound at a constant speed.

[0013] This configuration can accommodate various winding machines having a different yarn count or a spindle with a different diameters with no need to change the threshold value.

[0014] In claim 4, the yarn cut determination threshold value is set based on the detection of the load a specified length of time after the start of winding.

[0015] This configuration allows the threshold value to be set individually for each spindle based on the load in a stable condition, thereby enabling cut yarn to be detected accurately for spindles in various conditions.

Brief Description of the Drawing

[0016]

Figure 1 is a schematic drawing showing the entire configuration of a single-spindle-driven yarn winding machine.

Figure 2 is a side view showing a configuration of a spindle apparatus, a winding apparatus, and a contacting and separating apparatus for each spindle in the single-spindle-driven yarn winding machine.

Figure 3 is an enlarged view showing an example of a connection between the spindle apparatus and the driving motor.

Figure 4 is an enlarged view showing another example of a connection between the spindle apparatus and the driving motor.

Figure 5 is a graph showing a threshold value set for a motor controller in the single-spindle-driven yarn winding machine.

Figure 6 is a side view of a yarn winding machine in which spindles, each of which has a plurality of yarn supply packages, are installed in a row, showing the configuration of a spindle apparatus, a winding apparatus, and a contacting and separating apparatus for each spindle.

Figure 7 is a side view showing a conventional yarn winding machine.

Figure 8 is a side view showing a conventional yarn winding machine in which spindles each of which has a plurality of yarn supply packages, are installed in a row.

Detailed Description of the Preferred Embodiments

[0017] Two types of yarn winding machines according to embodiments of this invention are described with reference to Figures 1 to 6.

[0018] A single-spindle-driven yarn winding machine 1, which is shown in Figure 1, is described.

[0019] In Figure 1, the yarn winding machine 1 is a multiple twisting machine wherein a single spindle is composed of a spindle apparatus 2 (a spindle means) and a winding apparatus 3 installed above the spindle apparatus 2. Each spindle has a single yarn supply package 8, two spindles are placed back-to-back, and 80 to 308 spindles are provided in one row. In addition to the apparatuses 2 and 3, the yarn winding machine 1 comprises a driving system 5 having a winding motor 4 that drives the winding apparatus 2, a driving motor 6 (a driving means) that drives the spindle apparatus 2 of each spindle, and a controlling system 7 for driving and controlling each motor 4 or 6.

[0020] In the driving system 5 driving the winding apparatus 2, a belt 13 is passed around the first pulley 10 fixed to an output shaft of the winding motor 4 which is an induction motor, and a second pulley 12 fitted on an input shaft of a speed reducer 11. The speed reducer 11 has a plurality of gears (not shown in the drawings) and receives the rotational force of the winding motor 4 to reduce the speed by a specified amount while simultaneously reversing the rotation direction.

[0021] In addition, the speed reducer 11 has one input shaft and two output shafts 14 and 15, and a third pulley 16 is fitted on the output shaft 14 while a non-step transmission 17 that changes the winding angle is connected to the output shaft 15. A belt 20 is passed around the third pulley 16 and a fourth pulley 19 fitted on a support shaft 18. Winding drums 21 of the winding apparatuses 3 are fitted on the support shaft 18 at a predetermined interval, and a fifth pulley 22 is fitted on the support shaft 18 so as to be parallel with the fourth pulley 19. A belt 25 is passed around the fifth pulley 22 and a sixth pulley 24 on a support shaft 23, and feed rollers 26 of the winding apparatuses 3 are attached to the support shaft 23 at a predetermined interval.

[0022] In addition, the non-step transmission 17 is connected to a cam box 27 that converts rotational force into reciprocating motion, and a reciprocating rod 28 is connected to the cam box 27. Traverse guides 29, each of which traverse the yarn Y twisted by the spindle apparatus 2 to allow it to be wound around the winding package P that is rotated while being pressed by the winding drum 21, are attached to the reciprocating rod 28 at a predetermined interval.

[0023] In addition, each winding package P is contacted with and separated from the winding drum 21 by a contacting and separating apparatus 30 provided for each spindle. Thus, the output from the winding motor 4 is transmitted to the support shafts 18 and 23 and the reciprocating rod 28 via the pulleys, belts, speed reducer 11, non-step transmission 17, and cam box 27 to rotate the winding drum 21 and the feed roller 26 in order to reciprocate and traverse the traverse guide 29.

[0024] The driving motor 6 for each spindle comprises an induction motor or a DC brushless motor and is connected to each spindle apparatus 2. The spindle apparatus 2 is composed of a stationary plate 31 on which

one yarn supply package 8 is positioned, a tension apparatus 32 for applying a predetermined tension to the yarn Y released from the yarn supply package 8, and a rotating disc 33 connected to the output shaft 6 of the driving motor 6. The driving motor 6 and the spindle apparatus 2 may be connected together by connecting the rotating disc 33 via a coupling 36 to the output shaft 6A of the driving motor 6, which is a DC brushless motor, as shown in Figure 3, or directly fixing the rotating disc 33 to the output shaft of the DC brushless motor. In addition, as shown in Figure 4, the stationary plate 31 on which the yarn supply package 8 is placed is located on the output shaft 6A of the driving motor 6, which is an induction motor, via bearings 35, and the rotating disc 33 is fixed to the output shaft 6A below the stationary plate 31.

[0025] Thus, when the driving motor 6 for each spindle is driven, the yarn Y released from the yarn supply package 8 enters the tension apparatus 32 located at the center, where it is subjected to tension and ballooned by the rotating disc 33 rotating at a high speed to reach a balloon guide 37 located above, as shown in Figure 2. Then, as shown in the same figure, the yarn Y from the yarn supply package 8 is twisted once between the tension apparatus 32 and the rotating disc 33 and twisted again between the rotating disc 33 and the balloon guide 37. It then passes through the balloon guide 37, guide rollers 38 and 39, and the feed roller 26, and is traversed by the traverse guide 29 while being simultaneously wound around the winding package P rotated by the winding drum 21.

[0026] In addition, the winding package P is pivotally supported by a cradle 40 and can be contacted with and separated from the winding drum 21 by the contacting and separating apparatus 30, as shown in Figure 2. The contacting and separating apparatus 30 is composed of a link arm 41 that can be positioned between the winding package P and the winding drum 21, an air cylinder 42 that rotates the link arm 41, and a transfer valve 43 that supplies air to and ejects air from the air cylinder 42, and contacts and separates the winding package P and the winding drum 21 by using the air cylinder 42 to rotate the link arm 41 once, as shown in Figure 2. Thus, when the link arm 41 is inserted between the winding package P and the winding drum 21 to lift the winding package P, the friction between the link arm 41 and the winding package P causes the package P to be stopped in a short time.

[0027] The controlling system 7 controlling the driving of the motors 4 and 5 is composed of a control box 45 and a plurality of motor controllers (a determining means) 47 each connected independently to a driver 46 for the driving motor 6 for each spindle, as also shown in Figure 2. The control box 45 has a main controller 48 that controls the entire yarn winding machine 1 and drives the winding motor 4 via an AC/DC converter 50 connected to a power supply 49 at a number of rotations determined by the output frequency from an invertor 51.

[0028] In addition, the AC/DC converter 50 is connected to the driver 46 for the driving motor 6 for each spindle and drives the driving motor 6 at a predetermined rotations speed using a predetermined DC power supply that has been converted. The motor controller 47 for each spindle receives a feedback signal from a yarn cut sensor (a detection means) 52 that detects a load current through the driving motor 6 to compare the feedback signal (the load current) with a set threshold value in order to determine whether the yarn Y that is wound around the winding package P has been cut. If the yarn Y is cut, the motor controller 47 outputs a stop signal to the driver 46 and stops the driving of the driving motor 6.

[0029] In addition, the motor controller 47 feeds back the stop signal used when the yarn Y is cut, to an operation section 54 in the main controller 48. Upon receiving the stop signal, the main controller 48 drives the contacting and separating apparatus 30 shown in Figure 2 to separate from the winding drum 21 the winding package P from which the yarn Y has been cut off. If cut yarn is detected, each motor controller 47 may drive the contacting and separating apparatus 30.

[0030] In addition, the threshold value for the motor controller 47 is set using as
pindle is rotated at a predetermined speed corresponding to a target number of rotations, as shown in Figure 5. This load current has a value related to the tension of the yarn Y wound around the winding package P, and is relatively stable due to the fact that the variation is only 2% to 3%. Since the load current through the driving motor 6 decreases to below the reference value if the yarn is cut, the threshold value is set to fall within a specified range several percents (%) below the reference value in consideration of this variation. The motor controller 47 compares the threshold value with an actual load current through the driving motor 6 that is fed back from the yarn cut sensor 25, and if the actual load current is lower than the threshold value, determines that the yarn has been cut to output the stop signal to the driver 46 in order to stop the driving of the driving motor 6 for the spindle while feeding this signal back to the main controller 48. The threshold value is set in the motor controller 47 from an input board 53 via the main controller 48. The threshold value, or the ratio of the threshold value to the load current in a stable region, can be set at an arbitrary ratio for an arbitrary spindle (the driving motor 6) using the input board 53.

[0031] The single-spindle-driven yarn winding machine 1 is configured as described above, and a procedure for operating the yarn winding machine 1 is described below.

[0032] When power is supplied to the driver 46 and main controller 48 for each spindle from the power supply 49 via the converter 50, the driving motor 6 for each spindle is driven by the output from the converter 50 to rotate the rotating disc 33 of each spindle apparatus 2 at the same rotation speed. Until the number of rotations

of the rotating disc 33 reaches a specified value, the motor controller 47 does not determine whether the yarn has been cut. In addition, the main controller 48 drives the winding motor 4 at the rotation speed determined by the output frequency from the invertor 51. The output from the winding motor 4 is transmitted to the support shafts 18 and 23 and the reciprocating rod 28 via the pulleys, belts, speed reducer 11, non-step transmission 17, and cam box 27 to rotate the winding drum 21 and feed roller 26 of each spindle while simultaneously traversing the traverse guide 29 of each spindle.

[0033] When each section 33, 21, 26, or 29 of the apparatus 2 or 3 is operated, the yarn Y released from the yarn supply package 8 of each spindle enters the tension apparatus 32, where it is subjected to a predetermined tension and ballooned by the rotating disc 33 rotating at a high speed. The yarn Y is twisted twice before it reaches the balloon guide 37, and then reaches the feed roller 26. The twisted yarn Y is traversed by the traverse guide 29 of each spindle and is wound around the winding package P pressed by each winding drum 21. When the traverse guide 29 traverses the yarn Y, the non-step transmission 17 corrects the winding angle. In this wound state, the load current through the driving motor 6 increases over a predetermined length of time after the start of driving and maintains a constant value Io once the number of rotations of the rotating disc 33 has reached a specified value, as shown in Figure 5.

[0034] In addition, a predetermined length of time T1 after the feeding of the yarn Y from the yarn supply package 8 has been started, the motor controller 47 for each spindle compares the threshold value with an actual load current continuously fed back from the yarn cut sensor 52 to determine whether the yarn has been cut. When the load current from the yarn cut sensor 52 is higher than or equal to the threshold value, each motor controller 47 determines that the yarn is not cut and continues to drive the driving motor 6. In addition, when the load current from the yarn cut sensor 52 falls to below the threshold value, each motor controller 47 determines that the yarn has been cut and outputs the stop signal to the driver 46 in order to stop the driving motor 6. While stopping the driving motor 6, the motor controller 47 feeds the stop signal back to the main controller 48 to allow the main controller 48 to operate the contacting and separating apparatus 30, thereby separating from the winding drum 21 the winding package P from which the yarn is cut to stop winding.

[0035] As described above, the single-spindle-driven yarn winding machine 1 includes a driving motor 6 rotating the spindle apparatus 2 of each spindle independently, and when winding the twisted yarn Y, detects variations in the load current through the driving motor 6 due to the tension of the yarn Y in order to determine whether the yarn has been cut. This configuration eliminates the need to locate the conventional drop wire between the balloon guide 37 and the feed roller 26 to detect cut yarn, thereby enabling a cut in the yarn Y to be detected without limiting the arrangement of the yarn winding machine 1.

[0036] A yarn winding machine 61 in which spindles, each having a plurality of yarn supply packages, are installed in a row is described with reference to Figure 6. In this figure, the yarn winding machine 61 is a multiple twisting machine in which two yarn supply packages 8, 8 are stacked on top of each other on the stationary plate 31 of the spindle apparatus 2 of each spindle, and the other configuration is the same as that of the single-spindle-driven yarn winding machine shown in Figures 1 to 5.

[0037] To use the yarn winding machine 61 to combine and twist the yarns Y released from the yarn supply packages 8, 8 of the spindle before winding them around the winding package P, the driving motor 6 for each spindle is driven to rotate the rotating disc 33 at a high speed while rotating the winding drum 21 and feed roller 26 of each spindle, thereby causing the traverse guide 29 to execute traversing. Thus, the yarns Y released from the yarn supply packages 8, 8 of each spindle stacked on top of each other enter the tension apparatus 32 located at the center, where they are combined together. The yarns Y are then twisted twice by the rotating disc 33 rotating at a high speed before reaching the balloon guide 37. The twisted yarns Y are traversed by the traverse guide 29 while being simultaneously wound around the winding package P pressed by the winding drum 21 of each spindle.

[0038] In this wound state, the motor controller 47 for each spindle compares the set threshold value with a load current passing through the driving motor 6 that is fed back from the yarn cut sensor 52. The threshold value falls in the lower end of the specified range determined with the load current that passes through the driving motor 6, which exhibits a relatively stable variation of 2% to 3% when only one of the yarns from the two yarn supply packages of each spindle is cut, into account. When the actual load current from the yarn cut sensor 52 falls to below the threshold value, the motor controller 47 determines that one of the yarns has been cut to output the stop signal to the driver 46 in order to stop the driving motor 6. While stopping the driving motor 6, the motor controller 47 supplys the stop signal back to the main controller 48 to allow the main controller 48 to operate the contacting and separating apparatus 30, thereby separating from the winding drum 21 the winding package P from which the yarn is cut to stop winding.

[0039] Thus, the yarn winding machine 61 includes a driving motor 6 rotating the spindle apparatus 2 of each spindle independently and, when winding the combined and twisted yarns Y, detects variations in the load current through the driving motor 6 due to the tension of the yarns Y in order to determine whether the yarn has been cut. This configuration eliminates the need for the conventional drop wire disposed between the balloon

guide 37 and the feed roller 26 to detect cut yarn, thereby enabling a cut in the yarn Y to be detected without limiting the arrangement of the yarn winding machines. In particular, since the load current passing through the driving motor 6 for each spindle is detected to determine whether the yarn has been cut, a single yarn cut, which is conventionally difficult to detect, can be detected easily and accurately.

[0040] In the present yarn winding machines 1 and 61, the one or more yarn supply packages 8 remain stationary on the stationary plate 31 during twisting and winding, keeping the load current passing through the driving motor 6 is nearly constant during winding at a constant speed. Thus, since whether the yarn is cut is determined based on whether the nearly constant load current falls below the threshold value, the determination is simple and quick.

[0041] The invention in claim 1 or 2 includes for each spindle the driving means for driving a spindle means, and when winding the twisted yarn, detects variations in the load on the driving means due to the tension of the yarn in order to determine whether the yarn has been cut. This configuration eliminates the need to locate in a yarn path for the wound yarn a detecting means for detecting that yarn has been cut to enable cut yarn to be detected without limiting the arrangement of the yarn winding machines.

[0042] In particular, when the yarns released from the plurality of yarn supply packages are combined and twisted before being wound around the winding package, the invention in claim 2 can easily and accurately detect a single yarn cut in which the yarns from only one of the yarn supply packages is cut.

[0043] In addition, in the invention in claim 3, the determining means has a threshold value that is used to determine that yarn has been cut and that is set based on the load on the driving means when the yarn is wound at a constant speed. Thus, this invention accommodate various winding machines having different yarn number counts or spindle means with different diameters with no need to change the threshold value.

Claims

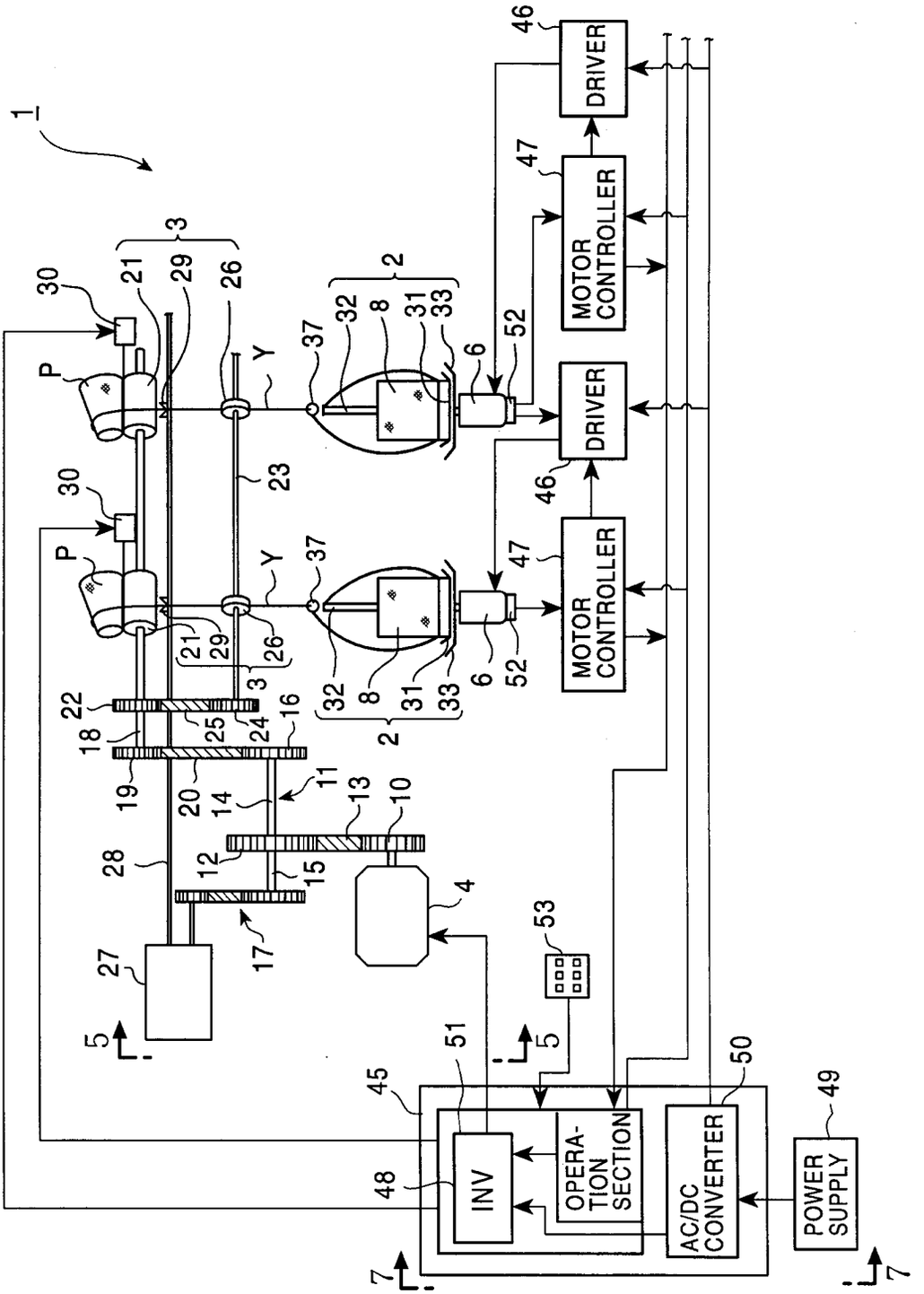
1. A yarn winding machine including spindles each having one yarn supply package and installed in a row, and twisting and winding a yarn released from the stationary yarn supply package of each spindle while ballooning the yarn around the yarn supply package by rotation of a spindle means of each spindle, characterized in that the yarn winding machine comprises a driving means for rotating the spindle means of each spindle; a detecting means for detecting the load on each driving means; and a determining means for determining that the yarn has been cut based on the load detected by each detecting means.

2. A yarn winding machine including spindles each having a plurality of yarn supply packages and installed in a row, and combining, twisting and winding yarns released from the plurality of stationary yarn supply packages of each spindle while ballooning the yarns around the plurality of yarn supply package by rotation of a spindle means of each spindle, characterized in that the yarn winding machine comprises a driving means for rotating the spindle means of each spindle; a detecting means for detecting the load on each driving means; and a determining means for determining that the yarn has been cut based on the load detected by each detecting means.

3. A yarn winding machine according to claim 1 or 2 characterized in that said determining means has a threshold value that is used to determine that the yarn has been cut and that is set based on the load on the driving means when the yarn is wound at a constant speed.

4. A yarn winding machine according to claim 3 characterized in that the threshold value determining that the yarn has been cut is set based on the detection of the load a specified length of time after the start of winding.

FIG. 1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DRIVER
MOTOR CONTROLLER
DRIVER
MOTOR CONTROLLER
INV
OPERA-TION SECTION
AC/DC CONVERTER
POWER SUPPLY

FIG. 2

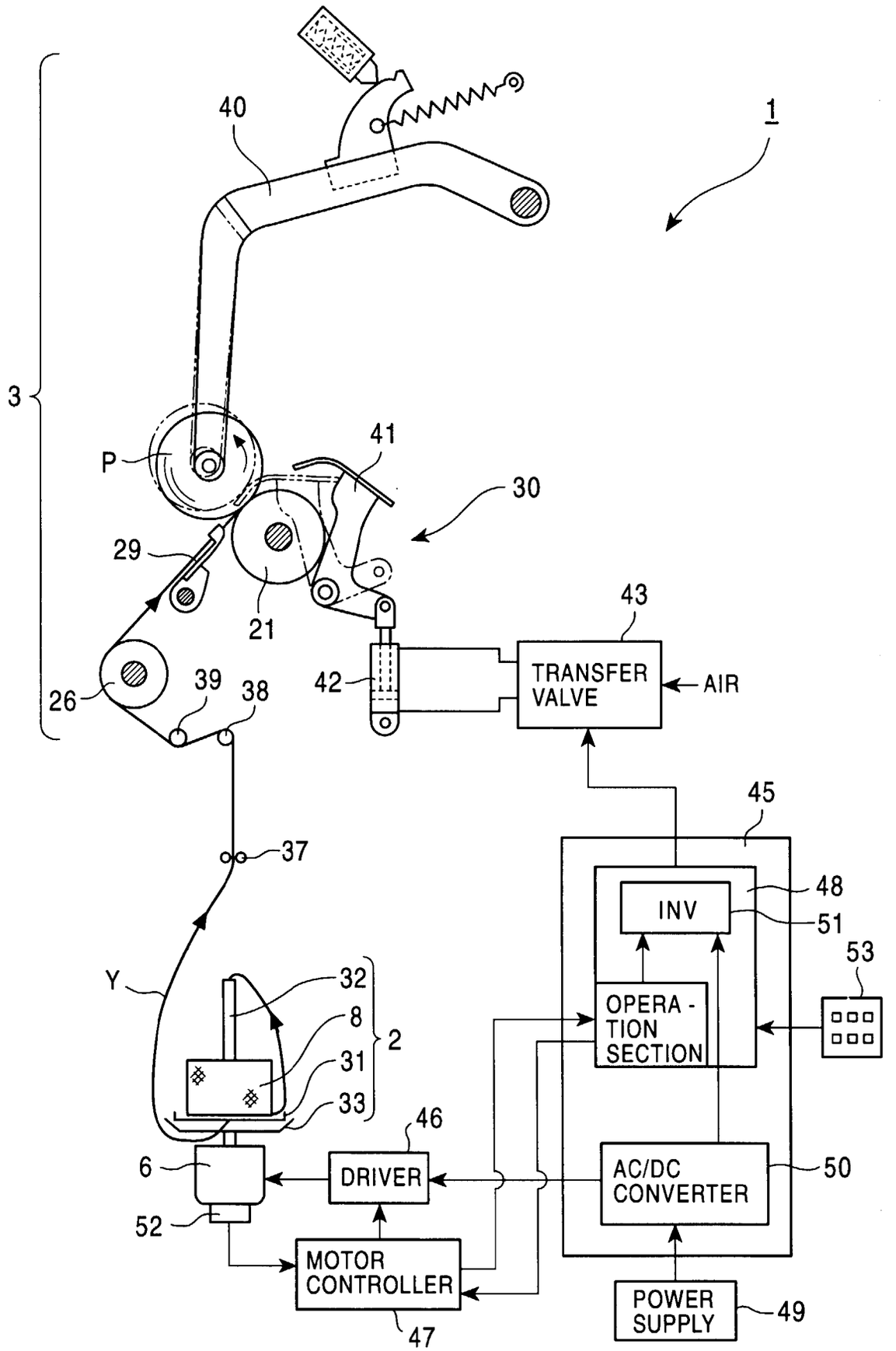
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FIG. 3

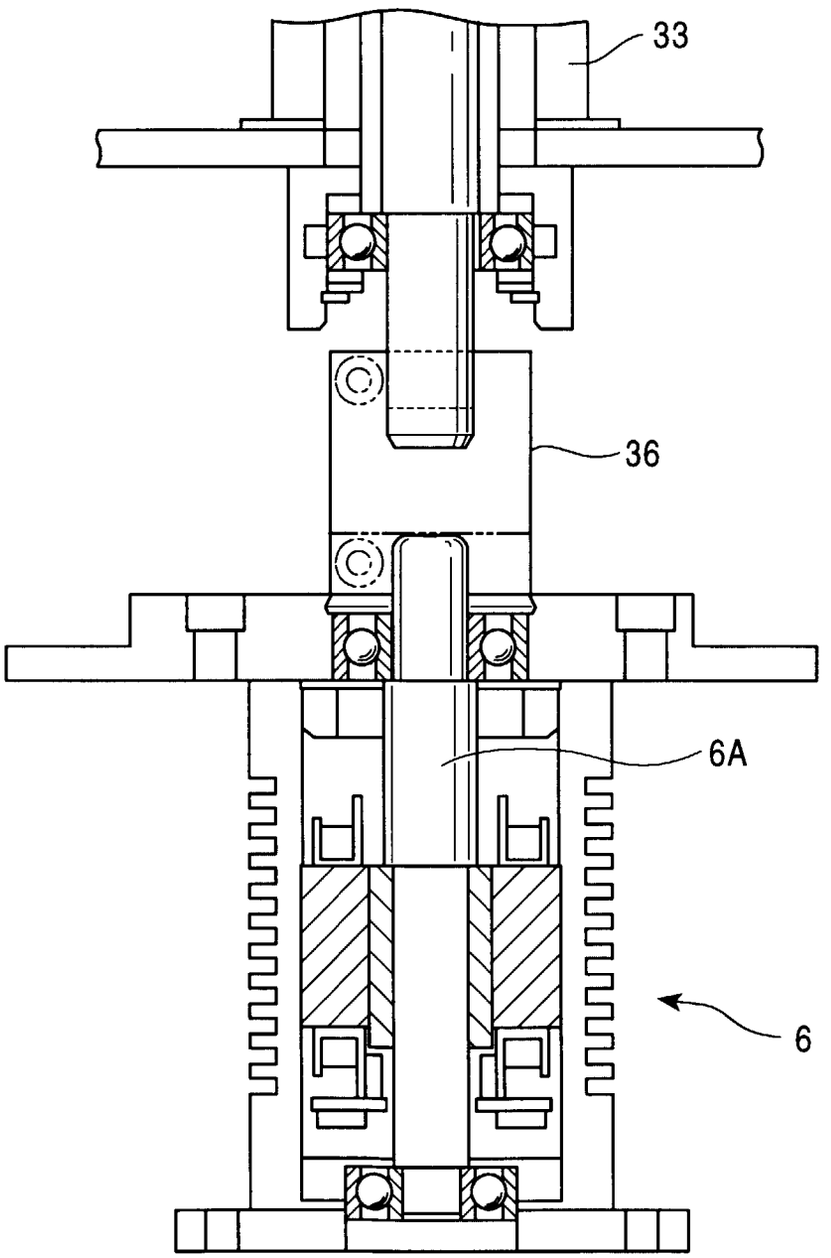


FIG. 4

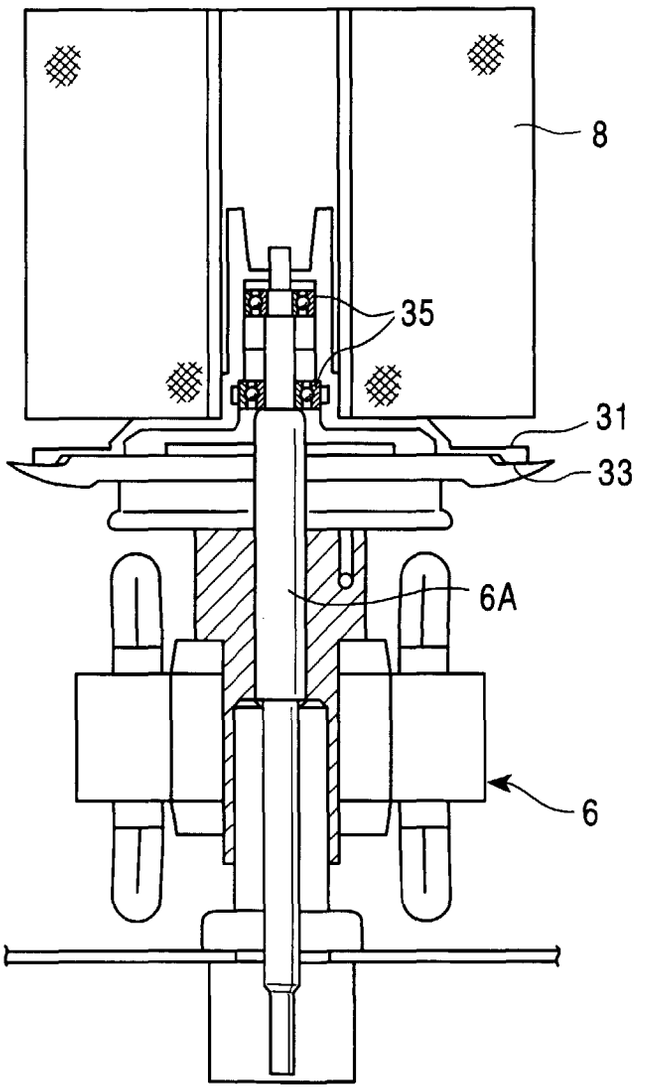
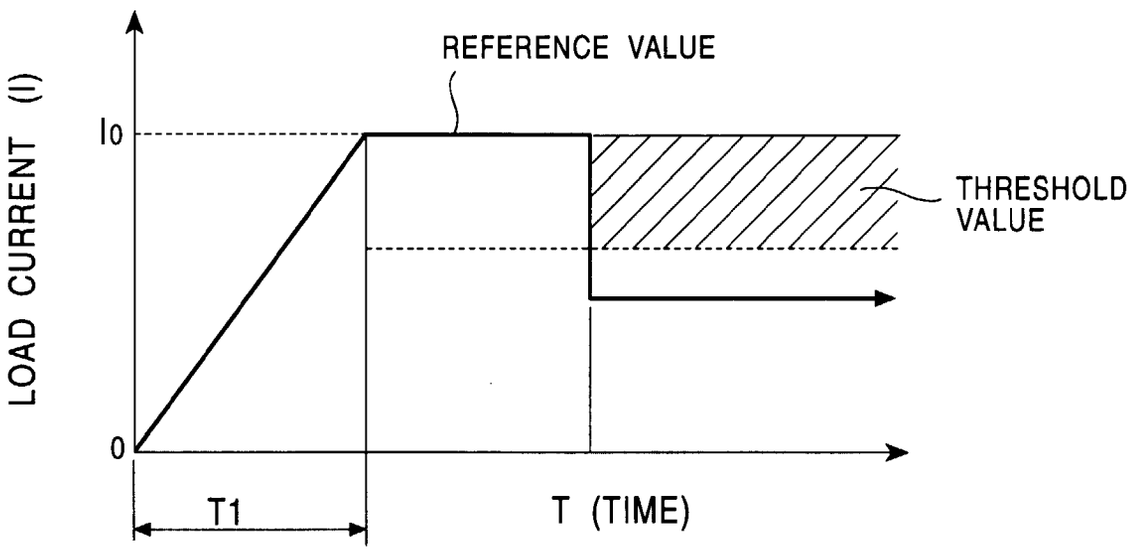


FIG. 5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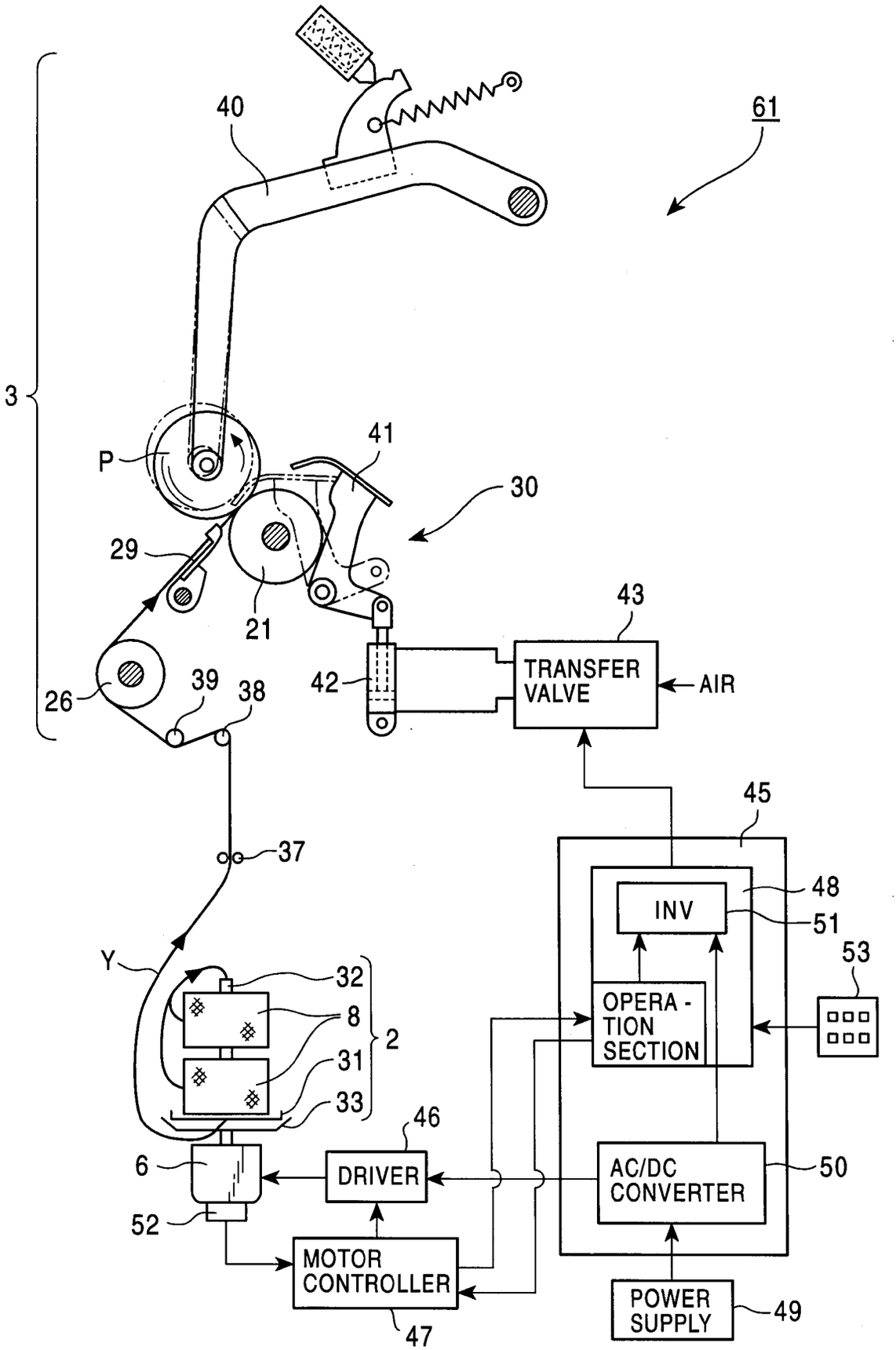
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FIG. 7

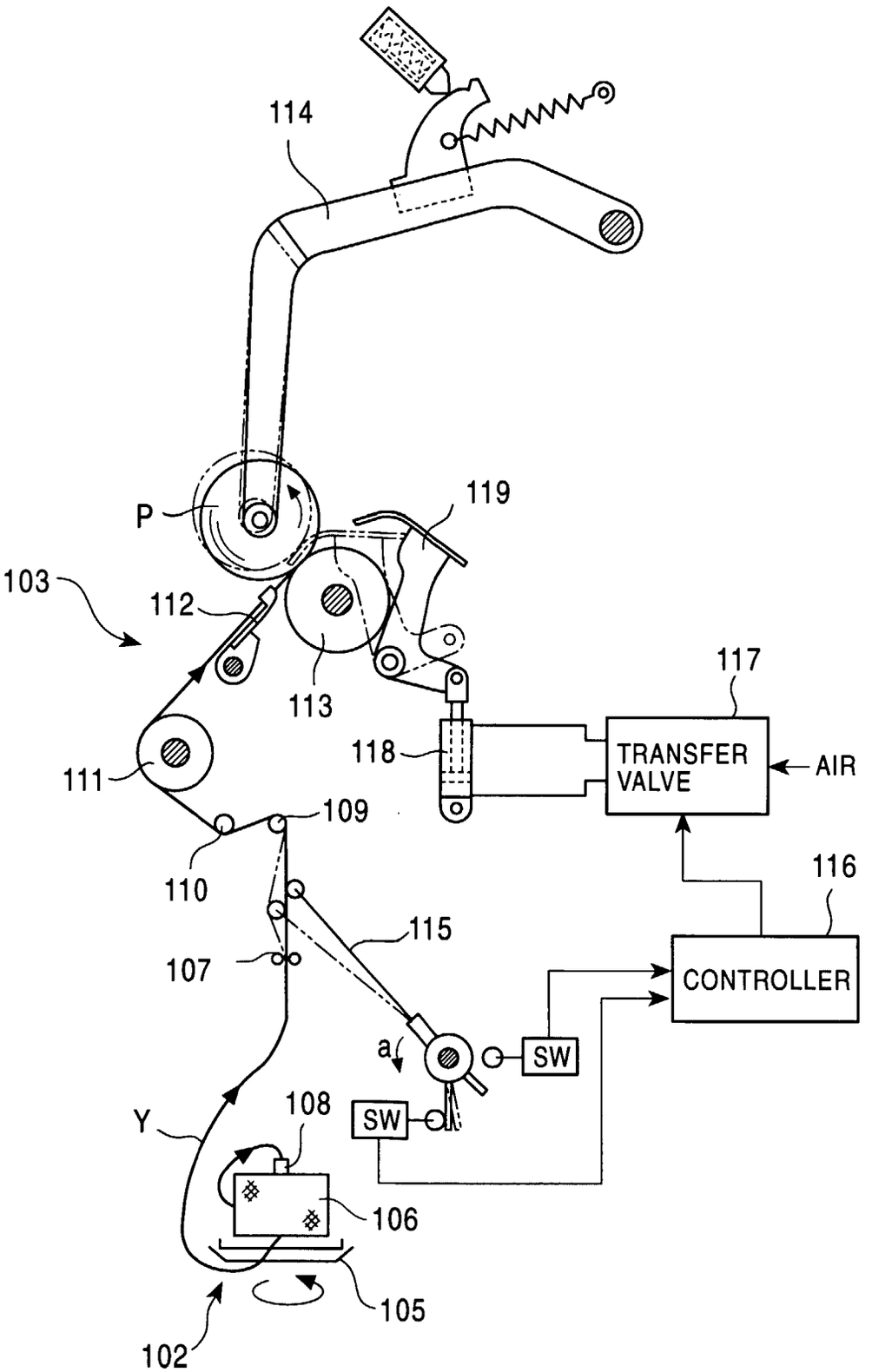
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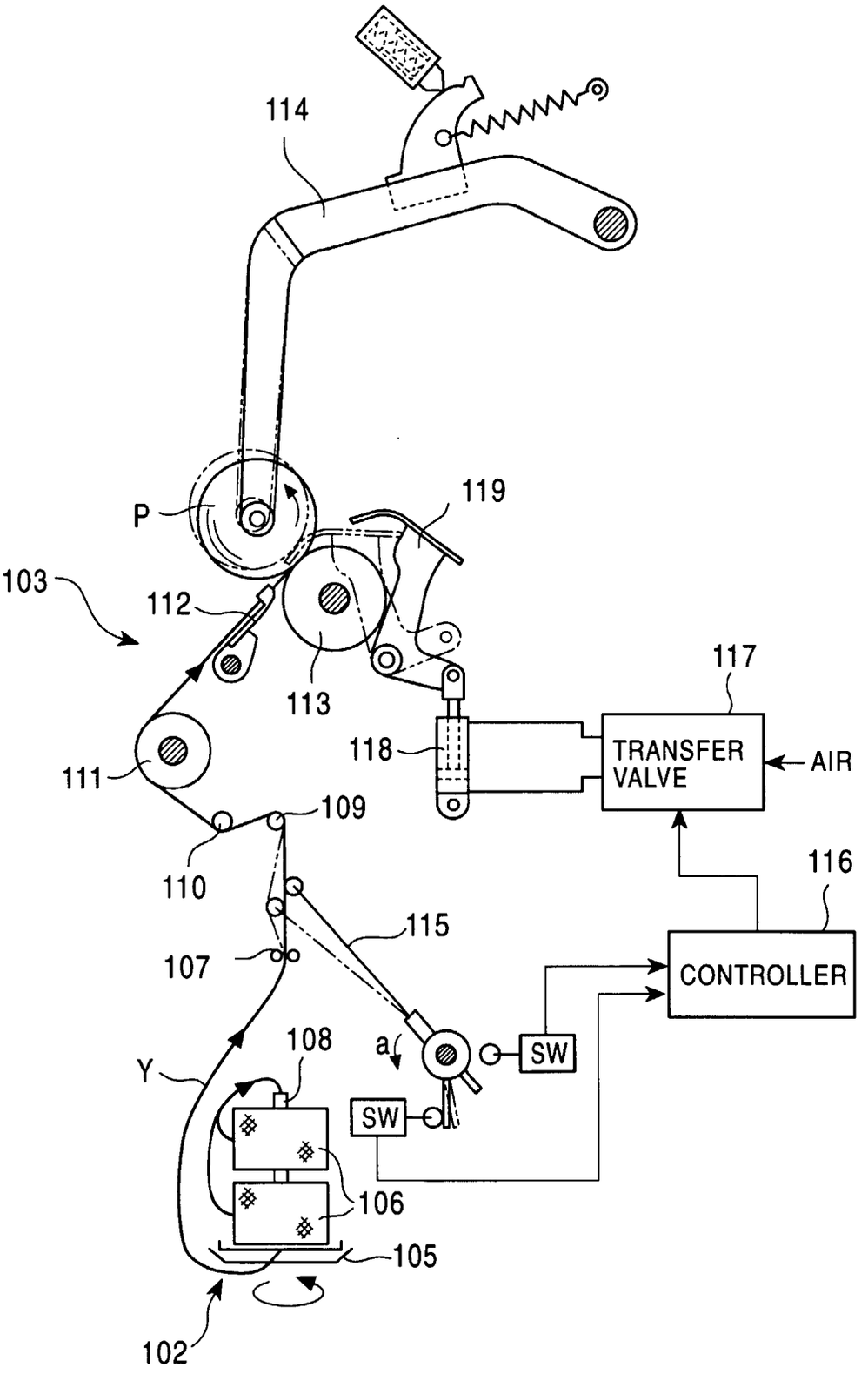
FIG. 8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