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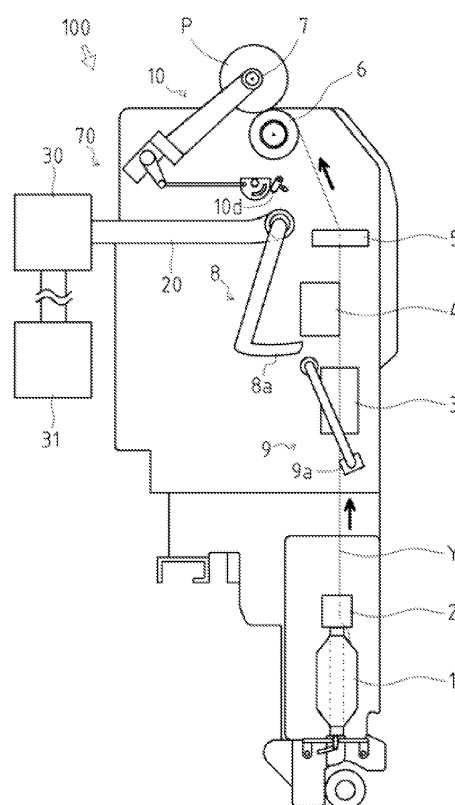
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(54) **Yarn Winding Device**

(57) A yarn end catching device 70 of a yarn winding device 100 includes a suction arm 8 that swings by catching a yarn end of a yarn Y wound into a package P through a suction mouth 8a formed at a leading end the suction arm 8 so that the yarn Y is pulled out from the package P by moving the suction mouth 8a closer to or away from the package P, a negative-pressure device 31 that generates negative pressure for sucking the yarn end of the yarn Y wound into the package P through the suction mouth 8a, and a suction force fluctuation mechanism 60 that controls suction force of the suction mouth 8a to fluctuate. The suction force fluctuation mechanism 60 controls suction force acting on the surface of the package P through the suction mouth 8a to fluctuate.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to technology of a yarn winding device.

2. Description of the Related Art

[0002] A yarn winding device that rotates a bobbin in order to wind a yarn and form a package has been conventionally known. The yarn winding device winds the yarn while continuously determining whether or not a yarn defect exists in a yarn.

[0003] A yarn winding device is a device in which when a yarn defect is detected in a yarn unwound from a yarn supplying bobbin, the yarn defect is removed to maintain yarn quality of the yarn at a constant level. Accordingly, the yarn winding device cuts the yarn to remove the yarn defect, splices yarn ends of the yarn together, and then rewinds the spliced yarn as a single yarn (refer to Japanese Unexamined Patent Application Publication No. 2009-46268, for example).

[0004] However, when a yarn is cut in a package forming process, one yarn end of the cut yarn is wound into a package and its hairiness is entangled with hairiness of a yarn which has been already wound into the package. Accordingly, there were cases where the yarn end of the yarn which has been wound cannot be caught and pulled out even when the yarn end is sucked through a suction mouth.

[0005] Further, Japanese unexamined Patent Application Publication No. H10-167577 discloses a technology in which a yarn loop of a yarn is untied and the yarn is pulled out from a package by reciprocating a suction nozzle opening (a suction mouth), for example. However, the technology is that the suction nozzle opening (the suction mouth) is reciprocated with relatively long strokes so as to move the suction nozzle opening closer to or away from the surface of a package. Accordingly, there were cases where suction force to be lowered when the suction nozzle opening is moved away from the surface of the package causes a function to pull out the yarn to deteriorate.

SUMMARY OF THE INVENTION

[0006] The present invention has been made to solve the above-described problems. It is a main object of the present invention to provide a yarn winding device capable of catching a yarn end of a yarn wound into a package with high accuracy.

[0007] Next, means for solving the problems will be described.

[0008] That is, in the present invention, a yarn winding device for winding a yarn fed from a yarn supplying bob-

bin to form a package includes a yarn end catching device that catches a yarn end of the yarn wound into the package and then pulls out the yarn from the package. The yarn end catching device includes a suction arm that swings by catching the yarn end of the yarn wound into the package through a suction mouth formed at a leading end of the suction arm so that the yarn is pulled out from the package by moving the suction mouth closer to or away from the package; a negative-pressure device that generates negative pressure for sucking the yarn end of the yarn wound into the package through the suction mouth; and a suction force fluctuation mechanism that controls suction force of the suction mouth to fluctuate. In a suction position in which suction force acting on the surface of the package is applied through the suction mouth and then the yarn end of the yarn wound into the package is sucked through the suction mouth, the suction force fluctuation mechanism controls the suction force acting on the surface of the package through the suction mouth to fluctuate.

[0009] In the present invention, in the suction position in which suction force acting on the surface of the package is applied through the suction mouth and then the yarn end of the yarn wound into the package is sucked through the suction mouth, the suction force fluctuation mechanism is a vibration generating device that controls the suction force acting on the surface of the package through the suction mouth to fluctuate by restricting the suction arm so as to vibrate the suction arm.

[0010] In the present invention, the vibration generating device includes a stepping motor that swings the suction arm while being synchronized with a pulse signal, a stopper that restricts swinging movement of the suction arm to a side of the package, and a control device that controls the suction force acting on the surface of the package through the suction mouth to fluctuate by driving the stepping motor and vibrating the suction arm so as to swing the suction arm to the side of the package even after the suction arm has made contact with the stopper.

[0011] In the present invention, in the suction position in which suction force acting on the surface of the package is applied through the suction mouth and then the yarn end of the yarn wound into the package is sucked through the suction mouth, the suction force fluctuation mechanism is a suction airflow amount fluctuation mechanism that controls an amount of airflow to be sucked through the suction mouth acting on the surface of the package to fluctuate.

[0012] In the present invention, the suction airflow amount fluctuation mechanism is a shutter that is formed such that the size of an open area of an internal passage of a suction pipe coupled to the suction arm from the negative-pressure device fluctuates. The shutter is formed such that suction force acting on the surface of the package through the suction mouth fluctuates by increasing or decreasing the size of the open area of the internal passage of the suction pipe.

[0013] Effects of the present invention will be de-

scribed as follows.

[0014] According to the present invention, when catching a yarn end of a yarn wound into a package, in a suction position in which suction force acting on the surface of the package is applied through a suction mouth and then the yarn end of the yarn wound into the package is sucked through the suction mouth, the suction force acting on the package can fluctuate. Accordingly, even when hairiness of the yarn is entangled by winding the yarn into the package, by applying impact caused by a suction function with fluctuation amplitude to the surface of the package, the yarn end of the yarn can be effectively moved up to the surface of the package. Consequently, the yarn end can be caught with high accuracy.

[0015] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Fig. 1 is a side view illustrating an overall structure of a yarn winding device 100.

[0017] Fig. 2 is a view illustrating swinging movement of a suction arm 8 and the operation of a stopper mechanism 10.

[0018] Fig. 3 is a flow chart illustrating an operational state of the yarn winding device 100.

[0019] Fig. 4 is a view illustrating a cutting operation S120 of the yarn winding device 100.

[0020] Fig. 5 is one view illustrating a placing operation S130 of the yarn winding device 100.

[0021] Fig. 6 is another view illustrating the placing operation S130 of the yarn winding device 100.

[0022] Fig. 7 (7A) is a perspective view illustrating a structure of a stepping motor 12. Fig. 7 (7B) is a sectional view of the stepping motor 12.

[0023] Fig. 8 (8A) is a schematic view illustrating a positional relation among a small tooth 12ct located in a magnetic pole creating the phase A, a small tooth 12at located on a first rotor 12a, and a small tooth 12bt located on a second rotor 12b. Fig. 8 (8B) is a schematic view illustrating a positional relation among a small tooth 12ct located in a magnetic pole creating the phase B, a small tooth 12at located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b. Fig. 8 (8C) is a schematic view illustrating a positional relation among a small tooth 12ct located in a magnetic pole creating the phase C, a small tooth 12at located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b.

[0024] Fig. 9 is a view illustrating vibration of a suction mouth 8a.

[0025] Fig. 10 is a side view illustrating an overall structure of a yarn winding device 200.

[0026] Fig. 11 is an exploded view illustrating a structure of a shutter 21.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0027] First, a yarn winding device 100 according to a first embodiment of the present invention will be described.

[0028] Fig. 1 is a side view illustrating an overall structure of the yarn winding device 100. Further, the arrows in Fig. 1 indicate a direction in which a yarn Y is fed.

[0029] The yarn winding device 100 includes a yarn unwinding assisting device 2, a gate tensor 3, a yarn splicing device 4, a yarn clearer 5, a traverse drum 6, and a bobbin 7, which are arranged along a direction in which the yarn Y unwound from the yarn supplying bobbin 1 is fed. Further, a main body of the yarn winding device 100 includes a suction arm 8, a bobbin yarn pulling out arm 9, a stopper mechanism 10, or the like.

[0030] The yarn unwinding assisting device 2 is for assisting in unwinding the yarn Y from the yarn supplying bobbin 1. The yarn unwinding assisting device 2 restricts spreading of the yarn Y unwound from the yarn supplying bobbin 1 caused by centrifugal force acting on the yarn Y and appropriately adjusts tension to be applied to the yarn Y in order to assist unwinding of the yarn Y.

[0031] The gate tensor 3 is for applying predetermined tension to the yarn Y to be fed from the yarn supplying bobbin 1 to the bobbin 7 and is used for maintaining the tension constant. The gate tensor 3 adjusts tension applied to the yarn Y by hooking the yarn Y on each of combs of a comb-teeth member, which allows the yarn Y to be wound by the bobbin 7 at high speed.

[0032] The yarn splicing device 4 is for splicing yarn ends of the yarn Y together. For example, when the yarn Y is cut to remove a yarn defect in the yarn Y, the yarn splicing device 4 splices yarn ends of the yarn Y which has been cut and divided together. Further, the yarn splicing device 4 of the yarn winding device 100 uses an air splicer device that uses whirling airflow to splice yarn ends together.

[0033] The yarn clearer 5 which is a yarn defect detecting device is for searching for a yarn defect in the yarn Y. The yarn clearer 5 is formed such that the yarn Y is illuminated by a light-emitting diode or the like employed as a light source, and determines whether or not a yarn defect exists by detecting an amount of light to be reflected from the yarn Y. Further, a cutter (not illustrated in the drawings), which cuts the yarn Y when the yarn clearer 5 detects a yarn defect in the yarn Y, is provided in the vicinity of the yarn clearer 5.

[0034] The traverse drum 6 is for driving and rotating the bobbin 7 and a package P formed on the bobbin 7 and is also for traversing the yarn Y. The traverse drum 6 is rotated by a motor (not illustrated in the drawings) and makes tension applied to the yarn Y stable by maintaining winding speed of the yarn Y constant. Further, the traverse drum 6 traverses the yarn Y to prevent the yarn Y from being unevenly wound into the package P.

[0035] The suction arm 8 is a suction duct mounted

capable of swinging on the main body of the yarn winding device 100. A suction mouth 8a is provided at a leading end of the suction arm 8, and a yarn end wound into the package P can be caught and held by sucking air through the suction mouth 8a. Further, the suction arm 8 can swing downward while holding the yarn Y, and then places the yarn Y in a predetermined position of the yarn splicing device 4. Furthermore, the suction arm 8 is connected to a negative-pressure duct 30 via a suction pipe 20. Accordingly, a negative-pressure device 31 supplies negative pressure to the suction mouth 8a via the negative-pressure duct 30, the suction pipe 20, and the suction arm 8; therefore, suction force can be generated through the suction mouth 8a.

[0036] The bobbin yarn pulling out arm 9 is a suction duct mounted capable of swinging on the main body of the yarn winding device 100. A suction mouth 9a is provided at a leading end of the bobbin yarn pulling out arm 9, and a yarn end located in the yarn supplying bobbin 1 can be caught and held by sucking air through the suction mouth 9a. Further, the bobbin yarn pulling out arm 9 can swing upward while holding the yarn Y, and then places the yarn Y in a predetermined position of the yarn splicing device 4.

[0037] The stopper mechanism 10 is for restricting swinging movement of the suction arm 8 to a side of the package P in order to place the suction mouth 8a in an appropriate suction position to catch a yarn end. The stopper mechanism 10 can control the suction mouth 8a to be constantly placed in the appropriate suction position with respect to the package P in which the diameter increases accompanying winding of the yarn Y.

[0038] Further, a structure capable of swinging the suction arm 8 and the operation of the stopper mechanism 10 will be described.

[0039] Fig. 2 is a view illustrating swinging movement of the suction arm 8 and the operation of the stopper mechanism 10. Further, the arrows in Fig. 2 indicate a swing direction of the suction arm 8 and an operating direction of each of members of the stopper mechanism 10.

[0040] The main body of the yarn winding device 100 has a built-in stepping motor 12 as a driving device capable of swinging the suction arm 8. An output gear 13 is fixedly mounted on an output shaft 12d of the stepping motor 12, and the output gear 13 is connected to an input gear 14 fixedly mounted on the suction arm 8 via a power transmitting belt 15. Accordingly, the stepping motor 12 receives a pulse signal transmitted from the control device 40 in order to be synchronized with the pulse signal and then to be driven, which makes it possible to swing the suction arm 8 upward or downward.

[0041] Further, the stopper mechanism 10 will be described. First, a cradle 10a which swings in accordance with the diameter of a package P rotates a cam 10c via a rod 10b. Then, the stopper 10d, which has been arranged so as to make contact with the cam 10c, is pressed and moved by the cam 10c. That is, the stopper

mechanism 10 controls the stopper 10d to move to a position which corresponds to the diameter of a package P so that the stopper 10d is made into contact with the suction arm 8, which restricts swinging movement of the suction arm 8.

[0042] The overall structure of the yarn winding device 100 according to the first embodiment of the present invention has been described above. Next, a description will be made on an operational state of the yarn winding device 100 in which when a yarn defect in the yarn Y is detected, the yarn defect is removed and then yarn ends of the yarn Y are spliced together.

[0043] Fig. 3 is a flow chart illustrating the operational state of the yarn winding device 100. Fig. 4 is a view illustrating a cutting operation S120 of the yarn winding device 100. Fig. 5 and Fig. 6 are views illustrating a placing operation S130 of the yarn winding device 100. Further, the arrows in the Fig. 5 and Fig. 6 indicate a swing direction of the suction arm 8 and the bobbin yarn pulling out arm 9.

[0044] As illustrated in Fig. 3, the operational state of the yarn winding device 100 mainly includes a searching operation S110, the cutting operation S120, the placing operation 130, and a yarn splicing operation S140.

[0045] The searching operation S110 is an operation of searching for a yarn defect in the yarn Y. As described above, the yarn clearer 5 of the yarn winding device 100 detects an amount of light to be reflected from the yarn Y in order to determine whether or not a yarn defect exists.

[0046] The cutting operation S120 is an operation in which when the yarn clearer 5 detects a yarn defect in the yarn Y, the yarn Y is cut off. As described above, the cutter provided in the vicinity of the yarn clearer 5 cuts the yarn Y when the yarn clearer 5 detects a yarn defect in the yarn Y.

[0047] Accordingly, as illustrated in Fig. 4, an upper yarn YU, which is a yarn end of the yarn Y located downstream of a cut part of the yarn Y, is wound into a package P. Meanwhile, a lower yarn YR, which is a yarn end of the yarn Y located upstream of the cut part of the yarn Y, is held by the suction mouth 9a of the bobbin yarn pulling out arm 9. Further, the yarn defect in the yarn Y is wound as a part of the upper yarn YU into the package P.

[0048] The placing operation S130 is an operation of placing the yarn Y which has been cut and divided in a predetermined position of the yarn splicing device 4. First, as illustrated in Fig. 5, the suction arm 8 swings upward to catch a yarn end of the upper yarn YU and then holds the yarn end. Then, as illustrated in Fig. 6, the suction arm 8 swings downward while holding the upper yarn YU, and places the upper yarn YU in the predetermined position of the yarn splicing device 4. Meanwhile, the bobbin yarn pulling out arm 9 swings upward while holding the lower yarn YR, and places the lower yarn YR in the predetermined position of the yarn splicing device 4.

[0049] By referring to Fig. 5 and Fig. 6, the placing operation S130 will be specifically described. First, the suction arm 8 is controlled to swing upward until making contact with the stopper 10d. At this point of time, swing speed of the suction arm 8 is controlled so as to be decreased immediately before the suction arm 8 makes contact with the stopper 10d. That is, the suction arm 8 swings at high speed immediately after starting to swing upward, and swings at low speed immediately before making contact with the stopper 10d. Further, in the present embodiment, the suction arm 8 is formed so as to swing in two stages (i.e., in a high-speed stage or a low-speed stage); however, the swing speed of the suction arm 8 can also be controlled so as to be gradually decreased.

[0050] As described above, the suction arm 8 makes contact with the stopper 10d and the swinging movement of the suction arm 8 is restricted, which indicates that the suction mouth 8a has been moved to the predetermined suction position. Then, by applying suction force to a package P through the suction mouth 8a, the yarn end of the upper yarn YU wound in the package P can be caught, and then the yarn end is held.

[0051] Then, the suction arm 8 swings downward while holding the yarn end of the upper yarn YU, and places the upper yarn YU in the predetermined position of the yarn splicing device 4. Further, the upper yarn YU is being sucked through the suction mouth 8a; therefore, the upper yarn YU is kept between the suction mouth 8a and the package P.

[0052] Meanwhile, the bobbin yarn pulling out arm 9 swings upward while holding the lower yarn YR from the yarn supplying bobbin 1, and places the lower yarn YR in the predetermined position of the yarn splicing device 4. Further, the lower yarn YR is being sucked through the suction mouth 9a; therefore, the lower yarn YR is kept between the suction mouth 9a and the yarn supplying bobbin 1.

[0053] The yarn splicing operation S140 is an operation of splicing a yarn end of the upper yarn YU and a yarn end of the lower yarn YR together. As described above, the yarn splicing device 4 uses whirling airflow to splice the yarn end of the upper yarn YU and the yarn end of the lower yarn YR together.

[0054] The yarn splicing operation S140 will be specifically described. First, the yarn splicing device 4 pulls out the upper yarn YU and the lower yarn YR to guide both the upper yarn YU and the lower yarn YR to a yarn splicing hole. Next, the yarn splicing device 4 fastens the upper yarn YU and the lower yarn YR together in a clamping operation, and then cuts off the yarn defect by the cutter. Accordingly, the yarn defect wound as a part of the upper yarn YU into the package P is sucked through the suction mouth 8a and is removed.

[0055] Next, the yarn splicing device 4 uses whirling airflow to perform an unwinding operation of unwinding a twist of yarn ends, and then a twisting operation of twisting the unwound yarn ends together. The twisting

operation is a process of twisting the unwound yarn ends together by using whirling airflow formed in an opposite direction from a direction in which the unwinding operation is performed.

5 **[0056]** Accordingly, the yarn winging device 100 can remove the yarn defect in the yarn Y. Further, in the yarn winding device 100, the yarn end of the upper yarn YU and the yarn end of the lower yarn YR are spliced together, which makes it possible to wind the spliced yarn as a
10 single yarn Y again.

[0057] The operational state of the yarn winding device 100 has been described above. Next, a description will be made on a structure in which when the yarn end of the upper yarn YU wound into the package P is caught
15 through the suction mouth 8a in the placing operation S130, suction force acting on the package P is controlled to fluctuate.

[0058] First, the stepping motor 12 which swings the suction arm 8 will be described in detail. As described
20 above, the stepping motor 12 is an electric motor that receives a pulse signal transmitted from the control device 40 in order to be synchronized with the pulse signal and then to be driven. Further, the control device 40 according to the present embodiment introduces a constant
25 electric-voltage driving system of forming a pulse signal by blocking a direct electric voltage. However, the control device 40 may introduce a constant electric-current driving system of forming a pulse signal by blocking a direct electric current.

30 **[0059]** Fig. 7 (7A) is a perspective view illustrating a structure of the stepping motor 12. Fig. 7 (7B) is a sectional view of the stepping motor 12. Further, the arrows in Fig. 7 (7A) and Fig. 7 (7B) indicate a rotational direction of the output shaft 12d.

35 **[0060]** As illustrated in Fig. 7 (7A) and Fig. 7 (7B), the stepping motor 12 mainly includes a first rotor 12a, a second rotor 12b, a stator 12c, and the output shaft 12d.

[0061] The first rotor 12a and the second rotor 12b are rotors formed in a substantially cylindrical shape. The
40 first rotor 12a is magnetized so as to be a magnetic north pole (i.e., an N pole); the second rotor 12b is magnetized so as to be a magnetic south pole (i.e., an S pole). Further, a plurality of small teeth 12at and a plurality of small teeth 12bt are respectively located on the outer peripheral surface of the first rotor 12a and the outer peripheral surface of the second rotor 12b; each small tooth 12at is located
45 half a pitch apart from each small tooth 12bt (refer to Fig. 8 (8A), Fig. 8 (8B), and Fig. 8 (8C)). Furthermore, the output shaft 12d is inserted to pass through the first rotor 12a and the second rotor 12b, and is rotated integrally with both the first rotor 12a and the second rotor 12b.

50 **[0062]** The stator 12c is a stator in which a plurality of magnetic poles are provided on the inner peripheral surface thereof, and each of the magnetic poles is excited by flow of an electric current into winding wires of the each of the magnetic poles (i.e., an electromagnet is made). Further, in the stator 12c, a pair of magnetic poles facing each other creates a plurality of magnetic phases

such as the phase A, the phase B, and the phase C as illustrated in the drawings. Furthermore, a plurality of small teeth 12ct are located in the each of the magnetic poles so as to face the first rotor 12a and the second rotor 12b.

[0063] In such a structure, by assuming that an electric current flows into a winding wire arranged in the phase A, a magnetic pole creating the phase A is excited, which assigns the polar characteristic of an S pole to the magnetic pole. Accordingly, a small tooth 12ct located in the magnetic pole creating the phase A and a small tooth 12at located on the first rotor 12a with the polar characteristic of an N pole attract each other. At the same time, the small tooth 12ct located in the magnetic pole creating the phase A and a small tooth 12bt located on the second rotor 12b with the polar characteristic of an S pole repel each other. Consequently, the output shaft 12d rotates to reach a stabilization point.

[0064] Next, the flow of an electric current is switched from the phase A to the phase B, and then the electric current flows into a winding wire arranged in the phase B, which excites a magnetic pole creating the phase B and assigns the polar characteristic of an N pole to the magnetic pole. Accordingly, a small tooth 12ct located in the magnetic pole creating the phase B and a small tooth 12bt located on the second rotor 12b with the polar characteristic of an S pole attract each other. At the same time, the small tooth 12ct located in the magnetic pole creating the phase B and a small tooth 12at located on the first rotor 12a with the polar characteristic of an N pole repel each other. Consequently, the output shaft 12d rotates to reach the next stabilization point.

[0065] As described above, the stepping motor 12 sequentially switches the flow of an electric current to the phase A, the phase B, the phase C, etc. in this order; which makes it possible to constantly rotate the output shaft 12d at a predetermined angle. Further, the stepping motor 12 sequentially switches the flow of an electric current in a backward direction; which also makes it possible to constantly rotate the output shaft 12d backward at a predetermined angle. Consequently, the stepping motor 12 can swing the suction arm 8 upward or downward.

[0066] Even after the suction arm 8 has made contact with the stopper 10d, the synchronization between the stepping motor 12 and the pulse signal is disabled by receiving another pulse signal transmitted from the control device 40, which makes it possible to vibrate the suction position of the suction mouth 8a with respect to the package P.

[0067] A detailed description will be made on a state in which by disabling the synchronization between the stepping motor 12 and the pulse signal transmitted from the control device 40, the stepping motor 12 vibrates the suction position of the suction mouth 8a with respect to the package P.

[0068] Fig. 8 (8A) is a schematic view illustrating a positional relation among a small tooth 12ct located in the magnetic pole creating the phase A, a small tooth 12at

located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b. Fig. 8 (8B) is a schematic view illustrating a positional relation among a small tooth 12ct located in the magnetic pole creating the phase B, a small tooth 12at located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b. Further, Fig. 8 (8C) is a schematic view illustrating a positional relation among a small tooth 12ct located in a magnetic pole creating the phase C, a small tooth 12at located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b. The arrows in Fig. 8 (8A), Fig. 8 (8B), and Fig. 8 (8C) indicate a direction in which magnetic force causes the small tooth 12at and the small tooth 12ct attract each other or magnetic force causes the small tooth 12bt and the small tooth 12ct to attract each other, and a rotational direction of both the first rotor 12a and the second rotor 12b (i.e., a rotational direction of the output shaft 12d).

[0069] As described above, by making the suction arm 8 to come into contact with the stopper 10 when the suction arm 8 swings upward, swinging movement of the suction arm 8 is restricted. Fig. 8 (A1) illustrates a positional relation among a small tooth 12ct located in the magnetic pole creating the phase A, a small tooth 12at located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b immediately before the suction arm 8 makes contact with the stopper 10d.

[0070] As illustrated in Fig. 8 (A1), a small tooth 12ct located in a magnetic pole with the polar characteristic of an S pole and a small tooth 12at located in the first rotor 12a with the polar characteristic of an N pole attract each other; which causes the output shaft 12d to rotate in the right-hand direction of Fig. 8 (A1) and to intend to reach a stabilization point.

[0071] However, when the suction arm 8 has made contact with the stopper 10d, the rotation of the output shaft 12d is forced to be stopped. Consequently, the small tooth 12ct located in the magnetic pole, the small tooth 12at located on the first rotor 12a, and the small tooth 12bt located on the second rotor 12b are stopped under a state illustrated in the Fig. 8 (A2). At this point of time, movement of the suction mouth 8a to a package P side is restricted at a closer position to the package P (refer to the solid line in Fig. 9). The position is referred to as the suction position in which suction force acting on the surface of the package P is applied through the suction mouth 8a and then a yarn end of a yarn Y wound into the package P is sucked through the suction mouth 8a. Further, the small tooth 12ct located in the magnetic pole and the small tooth 12at located on the first rotor 12a attract each other, which causes the output shaft 12d to be stabilized and stopped.

[0072] Then, as illustrated in Fig. 8 (B1), even after the rotation of the output shaft 12d has been stopped, the stepping motor 12 receives a pulse signal to switch the flow of an electric current to the phase B, which excites the magnetic pole creating the phase B and assigns the polar characteristic of an N pole to the magnetic pole.

[0073] Accordingly, a small tooth 12ct located in the magnetic pole with the polar characteristic of an N pole and a small tooth 12bt located on the second rotor 12b with the polar characteristic of an S pole attract each other; therefore, the output shaft 12d rotates in the left direction of the Fig. 8 (B1) to reach a stabilization point. That is, the stepping motor 12 does not rotate the output shaft 12d in synchronization with the switching the flow of an electric current from the phase A to the phase B, but rotates the output shaft 12d backward by disabling the synchronization (which is referred to as a step-out phenomenon). At this point of time, since the suction mouth 8a slightly moves in a direction in which the suction arm 8 swings slightly downward, the suction mouth 8a is separated from the package P (refer to the alternate long and double-short dashed line in Fig. 9). Further, the small tooth 12ct located in the magnetic pole and the small tooth 12bt located on the second rotor 12b attract each other, which causes the output shaft 12d to be stabilized and stopped in the position illustrated in Fig. 8 (B2).

[0074] Then, the stepping motor 12 receives a pulse signal to switch the flow of an electric current to the phase C, which excites a magnetic pole creating the phase C and assigns a polar characteristic of an S pole to the magnetic pole.

[0075] Accordingly, as illustrated in Fig. 8 (C1), a small tooth 12ct located in the magnetic pole with the polar characteristic of an S pole and a small tooth 12at located on the first rotor 12a with the polar characteristic of an N pole attract each other; which causes the output shaft 12d to rotate in the right-hand direction of Fig. 8 (C1) and to intend to reach a stabilization point.

[0076] However, when the suction arm 8 makes contact again with the stopper 10d, the rotation of the output shaft 12d is forced to be stopped. Consequently, the small tooth 12ct located in the magnetic pole, the small tooth 12at located on the first rotor 12a, and a small tooth 12bt located on the second rotor 12b are stopped under a state illustrated in the Fig. 8 (C2). At this point of time, the suction mouth 8a slightly moves in a direction in which the suction arm 8 swings upward. Consequently, the suction mouth 8a is located closer to the package P (refer to the solid line in Fig. 9). Further, the small tooth 12ct located in the magnetic pole and the small tooth 12at located on the first rotor 12a attract each other, which causes the output shaft 12d to be stabilized and stopped.

[0077] Accordingly, even after the suction arm 8 has made contact with the stopper 10d, the synchronization between the stepping motor 12 and the pulse signal can be disabled by receiving another pulse signal transmitted from the control device 40. Then, forward rotation or backward rotation of the stepping motor 12 is repeated in accordance with a pulse signal. Repeated slight movement of the suction arm 8 allows the suction mouth 8a to move repeatedly and slightly at the suction position of the suction mouth 8a (i.e., repeated slight movement of the suction arm 8 allows the suction mouth 8a to vibrate repeatedly and slightly at the suction position of the suc-

tion mouth 8a).

[0078] As described above, in the present embodiment, a vibration generating device 50 that vibrates the suction mouth 8a includes the stepping motor 12, the stopper 10d, and the control device 40 (refer to Fig. 2). Further, the vibration generating device 50 functions as a suction force fluctuation mechanism 60 that controls suction force of the suction mouth 8a to fluctuate (refer to Fig. 2). A yarn end catching device 70 includes the suction arm 8, the negative-pressure device 31, and the suction force fluctuation mechanism 60 (refer to Fig. 1).

[0079] When catching a yarn end of the upper yarn YU wound into a package P, such a structure allows suction force acting on the package P to fluctuate. Accordingly, even when hairiness of the upper yarn YU is entangled by winding the upper yarn YU into the package P, by applying impact caused by a suction function with fluctuation amplitude to the surface of the package P in the suction position in which suction force acting on the surface of the package P is applied through the suction mouth 8a and then the yarn end of the upper yarn YU wound into the package P is sucked through the suction mouth 8a, the yarn end of the upper yarn YU can be effectively moved up to the surface of the package P. Consequently, the yarn end can be caught with high accuracy.

[0080] Further, what is called a HV stepping motor is used as the stepping motor 12 in the present embodiment. However, a VR stepping motor or a PM stepping motor may be used as the stepping motor 12, for example. Both the VR stepping motor and the PM stepping motor can accomplish the above-described structure.

[0081] Next, a yarn winding device 200 according to a second embodiment of the present invention will be described. The yarn winding device 200 according to the present embodiment is different from the yarn winding device 100 according to the first embodiment in a way to control suction force acting on a package P to fluctuate (i.e., in the yarn winding device 200, a shutter 21 is used to control suction force acting on a package P to fluctuate). However, like reference numerals are used in the drawings for elements that are the same to those of the above-described yarn winding device 100. Elements that are different from those of the above-described yarn winding device 100 will be mainly described.

[0082] Fig. 10 is a side view illustrating an overall structure of the yarn winding device 200. Further, the arrows in Fig. 10 indicate a direction in which a yarn Y is fed.

[0083] The yarn winding device 200 includes a yarn unwinding assisting device 2, a gate tensor 3, a yarn splicing device 4, a yarn clearer 5, a traverse drum 6, and a bobbin 7, which are arranged along a direction in which the yarn Y unwound from a yarn supplying bobbin 1 is fed. Further, a main body of the yarn winding device 200 includes a suction arm 8, a bobbin yarn pulling out arm 9, a stopper mechanism 10, or the like.

[0084] In the yarn winding device 200 according to the present embodiment, a suction pipe 20 connected to a

suction mouth 8a of the suction arm 8 is provided with the shutter 21.

[0085] The shutter 21 adjusts the size of an open area of an internal passage of the suction pipe 20. By adjusting the size of the open area of the internal passage of the suction pipe 20, when a yarn end of a yarn Y (an upper yarn YU) wound into a package P is caught through the suction mouth 8a, the shutter 21 controls suction force acting on the package P to fluctuate.

[0086] Fig. 11 is an exploded view illustrating a structure of the shutter 21. Further, the arrows in Fig. 11 indicate a swing direction of a control plate 21b and airflow sucked through the suction mouth 8a.

[0087] The shutter 21 is formed such that one passage hole 21a and the other passage hole 21a connected to each other through the suction pipe 20 can be opened and closed by the control plate 21b. The control plate 21b is swung by a motor (not illustrated in the drawings) such as a stepping motor.

[0088] Accordingly, when the control plate 21b is swung in a holes opening direction in order to increase the size of the open area of the internal passage of the suction pipe 20, suction force of the suction mouth 8a is increased. Meanwhile, when the control plate 21b is swung in a hole closing direction in order to decrease the size of the open area of the internal passage of the suction pipe 20, the suction force of the suction mouth 8a is decreased.

[0089] As described above, in the present embodiment, a vibration generating device 50 for controlling suction force of the suction mouth 8a to fluctuate includes the shutter 21 (refer to Fig. 10). Further, the vibration generating device 50 functions as a suction airflow amount fluctuation mechanism 80 that controls the suction force of the suction mouth 8a to fluctuate (refer to Fig. 10).

[0090] When catching a yarn end of a yarn Y (an upper yarn YU) wound into a package P, such a structure allows suction force acting on the package P to fluctuate. Accordingly, even when hairiness of the yarn Y is entangled by winding the yarn Y into the package P, by applying impact caused by a suction function with fluctuation amplitude to the surface of the package P in the suction position in which suction force acting on the surface of the package P is applied through the suction mouth 8a and then the yarn end of the yarn Y wound into the package P is sucked through the suction mouth 8a, the yarn end of the yarn Y can be effectively moved up to the surface of the package P. Consequently, the yarn end of the yarn Y can be caught with high accuracy.

[0091] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope

of the present invention.

Claims

1. A yarn winding device (100, 200) that winds a yarn (Y) fed from a yarn supplying bobbin (1) to form a package (P) comprising a yarn end catching device (70) that catches a yarn end of the yarn (Y) wound into the package (P) and then pulls out the yarn (Y) from the package (P) and comprises
 - a suction arm (8) that swings by catching the yarn end of the yarn (Y) wound into the package (P) through a suction mouth (8a) formed at a leading end of the suction arm (8) so that the yarn (Y) is pulled out from the package (P) by moving the suction mouth (8a) closer to or away from the package (P) ; and
 - a negative-pressure device (31) that generates negative pressure for sucking the yarn end of the yarn (Y) wound into the package (P) through the suction mouth (8a); **characterised in that** the yarn end catching device (70) furthermore comprises:
 - a suction force fluctuation mechanism (60, 80) that controls suction force of the suction mouth (8a) to fluctuate, wherein in a suction position in which suction force acting on the surface of the package (P) is applied through the suction mouth (8a) and then the yarn end of the yarn (Y) wound into the package (P) is sucked through the suction mouth (8a), the suction force acting on the surface of the package (P) through the suction mouth (8a) is controlled to fluctuate.
2. The yarn winding device (100) according to claim 1, **characterized in that** in the suction position in which suction force acting on the surface of the package (P) is applied through the suction mouth (8a) and then the yarn end of the yarn (Y) wound into the package (P) is sucked through the suction mouth (8a), the suction force fluctuation mechanism (60) is a vibration generating device (50) that controls the suction force acting on the surface of the package (P) through the suction mouth (8a) to fluctuate by restricting the suction arm (8) so as to vibrate the suction arm (8).
3. The yarn winding device (100) according to claim 2, **characterized in that** the vibration generating device (50) includes a stepping motor (12) that swings the suction arm (8) while being synchronized with a pulse signal; a stopper (10d) that restricts swinging movement of the suction arm (8) to a side of the package (P) ; and a control device (40) that controls the suction force acting on the surface of the package (P) through the suction mouth (8a) to fluctuate by driving the stepping motor (12) and vibrating the suction arm (8) so as to swing the suction arm (8) to the

side of the package (P) even after the suction arm (8) has made contact with the stopper (10d).

4. The yarn winding device (100) according to claim 3, **characterized in that** an output gear (13) is mounted on an output shaft (12d) of the stepping motor (12), an input gear (14) is mounted on the suction arm (8), and the output gear (13) is connected to the input gear (14) via a power transmitting belt (15). 5
5. The yarn winding device (100) according to claim 4, **characterized by** further comprising a cradle (10a) that swings in accordance with the diameter of a package (P) and a cam (10c) that is rotated by the swung cradle (10a), wherein the stopper (10d) is moved by the cam (10c). 10 15
6. The yarn winding device (100) according to any one of claim 3 through claim 5, **characterized in that** the control device (40) controls the suction arm (8) to swing at high speed immediately after the suction arm (8) starts to swing upward, and controls the suction arm (8) to swing at low speed immediately before the suction arm (8) makes contact with the stopper (10d). 20 25
7. The yarn winding device (100) according to any one of claim 3 through claim 5, **characterized in that** the control device (40) controls the suction arm (8) to swing upward and makes the suction arm (8) to come into contact with the stopper (10d) while controlling a swing speed of the suction arm 8 to be gradually decreased. 30
8. The yarn winding device (100) according to claim 3, **characterized in that** the control device (40) controls the stepping motor (12) to be out of synchronization in order to vibrate the suction arm (8), and controls suction force acting on the surface of the package (P) through the suction mouth (8a) to fluctuate. 35 40
9. The yarn winding device (200) according to claim 1, **characterized in that** in the suction position in which suction force acting on the surface of the package (P) is applied through the suction mouth (8a) and then the yarn end of the yarn (Y) wound into the package (P) is sucked through the suction mouth (8a), the suction force fluctuation mechanism (60, 80) is a suction airflow amount changing mechanism (80) that controls an amount of airflow to be sucked through the suction mouth (8a) acting on the surface of the package (P) to fluctuate. 45 50
10. The yarn winding device (200) according to claim 9, **characterized in that** the suction airflow amount fluctuation mechanism (80) is a shutter (21) that is formed such that the size of an open area of an in-

ternal passage of a suction pipe (20) coupled to the suction arm (8) from the negative-pressure device (31) fluctuates,

characterized in that the shutter (21) is formed such that suction force acting on the surface of the package (P) through the suction mouth (8a) fluctuates by increasing or decreasing the size of the open area of the internal passage of the suction pipe (20).

FIG. 1

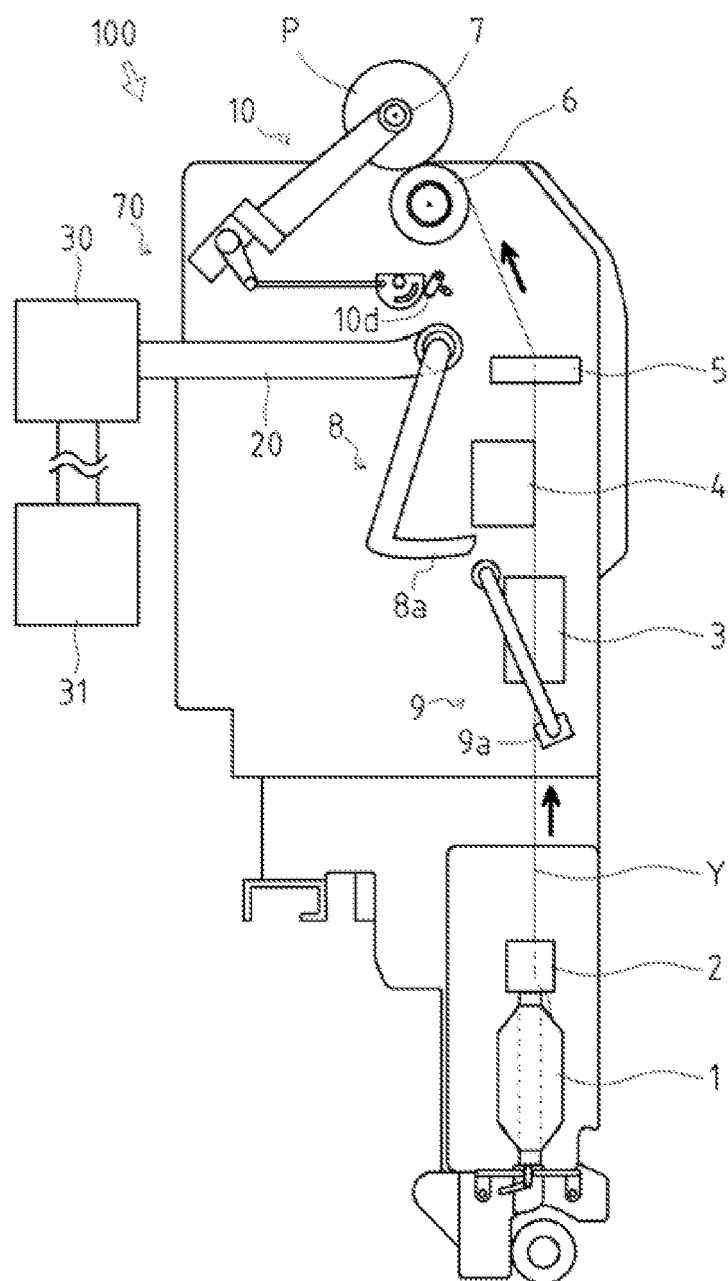


FIG. 2

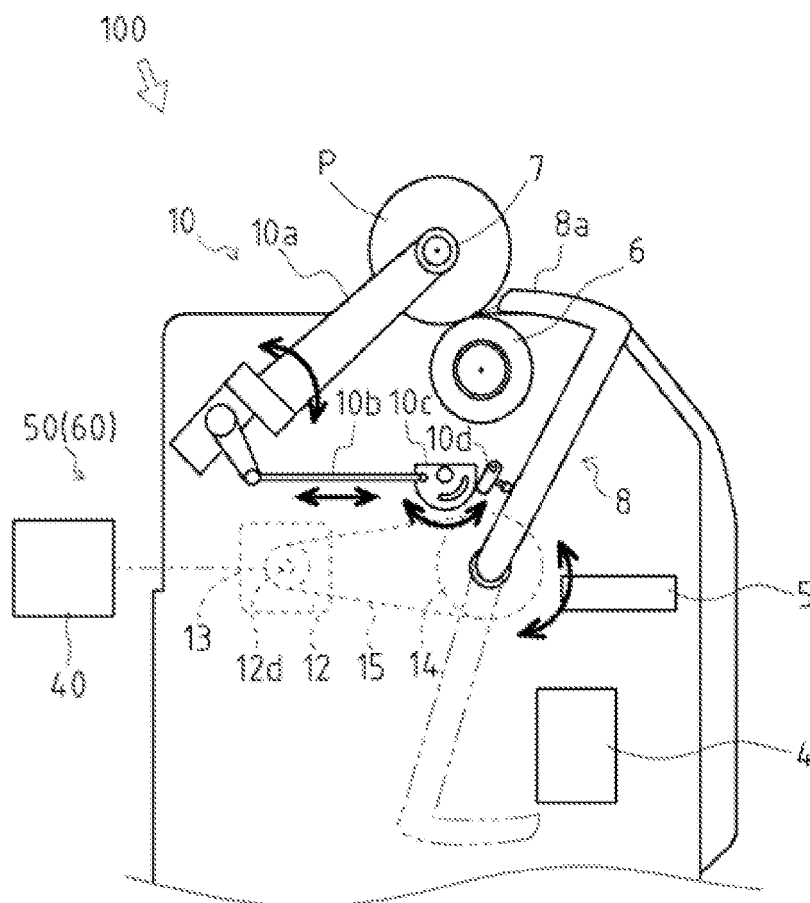


FIG. 3

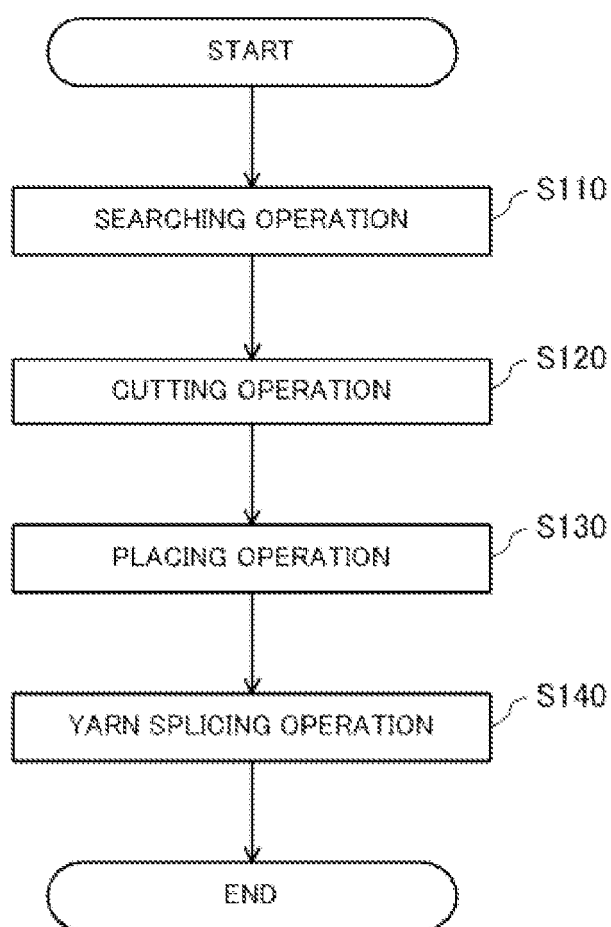


FIG. 4

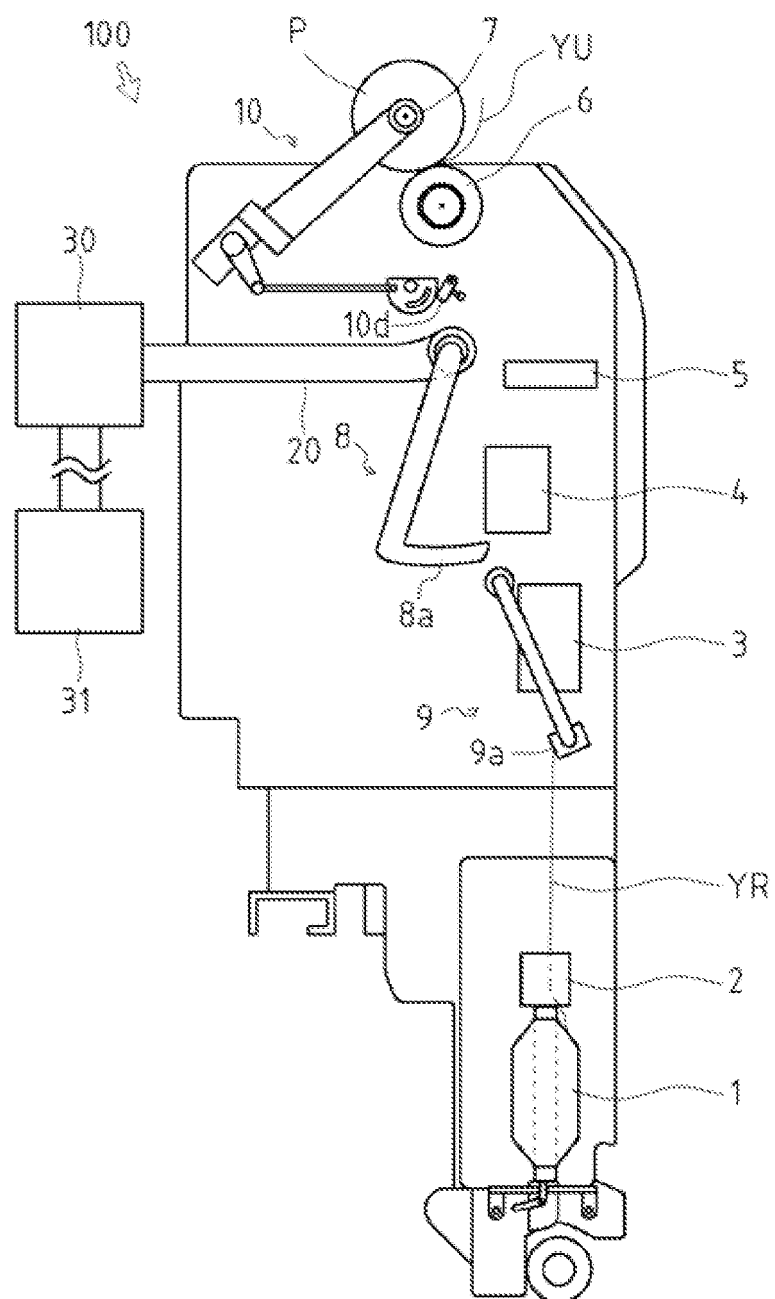


FIG. 5

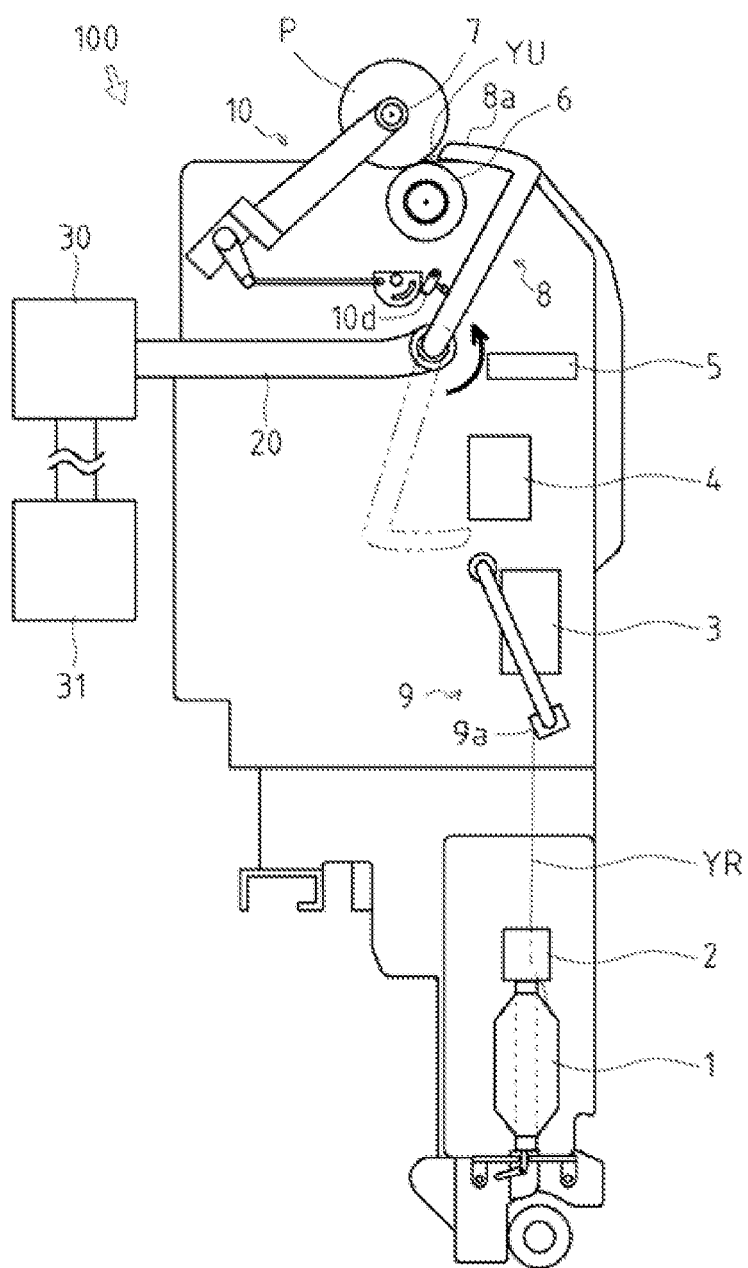


FIG. 6

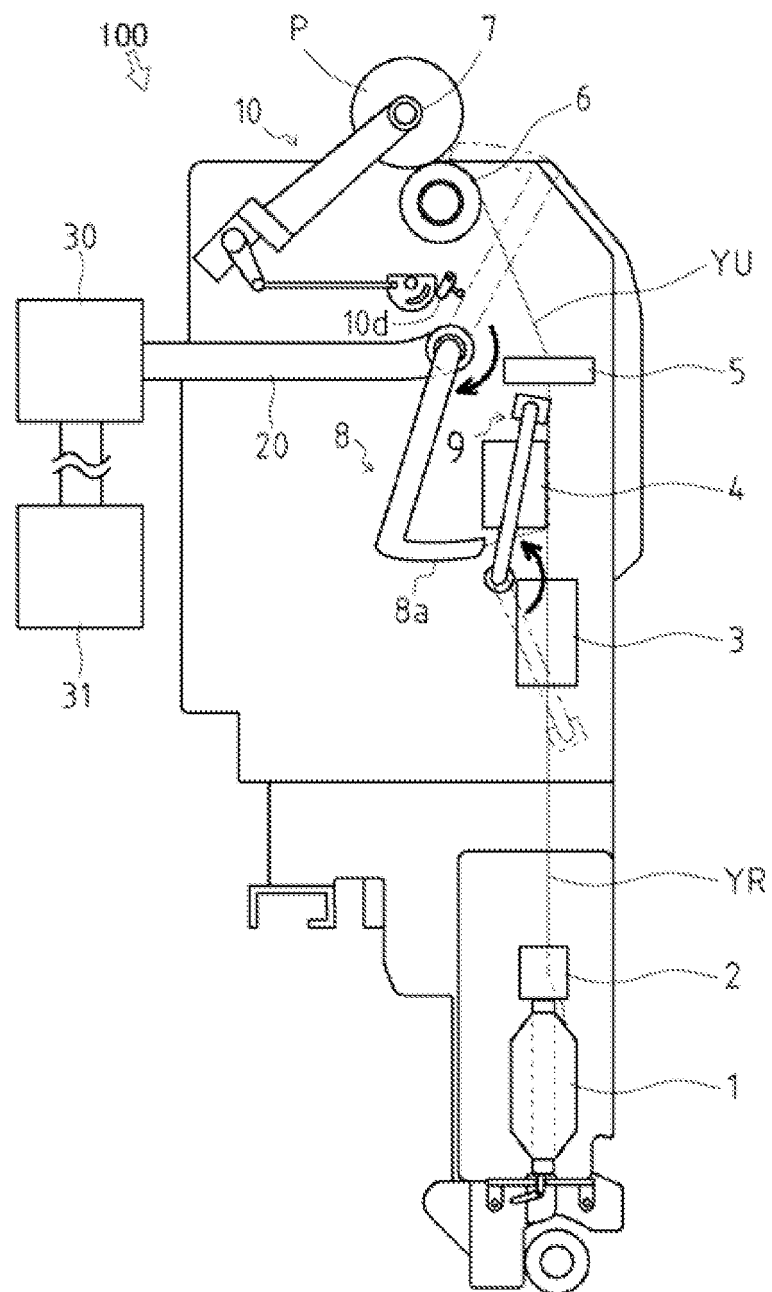


FIG. 7

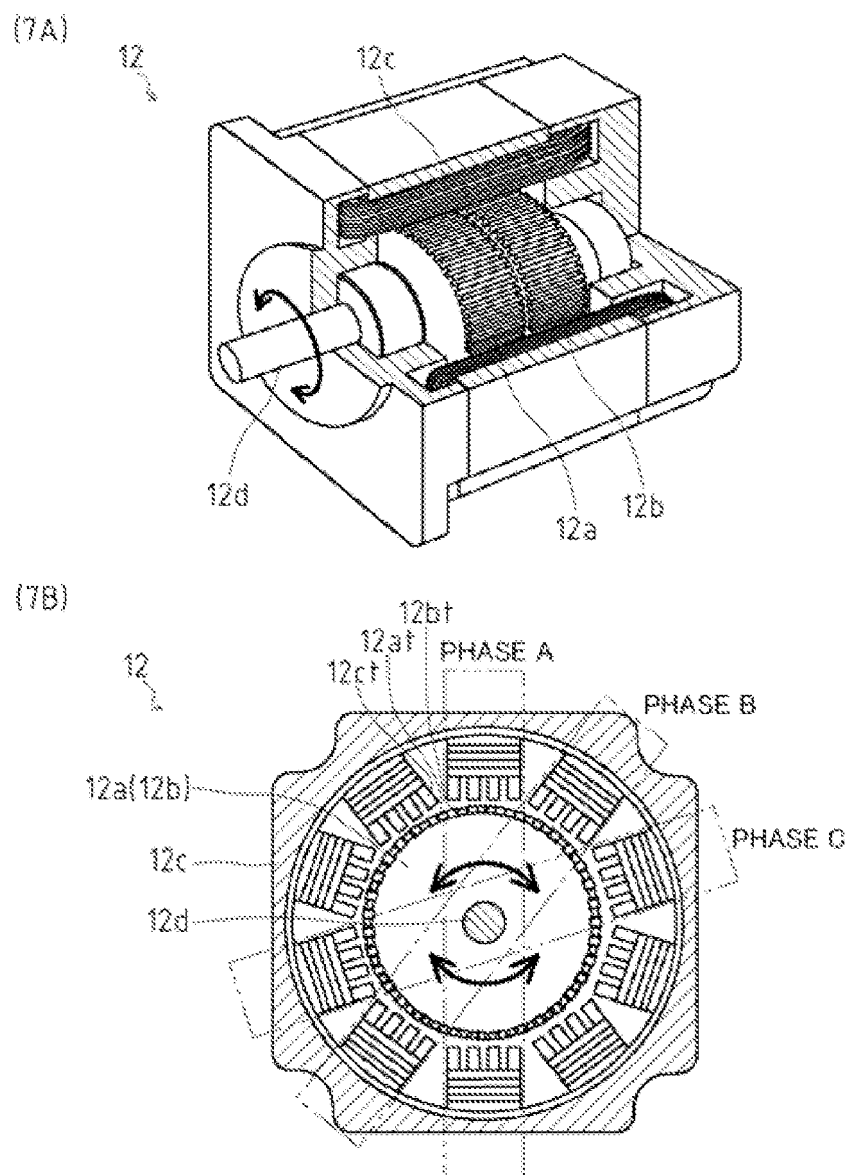
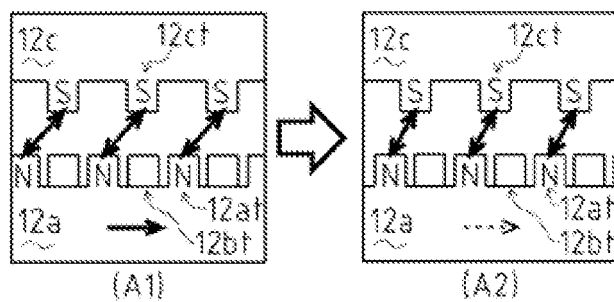
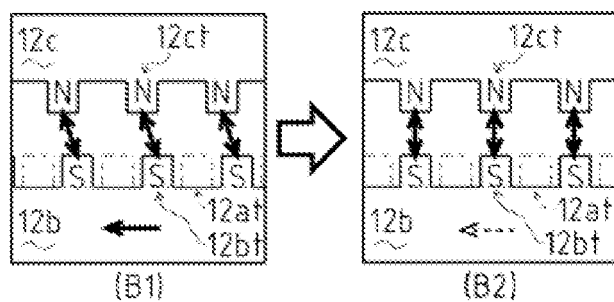


FIG. 8

(8A)



(8B)



(8C)

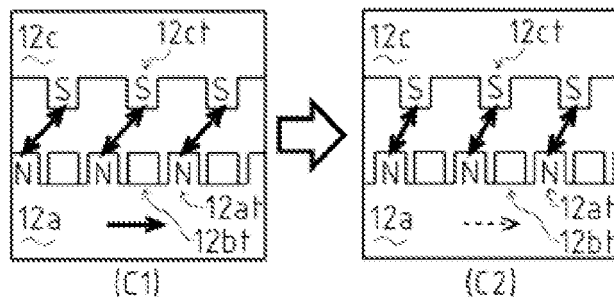


FIG. 9

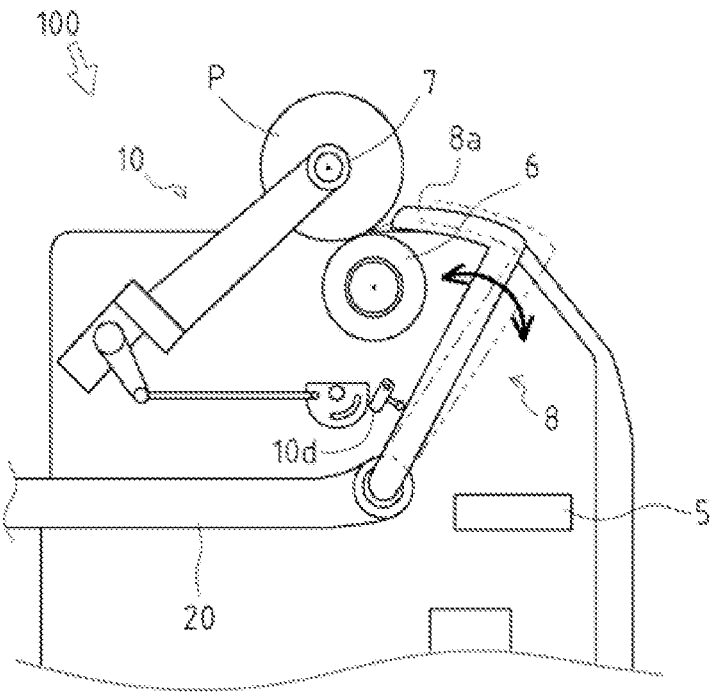


FIG. 10

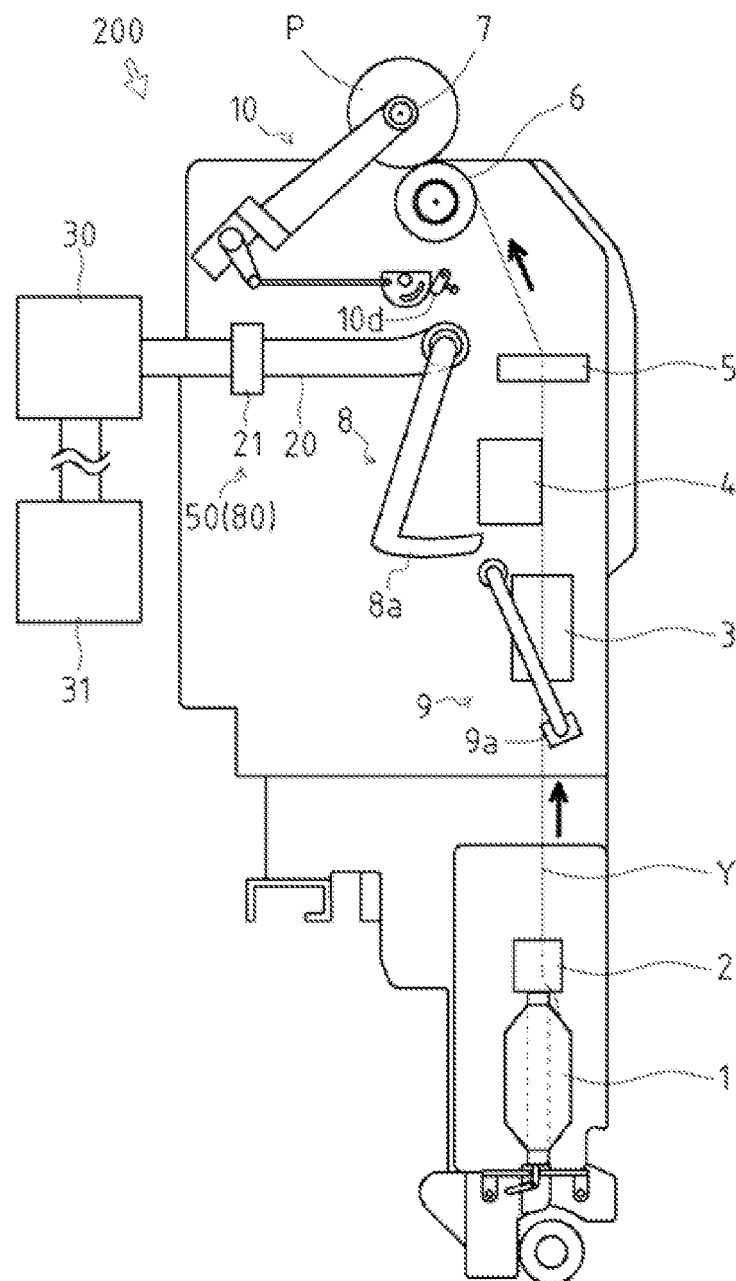
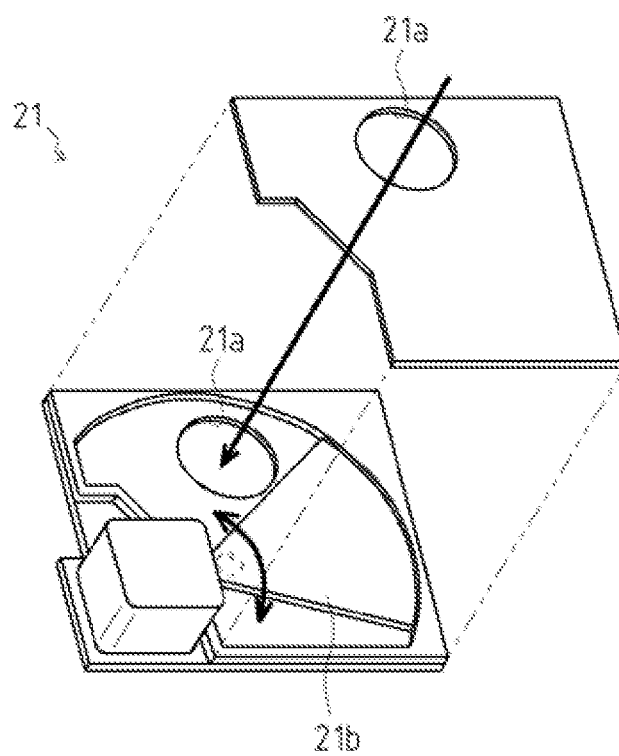


FIG. 11



REFERENCES CITED IN THE DESCRIPTION

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