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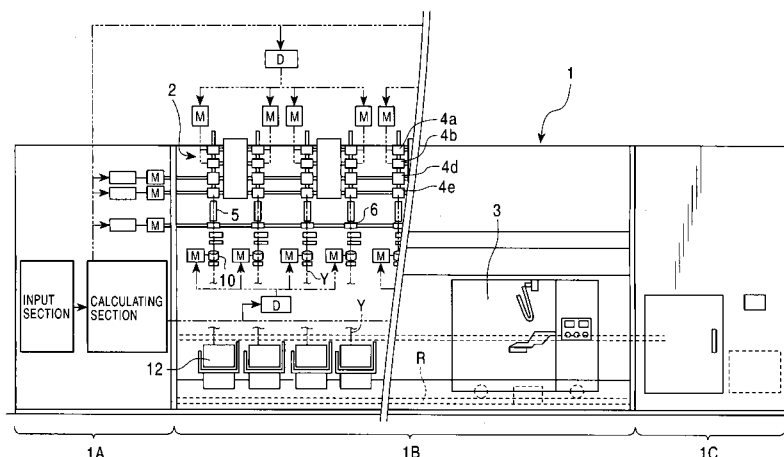
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(54) **Tension control and slack eliminating device for a yarn winder**

(57) The present invention stabilizes a yarn tension in a yarn winder in which a plurality of winding units are disposed, each of the winding units being provided with a yarn slack eliminating device. A transmitted force adjusting mechanism is provided to adjust a rotative driving force transmitted by a slack eliminating roller 21 of a yarn slack eliminating device 10 to an unwinding tension applying member 22. The transmitted force adjusting mechanism can be set so that when a load acting on the unwinding tension applying member 22 increases above a predetermined value, the unwinding tension

applying member 22 rotates or rotatively moves independently of the slack eliminating roller 21. When winding tension is weak, the unwinding tension applying member 22 rotates integrally with the slack eliminating roller 21 to tense a yarn. When the winding tension exceeds a predetermined value, the unwinding tension applying member 22 prevents the winding tension from becoming excessive to suppress a variation in tension. When the transmitted force adjusting mechanism is configured so as to vary the force transmitted to the unwinding tension applying member, it is easy to deal with spinning conditions (Fig.4).

FIG. 1



Description

Field of the Invention

[0001] The present invention relates to a yarn winder having a yarn slack eliminating device provided between a yarn supply side and a winding device to eliminate the slack of a yarn, and more specifically, to a yarn winder utilizing the yarn slack eliminating device to, for example, wind a slacking yarn that may occur during a yarn splicing operation, adjust a winding tension when a winding operation is restarted after a yarn splicing operation, and suppress a variation in the winding tension during a normal winding process.

Background of the Invention

[0002] With a spinning machine (for example, a pneumatic spinning machine) that uses a sliver (a bundle of fibers) as a material to generate a spun yarn and then winds the yarn into a predetermined package, if a yarn defect is detected, the yarn defect portion is cut by a cutter and removed. Then, a yarn splicing device splices the leading end of a yarn successively fed by a spinning device acting as a yarn supply side, to a yarn end of a package side. The yarn splicing operation is performed while winding of the yarn remains stopped. Accordingly, to eliminate the slack of the yarn successively fed by the spinning device, means may be employed which sucks the excessive part of the yarn using a suction tube called a slack tube as described in, for example, the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 2001-159039. However, the recent increase in spinning speed contributes to increasing the amount of yarn slack. Thus, it becomes more and more difficult to deal with an increased amount of yarn slack using the above described suction tube system. Another problem with the suction tube system is that since a yarn is pulled using only suction air based on a negative pressure, it is difficult to sufficiently tense the yarn during yarn slack elimination.

[0003] Thus, instead of the suction tube system, a roller type yarn storage device (yarn slack eliminating device) such as the one described in the Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272 has been proposed which eliminates yarn slack by temporarily winding a yarn fed by a spinning device around a storage roller (slack eliminating roller). The yarn storage device is loaded, together with a yarn binding device (yarn splicing device), on a maintenance device (work carriage) that can run along a spinning machine. Furthermore, the yarn storage device is provided with a return element composed of a yarn return ring, in addition to the storage roller. The return element has a function of guiding the introduction of a yarn when it is wound around the storage roller during yarn splicing, and guiding the yarn to a winding package while applying a certain amount of unwinding tension to the yarn

when the yarn is unwound from the storage roller after the yarn has restarted to be wound into a package.

[0004] In addition to yarn slack elimination during the yarn splicing operation, the yarn slack eliminating device may be used for adjustment of a yarn tension during a normal winding process. This involves a technique such as the one as described in, for example, Western Germany Patent No. 2553892. According to this technique, a yarn slack eliminating device is provided between a spinning device and a winding device and comprises a slack eliminating roller around which a yarn is wound. Then, the amount of slack on the slack eliminating roller is increased or reduced in accordance with a variation in the speed at which the yarn is wound into a package, to absorb a variation in tension (winding speed). Specifically, a variation in yarn tension (winding speed) can be absorbed by reducing the amount of slack on the slack eliminating roller when the yarn winding speed exceeds a spinning speed, while increasing the amount of slack when the yarn winding speed decreases below the spinning speed. For example, if a cone package is to be formed, this technique is expected to suppress a periodic variation in yarn tension which may be caused by a difference in yarn winding speed (the peripheral speed of the package) between the smaller diameter side and large diameter side of the package, which difference causes the amount of slack to increase on the smaller diameter side with a lower winding speed, while decreasing on the larger diameter side with a higher winding speed.

[0005] A first problem will be described. With the technique in the Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272, when a yarn is unwound from the storage roller after winding has been restarted, the return element of the yarn storage device is expected to contact with the yarn to tense it. Thus, the Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272 describes the adjustment of the unwinding tension executed by the return element. However, the yarn storage device is loaded on the maintenance device together with the yarn binding device. Thus, if the spinning machine has a plurality of spinning units arranged in line, it is not always possible to use an arbitrary spinning unit to wind the yarn around the yarn storage device for tension adjustment. Specifically, it is assumed that a yarn splicing operation is being performed on one of the spinning units of the spinning machine to which the maintenance device has been moved. Then, if a yarn splicing operation is requested by another spinning unit, the maintenance device must be moved to this spinning unit as quickly as possible. Thus, the spinning unit on which yarn splicing is being executed must complete the yarn splicing operation and then finish unwinding of the yarn from the storage roller as quickly as possible, the storage roller eliminating the yarn slack. To increase the unwinding speed, means for adjusting the unwinding tension must be used to preset the resistance of the return element to the yarn, at a

small value. However, this disadvantageously forces a decrease in the yarn tension between the return element and the winding package, that is, the winding tension, during yarn unwinding compared to the winding tension during normal winding.

[0006] On the other hand, Western Germany Patent No. 2553892 does not describe any means for adjusting the unwinding tension of the yarn unwound from the slack eliminating roller. That is, Western Germany Patent No. 2553892 does not disclose any means that can easily deal with a change in spinning conditions such as yarn type, yarn number, spinning speed, or the like. Accordingly, the technique in Western Germany Patent No. 2553892 cannot correct the unwinding tension or winding tension of the yarn when any of the spinning conditions is changed. As a result, the yarn may be wound into an inappropriate package. Moreover, for the spinning machine described in Western Germany Patent No. 2553892, the slack eliminating device uses a complicated structure for a yarn threading operation. Thus, a separate tenser for adjusting tension is required and the number of parts required may increase. Another disadvantage of this spinning machine is a yarn path configuration in which the yarn contacts with relevant parts at a large number of positions.

[0007] Second, a spinning machine (for example, a pneumatic spinning machine) uses a sliver (a bundle of fibers) as a material to generate a spun yarn and winds the yarn into a predetermined package, using a yarn winder in which a plurality of winding units are disposed and which comprises a yarn slack eliminating device that eliminates yarn slack that may occur between a spinning device acting as a yarn supply side and a winding device. With this spinning machine, if a yarn defect is detected, the yarn defect portion is cut and removed using a cutter. Then, a yarn splicing device splices the leading end of a yarn successively fed by the spinning device, to a yarn end of a package side. The yarn splicing operation is performed while winding of the yarn remains stopped.

[0008] Accordingly, to eliminate the slack of the yarn successively fed by the spinning device, means may be employed which sucks the excessive part of the yarn using a suction tube called a slack tube as described in, for example, the Unexamined Japanese Patent Application Publication (Tokkai-Hei) No. 2001-159039. However, the recent increase in spinning speed contributes to increasing the amount of yarn slack. Thus, it becomes more and more difficult to deal with an increased amount of yarn slack using the above described suction tube system. Another problem with the suction tube system is that since a yarn is pulled using only suction air based on a negative pressure, it is difficult to sufficiently tense the yarn during yarn slack elimination.

[0009] Thus, instead of the suction tube system, a roller type yarn storage device (yarn slack eliminating device) such as the one described in the Examined Japanese Patent Application Publication (Tokkou-Hei) No.

4-13272 has been proposed which eliminates yarn slack by temporarily winding a yarn fed by a spinning device around a storage roller (slack eliminating roller). The yarn storage device is loaded, together with a yarn binding device (yarn splicing device), on a maintenance device (work carriage) that can run along a spinning machine. Furthermore, the yarn storage device is provided with a return element composed of a yarn return ring, in addition to the storage roller. The return element has a function of guiding the introduction of a yarn when it is wound around the storage roller during yarn splicing, and guiding the yarn to a winding package while applying a certain amount of unwinding tension to the yarn when the yarn is unwound from the storage roller after the yarn has restarted to be wound into a package.

[0010] As a second problem, with the technique described in the Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272, the yarn storage device is loaded on the maintenance device together with the yarn binding device. It is assumed that a yarn splicing operation is being performed with one of the spinning units of the spinning machine to which the maintenance device has been moved. Then, if a yarn splicing operation is requested by another spinning unit, then the maintenance device cannot move to this spinning unit unless the spinning unit in which yarn splicing is being executed completes the yarn splicing operation and then finish unwinding of the yarn from the storage roller eliminating the yarn slack. Consequently, the time required to perform the yarn splicing operation directly affects the time required for the spinning operation. Thus, disadvantageously, a delay in yarn splicing operation may delay the entire spinning operation.

[0011] Thus, with the yarn storage device described in Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272, to increase the speed at which the yarn is unwound from the storage roller after yarn splicing has been completed, it is contemplated that the resistance of the return element, which guides yarn unwinding, to the yarn may be reduced. However, in this case, the yarn tension between the return element and the winding package, that is, the winding tension, during yarn unwinding becomes much smaller than that applied during regular winding. This results in a difference in winding tension between yarn unwinding and normal winding. This difference may reduce the winding tension when the yarn unwound from the storage roller is wound into a winding package. As a result, a non-uniform winding package may be obtained, and steps may be formed on the end surface of the package owing to a variation in the magnitude of the tension.

Summary of the Invention

[0012] According to the present invention, a yarn winder set forth in Claim 1 is employed to solve the conventional first problem. That is, the present invention provides a yarn winder in which a plurality of winding units

are disposed, each of the winding units being provided with a yarn slack eliminating device, the yarn winder being characterized in that the yarn slack eliminating device comprises a rotatively driven slack eliminating roller, an unwinding tension applying member that can be rotated concentrically with the slack eliminating roller, and a transmitted force adjusting mechanism provided between the slack eliminating roller and the unwinding tension applying member, and the transmitted force adjusting mechanism transmits rotative driving from the slack eliminating roller to the unwinding tension applying member so that the unwinding tension applying member rotates integrally with the slack eliminating roller when a load of a magnitude equal to or smaller than a predetermined value acts on the unwinding tension applying member, while the unwinding tension applying member rotates or rotatively moves independently of the slack eliminating roller when a load of a magnitude larger than the predetermined value acts on the unwinding tension applying member, the transmitted force adjusting mechanism being capable of adjusting the magnitude of the transmitted force.

[0013] The yarn winder according to the present invention has the transmitted force adjusting mechanism arranged between the slack eliminating roller and the unwinding tension applying member. This enables an appropriate winding tension to be easily maintained. Specifically, since only a light load acts on the unwinding tension applying member when the winding tension is weak, the unwinding tension applying member functions to apply a tension while rotating integrally with the slack eliminating roller to wind the yarn. When the winding tension increases to make the load acting on the unwinding tension applying member exceed a predetermined value, the unwinding tension applying member rotatively moves or rotates independently of the slack eliminating roller. This permits the yarn to be unwound to prevent the winding tension from becoming excessive. Accordingly, by applying the present invention to yarn slack that may occur during a yarn splicing operation, it is possible to adjust, after yarn splicing has been finished, the tension applied while the yarn is unwound from the slack eliminating roller, to an appropriate magnitude. That is, the tension can be made almost equal to that applied during regular winding. Consequently, excellent cone packaged can be easily obtained. Alternatively, if the present invention is utilized to manufacture, for example, cone packages, it is possible to suppress a variation in the tension of the yarn obtained when the yarn is unwound from or wound around the slack eliminating roller, by increasing or reducing the amount of yarn wound around the slack eliminating roller in association with a variation in winding speed caused by an inconstant winding radius in an axial direction.

[0014] Furthermore, the present invention does not require any tensers for adjusting tension. Advantageously, it is thus possible to reduce the number of parts required as well as the area of relevant parts with which

the yarn contacts. Moreover, a yarn threading operation can be performed using a simple structure. The transmitted force adjusting mechanism is configured to adjust a force transmitted to the unwinding tension applying member. This makes it possible to deal easily with a change in yarn unwinding tension and winding tension associated with winding conditions such as yarn type, yarn number, and spinning speed. This is advantageous in manufacturing various products.

[0015] As set forth in Claim 2, the transmitted force adjusting mechanism is provided in a junction between the slack eliminating roller and the unwinding tension applying member and has a transmitted force adjustment operating section that sets the magnitude of the transmitted force, and the transmitted force adjustment operating member is exposed so as to be externally operated. Then, if the yarn unwinding tension value is changed or adjusted in association with the previously described winding conditions, an operator can easily perform an adjusting operation.

[0016] As set forth in Claim 3, a leading end of the transmitted force adjusting mechanism is located closer to a proximal end of the slack eliminating roller than to a plane formed by a locus of a yarn unwound from the slack eliminating roller. In this case, the yarn unwound from the slack eliminating roller is unlikely to interfere or contact with the adjusting mechanism. This makes it possible to prevent the yarn from being degraded.

[0017] Moreover, as set forth in Claim 4, the leading end of the transmitted force adjusting mechanism is located between a leading end surface and the proximal end of the slack eliminating roller. In this case, it is possible to more reliably prevent the yarn unwound from the slack eliminating roller from interfering with the adjusting mechanism.

[0018] The present invention provides means that can solve the previously described conventional second problem. That is, the present invention provides a yarn winder in which a plurality of winding units are disposed and which is configured so that a work carriage comprising a yarn splicing device can be moved among the winding units, the yarn winder being characterized in that each of the winding units is provided with a yarn slack eliminating device having a slack eliminating roller around which a slacking yarn resulting from splicing is wound and an unwinding tension applying member that operates when the yarn wound around the slack eliminating roller is unwound, to apply a predetermined unwinding tension to the yarn (Claim 5).

[0019] With this arrangement, once a yarn splicing operation is completed on a winding unit that requires yarn splicing, the work carriage can be moved to another winding unit while the yarn slack eliminating device of the first winding unit is unwinding the yarn. Consequently, if a yarn splicing operation is consecutively performed on a plurality of winding units, it is possible to reduce the time for which the work carriage remains stopped per winding unit. This improves the operating efficiency

of the winder. Furthermore, a more time can be used to unwind the yarn wound around the slack eliminating roller of the yarn slack eliminating device. An appropriate tension can thus be easily applied to the yarn being unwound. Specifically, the tension during unwinding can be made equal to or close to that during regular winding. Therefore, properly wound yarn packages can be reliably obtained.

[0020] In this yarn winder, the unwinding tension applying member is desirably provided with an unwinding tension adjusting mechanism that can preset the magnitude of an unwinding tension applied to the yarn unwound from the slack eliminating roller (Claim 6). With the unwinding tension adjusting mechanism, the tension applied when the yarn is unwound from the slack eliminating roller can be preset or pre-adjusted in accordance with the winding conditions such as the yarn type and the yarn number.

[0021] Furthermore, it is contemplated that the tensioning force applying member may also function as a yarn guiding member that introduces a yarn into the slack eliminating roller. In this case, the number of the parts of the yarn slack eliminating device can advantageously be reduced to simplify the configuration (Claim 7).

[0022] It is further contemplated that the work carriage may be set to move to the position of a winding unit on the basis of a yarn splicing request signal outputted by the winding unit and so that when the work carriage arrives at the position of the winding unit, the slack eliminating roller starts to rotate on the basis of an arrival sensing signal (Claim 8). This arrangement enables the operation of the slack eliminating roller of the yarn slack eliminating device to be reliably linked with the operation of the work carrier.

[0023] Desirably, in this yarn winder, each slack eliminating roller comprises driving means so as to be rotatively driven independently (Claim 9). This arrangement enables different yarn slack eliminating operations to be independently performed on the respective winding units.

[0024] It is further contemplated that an arrangement may be employed in which after a yarn wound around the slack eliminating roller has been completely unwound, the unwinding tension applying member is moved to a position where it does not engage with the yarn (Claim 10). This makes it possible to prevent the unwinding tension applying member from contacting with or rubbing against the yarn being regularly wound after unwinding. It is therefore possible to avoid affecting yarn quality after winding has been restarted.

Brief Description of the Drawings

[0025]

Figure 1 is a front view showing a spinning machine according to a first embodiment of the present in-

vention.

Figure 2 is a front sectional view schematically showing the structure of essential parts of the first embodiment.

Figure 3 is a side view schematically showing the configuration of a spinning unit and a work carrier during normal winding according to the first embodiment.

Figure 4 is an enlarged side view of a yarn slack eliminating device section during normal winding according to the first embodiment.

Figure 5 is an enlarged front view of the yarn slack eliminating device section during normal winding according to the first embodiment.

Figure 6 is a side view schematically showing the configuration of the spinning unit and the work carrier immediately before the start of a yarn splicing operation according to the first embodiment.

Figure 7 is a side view schematically showing the configuration of the spinning unit and the work carrier upon the start of the yarn splicing operation according to the first embodiment.

Figure 8 is an enlarged side view schematically showing the configuration of the yarn slack eliminating device section upon the start of the yarn splicing operation according to the first embodiment.

Figure 9 is a side view schematically showing the configuration of the spinning unit and the work carrier during the yarn splicing operation according to the first embodiment.

Figure 10 is an enlarged side view schematically showing the configuration of the yarn slack eliminating device section during the yarn splicing operation according to the first embodiment.

Figure 11 is an enlarged front view schematically showing the configuration of the yarn slack eliminating device section upon the start of the yarn splicing operation according to the first embodiment.

Figure 12 is a side view schematically showing the configuration of the yarn slack eliminating device section after the yarn splicing and immediately before the restart of a winding operation according to the first embodiment.

Figure 13 is a time chart showing operations of a tension arm and a cradle arm performed after the yarn splicing and before the restart of the winding operation according to the first embodiment.

Figure 14 is a side view schematically showing the configuration of the spinning unit and the work carrier after the restart of the winding according to the first embodiment.

Figure 15 shows the first embodiment wherein Figure 15A is an enlarged side view schematically showing the configuration of the yarn slack eliminating device immediately after unwinding of the yarn from the roller following the restart of the winding operation, Figure 15B is a front view showing the slack eliminating roller in the same state as viewed

from its leading end, Figure 15C is an enlarged side view showing the configuration of the yarn slack eliminating device after reverse rotation of the slack eliminating roller executed after Figures 15A and 15B to avoid engaging with the yarn, and Figure 15D is a front view showing the slack eliminating roller in the same state as viewed from its leading end.

Figure 16 is a perspective view showing an example of a slack eliminating roller utilized in the yarn slack eliminating device according to the first embodiment as viewed from its leading end.

Figure 17 shows the example of the slack eliminating roller utilized in the yarn slack eliminating device according to the first embodiment wherein Figure 17A is a front view as viewed from the leading end of the slack eliminating roller and Figure 17B is a plan view.

Figure 18 is a side sectional view showing the example of the slack eliminating roller utilized in the yarn slack eliminating device according to the first embodiment.

Figure 19 shows the example of the slack eliminating roller of the yarn slack eliminating device according to the first embodiment wherein Figure 19A is an enlarged front view showing the upper half of the slack eliminating roller as viewed from its leading end and Figure 19B is an enlarged side sectional view showing the upper half of the slack eliminating roller.

Figure 20 is an enlarged front view schematically showing the configuration of a yarn slack eliminating device section according to a second embodiment.

Figure 21 is a side view schematically showing the configuration of a spinning unit and a work carrier of a spinning machine according to a fourth embodiment.

Figure 22 is a side view schematically showing the configuration of the spinning unit and work carrier of the spinning machine according to the fourth embodiment, wherein a process of reducing a winding speed is executed.

Figure 23 shows a slack eliminating roller and a yarn tension detecting device utilized in the yarn slack eliminating device according to the fourth embodiment of the present invention, wherein Figure 23A is a front view as viewed from the leading end of the slack eliminating roller and yarn tension detecting device and Figure 23B is a plan view.

Figure 24 is a side sectional view showing the slack eliminating roller and yarn tension detecting device utilized in the yarn slack eliminating device according to the fourth embodiment of the present invention.

Figure 25 is a bottom view showing a yarn breakage sensor provided on a bottom surface of a downstream side guide.

Figure 26 is a side sectional view showing a slack eliminating roller according to a seventh embodiment of the present invention.

5 Detailed Description of the Preferred Embodiments

[0026] With reference to the drawings, a description will be given of embodiments of a spinning machine according to the present invention. In the specification, the terms "upstream" and "downstream" are based on a direction in which a yarn runs during spinning. Specifically, the upstream side corresponds to a spinning device, while the downstream side corresponds to a winding device.

15 [First Embodiment]

[0027] Figure 1 is a front view showing an example of a spinning machine 1 to which the present invention is applied. Figure 2 is an enlarged view schematically showing the internal structure of a part of the spinning machine 1. The spinning machine 1 is composed of, for example, a pneumatic spinning machine. Main constituent members of the spinning machine 1 include a control section 1A, a spinning section 1B in which a large number of spinning units 2 are arranged in line, a blower section 1C, and a work carriage 3 comprising a yarn splicing device and adapted to run freely along a rail R between the spinning units 2.

[0028] The control section 1A controls the operations of driving motors 31, 32, 33 for driving shafts 41, 42, 43 that exert a driving force on all the spinning units 2 constituting the spinning section 1B, the operations of motors 34, 35 provided for each spinning unit 2, the operation of a winding device 12, and the like. In the present embodiment, on the basis of various set values (a spinning speed, the ratio of the spinning speed to a winding roller speed, and the like) inputted to an input section (a), a calculating section (b) outputs spinning speed information to the motors 31 ~ 34 via an inverter (c) or a driver substrate 30. Furthermore, rotation speed information on a slack eliminating roller (described later) is outputted to the motor 35 of the yarn slack eliminating device 10 via a driver substrate 40.

[0029] The spinning section 1B is composed of the large number of spinning units 2 arranged in line. Each of the spinning units 2 is configured to be independently controlled. The spinning machine 1 according to the present invention is characterized in that in addition to a spinning device 5 and a winding device 12, a yarn slack eliminating device 10 is provided for each spinning unit 2. The structure of the spinning unit 2 will be described later in detail.

[0030] The blower section 1C houses negative pressure supplying means for providing a negative pressure (suction pressure) to a desired position of the spinning unit 2 through an air duct. The negative pressure is allowed to act on a yarn sucking device 7 or the like.

[0031] On the basis of a yarn splicing request signal transmitted by an arbitrary spinning unit 2 that requires yarn splicing, the work carriage 3 runs on the rail R to the position of this spinning unit 2. Then, the work carriage 3 is stopped. As shown Figure 3 that is a side sectional view schematically illustrating the configuration of the spinning section 1B, the work carriage 3 comprises a yarn splicing device 17 such as a knotter or a splicer, a suction pipe 18 that sucks an end of a yarn formed by the spinning device 5 and guides the end to the yarn splicing device 17, a suction mouth 19 that sucks a yarn end of a package 16 supported by the winding device 12 and guides the yarn end to the yarn splicing device 17, and a tension arm 20 that contacts with and tenses a yarn Y as required (see Figure 12).

[0032] It is contemplated each spinning unit 2 is provided with the yarn splicing device 17, the suction pipe 18, and the suction mouth 19. However, when the yarn splicing device 17, the suction pipe 18, and the suction mouth 19 are loaded on the work carriage 3, which runs along the direction in which the spinning units 2 are arranged in line, this set of components enables a yarn splicing operation to be performed on all the spinning units 2. Consequently, the structure of the spinning machine 1 can be simplified.

[0033] The suction pipe 18, provided on the work carriage 3 for yarn splicing, functions as a member that sucks the spinning-side yarn end. The suction pipe 18 comprises a suction port 18a at its leading end and can be rotatively moved around a pivotal supporting section 18b. For a yarn splicing operation, the suction pipe 18 is rotatively moved upward as show by the alternate long and two short dashes line in Figure 6 to position the suction port 18a near a yarn discharge port in the spinning device 5. Then, the suction pipe 18 sucks the yarn end of the spun yarn Y and is then rotatively moved downward to its initial position shown by the solid line in the same figure while sucking the yarn. The suction pipe 18 thus guides a spinning side yarn Y1 to the yarn splicing device 17. On the other hand, the suction mouth 19 functions as a member that sucks a winding side yarn end. The suction mouth 19 comprises a suction port 19a at its leading end and can be rotatively moved around a pivotal supporting section 19b. For a yarn splicing operation, the package 16 is stopped and is then rotated in the direction opposite to the normal one. The yarn end is then sucked and caught in the suction port 19a at the leading end of the suction mouth 19 rotatively moved downward, to deliver the yarn. The suction mouth 19 is then rotatively moved upward to its initial position shown by the solid line in the same figure while sucking the yarn. The suction mouth 19 thus guides a package 16 side yarn Y2 to the yarn splicing device 17.

[0034] Now, a description will be given of the plurality of spinning units 2, arranged in the spinning section 1B. The winding unit 2 is a unit for manufacturing the yarn Y from a bundle of fibers S used as a material. As shown in Figure 3, the spinning unit 2 is composed of a draft

device 4, the spinning device 5, a yarn feeding device 6, a yarn sucking device 7, a cutter 8, a yarn defect detector 9, the yarn slack eliminating device 10, a waxing device 11, and the winding device 12. These components are arranged in this order from upstream side to downstream side of the yarn path E.

[0035] The draft device 4 is composed of four lines including, for example, a back roller 4a, a third roller 4b, a second roller 4d from which an apron 4c is extended, and a front roller 4e which are arranged in this order from the upstream side. The spinning device 5 is of, for example, a pneumatic type that utilizes whirling air currents to generate the spun yarn Y (hereinafter simply referred to as the "yarn Y") from the bundle of fibers S.

The spinning device 5 must be able to spin the yarn at a high speed of several hundred m/min. Alternatively, the spinning device 5 may be replaced with one having a different structure; the spinning device 5 may generate the yarn Y using a pneumatic spinning nozzle and a pair of twisting rollers or may be an open end spinning machine that generates the yarn Y by rotating a rotor. The yarn feeding device 6 is composed of a nip roller 6a and a delivery roller 6b to feed the yarn Y downward while sandwiching it between the rollers 6a, 6b. The yarn sucking device 7 always sucks the yarn Y, and when the yarn defect detector 9 detects a defect in the yarn Y, sucks and removes pieces of the yarn Y cut by the cutter 8.

[0036] The winding device 12 winds the yarn around a bobbin held on a cradle arm 14 to form a package 16. The winding device 12 comprises a rotating drum 13 that rotates in contact with the bobbin 15 or the package 16. The cradle arm 14 is configured to move rotatively to contact or separate the bobbin 15 or the package 16 with or from the rotating drum 13.

[0037] As shown in Figures 3 to 5, the yarn slack eliminating device 10, provided in each winding unit 2 comprises a yarn slack eliminating roller 21 that winds and retains the slacking yarn Y around an outer peripheral surface 21a (see Figure 17), an unwinding tension applying member 22 that concentrically rotates synchronously with or independently of the slack eliminating roller 21 in accordance with certain conditions, an upstream side guide 23 arranged slightly upstream of the slack eliminating roller 21, driving means 35 such as a stepping motor which rotatively drives the slack eliminating roller 21, a driver substrate 40 (see Figure 2) that controls the driving means 35, and a downstream side guide 36 provided downstream of the slack eliminating roller 21 and having a slit 36a. These components are fixed to the spinning unit 2 using a bracket 37 and the like.

[0038] As shown in Figures 16 to 18, the slack eliminating roller 21 is secured to a driving shaft 35a of the driving means 35 so as to rotate integrally with the driving shaft 35a. Accordingly, the slack eliminating roller 21 can be controllably rotated faithfully in accordance with a rotation speed set by the calculating section (b). A side of the slack eliminating roller 21 which has the

unwinding tension applying member 22 (the side toward which the yarn Y runs) is defined as a leading end P and its side connected to the driving means 35 is defined as a proximal end Q. Then, tapered portions 21b, 21d are formed on the proximal end Q side and leading end P side, respectively, of the outer peripheral surface 21a so that their diameters increase toward the corresponding end surfaces. An intermediate portion of the slack eliminating roller 21 is a cylindrical portion 21c having a fixed diameter. During yarn splicing, the yarn Y spun by the spinning device 5 is wound around the outer peripheral surface 21a from the proximal end Q side. The yarn Y is then unwound from the leading end P to the winding device 12 (see Figures 9 to 12). The tapered portion 21b on the proximal end Q side has a function of regularly winding the yarn Y around a surface of the cylindrical portion 21c by smoothly moving the supplied and wound yarn Y from a larger diameter portion 21b-1 to a smaller diameter portion 21b-2 and then to the intermediate cylindrical portion 21c. The tapered portion 21d on the leading end P side also has a function of ensuring the smooth withdrawal of the yarn Y by inhibiting a slip-out phenomenon in which the wound yarn Y slips out at a time, while sequentially winding the yarn Y around a small diameter portion 21d-2 and then a larger diameter portion 21d-1 to feed a wound yarn layer.

[0039] As shown in Figure 18, the unwinding tension applying member 22 is provided on the leading end P side of the slack eliminating roller 21 and a bar-like member 22a is attached to the slack eliminating roller 21 so as to be concentrically rotated by a transmitted force adjusting mechanism relative to the slack eliminating roller 21. The transmitted force adjusting mechanism is configured as follows. A wheel member 22b is rotatably installed, via a bearing member 22c such as a bearing, on a shaft portion 21e projected from a central portion of the slack eliminating roller 21. The proximal portion of the bar-like member 22a is attached to the wheel member 22b. The wheel member 22b is attached by preventing a transmitted force applying member 22f composed of urging means such as a spring from slipping out, using a transmitted force adjustment operating section 22g screwed over a bolt portion at the leading end of the shaft portion 21e and composed of, for example, a nut member 22d, a presser member 22e, and the like. Accordingly, the transmitted force adjusting mechanism according to the present embodiment can adjust the pressing force (frictional force) of the transmitted force applying mechanism 22f in a non-step-by-step manner by tightening the transmitted force adjustment operating section 22g screwed over the shaft portion 21e.

[0040] An operator can easily perform a transmitted force adjusting operation by providing the transmitted force adjusting mechanism in the junction between the slack eliminating roller 21 and the unwinding tension applying member 22 and exposing the transmitted force adjustment operating section 22g from the leading end

P side of the slack eliminating roller 21. To prevent the transmitted force adjusting mechanism from interrupting smooth yarn unwinding, it is desirable to hinder the transmitted force adjusting mechanism from interfering with a plane formed by the locus of the yarn Y unwound from the slack eliminating roller 21. In the present embodiment, the leading end of the shaft portion 21e is located away from the leading end P toward the interior of the slack eliminating roller 21. Accordingly, the shaft portion 21e and the transmitted force adjustment operating section 22g do not interfere with the yarn path of the yarn Y unwound from the slack eliminating roller 21. Therefore, smooth yarn unwinding is unlikely to be hindered.

[0041] The transmitted force adjusting mechanism can adjust the magnitude of the rotational resistance of the bar-like member 22a to the slack eliminating roller 21. Specifically, the pressing force (or the frictional force) of the transmitted force applying member 22f, exerted on the wheel member 22b, is reduced by loosening the transmitted force adjustment operating member 22g. Then, only a light load enables the bar-like member 22a to slip and rotate independently of the rotation of the slack eliminating roller 21. In contrast, the pressing force of the transmitted force applying member 22f, exerted on the wheel member 22b, is increased by tightening the transmitted force adjustment operating member 22g. Then, the bar-like member 22b does not slip unless a very heavy load acts on it, and rotates integrally and in unison with the slack eliminating roller 21.

[0042] Accordingly, the unwinding tension applying member 22 can appropriately adjust the tightening of the transmitted force adjustment operating section 22g to adjust the behavior of the bar-like member 22a, which can rotate independently of the slack eliminating roller 21, in association with the tension of the yarn Y unwound from the slack eliminating roller 21. That is, the transmitted force adjusting mechanism can preset the unwinding tension of the yarn Y from the slack eliminating roller 21, which tension varies depending on the spinning conditions such as the yarn type and the yarn number. The behavior of the bar-like member 22a depends on the interaction between a rotating force transmitted by the slack eliminating roller 21 via the transmitted force applying member 22f and the tension of the yarn Y unwound from the slack eliminating roller 21. Conversely speaking, by using the transmitted force adjusting mechanism to pre-adjust the behavior of the bar-like member 22a, it is possible to preset the magnitude of the resistance of the bar-like member 22a to the yarn Y unwound from the slack eliminating roller 21.

[0043] That is, the transmitted force adjusting mechanism functions to adjust the unwinding tension provided by the bar-like member 22a to the yarn Y.

[0044] The transmitted force adjusting mechanism according to the present embodiment can adjust the pressing force (frictional force) of the transmitted force applying mechanism 22f in a non-step-by-step manner

by tightening the transmitted force adjustment operating section 22g, including the nut member 22d and screwed over the shaft portion 21e. However, the present invention is not limited to this aspect. Instead of the shaft portion 21e, a shaft portion may be provided which has a position regulating section that positions the presser member 22e step by step at predetermined intervals in a longitudinal direction. Then, the position at which the presser member 22e is installed relative to the shaft portion can be changed step by step. Alternatively, plural types of presser members 22e may be provided which have different lengths in the longitudinal direction of the shaft portion. Then, the presser member 22e, attached to the shaft portion, can be properly changed in accordance with the conditions. It is further contemplated that instead of the above frictional adjusting mechanisms, for example, an electromagnetic clutch system using an electromagnet may be used as a non-contact adjusting mechanism to adjust the magnitude of the transmitted force by varying the magnetic attractive force of the magnet.

[0045] During slack elimination, the bar-like member 22a according to the present embodiment engages with the yarn Y (see Figures 7 and 8) to allow the yarn Y to be reliably wound around the outer peripheral surface 21a of the slack eliminating roller 21. The bar-like member 22a thus has a characteristic shape described below. As shown in the enlarged view in Figure 19, the bar-like member 22a is composed of a shaft portion 22a-1 shaped so as to connect to its proximal end attached to the wheel member 22b, to extend to a position where it projects slightly from the leading end P of the slack eliminating roller 21 toward the area in which the yarn Y is unwound, and then to bend gradually outward in a radial direction to a bent portion (m) close to the axis of the roller 21, an inclined portion 22a-2 connected to the shaft portion 22a-1 and extending from the bent portion (m), the boundary portion between the shaft portion 22a-1 and the inclined portion 22a-2, while inclining outward in the radial direction opposite to the rotating direction of the slack eliminating roller 21, and a leading end portion 22a-3 connected to the inclined portion 22a-2 and having a bent portion (k). The bar-like member 22a then has, on a side of the inclined portion 22a-2 which is closer to a leading end (j), a bent portion (l) bent toward the proximal end Q side (roller outer peripheral surface 21a side) of the slack eliminating roller 21. The bent portion (l) constitutes the boundary portion between the inclined portion 22a-2 and the leading end portion 22a-3. The leading end portion 22a-3, formed closer to the leading end (j) than the bent portion (l), bends, at the bent portion (k), outward in the rotating direction of the slack eliminating roller 21.

[0046] As is apparent from the figures, of the three bent portions (m), (l), (k), the bent portion (m) is located in an internal area in an axial projection view as viewed from the front of the slack eliminating roller 21. The two bent portions (l), (k) are located in an external area in

the axial projection view.

[0047] A yarn engaging section R formed by the leading end (j), the bent portion (k), and the bent portion (l) has an angle that is open toward the rotating direction of the slack eliminating roller 21. The yarn engaging section R also has predetermined distance to the roller outer peripheral surface 21a between the leading end P and proximal end Q of the slack eliminating roller 21. The yarn engaging section R is also located opposite the outer peripheral surface 21a of the slack eliminating roller 21. Moreover, in the projection view, the following two angles are both set to be acute: the angle α between the inclined portion 22a-2 and the tangent at the point where the outer peripheral edge of the slack eliminating roller 21 and the inclined portion 22a-2 cross each other and the angle β between the part from the bent portion (k) to bent portion (l) of the inclined portion 22a-2 and the rotational axis of the slack eliminating roller 21.

[0048] With the previously described form, the bar-like member 22a according to the present embodiment perform the following operations. First, the bent portion (m), the boundary between the shaft portion 22a-1 and the inclined portion 22a-2, is the internal area in the projection view. Consequently, when the bar-like member 22a, rotated integrally with the slack eliminating roller 21, catches and winds the yarn Y around the slack eliminating roller 21, the yarn Y being supplied by the spinning device 5 immediately before the start of a yarn splicing operation, the bar-like member 22a can easily catch the yarn Y using the inclined portion 22a-2. Further, the inclined portion 22a-2 extends and inclines outward in the radial direction opposite to the rotating direction of the slack eliminating roller 21, and has the acute angle α . Consequently, the yarn Y caught by the inclined portion 22a-2 can be reliably guided to the yarn engaging section R of the leading portion 22a-3. Furthermore, the form of the inclined portion 22a-2 functions to prevent the yarn Y from fitting into the gap between the bar-like member 22a and the slack eliminating roller 21. Moreover, the yarn engaging section R has the predetermined distance to the outer peripheral surface 21a of the slack eliminating roller 21 and is located opposite the outer peripheral surface 21a of the slack eliminating roller 21. Consequently, when the bar-like member 22a rotates with the slack eliminating roller 21, the yarn Y engaged with the yarn engaging section R can be stably wound around the outer peripheral surface 21a of the slack eliminating roller 21 at a predetermined position. The is, the yarn threading member 22 according to the present invention has the advantage of providing a yarn slack eliminating device that achieves a reliable yarn threading operation and a stable yarn winding operation.

[0049] It is assumed that the bent portion (m) is located in the external area in the projection view as shown by the imaginary alternate long and two short dashes line in Figure 19. Then, even if the bar-like member 22a rotates clockwise in Figure 19A, the yarn Y may contact

with shaft portion 22a-1 of the bar-like member 22a, which is closer to the proximal end than the bent portion (m), and enter the area between the bar-like member 22a and the roller leading end P without being caught by the inclined portion 22a-2 between the bent portion (m) and the bent portion (l). However, if the bent portion (m) is located in the internal area in the projection view as described above, the yarn Y can be contacted with the inclined portion 22a-2 between the bent portion (l) and the bent portion (m) and then picked up. The yarn Y can thus be guided from the bent portion (m) to the bent portion (l) along the inclined portion 22a-2 as the bar-like member 22a rotates.

[0050] Moreover, the bar-like member 22a is folded from the bent portion (l) toward the roller proximal end Q side. Consequently, as the bar-like member 22a rotates clockwise in Figure 19A, the yarn Y picked up by the inclined portion 22a-2 is guided along the inclined portion 22a-2 to the yarn engaging section R via the bent portion (l) and the bent portion (k). That is, the yarn Y can be loaded on the outer peripheral surface 21a of the slack eliminating roller at a position closer to the cylindrical portion 21-c (see Figure 17B) and then surely wound around the outer peripheral surface 21a of the slack eliminating roller 21.

[0051] Furthermore, in the bar-like member 22a according to the present embodiment, at least the part from the inclined portion 22a-2 to the leading end portion 22a-3 is formed of a single bar stock or wire rod. Consequently, the yarn Y can be smoothly moved from the bent portion (m) to the yarn engaging section R while sliding on the surface of the bar-like member 22a. Furthermore, the bar-like member 22a itself can have its weight reduced. This makes it possible to appropriately react to and follow a variation in load. Depending on the shape of the bar-like member 22a, it may be unnecessary that the yarn engaging section R is arranged opposite the roller outer peripheral surface 21a so as to maintain the predetermined distance from the roller outer peripheral surface 21a.

[0052] The work carrier 3 is provided with advancing and withdrawing means 24 composed of an air cylinder or the like which advances and withdraws the upstream side guide 23 and control means (not shown in the drawings) for controlling the advancing and withdrawing means 24. That is, the upstream side guide 23 is yarn moving means, and the advancing and withdrawing means 24 is driving means for the upstream side guide 23. However, the upstream side guide 23 may be fixed, while the yarn moving means may be separately provided. The upstream side guide 23, driven forward and backward by the advancing and withdrawing means 24 such as an air cylinder, is set as follows. When lying at a forward position (see Figures 4 and 5), the upstream side guide 23 holds the yarn path at a position where the yarn Y does not engage with the yarn slack eliminating device 10. When lying at a backward position (see Figures 7 and 8), the upstream side guide 23

moves the yarn path to a position where the yarn Y engages with the bar-like member 22a of the yarn slack eliminating device 10 and the yarn Y is wound to the slack eliminating roller 21. The bar-like member 22a is arranged to engage with the yarn Y on the yarn path joining the upstream side guide 23, which is at the backward position during the normal spinning, to the downstream side guide 36 so as to set the shortest distance between them. That is, the upstream side guide 23 is set so that a rotation locus surface of the bar-like member 22a, which rotates with the slack eliminating roller 21, crosses the yarn path.

[0053] A description will be given of the operation of the spinning machine 1 configured as described previously. As shown in Figures 3 to 5, while normal winding is being carried out in the spinning unit 2 at which the work carriage 3 is not stopped, the upstream side guide 23 of the yarn slack eliminating device 10 is forcibly pulled by a tensile member such as a spring (not shown in the drawings) to the backward position. When the yarn Y is not wound around the slack eliminating roller 21 during normal spinning (winding), the spinning unit 2 has not provided any yarn splicing request signals. In this case, no rotation instructions are outputted to the driving motor 35 via the driver substrate 40. Furthermore, control described later allows the bar-like member 22a to be stopped at a position where the bar-like member 22a is separate from and does not contact with the yarn path (see the alternate long and two short dashes line in Figure 8 and Figures 15C and 15D). Moreover, even if the slack eliminating roller 21 is rotating and the yarn Y is running on the yarn path on which the yarn Y can engage with the yarn slack eliminating device 10, the yarn Y is not wound around the slack eliminating roller 21 because a specified or larger amount of tension acts on the yarn Y. Each spinning unit 2 of the spinning machine 1 uses the draft device 4 to feed the bundle of fibers S into the spinning device 5. The spinning unit 2 then uses the yarn feeding device 6 to feed downstream the yarn Y spun and generated by the spinning device 5. The spinning unit 2 then passes the yarn Y directly in front of the suction device 7 and the yarn defect detector 9. Subsequently, the spinning unit 2 feeds the yarn Y to the winding device 12 via the upstream side guide 23, the downward guide 36, and the waxing device 11. The winding device 12 then winds the yarn Y around the bobbin 15 to form the package 16.

[0054] When the yarn defect detector 9 of any spinning unit 2 detects a defect such as a slab in the yarn Y, the cutter 8 of the winding unit 2 cuts the yarn Y. At the same time, the back roller 4a and third roller 4b of the draft device 4 stop rotations. In the winding device 12, the cradle arm 14 moves rotatively to separate the package 16 from the rotating drum 13 (see Figure 6). Subsequently, the package 16 naturally stops rotation or is forced to stop depending on the situation. The second roller 4d and the front roller 4e continue to be rotatively driven.

[0055] A winding device 12 side part Y2 of the yarn Y cut by the cutter 8 is wound around the package 16, which is continuously rotated by inertia. For a spinning device 5 side part Y1 of the yarn Y, the back roller 4a and third roller 4b of the draft device 4 stop rotations to pull and cut the bundle of fibers S between the stopped third roller 4b and the continuously rotating second roller 4d. A yarn piece extending from the cut position to the position of the cutter 8 is fed by the continuously rotating second roller 4d and front roller 4e. The yarn piece passes through the spinning device 5 and is then sucked and removed by the yarn sucking device 7.

[0056] On the basis of a yarn splicing request signal outputted while the spinning unit 2 is performing the above operation, the work carriage 3 runs and moves to the position of the spinning unit 3 that has requested splicing. Once the work carriage 3 arrives at a predetermined position, the advancing and withdrawing means 24 of the work carriage 3 moves the upstream side guide 23 to its forward position as shown in Figure 4. The yarn path is changed to a position where it does not engage with the yarn slack eliminating device 10. Then, on the basis of a subsequently outputted arrival detection signal, the spinning unit 2 outputs a rotation instruction to the driving motor 35 via the driver substrate 40. The spinning unit 2 starts rotating the slack eliminating roller 21 of the yarn slack eliminating device 10 at an appropriate time. Consequently, the operation of the slack eliminating roller 21 of the yarn slack eliminating device 10 can be reliably linked with the operation of the work carriage 3.

[0057] Subsequently, the work carriage 3 performs the following splicing operation. As shown by the alternate long and two short dashes line in Figure 6, the suction pipe 18 is rotatively moved upward to position the suction port 18a near the yarn discharge port in the spinning device 5. Consequently, the spinning unit 2 reactivates the stopped back roller 4a and third roller 4b to bring them into a driven state. The bundle of fibers S is thus fed into the spinning device 5 to restart spinning. The suction pipe 18 sucks and catches the yarn end of the yarn Y1 continuously spun by the spinning device 5. The suction pipe 18 then moves downward to its initial position shown by the solid line in Figure 6 to guide the yarn Y1 to the yarn splicing device 17. The yarn Y1 is introduced into the yarn feeding device 6 from a side of the nip roller 6a. The suction pipe 18 continuously sucks the yarn Y1 generated and fed by the spinning device 5 until a subsequent yarn splicing operation is started.

[0058] At the same time when (or slightly before or after) the suction pipe 18 starts moving rotatively, the suction mouth 19 is rotatively moved downward to the position shown by the alternate long and two short dashes line in Figure 6. Then, the suction port 19a at the tip of the suction mouth 19 is used to suck and catch the yarn end of the yarn Y2 from the package 16 rotating in the direction opposite to that used during normal winding. The yarn Y2 is thus pulled out. Then, while contin-

uing the suction, the suction mouth 19 is rotatively moved upward to its initial position shown by the solid line in Figure 6. The winding device 5 side yarn Y2 is thus positioned near the yarn splicing device 17.

[0059] Subsequently, the yarn splicing device 17 starts a yarn splicing operation 17. Once the spinning device 5 side yarn Y1 and the winding device 12 side yarn Y2 are positioned near the yarn splicing device 17, a yarn handling lever (not shown in the drawings) provided in the yarn splicing device 17 clamps and loads both yarns Y1, Y2 into a work executing section of the yarn splicing device 17. A yarn splicing operation is then performed. Before the yarn splicing operation is started, the upstream side guide 23 of the yarn slack eliminating device 10 is still at the forward position to hold the yarn path at a position where it does not engage with the unwinding tension applying member 22.

[0060] When the yarn splicing device 17 clamps the yarns Y1, Y2, the suction pipe 18 cannot suck or collect the yarn Y1. Accordingly, the yarn Y1, fed by the spinning device 5, is collected upstream of the yarn splicing device 17 if no action is taken. Thus, immediately before the yarn splicing operation is started, specifically, immediately before the yarn handling lever clamps the yarns Y1, Y2, the advancing and withdrawing means 24 is activated to withdraw the upstream side guide 23 as shown in Figures 7 and 8. The yarn Y1 changes its yarn path to a position where it can engage with the bar-like member 22a of the unwinding tension applying member 22. Thus, the bar-like member 22a, which rotates with the slack eliminating roller 21, catches and introduces the yarn Y1, fed by the spinning device 5, into the cylindrical portion 21c of the slack eliminating roller 21, which portion is used as a wound surface. The yarn Y1 is thus wound around the slack eliminating roller 21. This avoids the slack of the yarn Y1, which may occur between the spinning device 5 and the yarn splicing device 17 during a yarn splicing operation.

[0061] As described previously, the bar-like member 22a can be rotated independently of the slack eliminating roller 21. However, it rotates integrally with the slack eliminating roller 21 unless a load of a specified value or larger acts on the bar-like member 22a. During a yarn slack eliminating operation, a downstream (winding side) winding speed is low and almost zero. Accordingly, only a light load acts on the bar-like member 22a, which thus rotates integrally with the slack eliminating roller 21.

[0062] Since the bar-like member 22a is formed as described previously, it is ensured to engage with the yarn Y. Furthermore, the yarn Y does not fit into the gap between the slack eliminating roller 21 and the bar-like member 22a during winding. Moreover, the withdrawal of the upstream side guide 23 is an operation preformed in a direction in which the length of the yarn path is reduced (the above described shortest distance is established) to relax the yarn tension. Accordingly, an increase in yarn tension is reduced when the yarn Y1 engages with the bar-like member 22a. This prevents yarn

breakage. The arrangement disclosed in the Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272 rotatively moves the yarn guide to bend and push the yarn into the center of the roller. Consequently, the yarn is likely to be excessively tensed and broken. In contrast, the present invention prevents the yarn from being bent and pulled as in the case of the Examined Japanese Patent Application Publication (Tokkou-Hei) No. 4-13272. This prevents yarn breakage.

[0063] The rotation speed of the slack eliminating roller 21 is calculated by the calculating section (b) so as to provide an appropriate yarn tension, on the basis of a speed at which the spinning device 5 spins the yarn Y (substantially a speed at which the yarn feeding device feeds the yarn) as well as information inputted by the input section (a). The time when the upstream side guide 23 moves to the backward position is determined taking the spinning speed of the yarn Y1 into account. Using as a reference the time when the yarn splicing device 17 clamps the yarns Y1, Y2, the above time is set to be slightly before this clamp time. When this movement is delayed, the yarn Y1, successively spun by the spinning device 5, may be slacked. The slack eliminating roller 21 may then fail to catch the yarn Y1. In contrast, when the movement occurs excessively before the yarns Y1, Y2 are clamped, the yarn Y1 positioned in the yarn splicing device 17 may be wound around the slack eliminating roller 21, resulting in a failure to splice the yarn. Even if the yarn splicing device 17 successfully splices the yarn, an excessive amount of yarn may be wound around the slack eliminating roller 21. If the amount of wound yarn exceeds the permissible amount of retained yarn that can be wound around the slack eliminating roller 21, the yarn pieces may abnormally overlap each other on the slack eliminating roller 21. Then, the yarn Y may not be smoothly unwound, resulting in an imperfect yarn splicing operation such as yarn breakage.

[0064] Once the yarn splicing by the yarn splicing device 17 has been finished, the cradle arm 14 is rotatively moved in a returning direction to contact the package 16 with the rotating drum 13. Then, the operation of winding the yarn Y is restarted. However, the yarn Y extending from the yarn slack eliminating device 10 to the winding device 12 undergoes a reduced tension immediately after the yarn splicing has been completed. Accordingly, when the package 16 is rapidly brought into contact with the rotating drum 13, the yarn tension may vary rapidly to excessively tense and break the yarn Y. Thus, to solve this problem, the present embodiment provides a tension arm 20 which tenses the yarn Y and which can advance and withdraw and a return speed limiting mechanism 26 that adjusts the rotative movement speed of the cradle arm 14, as shown in Figure 12. The tension arm 20 is a lever structure such as the illustrated one. The tension arm 20 interferes with and bends the yarn Y to increase its tension immediately before the contact

of the package 16 with the rotating drum 13 is completed. Thus, a variation in yarn tension is small when winding is restarted. The speed limiting mechanism 26 is constructed utilizing a cam 26a, a link 26b, and the like which can be rotated by a driving source (not shown in the drawings). The speed limiting mechanism 26 is connected to a junction 26c provided in the cradle arm 14 to limit the rotative movement speed of the cradle arm 14 immediately before the package 16 comes into contact with the rotating drum 13.

[0065] The tension arm 20 and the cradle arm 14 operate as shown in, for example, the time chart in Figure 13. Specifically, the tension arm 20, the junction 26c, and the cradle arm 14 operate in accordance with appropriate timing, by being all driven, via the link 26b, by rotative driving executed by the cam 26a of the speed limiting mechanism 26. After the splicing has been completed (time T0), the cradle arm 14 first starts moving rotatively in the returning direction (time T1). The speed limiting mechanism 26 controls the cradle arm 14 so that its rotative movement speed (angular speed) does not exceed a predetermined value (ω). Once the package 16 has gotten very close to the surface of the rotating drum 13, the angular speed of the cradle arm 14 is reduced to a specified value (ω_1) (time T2). Then, until the contact of the package 16 with the rotating drum 13 is completed (time T4), the low angular speed (ω_1) is maintained. The driving of the cradle arm 14 at the low angular speed is referred to as sliding contact driving. This angular speed control allows the package 16 to come into sliding contact with the surface of the rotating drum 13. This reduces a rapid increase in tension upon contact.

[0066] On the other hand, the tension arm 20 is advanced (time T3) after the cradle arm 14 has started the sliding contact driving (time T2) and before the package 16 comes into sliding contact with the rotating drum 13 (time T4). The yarn Y is thus tensed. The yarn Y undergoes a reduced tension immediately after the yarn splicing has been finished. Then, the package 16 and the rotating drum 13 come into contact with each other to restart a regular winding operation. The yarn tension thus increases rapidly. Accordingly, as in the case of the present embodiment, the yarn tension is slightly increased before the package 16 comes into contact with the rotating drum 13 in order to prevent the yarn tension to increase rapidly. Then, a variation in yarn tension can be reduced when a regular winding operation is restarted, thus preventing the yarn from being excessively tensed and broken. Subsequently, in a second stage, the package 16 is brought into sliding contact with the rotating drum 13 to further reduce a variation in yarn tension. Once the package 16 completely contacts with the rotating drum 13 to restart a regular winding operation, the tension arm 20 is withdrawn and separated from the yarn Y (time T5).

[0067] Once the yarn splicing operation is finished and the winding operation is restarted, the work carriage

3 no longer engages with the yarn Y and can move freely from the spinning unit 2 in which the spinning operation has been performed. Accordingly, when another spinning unit outputs a yarn splicing request signal, the work carriage 3 can move immediately to the position of the target spinning unit after the winding operation has been restarted, without waiting for the yarn to be unwound from the slack eliminating roller 21. Consequently, the spinning machine 1 according to the present invention saves the time required by the work carriage 3 to remain at a single spinning unit 2.

[0068] This enables the work carriage 3 to move to another yarn splicing requesting unit more quickly than the work carriage 3 in the prior art. It is also possible to reduce the time for which another yarn splicing requesting unit must stop spinning, thus improving operating efficiency.

[0069] During the period from the yarn splicing operation till the restart of the winding operation, the yarn Y generated and fed by the spinning device 5 is wound around the slack eliminating roller 21. However, once the winding operation is restarted, the winding speed used between the yarn slack eliminating device 10 and winding device 12 increases above the specified value to allow the tensile force exerted on the winding device 12 to be applied to the yarn Y. This is because the ratio of the winding speed to the spinning speed is set so as to apply an appropriate tension to the yarn. Then, the yarn tension between the yarn slack eliminating device 10 and the winding device 12 allows a load of a predetermined magnitude to act on the bar-like member 22a on the basis of a value set by the transmitted force adjusting mechanism. The bar-like member 22a then exhibits independent behavior (rotative movement or rotation) against the force transmitted by the slack eliminating roller 21, which continues rotating in a winding direction. Thus, the yarn A wound around and retained on the slack eliminating roller 21 is gradually pulled out and unwound from the slack eliminating roller 21 via the downstream side guide 36. At this time, the bar-like member 22a of the unwinding tension applying member 22 and a roller larger diameter portion 21d-1 guide the yarn Y so that it is uniformly unwound, while preventing the yarn Y from slipping out. Rotational force is transmitted to the bar-like member 22a by the slack eliminating roller 21 and transmitted force applying member 22f, rotating in the direction opposite to the one in which the bar-like member 22a rotates in order to unwind the yarn Y. The bar-like member 22a thus applies an appropriate tension to the yarn Y in order to allow the yarn Y to offer resistance acting against a force that pulls the yarn Y unwound from the slack eliminating roller 21 to the winding device 12. Thus, the machine has a function of substantially matching the unwinding tension of the yarn T being unwound from the slack eliminating roller 21 to the regular winding tension to make the wound state of the package 16 uniform during both regular winding and slack elimination. These effects of the present invention

are particularly significant because efforts have been made in recent years to increase the spinning speed and because the amount of yarn slack increases consistently with the spinning speed.

[0070] In this case, the downstream side guide 36 must be located on an extension from the roller leading end P side of the shaft portion 21e of the slack eliminating roller 21 as shown in Figures 7 and 18. This is because if the downstream side guide 36 is located offset from the extension from the shaft portion 21e when the yarn Y is unwound from the slack eliminating roller 21, then depending on a position where the yarn Y is separated from the slack eliminating roller 21, the distance between this separated position and the downstream side guide 36 varies to in turn vary the unwinding tension. Moreover, if the downstream side guide 36 is located extremely offset from the extension from the shaft portion 21e, the rotating force of the slack eliminating roller 21 may induce a force that winds the yarn around the slack eliminating roller 21, the yarn actually having to be wound around the package 16.

[0071] As described previously, the unwinding tension applying member 22 according to the present embodiment is a single member having two functions. That is, the unwinding tension applying member 22 acts as a yarn handling member to introduce the yarn Y1 into the slack eliminating roller 21 immediately before the start of a yarn splicing operation. The unwinding tension applying member 22 also provides an unwinding tension applying function to apply a predetermined unwinding tension to the yarn wound around the slack eliminating roller 21 when this yarn is unwound. This effectively reduces the number of parts constituting the yarn slack eliminating device 10.

[0072] Once the winding operation is restarted and the yarn Y is completely unwound from the slack eliminating roller 21, the rotating force that the bar-like member 22a receives from the slack eliminating roller 21 balances with the tension of the running yarn. Thus, the bar-like member 22a is kept engaged with the yarn Y at the position shown Figures 14, 15A, and 15B. Normally during spinning, if the yarn Y is not wound around the slack eliminating roller 21, when no action is taken, the yarn Y runs while in contact with the bar-like member 22a before being wound into the package 16. Consequently, the friction between the yarn Y and the bar-like member 22a may affect the quality of the yarn and thus of the package 16. Thus, in the present embodiment, once the yarn starts to be unwound from the slack eliminating roller 21, the slack eliminating roller 21 is reversely rotated through almost 180 degrees to a separate position where the bar-like member 22a does not contact with the yarn Y, as shown by the alternate long and two short dashes line in Figure 8 and in Figures 15C and 15D. Subsequently, the slack eliminating roller 21 is stopped at this separate position. This makes it possible to avoid degrading the yarn Y.

[0073] For example, timer control can be used to ad-

just timing for reversely rotating the slack eliminating roller 21. Specifically, the slack eliminating roller 21 may be set to be automatically reversely rotated and then stopped after the slack eliminating roller 21 has rotated for a predetermined time since the start of the yarn slack eliminating operation in the yarn slack eliminating device 10. Alternatively, a tension sensor may be arranged at an appropriate position located upstream or downstream of the slack eliminating roller 21 to monitor the tension of the yarn being unwound. Then, once the tension value meets a specified condition, it may be determined that the yarn Y is completely loosened and unwound from the slack eliminating roller 21. Subsequently, the slack eliminating roller 21 may be reversely rotated and then stopped.

[0074] As shown in Figure 3 and so on, the cutter 8 and the yarn defect detector 9 are arranged upstream of the yarn slack eliminating device 10 and close to each other. The reason will be described below. If the cutter 8 is located downstream of the yarn slack eliminating device 10, if the yarn defect detector 9 detects a defect while the slack eliminating roller 21 is eliminating the slack, then the upstream yarn end cut by the cutter 8 remains wound around the slack eliminating roller 21. To remove this yarn end, a complicated arrangement and complicated control are required. That is, removal means separately provided downstream of the cutter 8 must be used to discard the remaining yarn end while the slack eliminating roller 21 is being reversely rotated.

[0075] Now, it is assumed that for the above described reason, the cutter 8 is located upstream of the yarn slack eliminating device 10, whereas the yarn defect detector 9 is arranged downstream of the yarn slack eliminating device 10. In this case, when the yarn defect detector 9 detects a yarn defect while the yarn slack eliminating device 10 is eliminating the slack, the cutter 8 cuts the yarn Y. The length of the yarn between the yarn end cut by the cutter 8 and the yarn defect portion detected by the yarn defect detector 9 increases by an amount equal to the length of the yarn wound around the slack eliminating roller 21. Since the suction mouth 19 sucks and catches the part of the yarn Y from its cut end to the yarn defect portion, a large amount of yarn may be discarded or a long time may be required for suction. In some cases, the suction mouth 19 may not be able to suck or catch the yarn defect portion and thus the yarn defect portion may fail to be removed before yarn splicing. Thus disadvantageously, the yarn defect portion may be wound into the package 16. Therefore, for the above described reason, the cutter 8 and the yarn defect detector 9 are preferably arranged upstream of the yarn slack eliminating device 10 and close to each other.

[0076] The upstream side guide 23 is advanced immediately before yarn slack elimination carried out by the slack eliminating roller 21 partly because the yarn Y must be removed from the yarn defect detector 9 while the yarn path of the yarn Y is at an unengaged position immediately before the slack elimination.

[0077] This is because if the yarn Y is threaded through the yarn defect detector 9 immediately before the slack elimination so that a yarn defect can be detected, shaking of the yarn Y that may occur while the bar-like member 22a is catching the yarn Y may be mistakenly detected as a yarn defect. Then disadvantageously, the yarn Y may be mistakenly cut. Thus, this disadvantage can be avoided by removing the yarn Y from the yarn defect detector 9 immediately before the slack elimination and allowing the yarn Y to pass through the yarn defect detector 9 so that a defect can be detected while the bar-like member 22a is catching the yarn for the slack elimination, as described in the present embodiment.

[Second Embodiment]

[0078] In the yarn slack eliminating device 10 according to the present invention, the upstream side guide 23 of the slack eliminating roller 21 may be fixed, whereas the downstream side guide 36 may be movable, as shown in Figure 20. However, in view of the previously described arrangement, in which the upstream side guide 23 is closer to the yarn defect detector 9 than the downstream side guide 36, if the condition that the yarn Y is removed from the yarn defect detector 9 immediately before slack elimination is met, the upstream side guide 23 is preferably advanced to bend the yarn Y in removing the yarn from the yarn defect detector 9. This method reduces a movement stroke and can prevent the member from projecting excessively compared to the case in which the downstream side guide 36 is advanced and withdrawn.

[0079] However, instead of operating the yarn defect detector 9 as described above, it is possible to, for example, provide such control as electrically turns on and off a yarn defect detecting operation so that the detecting operation of the yarn defect detector 9 is turned off immediately before elimination of the slack of the yarn Y, while the detecting operation of the yarn defect detector 9 is turned on immediately after the bar-like member 22a has caught the yarn Y. This eliminates the need to remove the yarn Y from the yarn defect detector 9. Therefore, the arrangement illustrated in Figure 19 can be easily implemented.

[Third Embodiment]

[0080] In the previously described embodiments, the yarn slack eliminating device is used to eliminate the slack that may occur during a yarn splicing operation. However, the yarn slack eliminating device can be used to construct a spinning machine designed so as to appropriately adjust the winding speed even during normal spinning to slack the yarn Y and allow the yarn Y to be always wound around the slack eliminating roller 21. An example is a spinning machine in which when a cone package is formed, the yarn Y is always wound around

the slack eliminating roller 21 in order to absorb a difference in winding tension between the larger diameter side and the smaller diameter side that may be caused by a difference in winding speed.

[0081] When a cone package is formed, the yarn tension is likely to vary because an axial yarn winding radius varies even within one traverse. Thus, the yarn slack eliminating device according to the present invention is arranged between the spinning device and the winding device. The yarn slack eliminating device is set so that the yarn fed by the spinning device is always wound around the slack eliminating roller and simultaneously unwound and fed to the winding device and so that the unwinding tension applying member engages with the unwound yarn. Specifically, a yarn winding operation is performed while maintaining a state such as the one shown in Figures 10 and 11. The unwinding tension applying member 22 is set to rotate integrally with the slack eliminating roller 21 when the load acting on the bar-like member 22a has a predetermined value or smaller but to rotatively move or rotate independently of the slack eliminating roller 21 when the load exceeds the predetermined value, as described previously. Accordingly, when the winding speed decreases, the bar-like member 22a, which rotates integrally with the slack eliminating roller 21, tenses the yarn while winding it around the slack eliminating roller 21. When the winding speed increases, then in unison with a variation in load, the bar-like member 22a rotatively moves or rotates independently of the slack eliminating roller 21 to suppress an increase in yarn tension.

[0082] Thus, the present invention provides a function of using the yarn slack eliminating device to reduce and stabilize a variation in yarn tension that may occur while the yarn is being wound into a cone package. Furthermore, the present invention employs the configuration in which the yarn slack eliminating device 10 and the slack eliminating roller 21 are connected together via the transmitted force adjusting mechanism. This makes it possible to easily vary the magnitude of the load associated with the rotative movement or rotation of the bar-like member 22a independent of the slack eliminating roller 21. Therefore, it is easily to deal with the unwinding tension, which varies depending on the various spinning conditions such as the yarn type, yarn number, and spinning speed.

[Fourth Embodiment]

[0083] If for example, a cone package is formed, it is necessary to keep the yarn wound around the slack eliminating roller in order to allow the yarn slack eliminating device to absorb a variation in winding speed or yarn tension. Thus, the present embodiment provides a spinning machine that can reliably prevent the insufficiency of the amount of slack retained on the slack eliminating roller 21 by reducing the rotation speed if the slack retained on the slack eliminating roller 21 is about

to be exhausted, to increase the amount of slack up to a predetermined value. The main arrangements of the spinning machine according to the present embodiment are common to the first embodiment. However, as shown in Figures 21 and 22, the cradle arm 14 of the winding device 12 can be pivoted around a pivoting shaft 14a. Furthermore, a pivoting control mechanism 60 as means for controlling a decrease in winding speed can be used to control the operation of contacting the bobbin 15 or package 16 with the rotating drum 13 and the time for which the bobbin 15 or package 16 remains separated from the rotating drum 13. The pivoting control mechanism 60 is composed of an air cylinder 64 having a piston rod 65 connected to one end of the cradle arm 14, a compressed air source that supplies the air cylinder 64 with compressed air for contact pressure and compressed air for separation, a solenoid valve device 63 that switches a path through which compressed air is supplied to the air cylinder 64, a controller 62 that controls operations of the solenoid valve device 63, a unit controller 61 that output control signals to the controller 62, and other components.

[0084] During spinning, the pivoting control mechanism 60 allows the compressed air for contact pressure to always act on the air cylinder 64 to withdraw the piston rod 65 to press the package 16 against the rotating drum 13 at a predetermined contact pressure. Then, the air cylinder 64 is subjected as required to the compressed air for separation, which has a pressure higher than the compressed air for contact pressure, to extend the piston rod 65 to separate the package 16 from the rotating drum 13. At this time, the unit controller 61 controls the time for which the package 16 remains separated from the rotating drum 13 and timing for the separation. Specifically, the unit controller 61 executes calculations on the basis of already inputted spinning condition data such as the yarn type, yarn number, and spinning speed and the time for which the spinning machine has been operated as measured by the timer section. The unit controller 61 then outputs a control signal required to cause the solenoid valve device 63 to perform a desired operation, to the controller 62 in accordance with the winding diameter of the package 16, that is, in association with the weight of the package 16.

[0085] The yarn slack eliminating device 10 is also provided with a yarn tension detecting device 50 that detects the tension of the yarn Y immediately upstream of the slack eliminating roller 21. As shown in Figures 23 and 24, the yarn tension detecting device 50 is composed of a generally L-shaped wire rod 51 arranged upstream of the slack eliminating roller 21 and close to its proximal end Q, a pivotal supporting section 52 that supports the middle of the wire rod 51 for rotative movement, and a switching member 54 such as a microswitch which outputs an ON operation signal when a terminal portion 53 of the wire rod 51 abuts against the switching member 54 to apply a predetermined pressure or higher to the switching member 54.

[0086] While the yarn Y is not wound around the slack eliminating roller 21 (see Figures 4 and 5), the wire rod 51 is positioned so as not to come into contact with the yarn Y. Accordingly, no force acts on the wire rod 51, and the terminal portion 53 does not apply any pressure. Consequently, the switching member 54 does not perform an ON operation (see the solid line in Figure 23B). When the yarn Y starts to be wound around the slack eliminating roller 21, the yarn Y comes into contact with the wire rod 51. The wire rod 51 is pressed by the tension of the yarn Y. As a result, as shown by the alternate long and two short dashes line in Figure 23B, the wire rod 51 is rotatively moved using the pivotal supporting section 52 as an axis to cause the terminal portion 53 to press the switching member 54. Then, a predetermined or higher tension acts on the wire rod 51 to allow the terminal portion 53 to apply a pressure of a predetermined value or larger. Then, the switching member 54 is turned on to output an operation signal to the unit controller 61.

[0087] As described above, the pressure of the wire terminal portion 53 on the switching member 54 depends on the magnitude of the tension of the yarn Y, which contacts with the wire rod 51. That is, the switching member 54 is turned on and off depending on the magnitude of the tension of the yarn Y. Furthermore, the tension of the yarn Y is determined by the amount of yarn wound around the slack eliminating roller 21 (the amount of slack). This is because when a large amount of yarn Y is wound, the resistance to the sliding friction between the yarn Y and the slack eliminating roller 21 is large. Accordingly, the yarn Y does not slide smoothly on the surface of the slack eliminating roller 21. Consequently, the tension of the yarn Y is high upstream of the slack eliminating roller 21. In contrast, when only a small amount of yarn Y is wound, the yarn Y slides smoothly on the surface of the slack eliminating roller 21. Accordingly, the tension of the yarn Y decreases upstream of the slack eliminating roller 21. Therefore, when there is a large amount of slack of the yarn Y on the slack eliminating roller 21, the yarn tension is high enough to allow the switching member 54 to maintain an ON operation. When the amount of slack of the yarn Y decreases, the yarn tension also decreases to turn off the switching member 54. With this mechanism, by properly setting the yarn tension with which the switching member 54 is turned on, the yarn tension detecting device 50 according to the present embodiment can make detection as to whether the amount of slack of the yarn Y on the slack eliminating roller 21 exceeds a predetermined value or is insufficient. The yarn tension detecting device 50 thus functions as wound yarn amount detecting means. It is therefore possible to optically detect the amount of yarn Y wound around the slack eliminating roller 21 and to detect the amount of slack using the simple mechanism and without contacting with the yarn Y wound around the slack eliminating roller 21.

[0088] A description will be given below of operations performed if the spinning machine 1 configured as de-

scribed previously is used to form a cone package. As shown in Figures 3 to 5, while a normal operation is being performed in the spinning unit 2 at which the work carriage 3 is not stopped, the upstream side guide 23 of the yarn slack eliminating device 10 is forcibly pulled by the tensile member such as a spring (not shown in the drawings) and thus remains at the backward position. In this state, a yarn winding operation is performed. Furthermore, in each spinning unit 2 of the spinning machine 1, the draft device 4 feeds the bundle of fibers S to the spinning device 5, and the yarn feeding device 6 feeds downstream the yarn Y spun and generated by the spinning device 5. The yarn Y is then passed directly in front of the yarn sucking device 7 and the yarn defect detector 9 and fed to the winding device 12 via the upstream side guide 23, the downstream side guide 36, and the waxing device 11. Then, the yarn Y is wound around the bobbin 15, rotatively driven by the rotating drum 13, to form the package 16.

[0089] After the yarn has started to be wound, a rotation instruction is outputted to the driving motor 35 for the slack eliminating roller 21 via the driver substrate 40 (see Figure 2) at an appropriate time. As shown in Figure 6, the slack eliminating roller 21 is rotatively driven and this rotative driving state is maintained during spinning. As described previously, the rotation locus surface of the bar-like member 22a, provided in the slack eliminating roller 21, is set to cross the yarn path defined by the upstream side guide 23 and the downstream side guide 36. Accordingly, rotating the slack eliminating roller 21 allows the bar-like member 22a to engage naturally with the yarn Y. Furthermore, the bar-like member 22a is shaped so as to engage easily with the yarn Y and so that the yarn Y does not easily fit into the gap between the slack eliminating roller 21 and the bar-like member 22a. The yarn Y can thus be reasonably provided to the outer peripheral surface of the slack eliminating roller 21. Consequently, the mere rotation of the slack eliminating roller 21 enables the yarn Y to be reliably wound around the outer peripheral surface of the slack eliminating roller 21 as shown in Figures 7 and 8. In this connection, on the basis of the yarn Y spinning speed of the spinning device 5 (substantially the yarn feeding speed of the yarn feeding device 6), the rotation speed of the slack eliminating roller 21 is calculated and set by the calculating section (b) on the basis of an input value from the input section (a) so that the yarn Y fed downstream by the yarn feeding device 6 undergoes an appropriate tension immediately after spinning.

[0090] The yarn slack eliminating device 10 provides a function of winding the yarn Y around the slack eliminating roller 21 to eliminate the slack of the yarn Y in the yarn path. The yarn slack eliminating device 10 also provides a function of increasing or reducing the amount of slack to adjust the winding tension of the yarn Y. This mechanism will be described below. The amount of slack of the yarn Y retained on the slack eliminating roller 21 is determined by the difference between the up-

stream spinning speed and downstream spinning speed (the speed at which the yarn is unwound from the slack eliminating roller 21) of the slack eliminating roller 21. The winding speed is normally set to be slightly higher than the spinning speed in order to apply an appropriate winding tension to the yarn Y. Then, a load equal to the difference in speed acts on the bar-like member 22a. This is because when the spinning speed is higher, the amount of yarn Y supplied to the slack eliminating roller 21 always exceeds the amount of yarn Y unwound and directed to the winding device 12, thus simply increasing the amount of yarn wound around the slack eliminating roller 21.

[0091] As described previously, the bar-like member 22a can be rotated independently of the slack eliminating roller 21. Furthermore, the transmitted force adjusting mechanism can adjust a rotative driving force transmitted by the slack eliminating roller 21 to the bar-like member 22a. Accordingly, when the load acting on the bar-like member 22a has a predetermined value or smaller, the bar-like member 22a rotates integrally with the slack eliminating roller 21. The yarn Y is thus wound around the slack eliminating roller 21 to increase the amount of slack. In contrast, when the load exceeds the predetermined value, the bar-like member 22a rotates or rotatively moves independently of the slack eliminating roller 21 to allow the yarn Y to be unwound from the slack eliminating roller 21. Accordingly, the transmitted force adjusting mechanism can properly set the magnitude of the load associated with the independent rotation (rotative movement) of the bar-like member 22a, to apply a predetermined winding tension to the yarn Y. If the winding speed does not vary but is constant, the yarn Y wound around the slack eliminating roller 21 is unwound at almost a fixed rate.

[0092] If a cone package is formed, the yarn winding radius varies within one traverse. The winding speed thus varies. If the downstream winding speed increases, there will be an increase in the amount of rotation or rotative movement of the bar-like member 22a independent of the slack eliminating roller 21 and in the amount of unwound yarn Y. The winding speed is thus allowed to increase. In contrast, if the winding speed drops, there will be a decrease in the amount of rotation or rotative movement of the bar-like member 22a independent of the slack eliminating roller 21 and in the amount of unwound yarn Y. The winding speed is thus allowed to decrease. In either case, the winding tension can be determined by the transmitted force adjusting mechanism provided between the slack eliminating roller 21 and the bar-like member 22a. Consequently, a stable winding tension can be applied without depending on an increase or decrease in winding speed. With the above described mechanism, the yarn slack eliminating device 10 according to the present embodiment provides a function of permitting a variation in winding speed that may occur while the yarn is being wound into a cone package, to make the winding tension constant.

[0093] To allow the yarn slack eliminating device 10 to provide the functions of permitting a variation in winding speed and stabilizing the winding tension and to minimize the number of operations of setting the yarn Y on the slack eliminating roller 21, it is necessary to make every effort to keep the yarn wound around the slack eliminating roller 21, that is, to avoid exhausting the slack. It is also necessary to maintain this state for a long time. Furthermore, the winding speed is normally set to be slightly higher than the spinning speed during winding. Accordingly, all of the yarn Y wound around the slack eliminating roller 21 is unwound soon unless the rotation of the package 16 is controlled. Thus, in the present embodiment, the amount of slack is sensed on the basis of the yarn tension sensed by the yarn tension detecting device 50, arranged immediately upstream of the slack eliminating roller 21. If it is detected that the amount of slack is insufficient, the winding speed of the package 16 is reduced to recover the amount of slack.

[0094] If a predetermined or larger amount of slack is present on the slack eliminating roller 21 and the upstream yarn tension has a predetermined value or larger, then as shown in Figure 23B, the switching member 54 of the yarn tension detecting device 50 continuously outputs an ON signal to the unit controller 61 of the pivoting control mechanism 60, shown in Figures 21 and 22. When the amount of slack on the slack eliminating roller 21 decreases to reduce the yarn tension below the predetermined value, the switching member 54 stops outputting the ON signal. Then, the unit controller 61 outputs a control signal to the controller 62 to separate the package. The controller 62 then outputs an operation signal to the solenoid valve device 63. Thus, compressed air for separation is supplied to the air cylinder 64. Then, as shown in Figure 22, the piston rod 65 of the air cylinder 64 is extended to pivot the cradle arm 14 to separate the package 16 from the rotating drum 13.

[0095] The package 16 separated from the rotating drum 13 and on which the rotative driving force is no longer exerted has its rotation speed reduced by the frictional resistance between the bobbin 15 and the cradle arm 14 and the like. As a result, as described previously, the downstream winding speed of the yarn slack eliminating device 10 decreases below the spinning speed of the yarn Y introduced into the slack eliminating roller 21. This difference in speed increases the amount of slack retained on the slack eliminating roller 21. After the time required to increase the amount of slack retained on the slack eliminating roller 21 has passed, the controller 62 outputs an operation signal on the basis of a control signal from the unit controller 61. The operation signal causes the solenoid valve device 63 to operate to remove the compressed air for separation from the air cylinder 64. Thus, the piston rod 65 withdraws to pivot the cradle arm 14 in the returning direction to bring the package 16 into contact with the rotating drum 13 again. Then, the yarn winding process is continued at the nor-

mal winding speed.

[0096] The package 16 has an inertia moment varying depending on the size of the winding diameter. Thus, the time varies which is required to reduce the winding speed to a predetermined value to increase the amount of slack retained on the slack eliminating roller 21 up to the desired value after the package 16 has been separated from the rotating drum 13. Specifically, when the package 16 has a large winding diameter, it has a large inertia moment. Accordingly, compared to a smaller winding diameter, a long time is required to reduce the winding speed to the predetermined value after the package 16 has been separated from the rotating drum 13. Thus, the present embodiment provides adjusting means for adjusting the amount of speed reduction control for the package 16 by calculating the winding diameter of the package 16 to determine the weight of the package 16 and then controlling the time for which the package 16 remains separated from the rotating drum 13, in accordance with the winding diameter.

[0097] It is contemplated that the adjusting means may be, for example, a winding length calculating section provided in the unit controller 61 and comprising a spinning speed storage section and a timer section, a yarn type and number storage section, a separation time calculating section, and other sections. The winding diameter of the package 16 is determined by the yarn type, yarn number, and winding length. The winding length can be calculated from the winding speed (or spinning speed) multiplied by the winding time. The yarn type, the yarn number, and the winding speed are present on the basis of spinning conditions. Accordingly, the winding diameter of the package 16 can be calculated from the winding time measured by the timer section. The winding diameter can then be used to calculate the separation time required to reduce the rotation speed of the package 16 to the predetermined value. In a practical sense, the yarn type, the yarn number, and the winding (spinning) speed have preset values, and the winding time is associated with the winding diameter of the package 16. Consequently, a program can be created such that pre-inputting data on the yarn type, yarn number, and winding (spinning) speed enables a separation time calculating section to calculate the optimum separation time in accordance with the winding diameter on the basis of the winding time measured by the timer section. That is, the package separation time can be adjusted only by the winding time.

[0098] With the above adjusting means, the spinning machine 1 according to the present embodiment operates as follows. If the yarn tension detecting device 50 senses during yarn winding that the amount of slack retained on the slack eliminating roller 21 decreases below the predetermined amount, the pivoting control mechanism 60 keeps separating the package 16 from the rotating drum 13 for the predetermined time. The adjusting means contained in the unit controller 61 calculates the optimum separation time in accordance with

the winding diameter of the package 16 on the basis of the already inputted spinning conditions and winding time. After the separation time has passed, the package 16 comes into contact with the rotating drum 13 again. When the package 16 has a small winding diameter, its inertia moment is also small. Thus, when the package 16 leaves the rotating drum 13, its rotation speed decreases rapidly. The amount of slack is then immediately recovered. Accordingly, the package separation time may be short. Since the inertia moment increases consistently with the winding diameter, the rotation speed of the package 16 decreases only slightly when the package 16 is separated from the rotating drum 13. Consequently, the separation time required to increase the amount of slack up to the predetermined time is set to be correspondingly long.

[0099] If the package separation time is not adjusted but is uniformly set, the amount of recovery of the slack amount decreases gradually with increasing winding diameter. As a result, the rotation of the package 16 caused by inertia may prevent the recovery of the amount of slack, thus causing the unwinding of all of the yarn Y wound around the slack eliminating roller 21. In contrast, in the present invention, the amount of retained slack is automatically adjusted in accordance with the package winding diameter. It is thus possible to keep the amount of recovery of the slack amount constant from beginning to end of the winding process to make the winding conditions uniform. This contributes to stabilizing the quality of the package 16.

[0100] When the package 16 has an excessively long separation time, the rotation of the package 16 is stopped. At this time, even through the yarn Y is stopped downstream of the yarn slack eliminating device 10, a traverse guide 70 attempts to traverse the yarn. As a result, the traverse guide 70 may affect the quality of the yarn Y or cause yarn breakage. Moreover, if the stopped package 16 is rapidly brought into contact with the rotating drum 13, the yarn tension may vary rapidly to cause yarn breakage. To avoid these problems, it is necessary to properly set the separation time for the package 16.

[0101] Moreover, for a short time after the yarn Y starts to be wound around an empty bobbin, the package 16 has a light weight. In this state, disadvantageously, the above separating operation may quickly stop the rotation of the package 16. Thus, to prevent this, it is desirable that for a short time after winding has been started, the separating operation be performed by repeating separations and contacts at short intervals to gradually increase the amount of slack retained on the slack eliminating roller 21 while preventing the stoppage of the rotation of the package 16.

[Fifth Embodiment]

[0102] An aspect can be employed in which the winding speed of the package 16 is reduced to increase the

amount of slack in accordance with a preset predetermined speed reduction schedule regardless of the amount of slack retained on the slack eliminating roller 21 of the yarn slack eliminating device 10. For example, it is contemplated that the amount of slack retained on the slack eliminating roller 21 can be recovered within a specified period by periodically executing a step of pivoting the cradle arm 14 to keep separating the package 16 from the rotating drum 13 for a predetermined time and then pivoting the cradle arm 14 in the returning direction to bring the package 16 into contact with the rotating drum 13 again. This configuration ensures that the amount of slack is recovered within a specified time. As a result, even if the amount of slack retained on the slack eliminating roller 21 decreases while the spinning machine is operating, the tension adjustment during the yarn winding process can be reliably continued without a stop. The speed reduction schedule for the winding speed may be properly set on the basis of the spinning conditions.

[0103] In the present embodiment, the yarn tension detecting device 50 arranged upstream of the slack eliminating roller 21 may be omitted. Furthermore, also in the present embodiment, the speed reduction time required to increase the slack of amount by a predetermined amount increases consistently with the winding diameter of the package 16. Accordingly, adjusting means is desirably provided which increases a speed reduction processing time per step of reducing the speed of the package 16, in accordance with the amount of increase in the winding diameter of the package 16.

[0104] Furthermore, the following aspect is very effective in solving both ribboning and saddle bag problems: the speed of the package 16 is reduced with the package 16 kept separate from the rotating drum 13 by a specified distance, while the package 16 is also separated from the traverse guide 70 of a traverse device to the extent that the yarn Y is not disengaged from the traverse guide 70.

[Sixth Embodiment]

[0105] Even if there remains no amount of slack, the degradation of the package may be prevented depending on the spinning conditions if slack elimination can be restarted within a predetermined short time. Thus, it is contemplated an unwinding sensor may be provided which senses that the yarn Y has been completely unwound from the slack eliminating roller 21 so that a process of reducing the speed of the package 16 is executed a predetermined time after the yarn Y has been completely unwound, so as to increase the amount of slack retained on the slack eliminating roller 21 up to a predetermined amount. The sensor sensing the completion of unwinding may be composed of, for example, a touch sensor, a photoelectric switch, a microswitch, or the like which senses that the yarn path of the yarn Y has shifted to one established when the yarn Y has been completely

unwound from the slack eliminating roller 21.

[0106] If the unwinding completion sensor detects that the yarn Y has been completely unwound for any reason, the unit controller 61 or the like controls the package 16 so that the package 16 is separated from the rotating drum 13 to reduce its rotation speed. The yarn path established when the yarn Y is completely unwound from the slack eliminating roller 21 during normal operation is set to cross the rotation locus surface of the bar-like member 22a of the unwinding tension applying member 22. Accordingly, once the speed of the package 16 is reduced to slack the yarn Y, the bar-like member 22a immediately engages with the yarn Y to surely engage the yarn Y with the slack eliminating roller 21. After the time required to increase the amount of slack up to a predetermined value has passed, the package 16 is brought into contact with the rotating drum 13 again. Then, the normal winding process is continued. Also in the present embodiment, the package separation time is desirably adjusted in accordance with the winding diameter of the package 16.

Re: Speed Reduction Control Means

[0107] It is contemplated that as control means for reducing the rotation speed of the package 16, braking means may be provided to apply a braking force to a support shaft of the bobbin 15 or a bobbin supporting section of the cradle arm 14 to force a reduction in the speed of the package 16. This braking means enables the magnitude of the braking force to be adjusted as the amount of speed reduction control. In this case, since the inertia moment varies depending on the winding diameter of the package 16, the magnitude and/or active time of the braking force is adjusted in accordance with the winding diameter of the package 16. Alternatively, a rotative driving motor for the rotating drum 13 may be provided for each spinning unit 2. Then, operations of this motor can be controlled to reduce the speed of the package 16.

Re: Winding Diameter Detecting Means

[0108] Means for detecting the winding diameter of the package 16 includes not only means for calculating the winding diameter from the winding time but also means for measuring the rotation speed of the bobbin 15, which supports the package 16, so that the winding diameter of the package 16 can be calculated from the rotation speed.

[Seventh Embodiment]

[0109] While a yarn splicing operation is being performed or a cone package is being formed as described previously, yarn breakage may occur downstream of the slack eliminating roller 21 for any reason even though the yarn remains wound around the slack eliminating

roller 21. In this case, if no action is taken, the slack eliminating roller 21 continues rotating, so that the cut yarn end may be caught in the slack eliminating roller 21 or the spun yarn Y may continue to be wound around the slack eliminating roller 21. In this case, the operator must perform a removing operation. Thus, a yarn breakage sensor is provided downstream of the slack eliminating roller 21 so that immediate action can be taken when yarn breakage is sensed.

[0110] In the present embodiment, as an example of a yarn breakage sensor 100, a component composed of a microswitch 101 and a wire- or bar-like sensor rod 103 supported by a hinge portion 104 for rotative movement is disposed downstream of the downstream side guide 36 (when the waxing device 11 is provided, this component is disposed further downstream) as shown in Figure 25. The sensor rod 103 can be rotatively moved between a position X1 where it abuts against a sensor section 102 of the microswitch 101 and a position X2 where it abuts against a stopper 105. The sensor rod 103 is installed so as to reliably come into contact with the yarn Y unwound from the slack eliminating roller 21 and passing through the slit 36a in the downstream side guide 36.

[0111] While the yarn Y pulled out of the slack eliminating roller 21 is being clamped by the yarn splicing device 17 (see Figure 7) or the yarn Y unwound from the slack eliminating roller 21 is being wound around the package 16 (see Figure 14), a tension of a predetermined value or larger acts on the yarn Y passing through the slit 36a in the downstream side guide 36. Thus, the sensor rod 103 of the yarn breakage sensor 100 is pushed by the yarn Y to the position X1. The sensor section 102 of the microswitch 101 is thus pressed to cause the microswitch 101 to output an ON signal. If yarn breakage occurs downstream of the slack eliminating roller 21 for any reason, the force acting on the sensor rod disappears. Then, the sensor rod 103 stops pressing the sensor section to in turn discontinue the ON signal from the microswitch 101. The occurrence of yarn breakage can be sensed by for example, allowing the unit controller, provided in the spinning unit 2, to detect the stoppage of the output of the ON signal.

[0112] If the yarn breakage sensor 100 thus senses the yarn breakage occurring downstream of the slack eliminating roller 21, the yarn spinning by the spinning device 5 is stopped and the slack eliminating roller 21 is reversely rotated to unwind the wound yarn. The yarn Y is then caught and sucked by the yarn sucking device 7, arranged upstream, and is then discarded.

[0113] In this connection, when the yarn sucking device 7 catches and sucks the yarn Y as described above, the friction coefficient of the surface of the slack eliminating roller 21 is desirably reduced. The purpose of this reduction is to allow the yarn Y to be quickly separated and unwound from the surface of the slack eliminating roller 21 and to prevent the yarn Y from being wound around the reversely rotating slack eliminating roller 21

in a direction opposite to the normal one; this phenomenon is what is called inverse winding. Means for reducing the friction coefficient includes satin finish on the outer peripheral surface 21a (at least the surface of the cylindrical portion 21c). However, the satin finish may be unnecessary depending on the conditions, for example, if the yarn sucking device 7 can apply a sufficient suction force.

[0114] Moreover, in the present embodiment, as shown in Figure 26, openings H are formed in the cylindrical portion 21c of the slack eliminating roller 21 so as to have an appropriate spacing between them. These openings serve to reduce the area with which the yarn Y wound around the surface of the slack eliminating roller 21 contacts, to in turn reduce the friction coefficient. Furthermore, the formation of the openings H reduces the weight of the slack eliminating roller 21. This advantageously makes it possible to reduce the load on the driving motor 35 as well as the cost of the material for the slack eliminating roller 21.

[0115] The openings H are desirably shaped like slots as shown in Figure 26. This shape allows the operator to easily insert a cutting edge of a yarn cutter or the like into the openings H if the yarn Y wound around the slack eliminating roller 21 gets entangled and cannot be removed by reverse rotation or suction. Figure 26 mainly shows the configuration of the slack eliminating roller 21. The illustration of the unwinding tension applying member 22, including the bar-like member 22a, is omitted.

[Other Embodiments]

[0116] The embodiments of the present invention are not limited to the above described aspects. In the first embodiment, the yarn splicing device 17 is mounted on the work carriage 3 and this single yarn splicing device 17 performs yarn splicing operations on all the spinning units 2. However, an arrangement may be employed in which the yarn splicing device is provided for each spinning unit 2. In this case, the work carriage 3 can be omitted. Furthermore, the specific configuration or shape of the present invention may be properly changed in accordance with the situation.

[0117] According to the yarn winder set forth in Claim 1 of the present invention, the yarn slack eliminating device is provided for each winding unit. Furthermore, the transmitted force adjusting mechanism is provided to adjust the magnitude of a force transmitted to the unwinding tension applying member of the yarn slack eliminating device. Accordingly, the yarn unwinding tension and winding tension can be maintained easily and appropriately. Consequently, during a yarn splicing operation, the yarn unwinding tension applied after yarn splicing has been finished can be made almost equal to the winding tension applied during normal winding, to prevent the formation of steps or the like. Therefore, excellent yarn packages can be easily obtained. Further-

more, if the present invention is applied to, for example, the manufacturing of cone packages, a variation in winding tension is absorbed to stabilize the tension of the yarn when it is unwound from or wound around the slack eliminating roller.

[0118] Moreover, the yarn winder according to the present invention can independently perform different yarn slack eliminating operations on the respective winding units. This solves the problem of Patent Document 2; the tension decreases when an attempt is made to move the work carriage at a high speed during a yarn splicing operation. Furthermore, the present invention does not require any tensers. Advantageously, it is possible to reduce the number of parts as well as the area of the relevant parts with which the yarn contacts. A yarn threading operation can be performed using a simple structure.

[0119] Consequently, the present invention eliminates all the conventional disadvantages described for the technique disclosed in Patent Document 3. Moreover, it is possible to adjust the force transmitted to the unwinding tension applying member of the transmitted force adjusting mechanism. This makes it possible to deal easily with changes in yarn unwinding tension and winding tension associated with the winding conditions such as the yarn type, yarn number, and spinning speed. The present invention can therefore be effectively used to manufacture various products.

[0120] According to the yarn winder set forth in Claim 2 of the present invention, the arrangement is employed in which the transmitted force adjustment operating section of the transmitted force adjusting mechanism is exposed so as to be externally operated. Consequently, if the yarn unwinding tension value is changed or adjusted in association with a change in winding conditions, the operator can easily perform an adjusting operation.

[0121] According to the yarn winder set forth in Claim 3 of the present invention, it is possible to prevent the yarn from being degraded by its interference and contact with the adjusting mechanism when it is unwound from the slack eliminating roller.

[0122] In the yarn winder set forth in Claim 5, each winding unit is provided with the yarn slack eliminating device having the slack eliminating roller around which the slacking yarn is wound during yarn splicing and the unwinding tension applying member that applies a predetermined unwinding tension to the yarn unwound from the slack eliminating roller. Accordingly, once a yarn splicing operation is completed on one winding unit, the work carriage can be moved to another winding unit while the yarn slack eliminating device of the first winding unit is unwinding the yarn. Consequently, if a yarn splicing operation is consecutively performed on a plurality of winding units, it is possible to reduce the time for which the work carriage remains stopped per winding unit. This enables the work carriage to be moved to another splicing-requesting unit more quickly than the conventional work carriages. It is also possible to reduce

the time for which another splicing-requesting unit stops winding. As a result, the operating efficiency of the yarn winder can be improved.

[0123] Furthermore, a more time can be used to unwind the yarn wound around the slack eliminating roller. An appropriate tension can thus be easily applied to the yarn being unwound. Specifically, the tension during unwinding can be made equal to or close to that during regular winding. Therefore, properly wound yarn packages can be reliably obtained.

[0124] In the yarn winder set forth in Claim 6, the unwinding tension applying member is provided with the unwinding tension adjusting mechanism. Accordingly, the tension applied when the yarn is unwound from the slack eliminating roller can be preset or pre-adjusted in accordance with the winding conditions such as the yarn type and the yarn number. This makes it possible to easily deal with a change in the winding conditions.

[0125] In the yarn winder set forth in Claim 7, the tensioning force applying member functions as a yarn guiding member that introduces the yarn into the slack eliminating roller. Consequently, the number of the parts of the yarn slack eliminating device can be reduced to simplify the configuration. Therefore, costs can be reduced.

[0126] In the yarn winder set forth in Claim 8, when the work carriage arrives at the position of the winding unit that requires yarn splicing, the slack eliminating roller starts to rotate on the basis of an arrival sensing signal. This setting enables the operation of the slack eliminating roller of the yarn slack eliminating device to be reliably linked with the operation of the work carrier. Consequently, a yarn splicing operation can be smoothly performed to reduce the loss of operating time of the yarn winder.

[0127] Furthermore, as set forth in Claim 9, in the yarn winder, each slack eliminating roller comprises the driving means so as to be rotatively driven independently. This arrangement enables different yarn slack eliminating operations to be independently performed on the respective winding units. It is thus easy to deal with the manufacturing of various products.

[0128] Moreover, as set forth in Claim 10, an arrangement is employed in which after the yarn wound around the slack eliminating roller has been completely unwound, the unwinding tension applying member is moved to a position where it does not engage with the yarn. This makes it possible to prevent the unwinding tension applying member from contacting with or rubbing against the yarn being regularly wound after unwinding. It is therefore possible to avoid affecting yarn quality after winding has been restarted.

Claims

1. A yarn winder in which a plurality of winding units are disposed, each of the winding units being provided with a yarn slack eliminating device, the yarn winder

being **characterized in that** the yarn slack eliminating device comprises a rotatively driven slack eliminating roller, an unwinding tension applying member that can be rotated concentrically with the slack eliminating roller, and a transmitted force adjusting mechanism provided between the slack eliminating roller and the unwinding tension applying member, and the transmitted force adjusting mechanism transmits rotative driving from the slack eliminating roller to the unwinding tension applying member so that the unwinding tension applying member rotates integrally with the slack eliminating roller when a load of a magnitude equal to or smaller than a predetermined value acts on the unwinding tension applying member, while the unwinding tension applying member rotates or rotatively moves independently of the slack eliminating roller when a load of a magnitude larger than the predetermined value acts on the unwinding tension applying member, the transmitted force adjusting mechanism being capable of adjusting the magnitude of the transmitted force.

2. A yarn winder according to Claim 1, **characterized in that** said transmitted force adjusting mechanism is provided in a junction between the slack eliminating roller and the unwinding tension applying member and has a transmitted force adjustment operating section that sets the magnitude of the transmitted force, and the transmitted force adjustment operating member is exposed so as to be externally operated.
3. A yarn winder according to Claim 2, **characterized in that** a leading end of said transmitted force adjusting mechanism is located closer to a proximal end of the slack eliminating roller than to a plane formed by a locus of a yarn unwound from the slack eliminating roller.
4. A yarn winder according to Claim 3, **characterized in that** the leading end of the transmitted force adjusting mechanism is located between a leading end surface and the proximal end of the slack eliminating roller.
5. A yarn winder in which a plurality of winding units are disposed and which is configured so that a work carriage comprising a yarn splicing device can be moved among the winding units, the yarn winder being **characterized in that** each of the winding units is provided with a yarn slack eliminating device having a slack eliminating roller around which a slacking yarn resulting from splicing is wound and an unwinding tension applying member that operates when the yarn wound around the slack eliminating roller is unwound, to apply a predetermined unwinding tension to the yarn.
6. A yarn winder according to Claim 5, **characterized in that** said unwinding tension applying member is provided with an unwinding tension adjusting mechanism that can preset the magnitude of an unwinding tension applied to the yarn unwound from the slack eliminating roller.
7. A yarn winder according to Claim 5 or Claim 6, **characterized in that** said tensioning force applying member also functions as a yarn guiding member that introduces a yarn into the slack eliminating roller.
8. A yarn winder according to any one of Claims 5 to 7, **characterized in that** said work carriage is set to move to the position of a winding unit on the basis of a yarn splicing request signal outputted by the winding unit and so that when the work carriage arrives at the position of the winding unit, said slack eliminating roller starts to rotate on the basis of an arrival sensing signal.
9. A yarn winder according to any one of Claims 5 to 8, **characterized in that** each slack eliminating roller comprises driving means so as to be rotatively driven independently.
10. A yarn winder according to any one of Claims 5 to 9, **characterized in that** said driving means is configured so that after a yarn wound around said slack eliminating roller has been completely unwound, a position of said unwinding tension applying member is changed to one located away from a yarn path established during regular winding, and then the unwinding tension applying member is stopped.

FIG. 1

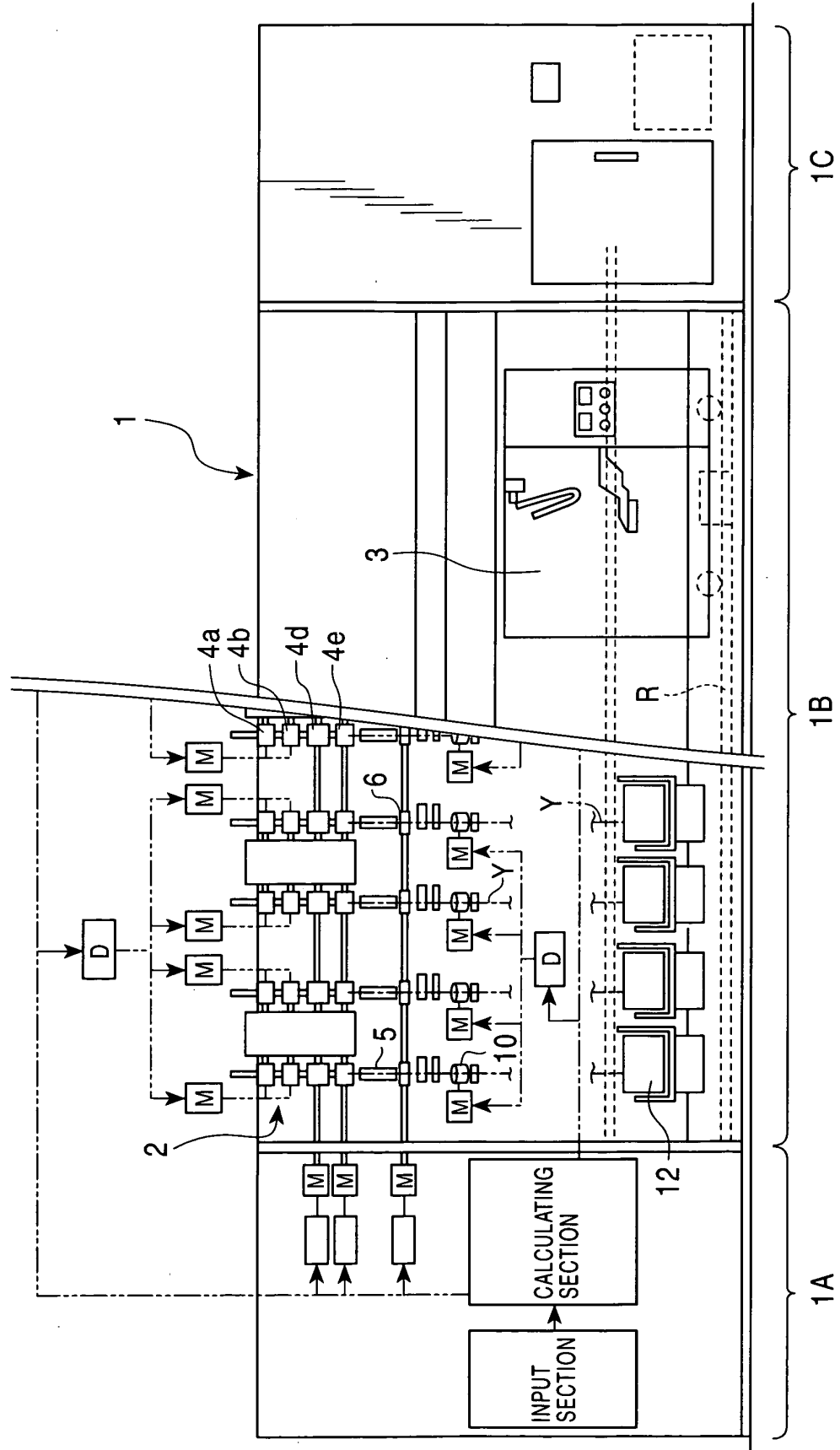


FIG. 2

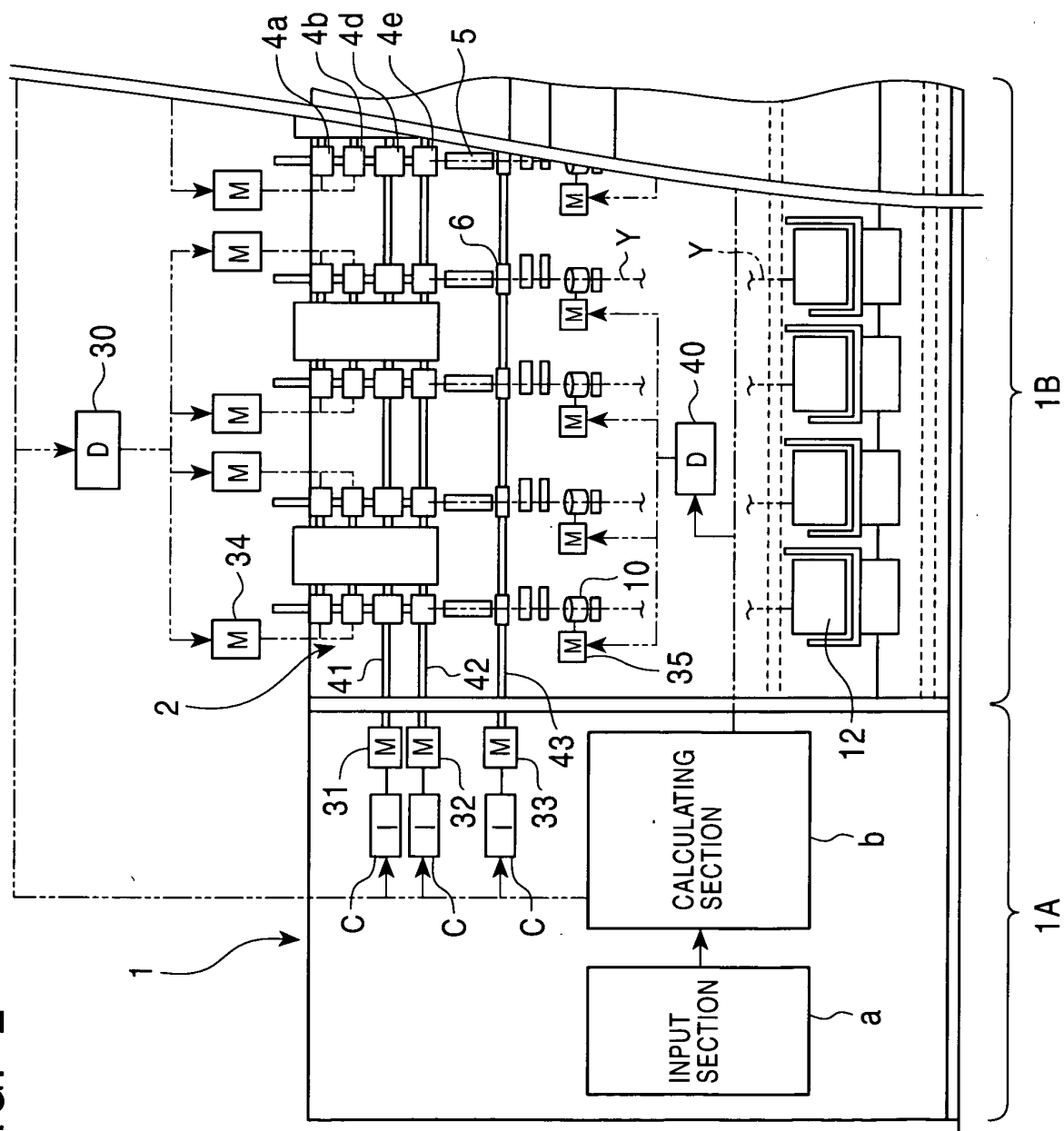


FIG. 3

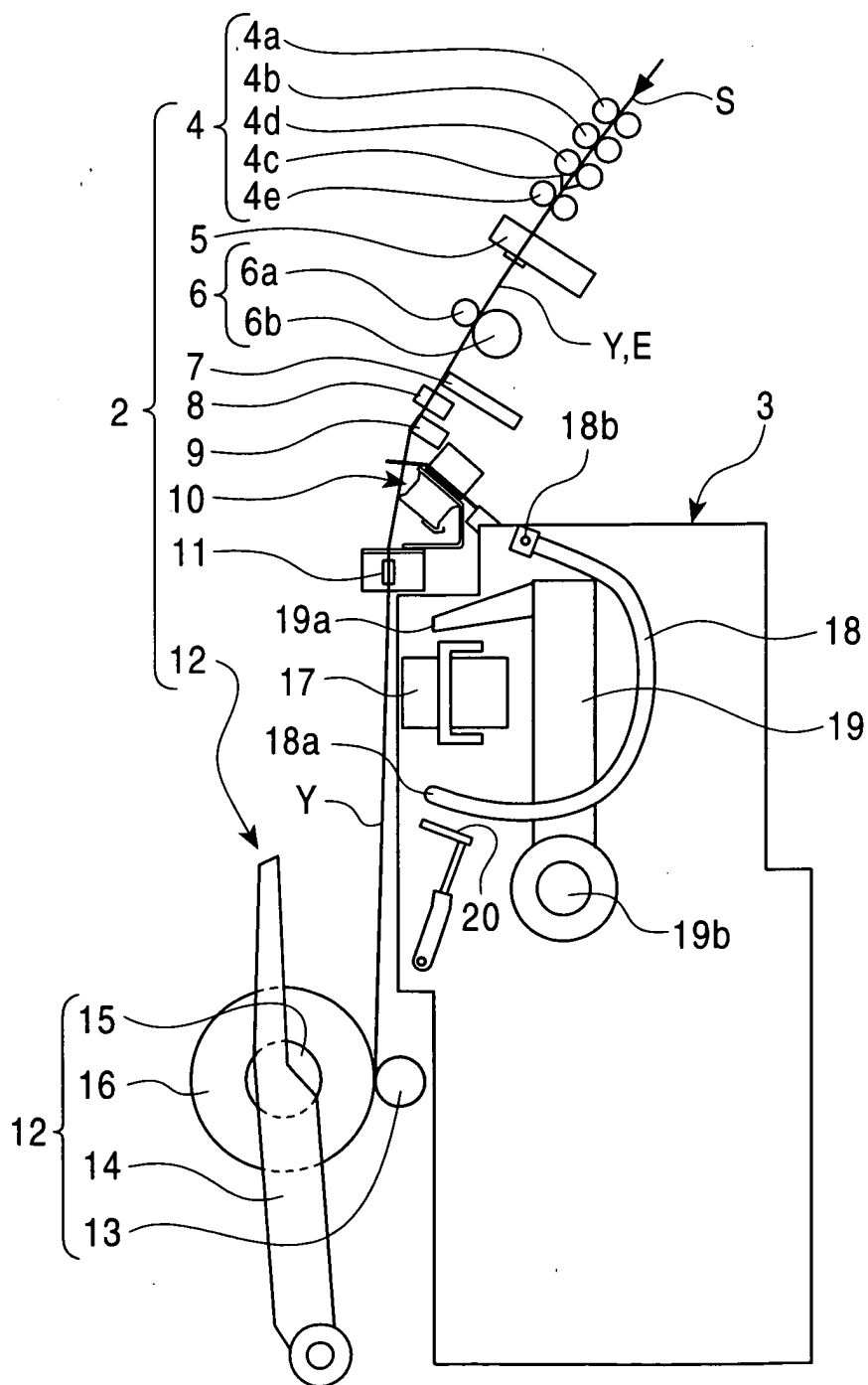


FIG. 4

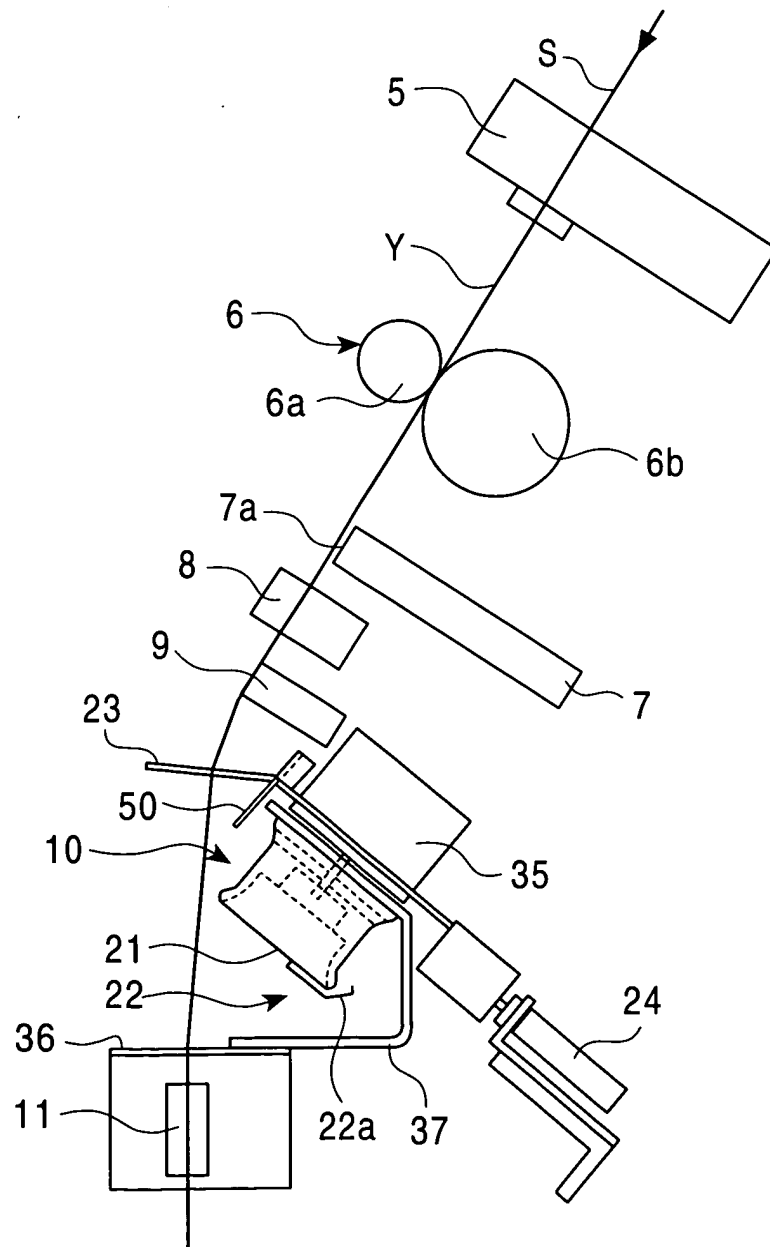


FIG. 5

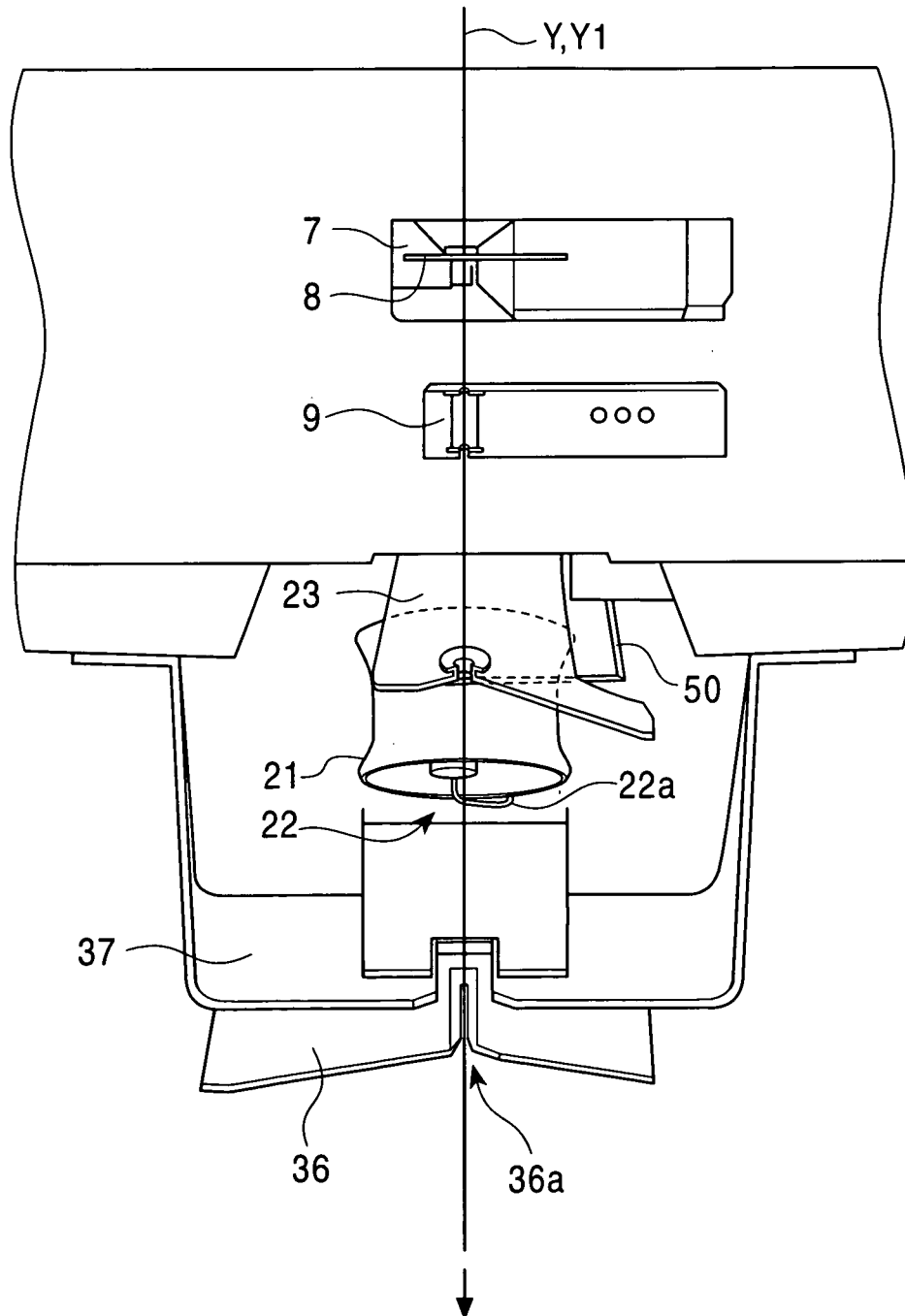


FIG. 6

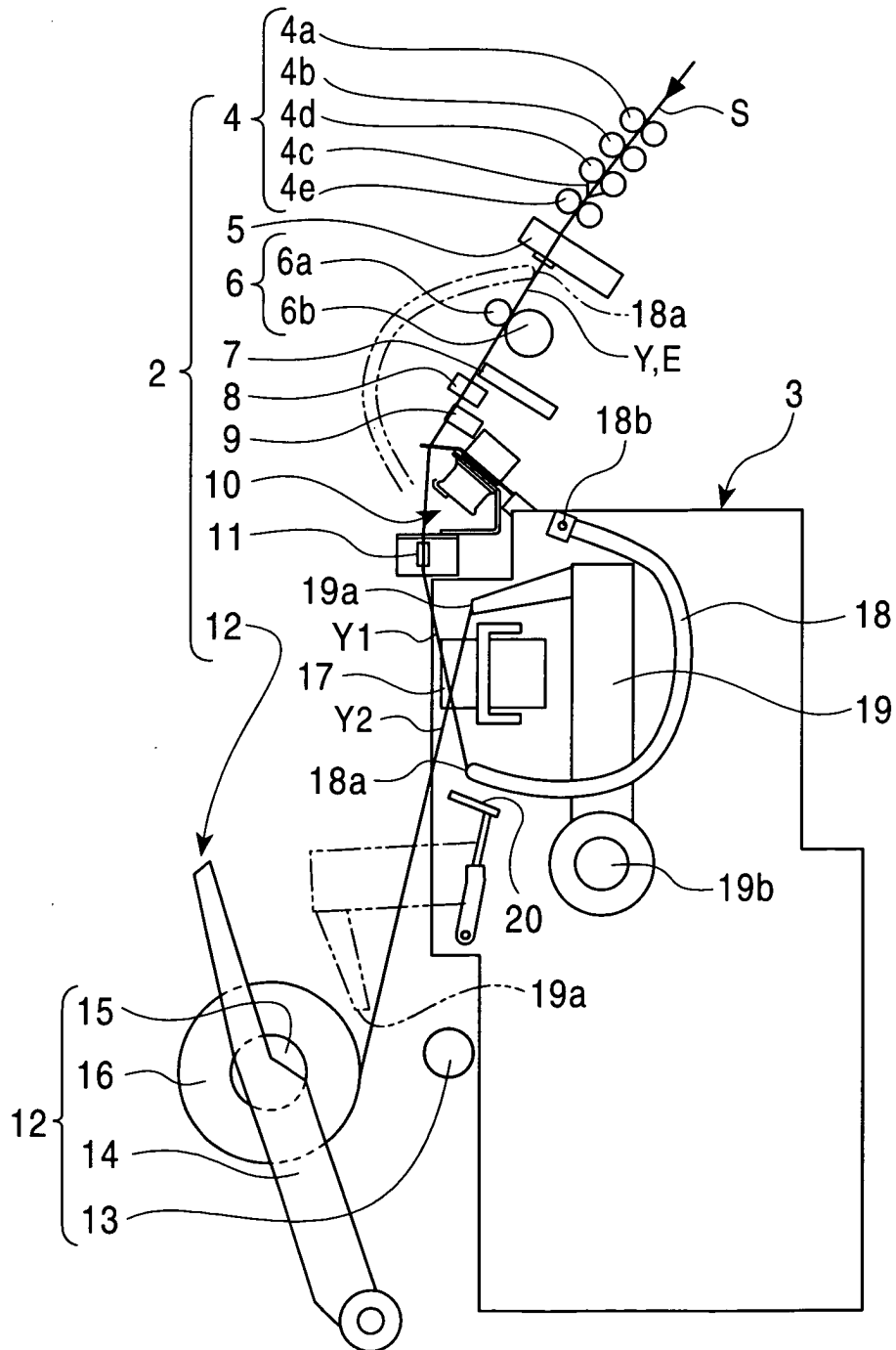


FIG. 7

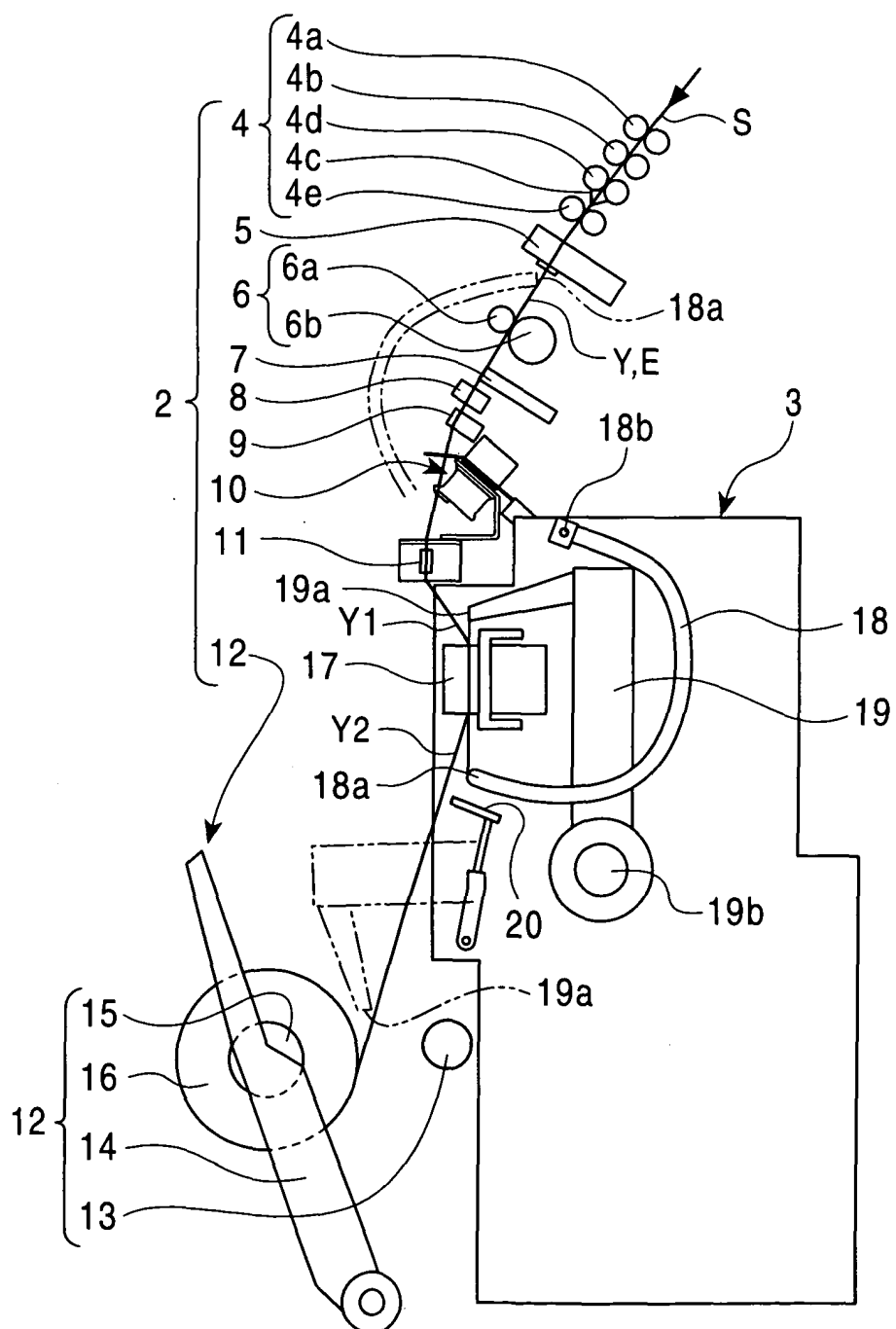


FIG. 8

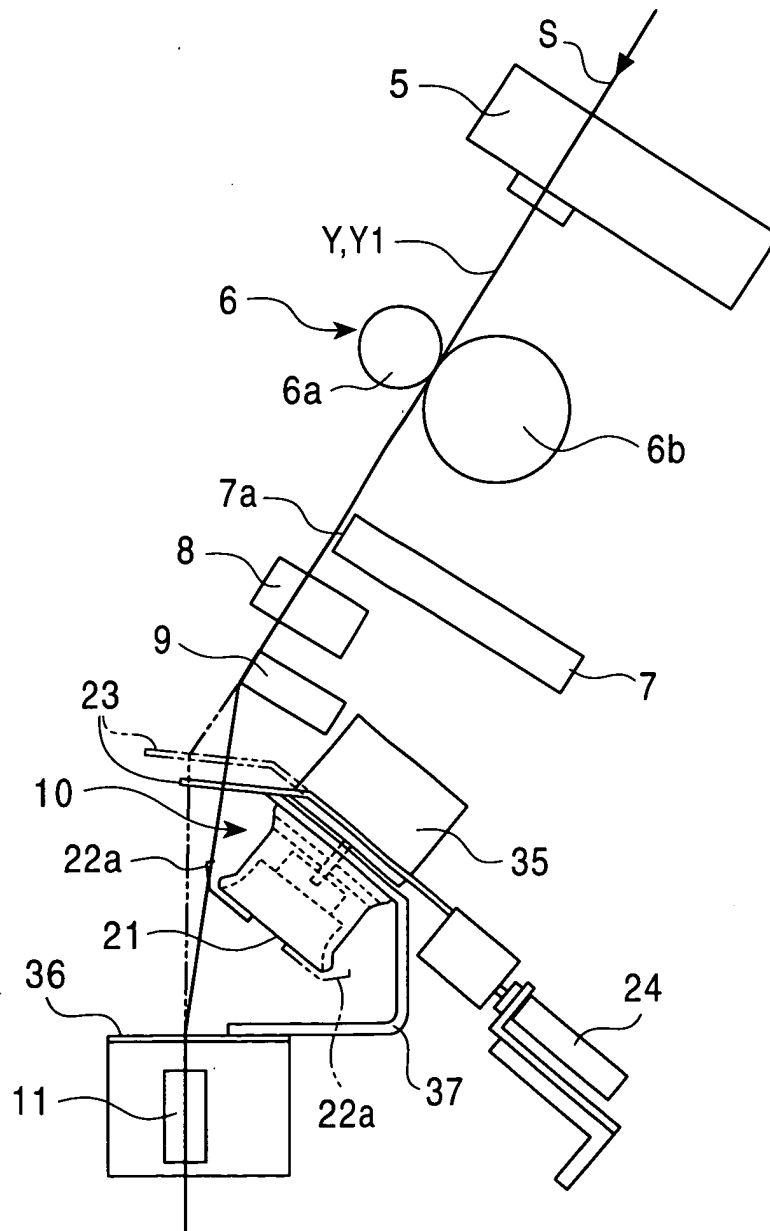


FIG. 9

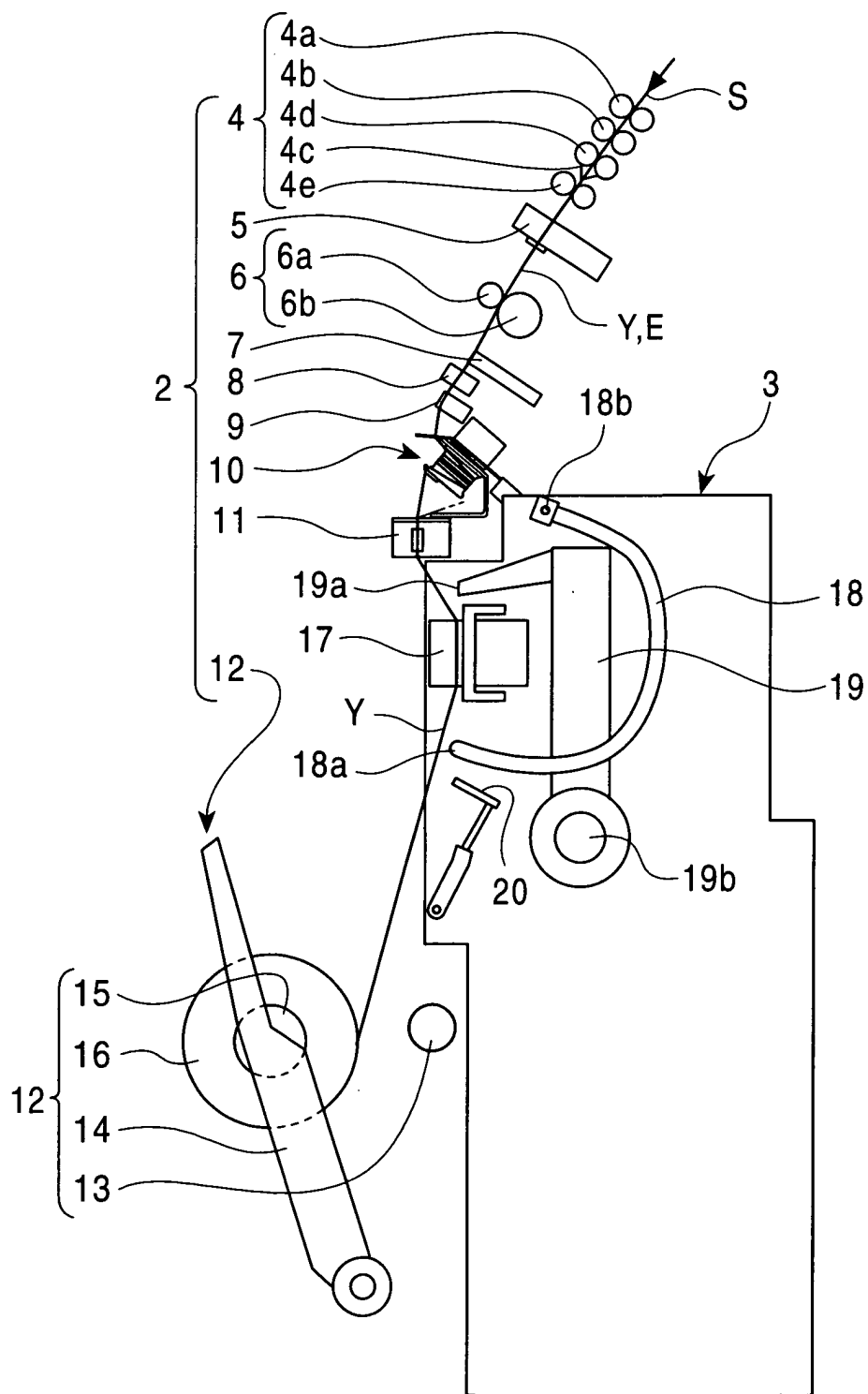


FIG. 10

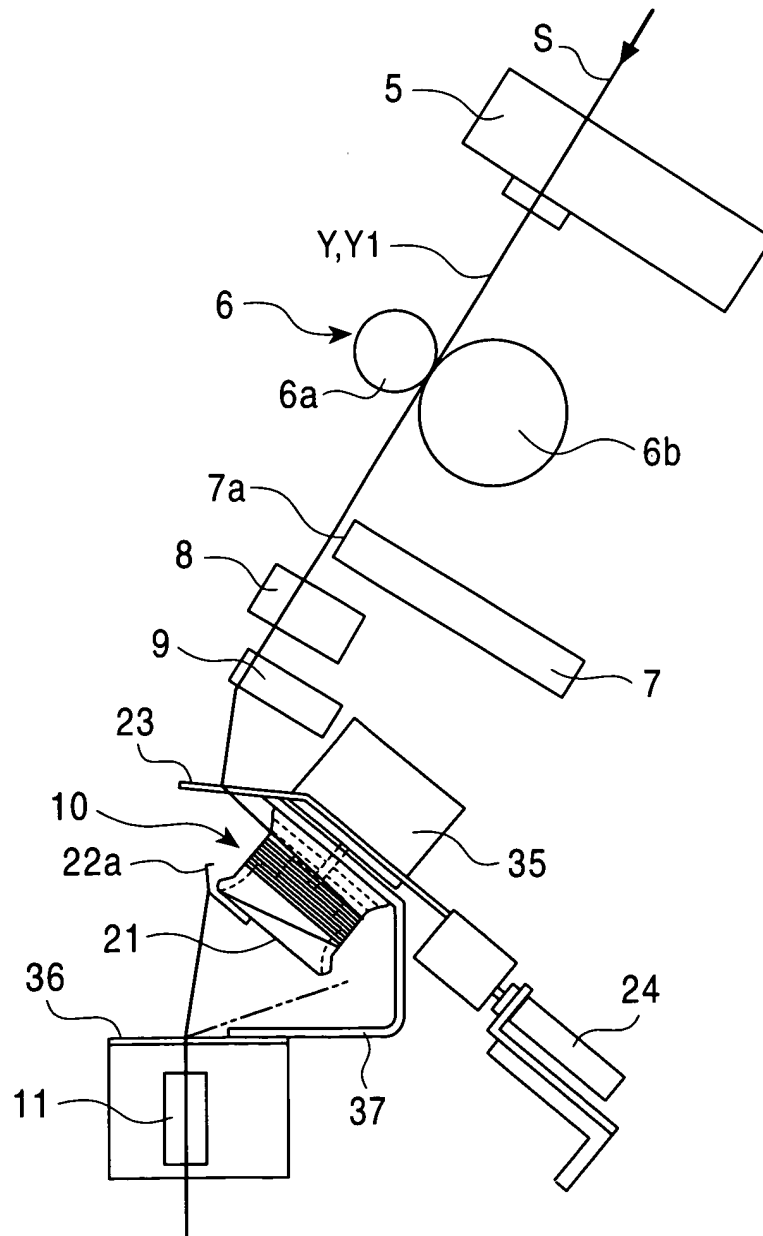


FIG. 11

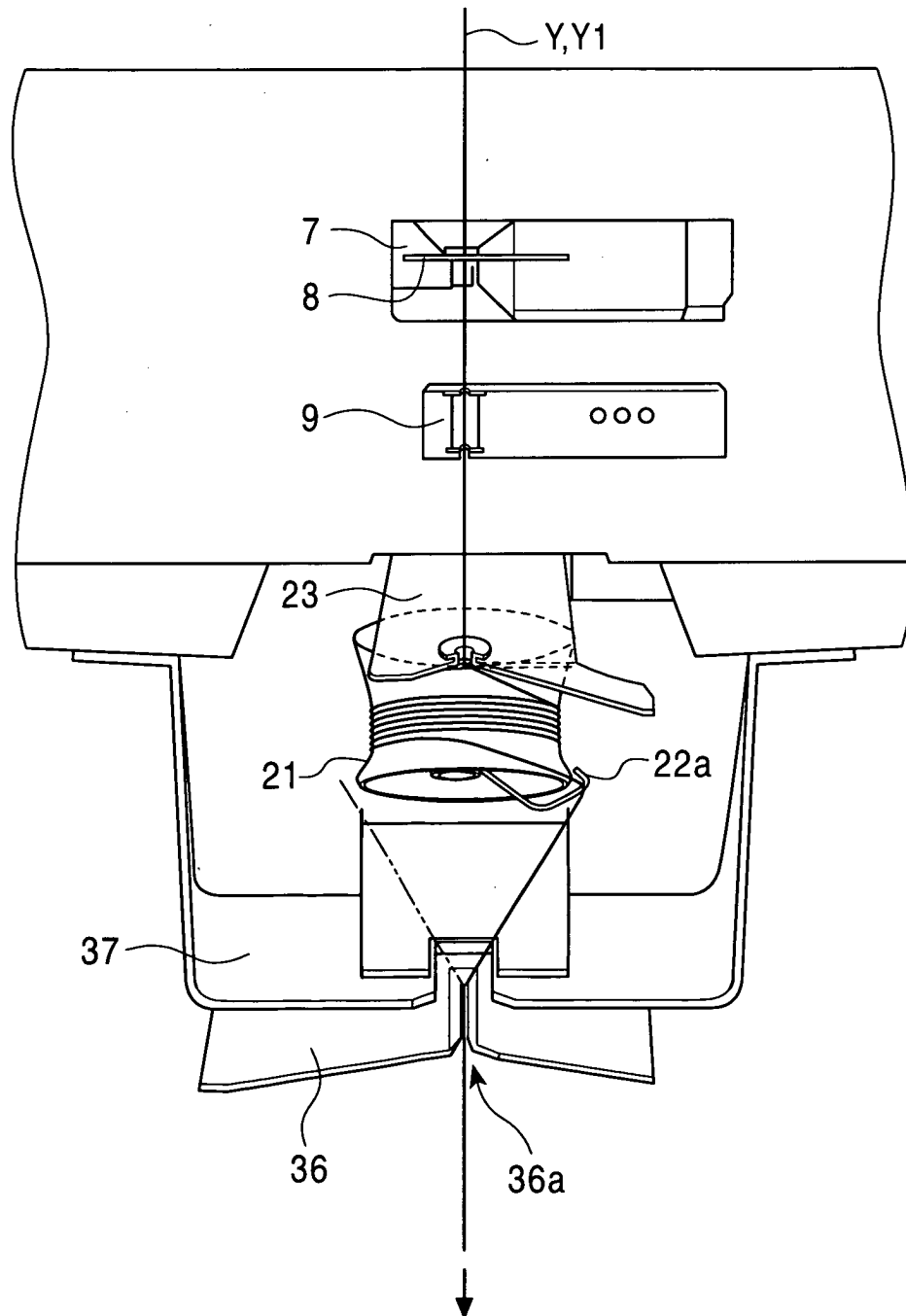


FIG. 12

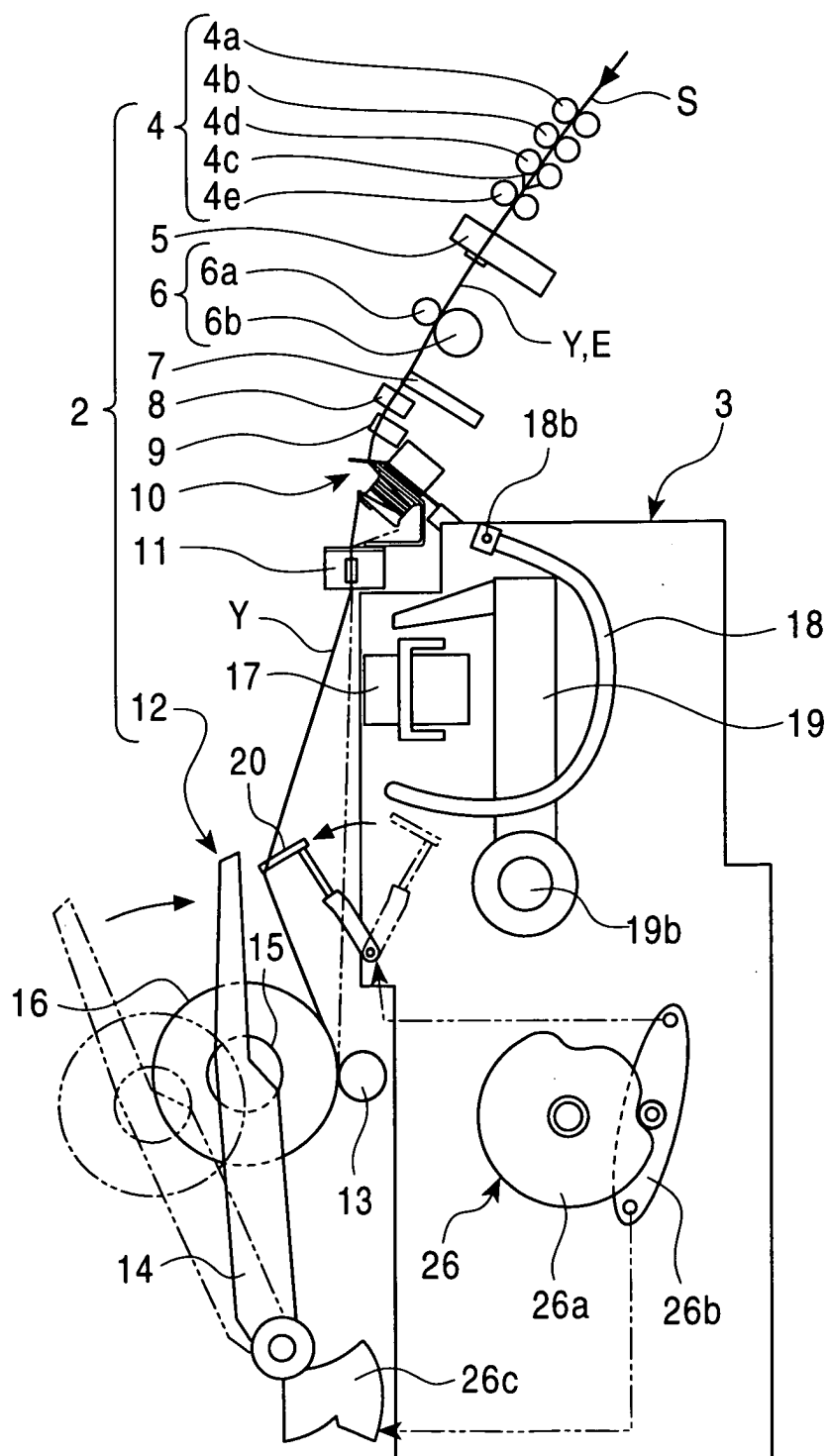


FIG. 13

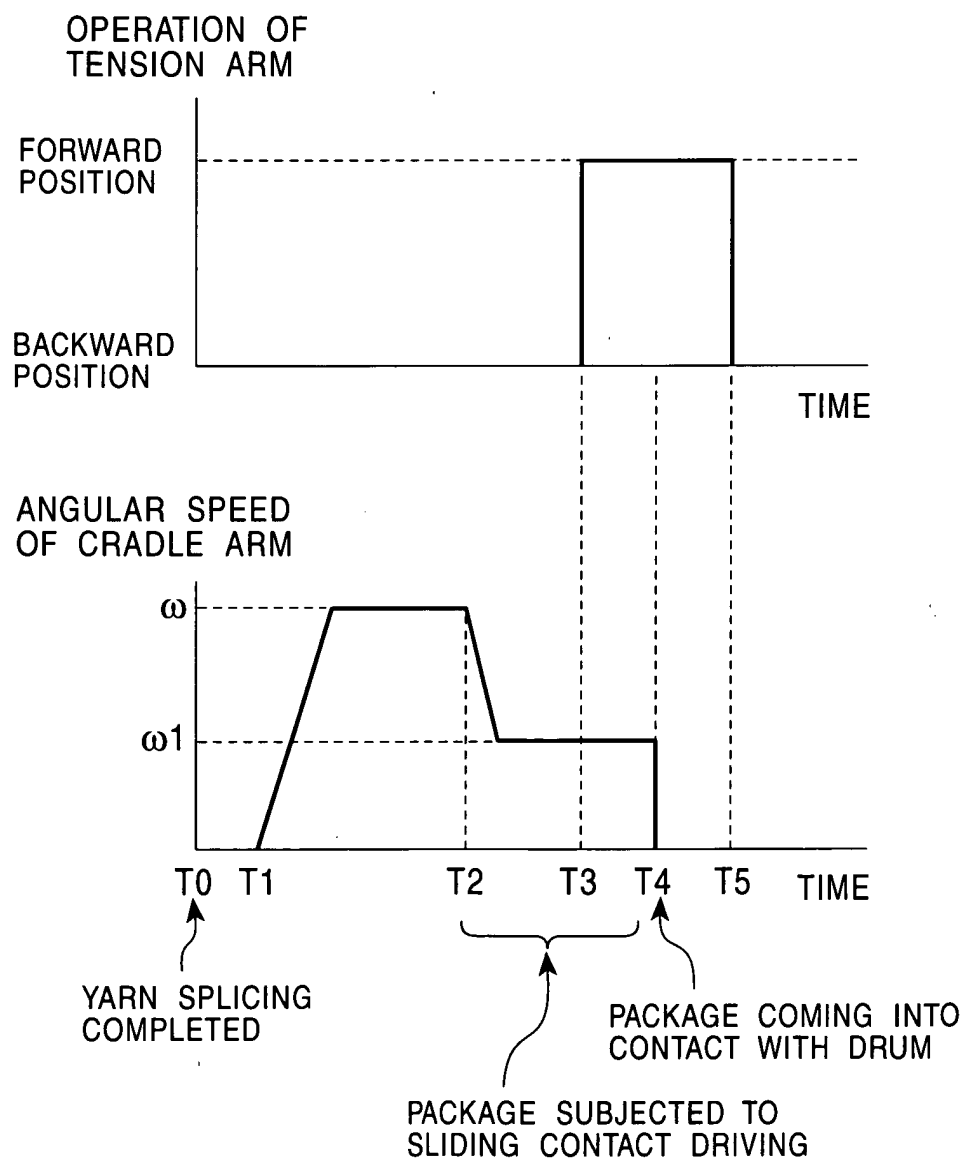


FIG. 14

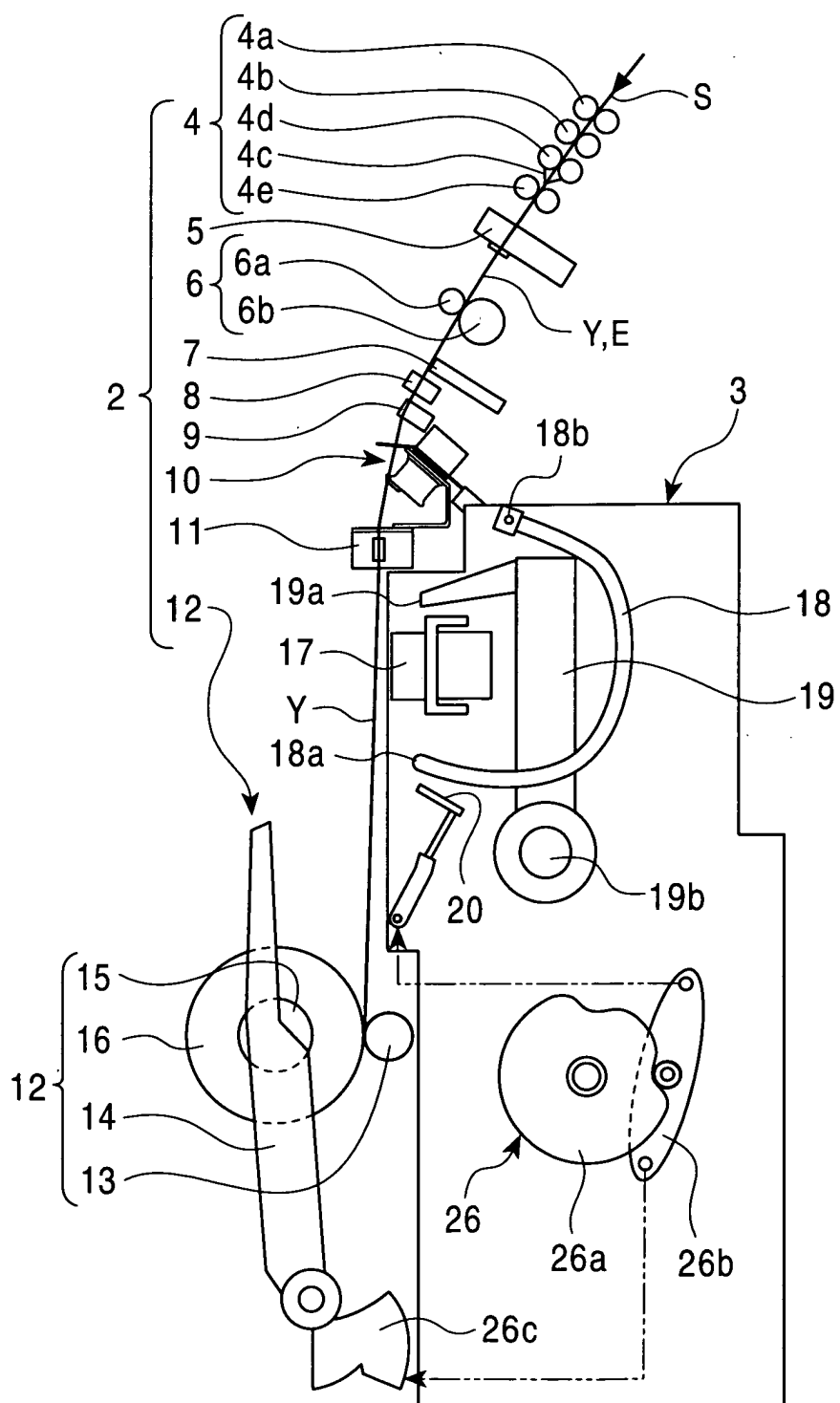


FIG. 15A

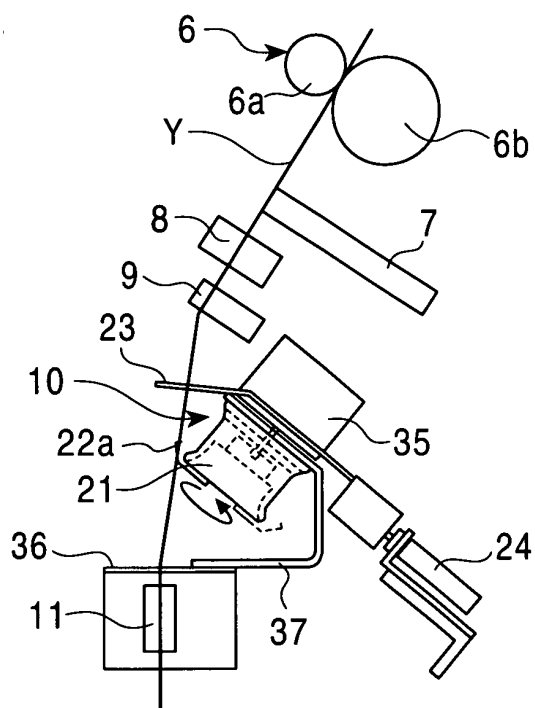


FIG. 15B

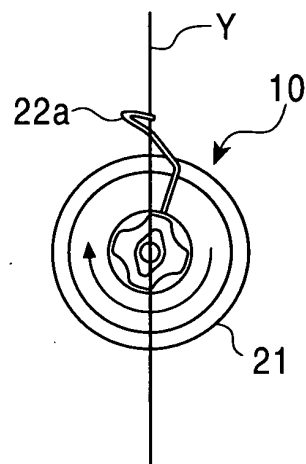


FIG. 15C

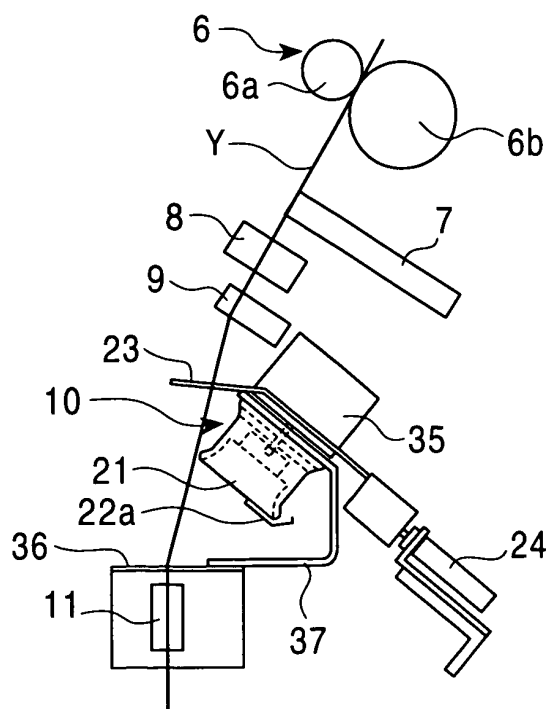


FIG. 15D

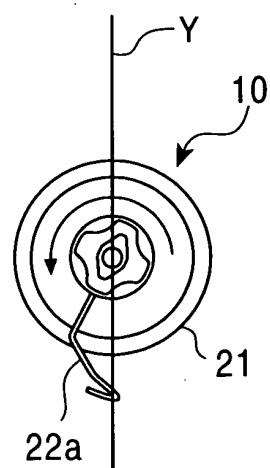


FIG. 16

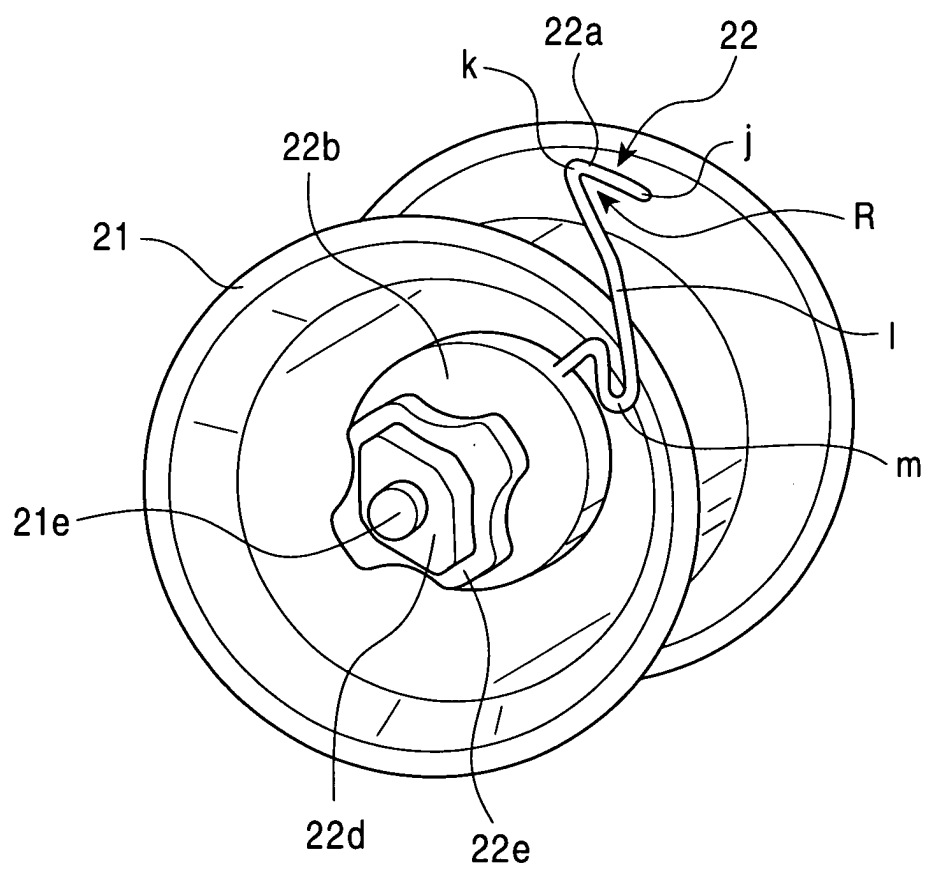


FIG. 17A

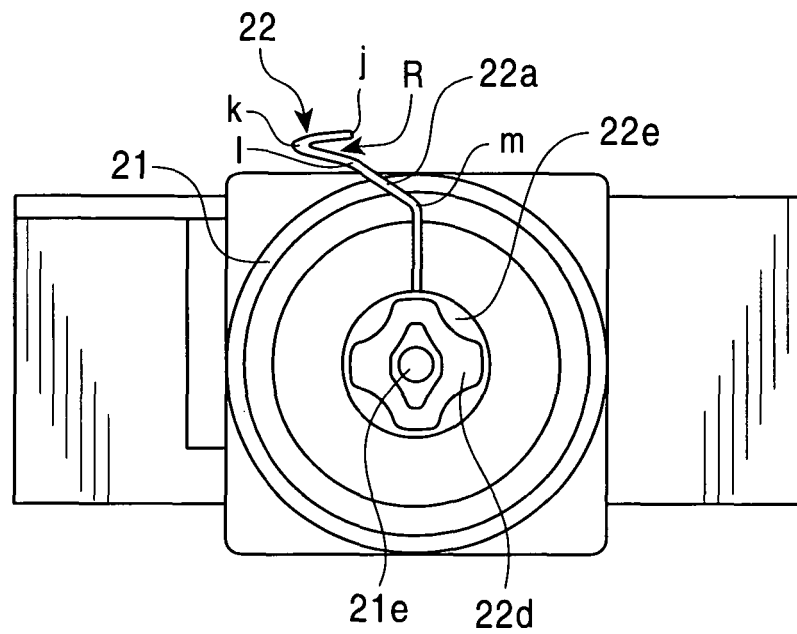


FIG. 17B

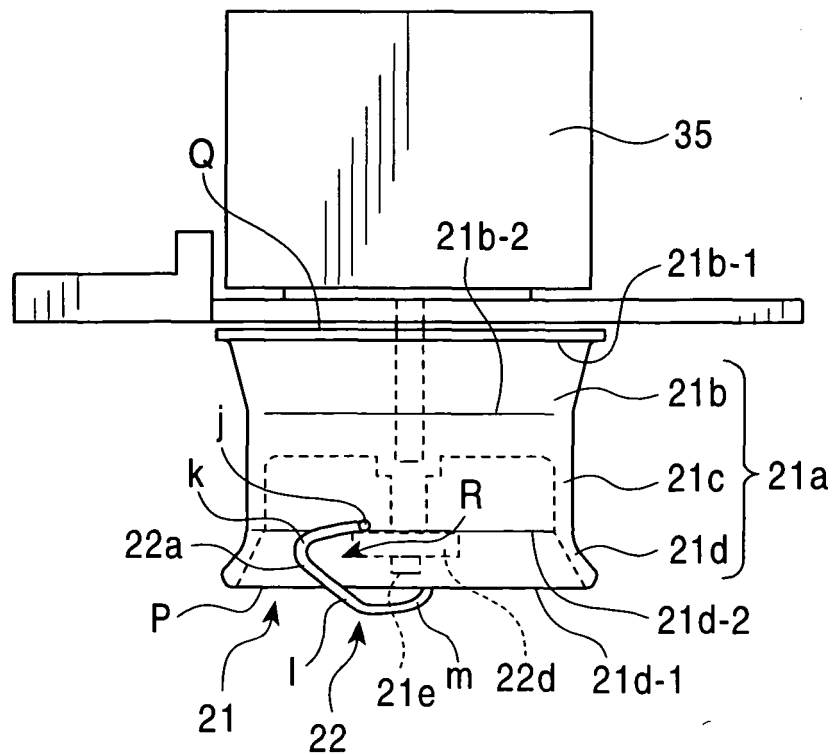


FIG. 18

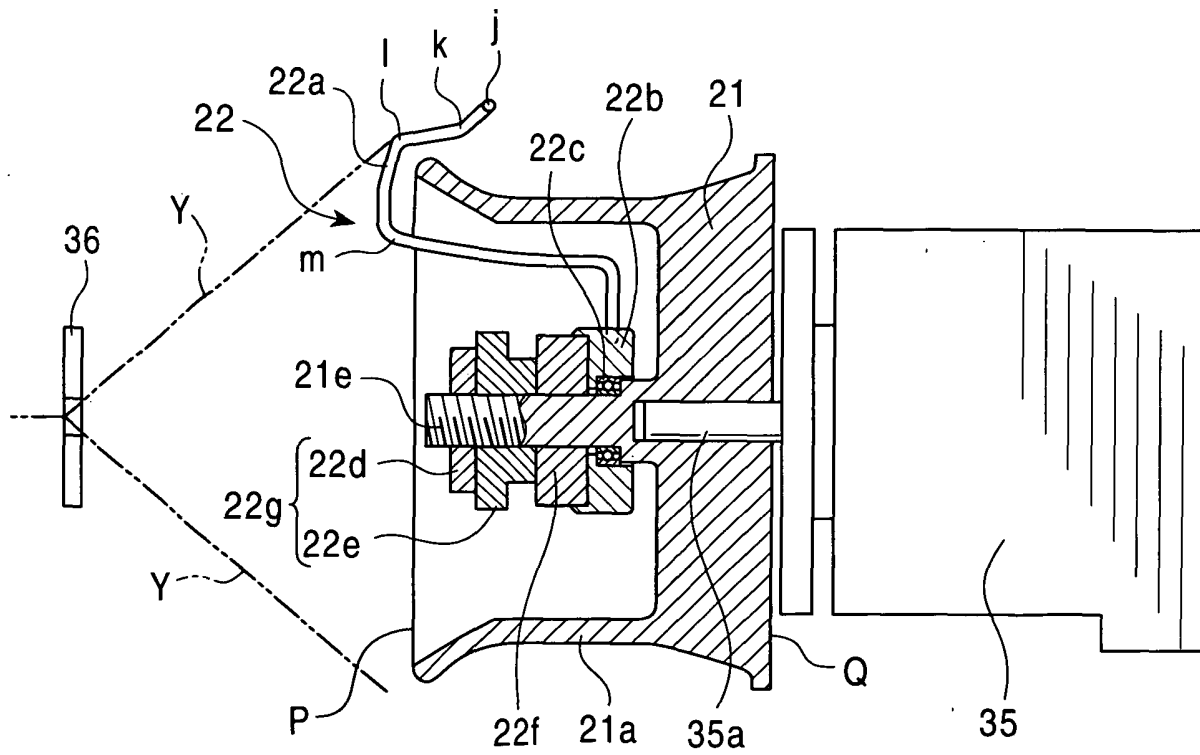


FIG. 19A

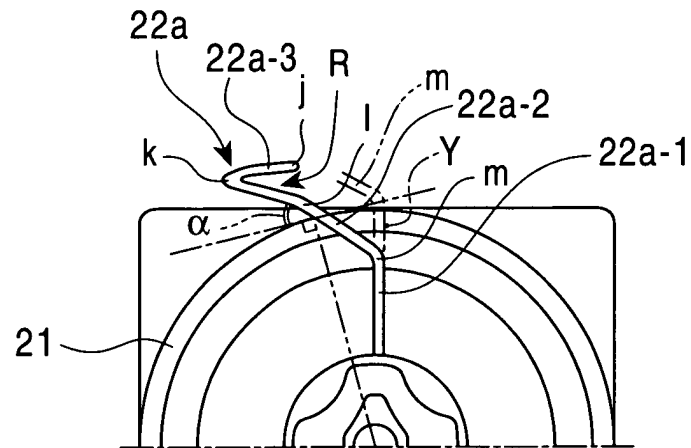


FIG. 19B

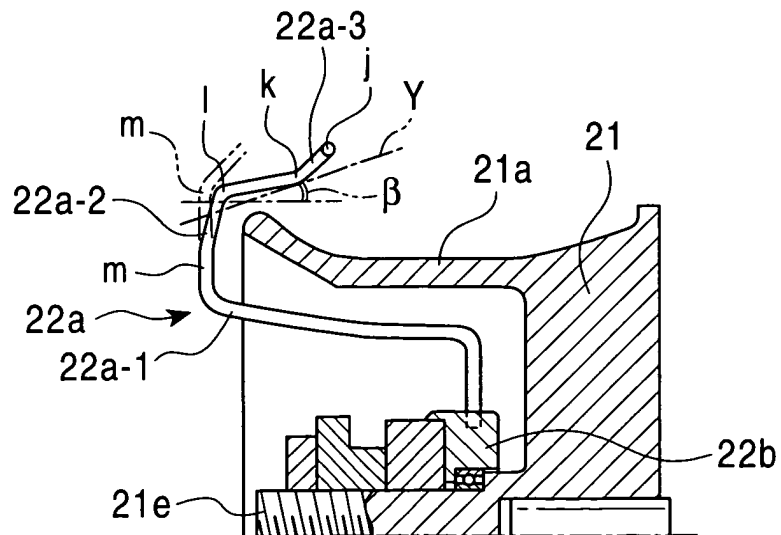


FIG. 20

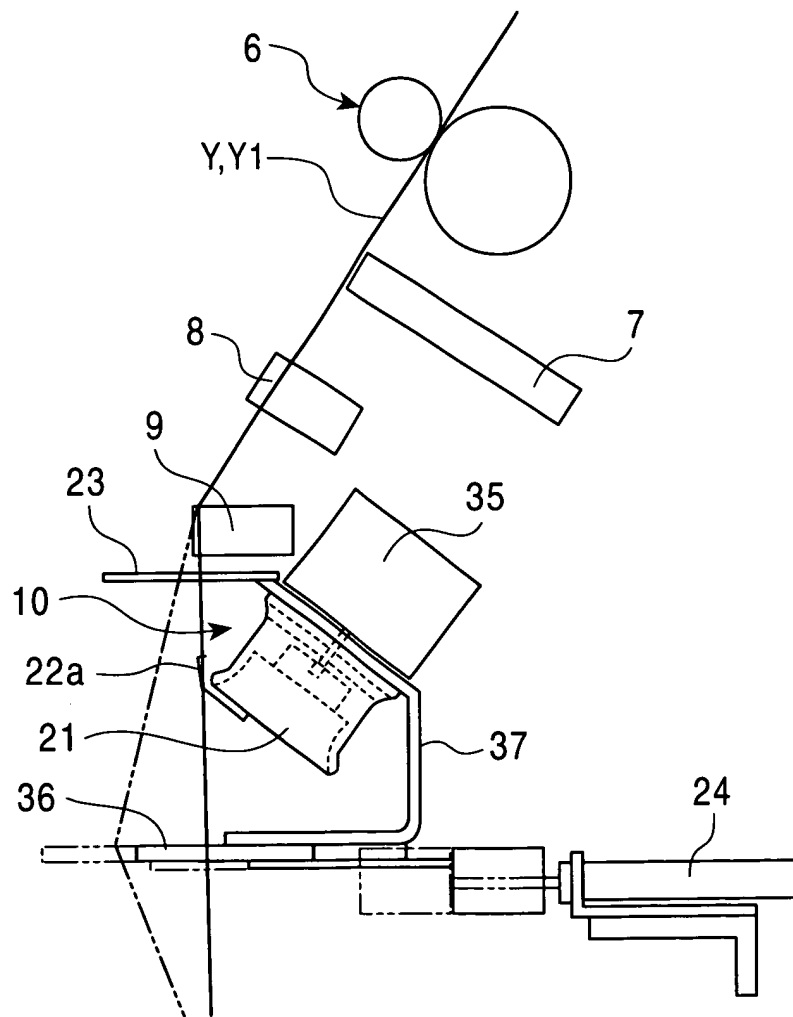


FIG. 21

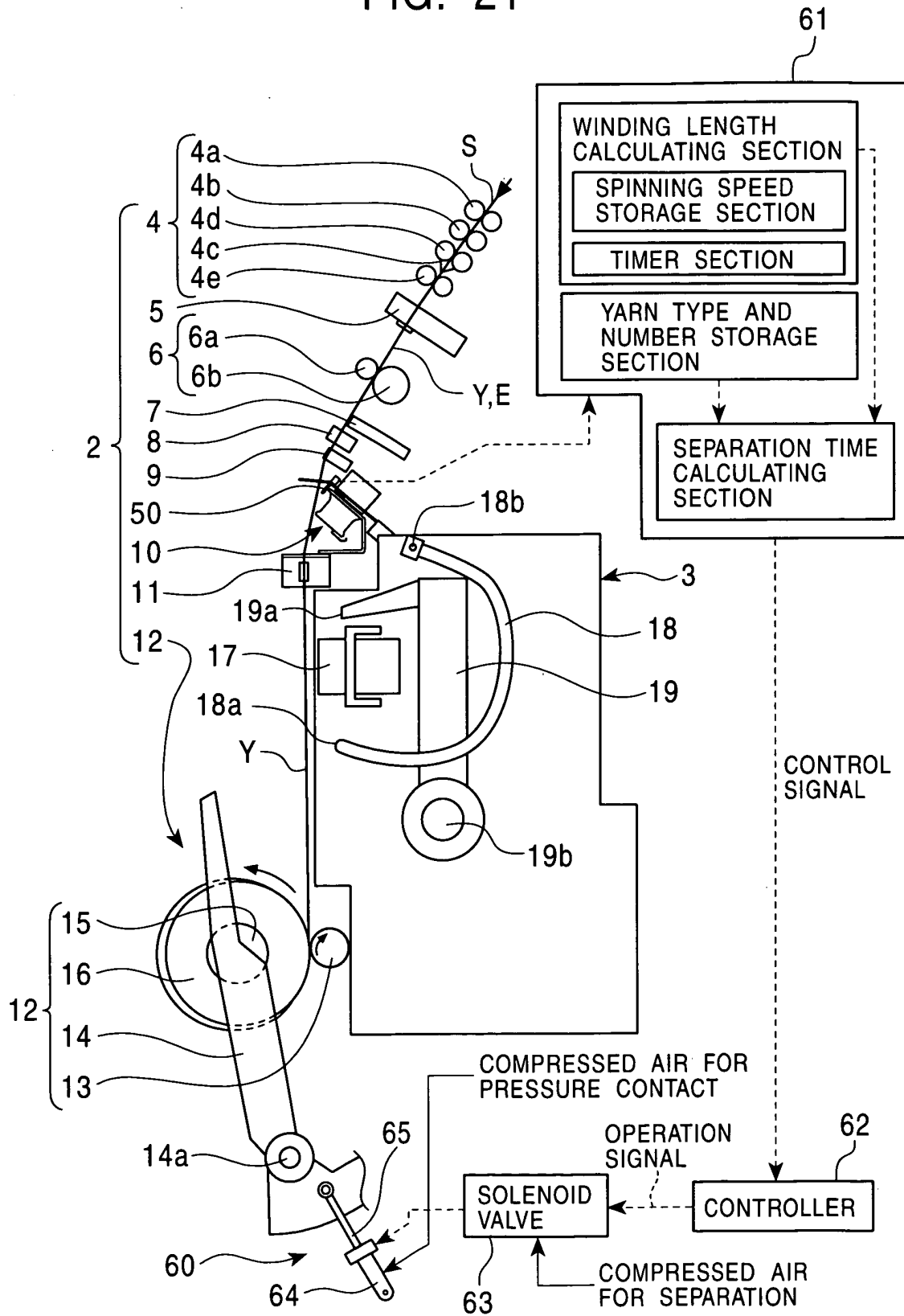


FIG. 22

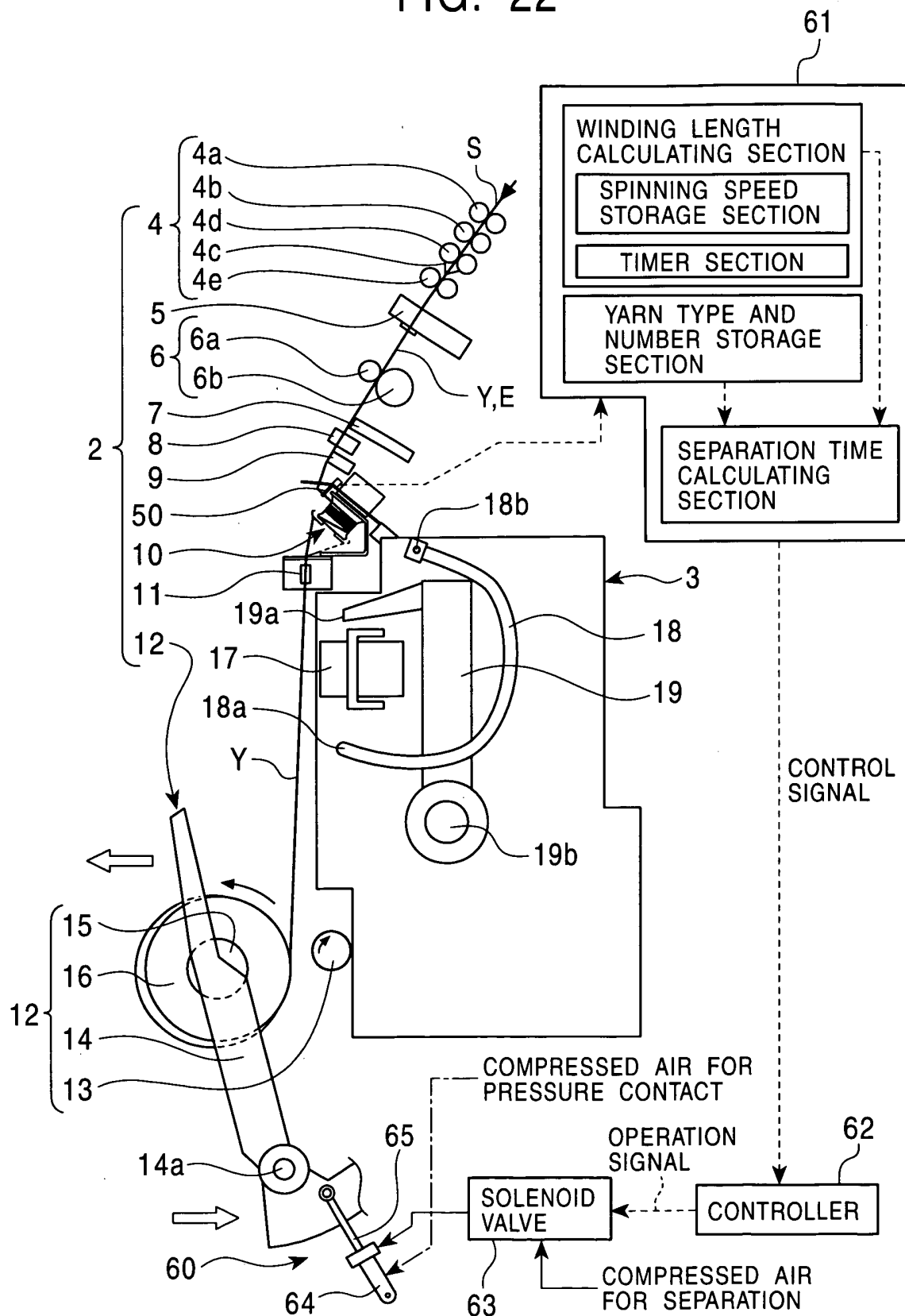


FIG. 23A

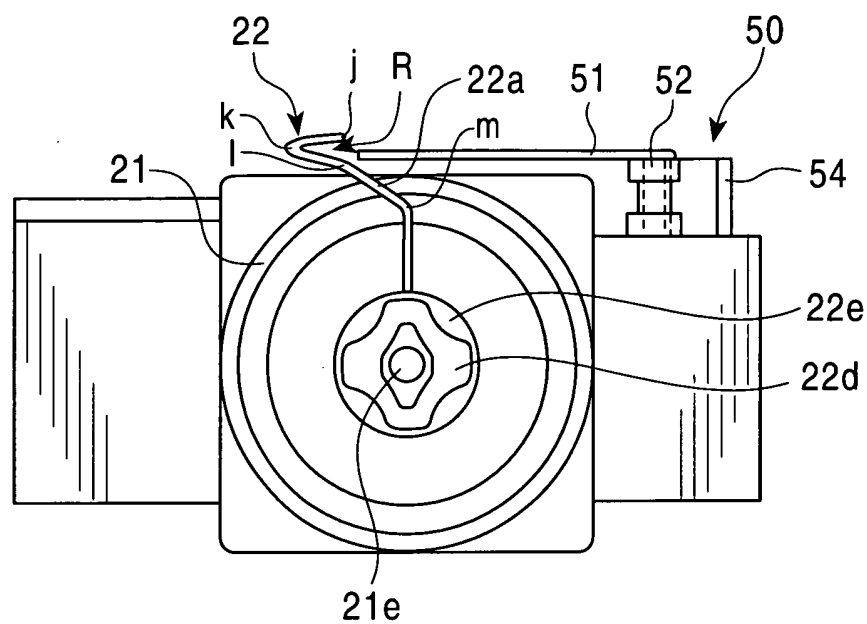


FIG. 23B

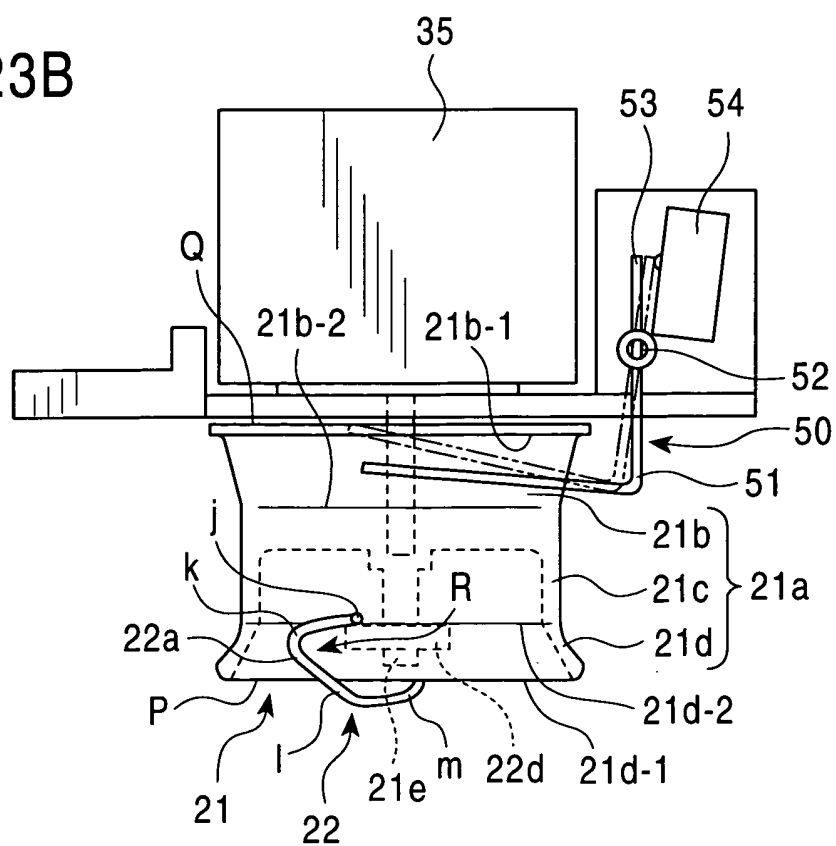


FIG. 24

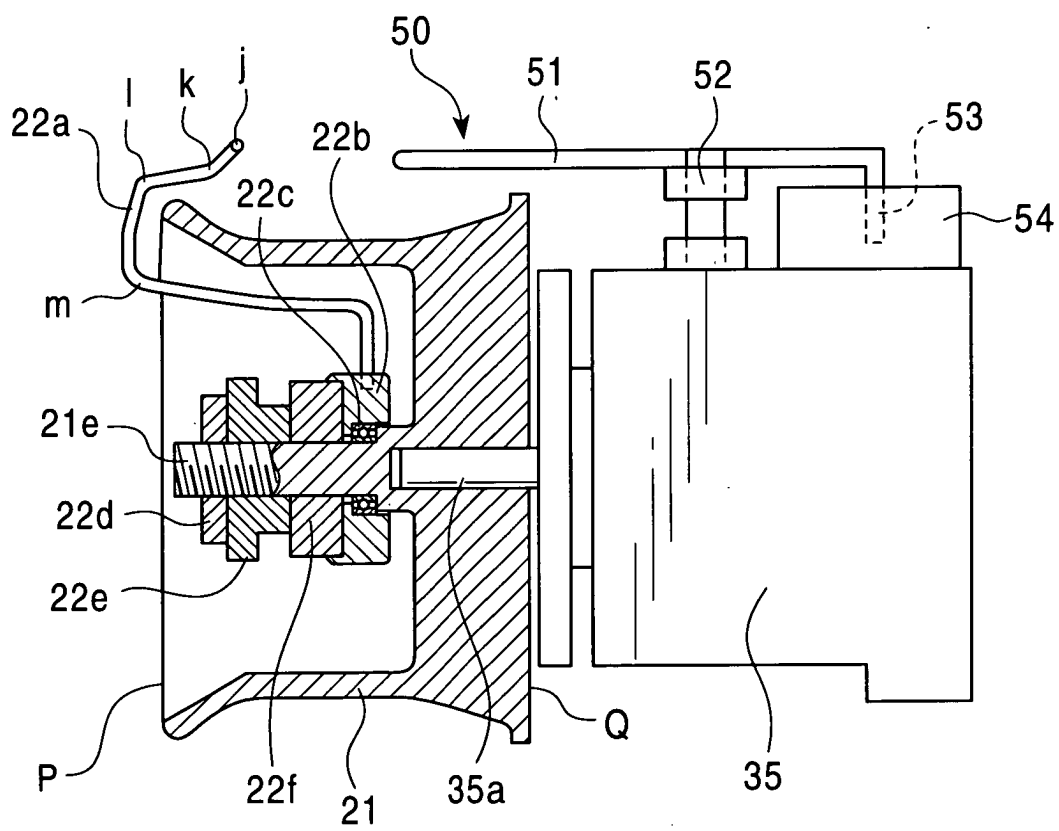


FIG. 25

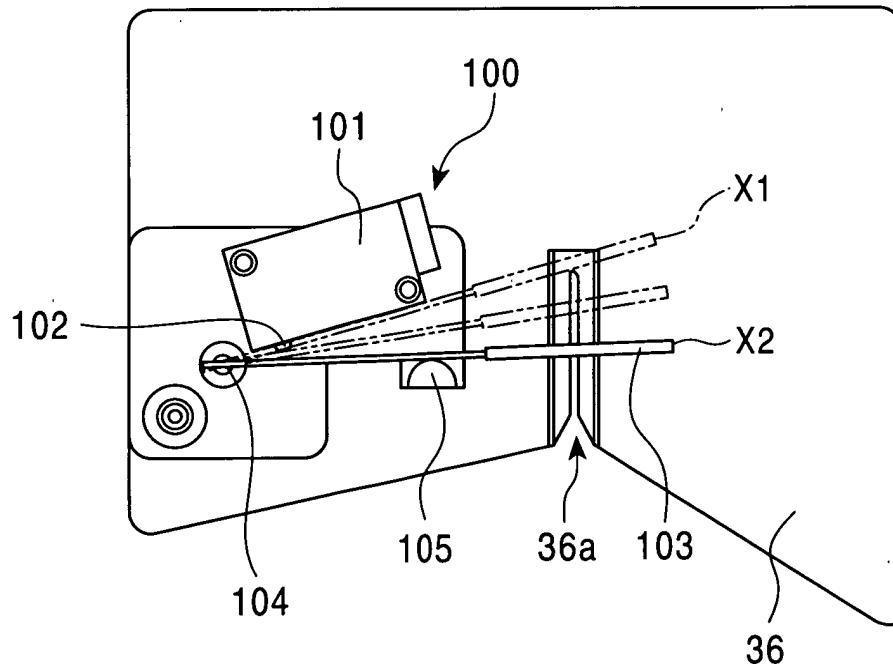


FIG. 26

