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(71) Applicant:
**Murata Kikai Kabushiki Kaisha**
**Minami-ku, Kyoto-shi, Kyoto 601 (JP)**

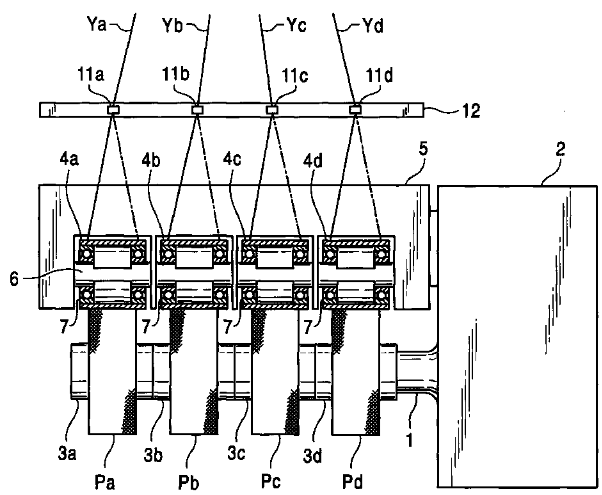
(72) Inventors:
- **Nakagawa, Osamu**
  **Sakyo-ku, Kyoto-shi, Kyoto (JP)**
- **Masai, Tetsuji**
  **Kusatsu-shi, Shiga (JP)**

(74) Representative:
**Liedl, Christine, Dipl.-Chem. et al**
**Albert-Rosshaupter-Strasse 65**
**81369 München (DE)**

# (54) Filament yarn take-up winder

(57) A plurality of packages are carried on a single bobbin holder, and package shape and yarn quality are made uniform. In a filament yarn take-up winder in which a plurality of packages Pa~Pd are carried on a single bobbin holder, and in which a rotating contact roller 4 applies pressure to the packages while winding is performed, a contact roller 4 is comprised of 4 individually rotatable roller segments 4a~4d, each arranged to correspond to one of the packages Pa~Pd. When each roller segment 4a~4d contains a driving DC brushless motor 10a~10d, the tensions of the filament yarns Ya~Yd being wound into packages Pa~Pd, respectively, are individually detected by tension detecting mechanisms 11a~11d. Each motor 10a~10d is controlled based on the detected tension values.

FIG. 1

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## Description

Field of the Invention

**[0001]** The present invention relates to a filament yarn take-up winder which winds yarn into a plurality of packages carried on a single bobbin holder while a rotating contact roller applies pressure, and more specifically, to a filament yarn take-up winder in which the contact roller is divided into a plurality of segments in the axial direction.

Background of the Invention

**[0002]** A conventional filament yarn take-up winder which winds yarn into a plurality of packages carried on a single bobbin holder while a single rotating contact roller applies pressure is known. A conventional filament yarn take-up winder in which the contact roller is divided into two segments to increase the critical speed limit so that the length of the bobbin holder and the winding speed can be increased is also known.

**[0003]** In such conventional filament yarn take-up winders, particularly in the case of high-speed rotation, subtle variation arises in both the pressure between each package and the contact roller, and in the winding tension of the filament yarn wound into each package. This variation is caused by flexure of the bobbin holder as the package becomes larger, differences in the angle of the bend in the yarn at the yarn guide, and the like. In such case, it is thought that even when the same bobbin holder is shared by all packages, when the rotary force is exerted against the contact roller in the direction of acceleration at a point on one package, the rotary force is exerted against the contact roller in the direction of deceleration at a point on another package. However, since the contact roller can normally only rotate integrally against all packages, unless there is appropriate compensation for such variations in pressure and winding tension, package shape and yarn quality may be adversely affected. Further, even when the contact roller is divided into two segments, if these segments are motor-driven and both rotary shafts are connected via a coupling that does not allow relative rotation, the same problems may arise as when a single contact roller is employed.

**[0004]** In the conventional machine where the contact roller is divided into two segments, and where it is not motor-driven (idle rotation), both roller segments are held so as to be independently rotatable. Thus, in contrast to the case where only a single contact roller is used, each package is allowed to respond to the rotary force exerted against its surface with relatively unforced idle rotation. However, when multiple packages are carried on a single bobbin holder, for various reasons described above, the appropriate rotary speed of the contact roller (the roller segment), whether idly driven or motor-driven, differs for each individual package. Thus, in such a conventional machine, arranging a smaller number of contact roller segments (two segments) than packages makes it impossible to maintain uniform package shape and yarn quality.

Summary of the Invention

**[0005]** It is thus an object of the present Invention to provide a filament yarn take-up winder which can maintain uniform package shape and yarn quality when winding a plurality of yarns into a plurality of packages carried on a single bobbin holder by arranging individually rotatable roller segments for each package, with each roller segment rotated at an individually appropriate rotary speed.

**[0006]** It is a second object of the present Invention to provide a filament yarn take-up winder which can maintain uniform package shape and yarn quality when winding yarns into a plurality of packages carried on a single bobbin holder, and which enables both the slip amount and the winding tension between the package and the contact roller to be be made uniform regardless of the position of the package on the bobbin holder.

**[0007]** It is a third object of the present invention to provide a filament yarn take-up winder that is more compact and easier to maintenance, that does not require a coupling connecting each rotary shaft, and that improves the exchangeability of bobbins.

**[0008]** In order to accomplish the first object, the present invention is a filament yarn take-up winder which winds yarns into a plurality of packages carried on a single bobbin holder while applying pressure with a rotating contact roller wherein the contact roller comprises a plurality of individually rotatable roller segments, each segment provided for each package. Thus, since an individually rotatable roller segment is provided for each of the plurality of packages carried on the single bobbin holder such that each package corresponds to each roller segment on a 1-to-1 basis, each roller segment, whether idly driven or motor-driven, is rotated at a individually appropriate rotary speed even when there is variation in the frictional force between each package and contact roller (roller segment) or in the yarn tension of the yarn being wound into each package.

**[0009]** Further, the present invention is provided with a driving motor for each roller segment. Each roller segment provided for each package is individually motor-driven. Thus, by driving rotation of the roller segments at a appropriate rotary speed with the driving motor, the slippage between each package and each roller segment can be maintained at an appropriate amount even when performing high-speed winding.

**[0010]** Still further, the driving motors of the present invention are arranged in each of the roller segments. Thus, since individual driving motors are arranged in each of the plurality of roller segments provided for each package, there is no need to provide a particular space in which to arrange the driving motor, and the structure of the take-up winder can be made more compact. In particular, by making the driving motor an outer rotor-type motor wherein a stator is fixed to the fixed axle and the rotor is fixed to the inner surface of the roller, stable rotary drive can be achieved with a simple structure.

**[0011]** Further still, the present invention is provided with a tension detecting means for individually detecting the tension of yarns being wound into the plurality of packages. Since the tension of each yarn is individually detected, when driving motors are provided in each roller segment, each driving motor can be controlled based on the detected tension value of each package, thus enabling a uniform winding tension to be maintained.

**[0012]** In order to accomplish the second object, the present invention is a filament yarn take-up winder which winds yarns into a plurality of packages carried on a single bobbin holder while applying pressure with a rotating contact roller wherein the contact roller is divided into a plurality of individually rotatable roller segments, with a driving motor arranged in each roller segment. Thus, since a contact roller comprised as a plurality of roller segments that are each individually rotary driven by a driving motor is provided for each of the plurality of packages carried on the single bobbin holder, the rotary speed of the roller segments at the far end can be made slightly different from those at the base end, or alternatively, the rotary speed of the roller segments in the middle section can be made slightly different from those at the end sections. In other words, each roller segment can be rotationally driven at an appropriate rotary speed individually suited to the position of the package along the axial direction of the bobbin holder for each of the plurality of packages carried on the bobbin holder.

**[0013]** Further, a roller segment and a driving motor are arranged in each of the plurality of packages carried on the bobbin holder. Since in the present invention, a roller segment and a driving motor are provided in a 1-to-1 correspondence for each of the plurality of packages carried on the bobbin holder, each roller segment can be rotationally driven at a rotary speed appropriate for each of the individual packages.

**[0014]** Still further, the present invention is comprised of a tension detection means for individually detecting the tension of yarns being wound into the plurality of packages, and a control means for individually controlling the plurality of driving motors in response to the detected tension. The present invention is enabled to individually control the rotary speed of the plurality of roller segments based on the detected value of the tension of the plurality of yarns. For example, when the detected tension of a yarn is higher than a predetermined value, the rotary speed of the corresponding roller segment is lowered, while when the detected tension is lower than the predetermined value, the rotary speed is raised. This enables the winding tension of each package to be made uniform. Particularly when the roller segments are arranged on a 1-to-1 basis with each package, a relatively uniform winding tension can be maintained for each package.

**[0015]** In order to accomplish the third object, the present invention is a filament yarn take-up winder provided with a contact roller driving motor, and which winds yarns into a plurality of packages carried on a single bobbin holder while applying pressure with a motor-driven contact roller wherein the driving motor is arranged inside the contact roller. Since in the present invention, the contact roller driving motor is arranged inside the contact roller, a coupling for connecting the contact roller rotary shaft with the motor shaft such that they are relatively unrotatable is unnecessary, and the distance between the end of the bobbin holder and the projecting member can be reduced, enabling the entire machine to be made compact. Further, since the driving motor is arranged inside the roller, each contact roller can be rotary-driven individually even when the contact roller is divided Into a plurality of segments.

**[0016]** Further, in the present invention, the driving motor includes a stator fixed to a fixed axle arranged in parallel to the bobbin holder, and a rotor fixed such that it faces the stator from the inner surface of the contact roller. The present invention comprises a fixed axle held in parallel to the bobbin holder such that it cannot be rotated, and a stator comprised of a core and a coil is fixed either directly or indirectly via an appropriate element around the fixed axle, and a rotor is fixed either directly or indirectly via an appropriate element to the inner surface of the contact roller. Thus, the rotor can be made to rotate via a rotating magnetic field generated by the stator which faces the rotor. Specifically, by making the driving motor inside the roller an outer-rotor type motor, the structure of the winder of the present invention can be simplified.

**[0017]** Still further, the fixed axle of the present invention is provided with a large diameter portion and a small diameter portion. The contact roller is held via a bearing outside the large diameter portion of the fixed axle so as to rotate independently, and the stator of the driving motor is fixed inside the small diameter portion. The present invention avoids enlarging the diameter of the contact roller, and enables the contact roller held outside the large diameter portion to be stabily rotated.

**[0018]** In the present invention the contact roller is divided in the axial direction into a plurality of roller segments, inside each of which a driving motor is arranged. By arranging each of the driving motors inside its roller, not outside it, the present invention enables each roller segment to be rotationally driven at a distinct speed.

**[0019]** In the present invention the contact roller is divided in the axial direction into a plurality of roller segments, with the fixed axle common to the plurality of roller segments. The plurality of roller segments are held so as to be independently rotatable around the single common fixed axle, enabling each roller segment to be reliably rotated around on the same axis with a device of simple structure.

Brief Description of the Drawing

**[0020]**

Figure 1 is a side-view schematic diagram showing a partial cross-section of a first embodiment of the present invention.
Figure 2 is a block diagram showing the control structure of the first embodiment of the present invention.
Figure 3 is a side-view schematic diagram showing a partial cross-section of a second embodiment of the present invention.
Figure 4 is a block diagram showing the control structure of the second embodiment of the present invention.
Figure 5 is a side-view schematic diagram showing a cross section of the structure of the tension detection mechanism.
Figure 6 is a side-view schematic diagram showing a partial cross-section of a third embodiment of the present invention.
Figure 7 is a block diagram showing the control structure of the third embodiment of the present invention.
Figure 8 is a side-view schematic diagram showing a partial cross-section of a fourth embodiment of the present invention.

Detailed Description of the Preferred Embodiments

**[0021]** Embodiment of the present invention will now be described in reference to the accompanying drawings. The following examples are included merely to aid in the understanding of the invention, and variations may be made by one skilled in the art without departing from the spirit and scope of the invention. In Figure 1, Figure 3, Figure 6 and Figure 7, the left side is the front end (the tip of the bobbin holder), and the right side is the rear end (the base of the bobbin holder).
**[0022]** The filament yarn take-up winder shown in embodiments 1 through 4 winds a plurality of filament yarns Y (such as melted spun nylon filament and polyester filament yarns) into a package P of fixed shape at a speed of approximately 6000 meters/ minute. A plurality of heating rollers (not shown in the drawings) with internal heaters may be arranged shove (on the upstream side) of the filament yarn take-up winder, and a plurality of filament yarns may be drawn according to the surface speed ratio of their heating rollers, and heated to become FDY (Full Draw Yarn). Next, the FDY yarn may be traversed between front and back (from left to right in the drawings) by a traverse device (not shown in the drawings) as it is wound onto a plurality of individual bobbins (into a package) carried on a bobbin holder 1.
**[0023]** The first embodiment will now be described using Figure 1 and Figure 2.
**[0024]** A plurality (4) of individual bobbins 3a, 3b, 3c, 3d are arranged in a row in the axial direction along a long bobbin holder 1 which projects horizontally from the front wall of a frame 2. The bobbin holder 1 is rotationally driven by an electric motor (not shown in the drawings) inside of the frame 2. Packages Pa, Pb, Pc, Pd are formed as filament yarns Ya, Yb, Yc, Yd are wound onto each bobbin 3a, 3b, 3c, 3d on the bobbin holder 1.
**[0025]** A hollow contact roller 4, which rotates in contact with the surface of each package, on top of the individual packages Pa through Pd, is arranged with its central axis running from front to back in parallel with the bobbin holder 1. In the present embodiment, the contact roller 4 is comprised of four roller segments 4a through 4d, segmented in the axial direction. Each roller segment 4a through 4d is arranged so as to be individually rotatable with a corresponding package Pa through Pd. These roller segments 4a through 4d are held, as described below, by a bracket 5. An actuator such as a cylinder (not shown in the drawings) in the frame 2 enables the bracket 5 to rise as the packages on the bobbin holder 1 grow thicker, and maintains a fixed (constant) pressure between the packages Pa through Pd and the roller segments 4a through 4d throughout the winding process. The material, diameter and axial length of the four roller segments 4a through 4d are exactly the same.
**[0026]** The roller segments 4a through 4d are arranged around a single fixed axle 6 running along a horizontal central axis, and held inside the bracket 5 such that it cannot rotate. The bracket 5 is provided with a downward projecting member at both the front and rear ends and in the middle, as well as between the front and middle projections and between the middle and rear projections (intermediary projections). The fixed axle 6 is arranged such that it runs through the central projection and the two intermediary projections, and fits between the front and rear projections. The fixed axle 6 is fixed to the downward projections of the bracket 5 at those five large diameter sections. The roller segments 4a through 4d, are also held at those five sections via bearings 7 such that they are independently rotatable. In other words, in the present embodiment, the fixed axle 6 is held at five locations including the front and rear sections of the bracket 5, and each roller segment 4a through 4d is held at the large diameter section of the fixed axle 6 between the downward projections via the bearings 7 such that each section is independently rotatable.
**[0027]** A fixed frame 12 is arranged running parallel to the center axis of the contact roller 4 and positioned above the bracket 5. Four tension detection mechanisms 11a, 11b, 11c, 11d corresponding to each of the four packages Pa through Pd are arranged at desired

positions on the fixed frame 12 as the tension detection means for individually detecting the winding tension of each of the filament yarns Ya through Yd that are wound into the packages Pa through Pd. Each tension detecting mechanism 11a through 11d is positioned at the center of the traverse width at the same distance apart as each of the packages Pa through Pd, and becomes the traverse fulcrum of its corresponding package Pa through Pd.

**[0028]** The structure of the tension detection mechanisms 11a through 11d will now be explained using Figure 5. Since each of the tension detection mechanisms 11a through 11d are exactly the same, one of the devices 11a will be explained as representative of the others.

**[0029]** A support rod 101 (holding member) is attached perpendicular to the fixed frame 12 in the latitudinal direction (from front to rear) of the fixed frame 12. One end of a vitreous enamel metal board (metal core base) 102 is attached at the end of the support rods 101 such that it is perpendicular to the axis of the support rod 101. At the other end of the metal board 102, one end of a rod 103 having a screw hole 103a is arranged perpendicular to the metal board 102. 104 is an axle member with a screw 104a attached at one end. A snail guide member 105 which acts as a traverse fulcrum guide is attached to the end of the axle member 104 opposite the side having the screw 104a. The snail guide 105 is attached to the rod 103 by screwing in the screw 104a formed in the axle member 104 into the screw hole 103a of the rod 103. A filament yarn Ya comprised of a plurality of filaments is passed through a ring section 105a of the snail guide 105. A strain gauge 106 (a strain response resistance body) is attached at a desired position on the metal board 102, and the elastic variation of the metal board 102 is detected as electronic signals by the strain gauge 106.

**[0030]** Parts such as the metal board 102 and the strain gauge 106 are covered with a casing 107 to protect them from oil and the like. The casing 107 is provided with a hole 107a, and the end of rod 103 juts out through the hole 107a. The circumference of the hole 107a forms a jutting stopper in order to protect the strain gauge 106 from excessive bending.

**[0031]** When the filament yarn Ya passed through the ring 105a of the snail guide 105 is traversed at a right angle to the rod 103 and the snail guide 105 by the traverse device (not shown in the drawings), the shape of the metal board 102 is transformed by using the tip of the rod 101 as a fulcrum, and generates electronic signals in response to the transformation amount through the strain gauge 106.

**[0032]** When the tension detection mechanisms 11a through 11d thus comprised are arranged in correspondence to each of the packages Pa through Pd, electronic signals indicating regular fluctuations over a fixed cycle according to the traverse cycle are generated by the strain gauge 106. The winding tension of each of the filament yarns Ya through Yd can be accurately detected based upon the size and amount of variation in these electronic signals (the voltage or current value).

**[0033]** The control system of the first embodiment of the present invention will now be explained.
As shown in Figure 2, the electronic signals (detection signals) from each of the tension detection mechanisms 11a through 11d each pass through their own individual digital/analog converter 13a through 13d, and are read in by a controller 14 (the control means). The controller 14 performs a predetermined alarm determination process based upon the detected tension value that is read-in.

**[0034]** The controller 14 is provided with averaging means 15 and comparing means 16. The controller 14 first averages the digitized electronic signals received from each of the tension detection mechanisms 11a through 11d by means of the averaging means 15. The averaging means 15 determines the average value A of the detection values from the four tension detection mechanisms 11a through 11d. The comparing means 16 determines whether or not to signal an alarm, and may, for example, generate an alarm signal if the difference between the tension values detected by each of the tension detection mechanisms 11a through 11d and the average value A, or if the difference between the values detected by each of the tension detection mechanisms 11a through 11d and a pre-set tension value B exceeds a predetermined value.

**[0035]** Further, the controller 14 reads-in detection signals from rotation speed detection mechanisms 18a through 18d. These signals are pulses generated in response to the number of times each of the roller segments 4a through 4d are rotated. The averaging means 15 calculates the average value C of the rotation speed detected by the four rotation speed detection mechanisms 18a through 18d. The comparing means 16 may, for example, generate an alarm signal if the difference between the rotation speed detected by each of the rotation speed detection mechanisms 18a through 18d and the average value C, or if the difference between the values detected by each of the rotation speed detection mechanisms 18a through 18d and a preset rotation speed D exceed a predetermined value.

**[0036]** When an alarm signal is generated, the filament yarn that have been spun continuously may be sucked in and removed, and the machine stopped. Further, an alarm indicator may be illuminated, and the operator may be notified of the problem through a message displayed on a screen (not shown in the drawings). It is preferable to display the set tension value B, the detected tension value, the contact roller set rotation speed D and the detected rotation speed of the roller segments 4a through 4d on a screen connected to the controller 14, so as to enable an operator to be aware of variations among the filament yarns Ya through Yd and the roller segments 4a through 4d, and changes in elapsed time. Such monitoring of the tension of the filament yarns Ya through Yd, and of the rotation of roller segments 4a through 4d enables breakdown of the take-up winder due to increased mechanical load, and yarn breakage accidents due to build-up of tension to be prevented.

**[0037]** In this first embodiment of the present invention, as described above, four individually idly rotating roller segments 4a through 4d are provided. Since each roller segment 4a through 4d is brought into contact with a corresponding package Pa through Pd, each roller segment 4a through 4d is enabled to rotate at a an appropriate rotation speed (rotation frequency) such that it does not impart extra load to its corresponding filament yarn Ya through Yd. Thus, the shape and yarn quality of each package Pa through Pd can be made uniform.

**[0038]** A second embodiment of the present invention will now be explained using Figure 3 and Figure 4. In the second embodiment, the roller segments 4a through 4d are arranged with the same support structure as in the first embodiment, and similarly correspond to each package Pa through Pd on a 1-to-1 basis. The explanation that follows will focus on the main differences between the present embodiment and the first embodiment.

**[0039]** In the second embodiment, each roller segment 4a through 4d is individually provided with a rotary driven driving motor 10a through 10d. Each motor 10a through 10d is arranged inside its corresponding roller 4a through 4, and each motor 10a through 10d is comprised of a stator 8a through 8d (a core and a coil) fixed to the outer surfaces of the four small diameter portion of the fixed axle 6, and outer rotor-type a DC motor 10a through 10d itslef comprised of rotors (permanent magnets) 9a through 9d fixed to the inner surface of the roller segments 4a through 4d such that they oppose each of the outer ends of the stators 8a through 8d. The DC motors 10a through 10d are brushless motors, and supply the stator coils 8a through 8d with electricity through an electricity supply line (not shown in the drawings) which passes through the inside of hollow fixed axle 6. Further, the stators 8a through 8d and the rotors 9a through 9d, respectively, may be attached directly to the fixed axle 6 and roller segment, or may be affixed through an appropriate element.

**[0040]** As shown in Figure 4, the electronic signals (detection signals) from each of the tension detection mechanisms 11a through 11d pass individually through digital/analog converters 13a through 13d, and are read in by the controller 14 (the control means). The controller 14 carries out fixed calculations based upon the detected tension values, and controls individually each of the four contact roller driving motors 10a through 10d.

**[0041]** An example of control in the second embodiment of the present invention will now be explained based on the tension values detected by each of the tension value detection mechanisms 11a through 11d.

**[0042]** The controller 14 is provided with averaging means 15, comparing means 16 and calculating means 17. First, digitized electronic signals from each of the tension detection mechanisms 11a through 11d are averaged by the averaging means 15. The averaging means 15 obtains an average value A of the tension values detected by the four tension detection mechanisms 11a through 11d and the preset tension value (target value) B. The calculating means 17 controls individually each of the corresponding motors 10a through 10d based on the tension values detected by each of the tension detection mechanisms 11a through 11d. This control may such that, for example, the rotation speed of the corresponding roller segment 4a through 4d is reduced in accordance with the detected tension value when the detected tension value is greater than the set tension value B, or alternatively, such that the rotation speed of the corresponding roller segment is increased in accordance with the detected tension value when the detected tension value is less than the set tension value B. In this way, the tension value of each of the filament yarns Ya through Yd can be maintained at an appropriate uniform value. Further, the control of the motors 10a through 10d may employ detection mechanisms 20a through 20d to create a feedback situation with the rotation frequency of each of the motors 10a through 10d.

**[0043]** The comparing means 16 determines whether or not to signal an alarm, and may, for example, generate an alarm signal if the difference between the tension values detected by each of the tension detection mechanisms 11a through 11d and the preset tension value B, or if the difference between the average value A and the preset tension value B exceed a predetermined amount. Further, in the first embodiment, the rotation frequency of each of the roller segments 4a through 4d is detected, and then it is determined whether or not to signal an alarm, but in the present invention, determination whether or not to signal an alarm can be made based upon the speed specified to the motors 10a through 10d. For example, if the instructed speed of the motors 10a through 10d falls out of a predetermined range, an alarm signal can be generated, and in the same manner as with the first embodiment, the winding can be stopped and the operator notified. Still further, the preset tension value and the detected tension value may be displayed in the same way as in the first embodiment.

**[0044]** In this second embodiment of the present invention, since, as described above, the four individually motor-driven roller segments 4a through 4d are provided, each roller can be actively rotated at an appropriate rotation speed (rotation frequency), thus enabling the tension value of each of the filament yarns to be maintained at an appropriate constant value, and enabling the shape and yarn quality of the plurality of the packages Pa through Pd on the single common bobbin holder 1 to be kept uniform. In this second embodiment, the control of only the roller segments 4a through

4d based upon the detected tension value has been described, bet it is also possible to enable appropriate control by controlling the bobbin holder side.

**[0045]** In this second embodiment of the present invention, since a plurality of roller segments arranged around the circumference of the single fixed axle 6 are held such that they are independently rotatable, and since each of the segments are rotationally driven independently by the outer rotor-type DC brushless motor, the machine structure can be simplified. Further, roller rotation can be made more stable ad more efficient without expanding the diameter of the roller segments 4a through 4d. Still further, since a plurality of small diameter and large diameter portions are formed in the fixed axle 6, each roller segment can be held in the large diameter section so as to independently rotate, and a motor can be arranged in the circumference of the small diameter section, thereby enabling stable, high-speed rotation of the roller segments 4a through 4d. Further still, since no heat is generated by the rotor fixed to the inner circumference of each of the roller segments, heat transmission to the packages contacted by the roller segments can be minimized.

**[0046]** The first and second embodiments have been described such that only one bobbin holder juts out from the front of the frame, but the present invention may also be employed in a filament yarn winding machine in which two independently rotatable bobbin holders are arranged to jut out in parallel, or in a machine that uses turret rotation or another method to switch the bobbin holders between a winding position and a stand-by position. Further, the number of bobbins (packages) carried on a single bobbin need not be limited to 4, there can, of course, be 6, 8, or more bobbins arranged on the bobbin holder.

**[0047]** A third embodiment of the present invention will now be explained using Figure 6 and Figure 7.

**[0048]** A plurality of bobbins (4 bobbins) 3a, 3b, 3c, 3d are lined up in the axial direction on the long bobbin holder 1 which juts out horizontally from the front of the frame 2. The bobbin holder 1 is rotationally driven by an electric motor (not shown in the drawings) inside the frame 2. The packages Pa, Pb, Pc, Pd are formed by the winding of each of the filament yarns Ya, Yb, Yc, Yd carried on each of the bobbins 3a, 3b, 3c, 3d carried on the bobbin holder 1.

**[0049]** A hollow contact roller 4, which rotates in contact with the surface of each package, on top of the individual packages Pa through Pd, is provided with its central axis arranged from front to back in parallel with the bobbin holder 1. The contact roller 4 is held by the bracket 5 arranged in the front side of the frame 2. An actuator such as a cylinder (not shown in the drawings) in the frame 2 enables the bracket 5 to rise as the packages on the bobbin holder 1 grow thicker, and maintains a fixed (constant) pressure between the packages Pa through Pd and the contact roller 4 throughout the winding process.

**[0050]** The contact roller 4 is divided into two roller segments 4a, 4b. Each of these two individual segments are independently rotatable, and their material, diameter and axial length are exactly the same. The front roller segment 4a is rotated in contact with the two front packages Pa, Pb on the bobbin holder 1, and the rear roller segment 4b is rotated in contact with the two rear packages Pc, Pd on the bobbin holder 1.

**[0051]** The roller segments 4a, 4b are arranged around the single fixed axle 6 which is held in the bracket 5 with its central axis held horizontally, and held such that it cannot be rotated. The bracket 5 is provided with downward projecting members at both the front and rear ends, and in a center section between the two ends. The fixed axle 6 fits through the central section, and is arranged in the between the front and rear downward projecting sections of the bracket 5. The fixed axle 6 is provided with large diameter sections at the front and rear, and in the middle. The fixed axle 6 is fixed to the downward projections of the bracket 5 at these three large diameter sections. The roller segments 4a, 4b are also held via the bearings 7 at these projections so as to be independently rotatable. In other words, in the present embodiment, the fixed axle 6 is held by the bracket 5 at three places including the front and rear ends, the front roller segment 4a is held between the front and center large diameter sections of the fixed axle 6 via the bearings 7 so as to be independently rotatable, and the rear roller segment 4b is held between the center and rear large diameter sections of the fixed axle 6 via the bearings 7 so as to be independently rotatable.

**[0052]** The outer rotor-type DC motor 10a, 10b comprised of the stator 8a, 8b (comprising a core and a coil) fixed to the outer surface of each of the two small diameter sections of the fixed axle 6, and the rotor 9a, 9b (permanent magnets) affixed to the inner surface of the roller segments 4a, 4b, such that they each face the outside of their corresponding stator 8a, 8b, are arranged in each roller segment 4a, 4b. The DC Motors 10a, 10b are brushless motors, and supply the stator coils with electricity through an electricity supply line (not shown in the drawings) which passes through the inside of the hollow fixed axle 6. The stators 8a, 8b and the rotors 9a, 9b may be respectively attached to the fixed axle 6 and the roller segments 4a, 4b directly, or may be affixed through an appropriate element.

**[0053]** The fixed frame 12 is arranged running parallel to the center axis of the contact roller 4 above the bracket 5. Four tension detection mechanisms 11a, 11b, 11c, 11d corresponding to each of the four packages Pa through Pd are arranged at fixed positions on the fixed frame 12 as tension detection means for individually detecting the winding tension of each of the filament yarns Ya through Yd that are wound into the packages Pa through Pd. Each tension detecting mechanism 11a through 11d is positioned at the center of the traverse width at the same distance apart as each of the packages Pa through Pd, and becomes the traverse fulcrum of its corresponding package Pa through Pd.

**[0054]** The structure of the tension detection mechanisms is shown in Figure 5.

**[0055]** The control system of the third embodiment of the present invention will now be explained.

**[0056]** As shown in Figure 7, the electronic signals (detection signals) from each of the tension detection mechanisms 11a through 11d each pass through their own individual digital/analog converter 13a through 13d, and are read-in by the controller 14 (the control means). The controller 14 performs a predetermined calculation based on the detected tension value, and controls individually the two contact roller driving motors 10a, 10b.

**[0057]** An example of the control procedure based on the tension detected by each of the tension detection mechanisms 11a through 11d is now explained.

**[0058]** The controller 14 is provided with the averaging means 15, the comparing means 16 and the calculating means 17. The controller 14 first averages the digitized electronic signals received from each of the tension detection mechanisms 11a through 11d by means of the averaging means 15. The averaging means 15 then determines the average value A of the two detection values from the tension detection mechanisms 11a, 11b of the front roller segment 4a, the average value B of the two detection values from the tension detection mechanisms 11c, 11d of the rear roller segment 4b, and the average value C of the detection values of all four tension detection mechanisms 11a through 11c. The calculating means 17 individually controls the motor 10a based on the previously input set tension value D (target value) and the average value A, and the motor 10b based on the set tension value D and the average value B. For example, if the average value A, B exceeds the set tension value D, the rotation speed of the roller segment is decreased. Alternatively, if the average value A, B falls below the set tension value D, the rotation speed of the roller segment is increased. Further, the control of the motors 10a, 10b may employ rotation speed detection mechanisms 20a, 20b such that the rotation frequencies of the motors 10a, 10b are controlled via a feedback control system.

**[0059]** The comparing means 16 determines whether or not to signal an alarm, and may, for example, generate an alarm signal if the difference between the average values A and C, the average values B and C, or the average values A, B, C and the set tension value D exceeds a predetermined amount. Further, since the roller segments 4a, 4b essentially rotate at a roughly constant speed from the point where winding begins until a full package has been formed, an alarm can be generated if the instructed speed sent to the motors 10a, 10b falls out of a predetermined range. When an alarm is generated, all filament yarns that have been spun continuously may be sucked in and removed, and the machine stopped. Further, the operator may be notified of the problem through illumination of an alarm indicator and by a message displayed on a screen (not shown in the drawings). Still further, the set tension value D and the detected tension values may be displayed on a screen connected to the controller 1. It is preferable to display of the detected tension values so that the operator can be aware of variations between the filament yarns Ya through Yd, and changes in tension over time. By thus monitoring variations in the tension of the filament yarns Ya through Yd, breakdown of the take-up winder due to increased mechanical load, and yarn breakage accidents due to build-up of tension can be eliminated.

**[0060]** In this third embodiment of the present invention, as described above, the contact roller 4 is divided into two segments, a front segment 4a and a rear segment 4b. Since each roller segment 4a, 4b is arranged so as to be independently driven by the driving motor 10a, 10b, respectively, even if differences between the pressure between the far packages Pa, Pb and the front roller segment 4a and the pressure between the base packages Pc, Pd and the rear roller segment 4b arise due to the flexure of the bobbin holder 1, this difference can be corrected by controlling the rotation of the two roller segments 4a, 4b. Thus, since the plurality of the roller segments 4a, 4b can be positively rotated at different speeds among the front and base rollers in relation to the common bobbin holder 1, an appropriate uniform tension of each filament yarn Ya through Yd can be maintained, and the shape and yarn quality of the plurality of the packages Pa through Pd on the common bobbin holder 1 can be kept uniform.

**[0061]** A fourth embodiment of the present invention will now be explained using Figure 8.

**[0062]** A plurality (4) of the individual bobbins 3a, 3b, 3c, 3d are arranged in a row in the axial direction along the long bobbin holder 1 which projects horizontally from the front wall of the frame 2. The bobbin holder 1 is rotationally driven by an electric motor (not shown in the drawing) inside of the frame 2. The packages Pa, Pb, Pc, Pd are formed as the filament yarns Ya, Yb, Yc, Yd are wound onto each bobbin 3a, 3b, 3c, 3d on the bobbin holder 1.

**[0063]** The hollow contact roller 4, which rotates in contact with the surface of each package, on the top of the packages Pa through Pd, is provided with its central axis arranged from front to back in parallel with the bobbin holder 1. The contact roller 4 is held by the bracket 5 arranged in the front wall of the frame 2. A cylinder inside a actuator (not shown in the drawing) in the frame 2 enables the bracket 5 to rise as the packages on the bobbin holder 1 grow thicker, and maintains a fixed (constant) pressure between the packages Pa through Pd and the contact roller from the start to the finish of winding.

**[0064]** The contact roller 4 is arranged around the single fixed axle 6 held along horizontal central axis by the bracket 5 such that it cannot be rotated. The bracket 5 is provided with downward projecting members at both its front and rear ends, and the fixed axle 6 is arranged between these downward projecting members. The fixed axle 6 is provided with large diameter sections at both the front and base end. The fixed axle 6 is affixed to the downward projecting members of the bracket 5 at both of these large diameter sections, and the contact roller 4 is held via the bearings 7 at these sections so as to be independently rotatable.

**[0065]** The outer rotor-type DC motor 10 comprised of the stator 8 (a coil and a core) fixed to the outer surface of the small diameter section of the fixed axle 6 between both large diameter end sections, and the rotor 9 (a permanent magnet) affixed to the inner surface of the contact roller 4 and opposing the outer surface of the stator 8, are arranged inside the contact roller 4. The motor 10 is a brushless motor, and supplies the stator coil 8 with electricity through a electricity supply line (not shown in the drawing) which passes through the inside of the hollow fixed axle 6. The stator 8 and the rotor 9 may be attached respectively directly to the fixed axle 6 and the contact roller 4, or they may be affixed through an appropriate element.

**[0066]** The fixed frame 12 is arranged running parallel to the center axis of the contact roller 4 above the bracket 5. The four tension detection mechanisms 11a, 11b, 11c, 11d corresponding to each of the four packages Pa through Pd are arranged at fixed positions on the fixed frame 12 as the tension detection means for individually detecting the winding tension of each of the filament yarns Ya through Yd that is wound into the packages Pa through Pd. Each tension detecting mechanism 11a through 11d is positioned at the center of the traverse width at the same distance apart as each of the packages Pa through Pd, and becomes the traverse fulcrum of the packages Pa through Pd.

**[0067]** The present invention, arranged as described above, achieves the following results.

1. According to the present invention, since each roller segment of each package, whether motor-driven or driven by idle rotation, is rotated at an individually appropriate rotations peed, the shape and yarn quality of the plurality of packages loaded on the single bobbin holder can be made uniform.
2. According to the present invention, the rotation speed of the plurality of rollers can be positively raised to different speeds through a driving motor. Thus, each roller segment is rotationally driven at an independently appropriate rotary speed, thus enabling the amount of slippage between each package and each roller segment to be maintained at an appropriate amount even when winding at high speeds. This enables the shape and yarn quality of each package to be appropriately maintained.
3. According to the present invention, since the winding tension can be maintained at a constant level by controlling a driving motor based on detected tension values for each package, the shape and yarn quality of each package can be held constant.
4. According to the present invention, since the contact roller is divided into a plurality of roller segments, and since a driving motor is arranged in each roller segment, the rotation speed of each roller segment can be positively raised to different levels, enabling the shape and yarn quality of each of the plurality of packages on the single bobbin holder to held uniform.
5. According to the present invention, a coupling is unnecessary, the portion jutting out from the end of the bobbin holder is made smaller, and the entire winding machine is made more compact, thus improving the ease of bobbin exchange and maintenance.
6. According to the present invention, since the driving motor inside the roller is an outer rotor-type motor, the structure of the machine can be simplified.
7. According to the present invention, since the contact roller is held at the large diameter section of the axle such that it can be independently rotated, the contact roller is enabled to rotate stabily. Further, since the driving motor is arranged at the location of the small diameter section of the axle, the diameter of the contact roller does not need to be enlarged, and a powerful rotational force can be imparted.
8. According to the present invention, the entire winding machine is not enlarged, and each roller segment can be individually rotationally driven.
9. According to the present invention, by making the fixed axle a common element, the structure of the machine is simplified, and each roller segment can be reliably rotated on the same axis.

## Claims

1. A filament yarn take-up winder which winds a plurality of yarns into a plurality of packages carried on a single bobbin holder while in contact with a pressure-applying rotating contact roller, wherein the contact roller comprises a plurality of individually rotatable roller segments arranged to correspond to each package.

2. The filament yarn take-up winder as in claim 1 wherein each roller segment is provided with a driving motor.

3. The filament yarn take-up winder as in claim 1 or claim 2 wherein a driving motor is arranged inside each roller segment.

4. The filament yarn take-up winder as in any one of claims 1~3 further comprising a tension detection means for detecting the tension of the individual yarns that are wound into the plurality of packages.

5. A filament yarn take-up winder which winds a plurality of yarns into a plurality of packages carried on a single bobbin holder while in contact with a pressure-applying motor-driven contact roller, wherein a contact roller is divided into a plurality of individually rotatable roller segments, and wherein a driving motor is provided in each roller segment.

6. The filament yarn take-up winder as in claim 5 wherein the roller segments and driving motors are arranged to correspond to each of the plurality of packages carried on the single bobbin holder.

7. The filament yarn take-up winder as in claim 5 or claim 6, further comprising a tension detecting means for detecting the tension of individual yarns that are wound into the plurality of packages, and

    a control means for individually controlling the plurality of driving motors in response to the detected tension.

8. A filament yarn take-up winder provided with a contact roller driving motor, and which winds a plurality of yarns into a plurality of packages carried on a single bobbin holder while in contact with a pressure-applying motor-driven contact roller, wherein the driving motor is arranged inside the contact roller.

9. The filament yarn take-up winder as in claim 8 wherein the driving motor includes a stator affixed to a fixed axle arranged parallel to the bobbin holder, and a rotor affixed opposed to the stator on the inner circumference of the contact roller.

10. The filament yarn take-up winder as in claim 9 wherein the fixed axle is provided with large diameter portions and small diameter portions, and wherein the contact roller is held at the large diameter portions via bearings such that the roller is independently rotatable, and wherein the stator of the driving motor is affixed at the small diameter portions.

11. The filament yarn take-up winder as in any one of claims 8~10, wherein the contact roller is divided into a plurality of roller segments in the axial direction, and wherein a driving motor is provided in each roller segment.

12. The filament yarn take-up winder as in claim 9 or claim 10 wherein the contact roller is divided into a plurality of roller segments in the axial direction, and wherein the fixed axle is shared by the plurality of roller segments.

FIG. 1

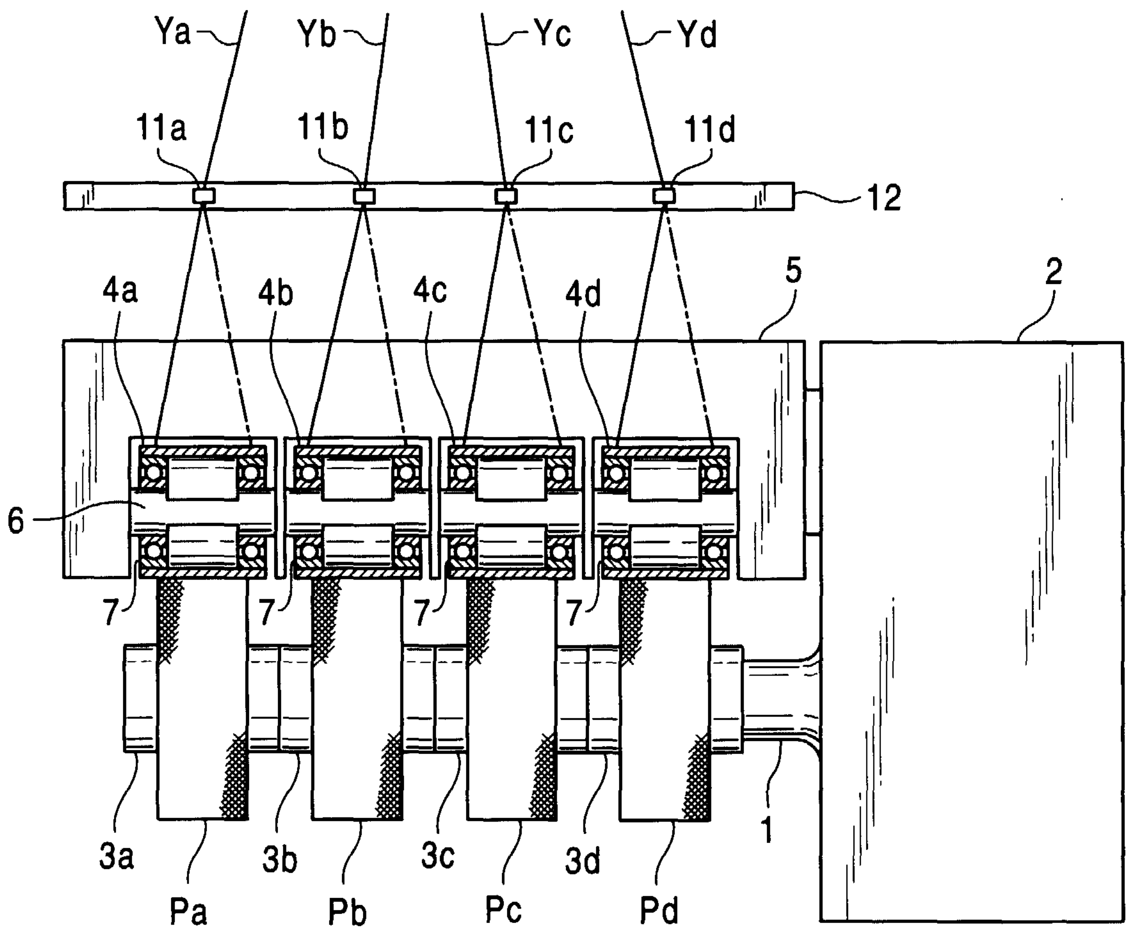
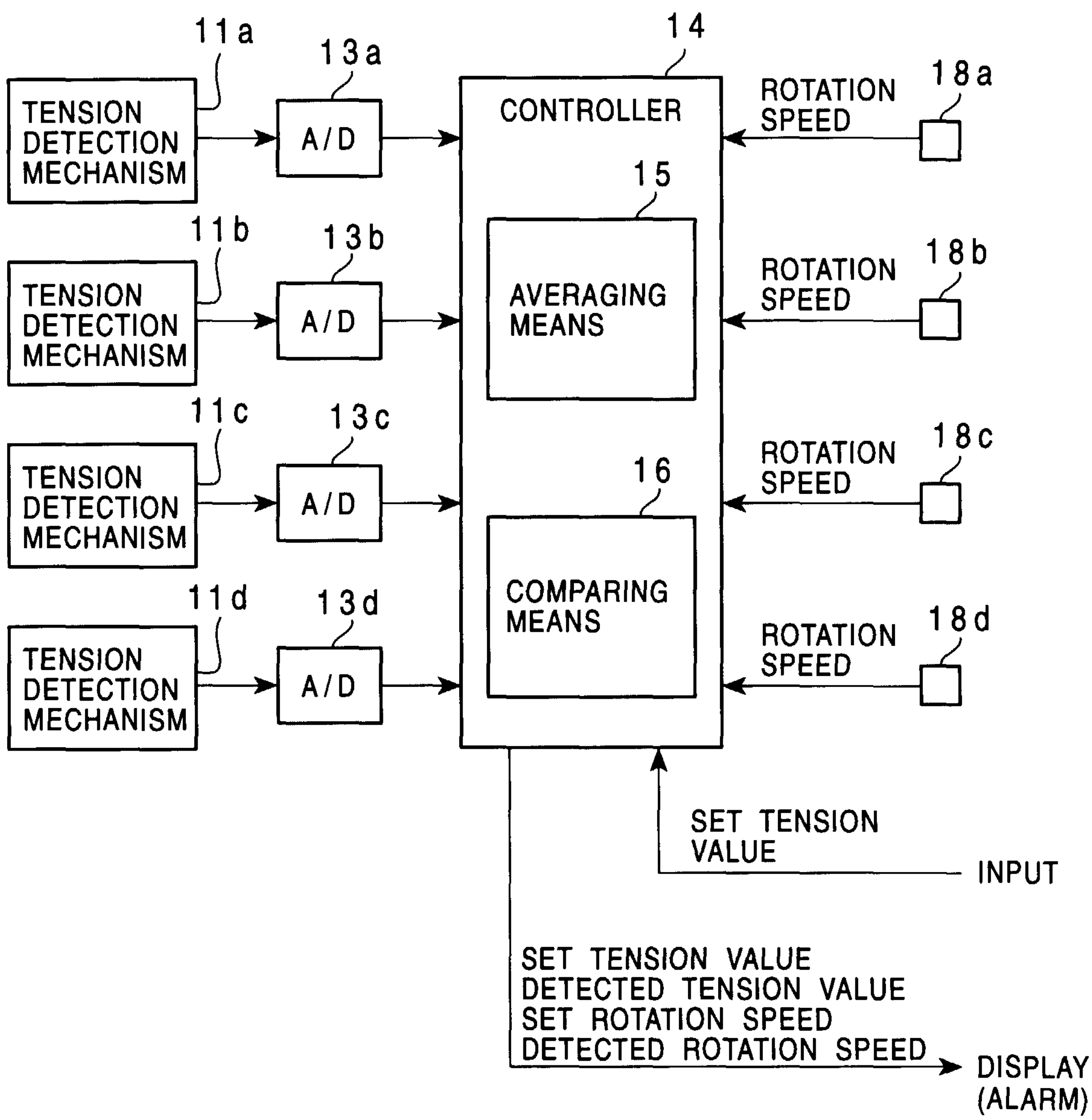

Ya
Yb
Yc
Yd
11a
11b
11c
11d
12
4a
4b
4c
4d
5
2
6
7
7
7
7
3a
3b
3c
3d
1
Pa
Pb
Pc
Pd

FIG. 2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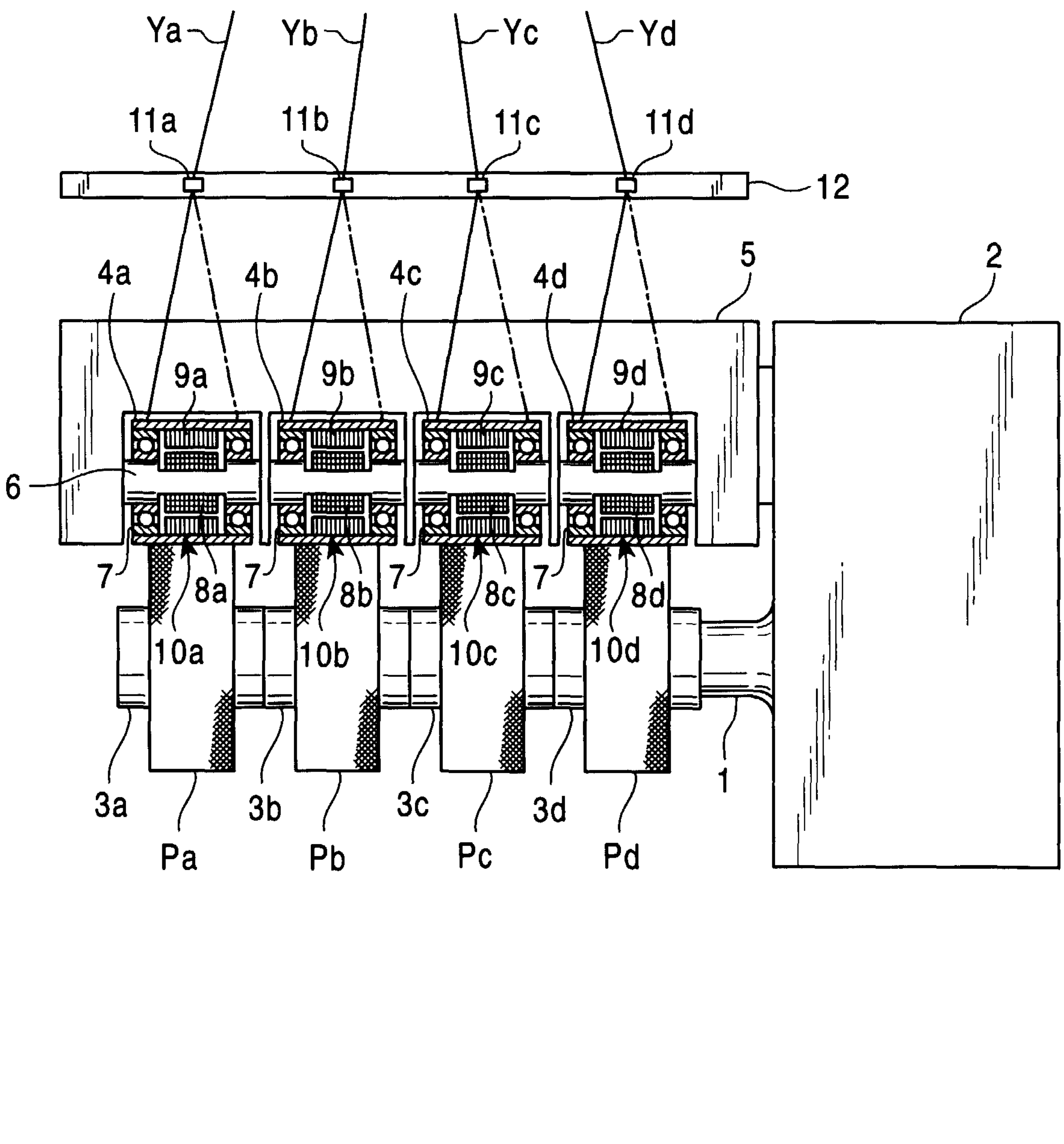
11b
11c
11d
TENSION DETECTION MECHANISM
TENSION DETECTION MECHANISM
TENSION DETECTION MECHANISM
TENSION DETECTION MECHANISM
13a
13b
13c
13d
A/D
A/D
A/D
A/D
14
CONTROLLER
15
AVERAGING MEANS
16
COMPARING MEANS
ROTATION SPEED
ROTATION SPEED
ROTATION SPEED
ROTATION SPEED
18a
18b
18c
18d
SET TENSION VALUE
INPUT
SET TENSION VALUE
DETECTED TENSION VALUE
SET ROTATION SPEED
DETECTED ROTATION SPEED
DISPLAY (ALARM)

FIG. 3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Yb
Yc
Yd
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11b
11c
11d
12
4a
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4d
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9c
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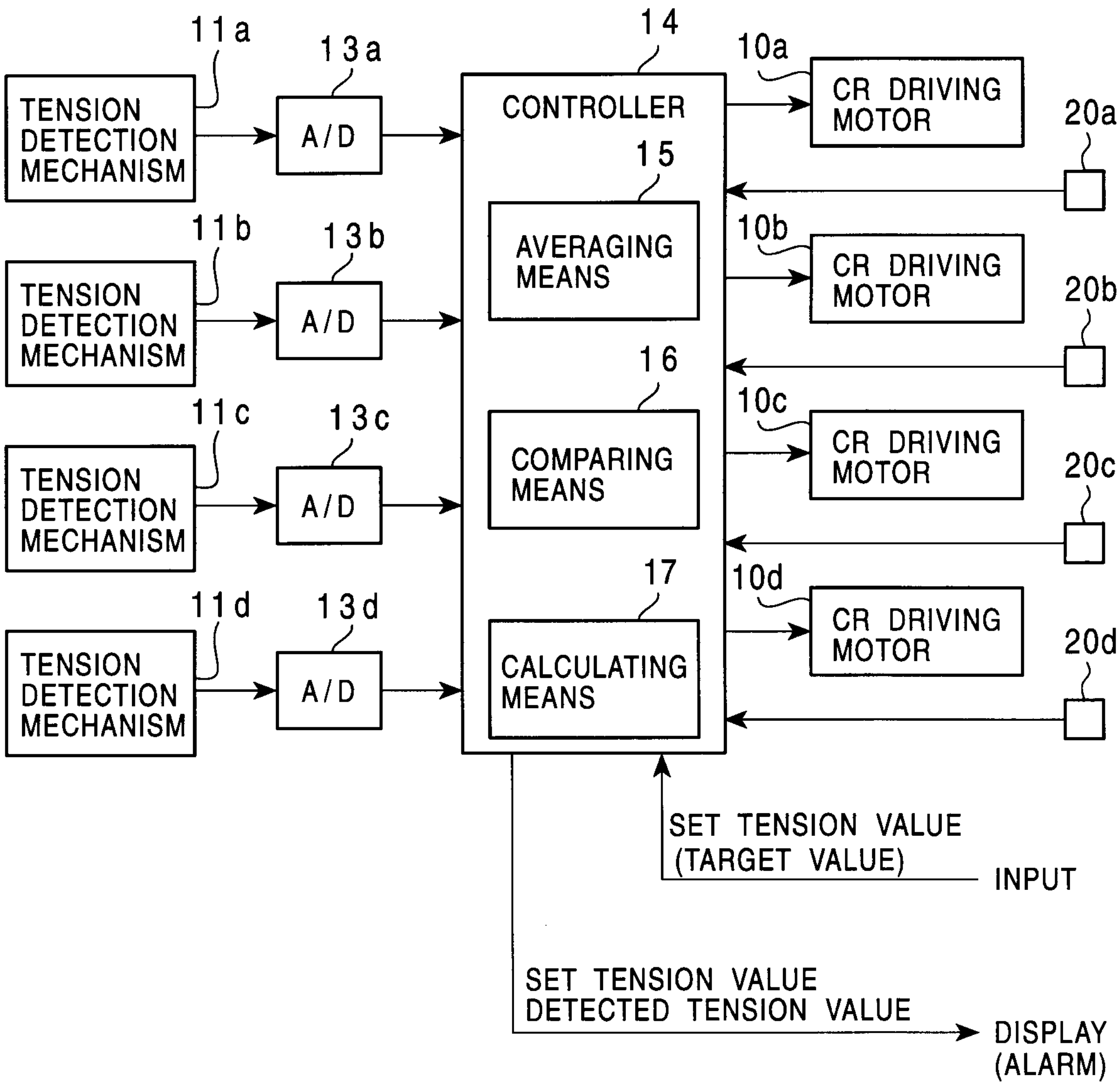
Pb
Pc
Pd

FIG. 4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13a
14
10a
TENSION DETECTION MECHANISM
A/D
CONTROLLER
CR DRIVING MOTOR
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15
11b
13b
AVERAGING MEANS
10b
TENSION DETECTION MECHANISM
A/D
CR DRIVING MOTOR
20b
16
11c
13c
10c
COMPARING MEANS
TENSION DETECTION MECHANISM
A/D
CR DRIVING MOTOR
20c
17
11d
13d
10d
TENSION DETECTION MECHANISM
A/D
CALCULATING MEANS
CR DRIVING MOTOR
20d
SET TENSION VALUE (TARGET VALUE)
INPUT
SET TENSION VALUE
DETECTED TENSION VALUE
DISPLAY (ALARM)

FIG. 5

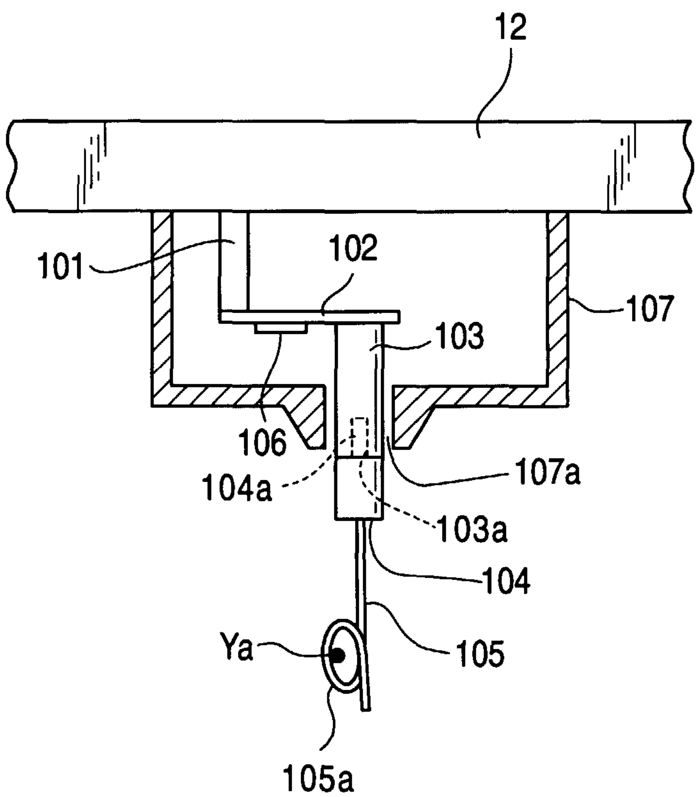
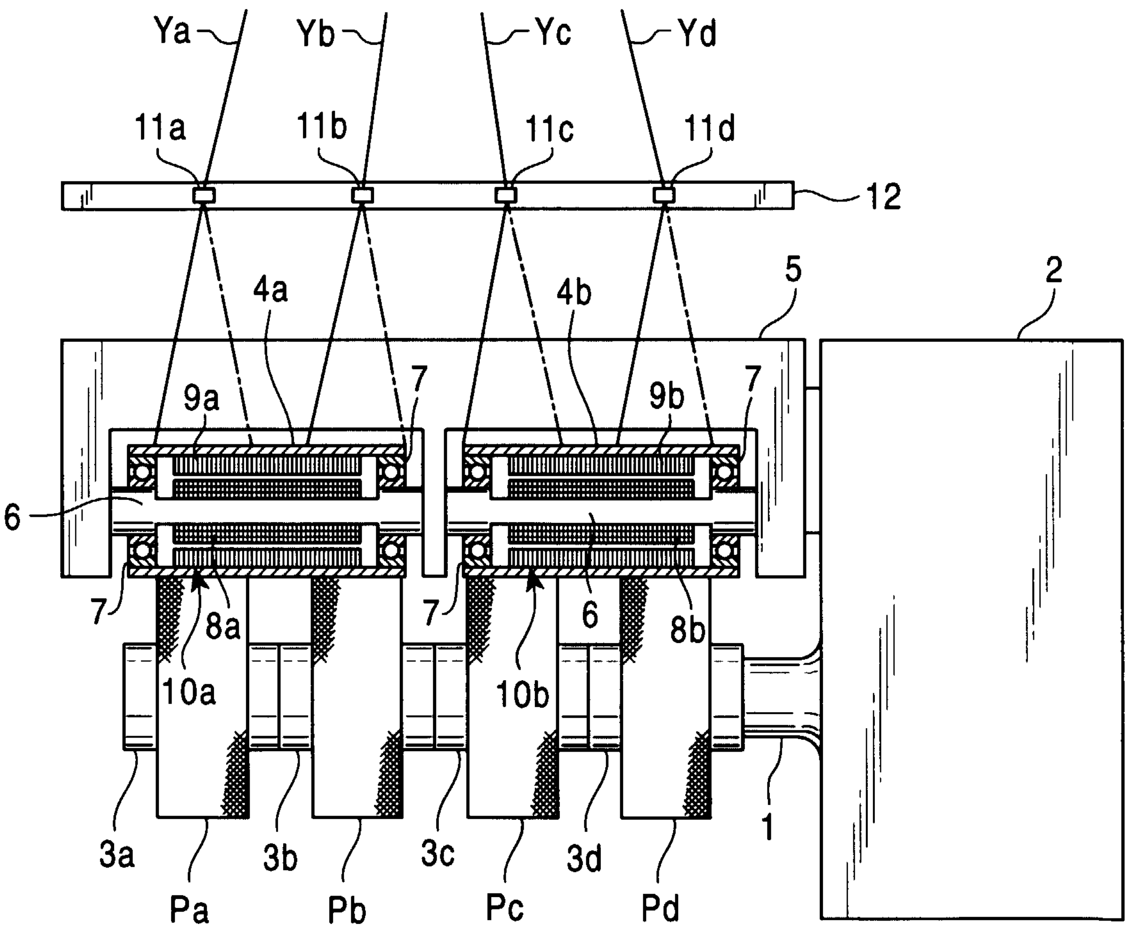


FIG. 6


Ya
Yb
Yc
Yd
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11b
11c
11d
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4a
4b
5
2
9a
9b
7
6
8a
8b
10a
10b
3a
3b
3c
3d
1
Pa
Pb
Pc
Pd

FIG. 7

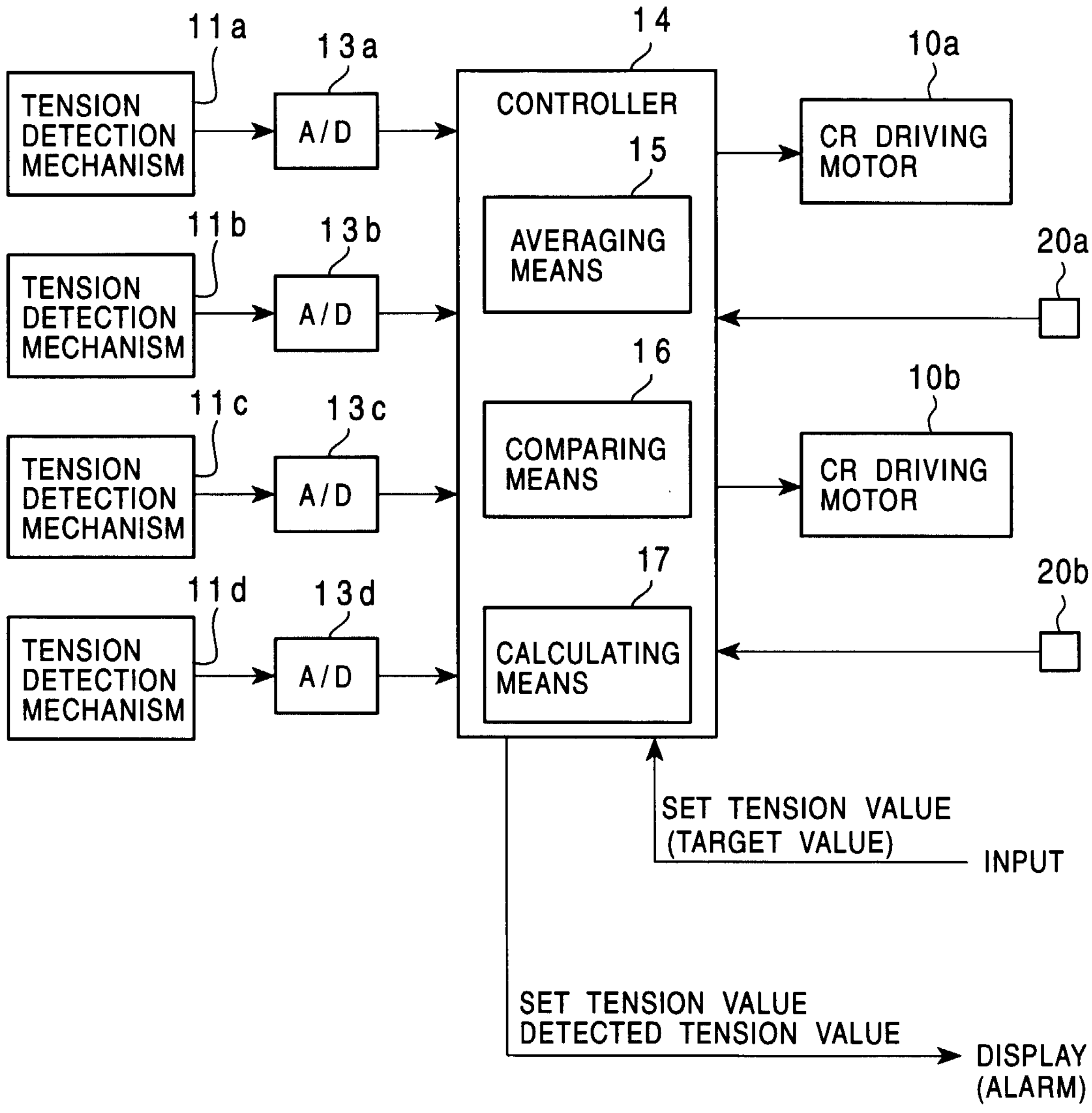
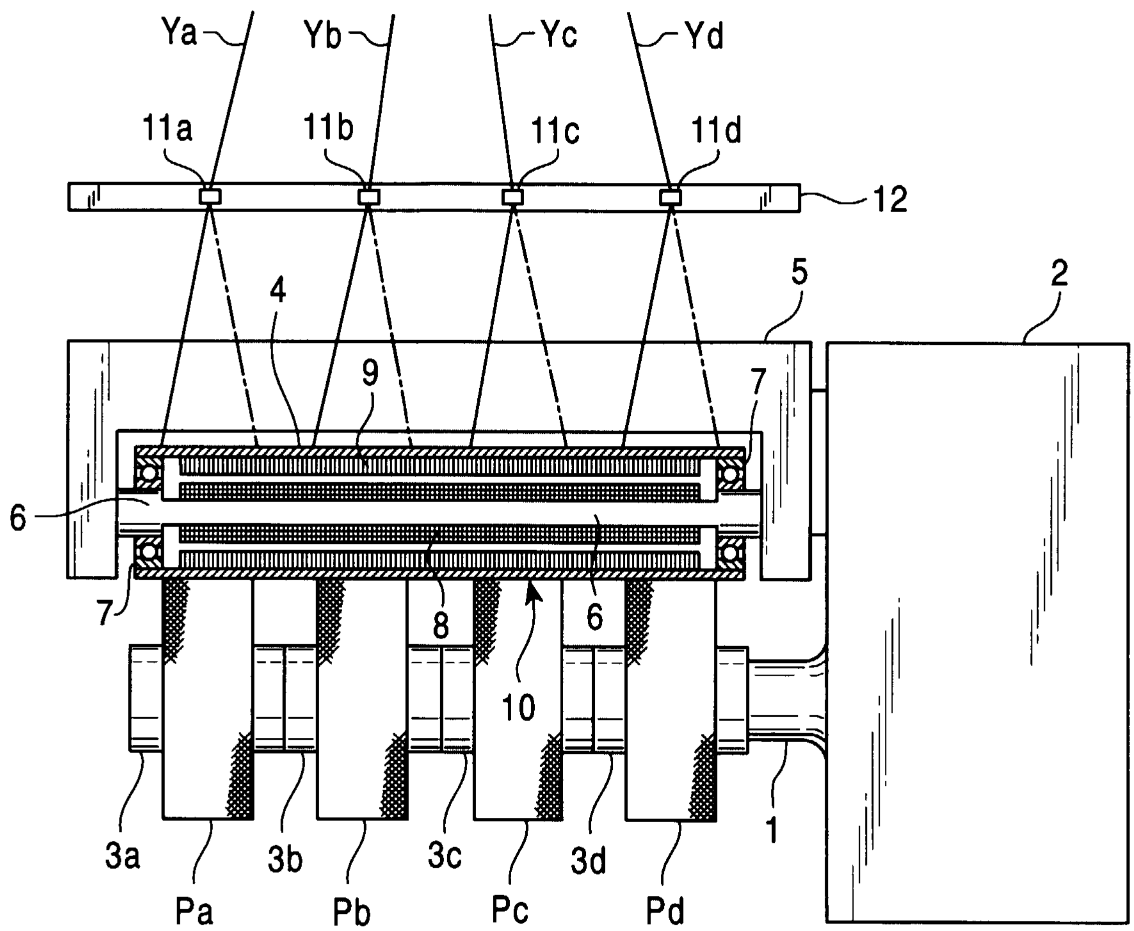

11a
11b
11c
11d
TENSION DETECTION MECHANISM
TENSION DETECTION MECHANISM
TENSION DETECTION MECHANISM
TENSION DETECTION MECHANISM
13a
13b
13c
13d
A/D
A/D
A/D
A/D
14
CONTROLLER
15
AVERAGING MEANS
16
COMPARING MEANS
17
CALCULATING MEANS
10a
CR DRIVING MOTOR
20a
10b
CR DRIVING MOTOR
20b
SET TENSION VALUE (TARGET VALUE)
INPUT
SET TENSION VALUE
DETECTED TENSION VALUE
DISPLAY (ALARM)

FIG. 8


Ya
Yb
Yc
Yd
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11b
11c
11d
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8
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3b
3c
3d
1
Pa
Pb
Pc
Pd