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(72) Inventors:
• **Hashimoto, Kinzo**
Kyoto, 612-8686 (JP)
• **Kagata, Kakeru**
Kyoto, 612-8686 (JP)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

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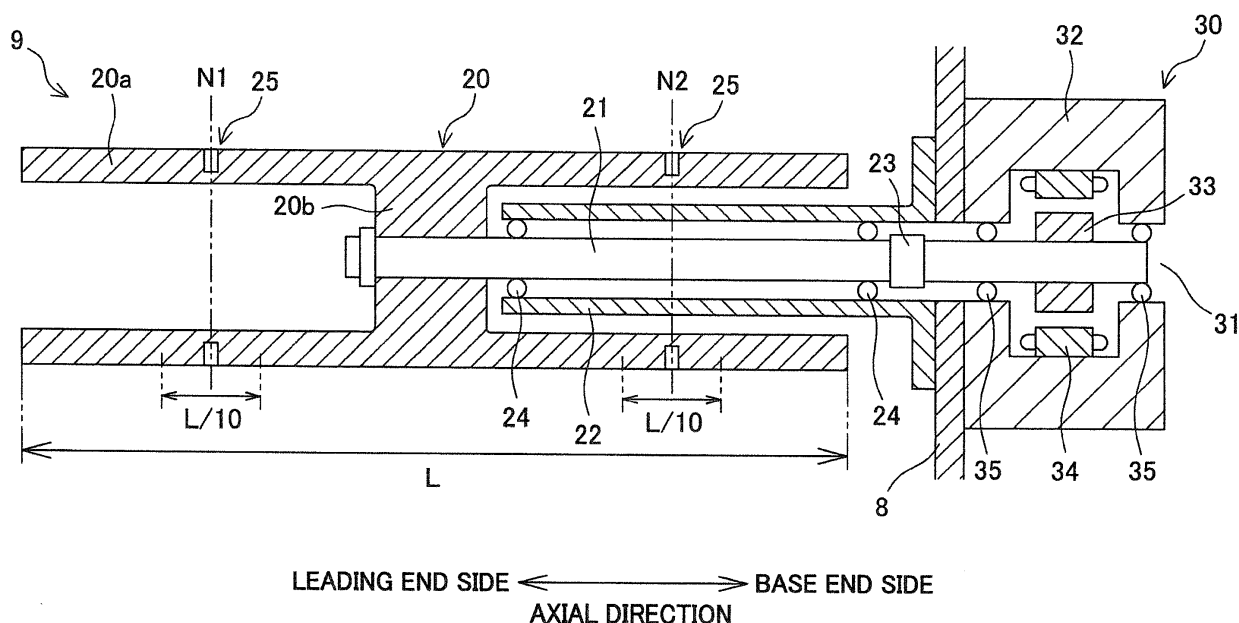
(71) Applicant: **TMT Machinery, Inc.**
Osaka-shi, Osaka 541-0041 (JP)

(54) **BALANCING METHOD AND ROTATION MEMBER**

(57) In a resonance mode in which bending occurs at a bobbin holding portion 20, an increase in vibration by a mass for balancing is prevented or lessened. Positions of nodes N1 and N2 of the bobbin holding portion 20 in a predetermined resonance mode of a bobbin holder 9, in which bending occurs at the bobbin holding portion

tion 20, are obtained. An unbalance corrector 25 for adding or removing a mass for balancing is provided at or around each node N1, N2, within a range of 10% of the length of the bobbin holding portion 20, the range being defined by taking the position of the node N1, N2 as the midpoint of the range.

FIG.2



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a balancing method for correcting unbalance in a rotation member, and a rotation member to which the balancing method is applied.

[0002] In a yarn winding device, which is a kind of textile machines, yarns are wound onto bobbins to form packages. Such a yarn winding apparatus is described, for example, in Patent Literature 1 (Japanese Examined Patent Publication No. H07-33206). A bobbin holder to which bobbins are attached is a long rotation member, and resonance occurs at a predetermined rotation speed. One of factors in the increase in vibration in the rotation member is unbalance in the rotation member. Unbalance in a rotation member means an uneven distribution of mass of the rotation member. Due to the existence of unbalance, the total sum of centrifugal forces acting at the time of rotation of the rotation member does not become zero, which increases vibration.

[0003] Patent Literature 1 describes that unbalance correction using weights for balancing is performed to dissolve unbalance in the bobbin holder. Specifically, the unbalance is corrected by adjusting the weights attached to both end portions and a central portion of the bobbin holder, i.e., three positions in the axial direction of the bobbin holder (in three planes). Furthermore, Patent Literature 1 describes that unbalance is dissolved well by performing the work of unbalance correction in a wide speed range from a low speed range to a high speed range.

SUMMARY OF THE INVENTION

[0004] It is certainly ideal to perform three-plane balancing over a wide speed range as described in Patent Literature 1. However, to do so, it is necessary to perform the following work repeatedly: the amount of unbalance is measured while the bobbin holder is rotated at a rotation speed; weights are adjusted based on the measurement result; and whether unbalance has been corrected is checked by rotating the bobbin holder again at the rotation speed. This makes the balancing process extremely laborious, and therefore the above method is not much practical.

[0005] Meanwhile, there is a simple balancing method in which the rotation member is regarded as a rigid rotor which is not elastically deformed, and weights are adjusted at two positions in the axial direction (in two planes). However, there has been a possibility that the weights added according to this method increase the centrifugal force rather than decrease, in a resonance mode in which bending occurs at the rotation member (i.e., in cases where the rotation member behaves as a flexible rotor not a rigid rotor). The increase in the centrifugal force may result in an increase in vibration in the

resonance mode.

[0006] The present invention has been made in view of the above-described problems. An object of the present invention is to prevent or lessen the increase in vibration due to a mass for balancing in a resonance mode in which bending occurs at a rotation member.

[0007] According to an embodiment of the present invention, a balancing method for reducing unbalance in a rotation member in a textile machine provided with a structure having the rotation member includes: a node position obtaining step of obtaining a position of at least one node of the rotation member in a predetermined resonance mode of the structure in which bending occurs at the rotation member; and an unbalance correcting step of adding or removing a mass for balancing to or from the rotation member based on an amount of unbalance of the rotation member rotated at a predetermined correction speed, wherein in the unbalance correcting step, the mass is added or removed at a position within a range of 10% of a length of the rotation member with respect to the axial direction of the rotation member, the range being defined by taking the position of the node as a midpoint of the range.

[0008] According to an embodiment of the present invention, a rotation member is provided. The rotation member is provided to a structure provided in a textile machine, and bending occurs at the rotation member when the structure vibrates in a predetermined resonance mode. An unbalance corrector for adding or removing a mass for balancing is provided at or around a position of at least one node of the rotation member in the predetermined resonance mode, within a range of 10% of a length of the rotation member with respect to an axial direction of the rotation member, the range being defined by taking the position of the node as a midpoint of the range.

[0009] In the above aspects of the present invention, the mass for balancing is added or removed at a position near the node of the rotation member in the predetermined resonance mode in which bending occurs at the rotation member. Due to this, when the rotation member vibrates in the predetermined resonance mode, the mass added or removed is not greatly displaced, and therefore it is possible to prevent or lessen the increase of the centrifugal force due to the mass. As a result, it is possible to prevent or lessen the increase in vibration due to the mass for balancing in the resonance mode in which bending occurs at the rotation member.

[0010] In the balancing method of the first aspect of the present invention, it is preferable that, in the unbalance correcting step, the mass is added or removed at the position of the node. In the rotation member of the second aspect of the present invention, it is preferable that the unbalance corrector is provided at the position of the node.

[0011] In the above arrangement, when the rotation member vibrates in the predetermined resonance mode, the mass added or removed is displaced little, and there-

fore it is possible to effectively prevent or lessen the increase of the centrifugal force due to the mass. As a result, it is possible to more effectively prevent or lessen the increase in vibration due to the mass for balancing in the resonance mode in which bending occurs at the rotation member.

[0012] Furthermore, in the balancing method of the above aspect of the present invention, it is preferable that: the at least one node of the rotation member in the predetermined resonance mode includes two or more nodes; and in the unbalance correcting step, the mass is added or removed at two positions in the axial direction determined based on positions of two of the two or more nodes.

[0013] In such two-plane balancing in which unbalance correction is made at two positions in the axial direction, the balancing process is greatly less laborious than in three or more-plane balancing.

[0014] Furthermore, in the balancing method of the above aspect of the present invention, it is preferable that the correction speed is lower than a rotation speed at which the predetermined resonance mode occurs.

[0015] Unbalance is reducible regardless of whether the correction speed is low or high, as long as an appropriate balancing method is used. However, when the correction speed is high, balancing using the balancing machine is difficult, and therefore in-place balancing is needed. In this case, the balancing process is laborious. Thus, setting the correction speed to a relatively low speed as described above makes the balancing process less laborious. Conventionally, there has been a possibility that merely setting the correction speed to a low speed cannot appropriately reduce vibration in a resonance mode occurring at a speed higher than the low speed (i.e., when the rotational member behaves as a flexible rotor). However, in the present invention, unbalance correction is made at the position(s) near the node(s) of the rotation member. In this configuration, even when the correction speed is a low speed, it is possible to reduce resonance in a speed range higher than the low speed.

[0016] Furthermore, in the balancing method of the above aspect of the present invention, it is preferable that: the textile machine is a yarn winding device configured to wind a yarn onto a bobbin to form a package; and the structure is a bobbin holder including a bobbin holding portion as the rotation member, the bobbin holding portion being configured to rotate with the bobbin attached to the bobbin holding portion.

[0017] When the structure is a bobbin holder, the application of the present invention thereto reduces vibration of the bobbin holder, and enables the formation of high-quality packages.

[0018] Furthermore, in the balancing method of the above aspect of the present invention, it is preferable that: the bobbin holder includes a rotation shaft attached to the bobbin holding portion, and a shaft supporting portion configured to support the rotation shaft in a rotatable manner; the bobbin holder has at least one other reso-

nance mode in which bending occurs at the shaft supporting portion when the bobbin holding portion is rotated at a speed lower than the rotation speed of the predetermined resonance mode in which bending occurs at the bobbin holding portion; and the correction speed is closer to the rotation speed at which the other resonance mode occurs than the rotation speed at which the predetermined resonance mode occurs.

[0019] In a known balancing technique for bobbin holders, it has been necessary to perform the work of unbalance correction also in a relatively high speed range in order to make the bobbin holders usable in or around the high speed range in which a resonance mode occurs at the bobbin holding portion. However, this makes the balancing process more laborious, as described above. Meanwhile, in the present invention, unbalance correction is made at the position(s) near the node(s) in the resonance mode of the bobbin holding portion. In this configuration, it is possible to reduce vibration in a high-speed range by performing the work of unbalance correction in a low-speed range. Furthermore, by setting the correction speed close to the rotation speed of the other resonance mode in which bending occurs at the shaft supporting portion, it is possible to reduce vibration well in the other resonance mode as well as in the predetermined resonance mode.

[0020] Furthermore, in the balancing method of the above aspect of the present invention, it is preferable that: the at least one other resonance mode of the bobbin holder includes two resonance modes; and the correction speed is a speed between two rotation speeds at which the two resonance modes respectively occur.

[0021] In the above arrangement, the work of unbalance correction is performed at a speed close to both the rotation speeds of the two resonance modes in each of which bending occurs at the shaft supporting portion. This makes it possible to reduce vibration well in the two resonance modes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 is a schematic diagram of a spun yarn take-up apparatus including a yarn winding device related to an embodiment of the present invention.

FIG. 2 is a cross section of a bobbin holder.

FIG. 3 is a graph showing the relationship between the rotation speed of the bobbin holder and vibration.

FIG. 4(a) to FIG. 4(c) are schematic diagrams showing deformations in respective resonance modes.

FIG. 5 is a schematic diagram showing the deformation of a bobbin holding portion in a tertiary resonance mode.

FIG. 6 is an enlarged view of an unbalance corrector. FIG. 7 is a flowchart showing a production process of the bobbin holder, including an unbalance correcting step.

FIG. 8 is a graph showing vibration occurring at the bobbin holder.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Spun Yarn Take-Up Apparatus)

[0023] The following will describe an example of embodiments of the present invention. FIG. 1 is a schematic diagram of a spun yarn take-up apparatus including a yarn winding device related to the present embodiment. A spun yarn take-up apparatus 1 is configured to wind synthetic fiber yarns Y spun out from a spinning apparatus 100 onto bobbins B, respectively, to form packages P. Hereinafter, upward, downward, forward, and rearward directions shown in FIG. 1 will be referred to as upward, downward, forward, and rearward directions of the spun yarn take-up apparatus 1.

[0024] The spun yarn take-up apparatus 1 includes godet rollers 3 and 4, a yarn winding device 5, and the like. In the spinning apparatus 100, polymer is extruded downward through a spinneret (not illustrated). Polymer is supplied by a polymer supplier (not illustrated) formed by a gear pump or the like. Yarns Y spun out from the spinning apparatus 100 are lined up in the direction perpendicular to the sheet of FIG. 1. While being arranged with a proper pitch by an unillustrated yarn path guide, the yarns Y run along a yarn path passing on the godet rollers 3 and 4. The yarns Y are distributed in the front-rear direction from the godet roller 4, and are then wound onto the bobbins B in the yarn winding device 5.

[0025] The yarn winding device 5 includes members such as a base 7, a turret 8, two bobbin holders 9, a supporting frame 10, a contact roller 11, a traverse unit 12, and the like. The yarn winding device 5 winds the yarns Y sent from the godet roller 4 onto the bobbins B simultaneously by rotating the bobbin holder 9, so as to form packages P.

[0026] The turret 8, which has a disc shape, is attached to the base 7. The turret 8 is driven and rotated by a motor (not illustrated) about a rotation axis which is in parallel to the front-rear direction. The two long cylindrical bobbin holders 9 cantilever from the turret 8 in a rotatable manner so as to extend in the front-rear direction. To each bobbin holder 9, the bobbins B are attached to be lined up along its axial direction (front-rear direction). As the turret 8 rotates, the positions of the two bobbin holders 9 are switched with each other, between an upper position and a lower position. The yarns Y are wound onto the bobbins B attached to the bobbin holder 9 at the upper position. After the yarns Y are fully wound onto the bobbins B attached to the bobbin holder 9 at the upper position and thereby the formation of the packages P is completed, the upper and lower positions of the two bobbin holders 9 are switched with each other. Then, the yarns Y are wound onto the bobbins B attached to the bobbin holder 9 which has just brought into the upper position.

[0027] The supporting frame 10 is a frame-shaped

member which is long in the front-rear direction. This supporting frame 10 is fixed to the base 7. A roller supporting member 13 which is long in the front-rear direction is attached to a lower part of the supporting frame 10 so as to be vertically movable relative to the supporting frame 10. The roller supporting member 13 supports both ends of the contact roller 11 in a rotatable manner. The contact roller 11 extends in the axial direction of the bobbin holders 9. The contact roller 11 is configured to contact the packages P supported by the bobbin holder 9 at the upper position, while the yarns Y are wound. With this, a predetermined contact pressure is applied to the packages P, to adjust the shape of the packages P.

[0028] The traverse unit 12 is attached to the roller supporting member 13 so as to be provided immediately above the contact roller 11. The traverse unit 12 includes traverse guides 14 lined up in the front-rear direction. The traverse guides 14 are driven by a motor (not illustrated) and reciprocate in the front-rear direction. The yarns Y are respectively threaded onto the traverse guides 14. As each traverse guide 14 reciprocates, the yarn Y threaded thereon is traversed about a corresponding fulcrum guide 15 in the front-rear direction. While being traversed, the yarn Y is wound onto the corresponding bobbin B.

(Bobbin Holder)

[0029] Now, the details of the structure of each bobbin holder 9 will be described. FIG. 2 is a cross section of each bobbin holder 9. The left-right direction in FIG. 2 is defined as an axial direction, the left side in FIG. 2 is defined as a leading end side, and the right side in FIG. 2 is defined as a base end side. The bobbin holder 9 includes a bobbin holding portion 20, a rotation shaft 21, a shaft supporting portion 22, and the like.

[0030] The bobbin holding portion 20 includes a cylindrical shell part 20a, and a boss part 20b provided at a central portion of the shell part 20a in the axial direction. The shell part 20a is long in the axial direction, and the bobbins B are attachable to/detachable from the outer circumferential surface of the shell part 20a. The internal space of the shell part 20a is divided by the boss part 20b into two spaces: a leading-end-side space and a base-end-side space. In the base-end-side space, the rotation shaft 21 and the shaft supporting portion 22 are provided.

[0031] A leading-end-side end portion of the rotation shaft 21 is fixed to a radially-central portion of the boss part 20b. A base-end-side end portion of the rotation shaft 21 is connected to a drive shaft 31 of a motor 30 (will be described later) via a coupling 23. The shaft supporting portion 22 is a cylindrical portion which is long in the axial direction. The shaft supporting portion 22 supports, in a rotatable manner, the rotation shaft 21 provided inside thereof via bearings 24. A base-end-side end portion of the shaft supporting portion 22 is fixed to the turret 8. That is, the shaft supporting portion 22 cantilevers from

the turret 8.

[0032] The motor 30 is incorporated in the turret 8. The motor 30 includes the drive shaft 31, a motor housing 32, a rotor 33, a stator 34, and the like. The drive shaft 31 is supported by the motor housing 32 in a rotatable manner via bearings 35. The drive shaft 31 is connected to the rotor 33. The stator 34 is attached to the motor housing 32. As an electric current passes through the stator 34, the rotor 33 rotates. The rotation of the rotor 33 is transmitted to the bobbin holding portion 20 via the drive shaft 31, the coupling 23, and the rotation shaft 21.

(Resonance of Bobbin Holder and Unbalance)

[0033] Now, a description will be given for resonance modes occurring at the bobbin holder 9. Note that each of the resonance modes described herein is merely an example, and shall not be deemed as a premise of the present invention. Furthermore, in the following description, expressions such as "the rotation (or rotation speed) of the bobbin holder 9" may be used. It should be noted that, to be precise, this means "the rotation (or rotation speed) of the bobbin holding portion 20".

[0034] FIG. 3 is a graph showing the relationship between the rotation speed of the bobbin holder 9 and vibration. As the rotation speed of the bobbin holder 9 increases, a first resonance mode (hereinafter, referred to as a "primary resonance mode") occurs at a rotation speed of "a" [m/min], a second resonance mode (hereinafter, referred to as a "secondary resonance mode") occurs at a rotation speed of "b" [m/min], and a third resonance mode (hereinafter, referred to as a "tertiary resonance mode") occurs at a rotation speed of "c" [m/min]. It is a matter of course that fourth and subsequent resonance modes will occur as the rotation speed further increases. However, in the present embodiment, the winding speed "r" [m/min] of the yarns Y is between the rotation speed b and the rotation speed c, as shown in FIG. 3. For this reason, it is less likely that the fourth and subsequent resonance modes have effect when the bobbin holder 9 rotates at the winding speed r. Accordingly, the fourth and subsequent resonance modes are not considered here.

[0035] FIG. 4(a) to FIG. 4(c) are schematic diagrams showing deformations in the respective resonance modes. Specifically, FIG. 4(a) to FIG. 4(c) respectively show the deformations in primary, secondary, and tertiary resonance modes. As shown in FIG. 4(a), in the primary resonance mode, no bending occurs at the bobbin holding portion 20, but primary bending occurs at the shaft supporting portion 22. As shown in FIG. 4(b), in the secondary resonance mode, no bending occurs at the bobbin holding portion 20, but secondary bending occurs at the shaft supporting portion 22. As shown in FIG. 4(c), in the tertiary resonance mode, bending occurs at the bobbin holding portion 20, in addition to the secondary bending occurring at the shaft supporting portion 22. In the tertiary resonance mode, bending occurs at the bob-

bin holding portion 20 in addition to the shaft supporting portion 22, and therefore vibration is larger than in the primary resonance mode and the secondary resonance mode, as shown in FIG. 3. FIG. 5 is a schematic diagram showing the deformation of the bobbin holding portion 20 in the tertiary resonance mode. In the tertiary resonance mode, the bobbin holding portion 20 vibrates between the state indicated with a solid line in FIG. 5 and the state indicated with a dashed line in FIG. 5.

[0036] Now, one of the factors in the increase in the vibration in the bobbin holder 9 other than resonance is unbalance in the bobbin holder 9, more precisely, unbalance in the bobbin holding portion 20. If there is great unbalance in the bobbin holding portion 20, a large centrifugal force is generated when rotating the bobbin holder 9, which makes the vibration of the bobbin holder 9 larger. To solve the unbalance in the bobbin holding portion 20, it is conceivable to perform unbalance correction using weights for balancing.

[0037] Conventionally, in the bobbin holding portion 20, it is general to make unbalance correction simply at two positions in the axial direction (two-plane balancing). In the conventional two-plane balancing, weights for balancing are added at positions P1 and P2 (see FIG. 5) at both end portions of the bobbin holding portion 20. The above method in which the weights are added at the both-end positions P1 and P2 is advantageous in that the bobbin holding portion 20 can be balanced efficiently using weights each having a small mass.

[0038] In the tertiary resonance mode, as shown in FIG. 4(c), the bobbin holding portion 20 is bent and displaced. That is, the bobbin holding portion 20 behaves as a flexible rotor. Because of this, in the tertiary resonance mode, the weights added at the both-end positions P1 and P2 are displaced in a direction different from the cases in which the bobbin holding portion 20 behaves as a rigid rotor (see FIG. 4(a) and FIG. 4(b), in the primary and secondary resonance modes). This disrupts the balance that has been achieved in the states of FIG. 4(a) and FIG. 4(b), and further increases the vibration in the tertiary resonance mode, disadvantageously. As described above, the vibration in the tertiary resonance mode is originally larger than that in the primary and secondary resonance modes. If such large vibration is further increased by the effect by the weights for balancing, the peak in the tertiary resonance mode shown in FIG. 3 is further heightened, which makes it difficult to increase the winding speed r.

[0039] In recent years, in order to improve the production efficiency of packages P, a demand for the increase in the winding speed r of the bobbin holder 9 has been increasing, and therefore it is important to minimize the vibration in the tertiary resonance mode. Furthermore, the length of the bobbin holder 9 has been becoming longer to increase the number of packages P formed at one time. Such a current situation is also one of the factors in the relative increase of the effect by the tertiary resonance mode. In view of the above, in the present

embodiment, to reduce the vibration in the tertiary resonance mode, weights for balancing are added at the positions of nodes N1 and N2 (see FIG. 5) of the bobbin holding portion 20 in the tertiary resonance mode. The following will describe its details.

(Unbalance Correction in Bobbin Holder)

[0040] As shown in FIG. 2, in the bobbin holding portion 20 of the present embodiment, an unbalance corrector 25 is provided at each of the positions of the nodes N1 and N2. Each of the nodes N1 and N2 is a portion of the bobbin holding portion 20 which is not displaced in a direction perpendicular to the axial direction in the tertiary resonance mode, in which bending occurs at the bobbin holding portion 20. As can be clearly seen from FIG. 5, in the tertiary resonance mode of the bobbin holder 9, there are two nodes N1 and N2 in the axial direction.

[0041] FIG. 6 is an enlarged view of the unbalance corrector 25. The unbalance corrector 25 is formed by: a plurality of threaded hole portions 26 arranged at equal intervals (e.g., at intervals of 30 degrees in its circumferential direction) on an outer circumferential surface of the bobbin holding portion 20; and one or more weights 27 each having a bolt-like shape and capable of being screwed into the threaded hole portions 26. It should be noted that all the threaded hole portions 26 do not have to be filled with the weights 27. Based on the measurement result of the amount of unbalance, which will be described later, one or more weights 27 are attached to the threaded hole portion(s) 26 determined as necessary. Various masses of weights 27 are prepared.

[0042] FIG. 7 is a flowchart showing a production process of bobbin holders, including an unbalance correcting step. First of all, at the time of designing the bobbin holder 9, a prototype or the like of the bobbin holder 9 is subjected to a vibration test (step S1). The vibration test herein is a hammering test in which, for example, the bobbin holder 9 in a stationary state is vibrated, and its response is measured. The result of the vibration test shows that the first to tertiary resonance modes occur at the bobbin holder 9, at rotation speeds a to c [m/min], respectively. Furthermore, through the vibration test, the positions of the nodes N1 and N2 of the bobbin holding portion 20 in the tertiary resonance mode, in which bending occurs at the bobbin holding portion 20, are obtained. (This step corresponds to a node position obtaining step in the present invention.) Then, after the positions of the nodes N1 and N2 of the bobbin holding portion 20 obtained through the vibration test are reflected on the design of the bobbin holder 9, the bobbin holder 9 is produced and assembled (step S2).

[0043] Subsequently, using a known balancing machine, the amount of unbalance of the bobbin holder 9 (bobbin holding portion 20) is measured (step S3). Every bobbin holder 9 assembled in step S2 is subjected to the measurement of the amount of unbalance in step S3 and to the unbalance correction in step S4, which will be de-

scribed later. The structure of the balancing machine has already been known, and therefore the detailed description thereof is not given here. A typical balancing machine is configured to receive an input of a correction speed and a correction position for which measurement of the amount of unbalance is desired, and to output the amount of unbalance with respect to the set correction speed and correction position. The unbalance amount is expressed, for example, as follows.

[0044] Correction position A: correction angle of 245 degrees, correction amount of 5 g.

[0045] Correction position B: correction angle of 30 degrees, correction amount of 10 g.

[0046] That is, the amount of unbalance is expressed as the correction angle and correction amount at each correction position. The correction angle means the angle in the circumferential direction from a preset referential position.

[0047] In the unbalance measurement of the present embodiment, the amount of unbalance is measured under the following conditions: the correction speed is p [m/min], and the correction positions are the positions of the nodes N1 and N2 (hereinafter, referred to as correction positions N1 and N2). As shown in FIG. 3, the correction speed p is between the rotation speed a , at which the primary resonance mode occurs, and the rotation speed b , at which the secondary resonance mode occurs.

[0048] After measuring the amount of unbalance in step S3, unbalance correction is made based on the measurement result, at the unbalance corrector 25 provided at each of the correction positions N1 and N2 (step S4: unbalance correcting step in the present invention). Specifically, at each of the correction positions N1 and N2, a weight 27 having an appropriate mass is attached into each of one or more threaded hole portions 26 out of the plurality of threaded hole portions 26 arranged in the circumferential direction. The one or more threaded hole portions 26 are determined based on the measurement result of the amount of unbalance. With this, the balancing process is completed. It is preferable to check whether the amount of unbalance is less than the tolerance in the balancing machine after the balancing process is completed.

[0049] In the present embodiment described above, the yarn winding device 5 is equivalent to the textile machine of the present invention, the bobbin holder 9 is equivalent to the structure of the present invention, and the bobbin holding portion 20 is equivalent to the rotation member of the present invention.

(Advantageous Effects)

[0050] As described above, in the present embodiment, unbalance correction is made at the positions of the nodes N1 and N2 of the bobbin holding portion 20 in the tertiary resonance mode in which bending occurs at the bobbin holding portion 20. In this arrangement, when

the bobbin holding portion 20 vibrates in the tertiary resonance mode, the added weights 27 are displaced little, and therefore it is possible to effectively prevent or lessen the increase of the centrifugal force due to the weights 27. As a result, it is possible to effectively prevent or lessen the increase in vibration due to the weights 27 for balancing in the tertiary resonance mode in which bending occurs at the bobbin holding portion 20. The reduction of the vibration of the bobbin holder 9 enables the formation of high-quality packages P.

[0051] FIG. 8 is a graph showing vibration occurring at the bobbin holder 9. In FIG. 8, "end-face correction" means the traditional balancing in which unbalance correction is made at the both-end positions P1 and P2 (see FIG. 5) of the bobbin holding portion 20. Meanwhile, "node correction" means the balancing in which unbalance correction is made at the positions of the nodes N1 and N2. In the end-face correction, vibration in the primary resonance mode and the secondary resonance mode is reduced. However, vibration is very large in the tertiary resonance mode. Thus, it is difficult to rotate the bobbin holder 9 at a high speed. Meanwhile, in the node correction, vibration is effectively reduced in the tertiary resonance mode as well as in the primary and secondary resonance modes. This makes it possible to increase the winding speed r , and thereby to improve the production efficiency of the packages P.

[0052] Furthermore, in the present embodiment, the bobbin holding portion 20 has two nodes N1 and N2 in the tertiary resonance mode, and unbalance correction is made at the two positions (correction positions N1 and N2) in the axial direction determined based on the positions of the two nodes N1 and N2. In such two-plane balancing in which unbalance correction is made at two positions in the axial direction, the balancing process is greatly less laborious than in three-plane balancing.

[0053] In the present embodiment, the correction speed p is lower than the rotation speed c at which the tertiary resonance mode occurs. Unbalance is reducible regardless of whether the correction speed is low or high, as long as an appropriate balancing method is used. However, when the correction speed is high, balancing using the balancing machine is difficult, and therefore in-place balancing is needed. In this case, the balancing process is laborious. Thus, setting the correction speed to a relatively low speed as described above makes the balancing process less laborious. Conventionally, there has been a possibility that merely setting the correction speed to a low speed cannot appropriately reduce vibration in a resonance mode occurring at a speed higher than the low speed (in the above embodiment, when the bobbin holding portion 20 behaves as a flexible rotor in the tertiary resonance mode). However, in the configuration of the present embodiment in which unbalance correction is made at the positions of the nodes N1 and N2 of the bobbin holding portion 20 in the tertiary resonance mode, it is possible to reduce vibration also in the tertiary resonance mode through the work of unbalance correc-

tion performed at a speed lower than the rotation speed at which the tertiary resonance mode occurs.

[0054] Furthermore, in the present embodiment, the bobbin holder 9 has the primary resonance mode (or the secondary resonance mode) in which bending occurs at the shaft supporting portion 22 when the bobbin holding portion 20 is rotated at the speed a (or b) which is lower than the rotation speed c of the tertiary resonance mode in which bending occurs at the bobbin holding portion 20; and the correction speed p is closer to the rotation speed a (or b) at which the primary resonance mode (or the secondary resonance mode) occurs than the rotation speed c at which the tertiary resonance mode occurs. In known balancing technique for bobbin holders, it has been necessary to perform the work of unbalance correction also in a relatively high speed range in order to make the bobbin holders usable in or around the high speed range in which a resonance mode (tertiary resonance mode) occurs at the bobbin holding portion 20. However, this makes the balancing process more laborious, as described above. Meanwhile, in the present embodiment, unbalance correction is made at the positions of the nodes N1 and N2 in the tertiary resonance mode. In this configuration, even though the correction speed is in a low speed range close to the rotation speed a (or b) at which the primary resonance mode (or the secondary resonance mode) occurs, it is possible to reduce vibration of the bobbin holding portion 20 in the tertiary resonance mode. Furthermore, because the work of unbalance correction is performed at the speed p close to the rotation speed a (or b) of the primary resonance mode (or the secondary resonance mode) in which bending occurs at the shaft supporting portion 22, it is possible to reduce vibration well in the primary resonance mode (or the secondary resonance mode) as well as in the tertiary resonance mode.

[0055] Furthermore, in the present embodiment, the bobbin holder 9 has the two resonance modes (the primary and secondary resonance modes) in which bending occurs at the shaft supporting portion 22 at the rotation speeds a and b , respectively, which are lower than the rotation speed c . The correction speed p is between the rotation speed a at which the primary resonance mode occurs and the rotation speed b at which secondary resonance mode occurs. In the above arrangement, the work of unbalance correction is performed at the speed p close to both the rotation speeds a and b of the primary and secondary resonance modes in each of which bending occurs at the shaft supporting portion 22. This makes it possible to reduce vibration well in the primary and secondary resonance modes.

(Other Embodiments)

[0056] While an embodiment of the present invention has been described, the present invention is not limited to the above-mentioned embodiment and can be suitably changed within the scope and spirit of the present inven-

tion.

[0057] For example, in the embodiment described above, the correction positions at which unbalance correction is made are the positions of the nodes N1 and N2. In this regard, the correction positions do not have to be exactly the same as the positions of the nodes N1 and N2. It is possible to reduce the vibration in the tertiary resonance mode as long as the correction positions are close to the nodes N1 and N2, respectively. To be more specific, suppose that the length of the bobbin holding portion 20 in the axial direction is L. The effect of reducing the vibration in the tertiary resonance mode is sufficiently provided when unbalance correction is made at a correction position within an axial distance range of L/10, the range being defined by taking each node N1, N2 as the midpoint of the range, as shown in FIG. 2.

[0058] In the embodiment described above, the two nodes N1 and N2 are generated at the bobbin holding portion 20 in the tertiary resonance mode, and unbalance correction is made at the positions of the positions of the two nodes N1 and N2 (in two planes). In this regard, it is possible to reduce vibration in a resonance mode in which three or more nodes are generated at the bobbin holding portion 20. In such a case, it is only required to make unbalance correction at the positions of two of the three or more nodes. Alternatively, it is also possible to make unbalance correction at the positions of three of the three or more nodes (in three planes).

[0059] In the embodiment described above, one or more weights 27 are added to the threaded hole portions 26 as needed, so as to function as the unbalance corrector 25. In this regard, unbalance correction may be made by removing the mass, for example by drilling. In this case, it is only required for the unbalance corrector to be a part of the rotation member which has a thickness allowing such drilling.

[0060] Furthermore, in the embodiment above, a vibration test is performed to obtain the positions of the nodes N1 and N2 of the bobbin holding portion 20. However, instead of performing the vibration test, vibration analysis using a computer model may be performed.

[0061] Furthermore, in the embodiment described above, the present invention is applied to the bobbin holder 9. However, the present invention is applicable to other structures as long as each structure includes a rotation member. For example, the present invention may be applied to the contact roller 11 shown in FIG. 1. Moreover, the present invention may be applied to structures which are provided to the textile machine and other than the yarn winding device 5.

Claims

1. A balancing method for reducing unbalance in a rotation member in a textile machine provided with a structure having the rotation member, the method comprising:

a node position obtaining step of obtaining a position of at least one node of the rotation member in a predetermined resonance mode of the structure in which bending occurs at the rotation member; and

an unbalance correcting step of adding or removing a mass for balancing to or from the rotation member based on an amount of unbalance of the rotation member rotated at a predetermined correction speed, wherein in the unbalance correcting step, the mass is added or removed at a position within a range of 10% of a length of the rotation member with respect to the axial direction of the rotation member, the range being defined by taking the position of the node as a midpoint of the range.

2. The balancing method according to claim 1, wherein in the unbalance correcting step, the mass is added or removed at the position of the node.

3. The balancing method according to claim 1 or 2, wherein:

the at least one node of the rotation member in the predetermined resonance mode includes two or more nodes; and

in the unbalance correcting step, the mass is added or removed at two positions in the axial direction determined based on positions of two of the two or more nodes.

4. The balancing method according to any one of claims 1 to 3, wherein the mode occurs.

5. The balancing method according to any one of claims 1 to 4, wherein:

the textile machine is a yarn winding device configured to wind a yarn onto a bobbin to form a package; and

the structure is a bobbin holder including a bobbin holding portion as the rotation member, the bobbin holding portion being configured to rotate with the bobbin attached to the bobbin holding portion.

6. The balancing method according to claim 5, wherein:

the bobbin holder includes a rotation shaft attached to the bobbin holding portion, and a shaft supporting portion configured to support the rotation shaft in a rotatable manner;

the bobbin holder has at least one other resonance mode in which bending occurs at the shaft supporting portion when the bobbin holding portion is rotated at a speed lower than the rotation speed of the predetermined resonance mode in

which bending occurs at the bobbin holding portion; and
the correction speed is closer to the rotation speed at which the other resonance mode occurs than the rotation speed at which the predetermined resonance mode occurs. 5

7. The balancing method according to claim 6, wherein:

the at least one other resonance mode of the bobbin holder includes two resonance modes; and
the correction speed is a speed between two rotation speeds at which the two resonance modes respectively occur. 10 15

8. A rotation member provided to a structure provided in a textile machine, bending occurring at the rotation member when the structure vibrates in a predetermined resonance mode, wherein 20
an unbalance corrector for adding or removing a mass for balancing is provided at or around a position of at least one node of the rotation member in the predetermined resonance mode, within a range of 10% of a length of the rotation member with respect 25
to an axial direction of the rotation member, the range being defined by taking the position of the node as a midpoint of the range.

9. The rotation member according to claim 8, wherein 30
the unbalance corrector is provided at the position of the node.

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FIG.1

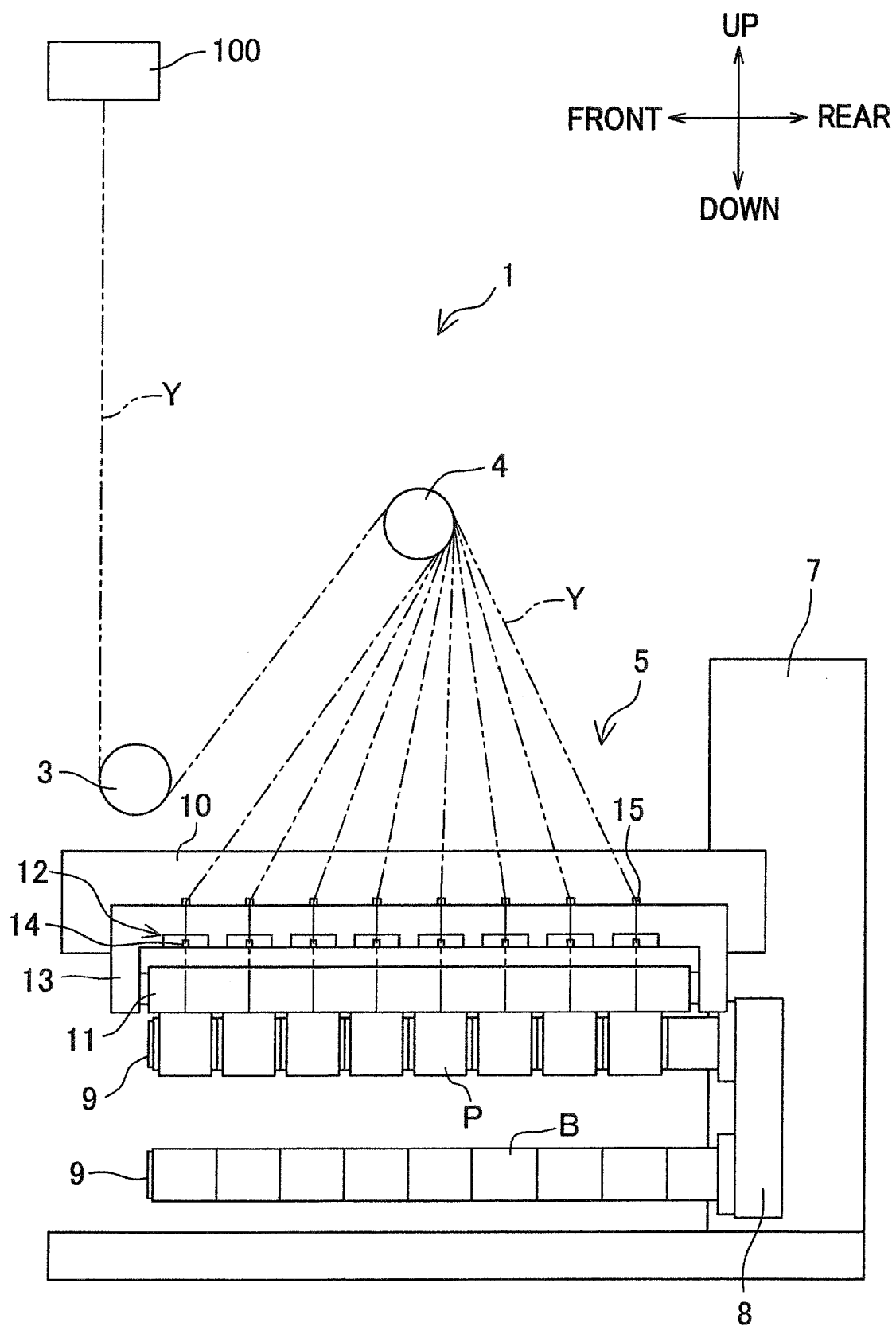


FIG.2

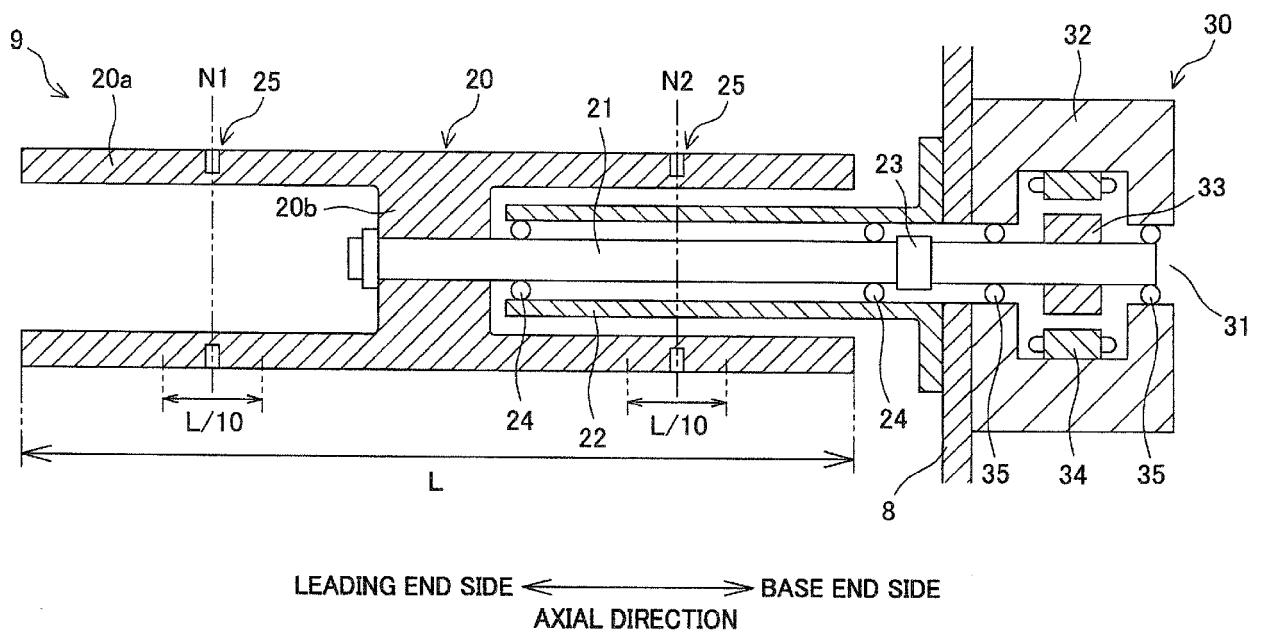


FIG.3

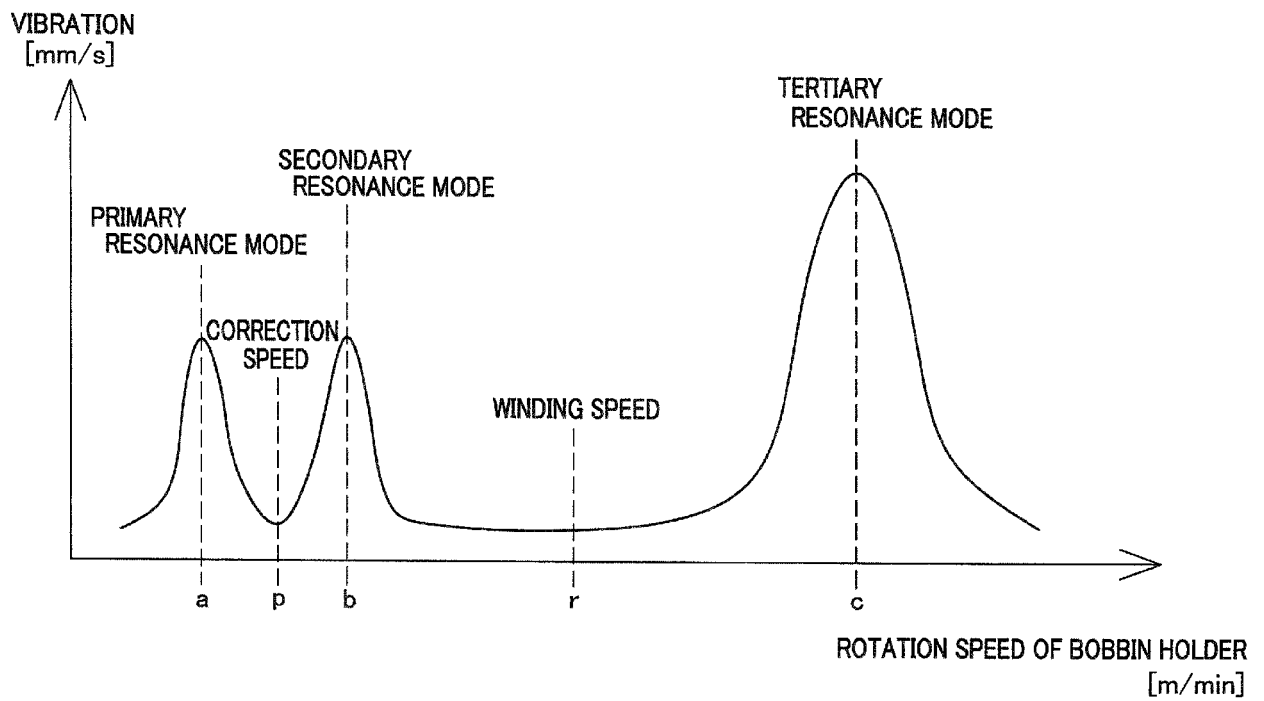


FIG.4

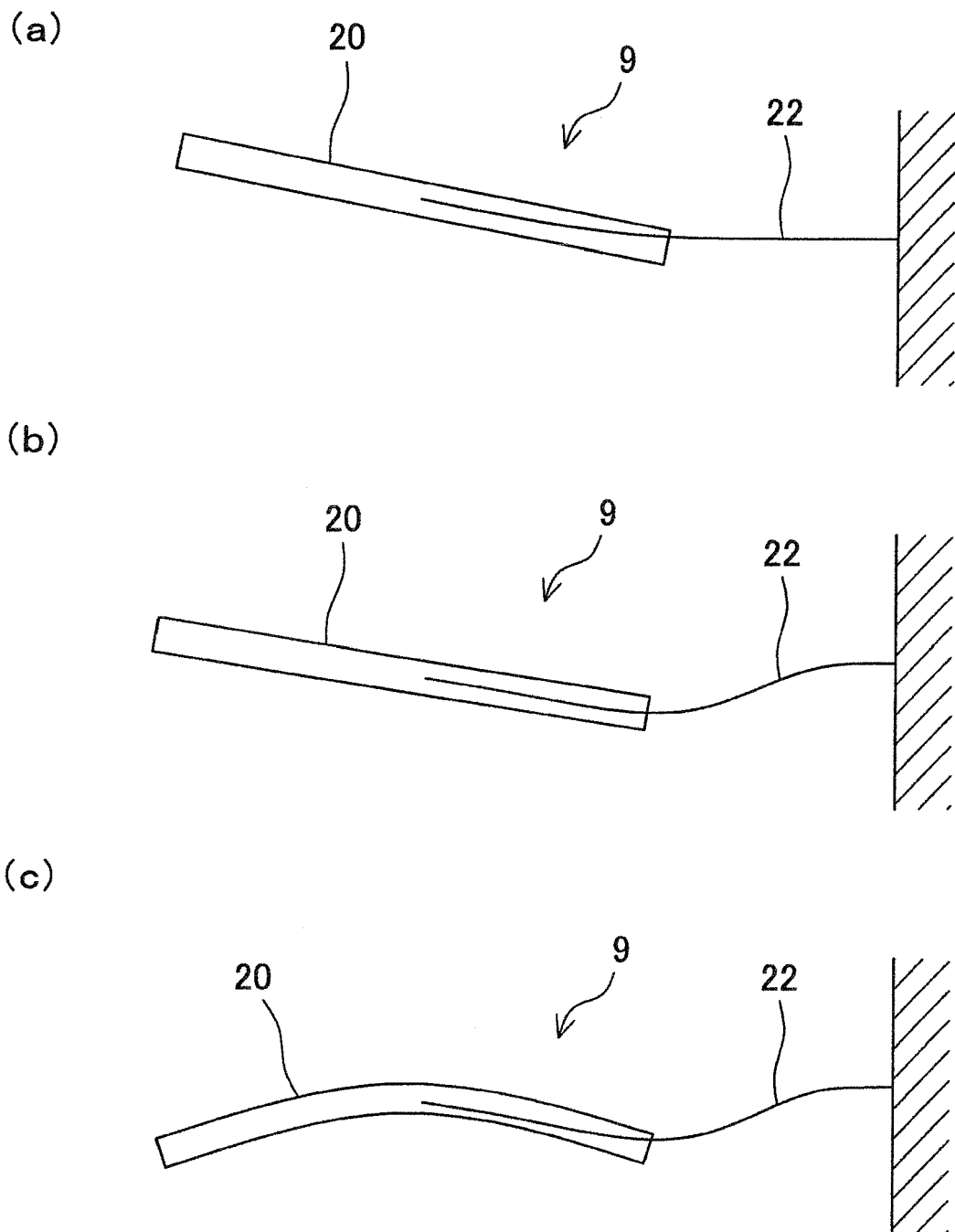


FIG.5

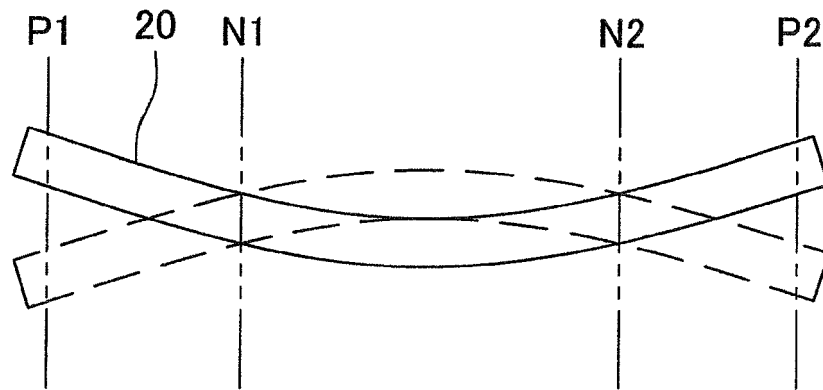


FIG.6

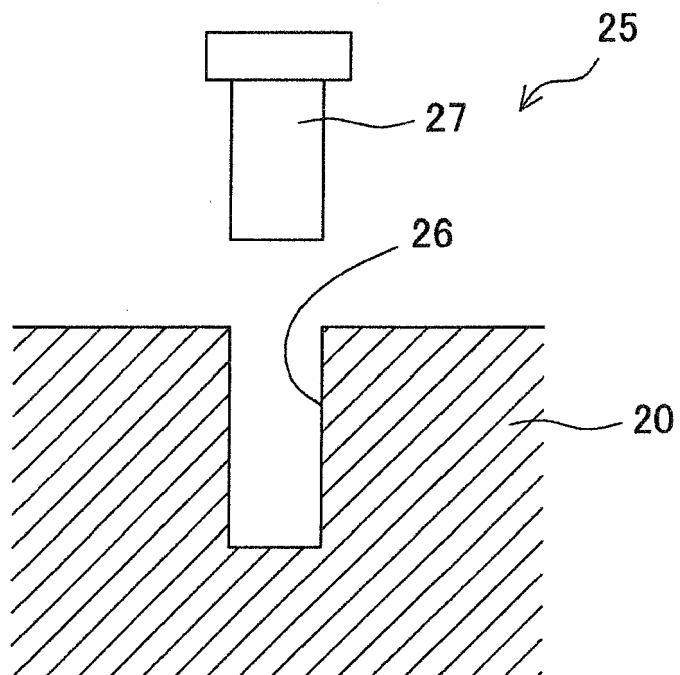


FIG.7

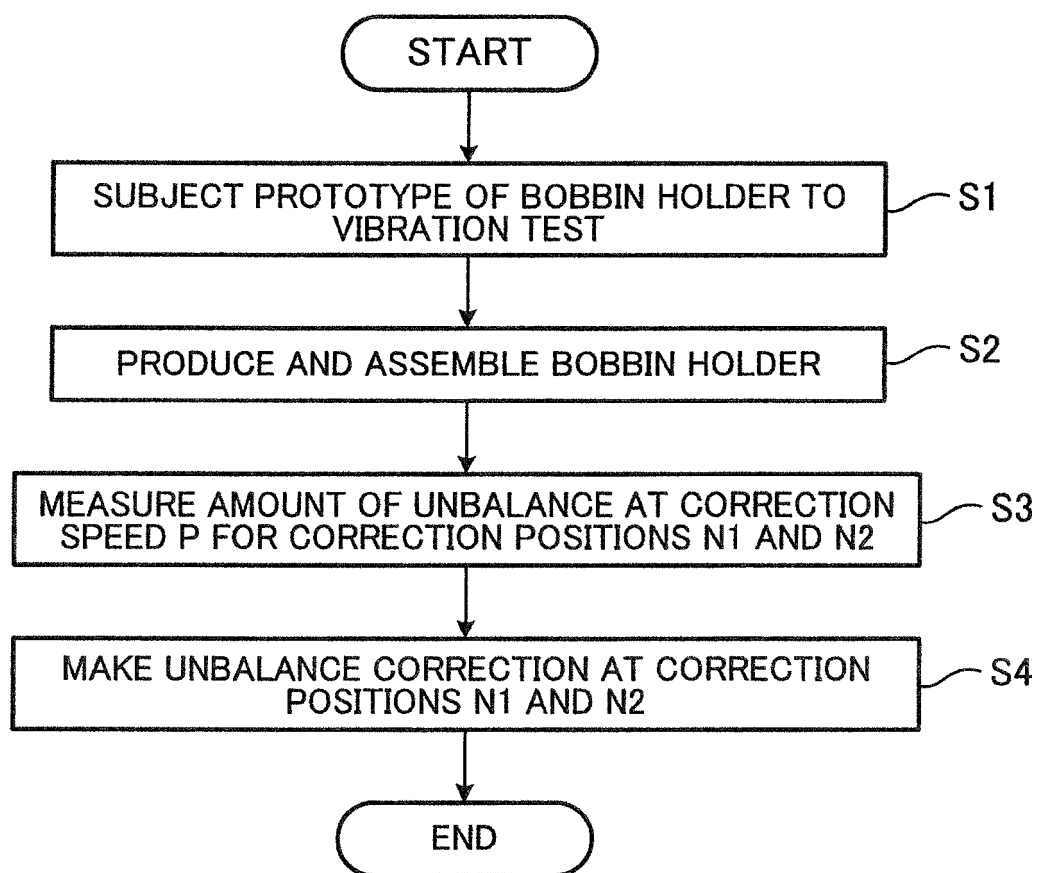
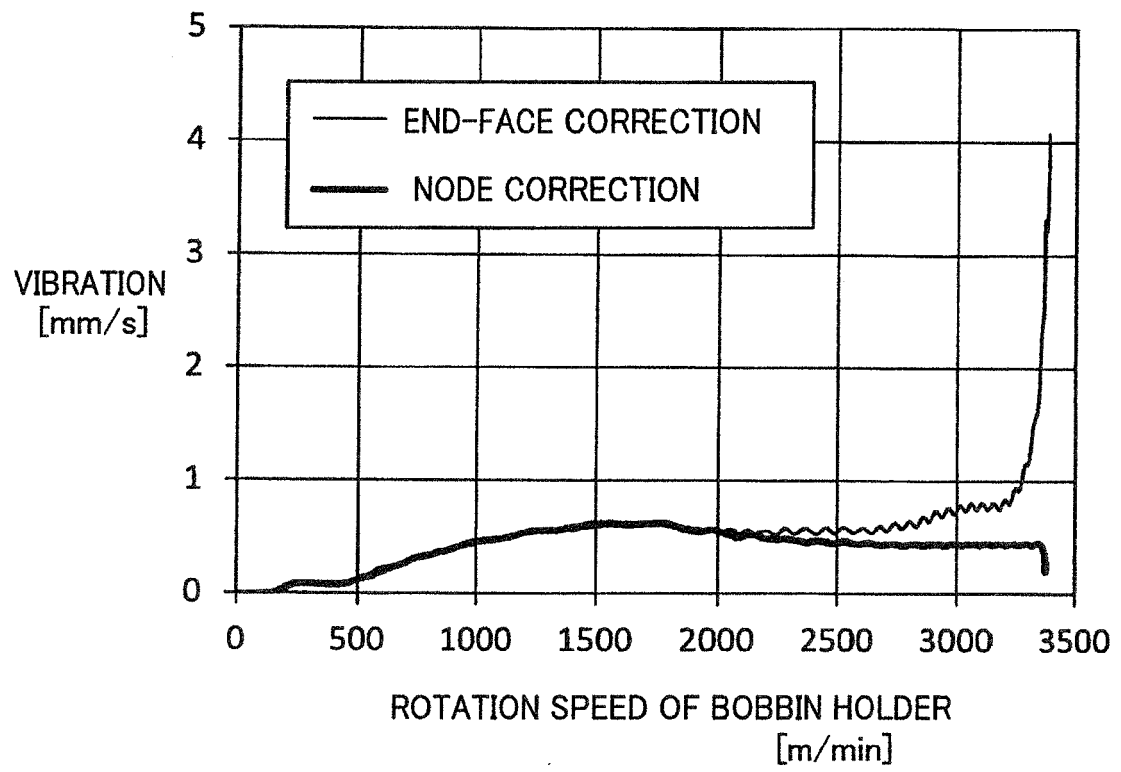


FIG.8





EUROPEAN SEARCH REPORT

Application Number
EP 17 19 7715

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 23 March 2018	Examiner Guisan, Thierry
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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