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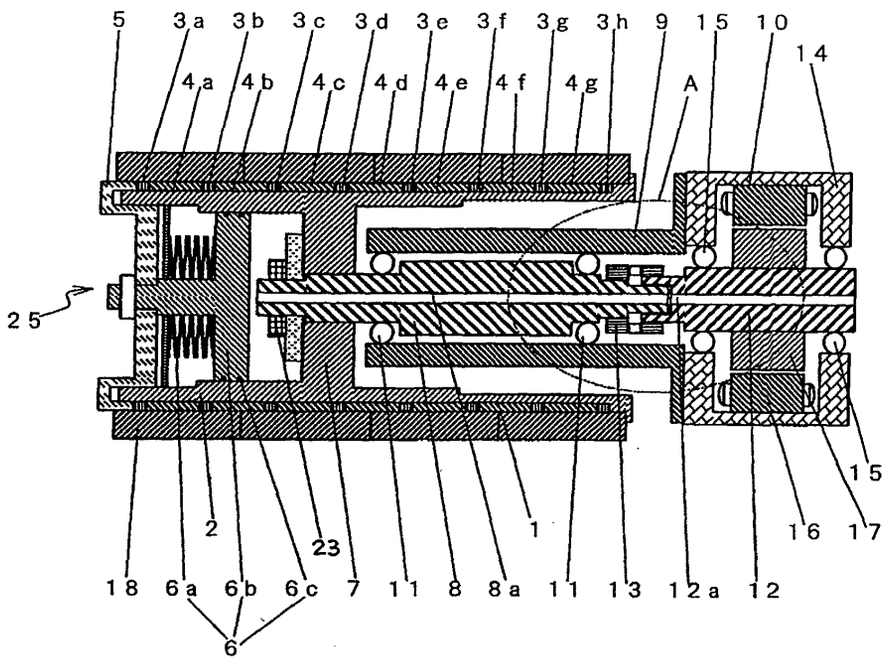
(54) Yarn winding apparatus and method of producing a yarn package

(57) A yarn winding apparatus having a fitting structure at connecting portion of a spindle (8) and a motor shaft (12), which fitting structure is constructed with a hole provided at the end surface of the motor shaft and an end portion of the spindle inserted into the hole or a hole provided at the end surface of the spindle and an end portion of the motor shaft inserted into the hole. At the connecting portion, the fitting structure forms a deflection control means for substantially conforming deflections of the spindle and the motor shaft with each other by supporting the spindle based on stiffness of the motor shaft.

Fig. 1



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Description

Field of the Invention

[0001] The present invention relates to a yarn winding apparatus being able to wind a yarn at high speed and a method of producing a yarn package.

Description of Related Art

[0002] Recently, a speed of process for producing synthetic fibers is promoted for accomplishing high productivity, quality and others and it becomes popular that a process for producing synthetic fibers has a yarn winding speed of 5,000 m/min or more.

[0003] On the other hand, it is tried to put a yarn winding apparatus that is possible to wind a yarn at a speed of 7,000 m/min or more in practical use.

[0004] Moreover, during the trial, if it is realized to make a bobbin holder in a yarn winder longer, it becomes possible to reduce a running cost and improve productivity of process for producing synthetic fibers.

[0005] In such circumstances, it is promoted to develop a bobbin holder having a longer length and being able to use in high speed. The biggest problem in the development is how to control vibration that occurs at high rotational speed on the long bobbin holder.

[0006] A bobbin holder used in a high speed yarn winder is disclosed in, for example, JP 2751551 B, JU 02-015888 B or JP 08-175753 A. A structure of the bobbin holder disclosed therein is shown in Fig. 13.

[0007] In Fig. 13, the bobbin holder 30 comprises a cylindrical member 31 on which four cylindrical bobbins 100 are mounted detachably. The cylindrical member 31 has a boss 36 therein. One (the left end portion) of the end portions of a spindle 34 is secured at the boss 36. The end face of the other end portion (the right end portion) of the spindle 34 is positioned face to face with the end face of one (the left end portion) of the end portions of a motor shaft 39 of a motor 38. On a motor housing 37, a tubular supporting member 33 is secured. The tip portion opposite to the fixed side of the tubular supporting member 33 is positioned at the inner side of the cylindrical member 31. The spindle 34 is positioned at the inner side of the tubular supporting member 33. Bearings 35 for supporting the spindle 34 rotatably are provided at the inner side of the tubular supporting member 33. The right end portion of the spindle 34 and the left end portion of the motor shaft 39 are connected with a flexible coupling 40 which is a torque transmission means to transfer torque of the motor shaft 39 to the spindle 34. A bobbin holding device 32 to hold the bobbins 100 detachably on the cylindrical member 31 of the bobbin holder 30 is provided on the cylindrical member 31. Pressurized air supplying holes 39a and 34a for operating the bobbin holding device 32 are provided respectively in the motor shaft 39 and the spindle 34.

[0008] Details of the flexible coupling 40 which is a torque transmission means to transfer torque of the motor shaft 39 to the spindle 34 is shown with Fig. 14. In Fig. 14, the rotation axis of the spindle 34 and the rotation axis of the motor shaft 39 coincide substantially with each other. The right end portion of the spindle 34 and the left end portion of the motor shaft 39 are face to face each other and positioned with a clearance. The right end portion of the spindle 34 and the left end portion of the motor shaft 39 are connected with the flexible coupling 40 to be able to transmit the torque of the motor shaft 39 to the spindle 34. A seal member 41 intervenes at the clearance portion between the right end portion of the spindle 34 and the left end portion of the motor shaft 39. Leakage of the pressurized air supplied through the pressurized air supplying holes 39a and 34a from the clearance portion is prohibited by the seal member 41.

[0009] The conventional connecting portion between the right end portion of the spindle 34 and the left end portion of the motor shaft 39 has simply a torque transmission means and a pressurized air supplying means only. It does not include a structure for supporting positively a deflection of the spindle 34.

[0010] It is disclosed in JP 02-225268 A, JP 2751551 or JP 08-175753 A that making yarn winding speed in high may be accomplished by improvement of a form or material of the cylindrical member of the bobbin holder.

[0011] It was tried to wind a yarn in stable at a winding speed of 6,000 m/min or more by using a bobbin holder having an axial length (total length of bobbins) of a bobbin holder on which bobbins are mounted. Unfortunately, a yarn winder being suitable for that could not realized only with the improvement of a form or material of the cylindrical member of the bobbin holder.

[0012] The inventors found that vibration caused by whirling based on deflection of the end portion of a spindle faced to a motor shaft occurs. In that state, it was not possible to accomplish a high speed rotation of the spindle for obtaining a yarn winding speed of 6,000 m/min or more.

[0013] It became clear that improvement of a natural frequency of a structure comprising a bobbin holder and a spindle is not accomplished at a high rotational speed over a certain level. Even though countermeasures to improve a natural frequency of the cylindrical member of the bobbin holder used in heretofore are taken, since vibration of the spindle is not caused only by vibration of the cylindrical member.

Summary of the Invention

[0014] It is an object of the invention to provide a yarn winding apparatus realizing winding of a yarn at a yarn winding speed of 7,000 m/min or more, while using a bobbin holder (a long bobbin holder) having an axial length of a portion on which a bobbin is mounted is 1,200 mm or more and a bobbin having an inner diameter of 125 mm or less.

[0015] It is another object of the invention to provide a method of producing a yarn package in which a yarn winding apparatus of the invention is used.

[0016] A yarn winding apparatus of the invention for achieving the objects comprises;

(a) a bobbin holder comprising a columnar member along on which peripheral surface a cylindrical bobbin is mounted;
(b) a spindle connected to the bobbin holder for supporting the bobbin holder in substantially horizontal and rotating the bobbin holder;
(c) bearings of the spindle for supporting thereof in rotatable;
(d) a motor shaft for rotating the spindle;
(e) bearings of the motor shaft for supporting thereof in rotatable; and
(f) a motor including the motor shaft and the bearings of the motor shaft,
(g) wherein the axis of rotation of the spindle and the axis of rotation of the motor shaft substantially collinear with each other and the first end portion of the spindle and the first end portion of the motor shaft face each other; and
(h) the spindle and the motor shaft are connected with torque transmission means for transmitting a torque of the motor shaft to the spindle,
(i) characterized in that the fist end portion of the spindle and the first end portion of the motor shaft are connected with a deflection control means for controlling deflection of the spindle based on stiffness of the motor shaft.

[0017] It is preferable in the invention that the deflection control means is constructed with a fitting structure comprising an insertion of the first end portion of the spindle into a hole provided at the end surface of the first end portion of the motor shaft, or an insertion of the first end portion of the motor shaft into a hole provided at the end surface of the first end portion of the spindle.

[0018] It is preferable that the relations of

$$1.5 \leqq (D1/d) \leqq 3,$$

and

$$1.5 \leqq (D2/d) \leqq 3$$

are satisfied, where D1 is a diameter of the spindle at one of the bearings located in the side of the first end portion of the spindle, d is a diameter of the first end portion of the spindle inserted into the hole provided at the end surface of the first portion of the motor shaft or a diameter of the first end portion of the motor shaft inserted into the hole provided at the end surface of the spindle, and D2 is a diameter of the motor shaft at one of the bearings located in the side of the first end portion of the motor shaft.

[0019] It is further preferable that the relation of

$$2 \leqq (L/d) \leqq 8$$

is satisfied, where L is a length of axis at the fitting structure of the first end portion of the spindle and the first end portion of the motor shaft.

[0020] It is preferable that an elastic member is intervened at a fitting surface of the fitting structure of the first end portion of the spindle and the first end portion of the motor shaft.

[0021] It is preferable that the elastic member is composed of rubber.

[0022] It is preferable that the columnar member constructing the bobbin holder comprises a cylindrical member. The cylindrical member has a boss portion therein. The second end portion of the spindle is connected to the boss portion. A tubular supporting member secured to a member of the yarn winding apparatus statically to rotations of the spindle and the motor shaft is provided. The end portion of the tubular supporting member opposite to the end portion secured is located in the cylindrical member. And further the bearings of the spindle are mounted on the inner surface

of the tubular supporting member.

[0023] It is preferable that a length in axial direction of a portion of the columnar member of the bobbin holder on which portion bobbin is mounted is 1,200 mm or more.

[0024] It is preferable that the torque transmission means is constructed with a flexible coupling.

[0025] It is preferable that the torque transmission means is constructed with a key means provided at a fitting surface of the fitting structure of the first end portion of the spindle and the first end portion of the motor shaft.

[0026] It is preferable that an inner diameter of the bobbin mounted on the bobbin holder is 125 mm or less.

[0027] A method of producing a yarn package of the invention for achieving the objects comprises winding a yarn on a rotating bobbin driven by a motor in a yarn winding apparatus in accordance with the invention, and forming a yarn package on the bobbin.

[0028] It is preferable that a yarn speed at a yarn winding is 7,000 m/min or more.

Brief Description of the Drawings

[0029]

Fig. 1 is a longitudinal section of a yarn winding apparatus of an embodiment of the invention.
Fig. 2 is a longitudinal section of a first embodiment of the connecting portion connecting the spindle and the motor shaft in the apparatus shown in Fig. 1.
Fig. 3 is a longitudinal section of a second embodiment of the connecting portion connecting the spindle and the motor shaft in the apparatus shown in Fig. 1.
Fig. 4 is a cross section taken on line I-I of Fig. 2 or 3.
Fig. 5 is a longitudinal section of a third embodiment of the connecting portion connecting the spindle and the motor shaft in the apparatus shown in Fig. 1.
Fig. 5 is a longitudinal section of a fourth embodiment of the connecting portion connecting the spindle and the motor shaft in the apparatus shown in Fig. 1.
Fig. 7 is a cross section taken on line II-II of Fig. 6.
Fig. 8 is a cross section of another embodiment than that shown in Fig. 7.
Fig. 9 is an enlarged longitudinal section of the upper half of the portion A in Fig. 1.
Fig. 10 is a graph showing a relation between the speed of rotation of a bobbin holder and the value of vibration in a yarn winding apparatus of the invention.
Fig. 11 is a graph showing a relation between the speed of rotation of a bobbin holder and the value of vibration in a yarn winding apparatus of a conventional yarn winding apparatus.
Fig. 12 is a schematic perspective view of an apparatus for producing a yarn package in which a yarn winding apparatus of the invention is used.
Fig. 13 is a longitudinal section of a conventional yarn winding apparatus.
Fig. 14 is a longitudinal section of the connecting portion connecting the spindle and the motor shaft in the apparatus shown in Fig. 13.

[0030] Explanation of the symbols in the drawings - 1: bobbin holder, 2: cylindrical member, 3a-3h: elastic rings, 4a-4g: cylindrical spacer, 5: front cover, 6: pressing mechanism, 6a: plate spring, 6b: piston, 6c: O-ring, 7: boss portion, 8: spindle, 8a: supplying hole of pressurized air, 8b: key mechanism, 8c: the right end portion of spindle (the first end portion), 8d: two parallel segment portions (portion of non-circular cross section), 8e: two couples of two parallel segment portions (portion of non-circular cross section), 8f: fitting structure, 9: tubular supporting member, 10: motor, 11: bearings, 12: motor shaft, 12a: supplying hole of pressurized air, 12b: key slot, 12c: hole, 12d: two parallel segment portions (portion of non-circular cross section), 12f: fitting face, 12e: two couples of two parallel segment portions (portion of non-circular cross section), 12g: the left end portion of motor shaft (the first end portion), 13: flexible coupling, 14: motor housing, 15: bearings, 16: stator, 17: armature, 18: bobbin, 20: ring elastic member, 21: key, 22: cylindrical elasticmember, 23: nut, 25: bobbin holding mechanism, 30: bobbin holder, 31: cylindrical member, 32: bobbin holding mechanism, 33: tubular supporting member, 34: spindle, 34a: supplying hole of pressurized air, 35: bearings, 36: boss, 38: motor, 39: motor shaft, 39a: supplying hole of pressurized air, 39b: bearings, 37: motor housing, 40: flexible coupling, 41: seal member, 42: connecting member, 42a: tooth, 43a: tooth, 43: connecting member, 44: screw, 46: key, 47: key, 48: rubber body, 48a: arm portion, 50: apparatus for producing yarn package, 51: spinning machine, 52: first drawing roller, 53: second drawing roller, 54: yarn taking-up apparatus, 55: yarn separating guide, 56: tension sensor, 57: traversing fulcrum guide, 58: yarn winding apparatus of the invention, 59: traversing apparatus, 60: touch roll, 61: yarn package, 62: machine frame, 100: bobbin.

Description of the Preferred Embodiments

[0031] An embodiment of a yarn winding apparatus of the invention is shown with Fig. 1. In Fig. 1, a bobbin holder 1 comprises a cylindrical member 2. In the hollow portion of the cylindrical member 2, a boss portion 7 is provided. In the hollow portion at the right side of the boss portion 7 of the cylindrical member 2, a bobbin holding mechanism 25 for holding bobbins 18 mounted along the peripheral surface of the bobbin holder 1 and a pressing mechanism for actuating the bobbin holding mechanism 25 are provided.

[0032] The one end portion (the left end portion) of a spindle 8 is protruded into the hollow portion at left side of the boss portion 7 of the cylindrical member 2 through a hole provided in the boss portion 7. The peripheral surface of the end portion at the left end portion of the spindle 8 has a screw and a nut 23 mounted on the screw. The spindle 8 is connected to the boss portion 7 by the nut 23.

[0033] A motor 10 comprises a motor housing 14 and a motor shaft 12. The motor shaft 12 is supported in rotatable by two bearings 15 mounted on the motor housing 14. An armature 17 is mounted on the motor shaft 12 and a stator 16 is provided on the motor housing 14.

[0034] At an end of the motor housing 14, a tubular supporting member 9 is secured. The end portion of the tubular supporting member 9 is located in the hollow portion at the right side of the boss portion 7 of the cylindrical member 2 and the spindle 8 is positioned in the hollow portion of the tubular supporting member 9. The spindle 8 is supported by two beatings 11 provided in the hollow portion of the tubular supporting member 9.

[0035] The bobbin holding mechanism 25 includes eight elastic rings 3a-3h, seven cylindrical spacers 4a-4g, a front cover 5, and a pressing mechanism 6. The eight elastic rings 3a-3h are inserted along the peripheral surface of the cylindrical member 2 in the longitudinal direction with a predetermined clearance respectively. The clearances are adjusted with the seven cylindrical spacers 4a-4g provided between the adjacent elastic rings respectively. By the construction, the elastic rings 3a-3h are positioned at the both side portions of the bobbin 18. The front cover 5 covers the opening face of the hollow portion at the left side of the boss portion 7 of the cylindrical member 2. The outer periphery of the front cover 5 is touched at a side surface of the elastic ring 3a. The pressing mechanism 6 is located in the hollow portion at the left side of the boss portion 7 of the cylindrical member 2 and comprises a plate spring 6a, a piston 6b and O-rings 6c. Pressing force produced by the plate spring 6a is acted on the front cover 5 in the right direction.

[0036] In Fig. 1, the tubular supporting member 9 is secured to the motor housing 14. However, where a yarn winding apparatus is a type in which yarn is changed in manual and a single bobbin holder is provided, the tubular supporting member 9 may be secured to a frame (not shown) of the yarn winding apparatus. Where a yarn winding apparatus is a type in which yarn is changed in automatic and a plurality of bobbin holders is provided, the tubular supporting members 9 may be secured to a turret member (not shown) on which the plurality of bobbin holders are mounted.

[0037] In Fig. 1, the right end portion (the first end portion) of the spindle 8 and the left end portion (the first end portion) of the motor shaft 12 are connected each other by a torque transmission means. The torque transmission means comprises a flexible coupling 13 for transmitting a torque of the motor shaft 12 to the spindle 8. The spindle 8 is rotated by the motor 10 and the rotation of the spindle 8 is braked by the motor 10.

[0038] The motor shaft 12 has a pressurized air supplying hole 12a and the spindle 8 also has a pressurized air supplying hole 8a. Pressurized air is supplied to the pressurized air supplying hole 12a from a pressurized air supplying source (not shown) such as a compressor, blower and the like. The supplied pressurized air pressurizes the space between the boss portion 7 and piston 6b in the hollow portion at the left side of the boss portion 7 of the cylindrical member 2 through the pressurized air supplying hole 8a. By the pressurizing action, the piston 6b and the front cover 5 in the pressing mechanism 6 are moved in the left direction and holding action of bobbins 18 is released.

[0039] The first embodiment of the connecting portion connecting the spindle 8 and the motor shaft 12 shown in Fig. 1 is shown in Fig. 2. In Fig. 2, as explained in the above, the right end portion (the first end portion) 8c of the spindle 8 and the left end portion (the first end portion) 12g of the motor shaft 12 are connected by the torque transmission means which comprises the flexible coupling 13 for transmitting a torque of the motor shaft 12 to the spindle 8.

[0040] Further, the right end portion (the first end portion) 8c of the spindle 8 and the left end portion (the first end portion) 12g of the motor shaft 12 are connected by a deflection control means constructed with a fitting structure. The fitting structure comprises a hole 12c provided at the end surface of the first end portion 12g of the motor shaft 12 and the first end portion 8c of the spindle which is inserted into the hole 12c. On the fitting structure, a diameter of the first end portion 8c of the spindle 8 is made in smaller than that of the main portion of the spindle 8, and the first end portion 8c having the smaller diameter of the spindle 8 is inserted into the hole 12c with the diameter.

[0041] At the fitting surface along the direction of the axis in the fitting structure, an elastic member is intervened. The elastic member 20, in Fig. 2, comprises a ring having a circular cross section, and the elastic member 20 is mounted on the peripheral surface of the first end portion 8c of the spindle 8 in plural with intervals.

[0042] By the deflection control means, the first end portion 8c of the spindle 8 is supported by the motor shaft 12 under stiffness of the motor shaft 12 and an extreme deformation of the elastic member 20. Each state of deflection

(a displacement in direction of deflection) of the spindle 8 and the motor shaft 12 at the connecting portion is controlled substantially in the same state each other by existence of the supporting structure.

[0043] The elastic member 20 acts also as a seal member to prevent leakage of the pressurized air supplying from the pressurized air supplying hole 12a to the pressurized air supplying hole 8a through the fitting surface of the first end portion 8c of the spindle 8 and the hole 12c.

[0044] It is preferable, from its function, that the elastic member 20 is formed with NBR (nitril-butadiene rubber) or fluoro rubber, has the Shore hardness of 50° to 90° and is a O-ring having the string diameter of 1.2 mm to 5.3 mm. The number of the elastic member mounted is preferable from 4 to 10.

[0045] O-ring having the Shore hardness of 50° to 90° and having the string diameter of 1.2 mm to 5.3 mm is easily obtained. A supporting based on the stiffness is ensured by the elastic members of 4 to 10. If the number of the elastic member mounted is less than 4, there is a case where a desired stiffness is not obtained. A sufficient stiffness is obtained with the providing number of the elastic member being up to 10.

[0046] The second embodiment of the connecting portion connecting the spindle 8 and the motor shaft 12 shown in Fig. 1 is shown in Fig. 3. In the second embodiment shown in Fig. 3, a cylindrical elastic member 22 is used, instead of the ring elastic member 20 in the first embodiment shown in Fig. 2. The other structures in the second embodiment shown in Fig. 3 are the same to that in the first embodiment shown in Fig. 2.

[0047] By a deflection control means shown in Fig. 3, the first end portion 8c of the spindle 8 is supported by the motor shaft 12 under stiffness of the motor shaft 12 and an extreme deformation of the elastic member 20. That is the same to the deflection control means shown in Fig. 2. Each state of deflection (a displacement in direction of deflection) of the spindle 8 and the motor shaft 12 at the connecting portion is controlled substantially in the same state each other by existence of the supporting structure.

[0048] The elastic member 22 acts also as a seal member to prevent leakage of the pressurized air supplying from the pressurized air supplying hole 12a to the pressurized air supplying hole 8a through the fitting surface of the first end portion 8c of the spindle 8 and the hole 12c.

[0049] It is preferable, from its function, that the elastic member 22 is formed with NBR (nitril-butadiene rubber) or fluoro rubber, has the Shore hardness of 30° to 90° , and is a cylindrical body.

[0050] The lower limit of the Shore hardness of 30° is lower than that of O-ring mentioned above. It is a reason that the volume of the solid portion of the cylindrical body is larger than the volume of the solid portion of the O-ring and it is possible to obtain a supporting based on stiffness at a lower value of Shore hardness. The Shore hardness of up to 90° is sufficient for obtaining a desired stiffness.

[0051] A cross section of the flexible coupling 13 shown in Fig. 2 or 3 is shown in Fig. 4. In Figs. 2-4, a connecting member 42 is fastened on the spindle 8 at the end portion (the right side end portion) 8c thereof at the side of motor shaft 12 by a key 46 and a screw 44. A connecting member 43 is fastened on the motor shaft 12 at the end portion (the left side end portion) 12g thereof at the side of the spindle 8 by a key 47 and a screw 45.

[0052] The connecting member 42 has a couple of teeth 42a positioned in opposite each other. The connecting member 43 also has a couple of teeth 43a positioned in opposite each other. Those couples of teeth 42a and 43a are sifted each other with the angle of 90° in circumferential direction.

[0053] Between the teeth 42a and the teeth 43a, a rubber body 48 having four arms 48a is positioned and inserted. In that construction, a torque of the motor shaft 12 is transmitted to the spindle 8 by the connection formed with insertion of the couple of teeth 42a and 43a of the connecting members 42 and 43 into the rubber body 48 in rotating direction. The flexible coupling 13 comprising that construction is generally known heretofore.

[0054] The third embodiment of the connecting portion connecting the spindle 8 and the motor shaft 12 shown in Fig. 1 is shown in Fig. 5. In Fig. 5, the right end portion (the first end portion) 8c of the spindle 8 and the left end portion (the first end portion) of the motor shaft 12 are connected by a deflection control means. The deflection control means comprises a fitting structure constructed with the hole 12c provided at the end surface of the first end portion 12g of the motor shaft 12 and the first end portion 8c of the spindle 8 inserted into the hole 12c. A diameter of the first end portion 8c of the spindle 8 at the fitting structure is smaller than that of the spindle 8 at the main portion. With that diameter, the first end portion 8c of the spindle 8 is inserted into the hole 12c. At the fitting surface of the fitting portion in the axial direction, an elastic member is intervened. This structure is the same to the structure shown in Fig. 2.

[0055] The connecting portion shown in Fig. 5 and the connecting portion shown in Fig. 2 are different from each other on the structure of the torque transmission means. The torque transmission means shown in Fig. 5 comprises a key means. The key means comprises the tip of the motor shaft 12, a key slot 12b provided on the surface of the hole 12c in the axial direction between the tip and the elastic member 20 which is located at the nearest to the tip, a key slot 8b provided on the first end portion 8c of the spindle 8 in the axial direction in correspondence with the key slot 12b, and a key 21 inserted into the key slots 12b and 8b.

[0056] The fourth embodiment of the connecting portion connecting the spindle 8 and the motor shaft 12 shown in Fig. 1 is shown in Fig. 6. In Fig. 6, the right end portion (the first end portion) 8c of the spindle 8 and the left end portion (the first end portion) 12g of the motor shaft 12 are connected with a deflection control means. The deflection control

means comprises a fitting portion constructed with the hole 12c formed on the end surface of the first end portion 12g of the motor shaft 12 and the first end portion 8c of the spindle 8 inserted into the hole 12c. A diameter of the first end portion 8c of the spindle 8 is smaller than that of the main portion of the spindle 8. With that diameter, the first end portion 8c of the spindle 8 is inserted into the hole 12c. At the fitting surface of the fitting portion in the axial direction, an elastic body is intervened. That structure is the same to the structure shown in Fig. 5.

[0057] The connecting portion shown in Fig. 6 and the connecting portion shown in Fig. 5 are different from each other on a key means for forming a torque transmission means. The torque transmission means shown in Fig. 6 comprises a key means. The key means is constructed with the tip of the motor shaft 12, a non-circular cross section of the hole 12c between the tip and the elastic body located at nearest to the tip, a non-circular cross section of the first end portion 8c of the spindle 8 which is fitted to the portion of the hole 12c having non-circular cross section, and an insertion of the portion of the spindle 8 having the non-circular cross section into the portion of the hole 12c of the motor shaft 12 having the non-circular cross section.

[0058] An example of the non-circular cross section is shown in Fig. 7. In Fig. 7, a part of the circular cross section of the hole 12c of the motor shaft 12 is deformed into two parallel segment portions 12d. The deformation has a desired length in the axial direction of the motor shaft 12 to bring function of key. Corresponding to that, a part of the circular cross section of the first end portion 8c of the spindle 8 is also deformed into two parallel segment portions 8d. A torque transmission means comprising the key means is formed by fitting the portion 12d having the non-circular cross section of the hole 12c of the motor shaft 12 with the portion 8d having the non-circular cross section of the spindle 8.

[0059] The deflection control means is formed by the fitting between the non-circular cross section portions 12d and 8d, and the fitting the portions 12f and 8f on which the elastic body 20 is positioned. That is, by the fitting between the hole 12c of the motor shaft 12 and the first end portion 8c of the spindle 8 as a whole, the deflection control means is formed.

[0060] Another example of non-circular cross section is shown in Fig. 8. In Fig. 8, a portion of the circular cross section of the hole 12c of the motor shaft 12 is deformed into two couples of two parallel segment portions 12e. The deformation has a desired length in the axial direction of the motor shaft 12 to be obtained function of key. Corresponding to that, a part of the circular cross section of the first end portion 8c of the spindle 8 is also deformed into two couples of two parallel segment portions 8e. A torque transmission means comprising the key means is formed by fitting the portion 12e having the non-circular cross section of the hole 12c of the motor shaft 12 with the portion 8e having the non-circular cross section of the spindle 8.

[0061] The deflection control means is formed by the fitting between the non-circular cross section portions 12e and 8e, and the fitting the portions 12f and 8f on which the elastic body 20 is positioned. That is, by the fitting between the hole 12c of the motor shaft 12 and the first end portion 8c of the spindle 8 as a whole, the deflection control means is formed.

[0062] The two examples of figures of non-circular cross sections on the hole 12c of the motor shaft 12 and the first end portion 8c of the spindle 8 are shown in Figs. 7 and 8. However, the figure of non-circular cross section is not limited to those figures. The essential thing is that the figure of non-circular cross section is sufficient for producing a fitting being able to bring a transmission of torque.

[0063] In the above embodiments, a style having the elastic body 20 or 22 provided in the connecting portion of the spindle 8 and the motor shaft 12 is explained. However, a style having no elastic body is acceptable, if it is possible to control that each state of deflection (displacement in direction of deflection) of the spindle 8 and the motor shaft 12 at the connecting portion is substantially in the same state each other. That is, where the accuracy of the concentricity between the spindle 8 and the motor shaft 12 is sufficient and there is no problem of vibration caused by displacement between the axes or abrasion and the like at the connecting portion, the intervention of the elastic body is not needed.

[0064] The figure of the cross section at the fitting portion of the first end portion 8c of the spindle 8 may be non-circular along the full length of the fitting portion in the axial direction. On this case, it is preferable that the figure of the cross section of the hole 12c provided at the first end portion 12g of the motor shaft 12 which is fitted with the first end portion 8c of the spindle 8 corresponds to the figure of the cross section of the first end portion 8c of the spindle 8.

[0065] Next, each preferable axial diameter of the spindle 8 and the motor shaft 12 at the connecting portion and a preferable length of the fitting portion in axial direction are explained.

[0066] In Fig. 9, where D1 is a diameter of the spindle 8 at one of the bearings 11 located in the side of the motor shaft 11 (the bearing 11 being in the side of the first end portion 8c of the spindle 8), d is a diameter of the spindle 8 at the fitting portion (the portion in which the elastic body 20 or 22 is mounted), and D2 is a diameter of the motor shaft 12 at one of the bearings 15 located in the side of the spindle 8 (the bearing 15 being in the side of the first end portion 12g of the motor shaft 12), it is preferable that the next two relations are satisfied.

$$1.5 \leqq (D1/d) \leqq 3,$$

and

$$1.5 \leqq (D2/d) \leqq 3$$

[0067] Further, where L is a length of the fitting surface in the axial direction of the first end portion 8c of the spindle 8 and the first end portion 12g of the motor shaft 12 at the fitting portion, it is preferable that the next relation is satisfied, in addition to the above two relations.

$$2 \leqq (L/d) \leqq 8$$

[0068] By satisfying those relations, a desirable effect of control of the deflection and easiness of forming the fitting portion and assembling are brought.

[0069] Where a figure of the cross section of the first end portion 8c of the spindle 8 at the fitting portion is non-circular, a virtual diameter obtained from calculation based on the moment of inertia of area decided by the figure of the cross section is used as the value of the diameter d.

[0070] In the above embodiments, a style in which the deflection control means comprises the fitting portion constructed with the insertion of the end portion of the spindle into the hole provided at the end surface of the motor shaft is explained. However, the formation of the fitting portion may be in reverse to that in the embodiments. That is, the end portion of the motor shaft may be inserted into a hole provided at the end surface of the spindle.

[0071] In the above embodiments, a style in which the fitting portion of the spindle 8 and the motor shaft 12 is formed with insertion of the end portion of one of the spindle and the motor shaft into the hole provided at the end surface of the other is explained. However, it is not limited to the style. It may be used a style in which the peripheral surface of the end portion of the spindle 8 and the peripheral surface of the end portion of the motor shaft 12 are inserted into a common sleeve and both end faces of the spindle 8 and the motor shaft 12 are faced each other in the sleeve. On this case, an elastic body is provided between the end face of the spindle 8 and the end face of the motor shaft 12, or between the respective shafts and the internal peripheral surface of the sleeve, if necessary.

Example 1

[0072] An example using the yarn winding apparatus shown in Figs. 1, 2 and 4 is explained.

[0073] In the apparatus, the diameter D1 of the spindle 8 was 25 mm, the diameter d was 15.9 mm, the diameter of the hole 12c of the motor shaft 12 was 16 mm, and the diameter D2 of the motor shaft 12 was 30 mm. The material of the ring like elastic body was NBR (nitril-butadiene rubber), the diameter of the string of the O-ring made of the material was 2.4 mm, the number of the O-ring was six (6), and the O-rings were mounted on the first end portion 8c of the spindle 8 with the interval of 6 mm.

[0074] Four cylindrical bobbins 18 having the width of 300 mm and the inner diameter of 125 mm were mounted on the bobbin holder 1. The total length of the bobbins was 1,200 mm.

[0075] In the yarn winding apparatus, the motor 10 was driven and the rotation of the bobbin holder 1 was increased. In the while, vibration at the portion of the bearing 15 of the motor shaft 12 was measured with a general acceleration vibrating sensor mounted on the peripheral surface of the motor 10. The measuring results are shown with Fig. 10. In Fig. 10, the abscissa represents the rotational speed (unit: rpm) of the bobbin holder 1 and the ordinates represents the value of vibration (unit: μm) detected by the sensor.

[0076] As shown in Fig. 10, the yarn winding apparatus was driven at the rotational speed of up to 18,900 min^{-1} under the value of vibration in the range of not exceeding the value of allowable vibration of 10 μm. The value of the rotational speed is equivalent to 8,000 m/min in conversion of the yarn winding speed (the peripheral speed of the bobbin 18). This means that it is possible to wind a yarn stably at the yarn winding speed of 7,000 m/min or more which is the object of the invention.

Comparative Example

[0077] The spindle, the motor and the connecting portion of those shafts in Example 1 were changed to the conventional one as shown with Figs. 13 and 14 and prepared a conventional yarn winding apparatus. In the apparatus, the motor 38 was driven and the rotation of the bobbin holder 30 was increased as the same to Example 1. In the while, vibration at the portion of the bearing 39b of the motor shaft 39 was measured with a general acceleration vibrating sensor mounted on the peripheral surface of the motor 38. The measuring results are shown with Fig. 11. In Fig. 11, the abscissa represents the rotational speed (unit: rpm) of the bobbin holder 1 and the ordinates represents the value

of vibration (unit: μm) detected by the sensor.

[0078] As shown in Fig. 11, the yarn winding apparatus could not be driven at the rotational speed of more than 16,300 min^{-1} under the value of vibration in the range of not exceeding the value of allowable vibration of 10 μm. The value of the rotational speed is equivalent to 6,900 m/min in conversion of the yarn winding speed (the peripheral speed of the bobbin 100). This value is lower 1,100 m/min from 8,000 m/min in Example 1, and does not reach the speed of 7,000 m/min or more which is the object of the invention.

Example 2

[0079] The yarn winding apparatus prepared in Example 1 was used in changing the diameter D1, the diameter d and the diameter D2 in various values, and the rotation of the bobbin holder 1 was increased as the same to Example 1. The results are shown in Table 1.

[0080] It is shown by Table 1 that it is possible to rotate the bobbin holder 1 up to 18,900 min^{-1} in the range of the allowable value of vibration in any combination case. Further, it is shown that the cases which satisfy the relations of $1.5 \leqq (D1/d) \leqq 3$ and $1.5 \leqq (D2/d) \leqq 3$, have a marked low level of the value of vibration.

Table 1

No.	D1 (mm)	D2 (mm)	d (mm)	D1/d	D2/d
1	22.5	23.9	15.9	1.42	1.50
2	23.9	23.9	15.9	1.50	1.50
3	23.9	23.9	15.9	1.50	1.50
4	23.9	30.0	15.9	1.50	1.89
5	23.9	30.0	15.9	1.50	1.89
6	23.9	30.0	15.9	1.50	1.89
7	23.9	30.0	15.9	1.50	1.89
8	23.9	30.0	9.9	2.41	3.03
9	23.9	30.0	7.4	3.23	4.05
10	25.0	30.0	15.9	1.57	1.89
11	35.0	35.0	15.9	2.20	2.20
12	35.0	35.0	11.4	3.07	3.07
13	35.0	35.0	9.9	3.64	3.64
14	35.0	35.0	9.9	3.64	3.64
15	35.0	35.0	9.9	3.64	3.64
16	22.5	22.5	15.9	1.42	1.42
17	20.0	20.0	15.9	1.26	1.26
18	24.0	24.0	18.9	1.27	1.27
19	26.5	26.5	18.9	1.40	1.40
20	28.5	26.5	18.9	1.51	1.40
21	28.5	28.5	18.9	1.51	1.51

Table 1 (continued)

No.	D1 (mm)	D2 (mm)	d (mm)	D1/d	D2/d
22	33.0	35.0	18.9	1.75	1.85
23	35.0	33.0	18.9	1.85	1.75
24	39.5	39.5	18.9	2.09	2.09
25	39.5	39.5	15.9	2.48	2.48
26	39.5	39.5	13.9	2.84	2.84
27	39.5	39.5	12.9	3.06	3.06
28	39.5	39.5	11.4	3.46	3.46
29	39.5	39.5	9.9	3.99	3.99
30	39.5	39.5	18.9	2.09	2.09
31	39.5	39.5	18.9	2.09	2.09
32	39.5	39.5	18.9	2.09	2.09
33	39.5	39.5	18.9	2.09	2.09
34	39.5	39.5	18.9	2.09	2.09
35	39.5	39.5	18.9	2.09	2.09
36	39.5	39.5	18.9	2.09	2.09
37	39.5	39.5	18.9	2.09	2.09
38	39.5	39.5	18.9	2.09	2.09
39	39.5	39.5	18.9	2.09	2.09
40	39.5	39.5	18.9	2.09	2.09
41	39.5	39.5	18.9	2.09	2.09

Table 1 (continued)

No.	L (mm)	L/d	Value of vibration at 18,900 min^{-1} (μm)	Evaluation based on value of vibration
1	25.0	1.57	7.0	good
2	25.0	1.57	6.0	good
3	32.0	2.01	4.5	excellent
4	32.0	2.01	3.8	excellent
5	80.0	5.03	3.5	excellent
6	125.0	7.86	3.5	excellent
7	140.0	8.81	6.0	good
8	50.0	5.05	6.5	good
9	38.0	5.13	8.0	slightly good
10	80.0	5.03	3.5	excellent
11	80.0	5.03	3.5	excellent
12	58.0	5.09	6.0	good
13	50.0	5.05	6.5	good
14	19.0	1.92	8.0	slightly good
15	80.0	8.08	7.0	good
16	80.0	5.03	6.5	good
17	80.0	5.03	8.5	slightly good
18	95.0	5.03	8.5	slightly good
19	95.0	5.03	6.2	good
20	95.0	5.03	5.8	good
21	95.0	5.03	4.0	excellent

Table 1 (continued)

No.	L (mm)	L/d	Value of vibration at 18,900 min^{-1} (μm)	Evaluation based on value of vibration
22	95.0	5.03	3.8	excellent
23	95.0	5.03	3.2	excellent
24	95.0	5.03	3.2	excellent
25	80.0	5.03	3.5	excellent
26	70.0	5.04	4.0	excellent
27	65.0	5.04	5.5	good
28	57.5	5.04	6.4	good
29	50.0	5.05	7.5	slightly good
30	70.0	3.71	4.0	excellent
31	50.0	2.65	4.5	excellent
32	37.5	1.98	6.0	good
33	25.0	1.32	7.5	slightly good
34	100.0	5.29	3.8	excellent
35	125.0	6.61	4.2	excellent
36	135.0	7.14	4.2	excellent
37	142.0	7.51	4.5	excellent
38	150.0	7.94	4.5	excellent
39	160.0	8.47	5.5	good
40	170.0	8.99	6.1	good
41	180.0	9.52	6.7	good

[0081] Based on the above examples, it is understood that it becomes possible to wind a yarn at a speed of 7,000 m/min or more by intervening an elastic body at the connecting portion of the spindle 8 and the motor shaft 12 and supporting the spindle 8 with the stiffness of the motor shaft 12.

[0082] A manufacturing apparatus 50 of a yarn package to implement a method of producing a yarn package of the invention is shown in Fig. 12. In Fig. 12, the manufacturing apparatus 50 of a yarn package is provided with a spinning machine 51 to extrude a molten polymer, a yarn taking-up apparatus comprising a first drawing roller 52 and a second drawing roller 53 to draw a yarn Y spun, and the like, a yarn separating guide 55, a tension sensor 56 to detect a yarn tension, a traversing fulcrum guide 57, and a yarn winding apparatus 58 of the invention to take each of the yarns up

as a plurality of yarn package, and others.

[0083] A traversing apparatus 59 and a touch roll 60 are provided on the yarn winding apparatus 58. A motor housing 14 including a motor for rotating a bobbin holder 1 in the yarn winding apparatus 58, the traversing apparatus 59 and the touch roll 60 are mounted on a machine frame 62, respectively.

[0084] All of he elements except the yarn winding apparatus 50 of the invention are known heretofore.

[0085] The method of producing a yarn package of the invention is performed with the yarn winding apparatus 50 and a plurality of yarn package 61 is produced.

Claims

1. A yarn winding apparatus, which comprises;

(a) a bobbin holder comprising a columnar member along on which peripheral surface a cylindrical bobbin is mounted;
(b) a spindle connected to the bobbin holder for supporting the bobbin holder in substantially horizontal and rotating the bobbin holder;
(c) bearings of the spindle for supporting thereof in rotatable;
(d) a motor shaft for rotating the spindle;
(e) bearings of the motor shaft for supporting thereof in rotatable; and
(f) a motor including the motor shaft and the bearings of the motor shaft,
(g) wherein the axis of rotation of the spindle and the axis of rotation of the motor shaft substantially collinear with each other and the first end portion of the spindle and the first end portion of the motor shaft face each other; and
(h) the spindle and the motor shaft are connected with torque transmission means for transmitting a torque of the motor shaft to the spindle,
(i) **characterized in that** the fist end portion of the spindle and the first end portion of the motor shaft are connected with a deflection control means for controlling deflection of the spindle based on stiffness of the motor shaft.

2. A yarn winding apparatus according to claim 1, wherein said deflection control means is constructed with a fitting structure comprising insertion of said first end portion of the spindle into a hole provided at the end surface of said first end portion of the motor shaft or a structure of insertion of said first end portion of the motor shaft into a hole provided at the end surface of said first end portion of the spindle.

3. A yarn winding apparatus according to claim 2, wherein the relations of

$$1.5 \leqq (D1/d) \leqq 3,$$

and

$$1.5 \leqq (D2/d) \leqq 3$$

are satisfied, where D1 is a diameter of said spindle at one of the bearings located in the side of said first end portion of the spindle, d is a diameter of said first end portion of the spindle inserted into said hole provided at the end surface of said first portion of the motor shaft or a diameter of said first end portion of the motor shaft inserted into said hole provided at the end surface of the spindle, and D2 is a diameter of said motor shaft at one of the bearings located in the side of said first end portion of the motor shaft.

4. A yarn winding apparatus according to claim 3, wherein the relation of

$$2 \leqq (L/d) \leqq 8$$

is satisfied, where L is a length of axis at said fitting structure of said first end portion of the spindle and the first end portion of the motor shaft.

5. A yarn winding apparatus according to any one of claims 2-4, wherein an elastic member is intervened at a fitting surface of said fitting structure of said first end portion of the spindle and the first end portion of the motor shaft.

6. A yarn winding apparatus according to claim 5, wherein said elastic member is composed of rubber.

7. A yarn winding apparatus according to claim 1, wherein said columnar member constructing the bobbin holder comprises a cylindrical member having a boss portion therein, the second end portion of the spindle is connected to the boss portion, a tubular supporting member which is secured to a member of said yarn winding apparatus statically to rotations of said spindle and said motor shaft is provided, the end portion of the tubular supporting member opposite to the end portion secured is located in the cylindrical member, and said bearings of the spindle are mounted on the inner surface of the tubular supporting member.

8. A yarn winding apparatus according to claim 7, wherein said deflection control means is constructed with a fitting structure comprising insertion of said first end portion of the spindle into a hole provided at the end surface of said first end portion of the motor shaft or a structure of insertion of said first end portion of the motor shaft into a hole provided at the end surface of said first end portion of the spindle.

9. A yarn winding apparatus according to claim 8, wherein the relations of

$$1.5 \leqq (D1/d) \leqq 3,$$

and

$$1.5 \leqq (D2/d) \leqq 3$$

are satisfied, where D1 is a diameter of said spindle at one of the bearings located in the side of said first end portion of the spindle, d is a diameter of said first end portion of the spindle inserted into said hole provided at the end surface of said first portion of the motor shaft or a diameter of said first end portion of the motor shaft inserted into said hole provided at the end surface of the spindle, and D2 is a diameter of said motor shaft at one of the bearings located in the side of said first end portion of the motor shaft.

10. A yarn winding apparatus according to claim 9, wherein the relation of

$$2 \leqq (L/d) \leqq 8$$

is satisfied, where L is a length of axis at said fitting structure of said first end portion of the spindle and the first end portion of the motor shaft.

11. A yarn winding apparatus according to any one of claims 8-10, wherein an elastic member is intervened at a fitting surface of said fitting structure of said first end portion of the spindle and the first end portion of the motor shaft.

12. A yarn winding apparatus according to claim 11, wherein said elastic member is composed of rubber.

13. A yarn winding apparatus according to claim 2 or 8, wherein a length in axial direction of a portion on which bobbin is mounted in said columnar member of the bobbin holder is 1,200 mm or more.

14. A yarn winding apparatus according to claim 2 or 8, wherein said torque transmission means is constructed with a flexible coupling.

15. A yarn winding apparatus according to claim 2 or 8, wherein said torque transmission means is constructed with a key means provided at a fitting surface of said fitting structure of said first end portion of the spindle and said first end portion of the motor shaft.

16. A yarn winding apparatus according to claim 2 or 8, wherein an inner diameter of said bobbin mounted on said bobbin holder is 125 mm or less.

17. A method of producing a yarn package comprising winding a yarn on a rotating bobbin driven by a motor in a yarn winding apparatus according to claim 5, and forming a yarn package on the bobbin.

18. A method of producing a yarn package comprising winding a yarn on a rotating bobbin driven by a motor in a yarn winding apparatus according to claim 11, and forming a yarn package on the bobbin.

19. A method of producing a yarn package comprising winding a yarn on a rotating bobbin driven by a motor in a yarn winding apparatus according to claim 16, and forming a yarn package on the bobbin.

20. A method of producing a yarn package according to claim 19, wherein a yarn speed at a yarn winding is 7,000 m/min or more.

Fig. 1

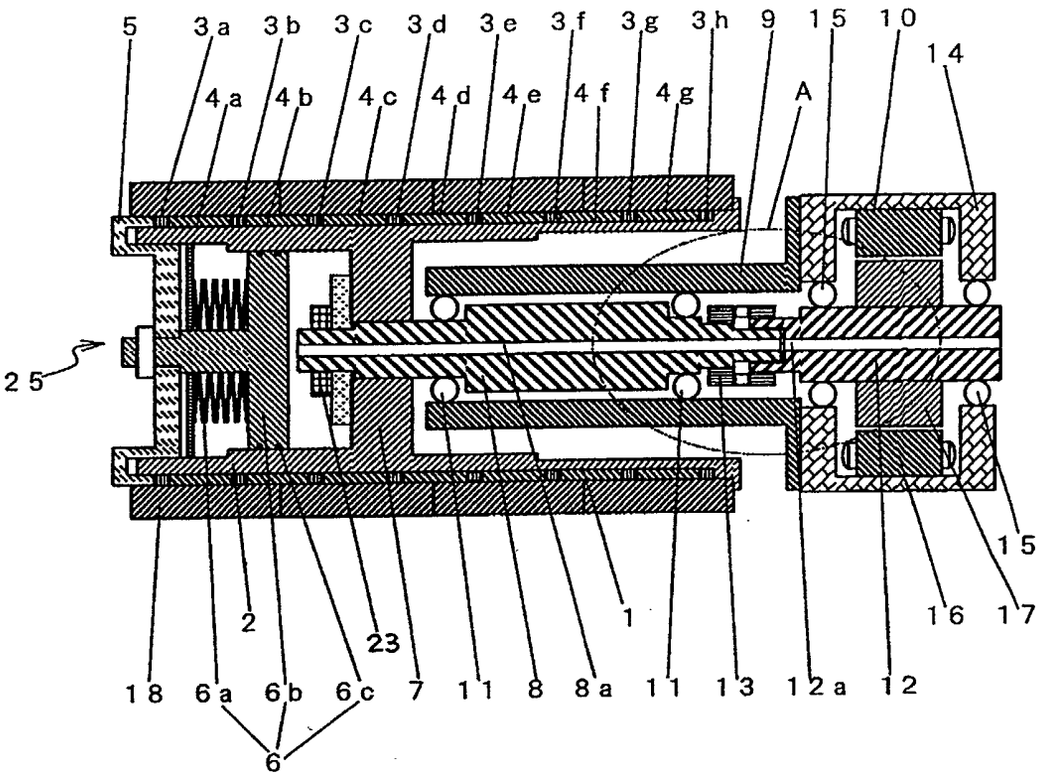
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Fig. 2

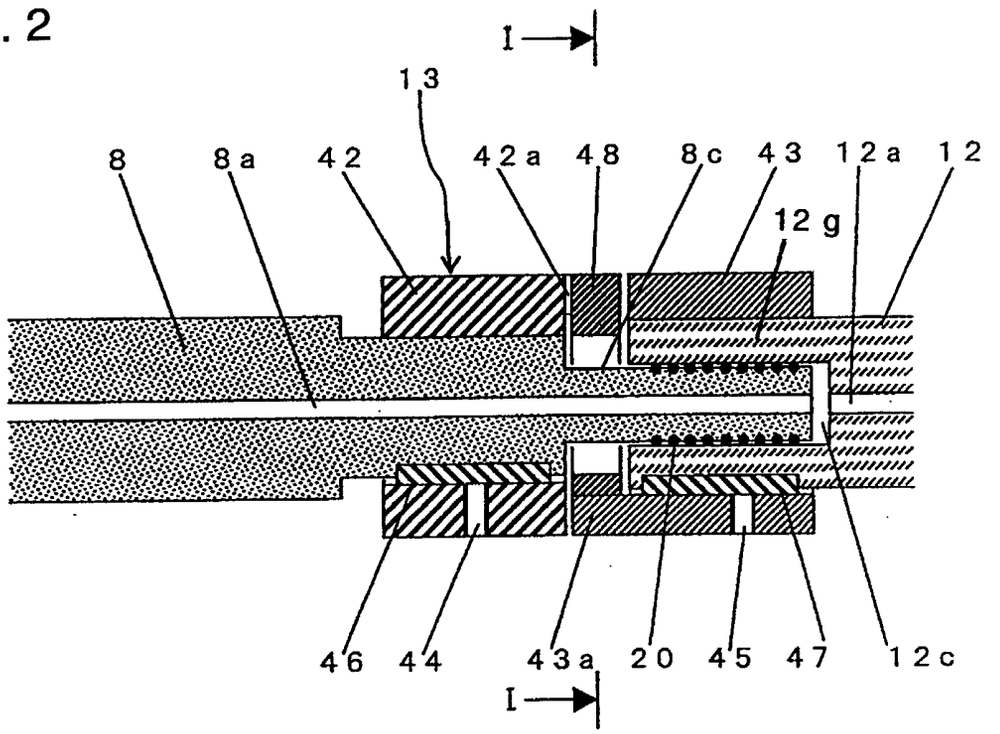
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Fig. 3

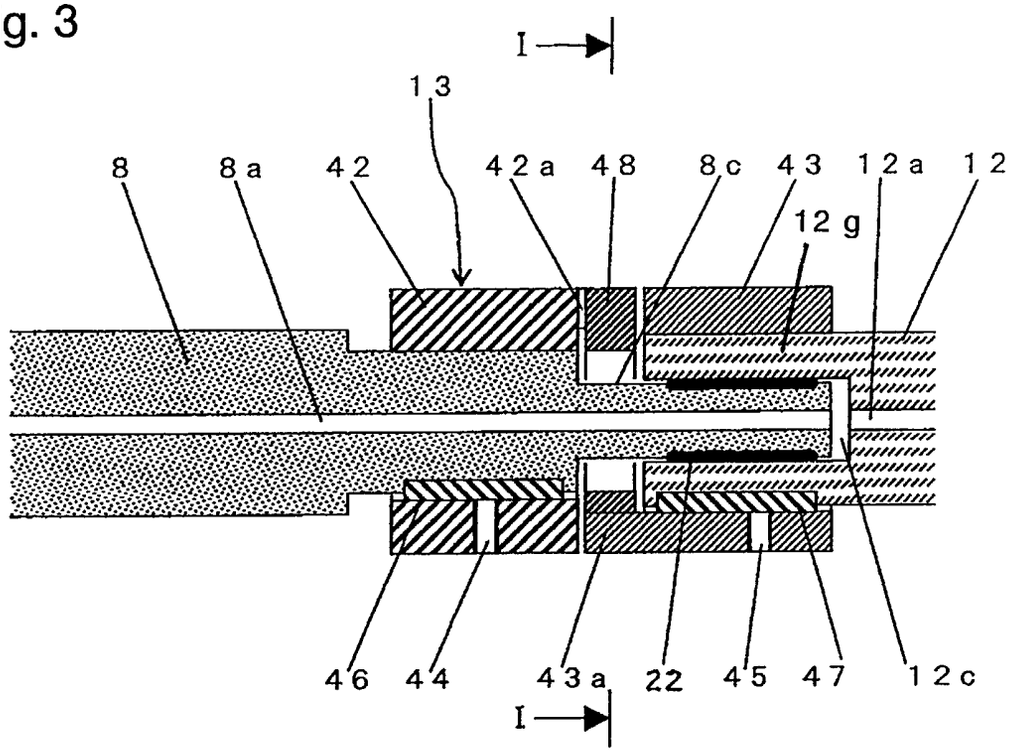
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Fig. 4

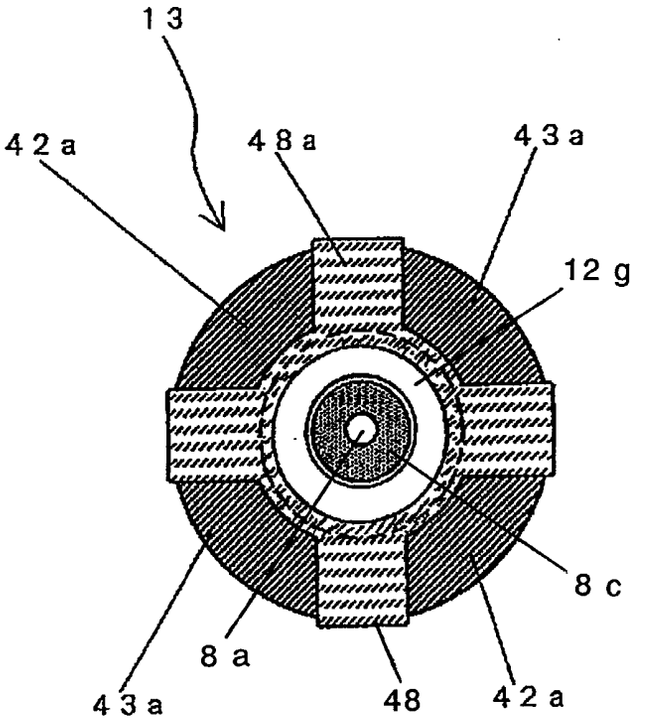
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Fig. 5

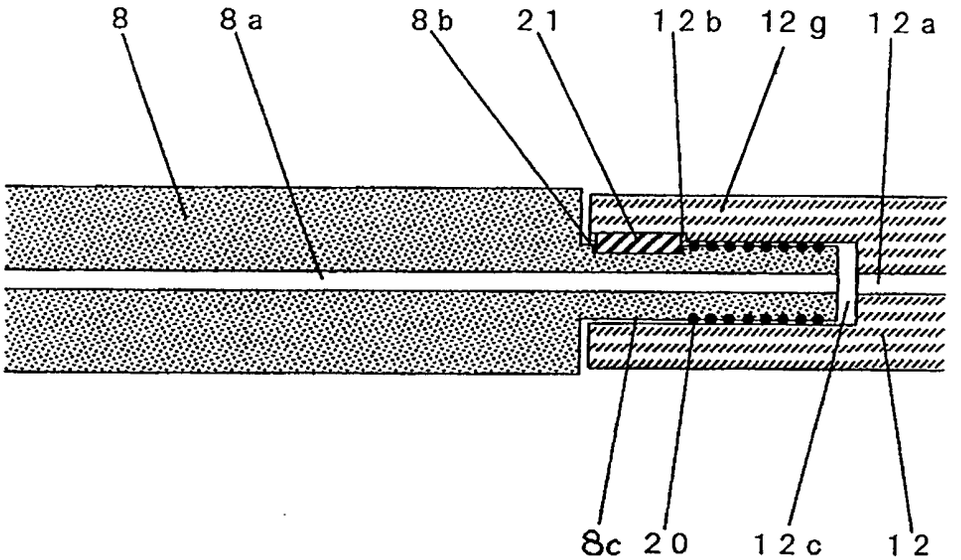
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Fig. 6

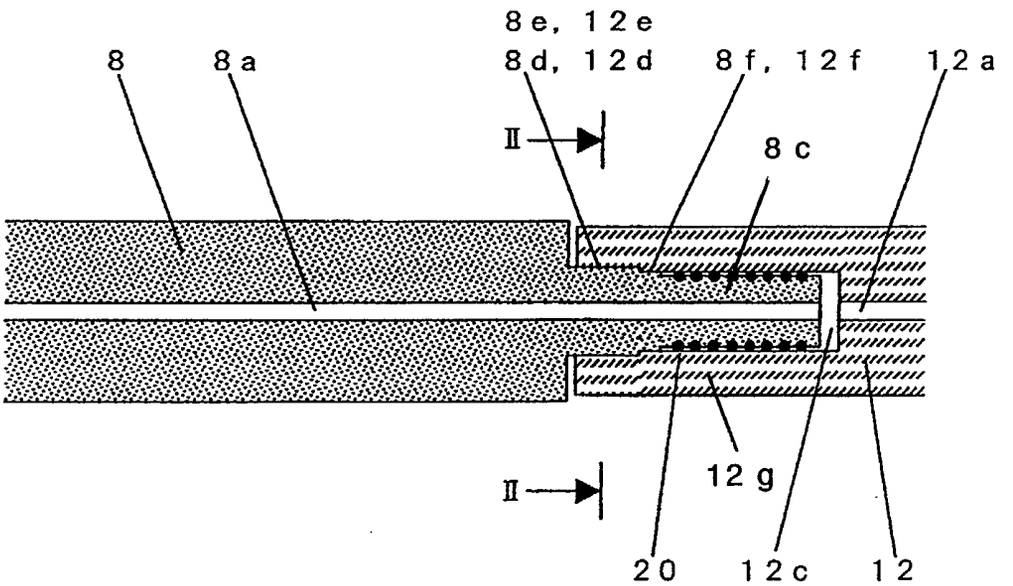
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Fig. 7

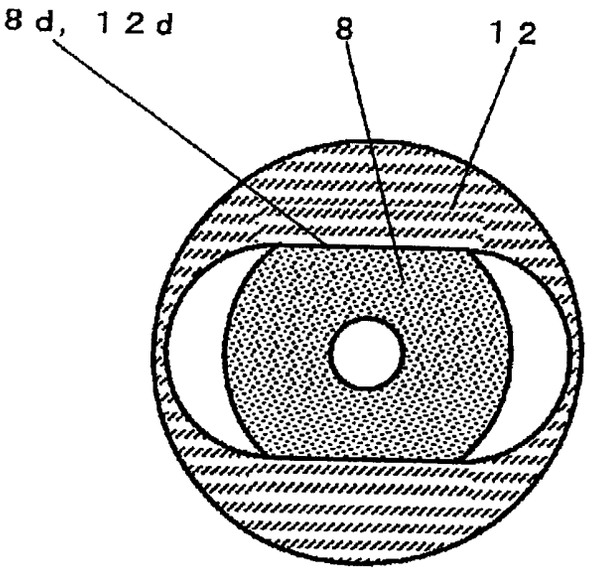

Fig. 8

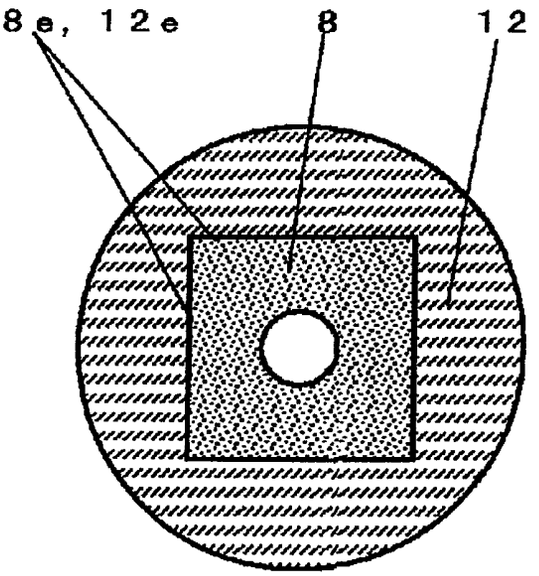

Fig. 9

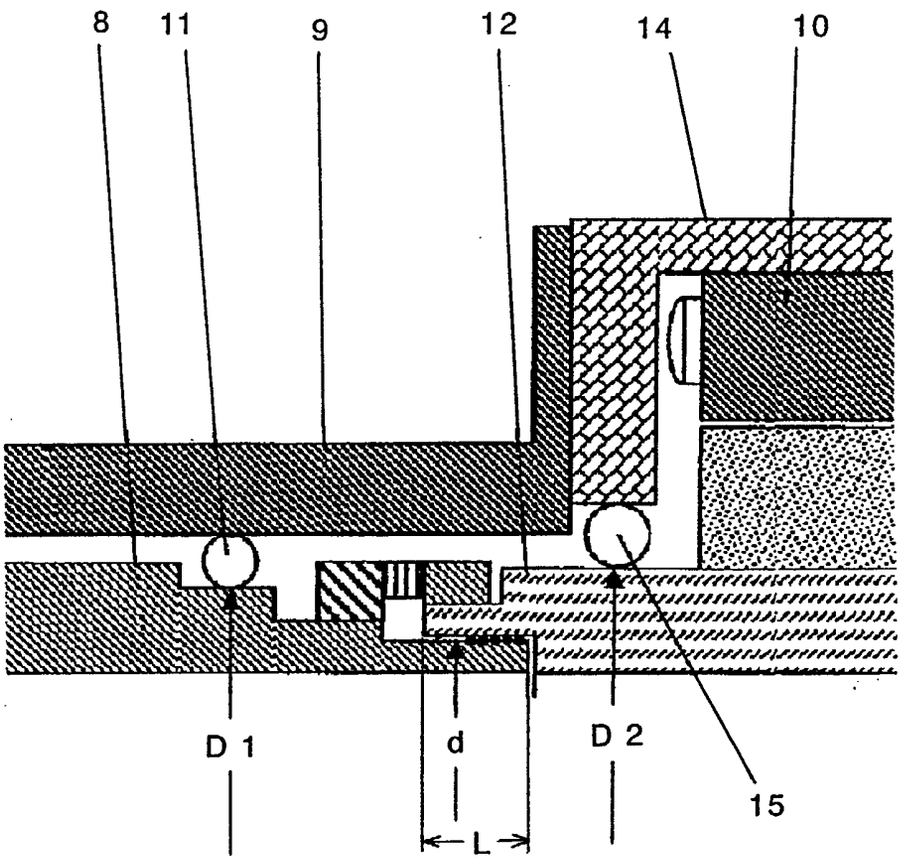

Fig. 10

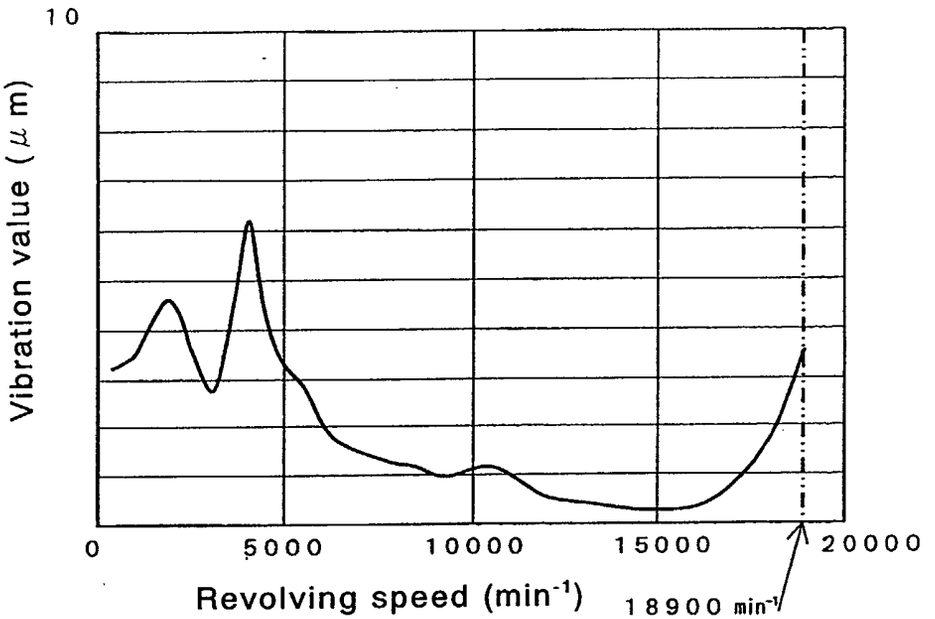
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Fig. 11

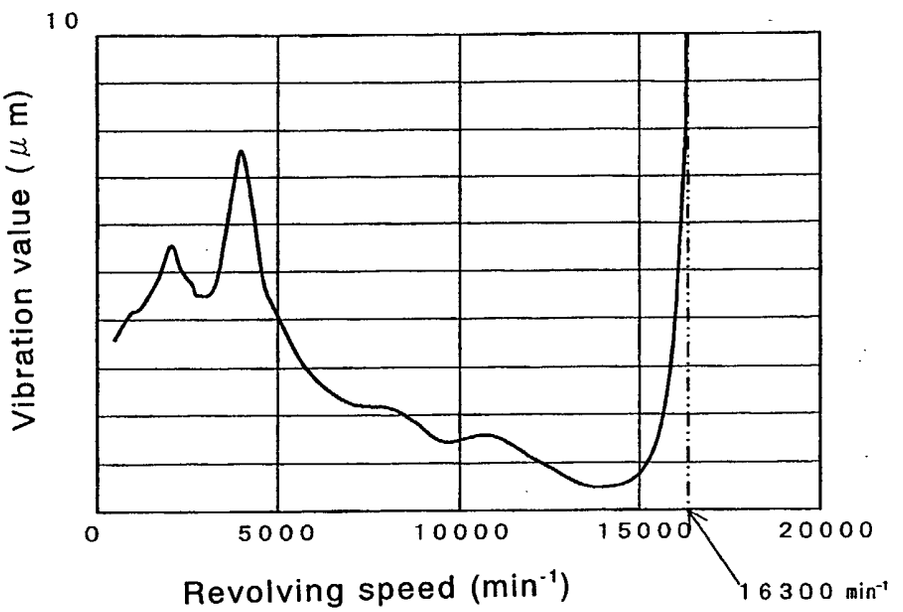
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Fig. 12

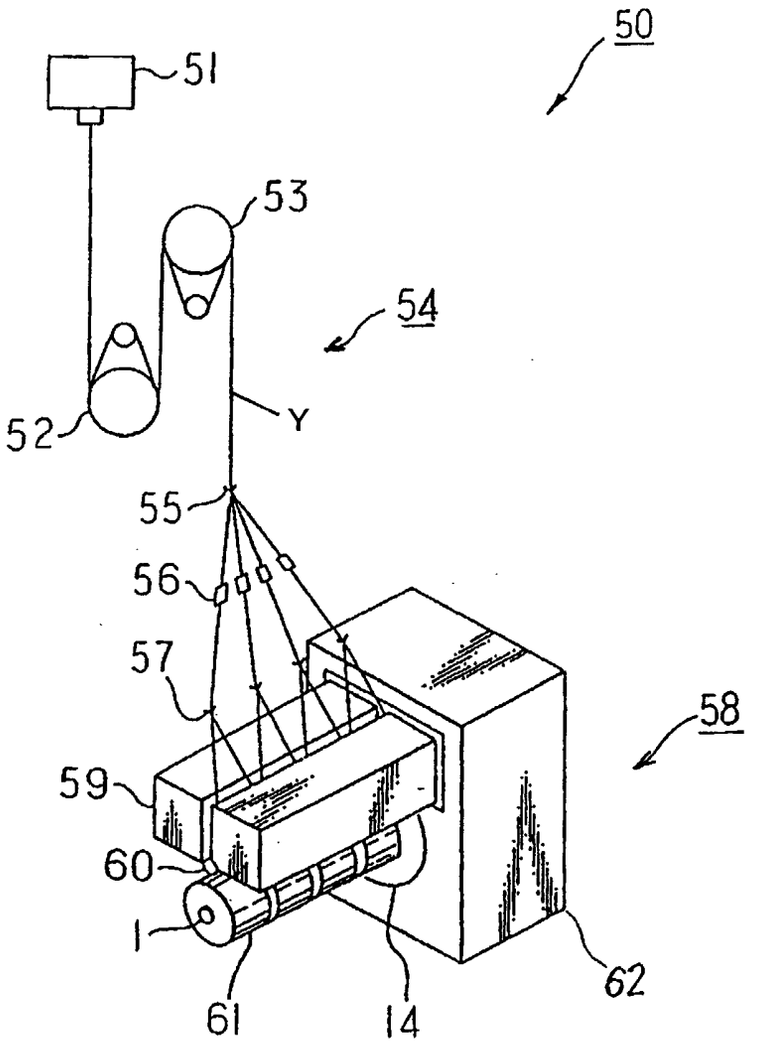

Fig. 13

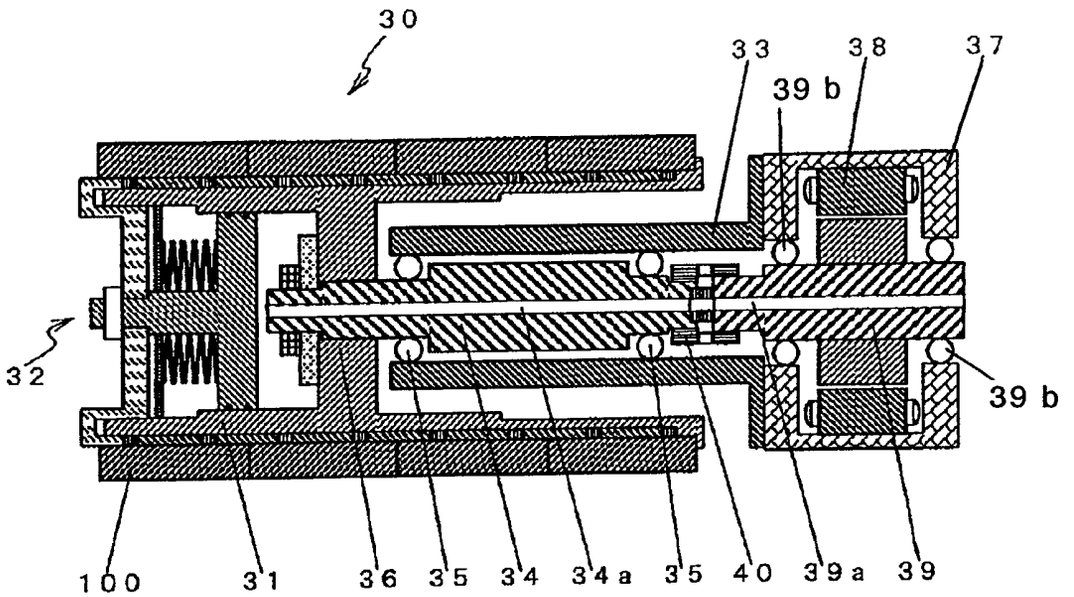
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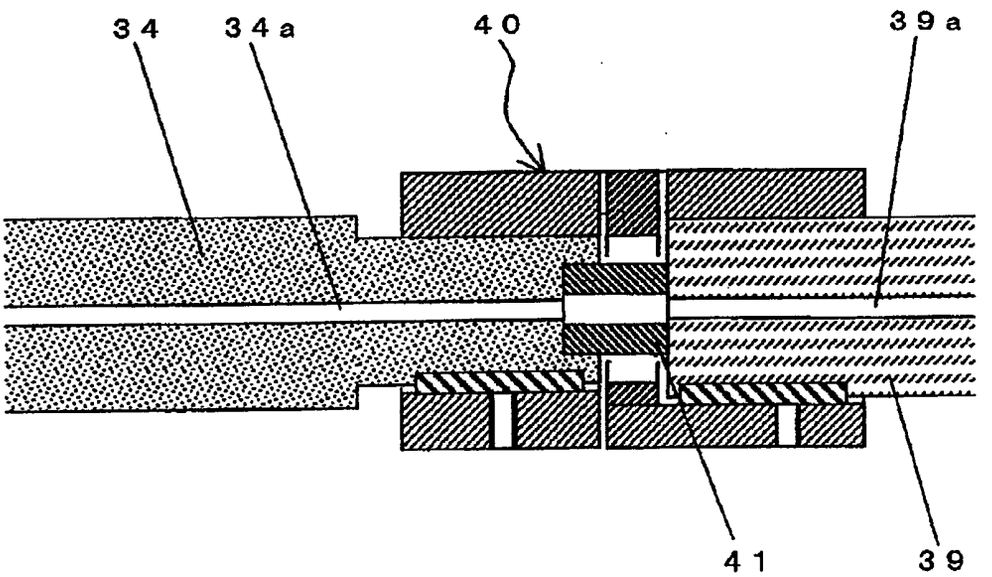
Fig. 14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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 01 0456

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	US 5 603 463 A (KUMO ICHIRO ET AL) 18 February 1997 (1997-02-18) * column 9, line 54 - column 14, line 36; figure 1 *	1-4, 7-10,13, 15-17,19	B65H54/44 B65H54/54 B65H54/547
Y	US 3 813 051 A (MILLER H) 28 May 1974 (1974-05-28) * column 4, line 13-27; figure 1 * * column 5, line 4-15 *	1-4, 7-10,13, 15-17,19	
A	DE 195 38 400 A (ROLAND MAN DRUCKMASCH) 17 April 1997 (1997-04-17) * column 2, line 63-67; figure 3 *	2-6, 8-12,14	
A	DE 40 05 938 A (METEOR AG) 25 October 1990 (1990-10-25) * column 2, line 34-39; figure 1 *	2,8,15	
A	GB 1 421 060 A (BARMEG BARMER MASCHINENFABRIK) 14 January 1976 (1976-01-14) * figures 1,3,4 *		TECHNICAL FIELDS SEARCHED (Int.Cl.7) B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	21 August 2002	Dreyer, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 01 0456

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21-08-2002

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