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(54) METHOD AND APPARATUS FOR CONTROLLING ROTARY RING UNIT OF FINE SPINNING FRAME OR THE LIKE.

(57) Method and apparatus for controlling the action of twisting of a rotary ring spinning/twisting unit having an annular rotary member (1) mounted rotatably on a holder (7) through a bearing mechanism (G). The method comprises detecting the rotational speed of each of the rotary member (1) and a spindle and comparing the detected speeds with each other to control the rotational speed of the rotary member so that the ratio of the rotational speed of the rotary member to that of the spindle falls within a preset range by rotational speed controlling means (17, 54, 55, 56, 57, 58, 59, 60). For example, a magnetic bearing (G) containing at least one electromagnet (14) is used to control the torque of the rotary member (1) around the magnetic bearing (G) by controlling a current flowing through the electromagnet (14).

Fig. 2

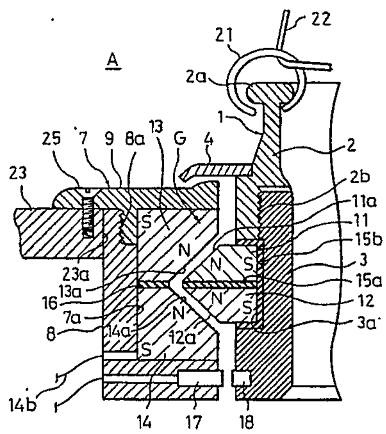

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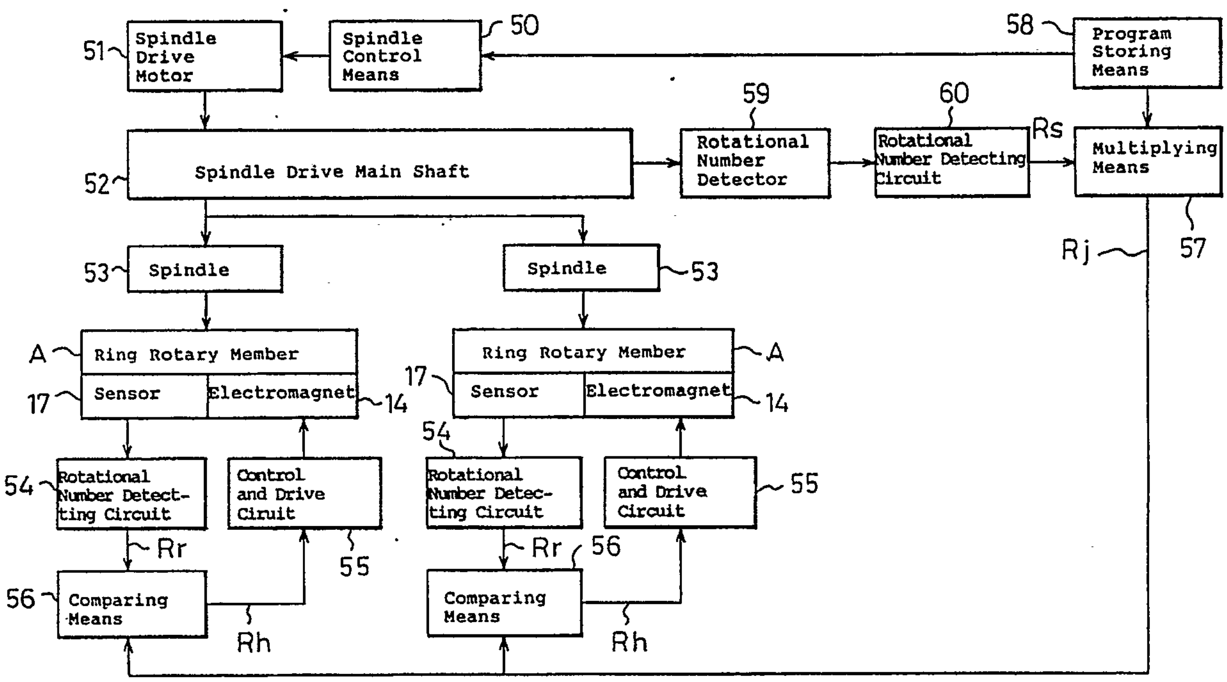
Fig. 1


Spindle Drive Motor
51
Spindle Control Means
50
Program Storing Means
58
Spindle Drive Main Shaft
52
Rotational Number Detector
59
Rotational Number Detecting Circuit
60
Rs
Multiplying Means
57
Rj
Spindle
53
Ring Rotary Member
A
Sensor
17
Electromagnet
14
Rotational Number Detecting Circuit
54
Control and Drive Circuit
55
Rr
Comparing Means
56
Rh

TECHNICAL FIELD

This invention relates to a method of controlling a rotary spinning ring assembly used in a textile machine including a ring rail and a spindle driving mechanism, such as a ring spinning frame, a ring twisting frame or the like and comprising an annular holder fixed in a horizontal posture on the ring rail, a ring rotary member supported coaxially and rotatably through a bearing mechanism by the holder, a spindle arranged coaxially in an inside space of the ring rotary member and driven by the spindle driving mechanism, and a rotation speed control means for controlling a rotational speed of the ring rotary member, and a related apparatus.

The term spinning machine as used herein includes all machines having a twisting mechanism in which a twist is applied to a yarn by using a ring and the spindle, including at least a machine for spinning a spun yarn, and further includes a draw twister used for manufacturing a synthetic fiber and a twisting machine used for manufacturing a covered yarn. Further all yarn like materials, such as a natural fiber yarn, a man-made fiber yarn, a metallic wire or the like, can be used as a yarn for the present invention.

PRIOR ART

A twisting method using a spindle and ring is an ancient and well known technique. The ring is fixed on a ring rail in this conventional twisting technique, and a rotary ring which rotates to stably twist a yarn, even if a rotational speed of the spindle is raised to increase productivity, is known. Several bearing mechanisms for rotatably supporting a ring rotary member of a rotary spinning ring assembly using the rotary ring in a spinning operation have been proposed. Namely, Japanese Examined Patent Publication (Kokoku) No. 54-15934 discloses a slide type bearing mechanism having a sliding face; Japanese Examined Patent Publications (Kokoku) No. 54-13528 and No. 54-15528 disclose a pneumatic bearing formed by injecting compressed air; and Japanese Unexamined Patent Publication (Kokai) discloses a bearing using a ball bearing.

Nevertheless, the bearing mechanisms used in the conventional rotary spinning ring assembly have various disadvantages; for example, when a machine such as a spinning frame or the like is stopped and the rotation of the spindle is then stopped, a lowering of a rotational speed of the ring rotary member is later than a lowering of a rotational speed of the spindle, due to an inertial rotation of the ring rotary member, and thus the ring rotary member may overrun the spindle. This overrun causes a generation of snarls in a yarn being twisted, and a breaking of the yarn may be caused by the snarl upon restarting the spinning operation. Accordingly although the rotary spinning ring assembly is considered to an excellent method by which a high speed rotation of the spindle, can be followed by the rotary spinning ring assembly, such an assembly has not been put to practical use.

To solve the above problems, a method of lowering a spinning tension of a yarn and relieving a torque of the ring rotary member including a traveller, by intermittently lowering the rotational speed of the spindle when the machine is to be stopped, whereby the machine is stopped after the rotational speed of the ring rotary member is lowered, or a method of simultaneously braking all of the ring rotary members by applying a friction thereto due to a grasping thereof upon stopping the machine, or of simultaneously braking all of the ring rotary members by imposing a resistance thereon of a fluid such as an oil, air or the like have been proposed, but although such methods can stop all of the ring rotary members in the machine when full bobbins are stopped, it is impossible to stop each ring rotary member, individually.

As described above, the rotary spinning ring assembly has been widely expected to become a useful means of enabling a high speed rotation of the spindle, but a problem of a control of the rotational speed of the ring rotary member, arising because a rotational speed of the spindle becomes too high occurs also in a twisting operation when all of the spindles in the machine are simultaneously stopped. Namely, the rotational speed of the ring rotary member is increased in proportion to an increase of a rotational speed of the spindle in the rotary spinning ring assembly, and accordingly, when the rotational speed of the spindle is high, the inertia of the ring rotary member becomes large. Therefore, when a twisted yarn is wound on a bobbin in the rotary spinning ring assembly, a rotation speed of the traveller on a portion of the bobbin having a larger diameter of a yarn layer is slightly bigger than that at a portion of the bobbin having a smaller diameter of a yarn layer, and thus a stable winding operation is achieved. When the ri ng rotary member has a much higher rotational speed, however, the above balance is lost due to an inertial rotation of the ring rotary member, and a rotational speed of the ring rotary member is synchronized with a maximum rotational speed in a chase of the traveller on the ring rotary member, and thus an irregularity in the spinning tension of the yarn arises. When a strong irregularity of the spinning tension is repeated in the chase, problems such as a generation of fuzz, a generation of nap by a scraping operation, and a lowering of a yarn quality, including a yarn weakening which depends on a type of fiber used, are generated.

Further in a spinning machine having a plurality of a spindles, e.g., 400 spindles, a twisting state at each spindle is different, as it is at each stage from a beginning stage to a finishing stage, i.e., a full bobbin stage. Accordingly, to obtain a stable twisting operation at all of the spindles in the machine the rotational speed of the ring rotary member must be controlled at each spindle, i.e., each ring rotary member in the machine. Nevertheless, such a control means has not been proposed.

The same inventor as of the present application proposed a rotary spinning ring assembly enabling a high rotational speed of the ring rotary member and having a rotational speed control means for controlling the rotational speed of the ring rotary member, in Japanese Unexamined Patent Publication (Kokai) No. 2-74633, and Japanese Patent Application No. 1-107060 filed on April 26, 1990, and claiming a priority of Japanese Patent Application No. 63-282854 filed on November 8, 1988. In the rotary spinning ring assembly disclosed in the former publication, the ring rotary member is rotatably supported through a magnetic bearing including an electrical magnet in at least a portion thereof with a holder. In the rotary spinning ring assembly filed in the later application, a motor having a permanent magnet arranged on a ring rotary member and an armature arranged on a holder is provided.

Nevertheless, even if the rotary spinning ring assembly proposed by the same inventors as of the present application is used, it is impossible to attain an essential object and quality of the rotary spinning ring assembly such that all of the ring rotary members arranged on all of the spindle, can be individually operated in a stable spinning state at all of the spinning stages by a conventional drive method.

DISCLOSURE OF THE INVENTION

The primary object of the present invention is to provide a method of controlling a twisting operation of a rotary spinning ring assembly, which prevents a synchronization of a rotation of a ring rotary member with a rotation of a traveller, an overrun of the ring rotary member when the machine is stopped or the like, for all of the spindles of the machine, and by controlling a rotational speed of the ring rotary member during all the spinning process, when a twisting operation is performed by using the rotary spinning ring assembly.

The second object of the present invention is to provide a twisting operation controlling apparatus for a rotary spinning ring assembly capable of obtaining the primary object of the present invention.

The primary object of the present invention is attained by a method of controlling a rotary spinning ring assembly, characterized in that a rotational speed of a ring rotary member and a rotational speed of a spindle are detected, respectively, the two detected rotational speed values are compared, and the rotational speed of the ring rotary member is controlled by a rotational speed control means in such a manner that the rotational speed of a ring rotary member is kept within a range of a predetermined optimum ratio of the rotational speed of the ring rotary member to the rotational speed of the spindle.

Preferably, a control program for controlling the rotational speed of the spindle, from a start of the manufacture of a yarn package to a completion thereof, to a predetermined rotational speed, and another control program for controlling a rotational speed of the ring rotary member to a rotational speed determined by a predetermined optimum ratio in connection with the control program for controlling the rotational speed of the spindle are provided, whereby the control of the rotational speed of the ring rotary member controlled by an optimum ratio controlling means is performed in such a manner that a difference between the detected rotational speed of the ring rotary member and a target rotational speed of the ring rotary member set in the control program is reduced.

The programmed control of the rotational speed of the ring rotary member is preferably performed in such a manner that the ring rotary member is rotated at a lower rotational speed than that of a traveller, and the rotation of the ring rotary member is proportionally controlled according to a ring rotary member speed-elevation curve having a speed-elevation ratio which is at least not larger than that of a spindle speed-elevation curve during a period of from a starting time to a time at which the rotational speed of the ring rotary member reaches a maximum rotational speed, the rotational speed of the ring rotary member is reduced and is kept within a region of between 40% and 60% of the rotational speed of the spindle during a period in which a half yarn package is spun, the rotational speed of the ring rotary member is raised before the rotational speed of the spindle is reduced from the maximum rotational speed thereof during a period before the yarn package becomes a full bobbin and in which a yarn breakage becomes larger, th e rotational speed of the ring rotary member is reduced at a reduction ratio which is at least not lower than that of the rotational speed of the spindle during a period in which the yarn package becomes a full bobbin, and then the rotational speed of the spindle is reduced and the ring rotary member is stopped at the same time as or before the spindle is stopped.

It is possible to make the time for which the spindle is driven at a maximum rotational speed a maximum value, to thereby attain an improved productivity and a stable spinning operation, by combining the control program for controlling the rotational speed of the spindle in a optimum correlative relationship with the control program for controlling the rotational speed of the ring rotary member, and by controlling the rotational speed of the ring rotary member on the basis of a comparative value of the detected rotational speed of the spindle and the detected rotational speed of the ring rotary member.

Further, it is preferable to include a start control in which a start of the rotation of the ring rotary member is applied after a slight time lag from a start of the rotation of the spindle, to ensure a first winding of the yarn on a bobbin. It is possible to apply a suitable winding tension to the bobbin by delaying the start of the rotation of the ring rotary member and thus it is possible to obtain a first winding of the yarn on the bobbin.

A magnetic bearing can be used as the bearing mechanism. The magnetic bearing is constituted by annular magnets coaxially arranged, respectively, on axial and radial opposite faces of the ring rotary member and the holder, with a minute gap therebetween in such a manner that the pole of the annular magnet of the ring rotary member is arranged to be opposite the pole of the annular magnet of the holder having the same magnetic properties as that of the annular magnet of the ring rotary member. Each opposite face of the annular magnets may have a profile such the both opposite faces are in contact with each other by at least a portion thereof when the ring rotary member moves in the axial direction thereof toward the holder, and an electromagnet may be used to form at least a plurality of magnets arranged in the annular magnet of the holder. When the magnetic bearing is used, the control of the rotational speed of the ring rotary member by the rotational speed controlling means can be performed by controlling an intensity of the mag netic field of the electromagnet and adjusting a gap between the ring rotary member and the holder in the magnetic bearing, to thus control a torque generated by the rotating of the ring rotary member.

The control of the intensity of the magnetic field of the electromagnet can be performed by changing an intensity or a direction of an electric current.

A rotary spinning ring assembly in which the ring rotary member is rotatably supported through a bearing mechanism with a holder, wherein the bearing mechanism is formed by an annular permanent magnet arranged on the ring rotary member and an armature arranged on the holder, can be used. In this rotary spinning ring assembly, the control of the rotational speed of the ring rotary member by the rotational speed control means is performed by controlling an electric current supplied to the armature. The control of the electric current fed to the armature can be performed by adjusting a value of a frequency, a value of an electric current, an electric voltage or a vector of the electric current.

A control apparatus of the rotary spinning ring assembly used for attaining the second object of the present invention can be used in a spinning machine such as a ring spinning frame and a ring twisting machine or a draw twister having a ring rail and a spindle driving mechanism, and is an apparatus for controlling each rotary spinning ring assembly of the textile machine including a plurality of the rotary spinning ring assemblies comprising, respectively, an annular holder fixed in a horizontal posture to the ring rail, a ring rotary member supported coaxially and rotatably through a bearing mechanism to the holder, a spindle arranged coaxially in an inner space of the ring rotary member and driven by the spindle driving mechanism, and a rotational speed control means of controlling a rotational speed of the ring rotary member. The control apparatus is characterized in that a magnetic bearing is used as the bearing mechanism, the magnetic bearing being constituted by annular magnets coaxially arranged, respectively, on axial and radial opposite faces of the ring rotary member and the holder, with a minute gap therebetween, in such a manner that a pole of the annular magnet of the ring rotary member is arranged to be opposite to a pole of the annular magnet of the holder having the same magnetic properties as that of the annular magnet of the ring rotary member, and the each opposite face of the annular magnets has a profile such that the both opposite faces are in contact with each other by at least a portion thereof, when the ring rotary member moves in the axial direction thereof toward the holder, at least a magnet in a plurality of magnets arranged in the annular magnet of the holder is an electromagnet, and the rotary spinning ring assembly control apparatus is comprised of a ring rotational speed detecting means for detecting a rotational speed of the ring rotary member, a spindle rotational speed detecting means for detecting a rotational speed of the spindle, a suppressing ratio storing means for storing a suppressing ratio, i.e., a target rotational speed ratio of the ring rotary member to the spindle, a multiplying means for multiplying the suppressing ratio by the rotational speed detected by the spindle rotational speed detecting means, a comparing means for comparing multiplied data obtained by the multiplying means with the rotational speed detected by the ring rotational speed detecting means, and an electric current control means for controlling an electric current supplied to the electromagnet arranged on the holder, and of the bearing mechanism, on the basis of a result obtained by the comparative means, in such a manner that the rotational speed of the ring rotary member reaches the target rotational speed thereof, and the spindle rotational speed detecting means, the suppressing ratio storing means, and the multiplying means, as elements constituting the rotary spinning ring assembly control apparatus, are arranged on each textile machine, respectively, and the other elements are arranged on each of a plurality of the ring rotary members, respectively.

It is possible to arrange on annular permanent magnet at a region constituting the bearing mechanism of the ring rotary member and arrange an armature in the holder, to form a motor, used instead of the magnetic bearing as the bearing mechanism.

It is preferable to further provide a means of storing a control program for controlling the rotational speed of the spindle to a predetermined rotational speed for the whole period of from a start of winding a yarn package to a completion thereof in the rotary spinning ring assembly control apparatus, to rotate the spindle according to the control program held in the storing means.

Where the rotary spinning ring assembly control apparatus in accordance with the present invention includes a control program setting means for setting a program in such a manner that a rotational speed of the spindle can be changed according to an advance of a formation of a cop over the whole period from the start to the completion, optimum spinning conditions of all the spinning process for the various types of yarn are stored in a program storing means, and a suppressing ratio, which is a target rotational speed ratio of the ring rotary member to the rotational speed of the spindle, is stored in a storing program thereof in such a manner that a variable speed control of the rotational speed of the spindle can be performed according to a package size ratio of the cop obtained by, for example, detecting a stretch length. It is further preferable to perform a group control of the rotational speeds of the spindle and the ring rotary member by inputting and storing the optimum spinning program in a group control system for a textil e machine group composed of several machines having the same conditions, detecting the optimum spinning conditions including a mean spinning tension from the textile machine group to obtain an average group value, and by operating the textile machines according to the optimum spinning program prepared in such a manner that the detected average group value is within a region of the optimum spinning conditions including the predetermined optimum spinning tension.

A function of the control of the rotational speed of the ring rotary member, which is performed by a control method and a control apparatus in accordance with the present invention, will be described with reference to a rotary spinning ring assembly equipped with a magnetic bearing as an example.

The rotary spinning ring assembly equipped with the magnetic bearing is provided with a permanent magnet arranged in an annular state at a substantially center portion of an outer circumference of the ring rotary member and formed as one body with the ring rotary member and a magnet arranged on a fixed holder surrounding same coaxially in an annular state to the ring rotary member from an outside thereof, wherein the permanent magnet is located opposite to the magnet, with a minute annular air gap therebetween, and with the same poles of the permanent magnet and the magnet are opposite to each other, and accordingly the permanent magnet and the magnet repulse each other, and thus the ring rotary member floats in a non-contact state with the holder, and as a result, the magnetic bearing is formed.

A part of annular magnets arranged on the holder is constituted by an electromagnet, and since this electromagnet has a component in an axial direction of the holder, an electromagnetic floating force or an electromagnetic absorbing force in the axial direction or an upper and lower direction of the ring rotary member can be changed by changing a value of the electric current or a direction of the electric current supplied to the electromagnet, and the ring rotary member moved in a direction in which the electromagnetic floating force is reduced or the electromagnetic absorbing force is increased, and thus a magnetic pole face of the ring rotary member, through a sliding member or the like, is in contact with a magnetic pole face of the holder. The degree of contact pressure can be controlled according to an intensity and a direction of the electric current supplied to the electromagnet of the holder, and accordingly, a braking force can be controlled by changing the contact and friction force.

When a magnet force of the ring rotary member and a magnet force of the holder are provide an equivalent support of the ring rotary member, the ring rotary member is fully floating, and thus the magnet bearing is maintained in a noncontact state whereby a rotational speed of the ring rotary member is increased to a maximum rotational speed at which the rotational speed of the ring rotary member reaches the same rotational speed as that of a traveller. Accordingly, to lower the rotational speed of the ring rotary member to a suitable range for a spinning condition, i.e., 60% of the rotational speed of the traveller as a mean value or 90% of the rotational speed of the traveller as a maximum value, a rotation of the ring rotary member is controlled by applying a resistance thereto caused by a difference between the magnetic forces of the poles of the magnetic bearing held in the non-contact state. When the difference in the magnetic forces becomes larger, the ring rotary member, through the sliding member, is in contact with either one of an upper pole or a lower pole of the magnet of the holder and a friction is generated therebetween. When a plus direction and a minus direction of the electric current supplied to the electromagnetic coil is reversed, an equilibrium state in which the pole of the ring rotary member and the pole of the holder face each other and are balanced by the repelling magnetic force or the absorbing magnetic force is broken, and the ring rotary member is suddenly braked by being brought into magnetic contact with either one of the upper magnetic pole or the lower magnetic pole of the magnet of the holder and the ring rotary member stop. Thus, the rotation of the ring rotary member can be electrically controlled from the outside.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram illustrating a preferable example of a method of controlling a rotary spinning ring assembly in accordance with the present invention;

Fig. 2 is a partially axial sectional view illustrating an example of a rotary spinning ring assembly controlled in accordance with the present invention;

Fig. 3 is a graph illustrating an example of a spinning program stored in a program storing means;

Fig. 4 is a flow chart illustrating an example of an operation of a comparative means of a control driving circuit;

Figs. 5 to 7 are a partial axial crosssectional view illustrating other examples of the rotary spinning ring assembly controlled in accordance with the present invention, respectively.

BEST MODE OF CARRYING OUT THE INVENTION

A rotary spinning ring assembly to which a control of the present invention is applied will be described, before a method of controlling the rotary spinning ring assembly and an apparatus therefor are described.

Figure 2 is a partial axial crosssectional view illustrating an example of the rotary spinning ring assembly controlled in accordance with the present invention.

In the rotary spinning ring assembly A shown in Fig. 2, a ring rotary member 1 is constituted by a flange rotor 2 having a ring flange portion 2a on which a traveller 21 is slidably rotated, and a lower rotor 3 is connected to the flange rotor 2 by screws 2b. The lower rotor 3 is made of a non-magnetic metal material such as an aluminum alloy having a magnetic resistance, a copper alloy, a stainless steel, a carbon group material or the like, and an electrical conductive synthetic material or the like, and thus a leakage of a magnetic flux is cut to a minimum value.

The ring rotary member 1 is rotatably supported in a holder 7 by a bearing mechanism G, and the holder 7 is inserted into an attaching hole 23a of a ring rail 23 and fixed by a screw 25.

The bearing mechanism is constituted as follows. Two annular permanent magnets 11 and 12 are fixed through a spacer 15a and 15b into a concave groove 3a formed in the lower rotor 3 of the ring rotary member 1. An outer circumference in a radial direction of the permanent magnets 11 and 15 has a tapered face 11a and 12a having an angle of around 45° relative to an axis thereof, and the magnetic pole of the tapered face 11a and 12a is an N pole.

The spacer 15b is used as a magnetic sealing means so that a leakage of magnetic flux of the permanent magnets 11 and 12 to the outside, in particular the ring flange portion 2a and the traveller 21, is prevented.

The holder 7 is constituted with a holder main body 8 and a cover 9 connected thereto by a screw 8a or the like.

An annular permanent magnet 13 and an annular electromagnet 14 are fixed through a spacer 13a into a concave portion 7a formed in the holder 7. Tapered faces 13a and 14a having an angle of 45° relative to an axis of the ring rotary member are formed on an inside circumference in a radial direction of the permanent magnet 13 and the electromagnet 14, in such a manner that both tapered faces form a groove having a substantial V shape, and the tapered faces 13a and 14a and the tapered faces 11a and 12a are arranged in an opposite relationship with a suitable gap therebetween.

A magnetic pole of the tapered face 13a is the same as the magnetic pole of the tapered face 11a, i.e., an N-pole, and a magnetic pole of the tapered face 14a of the electromagnet 14 is made an N pole by supplying an electric current in a normal direction, to a lead line 14b of the electromagnet 14. An intensity of the electromagnet 14 can be adjusted by adjusting the electric current.

It is possible to use electromagnets having various structures. For example, it is possible to use an electromagnet having a structure in which a plurality of pillar-like electromagnets constituted by winding a coil on a pillar-like core having a circular section or a fan-like section are arranged in a concave portion 7a of the holder 7 along a circumferential direction thereof, in a state such that a magnetic pole of the pillar-like electromagnet is fixed to an annular plate having magnetic properties, respectively, and an electromagnet having a structure in which a coil is wound on an iron core having a shape of a circular pillar is then accommodated in the concave portion 7a or the like.

The electromagnets 11, 12 and 13 are an isotropic magnet of a metal, a ferrite (an axidate ceramic), a rare earth element, a rubber, a plastic or the like. Further, if necessary, opposite faces of the permanent magnets 11, 12 and 13 and the electromagnet 14 are provided with a cover such as a sheet, a film or a coating layer, to protect a pole surface. This cover may be made of a non-lubricated sliding material having a lower friction coefficient, a superior resistance to abrasion and a superior resistance to heat, e.g., a ceramic, a tetrafluoroethylene including a filler such as a carbon fiber or the like, or a high polymer engineering plastic such as a polyimide, a polyimideamide or the like.

A spacer 16 is made of an electrical insulating material such as mica, a high polymer resin, a ceramic or the like, to electrically insulate the electromagnet 14 from the permanent magnet 13.

A sensor 17 is attached to a holder body 8, and a detecting member 18 for generating a pulse, i.e., a detecting signal, to the sensor 17 is arranged on an outer circumferential face of a lower rotor 3. Accordingly, by providing light and dark portions or notches, the rotational number, i.e., the rotational speed, can be detected by counting the detection signals from the sensor 17. The numeral 4 denotes a dust cover, and 22 a yarn supplied from a snarl wire in a ballooning state and wound on a cop (not shown).

In this ring rotary member A, a magnetic pole having substantially the same intensity as that of a tapered face 13a of the permanent magnet 13 is formed on a tapered face 14a of the electromagnet 14 by supplying a suitable electric current through a lead line 14b to the electromagnet 14, and thus the permanent magnets 11 and 12 are floated from the permanent magnet 13 and the electromagnet 14, because the tapered faces 11a and 12a and the tapered faces 13a and 14a repel each other, and is in a noncontact state.

Accordingly, the ring rotary member 1 can be rotated by an extremely small rotational speed and an energy loss caused by a friction or the like become extremely small, and thus the ring rotary member can be rotated at the high rotational speed by a torque applied from a traveller 21.

When the electric current supplied to the electromagnet 14 is reduced, since a magnetic force of the electromagnet 14 lowers and a component pressing up the permanent magnets 11 and 12 is lowered, the ring rotary member 1 moves downward and the tapered face 12a comes into contact with the tapered face 14a by a repelling force between the tapered face 11a of the permanent magnet 11 and the tapered face 13a of the permanent magnet 13 and the ring rotary member's own weight. This contact pressure can be controlled by varying the intensity of the electric current supplied to the electromagnet 14.

When a direction of the electric current is reversed, the magnetic pole of the tapered face 14a of the electro magnet 14 becomes a S-pole, and a strong braking force is generated because the S-pole of the tapered face 14a and the tapered face 12a of the permanent magnet 12 are attracted to each other.

Accordingly, the braking force can be controlled by controlling the amperage and the direction of the electric current supplied to the electromagnet 14, and thus a rotational number of the ring rotary member and a time required to stop the ring rotary member when rotating at a high rotational speed can be controlled.

A method of controlling the rotary spinning ring assembly in accordance with the present invention, and an apparatus therefor will be described hereafter.

Figure 1 is a block diagram of a controller H relating to the present invention. Note, only two spindles are illustrated in Fig. 1, but in practice all of the spindles in a spinning frame are controlled by the controller H.

In Fig. 1 a program storing means 58 is a RAM or ROM, and is provided with a spinning program for all of the spinning process, as determined for each type and yarn count of the various yarns to be spun. This spinning program is an optimum range of a spinning tension for each spun yarn, and data of a standard rotational speed of a spindle 53 and the ring rotary member 1, are determined according to a size ratio of a cop and by a stretch length from a starting time to a time at which a full bobbin is wound.

The rotational number of the spindle can be controlled on the basis of the size ratio by detecting and inputting a position of the ring rail on a linear scale or by bringing the ring rail into sequential contact with a plurality of microswitches, comparing the input data with a preinput program and then changing the rotation of the spindle.

A data of the rotational number of the ring rotary member 1 is stored as a suppressing ratio K, i.e., a target rotational speed ratio of the ring rotary member 1 to the spindle 53.

A rotation of the spindle drive motor 51 is controlled such that the spindle 53 is rotated at a predetermined rotational number on the basis of the data sent from the program storing means 58, by a spindle control means 50.

A spindle drive main shaft 52 is rotated by the spindle drive motor 51, and a rotation of each spindle 53 is obtained through a belt or the like driven by the rotation of the spindle drive main shaft 53. The spindle drive main shaft is provided with a rotational number detector 59, such as a tachogenerator, a rotary pulse generator or the like, and a rotational number Rs of the spindle 53 is detected by a rotational number detecting circuit 60 which receives an output of the rotational number detector 59.

The rotational number Rs of the spindle 53 detected by the rotational number detecting circuit 60 is multiplied by a suppressing ratio K output from a storing means 58, and the obtained data is output as a target rotational number Rj.

A rotational number detecting circuit 54 detects a rotational number Rr of the ring rotary member 1 by counting pulses output by the sensor 17.

A comparing means 56 compares the rotational number Rr detected by the rotational speed detecting circuit 54 with the target rotational number Rj output by the multiplying means 57, and outputs an adjusting signal Rh determined on the basis of the difference obtained by the comparison.

A braking and driving circuit 56 controls an amperage and a direction of the electric current supplied to the electromagnet 14, on the basis of the adjusting signal Rh output from the comparing means 56, and adjusts a braking force in the bearing mechanism G, whereby the rotational number Rr of the ring rotary member 1 is controlled to the target rotational number Rj.

The above circuits and means are realized by hardware or a microprocessor including a suitable program.

An example of the rotational number control of the ring rotary member as performed by the controller H will be described with reference to Fig. 3.

Fig. 3 is a diagram of an example of a spinning program of a standard cotton spun yarn having a medium yarn count, e.g., 40's to 60's, and manufactured by a high speed spinning frame equipped with a controller such as a sequencer or the like. This spinning program is prepared in such a manner that yarn breakages are kept to a minimum in a period from the rotation of an empty bobbin, or a time at which a yarn is first wound on a bobbin, to size ratio of 0.3, and a period from a size ratio of 0.9 to a full bobbin. If too many yarn breakages occur, a rotational speed of the spindle is increased to an allowable maximum value, a period in which the yarn is spun at the maximum rotational speed of the spindle reaches a maximum value to complete the entire spinning process in the shortest time. As a result, a minimum of yarn breakages, a high quality, and a maximum productivity can be attained.

Recently, a multiple stage speed control of the rotational speed of the spindle using an inverter or the like has been proposed. The present invention aims to provide a controlling means which can control the rotation of the ring rotary member before a control of the rotation of the spindle, and a control program thereof, in such a manner that an optimum spinning condition including an optimum spinning tension in a spinning program for every yarn type and yarn count can be obtained by applying a control of the rotational speed of the ring rotary member by using an electrically controllable rotary spinning ring assembly controlled according to a control of the rotational speed of the spindle.

The control of a rotational speed of the ring rotary member according to the rotation of the spindle will be described hereafter.

(1) A suppressing ratio K, which is an optimum ratio of a ring rotary member rotational speed control curve RC to a spindle rotational speed control curve SC in each spinning program, is determined, an upper limit of the ring rotation to the spindle rotation is denoted as ru, and a lower limit thereof is denoted as rd.

(2) A time relationship between a speed change diagram in the SC curve and a speed change diagram in the RC curve is determined.

(3) A control process of the rotational speed of the ring rotary member is as follows.

① Variable widths of a spinning tension for every yarn type and yarn count are predetermined, an upper spinning tension at which yarn breakages are not generated is denoted as TSU, and a lower spinning tension at which a collapse of a ballooning of the yarn does not occur is denoted as TSD. When the variable width of the spinning tension will be come outside a range determined by the upper spinning tension TSU and the lower spinning tension TSU, the rotational number of the ring rotary member is controlled before a control of the rotation of the spindle, to return a spinning tension to a spinning tension region in which yarn breakages are not generated.

If the return of the spinning tension to the suitable spinning tension region by the speed control of the ring rotary member is difficult, a control of the rotational speed of the spindle is performed as an additional adjusting control.

② A diagram speed control of the rotational speed of the ring rotary member corresponding to a change of the size ratio caused by an advance of the spinning time is performed by detecting positions of the ring rail and a rapet rail, and measuring a size of the bobbin on the basis of a change of a stretch length.

③ A speed control of the rotational speed of the ring rotary member in a chase in which control a rotational speed of the ring rotary member at an upper portion and a lower portion of the chase and during an elevation and a descent movement of the ring rail is accelerated around the most upper portion by detecting a position of the ring rail and a moving direction of the ring rail and following an accelerating speed control of the ring rotary member between the chases, i.e., a V-letter time chart having a bottom thereof at the upper portion of the chase and corresponding to a change of the spinning tension between the chases of the cop, and without the use of decelerating control of the spindle at an upper portion of the chase, i.e., the portion having a minimized diameter, are applied during a whole spinning process.

(4) In accordance with Fig. 3 showing an example of a standard spinning program.

① An SC curve is prepared by setting a rotational number NS of the spindle when a machine is switched from 10,000 r.p.m. to 12,000 r.p.m. A required time P1 of an accelerating 1st period N1 from the switching-on to a set speed S1 is generally 5 sec to 10 sec, but this depends on a load at the main drive source. The rotational number NR of the ring rotary member in this period is set at zero, and a ring rotation control curve RC is started later by a time difference, i.e., a period P1, e.g., 5 sec to 10 sec from the start of the machine, and at this time, the rotational speed NS of the spindle is raised to a set speed S1 of between 10,100 r.p.m. and 12,000 r.p.m.

② After the SC curve reaches the initial set speed N1, the rotational speed of the ring rotary member is accelerated to a 1st speed S.S. of 15,000 r.p.m. corresponding to a half value of a target maximum speed Sh for a period P2 of 20 sec to 30 sec from the switch on, the rotational speed of the ring rotary member is immediately accelerated to a speed S3 of around 18,000 r.p.m. corresponding to 60% of the target maximum speed Sh, within 60 sec from the switch on, and further, is accelerated to a speed S4 of around 20,000 r.p.m. corresponding to two-thirds of the target maximum speed Sh along an accelerating line N4, and reaches a second speed or a constant speed Sℓ. An initial cop bottom portion having a size ratio of 0.05 or more is formed at this constant speed Sℓ.

In a ring rotation control diagram RC in the above region of the rotation of the spindle, a rotational speed of the ring rotary member NR is determined to be a value of 40% to 50% of the rotational speeds N2 and N3, as shown by the marks K1, K2 in Fig. 3, and is accelerated to the speed. R1 along an accelerating line N4 corresponding to 50% to 60% of the value of N4. As a result, the rotational number R1 of the ring rotary member is determined to be 10,000 r.p.m. to 12,000 r.p.m., corresponding to a value of 50% to 60% of the value of Sℓ.

With regard to the proportional control of the ring rotation control program RC to the spindle rotation control program SC in an initial cop bottom portion forming period from the switch on to the size ratio of 0.05 to 0.1, when an increment of a torque applied to the ring rotary member is rapid, due to a sharp angle of the curve SC when the spindle is started, it is possible to absorb an accelerating shock applied to a traveller by increasing a rotational ratio of the rotational number NR of the ring rotary member to the rotational number NS of the ring, from 40% to 60% as described herebefore to 80% to 90%. Generally, an accelerating ratio of the ring rotary member to the spindle rotation control curve SC is determined in such a manner that a suitable resistance to friction is applied between the ring rotary member and the traveller, and a collapse of a shape of the bottom portion is prevented during a long spinning time under a high speed, because the yarn is wound on the bobbin with a normal spinning tension at a value preferably determined as a higher winding tension in a region whereat yarn breakages are not generated when starting the spinning operation.

③ After the operation described above, a limit of the spinning speed depends on a yarn type, a yarn count, a mechanical condition of the machine or the like. Generally, in a region where the rotational speed of the spindle is accelerated along a line N5 and a region where the rotational speed of the spindle is kept at a constant 3rd speed s.m. in which the formation of the cop bottom portion is completed and a cop having a size ratio of 0.22 to 0.30 is formed, the ring rotation control curve RC may be determined as 85% of the value corresponding to the maximum speed Sh in the spindle rotation control curve SC. For example, the rotational number Sm in Fig. 3 is determined to be 25,000 r.p.m. corresponding to 85% of the value of Sh of 30,000 r.p.m.

In a region after the cop bottom portion is formed and the cop is formed by the size ratio of 0.4 to 0.5, the rotational number of the spindle is slowly accelerated to the maximum spinning speed Sh, i.e., 30,000 r.p.m., along a slow acceleration line N6. A ring rotation control curve RC in this region, follows the spindle rotation control curve SC at a proportion of 50% to 60%, as shown as K4 to N5, R2 to Sm, and K5 to N6 in Fig. 3, to maintain a relative speed at the rotational speed of the spindle in a range in which yarn breakages do not occur, to absorb shock generated by a variation of the spinning tension or the like and caused by the acceleration of the rotational speed of the ring rotary member, and to unify the spinning tension, by changeably controlling the rotational speed of the ring rotary member according to a change of the rotational speed of the traveller in a chase, caused by a change of the stretch and a bobbin winding operation.

④ In a period from the size ratio of 0.45 to 0.50 to the size ratio of around 0.55 in which the spinning condition becomes stable, the ring rotation control curve RC keeps the maximum value R3 thereof. In a period upto the size ratio of 0.85 to 0.90 in which the spinning condition is stable and few yarn breakages occur, the rotational speed of the ring rotary member is decelerated to the rotational speed R4 of 40% - 50% of the maximum value Sh of the rotational speed of the spindle, to reduce a torque necessary to rotate the ring rotary member. In this period, the rotation of the ring rotary member can be easily changed in the chase according to a torque applied to the traveller, and it is possible to make the spinning condition stable, and a saving of an electric consumption required in this period which is at the highest speed and the longest time in all of the spinning process, and an abrasion of a bearing of the ring rotary member can be reduced.

⑤ When the size ratio becomes around 0.85 to 0.95, the rotational speed of the ring rotary member is accelerated from R4 to R5, i.e., 18,000 r.p.m., corresponding to 50% to 60% of the maximum speed Sh of the spindle along an accelerating line K7, and this speed R5 is kept at a point just before the size ratio of 0.95 to 1.00. After the size ratio of 0.95, the rotation of the spindle is decelerated from the maximum speed Sh to a speed SS corresponding to a half or two thirds of Sh along a decelerating line N7. When the cop becomes a full bobbin at the point SS-(a), a motor of the machine is switched off by a signal from an automatic stopping device, a ring rail is automatically lowered, and a tail winding is completed. The rotation of the ring rotary member is decelerated to R6, i.e., 6,000 r.p.m. or less, corresponding to a value of 30% to 40% of the speed SS of the spindle to reduce an inertia of the ring rotary member. The rotation of the ring rotary member is further decelerated from a point R6-b corresponding to a point SS-a of the spindle rotation control curve along a decelerating line having an angle β which is smaller than an angle α of a decelerating line of the rotation of the spindle. Thus a time H.R. from the point R6-b to a point at which the ring rotary member is completely stopped is determined to be a short value compared with a time HS from the point SS-a to a point at which the spindle is completely stopped. Namely, the rotation of the ring rotary member must be stopped at the same time or earlier than a time at which the spindle is stopped.

The time HS depends on various conditions, such as a total load of the yarn package or the like, use of various braking devices used in the machine, and a rotational speed of the spindle and a torque when the inertial rotation of the ring rotary member starts, but the value of HR can be reduced to around 10 sec by using an inverter and a main motor braking device. When the value of HS is determined, it is necessary to determine the value of HR as 5 sec to 9 sec.

Fig. 4 is a flow chart illustrating an example of the operation of a comparing means 56 and a braking and controlling circuit 55.

As shown in Fig. 4, a difference between the rotational number Rr of the ring rotary member and the target rotational number Rj at the step #11.

When the rotational number Rr is bigger than the target rotational number Rj, an electric current supplied to the electromagnet 14 is controlled by multiplying a difference between the rotational number Rr and the target rotational number Rj by a gain α, to generate an increment F of a braking force caused by the electromagnet 14 in step #12.

When the rotational number Rr is smaller than the target rotational number Rj, an electric current supplied to the electromagnet 14 is controlled to reduce a braking force caused by the electromagnet 14 in step #13.

When the rotational speed Rr is identical to the target rotational speed Rj, the value of the electric current is kept without change.

When the size ratio becomes 1, i.e., the cop becomes a full bobbin, a command of a rotational speed of 0 is applied to a spindle drive motor 51 or a supply of an electric power is switched off and the electric current supplied to the electromagnet 14 is controlled by the braking and controlling circuit 55. For example, a direction of the electric current is changed to generate an absorbing power between the permanent magnet 12 and the electromagnet 14 and suddenly increase a braking force of the bearing mechanism, and thus the rotation of the ring rotary member is controlled in such a manner that the ring rotary member is stopped at the same time or before the spindle is stopped.

Where the ring rotary member 1 and the spindle 53 are controlled in accordance with the spinning program shown in Fig. 3, a generation of a snarl caused by a yarn winding having an opposite direction can be prevented, and it is possible to perform a suitable control of a spinning tension during a high speed spinning operation. Further, a centripetal force is generated by the use of tapered faces 11a to 14a having an angle inclined to an axis thereof, and thus a fluctuation of the axis of the ring rotary member 1 and a waving rotation in a horizontal plane thereof are not generated, whereby a stable rotation can be obtained.

No yarn breakages occur in a period between first winding the yarn and a period near to a full bobbin when the spinning operation is performed as described in the example, and thus it is possible to obtain a high speed spinning operation. Further, since it is possible to perform a stable spinning operation under a high speed in a period of around a half size ratio, by lowering a rotational speed of the ring rotary member and minimizing a variation of the spinning tension caused by a change of the speed in a chase, the productivity is increased by using less power for rotating the ring rotary member.

Although, the spinning program is set according to a size ratio based on a stretch length in the above-mentioned example, it is possible to set the spinning program on the basis of a time schedule which is previously known. A storing operation of the spinning program to a program storing means 58 may be performed by loading from a suitable external device, or may be input by a keyboard, a digital switch or the like. The other circuits can be adopted as a circuit of the controller H.

It is possible to use the two permanent magnets 11 and 12 used in the example, as one body. Further, the two permanent magnets 11 and 12 can be made as one body with the ring rotary member 1. An electromagnet 14 is used as a magnet arranged on a lower one of the magnets arranged on a holder 7, in the example, but the electromagnet 14 can be used for a magnet arranged on an upper one of the magnet, and further, both magnets in the holder can be electromagnets. The pole of the magnet arranged on opposite faces is N in the example, but an S-pole also can be used in this case, and it is possible to use magnets having different poles as an upper magnet and a lower magnet.

Fig. 5 is a partial axial crosssectional view of another example B of a rotary spinning ring assembly in accordance with the present invention. Members having the same function in the rotary spinning ring assembly shown in Fig. 5 as that of members used in the rotary spinning ring assembly shown in Fig. 2 are given the same reference numeral, and a description thereof is omitted.

In a ring rotary member 1 in this example, a flange rotor 2 and a lower rotor 3 are connected by a thread 2b and are fixed through a belleville spring 31b by a locknut 31 having a tool engaging groove. A notch 18a is provided in a lower end of the lower rotor 3 and a sensor 17 detects the notch 18a and generates a signal denoting a rotational number.

A holder 7 is attached with a yoke case 34, a plurality of equally spaced holes are arranged in a circumferential direction in the yoke case 34, and a wave guide 35 is accommodated in each hole. Electromagnets 32 and 33 having a crosssection of a circular shape or a fan-like shape, and on which a coil is wound, are accommodated in the wave guide. The lead lines extend from the electromagnet 32 and 33. The numeral 10 denotes a cover, 36 a bottom plate, 37, an end ring, 38 a stop ring, and 39 a spring used for fixing the ring.

It is possible to greatly increase an intensity of a magnetic force of the electromagnets 32 and 33 in the rotary spinning ring assembly B, whereby the operation of a bearing mechanism G is stabilized, and thus it is possible to effect a strong braking force by a control of an electric current supplied to the electromagnets 32 and 33.

A constitution wherein the permanent magnets 11, 12 and 13, and electromagnets 14, 32 and 33 include a tapered face, respectively, is used in the above examples, but it is possible to adopt a constitution not having the tapered face. For example, in a rotary spinning ring assembly C shown in Fig. 6, a permanent magnet 41 adhered to the ring rotary member 1 is formed as an annular plate having a rectangular crosssection, and permanent magnets 42 and 43, and an electromagnet 44 may be arranged in such a manner that a part of an upper side and a lower side, and a side between the upper side and the lower side, form a C letter type crosssection.

Fig. 7 shows a partial axial crosssection of another example D of the rotary spinning ring assembly in accordance with the present invention.

In this rotary spinning ring assembly D, a ring rotary member 1 is rotatably supported through a bearing 72 in a holder 7, a motor 71 comprised of a permanent magnet rotator 73 arranged on a substantially center portion in an axial direction in an outer circumferential portion of the ring rotary member 1, and an armature 74 arranged on a substantially center portion is an axial direction in an inner circumferential portion of the holder 7, so that the rotator 73 and the armature 74 are opposite to each other. This motor 71 directly drives the ring rotary member 1 and a rotational speed of the ring rotary member 1 can be changed by adjusting a frequency or an amperage of the electric current supplied to the motor 71. The numeral 18b denotes a detecting plate having a white portion and a black portion used for detecting a rotational speed thereof by a reflection type sensor 17, 76 is a rebound spring, 77 a spacer, and 78 a stop ring.

When using this rotary spinning ring assembly D, it is possible to control the assembly D by adjusting a frequency or an amperage of the electric current supplied to the motor 71 by the braking and controlling circuit 55, and coincide the rotational number Rr of the ring rotary member 1 with the target rotational number Rj.

It is possible to calculate a rotational number Nt of a traveller 21 by detecting a delivering speed ℓ of a yarn based on the rotational speed of the spindle and a thickness of a yarn layer on an bobbin. It is also possible to control the rotational number Rr of the ring rotary member 1 so that it does not exceed the rotational number of the traveller 21, on the basis of the above detected value. Note, since a difference between the rotational number Rs of the spindle and the rotational number Nt of the traveller is not large, a maximum value of the rotational number Rr of the ring rotary member may be roughly determined from the following equation.

$$Rs \times 0.9 \leqq Rr$$

Note, the above control operation is performed by a fuzzy control method.

As described in the above examples, a control of a rotation of a spindle based on an optimum spinning diagram depending on a yarn type or a yarn count of the yarn to be spun, a control of the ring rotary member performed by following the control of the rotation of the spindle to make a ratio between the rotational speed of the spindle and the rotational speed of the ring rotary member an optimum value, an attaining of a maximum rotation of the machine in a minimum time, and an attaining of a stop of the machine in a minimum time can be performed in accordance with the present invention, and accordingly, a preparation of a spinning program whereby a spinning operation is performed at a maximum rotational speed, a maximum value can be attained, and further, it is possible to prevent a synchronization of the rotations of the ring rotary member and the traveller and an overrun of the ring rotary member when stopping the ring rotary member.

The flange rotor 2 and the lower rotor 3 may be united as one body by pressing one member into another. A shape, a dimension, a structure, a material, a number of members used, and an arrangement of the members are optionally determined in accordance with the present invention.

CAPABILITY OF EXPLOITATION IN INDUSTRY

A control of a rotation of a spindle based on an optimum spinning diagram depending on a yarn type or a yarn count of the yarn to be spun, a control of the ring rotary member performed by the control of the rotation of the spindle to make a ratio between the rotational speed of the spindle and the rotational speed of the ring rotary member an optimum value, an attaining of an maximum rotation of the machine in a minimum time, and an attaining of a stop of the machine in a minimum time can be performed in accordance with the present invention, and accordingly, a preparation of spinning program making a spinning operation performed at a maximum rotational speed a maximum value can be attained, and further, it is possible to prevent a synchronization of the rotations of the ring rotary member and the traveller and an overrun of the ring rotary member when stopping the ring rotary member.

Accordingly, it is possible to prevent a generation of snarls caused by winding the yarn in an opposite direction, and to maintain a controlled operation of a spinning tension, and thus a spinning operation under a high speed and without yarn breakages can be attained and the productivity of a spinning machine can be remarkably improved when the method and the apparatus in accordance with the present invention are used in a spinning frame.

In particular, since a control of the rotational speed of the ring rotary member in the rotary spinning ring assembly can be applied to each spindle in the textile machine, using a method and an apparatus in accordance with the present invention, it is possible to obtain a stable operation of all of the spindle in the textile machine, and to obtain a yarn having a superior quality.

The method and the apparatus in accordance with the present invention can be applied not only to a spinning frame but also to all textile machines having a twisting mechanism using a ring and a spindle, such as a twisting machine, a draw twister, a twister manufacturing a cover yarn or the like.

LIST OF REFERENCE NUMBERS AND MARKS

1	Ring rotary member
2	Holder
14, 32, 33	Electromagnet (Rotational speed controlling means)
17	Sensor
54	Rotational speed detecting circuit (Ring speed detecting means)
55	Braking and driving circuit (Braking force controlling means)
56	Comparing means
57	Multiplying means
58	Program storing means (Suppressing ratio storing means)
59	Rotational number detector (Spindle speed detecting means)
60	Rotational number detecting circuit (Spindle speed detecting means)
71	Motor (Rotational speed control means)
72	Bearing (Bearing mechanism)
73	Permanent magnet
74	Armature
Rr	Rotational number (Rotational number of ring rotary member)
Rs	Rotational number (Rotational number of spindle)
Rj	Target rotational number
K	Suppressing ratio
G	Bearing mechanism (magnet bearing)
H	Controller

Claims

1. A method of controlling a rotary spinning ring assembly used in a textile machine including a ring rail and a spindle driving mechanism, such as a ring spinning frame, a ring twisting frame or the like and comprising an annular holder fixed in a horizontal posture on the ring rail, a ring rotary member supported coaxially and rotatably through a bearing mechanism by the holder, a spindle arranged coaxially in an inside space of the ring rotary member and driven by the spindle driving mechanism and a rotation speed control means of controlling a rotational speed of the ring rotary member: characterized in that the rotational speed of the ring rotary member and a rotational speed of a spindle are detected, respectively, the two detected values of the rotational speeds are compared, and the rotational speed of the ring rotary member is controlled by a rotational speed control means in such a manner that the rotational speed of the ring rotary member is kept within a range of a predetermined optimum ratio of th e rotational speed of the ring rotary member to the rotational speed of the spindle.

2. A method according to claim 1, characterized in that a control program for controlling the rotational speed of the spindle for the entire period from a starting of a yarn package to a completion thereof to a predetermined rotational speed, and another control program for controlling a rotational speed of the ring rotary member to a rotational speed determined to be a predetermined optimum ratio in connection with the control program for controlling the rotational speed of the spindle, are provided, and the control of the rotational speed of the ring rotary member by an optimum ratio control means is performed in such a manner that a difference between the detected rotational speed of the ring rotary member and a target rotational speed of the ring rotary member set in the control program is reduced.

3. A method according to claim 2, characterized in that the program control of the rotational speed of the ring rotary member is performed such that the ring rotary member is rotated at a lower rotational speed than that of a traveller and the rotation of the ring rotary member is proportionally controlled according to a ring rotary member speed-elevation curve having a speed-elevation ratio which is at least not bigger than that of a spindle speed-elevation curve in a speed-elevation period from a starting time to a time at which the rotational speed of the ring rotary member reaches a maximum rotational speed, the rotational speed of the ring rotary member is reduced and is kept in a region between 40% and 60% of the rotational speed of the spindle for a period in which a half yarn package is suitably spun, the rotational speed of the ring rotary member is increased before the rotational speed of the spindle is reduced from the maximum rotational speed thereof for a period before the yarn package becomes a f ull bobbin the rotational speed of the ring rotary member is reduced at a reduction ratio which is at least not lower than that of the rotational speed of the spindle for a period in which the yarn package becomes a full bobbin, and then the rotational speed of the spindle is reduced, and the ring rotary member is stopped at the same time as or before the spindle is stopped.

4. A method according to claim 3, characterized in that a starting control of the rotation of the spindle is performed in such a manner that a start of the rotation of the ring rotary member is performed at the same time or later than start of the rotation of the spindle.

5. A method according to claim 1, characterized in that a magnetic bearing is used as the bearing mechanism, the magnetic bearing is constituted by annular magnets coaxially arranged, respectively, on axially and radially opposite faces of the ring rotary member and the holder, with a minute gap therebetween in such a manner that a pole of the annular magnet of the ring rotary member is opposite to a pole of the annular magnet of the holder having the same magnetic properties as that of the annular magnet of the ring rotary member, and the each opposite face of the annular magnet has a profile which ensures that both opposite faces are in contact with each other at least at a portion thereof, when the ring rotary member moves in the axial direction thereof toward the holder, at least a magnet in a plurality of magnets arranged in the annular magnet of the holder is an electric magnet, and a control of the rotational speed of the ring rotary member by the rotational speed controlling means can be performed by controlling an intensity of a magnetic field of the electromagnet and adjusting a gap between the ring rotary member and the holder in the magnetic bearing to control a torque obtained by rotating t he ring rotary member.

6. A method according to claim 5, characterized in that the control of the intensity of the magnetic field is performed by changing an intensity of an electric current supplied to the electromagnet.

7. A method according to claim 5, characterized in that the control of the intensity of the magnetic field is performed by changing a direction of an electric current supplied to the electromagnet.

8. A method according to claim 5, characterized in that the control of the intensity of the magnetic field is performed by changing an intensity and a direction of an electric current supplied to the electromagnet.

9. A method according to claim 1, characterized in that an annular permanent magnet is arranged in a region of the bearing mechanism on the ring rotary member and an armature is arranged on the holder, to form a ring motor, and the control of the rotational speed of the ring rotary member by the rotational speed control means is performed by controlling an electric current supplied to the armature.

10. A method according to claim 9, characterized in that the control of the electric current is performed by changing a frequency thereof.

11. A method according to claim 9, characterized in that the control of the electric current is performed by changing an amperage of the electric current.

12. A method according to claim 9, characterized in that the control of the electric current is performed by changing a voltage of the electric current.

13. A method according to claim 9, characterized in that the control of the electric current is performed by changing a vector of the electric current.

14. An apparatus for controlling a rotary spinning ring assembly of a textile machine such as a ring spinning frame, a ring twisting machine or the like having a ring rail, a spindle driving mechanism and a plurality of the rotary spinning ring assemblies comprising, respectively, an annular holder fixed in a horizontal posture to the ring rail, a ring rotary member supported coaxially and rotatably through a bearing mechanism to the holder, a spindle arranged coaxially in an inner space of the ring rotary member and driven by the spindle driving mechanism, and a rotational speed control means for controlling a rotational speed of the ring rotary member, characterized in that a magnetic bearing is used as the bearing mechanism, the magnetic bearing is composed of annular magnets coaxially arranged, respectively, on axially and radially opposite faces of the ring rotary member and the holder, with a minute gap therebetween, in such a manner that a pole of the annular magnet of the ring rotary member is opposite to a pole of the annular magnet of the holder and having the same magnetic properties as that of the annular magnet of the ring rotary member, and each opposite face of the annular magnet has a profile such that both opposite faces are in contact with each other at at least a portion thereof, when the ring rotary member moves in

the axial direction thereof toward the holder, at least a magnet in a plurality of magnets arranged in the annular magnet of the holder is an electric magnet, and the rotary spinning ring assembly control apparatus is comprised of a ring rotational speed detecting means for detecting a rotational speed of the ring rotary member, a spindle rotational speed detecting means for detecting a rotational speed of the spindle, a suppressing ratio storing means for storing a suppressing ratio, i.e., a target rotational speed ratio of the ring rotary member to the spindle, a multiplying means for multiplying the suppressing ratio on the rotational speed detected by the spindle rotational speed detecting means, a comparing means for comparing multiplied data obtaine d by the multiplying means with the rotational speed detected by the ring rotational speed detecting means, and an electric current control means for controlling an electric current supplied to the electromagnet arranged on the holder, and of the bearing mechanism, on the basis of a result obtained by the comparative means, in such a manner that the rotational speed of the ring rotary member reaches the target rotational speed thereof, and the spindle rotational speed detecting means, the suppressing ratio storing means, and the multiplying means as elements constituting the rotary spinning ring assembly control apparatus are arranged on each textile machine, respectively, and the other elements are arranged at each of the plurality of ring rotary members, respectively.

15. An apparatus according to claim 14, characterized in that a storing means of storing a control program for controlling the rotational speed of the spindle to a predetermined rotational speed in the entire period from a starting of a winding a yarn package to a completion thereof is provided in the rotary spinning ring assembly control apparatus and the spindle is rotated on the basis of the control program in the storing means.

16. An apparatus of controlling a rotary spinning ring assembly of an textile machine such as a ring spinning frame, a ring twisting machine or the like having a ring rail, a spindle driving mechanism and a plurality of the rotary spinning ring assemblies comprising, respectively, an annular holder fixed in a horizontal posture to the ring rail, a ring rotary member supported coaxially and rotatably through a bearing mechanism to the holder, a spindle arranged coaxially in an inner space of the ring rotary member and driven by the spindle driving mechanism, and a rotational speed control means for controlling a rotational speed of the ring rotary member, characterized in that an annular permanent magnet is arranged in a region of the bearing mechanism on the ring rotary member and an armature is arranged on the holder to form a ring motor, and the rotary spinning ring assembly control apparatus is comprised of a ring rotational speed detecting means for detecting a rotational speed of the ring rotary member, a spindle rotational speed detecting means for detecting a rotational speed of the spindle, a suppressing ratio storing means for storing a suppressing ratio, i.e., a target rotational speed ratio of the ring rotary member to the spindle, a multiplying means for multiplying the suppressing ratio on the rotational speed detected by the spindle rotational speed detecting means, a comparing means for comparing a multiplied data obtained by the multiplying means with the rotational speed detected by the ring rotational speed detecting means, and an electric current control means for controlling an electric current supplied to the armature arranged on the holder, and of the bearing mechanism, on the basis of a result obtained by the comparative means, in such a manner that the rotational speed of the ring rotary member reaches the target rotational speed thereof, and the spindle rotational speed detecting means, the suppressing ratio storing means, and the multiplying means as elements constituting the rotary spinning ring assembly control apparatus are arranged on each textile machine, respectively, and the other elements are arranged at each of the plurality of the ring rotary members, respectively.

17. An apparatus according to claim 16, characterized in that a storing means for storing a control program for controlling the rotational speed of the spindle to a predetermined rotational speed in the entire period from a starting of a winding a yarn package to a completion thereof is provided in the rotary spinning ring assembly control apparatus and the spindle is rotated on the basis of the control program in the storing means.

Fig. 1

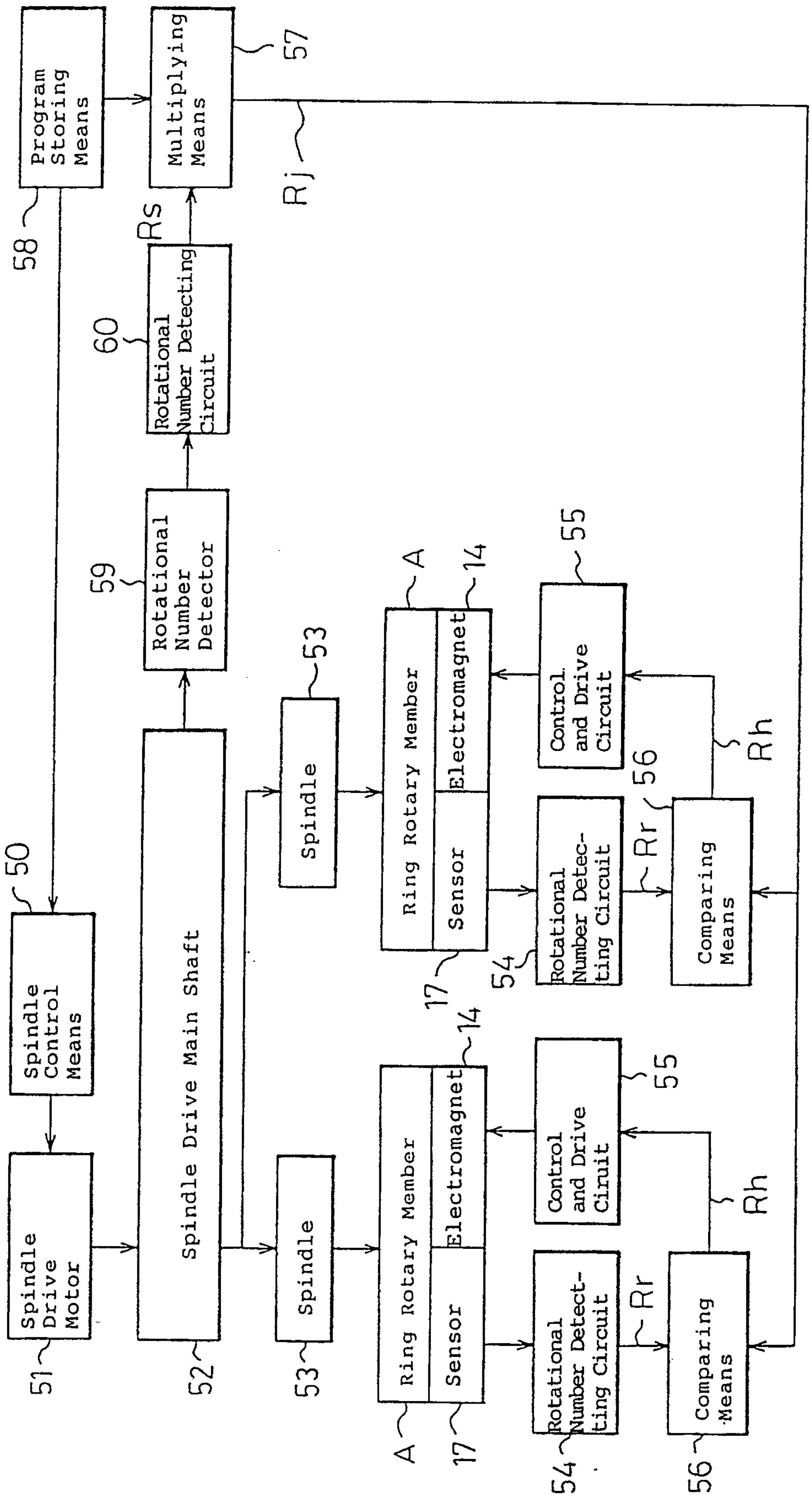

Spindle Drive Motor
Spindle Control Means
Program Storing Means
Multiplying Means
Rotational Number Detecting Circuit
Rotational Number Detector
Spindle Drive Main Shaft
Spindle
Spindle
Ring Rotary Member
Sensor
Electromagnet
Ring Rotary Member
Sensor
Electromagnet
Control and Drive Circuit
Control and Drive Ciruit
Rotational Number Detec-ting Circuit
Rotational Number Detect-ting Circuit
Comparing Means
Comparing Means
Rs
Rj
Rh
Rh
Rr
Rr
A
A
14
14
17
17
50
51
52
53
53
54
54
55
55
56
56
57
58
59
60

Fig. 2

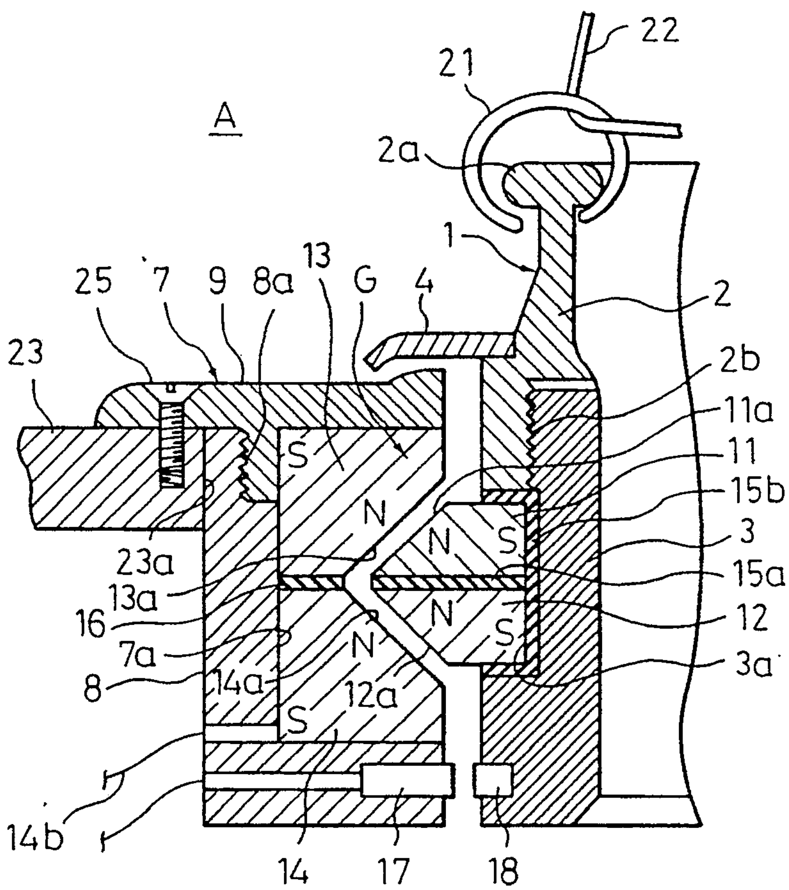

A
21
22
2a
1
2
25
7
9
8a
13
G
4
23
2b
11a
11
15b
3
15a
12
3a
S
N
23a
13a
16
7a
8
14a
12a
14b
14
17
18

Fig. 3

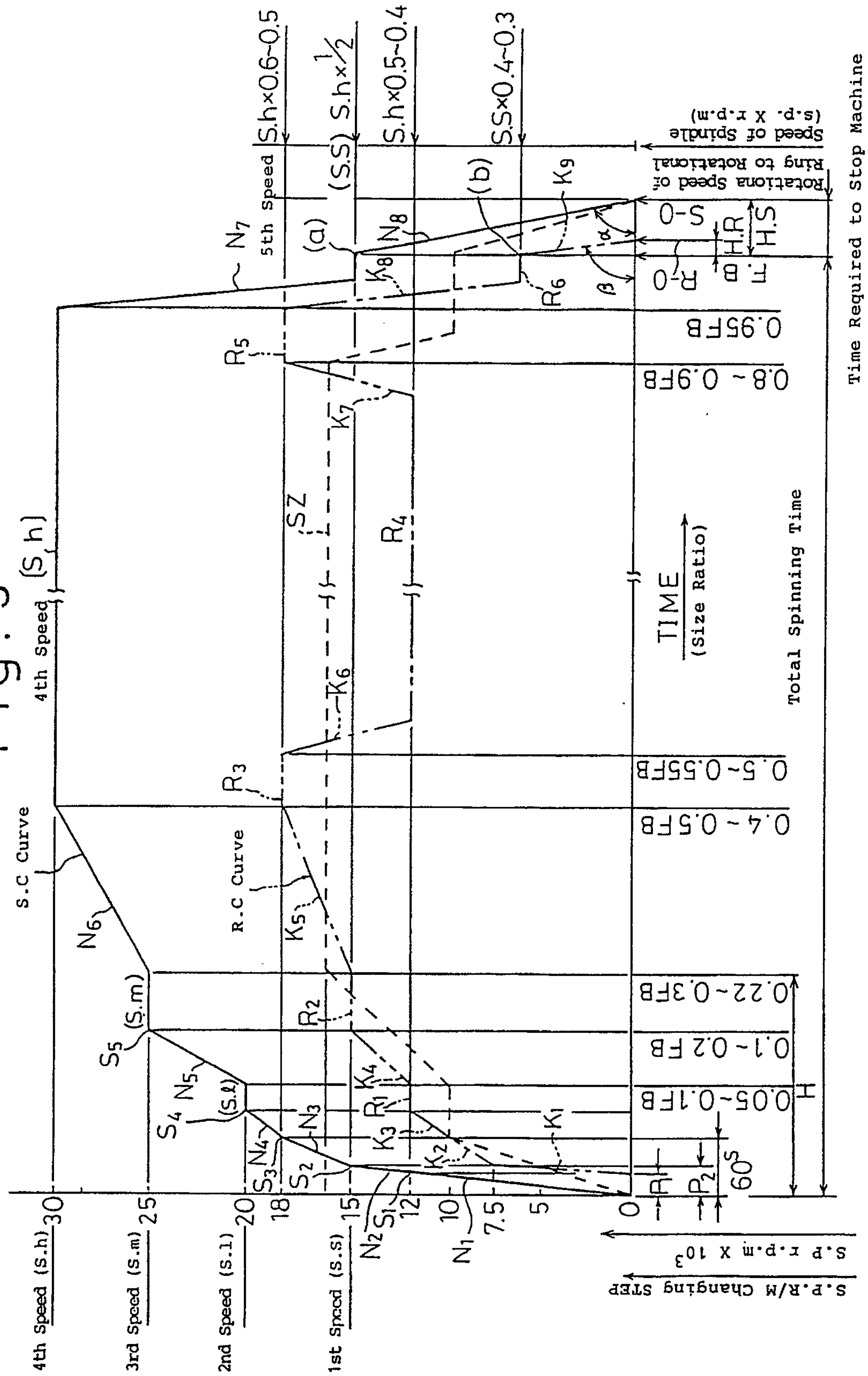

S.C Curve
R.C Curve
4th Speed
5th Speed
TIME
(Size Ratio)
Total Spinning Time
Time Required to Stop Machine
Rotationa Speed of Ring to Rotational Speed of Spindle (s.p. x r.p.m)
S.P r.p.m X 10³
S.P.R/M Changing STEP
4th Speed (S.h)
3rd Speed (S.m)
2nd Speed (S.l)
1st Speed (S.S)

Fig. 4

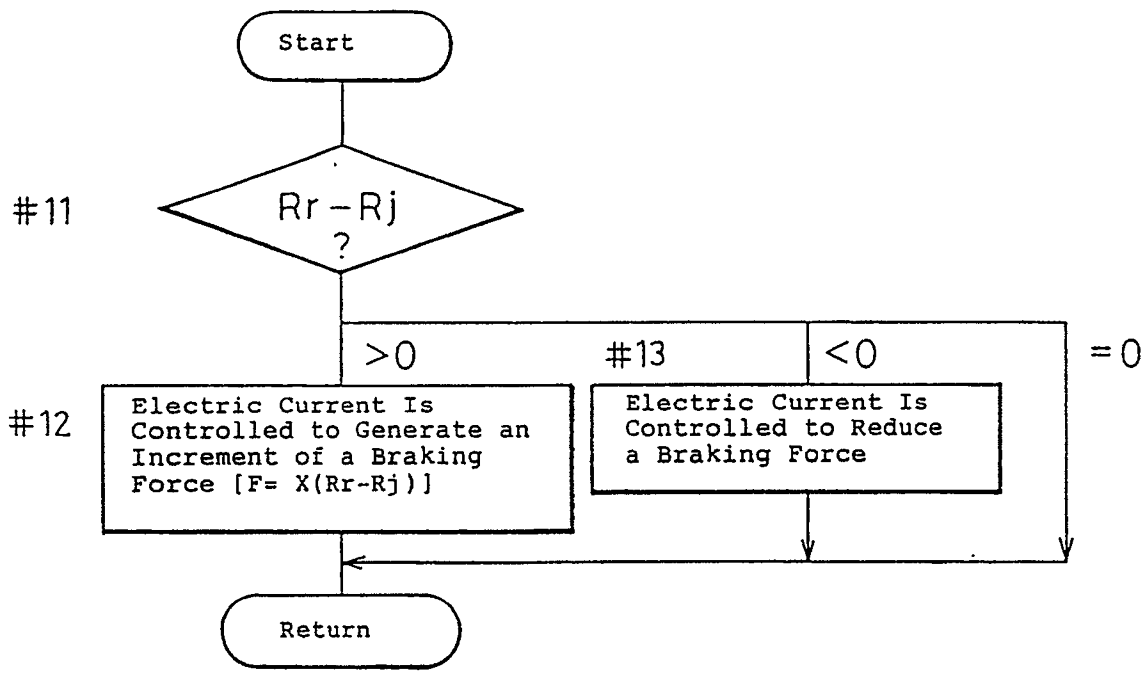

Start
#11
Rr − Rj
?
>0
#13
<0
=0
#12
Electric Current Is Controlled to Generate an Increment of a Braking Force [F= X(Rr-Rj)]
Electric Current Is Controlled to Reduce a Braking Force
Return

Fig. 5

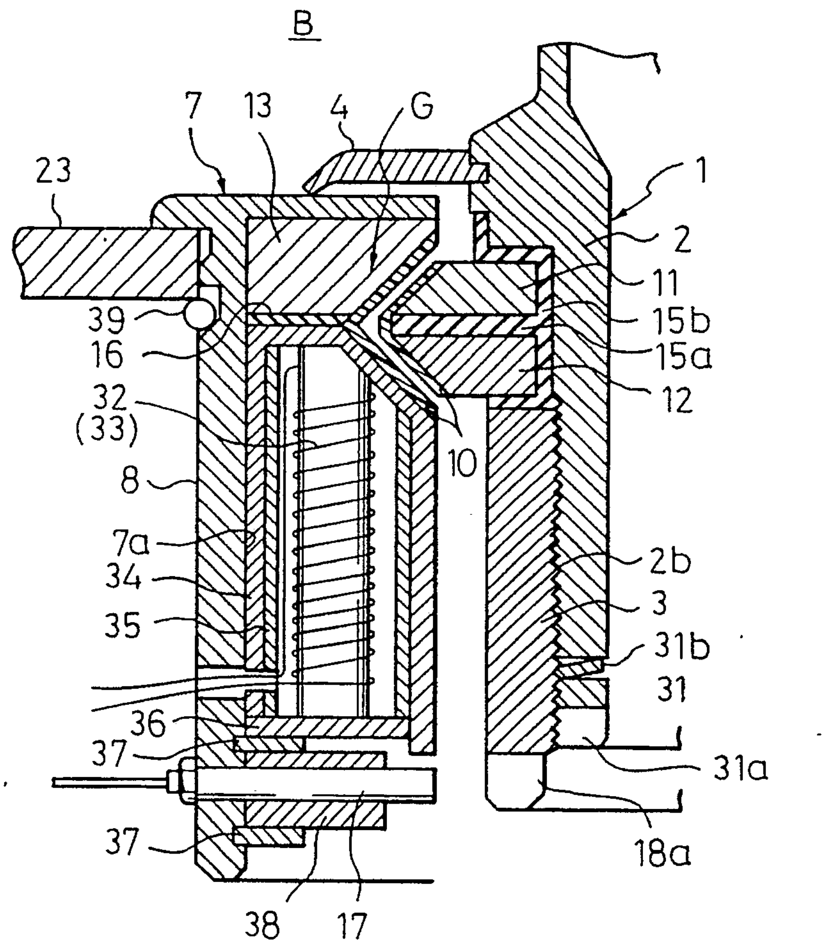

B
7
13
4
G
23
1
2
11
39
15b
16
15a
12
32
(33)
10
8
7a
2b
34
3
35
31b
31
36
37
31a
37
18a
38
17

Fig. 6

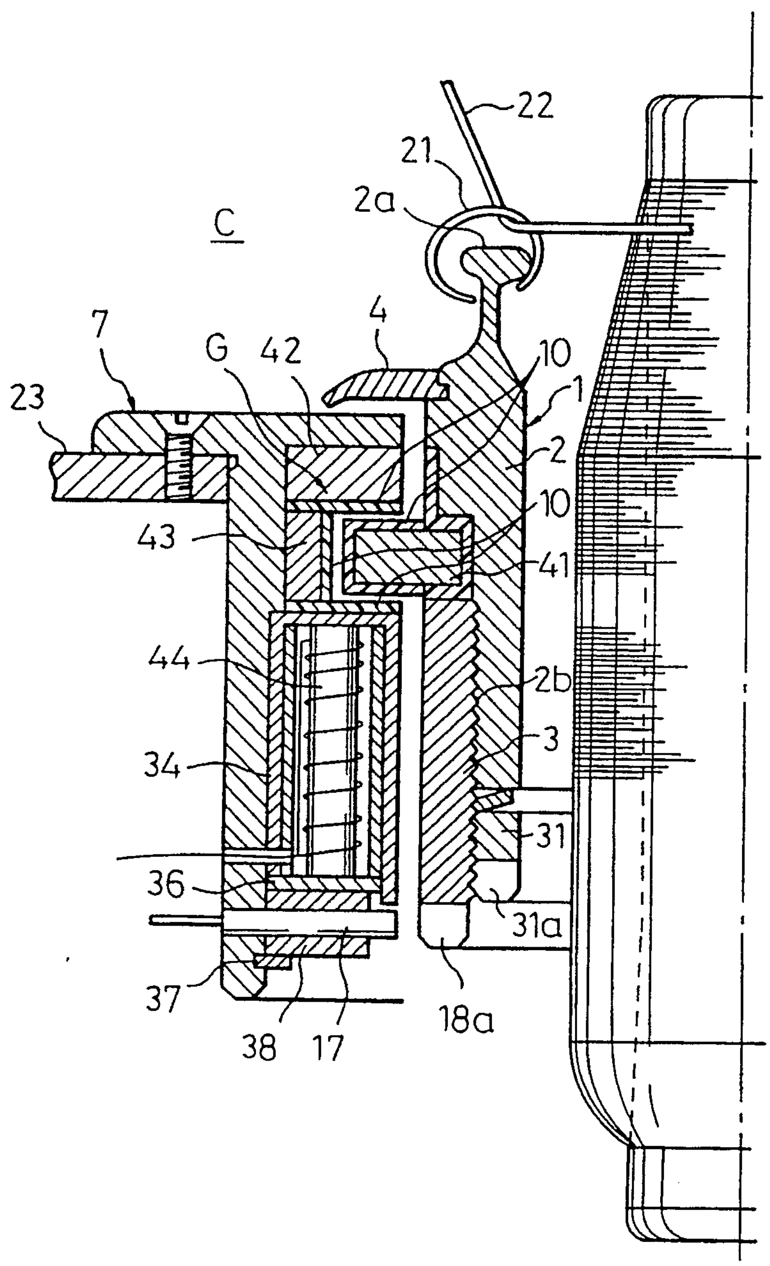
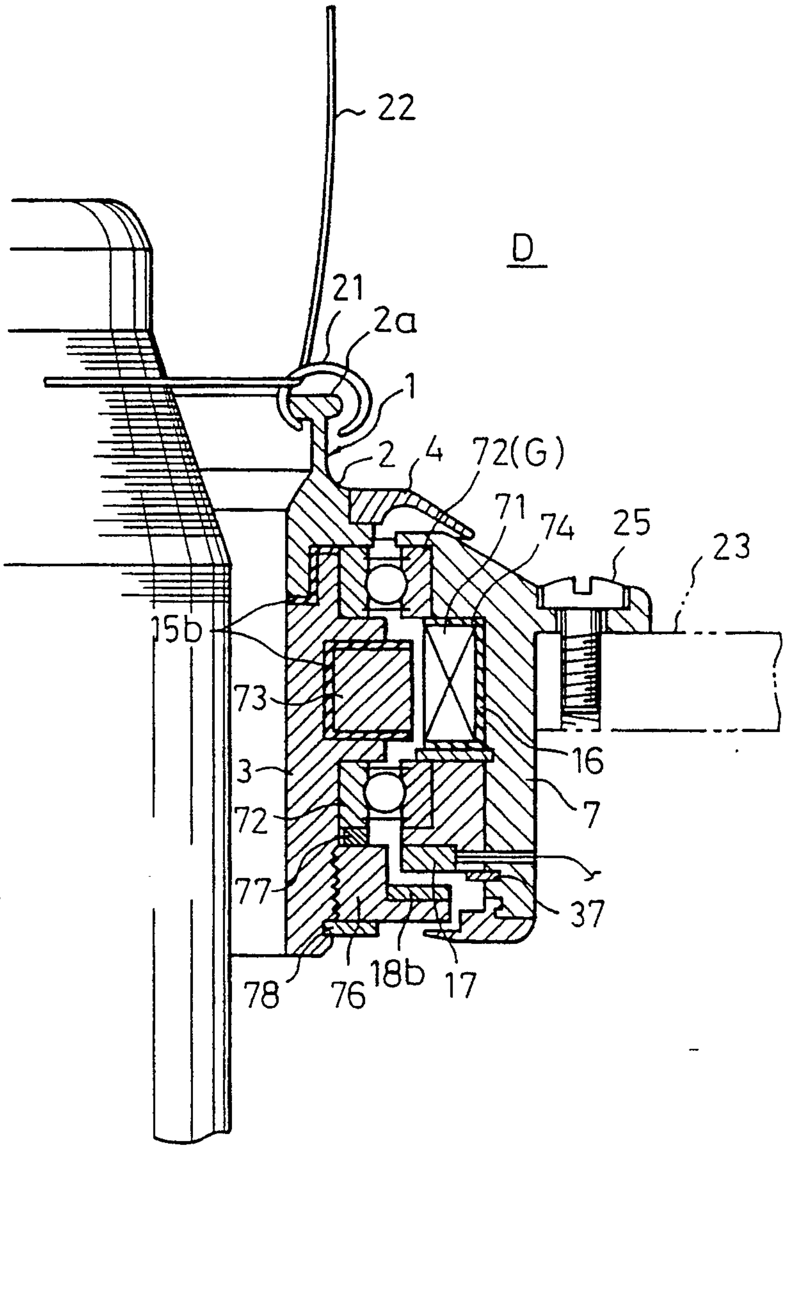


Fig. 7



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/00998

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl^5 D01H7/56

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	D01H7/56, 7/58

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1926 - 1990
Kokai Jitsuyo Shinan Koho	1971 - 1990

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	JP, A, 1-168923 (Zaidanhojin Nippon Mengyo Gijutsu Keizai Kenkyusho), 4 July 1989 (04. 07. 89), (Family: none)	1 - 17
A	JP, A, 61-152835 (Hiroyuki Kanai), 11 July 1986 (11. 07. 86), (Family: none)	1 - 17

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
September 5, 1990 (05. 09. 90)	September 17, 1990 (17. 09. 90)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	