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(54) Spindle actuating controller for spinning machine.

(57) A spindle actuating controller is provided for a spinning machine having a variable speed motor for actuating spindles in order to wind thread around bobbins carried by the spindles. The controller calculates desired speed gradients on the basis of desired spindle rotating speed at various stages in the winding process. The spindle rotating speed is then increased or reduced gradually and not abruptly. Accordingly, the traveler can always run on the ring flange smoothly in a stable posture even when the spindle is rotated at a maximum level of 20000 to 25000 rpm.

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SPINDLE ACTUATING CONTROLLER FOR SPINNING MACHINE

FIELD OF THE INVENTION

The present invention relates to a spindle actuating controller for a spinning machine such as a ring spinning machine and a ring thread-plying machine.

RELATED BACKGROUND ART

A conventional spinning machine of this type has a ring rail which moves vertically when treated is wound around a bobbin. The winding of thread around a bobbin is carried out by a traveler (thread guiding member) which moves on a ring flange of the ring provided on the ring rail. Accordingly, in order to prevent breakage and degradation of thread quality, it is necessary for the traveler to slide on the ring flange stably and smoothly. Moreover, it is also necessary to replace the traveler after a predetermined period of use (typically every 2 or 3 weeks) because it wears due to friction with the ring flange.

Generally, when a spinning machine is operated, the spindle rotating speed is increased gradually in a step-by-step manner rather than as a single step. One conventional method of changing the spindle rotating speed in a step by step manner is to drive the spindle actuating motor through an invertor whose frequency can be arranged. According to this method, the spindle rotating speed or the frequency of the invertor is set by a speed setting apparatus equipped with a variable resistor. Then, the rotating speed is adapted to be increased or reduced to the level preset by the speed setting apparatus when the time elapsed from the start of this machine or the production amount counted by a counter reaches a predetermined value. Incidentally, in another known method the spindle rotating speed is changed every 10 % of the production amount when the bobbins are fully wound with thread (Japanese Unexamined Patent Publication No. 53-41529).

There is no problem in the conventional methods so long as the spinning machine is operated under the condition where the spindle is rotated at a maximum speed of 12000 to 16000 rpm. However, if the spindle is rotated at a maximum level of, for example, 20000 to 25000 rpm, the traveler cannot be driven in a stable state. As the result, thread breakage and damage of the traveler or ring flange are likely to be caused. Namely, in such a conventional method, the spindle rotating speed is increased to or reduced from the maximum level through 2 to 3 steps. Accordingly, a fixed speed gradient is used when the rotating speed of a certain level is increased to a next step, and such speed change occurs abruptly, so that the tension of thread is suddenly changed with the change of the rotating speed and the posture of the traveler becomes unstable causing the problems as described above.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a spindle actuating controller for a spinning machine, in which the operational condition can be changed corresponding to changes in the spinning condition to allow the traveler to always run smoothly on the ring flange in a stable posture, whereby breakage of thread and damage of the traveler can be prevented even when the spindle is rotated at a maximum level of 20000 to 25000 rpm.

To achieve the object, the present invention a spindle actuating controller is provided for a spinning machine having a variable speed motor for actuating at least one spindle in order to wind thread around a bobbin carried by the spindle. The controller includes a storage device for storing a desired production amount value indicative of the amount of thread to be wound about the bobbin. It also stores values indicative of the desired spindle rotating speeds at a plurality of speed change start points and speed change end points at various points during the winding process. A setting mechanism inputs the desired production amount value and the desired spindle rotating speeds values to the storage device. A computing device then calculates speed gradients between each adjacent pair of speed change points on the basis of information inputted by the setting mechanism and outputs speed command signals to drive the variable speed motor at the calculated speed gradients.

In a preferred arrangement, the production amount is set based on the unit value of 10 % of that when the bobbins are fully wound with thread, or directly on the length of thread or the time elapsed. The controller calculates the speed gradients between every adjacent two speed change points on the basis of the set values, and outputs speed command signals successively to the actuating controller so as to realize the calculated speed gradients. Then, speed variable control of the speed variable motor for actuating the spindles is achieved by the actuating controller. Thus, unlike in the prior art, the spindle rotating speed is increased or reduced gradually and not abruptly. Accordingly, the traveler can always run on the ring flange smoothly in a stable posture without suffering sudden change in the posture, and the thread breakage and damage of the traveler can be prevented even when the spindle is rotated at a maximum level of 20000 to 25000 rpm. Moreover, since the spindle rotation speed and the production amount at each speed change point can arbitrarily be set by the setting means, and each speed gradient between the adjacent two speed change points can be automatically set based on the set values, it is possible to set the optimum operational conditions well adapted to the spinning condition.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of the present controller;

Fig. 2 is an explanatory diagram showing change of the spindle rotating speed;

Fig. 3(a) through 3(e) are diagrams showing standard patterns of the spindle speed change in a second embodiment, respectively; and

Fig. 4 is a diagram showing an example of change with time of the spindle rotating speed in the operative mode for smoothing the spinning after replacement of travelers in the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A first embodiment of the present invention will be described below with reference to the drawings.

As shown in Fig. 1, a plurality of spindles 1 are set on both sides of a spinning machine with at predetermined intervals. A variable speed spindle actuating motor 2 is used to drive the spindles. Specially, a belt 5 extends between and around guide pulleys 3 and a drive pulley 4 provided on the spindle actuating motor 2, so that the spindles 1 may be rotated by the spindle actuating motor 2 through the belt 5. The spindle actuating motor 2 is connected to a controller 6 through an invertor 7, so that variable speed control of the motor 2 may be achieved based on the output signals generated from the controller 6 through the invertor 7.

The controller 6 includes a central processing unit (CPU) 8 and a program memory 9 comprising a read only memory (ROM) which stores control programs. Moreover, the controller 6 has a memory (RAM) 10 as a storage device which can read and rewrite for temporarily storing the operational results from the CPU 8, and the production amounts and the spindle rotating speeds at a plurality of speed change start points and speed change end points provided within an interval from the start of the spindle to the state where the spindle is rotated at the maximum level and the interval from the state where the spindle is rotated at the maximum level of the stoppage of the spinning machine. The CPU 8 is operated on the basis of the program data stored in the program memory 9. An input device 11 comprising, for example, a keyboard is provided as a setting means in the controller 6. By the input device 11, the operation condition based on the data such as the production amounts and the spindle rotating speeds at the respective speed change points is set. Furthermore, the CPU 8 is so constructed that output signals from a rotation detector 12 for detecting the rotation speed of a front roller of a draft part (not shown) for drawing a roving are inputted to the CPU 8 through an input-output interface 13.

The CPU 8 calculates each gradient between adjacent two points on the basis of the set values of the production amount and the spindle rotating speed at the respective speed change points inputted from the input device 11 through the input-output interface 13. Then, the CPU 8 outputs a predetermined command signal to the invertor 7 through the input-output interface 13 and a digital-analog converter (D/A converter) 14. In response to the command signal, the invertor 7 outputs a frequency signal corresponding to the calculated gradient to the spindle actuating motor 2.

Next, the operation of the apparatus constructed as described above will be explained with reference to Fig. 2. First, an operator sets data concerning the spindle rotating speed Ni and the production amount Bi at the respective speed change points Pi (i is a natural number) using the input device 11 on the basis of the unit of 10 % of the production amount when the bobbins are fully wound so that the spindle rotating speed may change as desired relative to the production amount correspondingly to the spinning condition.

Incidentally, both the spindle rotating speeds N4, N5 at the speed change points P4, P5 are set at the same maximum value. The CPU 8 calculates each gradient ($\Delta N/\Delta B$) between the adjacent two speed change points Pi, P(i+1) on the basis of the set values in accordance with the following equation.

$$\Delta N/\Delta B = \{N(i+1)-Ni\} / \{B(i+1)-Bi\}$$

To describe specifically taking the adjacent two change points P3 (20000 rpm, at the production amount of 40 %) and P4 (25000 rpm, at the production amount of 60 %), the $\Delta N/\Delta B$ becomes as follows.

$$\Delta N/\Delta B = \{N(i+1)-Ni\} / \{B(i+1)-Bi)$$
$$= (25000-2000) / (6-4)$$
$$= 5000/2$$
$$= 2500(\text{rpm}/10\ \%\ \text{of full bobbin})$$

Namely, in this case, the gradient obtained is 2500 (rpm/10 % of full bobbin). When the length of thread is 2200 m at the time of full bobbin, 10 % of the production amount thereof can be expressed by the thread length of 220 m. Thus, the spindle rotating speed per meter becomes 2500/220 (rpm/m).

On the other hand, when a 10-bit unit is used as the D/A converter 14, the minimum spindle speed variable rotating speed decided by the D/A converter 14 becomes as follows. (In this case, 1001 to 1024 are not used).

25000 rpm/1000 steps = 25 (rpm/step)

Next, the length of thread spun during one step is obtained as follows.

Length = 220/(2500/25)

= 220/100

= 2.2 (m/step)

Then, the data are stored in the working memory 10.

Likewise, all the gradients between the every two adjacent speed change points Pi, P(i + 1) and the lengths of thread spun in the respective steps are calculated, and the data obtained are stored in the working memory 10. When the spinning machine is started, the CPU 8 calculates the production amount (the length of thread) on the basis of the output signals generated from the rotation detector 12. Then, the CPU 8 successively outputs the speed command signal for each step (25 rpm) in response to each of the speed change data between the respective speed change points stored in the memory 10, that is, the length of thread spun in each step to the D/A converter 14. The D/A converter 14 converts the digital signal into a current signal and outputs it to the invertor 7. The invertor 7 drives the spindle actuating motor 2 at a rotating speed corresponding to the current signal inputted thereto. Namely, the rotating speed of the spindle actuating motor 2 is not changed greatly at a time, but controlled so as to change in finely divided steps. However, by the effect of the force of inertia or the like, the rotating speed shows almost linear change. Accordingly, between the speed change point P3 and the speed change point P4, the CPU 8 outputs a speed command signal for one step (25 rpm) every 2.2 m of thread length till the spindle rotating speed is gradually increased from 20000 rpm to 25000 rpm.

Accordingly, when the rotating speed of the spindle of the controller in the present invention is changed, it is gradually changed unlike in the conventional apparatus in which the rotating speed is rapidly changed. Thus, the traveler can always run smoothly on the ring flange in a stable posture, preventing thread breakage and the damage of the traveler or ring. Moreover, the speed change gradient can be automatically set merely by inputting the spindle rotating speeds or the production amounts at the respective speed change points. This is done using the input device 11. Therefore, the optimum speed variable operation condition can easily be set when the spinning condition is changed. Particularly when the production amount is set on the basis of the unit of 10 % of the production amount of full bobbin as in the above embodiment, the operation condition can easily be grasped by the operator, so that the speed change condition intended by the operator can easily be realized.

If the invertor 7 is capable of receiving digital inputs, the D/A converter 14 can be omitted to allow the output signal of the controller 6 to be inputted directly to the invertor 7. If a section where the spindle rotating speed is set at the same value between every adjacent two speed change points is provided at the time of setting the condition of increasing or reducing the speed, it is possible to set a speed change condition similar to conventional ones. Moreover, when the values of the production amount at the respective speed change points are set, it is possible to directly set the length of thread or the process time instead of setting the production amount on the basis of the unit of 10 % of the production amount of full bobbin.

[Second Embodiment]

Next, a second embodiment will be explained with reference to Figs. 3 and 4.

According to this embodiment, it is possible to automatically shift the operative mode to an ordinary high-speed operative mode after the smoothing operation in the optimum speed change pattern corresponding to the spinning condition after the installation of the spinning potion of the spinning machine, and replacement of travelers or rings.

The constitution of the spindle actuating apparatus is basically the same as that of the first embodiment, but a mechanism for automatically shifting the smoothing operative mode to the ordinary high-speed operative mode is added anew. To the controller 6, a doffing completion signal is inputted from a spinning completion detector (not shown) provided at the spinning machine.

Moreover, in the program memory 9, a plurality of standard patterns (five patterns in this embodiment) of the speed change of the spindle actuating motor 2 from the start to stop of the spinning machine are stored. As shown in Fig. 3, the speed change standard patterns include a speed change standard pattern M0 for the highest speed operative mode, and speed change standard patterns

M1 to M4 mainly used in the smoothing operative mode. The speed change pattern M0 for the highest speed operative mode includes six speed change points P0 to P5 till the rotating speed reaches the highest level of n4. On the other hand, the speed change pattern M4 includes five speed change points P0 to P4 till the rotating speed reaches at the highest level of n3, so as to almost corespond to the speed change of the pattern M0 for the highest speed operative mode. Moreover, the three speed change patterns M1 to M3 are so set that the spindle rotating speed may be changed step by step with time. In this case, values of the spindle rotating speed (ni) in the respective step are so set that it may correspond to the values of the speed at the respective speed change points in the speed change pattern M4. Furthermore, the values of the rotating speed at the respective speed change points and in the respective steps are set at the values already inputted by the input device 11.

The speed change patterns M0 to M4 after the setting of values of the rotating speed or speed data at the respective speed change points and in the respective steps are adapted to be stored in the memory 10. Then, the CPU 8 calculates the gradients between every adjacent two speed change points and the length of thread spun while the speed is increased in one step on the basis of values of the rotating speed at the respective speed change points in the speed change patterns M0 to M4, and the data calculated are stored in the memory 10. Accordingly, the values of the rotating speed at the respective speed change points and in the respective steps in the speed change patterns M0 to M4 can be set independently of other speed change patterns.

On the other hand, the input device 11 is so constructed that it can select a necessary speed-change pattern from the speed change patterns M0 to M4 and set the number of repetition times of the speed change patterns and the output order thereof. Moreover, the speed change patterns selected, the number of repetition times and the output order set by the input device 11 are stored in the memory 10. The controller 6 is adapted to output control signals for controlling the spindle actuating motor 2 to the invertor 7 on the basis of the program data of the program memory 9 and the speed data in the speed change patterns stored in the memory 10.

Next, the operation of the second embodiment so constructed as described above will be explained. The setting operation of the operation condition changes depending on whether the smoothing operation is performed or not. In the ordinary spinning operation without the smoothing operation, the setting of the operation condition is completed by selecting one of the standard speed change patterns M0 to M4, and setting the speed data at the respective speed change points and in the respective steps of the selected speed change pattern in the input device 11. Then, when the operation of the spinning machine is started, the machine is repeatedly operated by the command from the controller 6 so that the speed change may be realized according to the selected speed change pattern.

On the other hand, when the smoothing operation is required, the speed change pattern M0 for the highest speed operative mode and a speed change pattern whose speed is lower than that of the pattern M0 on the smoothing operation are selected by the input device 11. Then the speed data on the respective speed change patterns are set. For example, when the low-speed speed change patterns M1 to M4 for the low speed operation are all selected for carving out smoothing operation after replacement of the travelers, the speed data at the respective speed change points and in the respective steps are set with respect to all the speed change patterns M0 to M4. In this case, the speed data at the respective speed change points of the speed change pattern M0 for the highest speed operation are first set by the input device 11. Thereafter, the speed data at the respective speed change points and in the respective steps of the speed change patterns M1 to M4 for the low speed operation are set at the levels corresponding to the speed data of the respective speed change points in the speed change pattern M0 for the highest speed operation. Then, the speed change patterns M0 to M4 after the setting of the speed data are stored in the memory 10, and the numbers of repetition times of the speed change patterns M0 to M4 after the setting of the speed data are set. For example, in case of setting the numbers of repetition times of the respective speed change patterns M1 to M4 are set at 9, 5, 2 and 1, respectively, these data are stored in the working memory 10, and thus the setting of the operation condition is completed.

Thereafter, when the operation of the spinning machine is started after replacement of the travelers, the controller 6 successively outputs the speed data to the invertor 7 in accordance with the operation condition stored in the working memory 10. Then, the inventor 7 controls the spindle actuating motor 2 in accordance with the speed data. The controller 6 counts the input signals from the doffing completion detector and performs shifting of the speed change pattern whenever the count value reaches a predetermined value. As shown in Fig. 4, the smoothing spinning operation is carried out at each selected speed change pattern (M1 to M4) the number of times inputted by the input device 11. Thereafter, the spinning machine at the highest speed pattern M0.

When the highest operational rotating speed of the spindles 1 is at an ultra-high level of over 18000 rpm, and when it is desired to perform the smoothing operative mode using a multiplicity of steps, the number of the repetition times of the speed change patterns can easily be set in different states by the key operation of the input device 11. After, the smoothing operation is completed using the optimum smoothing pattern, the ordinary high-speed spinning operation is automatically started.

Generally, the period of smoothing spinning operation is about 24 hours under the condition where the highest rotating speed of the spindles 1 is 12000 to 16000 rpm. However, when the highest rotating speed of the spindles 1 becomes as high as 20000 to 25000 rpm, the period of smoothing spinning operation after replacement of the travelers requires about 2 to 3 days to make the running posture of the traveler stable. Moreover, when the highest rotating speed of the spindles 1 is 20000 to 25000 rpm, the amount of thread to be wound around the bobbins is reduced to 70 to 80 % of that when the highest rotating speed of the spindles 1 is 10000 to 12000 rpm. Therefore, doffing of full bobbins is required many times during the period of smoothing spinning operation. Furthermore, when the highest rotating speed of the spindles 1 is about 14000 to 15000 rpm, it is not necessary to increase stepwise the speed to the maximum level at the time of the low-speed smoothing operation, before the ordinary high-speed operation is started. However, when the high-speed operation is carried out at a high speed of 18000 rpm or more, it is preferred to increase stepwise the speed of the smoothing operation to the highest level after replacement of the travelers.

By the way, there is a known method for automatically changing the operative mode from the smoothing operation to the ordinary spinning operation after the smoothing operation is conducted at a predetermined low speed for a fixed time set in a timer or a fixed number of doffing times counted by a counter. However, this method suffers an inconvenience that it allows only two steps of speed change between high speed and low speed. On the other hand, in the embodiment according to this invention, the operative mode can automatically be shifted to the ordinary high-speed operative after the smoothing operation is so conducted as to successively increase the rotating speed of the spindles stepwise to the maximum level.

Depending on the kinds of the travelers used and the spinning condition, it will not always be necessary to use all the speed change patterns M1 to M4 in the smoothing operation. Rather the number of the speed change patterns and the number of the repetition times are selected in accordance with the spinning condition. For example, when the speed change patterns M1, M3 are selected for the smoothing operation, and the number of the repetition times of the speed change patterns M1, M3 are respectively set at 2, 5, the speed change pattern M1 is repeated twice, then the pattern M3 is repeated five times. Subsequently, the speed change pattern M0 for the highest speed operation is executed.

Incidentally, while the number of the speed change patterns is five in the above embodiment, it is not limited to five but should be three or more. Moreover, it is not necessary to always set the rotating speed at the respective speed change points and in the respective steps in the low-speed speed change patterns M1 to M4 for the smoothing operation to correspond to the rotating speed at the respective speed change points in the highest-speed speed change pattern M0. Further, as the highest-speed speed change pattern, it is possible to select other speed change patterns than the speed change pattern M0. Accordingly, it is also possible to use speed change patterns for the smoothing operation whose speeds are lower than that of the highest-speed pattern selected in place of the pattern M0. Furthermore, it is possible to set speed change patterns of the spindle actuating motor 2 by the input device 11 prior to the operation of the spinning machine instead of storing the standard speed change patterns in the program memory 9.

A spindle actuating controller is provided for a spinning machine having a variable speed motor for actuating spindles in order to wind thread around bobbins carried by the spindles. The controller calculates desired speed gradients on the basis of desired spindle rotating speed at various stages in the winding process. The spindle rotating speed is then increased or reduced gradually and not abruptly. Accordingly, the traveler can always run on the ring flange smoothly in a stable posture even when the spindle is rotated at a maximum level of 20000 to 25000 rpm.

Claims

1. A spindle actuating controller for a spinning machine having a variable speed motor for actuating at least one spindle in order to wind thread around a bobbin carried by the spindle, the controller comprising:

a storage device for storing a desired production amount value indicative of the amount of thread to be wound about the bobbin, and values indicative

of the desired spindle rotating speeds at a plurality of speed change start points and speed change end points at various points during the winding process;
setting means for inputting the desired production amount value and the desired spindle rotating speeds values to the storage device; and
computing means for calculating speed gradients between each adjacent pair of speed change points on the basis of information inputted by the setting means and for outputting speed command signals so as to drive the variable speed motor at the calculated speed gradients.

2. A spindle actuating controller according to Claim 1, wherein the change of the rotating speed of the spindles within the interval from the starting of the spindles to the stoppage of the spinning machine is made into a plurality of patterns, which are stored in the storage device, and the respective speed change patterns can selectively be combined with one another by the setting means.

Fig.1

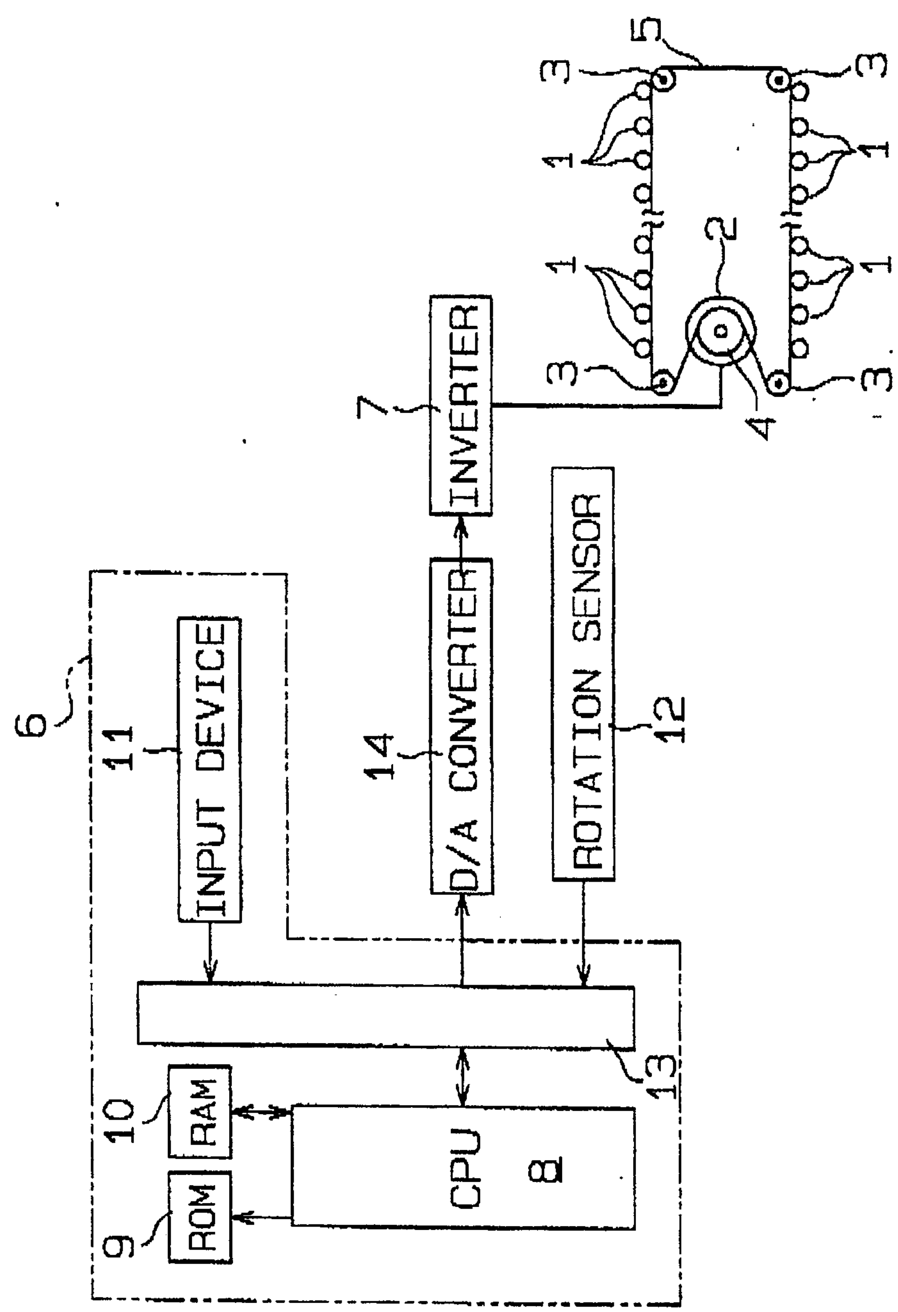
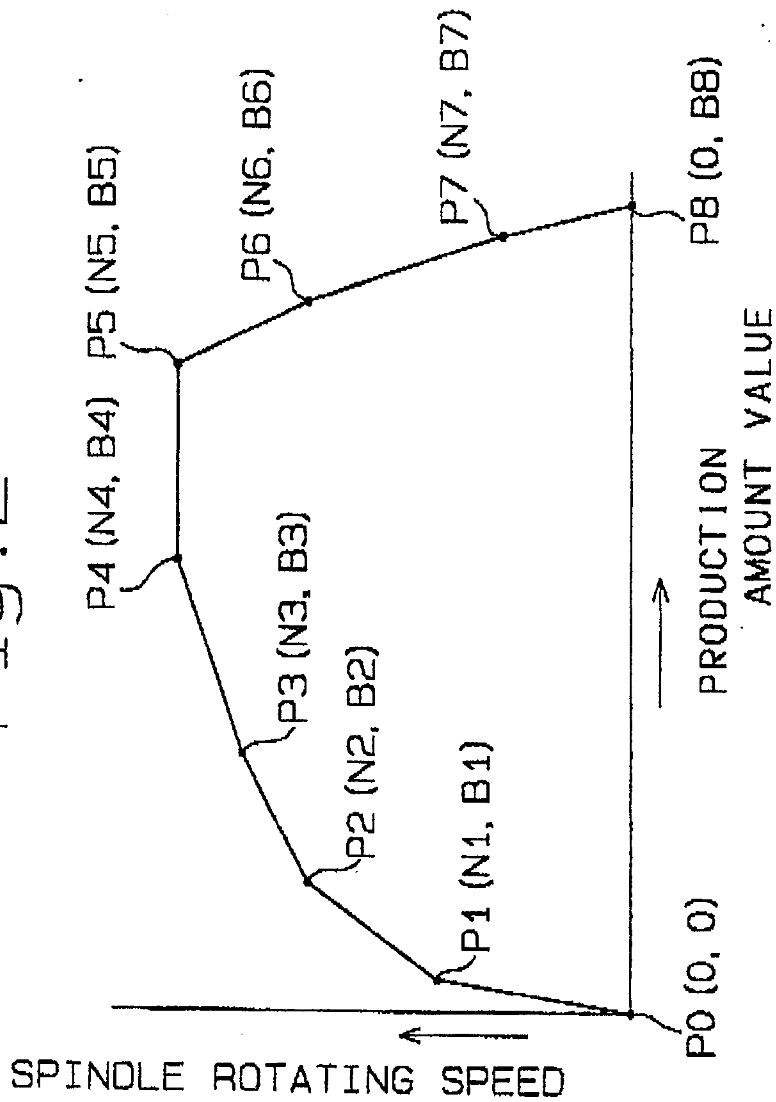

INPUT DEVICE
D/A CONVERTER
ROTATION SENSOR
INVERTER
CPU
RAM
ROM
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Fig. 2


P0 (0, 0)
P1 (N1, B1)
P2 (N2, B2)
P3 (N3, B3)
P4 (N4, B4)
P5 (N5, B5)
P6 (N6, B6)
P7 (N7, B7)
P8 (0, B8)
SPINDLE ROTATING SPEED
PRODUCTION AMOUNT VALUE

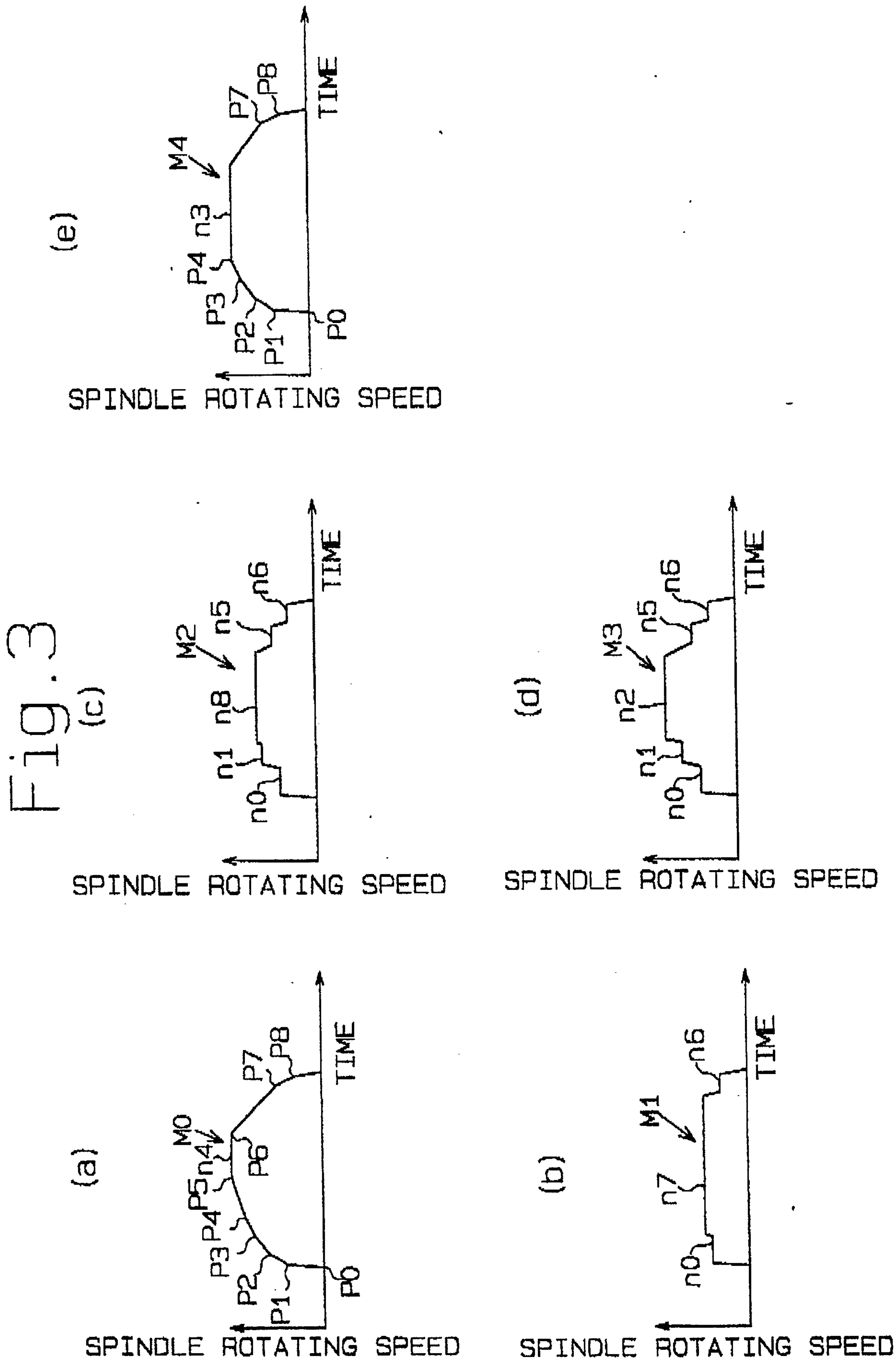


Fig. 3
(a)
SPINDLE ROTATING SPEED
TIME
P0
P1
P2
P3
P4
P5
n4
M0
P6
P7
P8
(b)
SPINDLE ROTATING SPEED
TIME
n0
n7
M1
n6
(c)
SPINDLE ROTATING SPEED
TIME
n0
n1
n8
M2
n5
n6
(d)
SPINDLE ROTATING SPEED
TIME
n0
n1
n2
M3
n5
n6
(e)
SPINDLE ROTATING SPEED
TIME
P0
P1
P2
P3
P4
n3
M4
P7
P8

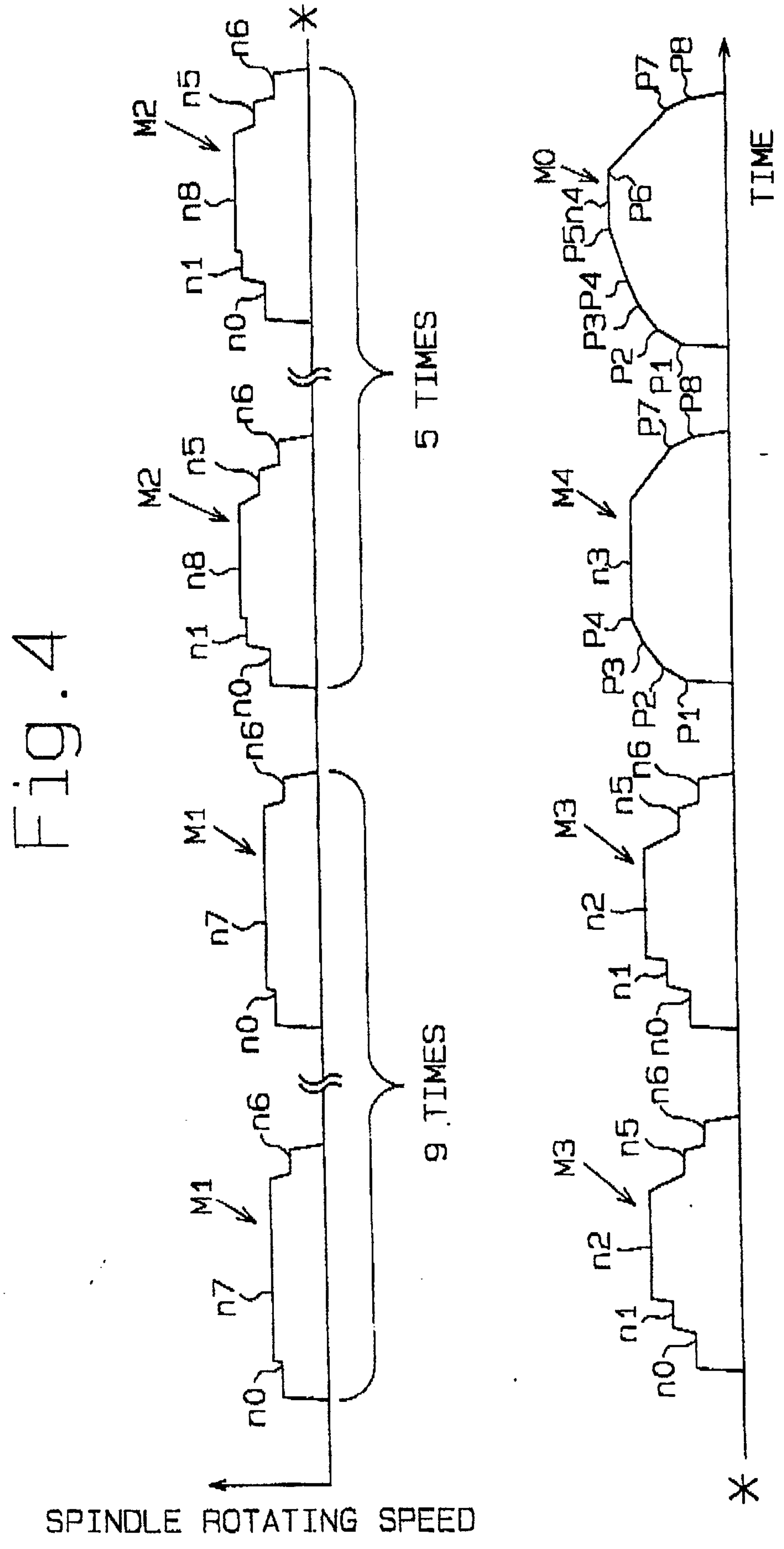


Fig. 4
SPINDLE ROTATING SPEED
TIME
9 TIMES
5 TIMES
M1
M2
M3
M4
M0
n0
n1
n2
n3
n4
n5
n6
n7
n8
P1
P2
P3
P4
P5
P6
P7
P8