

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a driving control method of a loom in which driving of a driving motor that drives a main shaft such that the main shaft is rotationally driven at the time of a steady-state operation in accordance with a set rotational speed that has been previously set is controlled, and to a driving control device therefor.

2. Description of the Related Art

[0002] In a loom, as disclosed in, for example, Japanese Unexamined Patent Application Publication No. 5-64478, the rotational speed of a main shaft at the time of a steady-state operation is previously set as a set rotational speed, and, at the time of the steady-state operation, the main shaft is driven by a driving motor such that the main shaft is rotationally driven at the set rotational speed to thereby perform weaving. Moreover, in general looms of recent years, when the looms are started from a stopped state, the looms are started in a mode in which the driving of the driving motor is controlled such that the rotational speed of the main shaft reaches the aforementioned set rotational speed in a short start-up time (for example, a time corresponding to one to two cycles of the looms).

[0003] However, in a loom starting method in which the rotational speed of the main shaft is raised to the set rotational speed in a short start-up time as mentioned above, an excessive load may be applied to a main-shaft driving device including the driving motor depending upon, for example, weaving conditions.

[0004] Specifically, for example, a case in which the set rotational speed is high is an example. That is, when the set rotational speed is high and the start-up time is short, since the driving motor needs to be accelerated in accordance with the set rotational speed and the start-up time thereof, an excessive load may be applied to the main-shaft driving device at the time of start-up depending upon the set rotational speed thereof. In a case in which the number of frames used in a shedding device is large or in a case in which a large force is required for driving heald frames depending upon the set tension or the type of warp used in weaving, in a loom in which the shedding device uses a driving motor as a driving source, the load that is applied to the main-shaft driving device at the time of start-up is large. Therefore, even in these cases, when an attempt is made to start up the main shaft in a short time as mentioned above, an excessive load is applied to the main-shaft driving device.

[0005] At the time of start-up of the loom, when an excessive load is applied to the main-shaft driving device as mentioned above, depending upon, for example, the state of the loom, problems that the rotational speed of

the main shaft is not raised to the set rotational speed within an assumed start-up time or that defects, such as a weaving bar, occur in a fabric without weaving being performed in a desired state may occur. Further, when an excessive load as that mentioned above is applied to the main-shaft driving device every time the loom is started, a problem that the main-shaft driving device is damaged early may also occur.

[0006] Accordingly, in order to prevent the occurrence of such problems above, a loom may be started by a starting method in which the start-up time that is assumed in raising the rotational speed of the main shaft to the set rotational speed is a longer time (a period for a plurality of cycles of the loom) instead of a short time as mentioned above and in which the rotational speed of the main shaft is linearly increased in the long start-up time. According to such a starting method, compared to when the rotational speed of the main shaft is raised to the set rotational speed in a short start-up time as mentioned above, the load that is applied to the main-shaft driving device is reduced, so that it is possible to prevent the occurrence of the problems above to the extent possible.

[0007] However, when a loom is started in a long start-up time for a plurality of cycles of the loom in this way, it is desirable that a weft insertion be performed even in this period. This is because, since, as the driving of the main shaft (driving motor) is started, a swinging motion of a reed, which uses this as a driving source, is also started, when a weft insertion is not performed, a plurality of blank beatings are performed, as a result of which a weaving bar (heavy filling bar) may occur in a fabric.

[0008] However, when a loom is started in a long start-up time as mentioned above, even if a weft insertion is performed, a weaving bar (light filling bar) may occur in a fabric. Specifically, when the rotational speed of the main shaft is linearly raised to the set rotational speed for a plurality of cycles of the loom, the acceleration slope of the rotational speed of the main shaft becomes gentle. Therefore, during the few cycles immediately after starting the start-up, the loom is operated with the rotational speed of the main shaft being low, and weaving accompanied by a weft insertion is performed in this state. However, in the state in which the rotational speed of the main shaft is low in this way, since a beating force produced by the swinging motion of the reed is also weak, weft that is inserted is not sufficiently beaten during this time, as a result of which a light filling bar may occur.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is an object of the present invention to make it possible to reduce the load that is applied to a main-shaft driving device when raising the rotational speed of a main shaft and to prevent the occurrence of a weaving bar in a fabric caused by insufficient beating force mentioned above when performing a weft insertion in a start-up period.

[0010] To this end, according to the present invention,

a driving control method of a loom according to the present invention is one in which, in the loom in which driving of a driving motor of a main-shaft driving device is controlled, a start-up rotational speed that is set to a rotational speed that is lower than a set rotational speed, that is less than or equal to a rotational speed that is determined by considering a load of the main-shaft driving device, and that is set so as to be greater than or equal to 25% of the set rotational speed is previously set, the main-shaft driving device driving a main shaft such that the main shaft is rotationally driven at a time of a steady-state operation in accordance with the set rotational speed that has been previously set. In addition, in performing a start-up of the loom from when the start-up is started to when a rotational speed of the main shaft reaches the set rotational speed, the start-up is performed while being accompanied by a weft insertion in a start-up period for one or more cycles of the loom, and control of the driving motor from when the start-up is started is performed in accordance with the start-up rotational speed, and, when and after the rotational speed of the main shaft has reached the start-up rotational speed, control of the driving of the driving motor is performed such that the rotational speed of the main shaft is increased from the start-up rotational speed to the set rotational speed in accordance with a predetermined rotational-speed increase mode.

[0011] A driving control device according to the present invention controls driving of a driving motor of a main-shaft driving device that drives a main shaft such that the main shaft is rotationally driven at a time of a steady-state operation in accordance with a set rotational speed that has been previously set, controls an operation of each weft-insertion related device involved in a weft insertion to perform the weft insertion, and includes a storage section that stores a start-up rotational speed and a driving set value, the start-up rotational speed being set to a rotational speed that is lower than the set rotational speed, being less than or equal to a rotational speed that is determined by considering a load of the main-shaft driving device, and being set so as to be greater than or equal to 25% of the set rotational speed, the driving set value being set in accordance with a rotational-speed increase mode that has been predetermined for increasing a rotational speed of the main shaft from the start-up rotational speed to the set rotational speed. In addition, the driving of the driving motor and the operation of each weft-insertion related device are controlled such that a start-up of the loom from when the start-up of the loom is started to when the rotational speed of the main shaft reaches the set rotational speed is performed while being accompanied by a weft insertion in a start-up period for one or more cycles of the loom, and control of the driving motor from when the start-up is started is performed in accordance with the start-up rotational speed, and, when and after the rotational speed of the main shaft has reached the start-up rotational speed, the control of the driving motor is performed based on the driving set value

such that the rotational speed of the main shaft is increased from the start-up rotational speed to the set rotational speed in accordance with the rotational-speed increase mode.

[0012] The aforementioned "one cycle of a loom" is a period corresponding to a period in which the main shaft rotates once (0° to 360°) during continuous operation of the loom, and a period in which, during the one rotation, a series of weaving operations (weft insertion to beating) is performed once. "Weft-insertion related devices" are devices that are involved in a weft insertion of a weft drawn out from a weft supply package, and include, for example, a measuring-and-storing device (stopper pin) and a main nozzle. When weft-insertion devices include, for example, an auxiliary main nozzle, a sub-nozzle, a weft brake, and a clamper, weft-insertion related devices also include these.

[0013] In addition, in the driving control method and the driving control device according to the present invention, the rotational-speed increase mode is determined so as to include a state in which the main shaft is rotationally driven for the one or more cycles of the loom at one or more intermediate rotational speeds that are determined as rotational speeds that are lower than the set rotational speed and higher than the start-up rotational speed.

[0014] Further, with the rotational-speed increase mode being determined so as to include the one or more intermediate rotational speeds as mentioned above, according to the present invention, a rotational-speed increase amount towards the one or more intermediate rotational speeds may be set at the loom, and the control of the driving of the driving motor in a process of increasing the rotational speed of the main shaft from the start-up rotational speed to the set rotational speed may be performed based on the rotational-speed increase amount. Note that, in this case, in the driving control device, the driving set value is set so as to include the rotational-speed increase amount.

[0015] In addition, in the loom, a basic weft-insertion condition, which is a weft-insertion condition for a weft insertion at the time of the steady-state operation, is previously set at the loom, and the weft insertion at the time of the steady-state operation is performed in accordance with the basic weft-insertion condition; however, in the loom, the driving control method and the driving control device according to the present invention may be such that, in the start-up period, a weft insertion when the main shaft is rotationally driven in accordance with the start-up rotational speed and a weft insertion when the main shaft is rotationally driven in accordance with the one of more intermediate rotational speeds are performed in accordance with weft-insertion conditions determined in accordance with the rotational speeds corresponding thereto.

[0016] Further, a condition of the weft-insertion when the main shaft is rotationally driven in accordance with the start-up rotational speed and a condition of the weft-

insertion when the main shaft is rotationally driven in accordance with the one or more intermediate rotational speeds may be determined by a calculation based on the basic weft-insertion condition and the rotational speeds corresponding thereto. Note that the so-called "weft-insertion condition" here is a condition in which operation timings of the weft-insertion related devices are set.

[0017] According to the driving control method of a loom and the driving control device of a loom according to the present invention, control of the driving motor from when the start-up is started is performed in accordance with the start-up rotational speed that has been set as described above, and control of the driving motor is performed in accordance with the rotational-speed increase mode when and after the rotational speed of the main shaft has reached the start-up rotational speed. By this, compared to an existing starting method in which control of the driving motor is performed such that the rotational speed of the main shaft is increased all at once to the set rotational speed in a short start-up time, the load that is applied to the main-shaft driving device in the start-up period in which the rotational speed of the main shaft is raised to the set rotational speed is reduced. As a result, it is possible to prevent the occurrence of the problem that defects, such as a weaving bar, occur in a fabric that is woven because the rotational speed of the main shaft is not raised to the set rotational speed within the assumed start-up time, and the occurrence of the problem that the main-shaft driving device is damaged early due to repeated applications of an excessive load on the main-shaft driving device.

[0018] In addition, compared to a starting method in which, in the same way, in order to reduce the load that is applied to the main-shaft driving device, the start-up period is set to a long period for a plurality of cycles of the loom and the rotational speed of the main shaft is increased to the set rotational speed with a gentle and constant acceleration slope, since a sufficient beating force can be generated from the loom cycle immediately after starting the start-up, it is possible to prevent the occurrence of a weaving bar in a fabric caused by the aforementioned blank beating or insufficient beating force.

[0019] The present invention assumes that a weft insertion is performed in the start-up period by fixing the rotational-speed increase mode so as to include a state in which the main shaft is rotationally driven for one cycle or more of the loom at the intermediate rotational speed such as those mentioned above. This weft insertion can be stably performed.

[0020] Further, by performing the weft insertion in the start-up period in accordance with the weft-insertion conditions determined in accordance with the respective rotational speeds as described above, the weft insertion in the start-up period is performed under an optimal weft-insertion condition. Moreover, by determining the weft-insertion condition for a weft insertion in the start-up pe-

riod by a calculation based on the basic weft-insertion condition such as that described above and each of the aforementioned rotational speed, even if the set rotational speed or the rotational-speed increase mode is changed, the trouble of manually inputting the weft-insertion condition for each change is eliminated. Therefore, it is possible to reduce the burden on an operator in a setting operation.

10 BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is an overall structural view showing an air jet loom to which the present invention is applied;

Fig. 2 is a block diagram showing an internal structure of a driving control device of the present invention; and

Fig. 3 is an explanatory view showing a series of flow up to when the rotational speed of a main shaft reaches a set rotational speed by performing a driving control method of a loom of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] An embodiment of the present invention is described below on the basis of Figs. 1 to 3. However, in the present embodiment, an air jet loom, which is a loom that is assumed, is taken as an example to describe the present invention.

[0023] As shown in Fig. 1, in an air jet loom 1, a weft-insertion device 10 includes a weft supply package 11, a measuring-and-storing device 12 that stores a weft drawn out from the weft supply package 11 by a length corresponding to a weft-insertion length, a main nozzle 13 for inserting a weft, a plurality of sub-nozzles 14 that assist the movement of travel of the weft ejected from the main nozzle 13, and a thread cutter 15 for cutting the inserted weft. In the illustrated example, the weft-insertion device 10 also includes an auxiliary main nozzle 16 that is provided on an upstream side of the main nozzle 13 and that assists in the weft insertion performed by the main nozzle 13, and a weft brake device 17 for causing a braking force to act on the weft at the end of the weft insertion.

[0024] In the weft-insertion device 10, the main nozzle 13 and the auxiliary main nozzle 16 are connected to a fluid supply source 18, which supplies compressed air, via electromagnetic on-off valves 13a and 16a, which are provided in correspondence with the main nozzle 13 and the auxiliary main nozzle 16, and pressure regulators 13b and 16b for adjusting the pressure of the compressed air that is supplied to the nozzle 13 and the nozzle 16. Each sub-nozzle 14 is connected to the fluid supply source 18, which is used in common by the main nozzle 13, via an electromagnetic on-off valve 14a, which is provided in correspondence with the sub-nozzle 14, and a pressure regulator 14b, which is used in common by each sub-

nozzle 14.

[0025] Moreover, in the air jet loom 1, the electromagnetic on-off valves 13a and 16a are controlled at a previously set jetting start timing and compressed air is supplied to the main nozzle 13 and the auxiliary main nozzle 16, and, subsequently, at a weft-insertion start timing, in the measuring-and-storing device 12, a stopper pin 12a is driven and the stopping of the weft on a storage drum 12b by the stopper pin 12a is released. By this, while the weft stored on the storage drum 12b in the measuring-and-storing device 12 is freed, a weft-insertion operation in which the weft is ejected from the main nozzle 13 is started.

[0026] Further, the weft ejected from the main nozzle 13 travels into a warp shed while the movement of the weft is assisted by compressed air ejected from the sub-nozzles 14. Then, at a weft-insertion end timing, which is a timing in which an end of the weft reaches a predetermined position on the opposite side of weft supply, in the measuring-and-storing device 12, by stopping the weft by the stopper pin 12a, the weft is restrained and stops traveling, so that one weft insertion is completed. Note that the jetting of compressed air from the main nozzle 13 and the auxiliary main nozzle 16 is stopped at a jetting end timing that has been set as a timing during a weft-insertion period.

[0027] At the end of the weft insertion, by operating the weft brake device 17, the travel speed of the weft is reduced, and shock that is applied to the weft when restrained by the aforementioned stopper pin 12a is reduced. When the weft insertion is completed in this way, the inserted weft is beaten with respect to a cloth fell by a reed 19, and a warp shed is closed, so that the inserted weft is in a woven state at the cloth fell. Further, after the beating, the weft that is provided consecutively with the main nozzle 13 is cut by the thread cutter 15. By this, one end of the weft inserted into the main nozzle 13 becomes a free end, thereby making it possible to perform the next weft insertion. Incidentally, a warp shedding device (not shown) that forms/closes a warp shed and the reed 19 are connected to a main shaft 20 of the air jet loom 1, and are driven during weaving in a predetermined mode with the main shaft 20 as a driving source.

[0028] In such an air jet loom 1, the weft-insertion device 10 also includes a weft-insertion control device 32 that controls the operation of each of the electromagnetic on-off valves 13a and 16a that control the supply of compressed air with respect to the main nozzle 13, the auxiliary main nozzle 16, and each sub-nozzle 14, an advancing-and-retreating operation of the stopper pin 12a in the measuring-and-storing device 12, and the operation of the weft brake device 17 (more specifically, the driving of a driving motor 17b for driving a brake member 17a in the weft-insertion device 10).

[0029] The weft-insertion control device 32 includes a storage unit 32a. The storage unit 32a stores set values of, for example, a jetting start/end timing of the main nozzle 13, the auxiliary main nozzle 16, and each sub-nozzle

14, the weft-insertion start/end timing, and an operation start/end timing of the weft brake device 17, as weft-insertion conditions.

[0030] Note that the air jet loom 1 includes an input setting unit 40, and each set value above is set at the input setting unit 40, is transmitted to the weft-insertion control device 32 from the input setting unit 40, and is stored in the storage unit 32a. The air jet loom 1 also includes an angle detecting unit 50 that detects the rotation angle of the main shaft 20, and is configured to detect the rotation angle of the main shaft 20 in units of one rotation. The detected rotation angle of the main shaft 20 is also output to the weft-insertion control device 32.

[0031] Moreover, based on the rotation angle of the main shaft 20 output from the angle detecting unit 50 and each of the set values in the storage unit 32a, the weft-insertion control device 32 controls, for example, the operation of each of the electromagnetic on-off valves 13a, 14a, and 16a, the advancing-and-retreating operation of the stopper pin 12a, and the operation of the weft brake device 17 in the aforementioned weft-insertion device 10.

[0032] Specifically, regarding the main nozzle 13 and the auxiliary main nozzle 16, when the set value of the jetting start timing that has been set with respect to the main nozzle 13 and the auxiliary main nozzle 16 and the rotation angle position of the main shaft 20 (may also be called "crank angle" below) match, the weft-insertion control device 32 performs control to open the electromagnetic on-off valve 13a corresponding to the main nozzle 13 and the electromagnetic on-off valve 16a corresponding to the auxiliary main nozzle 16. By this, the supply of compressed air to the main nozzle 13 and the auxiliary main nozzle 16 is started, and, at the jetting start timing, the jetting of compressed air from the main nozzle 13 and the auxiliary main nozzle 16 is started. When the set value of the jetting end timing that has been set with respect to the main nozzle 13 and the auxiliary main nozzle 16 and the crank angle match, the weft-insertion control device 32 performs control to close each of the electromagnetic on-off valves 13a and 16a that has been opened as described above. By this, the supply of compressed air to the main nozzle 13 and the auxiliary main nozzle 16 is stopped, and, at the jetting end timing, the jetting of compressed air from the main nozzle 13 and the auxiliary main nozzle 16 is stopped.

[0033] Further, regarding each sub-nozzle 14, when the set value of jetting start timing that has been set with respect to each sub-nozzle 14 and the crank angle match, the weft-insertion control device 32 performs control to open the electromagnetic on-off valves 14a corresponding to the respective sub-nozzles 14. By this, the supply of compressed air to each sub-nozzle 14 is started, and, at each jetting start timing, the jetting of compressed air from each sub-nozzle 14 is started. When the set value of the jetting end timing that has been set with respect to each sub-nozzle 14 and the crank angle match, the weft-insertion control device 32 performs control to close each of the electromagnetic on-off valves 14a. By this,

the supply of compressed air to each sub-nozzle 14 above is stopped, and, at each jetting end timing, the jetting of compressed air from each sub-nozzle 14 is stopped.

[0034] Regarding the measuring-and-storing device 12, when the set value of the weft-insertion start timing and the crank angle match, the weft-insertion control device 32 performs control to cause the stopper pin 12a to retreat in order to move the stopper pin 12a away from the storage drum 12b (more specifically, control a driving device, such as a solenoid, that drives the stopper pin 12a to advance or retreat the stopper pin 12a). By this, the measuring-and-storing device 12 is brought into a state in which the weft stored on the storage drum 12b is capable of being freed (weft insertable state). At a previously set advance timing of the stopper pin 12a (prior-to-end-of-weft-insertion timing), the weft-insertion control device 32 performs control to advance the stopper pin 12a towards the storage drum 12b in order to bring the stopper pin 12a into a weft stoppable state. By this, the measuring-and-storing device 12 is brought into a state in which the weft is brought into a stoppable state, and, as the weft travels, the weft moving around the storage drum 12b is stopped by the stopper pin 12a, and the travel of the weft is stopped.

[0035] Regarding the weft brake device 17, when the set value of the operation start timing that has been set with respect to the weft brake device 17 and the crank angle match, the weft-insertion control device 32 performs control to drive the brake member 17a by the driving motor 17b such that a braking force acts upon the weft. However, the operation start timing is set as a timing of the end period of the weft-insertion process (weft-insertion end period). At the weft-insertion end period, the weft on the weft supply side is brought into a bent state by the brake member 17a, and the traveling weft is brought into a braked state. Further, when the set value of the operation end timing that has been set with respect to the weft brake device 17 and the crank angle match, the weft-insertion control device 32 performs control to drive the brake member 17a by the driving motor 17b so as to move away from the weft. However, the operation end timing is set as an after-ending-of-weft-insertion timing). Then, by driving the brake member 17a the bent state of the weft is cancelled.

[0036] Note that, in the air jet loom 1 of the present embodiment described above, the advancing-and-retreating operation of the stopper pin 12a in the measuring-and-storing device 12, the jetting operations of the main nozzle 13, the auxiliary main nozzle 16, and each sub-nozzle 14, and the operation of the weft brake device 17 are controlled in accordance with the set values of the weft-insertion conditions stored in the storage unit 32a. Moreover, during weaving under a steady-state operation state, the operation of each device above is controlled in accordance with basic weft-insertion conditions as weft-insertion conditions for the steady-state operation. In the present embodiment, the measuring-and-storing

device 12 (stopper pin 12a), the main nozzle 13, the auxiliary main nozzle 16, each sub-nozzle 14, and the weft brake device 17, whose operations are controlled in accordance with weft-insertion conditions in this way, correspond to the so-called weft-insertion related devices in the present invention.

[0037] The air jet loom 1 also includes a main control device 31. The input setting unit 40 above is connected to the main control device 31. The weft-insertion control device 32 above is also connected to the main control device 31. Further, the angle detecting unit 50 is connected to the main control device 31. The rotation angle of the main shaft 20 detected by the angle detecting unit 50 is input to the main control device 31. The rotation angle of the main shaft 20 detected by the angle detecting unit 50 is output to the weft-insertion control device 32 as described above via the main control device 31.

[0038] The air jet loom 1 includes an inverter 33 that controls the driving of a driving motor 60a of a main-shaft driving device 60 that rotationally drives the main shaft 20. The air jet loom 1 is configured to control the driving of the driving motor 60a by controlling the inverter 33 on the basis of a target rotational speed of the main shaft 20. Specifically, the inverter 33 controls the driving of the driving motor 60a such that the driving motor 60a is driven at the rotational speed (target rotational speed) corresponding to the target rotational speed of the driving motor 60a by generating an output frequency corresponding to the target rotational speed of the main shaft 20 (main-shaft rotational speed). That is, the driving motor 60a is controlled so as to be driven at the rotational speed corresponding to the output frequency of the inverter 33. Incidentally, in the present embodiment, the air jet loom 1 is configured such that the driving motor 60a is connected to the main shaft 20 via a drive transmission mechanism (not shown), and the rotation of the driving motor 60a (output shaft) is transmitted to the main shaft 20 via the drive transmission mechanism. Therefore, the main-shaft driving device 60 of the air jet loom 1 of the present embodiment also includes the drive transmission mechanism.

[0039] However, in general looms of recent years, compared to when the rotational speed is changed at the time of, for example, a steady-state operation (steady-state operation control) such that, at the time of start-up, the rotational speed of the driving motor 60a reaches the target rotational speed in a short time, control of the driving motor 60a in different states (start-up control) is performed. Even in the air jet loom 1 of the present embodiment, at the time of the start-up in which the rotational speed of the driving motor 60a is raised from zero, the driving of the driving motor 60a is controlled by performing the start-up control. When and after the main-shaft rotational speed has reached the set rotational speed at the time of steady-state operation, the driving of the driving motor 60a is controlled by the steady-state operation control.

[0040] As described above, the air jet loom 1 includes

the main control device 31, the weft-insertion control device 32, and the inverter 33. Each control device is included in a driving control device 30 of the air jet loom 1. Moreover, in the present invention, instead of controlling the driving motor 60a such that, at the time of start-up of the loom, the main-shaft rotational speed is raised all at once to a certain set rotational speed, which is the rotational speed at the time of steady-state operation, as it is conventionally, the driving control device 30 performs the following. That is, the driving control device 30 first raises the main-shaft rotational speed to the start-up rotational speed that has been set as the rotational speed that is lower than the set rotational speed, and, when and after the main-shaft rotational speed has reached the start-up rotational speed, controls the driving motor 60a such that the main-shaft rotational speed is increased to the set rotational speed in accordance with the increase mode (rotational-speed increase mode) of the main-shaft rotational speed that has been predetermined. A detailed structure of the driving control device 30 is described in detail below.

[0041] The driving control device 30 includes a driving control section 34 connected to the aforementioned inverter 33. The driving control section 34 includes a storage section 34a that stores the set rotational speed and the start-up rotational speed. Further, the driving control section 34 is connected to the aforementioned main control device 31. The aforementioned set rotational speed and start-up rotational speed are set at the input setting unit 40, and, by transmitting the aforementioned set rotational speed and start-up rotational speed to the driving control section 34 via the main control device 31 from the input setting unit 40, they are stored in the storage section 34a. The rotation angle of the main shaft 20 detected by the angle detecting unit 50 and input to the main control device 31 as mentioned above is output to the driving control section 34 via the main control device 31.

[0042] The driving control section 34 outputs to the inverter 33 a frequency command signal corresponding to the target main-shaft rotational speed such that the inverter 33 generates an output frequency corresponding to the target main-shaft rotational speed as mentioned above. Therefore, in raising the main-shaft rotational speed towards the start-up rotational speed as mentioned above, when starting the start-up, the driving control section 34 outputs a frequency command signal corresponding to the start-up rotational speed, and the inverter 33 generates an output frequency corresponding to the start-up rotational speed in accordance with the frequency command signal. In increasing the main-shaft rotational speed from the start-up rotational speed to the set rotational speed in accordance with the aforementioned rotational-speed increase mode, a frequency command signal corresponding to the rotational-speed increase mode is output, and the inverter 33 generates an output frequency corresponding to the rotational-speed increase mode in accordance with the frequency

command signal.

[0043] Note that the start-up rotational speed is the rotational speed that is set as the rotational speed that is lower than the set rotational speed as mentioned above. Specifically, the start-up rotational speed is set as the rotational speed less than or equal to the rotational speed that is determined by considering the load that is applied to the main-shaft driving device 60 at the time of start-up of the loom. However, in the present invention, the start-up rotational speed is set so as to be greater than or equal to 25% of the set rotational speed. This is described in more detail as follows.

[0044] In the present embodiment, a case in which the set rotational speed is set at 1800 rpm that is very high compared to the rotational speed of general looms is used as an example. In this case, even if the specification and the weaving conditions of the looms are the same, when an attempt is made to raise the main-shaft rotational speed to the set rotational speed in a time that is the same as the start-up time (the time required to increase the main-shaft rotational speed to the set rotational speed) of general looms, an excessive load is applied to the main-shaft driving device, and, thus, the aforementioned problems caused by this load may occur. Accordingly, considering the time for starting up the main shaft and the load that is applied to the main-shaft driving device during this time, the start-up rotational speed is set after fixing the rotational speed (allowable rotational speed) that does not cause these problems to occur. Note that the allowable rotational speed differs depending upon, for example, the specification and the weaving conditions of the loom; however, in the present embodiment, 1000 rpm is used as an example.

[0045] By fixing the allowable rotational speed as mentioned above, the start-up rotational speed is set as the rotational speed less than or equal to the allowable rotational speed. However, the start-up rotational speed is set so as to be greater than or equal to 25% of the set rotational speed as mentioned above. This is because the present invention assumes that, even in a start-up period from a state in which the main-shaft rotational speed is zero to when the main-shaft rotational speed is increased to the set rotational speed (start-up period), a weft insertion is performed. This is because, in this case, since a sufficient beating force from a loom cycle immediately after starting the start-up is required such that, for example, a weaving bar caused by an insufficient beating force described above does not occur, the start-up rotational speed needs to be set such that the main-shaft rotational speed reaches the rotational speed that allows such a sufficient beating force to be acquired even immediately after starting the start-up.

[0046] Accordingly, although the start-up rotational speed is basically not a problem as long as the start-up rotational speed is greater than or equal to 25% of the set rotational speed, depending upon, for example, the specification and weaving conditions of the loom, the beating force may be insufficient even if the start-up ro-

tational speed is greater than or equal to 25% of the set rotational speed. Therefore, in the present invention, the start-up rotational speed is desirably set as the rotational speed that is greater than or equal to 40% of the set rotational speed. Moreover, in the present embodiment, in order to ensure a sufficient beating force and to reduce the time for increasing the main-shaft rotational speed to the set rotational speed, the start-up rotational speed is set at the maximum allowable rotational speed, that is, 1000 rpm. Note that 1000 rpm is the rotational speed that is greater than or equal to 40% of 1800 rpm, which is the set rotational speed.

[0047] Regarding the aforementioned rotational-speed increase mode, the rotational-speed increase is mode is for determining how to increase the main-shaft rotational speed from the start-up rotational speed to the set rotational speed. An example of the rotational-speed increase mode is one in which, with the number of rotational speeds (the so-called "intermediate rotational speeds" in the present application) that are higher than the start-up rotational speed and lower than the set rotational speed being determined to one or more, the main-shaft rotational speed is increased in stages by increasing the main-shaft rotational speed from the start-up rotational speed towards an intermediate rotational speed and by increasing the main-shaft rotational speed from the intermediate rotational speed to the set rotational speed. However, in this mode, when the number of intermediate rotational speeds is two or more, a stage in which the main-shaft rotational speed is increased from the lower intermediate rotational speed to the higher rotational speed during this time is included.

[0048] Moreover, in the present embodiment, the rotational-speed increase mode is determined such that the main-shaft rotational speed is increased in stages to the set rotational speed a plurality of times by a previously set predetermined rotational-speed increase amount at a time. In other words, the rotational-speed increase mode of the present embodiment is set to a mode in which a rotational-speed range from the start-up rotational speed to the set rotational speed is equally divided into a plurality of portions and the main-shaft rotational speed is increased in stages to the set rotational speed through each intermediate rotational speed. Specifically, in the embodiment, the rotational-speed increase mode is determined as a mode in which the range (1000 rpm to 1800 rpm) is divided into four portions and the main-shaft rotational speed is increased by a rotational-speed increase amount of 200 rpm at a time towards each intermediate rotational speed (1200 rpm, 1400 rpm, 1600 rpm). Moreover, in the present embodiment, the rotational-speed increase amount of 200 rpm is stored in the storage section 34a of the driving control section 34. Note that the rotational-speed increase amount is also input and set by the input setting unit 40 and is transmitted to the storage section 34a.

[0049] In a general loom starting method, the raising of the main-shaft rotational speed to the set rotational

speed at the time of start-up is performed by the aforementioned start-up control. In contrast, in the present embodiment, the starting method is one in which the raising of the main-shaft rotational speed to the aforementioned start-up rotational speed is performed by the start-up control, and, in the meantime, in increasing the main-shaft rotational speed to the set rotational speed after the main-shaft rotational speed has reached the start-up rotational speed, the main-shaft rotational speed is set by being controlled in accordance with the steady-state operation control. That is, the increasing of the main-shaft rotational speed towards the intermediate rotational speed and the increasing of the main-shaft rotational speed from the intermediate rotational speed towards the set rotational speed are performed in accordance with the steady-state operation control).

[0050] Note that, in the steady-state operation control, the time required for increasing the main-shaft rotational speed by the rotation amount to be increased is influenced by, for example, the structure of the main-shaft driving device 60 and the load that is applied to the main-shaft driving device 60. Therefore, the rotational-speed increase mode of the present embodiment is one in which the period from when a frequency command signal is output from the driving control section 34 for increasing the main-shaft rotational speed to an intermediate rotational speed as mentioned above to when a frequency command signal is output next from the driving control section 34 for increasing the main-shaft rotational speed to an intermediate rotational speed (or the set rotational speed) as mentioned above is set by considering such influences mentioned above. Specifically, in the present embodiment, the rotational-speed increase mode is determined such that the period becomes two cycles of the loom. Moreover, in order to realize the rotational-speed increase mode, a set value (set period) of the aforementioned period (two cycles) is stored in the storage section 34a of the driving control section 34. This set period is also input and set by the input setting unit 40 and is transmitted to the storage section 34a.

[0051] According to the driving control device 30 of the present embodiment as described above, when, in order to start the operation of the air jet loom 1, an operator operates an operation button provided in the input setting unit 40 and an operation signal is output from the input setting unit 40 towards the main control device 31, the operation signal is input to the driving control section 34 via the main control device 31. The driving control section 34 is switched to a state in which the aforementioned start-up control is performed as the operation signal is input, and outputs to the inverter 33 a frequency command signal corresponding to the start-up rotational speed (1000 rpm). By this, the driving of the driving motor 60a is controlled by performing the start-up control, and the main-shaft rotational speed is raised to the start-up rotational speed in a short time.

[0052] After the main-shaft rotational speed has reached the start-up rotational speed, the driving control

section 34 is switched to a state in which the driving motor 60a is controlled such that the main-shaft rotational speed is increased in accordance with the rotational-speed increase mode determined as mentioned above; however, in the present embodiment, the switching point in time is set to a point in time in which a period of about two rotations of the main shaft 20 has passed from the operation of the operation button. Specifically, the switching point in time needs to be set to a point in time that exceeds a period up to when the main-shaft rotational speed reaches the start-up rotational speed from the operation of the operation button (from the point in time in which the operation signal is generated). The period in which the main-shaft rotational speed is raised to the set rotational speed by performing the start-up control from when the operation button is operated can be known from, for example, tests or past results. Therefore, in the present embodiment, the switching point in time is set as mentioned above by considering the known period. Specifically, the crank angle when starting the start-up is 300°, and the switching point in time is determined so as to become the point in time in which the crank angle reaches the second 360° (0°).

[0053] The switching point in time determined in this way is stored in the storage section 34a of the driving control section 34. The driving control section 34 is configured to determine whether or not the crank angle has reached the switching point in time from when the operation button has been operated on the basis of the crank angle that is output from the main control device 31 and the switching point in time stored in the storage section 34a. Moreover, when the driving control section 34 has determined that the crank angle has reached the switching point in time, the driving control section 34 is switched to a state in which the steady-state operation control is performed from the start-up control, and a frequency command signal corresponding to the rotational-speed increase mode is output to the inverter 33.

[0054] Note that the frequency command signal that is output from the driving control section 34 at the time of and after the switching becomes a frequency command signal corresponding to an intermediate command signal. However, as mentioned above, in the present embodiment, information that is stored in the storage section 34a is the rotational-speed increase amount (200 rpm) as that mentioned above instead of the intermediate rotational speed. Therefore, when the driving control section 34 outputs a frequency command signal, after the driving control section 34 has calculated the next rotational speed to be increased, the driving control section 34 outputs the calculated rotational speed. In other words, the driving control section 34 of the present embodiment has the function of determining such a calculated rotational speed (calculation function). Specifically, the driving control section 34 adds the rotational-speed increase amount to the main-shaft rotational speed at the time of outputting the frequency command signal (start-up rotational speed or intermediate rotational

speed) and outputs the frequency command signal corresponding to the calculated rotational speed determined thereby. In the present embodiment, the rotational-speed increase amount that is stored in the storage section 34a and that is used to determine the next calculated rotational speed for outputting the next frequency command signal as mentioned above corresponds to the so-called driving set value in the present invention.

[0055] Moreover, therefore, the frequency command signal that is output from the driving control section 34 at the switching point in time is a frequency command signal corresponding to the calculated rotational speed (intermediate rotational speed = 1200 rpm) determined by adding the rotational-speed increase amount (200 rpm) to the start-up rotational speed (1000 rpm). By controlling the driving motor 60a by the inverter 33 in accordance with the output frequency based on the frequency command signal, the main-shaft rotational speed is increased to the first intermediate rotational speed (1200 rpm).

[0056] In order to realize the rotational-speed increase mode of the present invention, as mentioned above, the driving control section 34 is configured to store the set period (two cycles) in the storage section 34a and to output a frequency command signal corresponding to the rotational-speed increase mode for every two cycles. Further, the driving control section 34 is configured to calculate the calculated rotational speed by the calculation function such as that mentioned above at a predetermined timing (calculation timing) that is set before the point in time of output of the next frequency command signal.

[0057] Therefore, regarding, for example, a "later" point in time, which is a point in time after the passage of two cycles from the switching point in time (an "earlier" point in time in which the frequency command signal corresponding to the calculated rotational speed is output), the rotational speed that serves as a basis of a frequency command signal that is output at the later point in time is calculated at a calculation timing before the later point in time and after the earlier point in time (the switching point in time). The frequency command signal corresponding to the calculated rotational speed (1200 + 200 = 1400 rpm) determined at the calculation timing is output at the later point in time, and, consequentially, the main-shaft rotational speed is increased to the next intermediate rotational speed (1400 rpm). Subsequently, the later point in time becomes an earlier point in time and a point in time after two cycles becomes a later point in time, and, similarly to the above, the calculation of the calculated rotational speed and the output of a frequency command signal corresponding to the calculated rotational speed are performed.

[0058] Moreover, the driving control section 34 is configured to, when the calculated rotational speed determined by the calculation function matches the set rotational speed, output a frequency command signal based on the set rotational speed stored in the storage section

34a instead of the calculated rotational speed, and disable the calculation function at the time of and after the output (that is, to not perform a calculation). By this, the main-shaft rotational speed is increased to the set rotational speed (1800 rpm), and at the time of and after the main-shaft rotational speed has reached the set rotational speed, the air jet loom 1 is brought into a state in which the main shaft 20 is rotationally driven at the set rotational speed (steady-state operation state) without increasing the main-shaft rotational speed further.

[0059] Incidentally, a line diagram of the mode of the present embodiment such as that described above in which the main-shaft rotational speed is increased becomes a solid line in Fig. 3. Moreover, when the main shaft 20 is driven in such a mode, the actual change in the main-shaft rotational speed is as shown by a broken line in Fig. 3.

[0060] In this way, according to the driving control method of a loom at the time of start-up by the driving control device 30 of the present embodiment, the loom is started by temporarily raising the main-shaft rotational speed to the start-up rotational speed that is lower than the set rotational speed and that is set by considering the load that is applied to the main-shaft driving device 60 when starting the loom, and then by increasing the main-shaft rotational speed to the set rotational speed in accordance with the predetermined rotational-speed increase mode. Therefore, according to this starting method, compared to the existing starting method (existing method) in which the main-shaft rotational speed is

raised all at once to the set rotational speed as it has been conventionally, the load that is applied to the main-shaft driving device 60 at the time of start-up is reduced. **[0061]** Note that, according to the starting method, since the load that is applied to the main-shaft driving device 60 is reduced as mentioned above, even if the loom is started in a control mode that is a mode at the time of start-up performed in existing general looms and that allows the main-shaft rotational speed to be raised to a target rotational speed (start-up rotational speed in the case of the present invention) in a short time, the load that is applied to the main-shaft driving device 60 at the time of start-up is allowed. Therefore, since it is not necessary to start the loom by a starting method in which the main-shaft rotational speed is raised to the set rotational speed with a gentle acceleration slope by considering the load, a weaving bar caused by an insufficient beating force does not occur immediately after starting the loom.

[0062] Further, in the present embodiment, the rotational-speed increase mode is determined so as to include a plurality of intermediate rotational speed as mentioned above. By this, it is assumed that a weft insertion is performed even in the start-up period as mentioned above; however, the weft insertion is stably performed.

[0063] Specifically, in the present invention, the rotational-speed increase mode may be a mode that does not include an intermediate rotational speed, that is, a mode in which the main-shaft rotational speed is in-

creased all at once from the start-up rotational speed to the set rotational speed. Even in such a mode, compared to the existing method, the load that is applied to the main-shaft driving device 60 at the time of start-up is reduced. However, in this case, the main-shaft rotational speed changes continuously from the start-up rotational speed towards the set rotational speed. In contrast, the rotational-speed increase mode of the present embodiment is fixed to a mode that includes a plurality of intermediate rotational speed and that allows the main-shaft rotational speed to be increased in stages from the start-up rotational speed to the set rotational speed via each intermediate rotational speed.

[0064] Specifically, the rotational-speed increase mode is determined such that one increase amount of the main-shaft rotational speed that is increased by outputting a frequency command signal is 200 rpm and the frequency command signal is output at an interval of two cycles of the loom. Note that, in the present embodiment, the set period that is set to two cycles is set by considering the influences of, for example, the load that is applied to the main-shaft driving device 60 as mentioned above, and is a (sufficiently) longer period than a period that is required to increase the main-shaft rotational speed by the set rotational-speed increase amount (200 rpm).

[0065] Therefore, according to the rotational-speed increase mode that is determined in this way, there exists a period in which the main shaft 20 is rotationally driven at the intermediate rotational speed while the main-shaft rotational speed is increased from the start-up rotational speed to the set rotational speed. The rotational-speed increase amount (change amount) in the period in which the rotational speed is increased is also lower than that when the main-shaft rotational speed changes continuously. By this, it is assumed that a weft insertion is performed even in the start-up period as mentioned above; however, the weft insertion is stably performed.

[0066] The driving control device 30 of the present embodiment is configured to perform a weft insertion at the start-up period not in accordance with the aforementioned basic weft-insertion conditions but in accordance with weft-insertion conditions determined in correspondence with the rotational speed (start-up rotational speed or intermediate rotational speed (calculated rotational speed)) in each operation state of the loom existing for one cycle or more at an earlier point in time than a point in time when the frequency command signal corresponding to the set rotational speed is output.

[0067] Specifically, in the driving control device 30, the driving control section 34 is also connected to the aforementioned weft-insertion control device 32. The driving control section 34 is configured to, at the point in time of outputting a frequency command signal to the inverter 33, output to the weft-insertion control device 32 the start-up rotational speed or intermediate rotational speed (calculated rotational speed) serving as a basis of the frequency command signal that is output. However, the driving control section 34 is configured to, when the calcu-

lated rotational speed determined by the calculation function matches the set rotational speed, output to the weft-insertion control device 32 the set rotational speed stored in the storage section 34a instead of the calculated rotational speed.

[0068] Moreover, the weft-insertion control device 32 is configured to determine, on the basis of the start-up rotational speed or the calculated rotational speed that is input from the driving control section 34 (hereunder generically called "input rotational speed"), the weft-insertion conditions corresponding to the respective input rotational speed, and to perform a weft insertion during two cycles from when the driving control section 34 has output a frequency command signal corresponding to the input rotational speed in accordance with the determined weft-insertion condition.

[0069] Regarding the method of determining the weft-insertion conditions corresponding to the respective input rotational speed in the weft-insertion control device 32, in the present embodiment, the weft-insertion control device 32 stores computing equations for determining the set values of the respective weft-insertion conditions corresponding to the input rotational speeds. Regarding each weft-insertion condition, the computing equations include the set rotational speed and the set values (basic set values) of the basic weft-insertion conditions as fixed values, and each basic set value is set so as to be changed to the set value corresponding to the input rotational speed by using the ratio between the input rotational speed and the set rotational speed corresponding thereto.

[0070] By this, the weft-insertion control device 32 determines the set values corresponding to the input rotational speed for the respective weft-insertion conditions by using the computing equations each time an input rotational speed is input from the driving control section 34 as mentioned above. Moreover, the weft-insertion control device 32 temporarily stores the determined set values of the respective weft-insertion conditions, and controls the operation of each weft-insertion related device as described above in accordance with the corresponding set value.

[0071] In this way, according to the driving control device 30 of the present embodiment, regarding the weft insertion in the start-up period, in an operation state in which the main-shaft rotational speed is controlled in accordance with the start-up rotational speed, a weft insertion is performed by controlling the operation of each weft-insertion related device in accordance with the set value of its corresponding weft-insertion condition corresponding to the start-up rotational speed. In an operation state in which the main-shaft rotational speed is controlled in accordance with each intermediate rotational speed (calculated rotational speed), a weft insertion is performed by controlling the operation of each weft-insertion related device in accordance with the set value of its corresponding weft-insertion condition corresponding to the calculated rotational speed. By this, the weft

insertion in the start-up period is performed under the optimal weft-insertion conditions corresponding to the respective operation states, and each weft insertion is stably performed. Note that, when the calculated rotational speed calculated as mentioned above matches the set rotational speed, the operation state is brought into a state in which the main-shaft rotational speed is controlled in accordance with the set rotational speed; however, in the operation state, a weft insertion is performed in accordance with the basic set value of the basic weft-insertion condition.

[0072] In the present embodiment, the set values of the weft-insertion conditions corresponding to the respective operation states are calculated by using previously set computing equations. According to this, even if, for example, the set rotational speed and the basic set values of the basic weft-insertion conditions are changed, an operator does not need to go to the trouble of manually inputting a weft-insertion condition corresponding to the start-up rotational speed and a weft-insertion condition corresponding to an intermediate rotational speed for every change, thereby reducing the burden on the operator in a setting operation.

[0073] An embodiment (referred to as "the embodiment" below) of the driving control device according to the present invention in which an air jet loom is taken as an example of a loom that is assumed has been described above. However, the present invention is not limited to what has been described in the embodiment. Other embodiments (modifications) such as those described below can be carried out.

(1) In the embodiment, the present invention is described with a loom whose set rotational speed is 1800 rpm being taken as an example. However, the loom that is assumed by the present invention is not particularly limited in terms of its set rotational speed, so that the set rotational speed includes rotational speeds that are set higher than 1800 rpm of the embodiment, or rotational speeds that are set lower than 1800 rpm of the embodiment. That is, the present invention is applied to a loom by considering the load that is applied to the main-shaft driving device at the time of start-up, and is not applied in accordance with the set rotational speed. Therefore, the set rotational speed of the loom to which the present invention is applied is not particularly limited to certain set rotational speeds.

Note that, as mentioned above, when the set rotational speed is high, the load becomes large in order to raise the main-shaft rotational speed to the set rotational speed; however, even if the set rotational speed is low, in particular, when the set rotational speed is lower than the start-up rotational speed in the embodiment (such as 700 rpm), the present invention is applied. That is because, in, for example, a loom where the shedding device uses a driving motor as a driving source and, as mentioned above,

a large force is needed for driving a heald frame in the shedding device, even if the set rotational speed is set as a low rotational speed, similarly to when the aforementioned set rotational speed is high, the load is large at the time of start-up, and a problem that the main-shaft driving device breaks due to the large load occurs.

Moreover, the start-up rotational speed in the present invention is, as mentioned above, the rotational speed that is set based on the set rotational speed at that time in the loom to which the present invention needs to be applied, is less than or equal to the aforementioned allowable rotational speed that is lower than the set rotational speed, and is set so as to be greater than or equal to 25% of the set rotational speed. Therefore, the start-up rotational speed is naturally not limited to 1000 rpm of the embodiment. For example, when the set rotational speed is the aforementioned 700 rpm and the allowable rotational speed is 500 rpm, the start-up rotational speed is set at any value (desirably a value close to an upper limit) between 175 rpm to 500 rpm. (2) Regarding the rotational-speed increase mode, in the embodiment, the rotational-speed increase mode is determined so as to include intermediate rotational speeds, and the rotational-speed increase amount towards the intermediate rotational speeds or the set rotational speed is uniformly set at the same value of 200 rpm in each increase stage. However, in the present invention, even if the rotational-speed increase mode is determined so as to include intermediate rotational speeds as in the embodiment, the rotational-speed increase amount in each increase stage towards each intermediate rotational speed or the set rotational speed is not limited to the setting in the embodiment, and is arbitrarily settable. For example, the rotational-speed increase mode may be a mode in which, when the start-up rotational speed and the set rotational speed are the same as those of the present embodiment, first, the rotational speed is increased by 400 rpm from the start-up rotational speed, the rotational speed is thereafter increased again by 400 rpm from an intermediate rotational speed (1400 rpm), and the main-shaft rotational speed becomes the set rotational speed. In this case, the rotational-speed increase amount in each increase stage is uniformly the same in the embodiment; however, the intermediate rotational speed in the rotational-speed increase mode is only one. In the same case, the rotational-speed increase mode may be a mode in which the main-shaft rotational speed becomes the set rotational speed after three increase stages from the start-up rotational speed, the rotational-speed increase amount is 300 rpm in two of the three increase stages, and the remaining rotational-speed increase amount is 200 rpm. That is, the rotational-speed increase amount in each increase stage is not limited to the case in

which it is uniformly the same for all increase stages as it is in the embodiment, and may be arbitrarily set in each increase stage.

However, the rotational-speed increase amount is set in a range of an allowable increase amount that is determined (so as not to adversely influence the weft insertion) by considering the influence that changes in the main-shaft rotational speed when increasing the main-shaft rotational speed by an increase amount has on the weft insertion. Note that, as mentioned above, in the loom to which the present invention is applied, the set rotational speed is not particularly limited to certain set rotational speed, and the start-up rotational speed is set based on the set rotational speed and the allowable rotational speed. Considering the allowable increase amount and the range from the start-up rotational speed at this time to the set rotational speed, the rotational-speed increase amount in the rotational-speed increase mode is determined based on, for example, whether to increase the rotational speed by dividing the range into a number of stages or how much the increase amount is to be increased in each increase stage.

(3) Regarding the rotational-speed increase mode, in the embodiment, in order to increase the main-shaft rotational speed according to the rotational-speed increase mode, the aforementioned set period is set such that the frequency command signal for increasing the main-shaft rotational speed is output every predetermined period. Note that the set period is set by considering the time (increase period) required for increasing the main-shaft rotational speed by the rotational-speed increase amount as mentioned above. Moreover, in the embodiment, the set period includes the aforementioned increase period in which the main-shaft rotational speed is increased by 200 rpm and is set at two cycles, which is the shortest period, by setting the set period in cycle units of a loom.

However, in the present invention, the rotational-speed increase mode is not limited to a mode in which the set period is set to the shortest period as it is in the embodiment. That is, the set period may be a period that includes the increase period and that is an integral multiple of loom cycles. Therefore, for example, even when the rotational-speed increase amount is 200 rpm, which is the same as that of the embodiment, the set period may be any period that is longer than two cycles, which is the shortest period mentioned above. However, when the set period is made long, the start-up time becomes correspondingly longer, so that the set period is set by also considering the start-up period.

Further, even if, as mentioned above, the rotational-speed increase mode includes a plurality of intermediate rotational speed and a plurality of the increase stages (including a plurality of set periods) as men-

tioned above, all set periods need not be set at the same number of cycles. That is, in this case, the set periods of the corresponding increase stages in the start-up period are not limited to the same number of cycles in all of the increase stages as it is in the embodiment, and may be arbitrarily set in each increase stage.

In the present invention, the rotational-speed increase mode is not limited to a mode including set periods as in the embodiment. For example, the driving control device is configured to, for example, have the function of detecting the main-shaft rotational speed and have the function of comparing the rotational speed (command rotational speed) based on a frequency command signal at and after the output of the frequency command signal with the detected main-shaft rotational speed (detected rotational speed). Moreover, the driving control device is configured to output the next frequency command signal at a predetermined timing when and after the command rotational speed and the detected rotational speed have matched (for example, when the crank angle has reached 0°). According to this structure, even if the set period is not set as mentioned above, a frequency command signal can be output every period corresponding to the rotational-speed increase amount.

(4) In the embodiment, in implementing the rotational-speed increase mode including such intermediate rotational speeds mentioned above, the rotational-speed increase amount (200 rpm) is set and is stored in the driving control section, and the rotational speed to be increased next is calculated by using the rotational-speed increase amount and is determined. However, in the present invention, even if the rotational-speed increase mode includes intermediate rotational speeds as in the embodiment, the method is not limited to the method of determining the intermediate rotational speed by a calculation by setting the rotational-speed increase amount as in the embodiment, and may be a method in which the intermediate rotational speeds, themselves, that are assumed in the rotational-speed increase mode are previously stored in the driving control section (storage section), and the next intermediate rotational speed is selected when a frequency command signal is output.

Note that, in this case, for example, by configuring the driving control device to associate an intermediate rotational speed with the number of cycles from the switching point in time and store the intermediate rotational speed or to output a frequency command signal based on the detected rotational speed as mentioned above, the frequency command signal is output every predetermined period. Further, in this case, the output of the frequency command signal corresponding to the set rotational speed after the driving based on the last intermediate rotational

speed (when there is only one intermediate rotational speed, this intermediate rotational speed) may be performed in a mode that is the same as the mode for the intermediate rotational speed. In this case, the intermediate rotational speeds that are stored in the storage section of the driving control section in this way correspond to so-called driving set values in the present invention.

(5) Regarding the weft insertion in the start-up period, in the embodiment, the weft-insertion control device is configured to calculate set values of respective weft-insertion conditions corresponding to input rotational speeds (start-up rotational speed or intermediate rotational speed) based on the input rotational speed that are input from the driving control section, and to control the operation of each weft-insertion related device in accordance with each set value and perform the weft insertion.

However, in the present invention, the method of determining the set value of each weft-insertion condition is not limited to one in which the set value of each weft-insertion condition is determined by a calculation based on the input rotational speed as in the embodiment. The method may be one in which, as with the basic weft-insertion conditions, the set values of respective weft-insertion conditions corresponding to the start-up rotational speed and intermediate rotational speed are previously stored in the weft-insertion control device (storage unit) and the set values of the respective weft-insertion conditions are selected in accordance with the input rotational speed that are input as mentioned above. Specifically, in an operation state in which the main-shaft rotational speed is controlled in accordance with the start-up rotational speed, the set values of the respective weft-insertion conditions corresponding to the start-up rotational speed when start-up is started are selected. Further, in an operation state in which the main-shaft rotational speed is controlled in accordance with intermediate rotational speeds, when the intermediate rotational speeds are input to the weft-insertion control device, the set values of the respective weft-insertion conditions corresponding to the intermediate rotational speeds are selected.

However, as mentioned above, since the start-up rotational speed is set so as to be greater than or equal to 25% of the set rotational speed at that time and is arbitrarily set within a range that is less than or equal to the allowable rotational speed, depending upon the set rotational speed and the set start-up rotational speed at that time, the difference between the set rotational speed and the start-up rotational speed is low (for example, the set rotational speed mentioned above is 700 rpm and the start-up rotational speed is set at 500 rpm, which is the allowable rotational speed). Accordingly, when the difference between the set rotational speed and the start-up rotational speed is low and does not hinder the weft

insertion, the weft insertion in the start-up period may be performed in accordance with the set value of the basic weft-insertion condition corresponding to the set rotational speed. That is, in the present invention, the weft insertion in the start-up period may be performed in accordance with the set value of the basic weft-insertion condition as long as the weft insertion is not hindered.

(6) Regarding the rotational-speed increase mode, in the embodiment, the rotational-speed increase mode is determined so as to include intermediate rotational speeds, and, when and after the main-shaft rotational speed has reached the start-up rotational speed, is determined to a mode in which the rotational speed increases from the start-up rotational speed to the set rotational speed via the intermediate rotational speeds (via a plurality of increase stages). However, the rotational-speed increase mode of the present invention is not limited to one including such intermediate rotational speeds. That is, the rotational-speed increase mode is not limited to one in which the main-shaft rotational speed is increased from the start-up rotational speed to the set rotational speed via the plurality of increase stages as in the embodiment. Specifically, for example, when the difference between the set rotational speed and the start-up rotational speed is low as mentioned above (set rotational speed is 700 rpm, and start-up rotational speed is 500 rpm), and the range from the start-up rotational speed to the set rotational speed is within a range of the allowable increase amount, the rotational-speed increase mode may be a mode that does not include intermediate rotational speeds. In this case, the rotational-speed increase mode is a mode in which the main-shaft rotational speed is increased from the start-up rotational speed to the set rotational speed all at once.

(7) Note that the present invention is not limited to the air jet loom described in the embodiment, and is also applicable to other shuttle-less looms, such as a water jet loom or a rapier loom. The present invention is not limited to any of the embodiments described above, and can be variously changed without departing from the spirit of the present invention.

Claims

1. A driving control method of a loom in which driving of a driving motor (60a) of a main-shaft driving device (60) is controlled, the main-shaft driving device (60) driving a main shaft (20) such that the main shaft (20) is rotationally driven at a time of a steady-state operation in accordance with a set rotational speed that has been previously set, the method comprising:

previously setting a start-up rotational speed that is set to a rotational speed that is lower than

the set rotational speed, that is less than or equal to a rotational speed that is determined by considering a load of the main-shaft driving device (60), and that is set so as to be greater than or equal to 25% of the set rotational speed; and in performing a start-up of the loom from when the start-up is started to when a rotational speed of the main shaft (20) reaches the set rotational speed, performing the start-up while being accompanied by a weft insertion in a start-up period for one or more cycles of the loom, and performing control of the driving motor (60a) from when the start-up is started in accordance with the start-up rotational speed, and, when and after the rotational speed of the main shaft (20) has reached the start-up rotational speed, performing control of the driving of the driving motor (60a) such that the rotational speed of the main shaft (20) is increased from the start-up rotational speed to the set rotational speed in accordance with a predetermined rotational-speed increase mode.

2. The driving control method of the loom according to Claim 1, wherein the rotational-speed increase mode is determined so as to include a state in which the main shaft (20) is rotationally driven for the one or more cycles of the loom at one or more intermediate rotational speeds that are determined as rotational speeds that are lower than the set rotational speed and higher than the start-up rotational speed.
3. The driving control method of the loom according to Claim 2, wherein, with the rotational-speed increase mode being determined so as to include the one or more intermediate rotational speeds, a rotational-speed increase amount towards the one or more intermediate rotational speeds is set at the loom, and the control of the driving of the driving motor (60a) in a process of increasing the rotational speed of the main shaft (20) from the start-up rotational speed to the set rotational speed is performed based on the rotational-speed increase amount.
4. The driving control method of the loom according to Claim 2 or Claim 3, wherein a basic weft-insertion condition, which is a weft-insertion condition for a weft insertion at the time of the steady-state operation, is previously set at the loom, and the weft insertion at the time of the steady-state operation is performed in accordance with the basic weft-insertion condition, and wherein, in the start-up period, a weft insertion when the main shaft (20) is rotationally driven in accordance with the start-up rotational speed and a weft insertion when the main shaft (20) is rotationally driven in accordance with the one of more intermediate rotational speeds are performed in accordance with

weft-insertion conditions determined in accordance with the rotational speeds corresponding thereto.

5. The driving control method of the loom according to Claim 4, wherein a condition of the weft-insertion when the main shaft (20) is rotationally driven in accordance with the start-up rotational speed and a condition of the weft-insertion when the main shaft (20) is rotationally driven in accordance with the one or more intermediate rotational speeds are determined by a calculation based on the basic weft-insertion condition and the rotational speeds corresponding thereto.

6. A driving control device (30) of a loom, the driving control device (30) controlling driving of a driving motor (60a) of a main-shaft driving device (60) that drives a main shaft (20) such that the main shaft (20) is rotationally driven at a time of a steady-state operation in accordance with a set rotational speed that has been previously set and controlling an operation of each weft-insertion related device involved in a weft insertion to perform the weft insertion, the driving control device (30) comprising:

a storage section (34a) that stores a start-up rotational speed and a driving set value, the start-up rotational speed being set to a rotational speed that is lower than the set rotational speed, being less than or equal to a rotational speed that is determined by considering a load of the main-shaft driving device (60), and being set so as to be greater than or equal to 25% of the set rotational speed, the driving set value being set in accordance with a rotational-speed increase mode that has been predetermined for increasing a rotational speed of the main shaft (20) from the start-up rotational speed to the set rotational speed,

wherein the driving of the driving motor (60a) and the operation of each weft-insertion related device are controlled such that a start-up of the loom from when the start-up of the loom is started to when the rotational speed of the main shaft (20) reaches the set rotational speed is performed while being accompanied by a weft insertion in a start-up period for one or more cycles of the loom, and

control of the driving motor (60a) from when the start-up is started is performed in accordance with the start-up rotational speed, and, when and after the rotational speed of the main shaft (20) has reached the start-up rotational speed, the control of the driving motor (60a) is performed based on the driving set value such that the rotational speed of the main shaft (20) is increased from the start-up rotational speed to the set rotational speed in accordance with the rotational-

speed increase mode.

7. The driving control device (30) of the loom according to Claim 6, wherein the rotational-speed increase mode is determined so as to include a state in which the main shaft (20) is rotationally driven for the one or more cycles of the loom at one or more intermediate rotational speeds that are determined as rotational speeds that are lower than the set rotational speed and higher than the start-up rotational speed.

8. The driving control device (30) of the loom according to Claim 7, wherein, with the rotational-speed increase mode being determined so as to include the one or more intermediate rotational speeds, the driving set value is set so as to include a rotational-speed increase amount towards the one or more intermediate rotational speeds.

9. The driving control device (30) of the loom according to Claim 7 or Claim 8, wherein a basic weft-insertion condition, which is a weft-insertion condition for a weft insertion at the time of the steady-state operation, is previously set at the loom, and the weft insertion at the time of the steady-state operation is performed in accordance with the basic weft-insertion condition, and

wherein, in the start-up period, a weft insertion when the main shaft (20) is rotationally driven in accordance with the start-up rotational speed and a weft insertion when the main shaft (20) is rotationally driven in accordance with the one of more intermediate rotational speeds are performed in accordance with weft-insertion conditions determined in accordance with the rotational speeds corresponding thereto.

10. The driving control device (30) of the loom according to Claim 9, wherein a condition of the weft-insertion when the main shaft (20) is rotationally driven in accordance with the start-up rotational speed and a condition of the weft-insertion when the main shaft (20) is rotationally driven in accordance with the one or more intermediate rotational speeds are determined by a calculation based on the basic weft-insertion condition and the rotational speeds corresponding thereto.

FIG. 1

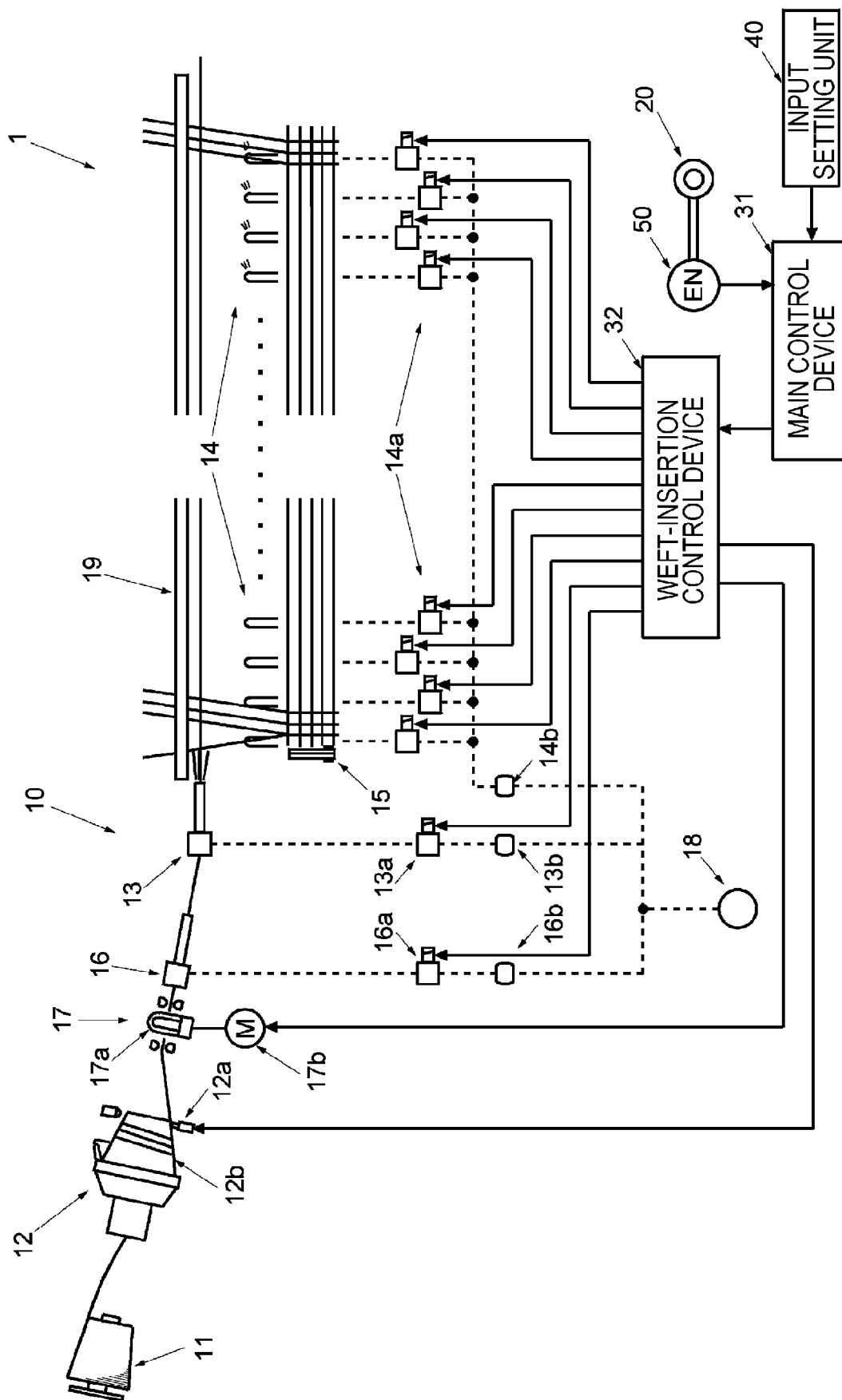


FIG. 2

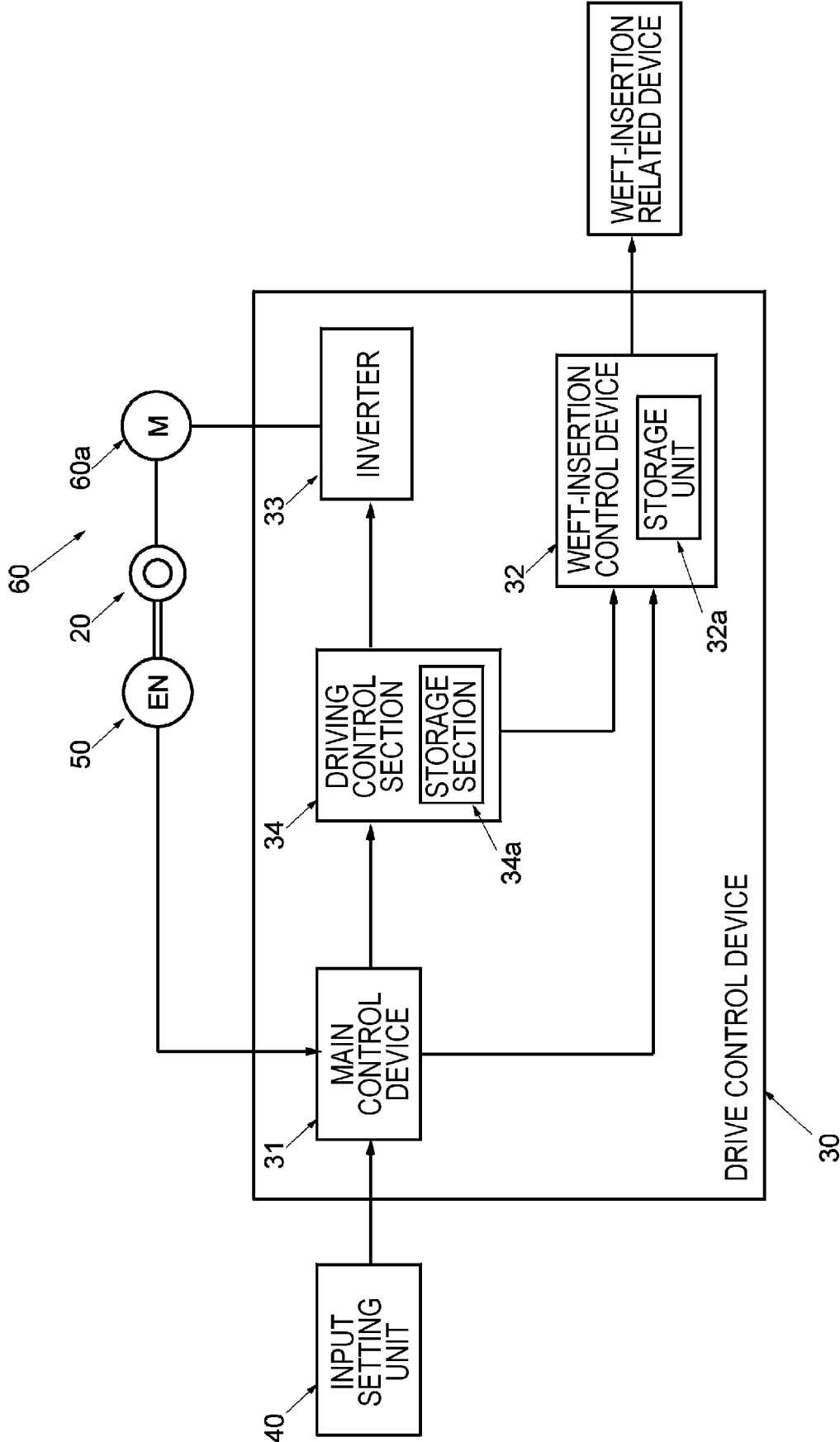
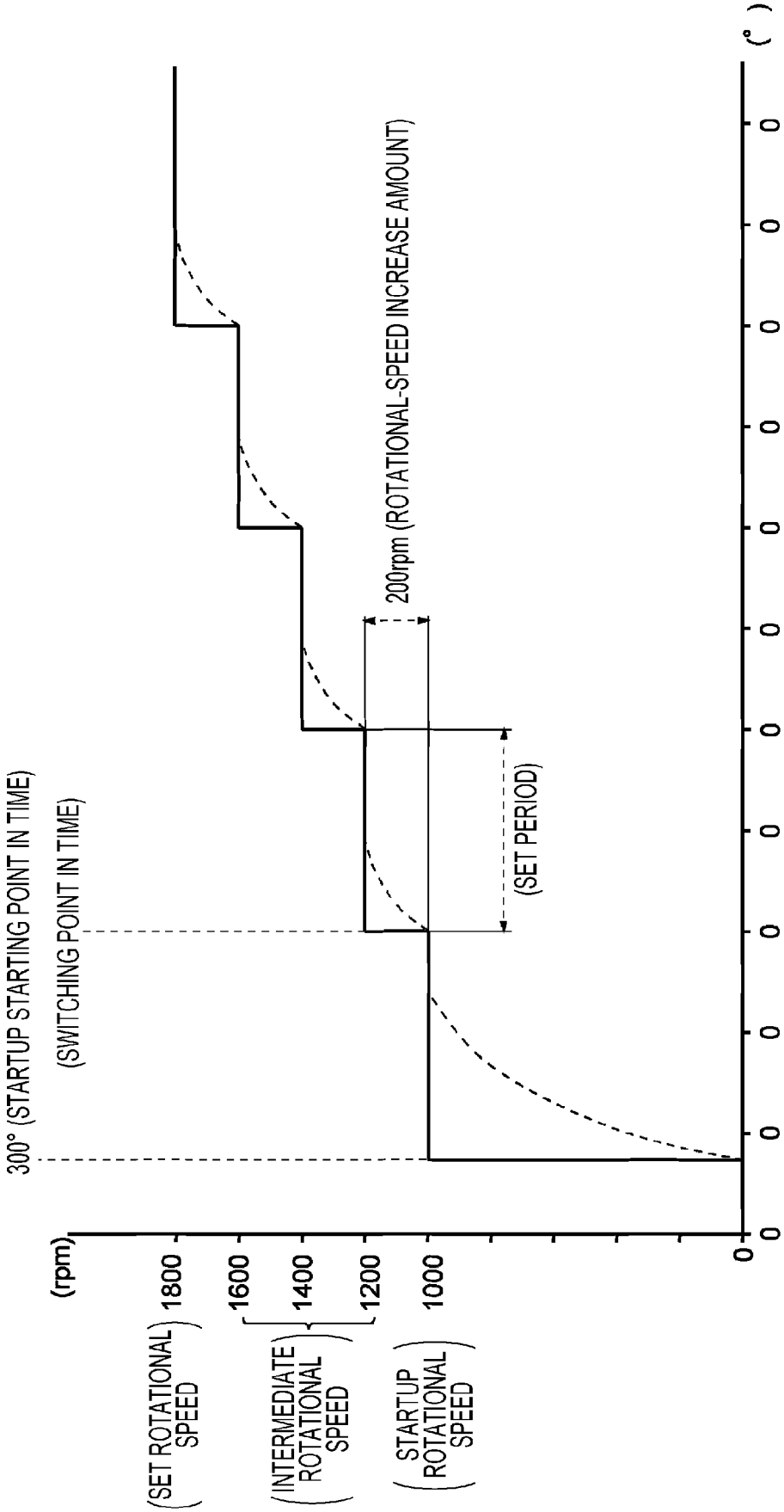


FIG. 3





EUROPEAN SEARCH REPORT

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Place of search Munich		Date of completion of the search 25 June 2019	Examiner Hausding, Jan
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