Method and device for controlling driving of processing machine

This invention relates to a sheet-fed offset printing press including a gear (3) driven by an upstream drive motor (1A), a gear (2) rotationally driven by the upstream drive motor (1A) through the gear (3), an impression cylinder (23) of an upstream printing unit group (20A), and a transfer cylinder (24) of a downstream printing unit group (20B). The impression cylinder (23) is rotationally driven by the gear (2) and has a holding portion for holding a paper sheet W. The transfer cylinder (24) is rotationally driven by a downstream drive motor (1B) and has a holding portion for receiving the paper sheet W from the holding portion of the impression cylinder (23). The printing press further includes an impression-cylinder-side peripheral speed measuring device (6A) for measuring the peripheral speed of the impression cylinder (23) and a transfer-cylinder-side peripheral speed measuring device (6B) for measuring the peripheral speed of the transfer cylinder (24). The rotational phase difference between the impression and transfer cylinders (23, 24) is obtained from signals from the impression-cylinder-side and transfer-cylinder-side peripheral speed measuring devices (6A, 6B).

Fig.13
Description

[Technical Field]

[0001] The present invention relates to a method and device for controlling the driving of a processing machine such as a sheet-fed offset printing press.

[Background Art]

[0002] In conventional convertible sheet-fed offset printing presses and latest sheet-fed offset printing presses which include a large number of processing units in order to deal with an increased number of colors for higher-quality printing or add other processing units (for coating, embossing, and the like) for high-value-added production, all the processing units have been driven by one drive motor.

[0003] Accordingly, there has been the following problem: since the load on the drive motor is heavy, a drive motor having a large capacity must be used; as a result, an expensive motor must be used, and a driving system having great rigidity is required, leading to a further increase in size; thus, a motor having an increasingly larger capacity must be used, and faster printing cannot be dealt with.

[Citation List]

[Patent Literature 1]


[Summary of Invention]

[Technical Problem]

[0005] Accordingly, as described in Patent Literature 1, one possible configuration is as follows: a processing unit group (called a printing unit in Patent Literature 1) located on the upstream side in the paper flow direction and a processing unit group (called a machining unit in Patent Literature 1) located on the downstream side are driven by different drive motors, respectively; and the two drive motors are controlled so that the speeds and phases thereof may be synchronized with each other.

[0006] However, by taking as an example a sheet-fed offset printing press including a large number of processing units, due to non-uniformity in mass caused by the presence of a notched portion of an impression cylinder located at the rearmost position in an upstream printing unit group and non-uniformity in mass caused by the presence of a notched portion of a transfer cylinder located at the foremost position in a downstream printing unit group, non-uniform rotation is caused by a clearance between a gear of the impression cylinder of the upstream printing unit group and a gear of a transfer cylinder located adjacent upstream thereof, and non-uniform rotation is caused by a clearance between a gear of the transfer cylinder of the downstream printing unit group and a gear of an impression cylinder located adjacent downstream thereof.

[0007] Moreover, also in each printing unit, non-uniform rotation is caused by a clearance between gears due to load variations between a plate cylinder and a blanket cylinder (e.g., load variations between the state in which the peripheral surfaces of the plate and blanket cylinders are in contact with each other and subjected to the pressure of the contact therebetween and the state in which the notched portions of the plate and blanket cylinders face each other and are not subjected to contact pressure).

[0008] This may cause the following problem: when paper is passed from the upstream printing unit group to the downstream printing unit group, the paper cannot be passed to a correct position every time, and a printing trouble may occur; if variations in the rotational speeds become larger, there may occur a paper gripping error, a folded paper edge, or the like, and it may take an enormous time to resume the operation of the printing press.

[0009] Accordingly, an object of the present invention is to solve the above-described problems by measuring the respective peripheral speeds of rotating parts by which a workpiece is passed between processing unit groups driven by different driving means, obtaining the rotational phase difference between these rotating parts from the measured peripheral speeds, and thus enabling an instant determination as to whether or not there is a synchronization error.

[Solution to Problem]

[0010] To achieve the above-described object, a method for controlling the driving of a processing machine according to the present invention has the following characteristics:

(1) The processing machine includes first driven means driven by first driving means, second driven means rotationally driven by the first driving means through the first driven means, a first rotating part which is rotationally driven by the second driven means and which has a notched portion containing a first holding portion for holding a workpiece, a second rotating part which is rotationally driven by second driving means and which has a notched portion containing a second holding portion for receiving the workpiece from the first holding portion of the first rotating part, first peripheral speed measuring means for measuring a peripheral speed of the first rotating part, and second peripheral speed measuring means for measuring a peripheral speed of the second rotating part; and a rotational phase difference between the first and second rotating parts is obtained from respective signals from the first and
According to the present invention configured as described above, by obtaining the rotational phase difference (position deviation) between the first and second rotating parts separately rotationally driven, an instant and quantitative determination can be made as to whether or not there is a synchronization error. Thus, subsequent handling of the processing machine can immediately be performed, and the frequency of occurrence of printing troubles and the like can be reduced to the minimum. Further, the time from an abnormal stop of the machine to the resumption of the operation thereof can be reduced to improve the operation rate thereof.

Moreover, the actual peripheral speeds of the first and second rotating parts are measured by peripheral speed measuring means which are provided separately from and outside of a synchronization control system and which measure the actual peripheral speeds of
the first and second rotating parts, the actual rotational phase difference (position deviation) between the first and second rotating parts is obtained from the difference between the measured peripheral speeds, and a determination is made based on the rotational phase difference as to whether or not paper or the like is being conveyed correctly. Accordingly, a correct determination can be made as to whether or not there is abnormal conveyance.

[Brief Description of Drawings]

**0022**

[Fig. 1A] Fig. 1A is a partial hardware block diagram of an upstream printing unit group drive control device, showing one example of the present invention. [Fig. 1B] Fig. 1B is a partial hardware block diagram of the upstream printing unit group drive control device, showing one example of the present invention. [Fig. 2] Fig. 2 is a hardware block diagram of a downstream printing unit group drive control device. [Fig. 3A] Fig. 3A is a partial hardware block diagram of a synchronization error determination device. [Fig. 3B] Fig. 3B is a partial hardware block diagram of the synchronization error determination device. [Fig. 4A] Fig. 4A is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 4B] Fig. 4B is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 4C] Fig. 4C is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 4D] Fig. 4D is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 5A] Fig. 5A is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 5B] Fig. 5B is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 5C] Fig. 5C is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 6A] Fig. 6A is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 6B] Fig. 6B is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 6C] Fig. 6C is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 7A] Fig. 7A is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 7B] Fig. 7B is a partial operation flow diagram of the upstream printing unit group drive control device. [Fig. 8A] Fig. 8A is a partial operation flow diagram of the downstream printing unit group drive control device. [Fig. 8B] Fig. 8B is a partial operation flow diagram of the downstream printing unit group drive control device. [Fig. 9A] Fig. 9A is a partial operation flow diagram of the downstream printing unit group drive control device. [Fig. 9B] Fig. 9B is a partial operation flow diagram of the downstream printing unit group drive control device. [Fig. 10A] Fig. 10A is a partial operation flow diagram of the downstream printing unit group drive control device. [Fig. 10B] Fig. 10B is a partial operation flow diagram of the downstream printing unit group drive control device. [Fig. 11A] Fig. 11A is a partial operation flow diagram of the synchronization error determination device. [Fig. 11B] Fig. 11B is a partial operation flow diagram of the synchronization error determination device. [Fig. 11C] Fig. 11C is a partial operation flow diagram of the synchronization error determination device. [Fig. 11D] Fig. 11D is a partial operation flow diagram of the synchronization error determination device. [Fig. 12] Fig. 12 is a schematic side view showing the configuration of a sheet-fed offset printing press. [Fig. 13] Fig. 13 is a plan view showing a drive separation portion of the sheet-fed offset printing press.

[Description of Embodiments]

**0023** With reference to the drawings, a method and device for controlling the driving of a processing machine according to the present invention will be described in detail below using examples.

[Example]

**0024** Figs. 1A and 1B constitute a hardware block diagram of an upstream printing unit group drive control device, showing one example of the present invention. Fig. 2 is a hardware block diagram of a downstream printing unit group drive control device. Figs. 3A and 3B constitute a hardware block diagram of a synchronization error determination device.

**0025** Figs. 4A to 4D constitute an operation flow diagram of the upstream printing unit group drive control device. Figs. 5A to 5C constitute an operation flow diagram of the upstream printing unit group drive control device. Figs. 6A to 6C constitute an operation flow diagram of the upstream printing unit group drive control devices. Figs. 7A and 7B constitute an operation flow...
As shown in Fig. 12, the sheet-fed offset printing press (processing machine) includes a feeder 10, a printing section 20, and a delivery unit 30. The printing section 20 includes an upstream printing unit group 20A and a downstream printing unit group 20B. The upstream printing unit group 20A includes offset printing units 20a to 20f, the cooling unit 20j cools the paper sheet W passed through a transfer cylinder 24, and then transfers the paper sheet W to a subsequent unit. Each of the offset printing units 20a to 20f performs printing on a paper sheet W passed through a transfer cylinder 24 and then transfers the paper sheet W to a subsequent unit.

The coating unit 20g includes an impression cylinder 23 and a bracket cylinder 25. The coating unit 20g performs coating on a paper sheet W passed through a transfer cylinder 24 and then transfers the paper sheet W to the drying unit 20h. The drying unit 20h includes a transport cylinder 26 and UV lamps 27. The drying unit 20h includes a transport cylinder 26 and UV lamps 27. The drying unit 20h dries ink and a coating agent on the paper sheet W passed from the transport cylinder 26 of the cooling unit 20j to be delivered onto a delivery chain 32 looped over a delivery cylinder 31 to be delivered onto an output tray 33.

In this example, as shown in Fig. 13, the upstream printing unit group 20A and the downstream printing unit group 20B are separately driven: the upstream printing unit group 20A is driven by an upstream drive motor (first driving means; electric motor) 1A through a wound transmission device such as a belt 4A, and the downstream printing unit group 20B is driven by a downstream drive motor (second driving means; electric motor) 1B through a wound transmission device such as a belt 4B. Specifically, a gear (second driven means) 2 of the rearmost impression cylinder 23 (first rotating part) 23 of the upstream printing unit group 20A does not engage with a gear 3 of the foremost transfer cylinder (second rotating part) 24 of the downstream printing unit group 20B.

In this example, as shown in Fig. 13, the downstream printing unit group 20B is driven by a downstream drive motor (first driving means; electric motor) 1A through a wound transmission device such as a belt 4A, and the downstream printing unit group 20B is driven by a downstream drive motor (second driving means; electric motor) 1B through a wound transmission device such as a belt 4B.

Specifically, a gear (second driven means) 2 of the rearmost impression cylinder 23 (first rotating part) 23 of the upstream printing unit group 20A does not engage with a gear 3 of the foremost transfer cylinder (second rotating part) 24 of the downstream printing unit group 20B. The gear 2 of this impression cylinder 23 engages with a gear (first driven means) 3 of the rearmost transfer cylinder 24 of the upstream printing unit group 20A to constitute part of a gear train of the upstream printing unit group 20A, thus conveying the driving force of the upstream drive motor 1A. On the other hand, the gear 3 of the foremost transfer cylinder 24 of the downstream printing unit group 20B engages with a gear 2 of the foremost impression cylinder 23 of the downstream printing unit group 20B to constitute part of a gear train of the downstream printing unit group 20B, thus conveying the driving force of the downstream drive motor 1B. It should be noted that in Fig. 13, each of 5A and 5B denotes a drive pinion.

The cylinder shaft of the foremost impression cylinder 23 of the upstream printing unit group 20A has an upstream drive motor encoder 8A attached to the end thereof opposite the gear 2 with a coupling 7A interposed therebetween. The cylinder shaft of the foremost impression cylinder 23 of the downstream printing unit group 20B has a downstream drive motor encoder 8B attached to the end thereof opposite the gear 2 with a coupling 7B interposed therebetween.

At a position opposite the peripheral surface of a bearer 23a of the rearmost impression cylinder 23 of the upstream printing unit group 20A, an impression-cylinder-side peripheral speed measuring device (first peripheral speed measuring means) 6A such as a Doppler sensor which detects a moving object based on a frequency shift due to the Doppler effect is provided to measure the peripheral speed of this impression cylinder 23. Further, at a position opposite the peripheral surface of a bearer 24a of the foremost transfer cylinder 24 of the downstream printing unit group 20B, a transfer-cyl-
ider-side peripheral speed measuring device (second peripheral speed measuring means) 6B such as a Doppler sensor which detects a moving object based on a frequency shift due to the Doppler effect is provided to measure the peripheral speed of this transfer cylinder 24.

It should be noted that the peripheral surfaces of the bearers 23a and 24a which are opposite the impression-cylinder-side peripheral speed measuring device 6A and the transfer-cylinder-side peripheral speed measuring device 6B are complete circumferential surfaces having the same radius so that the impression-cylinder-side peripheral speed measuring device 6A and the transfer-cylinder-side peripheral speed measuring device 6B can precisely measure the peripheral speeds of the rearmost impression cylinder 23 of the upstream printing unit group 20A and the foremost transfer cylinder 24 of the downstream printing unit group 20B, respectively.

The driving of the upstream drive motor 1A is controlled by the undermentioned upstream printing unit group drive control device (controlling means) 40, and the driving of the downstream drive motor 1B is controlled by the undermentioned downstream printing unit group drive control device (controlling means) 60.

Further, the upstream and downstream drive motors 1A and 1B are controlled by the upstream printing unit group drive control device 40 so that the speeds and phases thereof may be synchronized with each other. The undermentioned synchronization error determination device (controlling means) 80 determines whether or not there is an error in this synchronization control. That is, the synchronization error determination device 80 is configured to obtain the rotational phase difference between the rearmost impression cylinder 23 of the upstream printing unit group 20A and the foremost transfer cylinder 24 of the downstream printing unit group 20B based on respective signals from the impression-cylinder-side peripheral speed measuring device 6A and the transfer-cylinder-side peripheral speed measuring device 6B and to determine from this rotational phase difference (position deviation) whether or not there is a synchronization error.

As shown in Figs. 1A and 1B, the upstream printing unit group drive control device 40 is configured by connecting between not only a CPU 41, ROM 42, and RAM 43, but also input/output devices 44a to 44f, an interface 46, and an internal clock counter 45 with a BUS (bus).

There are further components connected to the BUS: memory M1 for storing a slower operation rotational speed, memory M2 for storing the currently set rotational speed, memory M3 for storing a previously set rotational speed, memory M4 for storing the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device, memory M5 for storing the count value of a counter for detecting the current rotational phase of the upstream printing unit group, memory M6 for storing the current rotational phase of the upstream printing unit group, memory M7 for storing a correction value for the rotational phase of the downstream printing unit group, and memory M8 for storing an assumed current rotational phase of the downstream printing unit group.

There are still further components connected to the BUS: memory M9 for storing a commanded rotational speed, memory M10 for storing an adjustment value for a rotational speed during acceleration, memory M11 for storing an adjusted currently set rotational speed, memory M12 for storing an adjustment value for a rotational speed during deceleration, memory M13 for storing the output of an F/V converter, and memory M14 for storing the current rotational speeds of the upstream and downstream printing unit groups.

Connected to the input/output device 44a are a synchronized operation start switch 47, a synchronized operation stop switch 48, input devices 49 such as a keyboard and various switches and buttons, display devices 50 such as a CRT and a lamp, and output devices 51 such as a printer and a floppy disk (trademark) drive.

To the input/output device 44b, a rotational speed setter 52 is connected.

To the input/output device 44c, the upstream drive motor 1A is connected through a D/A converter 53 and an upstream drive motor driver 54.

To the input/output device 44d, the upstream drive motor rotary encoder 8A connected to and driven by the upstream drive motor 1A is connected through a counter 55 for detecting the current rotational phase of the upstream printing unit group. The upstream drive motor rotary encoder 8A is connected also to the above-described upstream drive motor driver 54.

To the input/output device 44e, the aforementioned upstream drive motor rotary encoder 8A is connected through an A/D converter 56 and an F/V converter 57.

To the input/output device 44f, the downstream drive motor rotary encoder 8B is connected through an A/D converter 58 and an F/V converter 59.

Moreover, connected to the interface 46 are a printing press control device 90, the downstream printing unit group drive control device 60, and the synchronization error determination device 80.

As shown in Fig. 2, the downstream printing unit group drive control device 60 is configured by connecting between not only a CPU 61, ROM 62, and RAM 63, but also input/output devices 64a to 64f, an interface 46, and an internal clock counter 45 with a BUS (bus).

There are further components connected to this BUS: memory M15 for storing the currently set rotational speed, memory M16 for storing an assumed current rotational phase of the downstream printing unit group, memory M17 for storing the count value of a counter for detecting the current rotational phase of the downstream printing unit group, memory M18 for storing the current rotational phase of the downstream printing unit group,
and memory M19 for storing the current rotational phase difference of the downstream printing unit group.

There are still further components connected to the above-described BUS: memory M20 for storing the absolute value of the current rotational phase difference of the downstream printing unit group, memory M21 for storing a tolerance for the current rotational phase difference of the downstream printing unit group, memory M22 for storing a commanded rotational speed, memory M23 for storing a conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds, and memory M24 for storing a correction value for a set rotational speed.

Connected to the input/output device 64a are input devices 66 such as a keyboard and various switches and buttons, display devices 67 such as a CRT and a lamp, and output devices 68 such as a printer and a floppy disk (trademark) drive.

To the input/output device 64b, the downstream drive motor 1B is connected through a D/A converter 69 and a downstream drive motor driver 70.

To the input/output device 64c, the downstream drive motor rotary encoder 8B connected to and driven by the downstream drive motor 1B is connected through a counter 71 for detecting the current rotational phase of the downstream printing unit group. The downstream drive motor rotary encoder 8B is connected also to the above-described downstream drive motor driver 70.

To the interface 65, the upstream printing unit group drive control device 40 is connected.

As shown in Figs. 3A and 3B, the synchronization error determination device 80 is configured by connecting not only a CPU 81, ROM 82, and RAM 83, but also input/output devices 84a and 84b and an interface 85 with a BUS (bus).

There are further components connected to this BUS: memory M25 for storing a count value N, memory M26 for storing a peripheral speed measurement time interval, memory M27 for storing the output of the impression-cylinder-side peripheral speed measuring device, memory M28 for storing the output of the transfer-cylinder-side peripheral speed measuring device, memory M29 for storing the impression cylinder’s current peripheral speed, memory M30 for storing the transfer cylinder’s current peripheral speed, and memory M32 for storing a transfer cylinder’s average peripheral speed. It should be noted that the peripheral speed measurement time interval stored on the memory M26 is set to a time interval shorter than the time intervals at which clock pulses are generated by the upstream and downstream drive motor rotary encoders 8A and 8B during the normal printing of the sheet-fed offset printing press.

There are still further components connected to the above-described BUS: memory M33 for storing an impression cylinder’s speed variation, memory M34 for storing a transfer cylinder's speed variation, memory M35 for storing a speed deviation, memory M36 for storing a position deviation, memory M37 for storing the absolute value of the position deviation, memory M38 for storing a tolerance for the position deviation, memory M39 for storing the total of impression cylinder’s peripheral speeds obtained previously, memory M40 for storing the current total of impression cylinder’s peripheral speeds, memory M41 for storing a count value N+1, memory M42 for storing the total of transfer cylinder’s peripheral speeds obtained previously, and memory M43 for storing the current total of transfer cylinder’s peripheral speeds.

To the input/output device 84a, the impression-cylinder-side peripheral speed measuring device 6A is connected through an A/D converter.

To the input/output device 84b, the transfer-cylinder-side peripheral speed measuring device 6B is connected through an A/D converter.

To the interface 85, the upstream printing unit group drive control device 40 is connected.

The above-described configuration allows the upstream printing unit group drive control device 40 to operate according to the operation flow shown in Figs. 4A to 4D, 5A to 5C, 6A to 6C, and 7A and 7B.

Specifically, a determination is made in step P1 as to whether or not the synchronized operation starts when switch 47 is turned on. If the result of the determination is positive, the upstream printing unit group drive control device 40 goes to step P4 described later. On the other hand, if the result of the determination is negative, a determination is made in step P2 as to whether or not a set rotational speed has been inputted to the rotational speed settler 52.

Next, if the result of the determination in step P2 is positive, the set rotational speed is read from the rotational speed settler 52 and stored on the memory M2 for the currently set rotational speed in step P3, and then the upstream printing unit group drive control device 40 returns to step P1. On the other hand, the result of the determination in step P2 is negative, the upstream printing unit group drive control device 40 returns directly to step P1.

Next, in the aforementioned step P4, a synchronized operation start command is sent to the downstream printing unit group drive control device 60. Then, in step P5, a home positioning start command is sent to the downstream printing unit group drive control device 60.

Next, in step P6, the slower operation rotational speed is read from the memory M1. Then, in step P7, the slower operation rotational speed is written to the memory M2 for storing the currently set rotational speed and the memory M3 for storing a previously set rotational speed.

Next, in step P8, the internal clock counter (for counting elapsed time) 45 is started counting. Then, in step P9, the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the down-
stream printing unit group drive control device is read from the memory M4.

[0071] Next, in step P10, the count value of the internal clock counter 45 is read. Then, in step P11, a determination is made as to whether or not the count value of the internal clock counter is not less than the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device.

[0072] Next, if the result of the determination in the above-described step P11 is positive, a count value is read from the counter 55 for detecting the current rotational phase of the upstream printing unit group and stored on the memory M5 in step P12. Then, in step P13, the current rotational phase of the upstream printing unit group is calculated from the count value of the counter 55 for detecting the current rotational phase of the upstream printing unit group, and stored on the memory M6.

[0073] Next, in step P14, a correction value for the rotational phase of the downstream printing unit group is read from the memory M7. Then, in step P15, by adding the correction value for the rotational phase of the downstream printing unit group to the current rotational phase of the upstream printing unit group, an assumed current rotational phase of the downstream printing unit group is calculated to be stored on the memory M8.

[0074] Next, in step P16, the currently set rotational speed (slower operation rotational speed) is read from the memory M2. Then, in step P17, the currently set rotational speed (slower operation rotational speed) and the assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device 60.

[0075] Next, in step P18, the memory M9 for storing a commanded rotational speed is overwritten with the currently set rotational speed (slower operation rotational speed). Then, in step P19, the commanded rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P20, the currently set rotational speed (slower operation rotational speed) is stored on the memory M3 for storing a previously set rotational speed. Then, the upstream printing unit group drive control device 40 returns to step P8.

[0076] On the other hand, if the result of the determination in step P11 is negative, a determination is made in step P21 as to whether or not a home positioning completion signal has been sent from the downstream printing unit group drive control unit 60. If the result of this determination is positive, the upstream printing unit group drive control device 40 goes to step P22 described later. On the other hand, if the result of the determination is negative, the upstream printing unit group drive control device 40 returns to step P9.

[0077] Next, in the above-described step P22, the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device is read from the memory M4. Then, in step P23, the count value of the internal clock counter 45 is read.

[0078] Next, in step P24, a determination is made as to whether or not the count value of the internal clock counter 45 is not less than the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device. If the result of the determination is positive, a count value is read from the counter 55 for detecting the current rotational phase of the upstream printing unit group and stored on the memory M5 in step P25. On the other hand, if the result of the determination is negative, the upstream printing unit group drive control device 40 returns to step P22.

[0079] Next, in step P26, the current rotational phase of the upstream printing unit group is calculated from the count value of the counter 55 for detecting the current rotational phase of the upstream printing unit group, and stored on the memory M6. Then, in step P27, the correction value for the rotational phase of the downstream printing unit group is read from the memory M7.

[0080] Next, in step P28, by adding the correction value for the rotational phase of the downstream printing unit group to the current rotational phase of the upstream printing unit group, an assumed current rotational phase of the downstream printing unit group is calculated to be stored on the memory M8. Then, in step P29, the currently set rotational speed (slower operation rotational speed) is read from the memory M2.

[0081] Next, in step P30, the currently set rotational speed (slower operation rotational speed) and the assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device 60. Then, in step P31, the memory M9 for storing a commanded rotational speed is overwritten with the currently set rotational speed (slower operation rotational speed).

[0082] Next, in step P32, the commanded rotational speed is outputted to the upstream drive motor driver 54. Then, in step P33, the currently set rotational speed (slower operation rotational speed) is stored on the memory M3 for storing a previously set rotational speed.

[0083] Next, in step P34, a print start command is sent to the printing press control device 90. Then, in step P35, a measurement start command is sent to the synchronization error determination device 80.

[0084] Next, in step P36, the internal clock counter (for counting elapsed time) 45 is started counting. Then, in step P37, the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device is read from the memory M4.

[0085] Next, in step P38, the count value of the internal clock counter 45 is read. Then, in step P39, a determination is made as to whether or not the count value of
In step P52, the memory M9 for storing a commanded rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device. Then, in step P53, the commanded rotational speed is outputted to the upstream drive motor driver 54. Then, in step P54, the currently set rotational speed is stored on the memory M3 for storing a previously set rotational speed. Subsequently, the upstream printing unit group drive control device 40 returns to step P56. Then, in step P55, the currently set rotational speed is overwritten with the currently set rotational speed.

Next, in step P57, the command value is read from the count value of the counter 55 for detecting the current rotational phase of the downstream printing unit group and stored on the memory M8. Then, in step P58, by adding the correction value for the rotational phase of the downstream printing unit group to the current rotational phase of the upstream printing unit group, an assumed current rotational phase of the downstream printing unit group is calculated to be stored on the memory M8.

Next, in step P59, the set rotational speed is read from the rotational speed setter 52 and stored on the memory M2 for storing the currently set rotational speed. Then, in step P60, the set rotational speed is read from the memory M7.

Next, in step P61, the memory M9 for storing a commanded rotational speed is outputted to the upstream drive motor driver 54. Then, in step P62, the commanded rotational speed is overwritten with the currently set rotational speed. Then, in step P63, the currently set rotational speed is stored on the memory M3 for storing a previously set rotational speed.

Next, in step P64, the count value of the internal clock counter (for counting elapsed time) is started counting. Then, in step P65, the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device is read from the memory M4.

Next, in step P66, the count value of the internal clock counter 45 is read. Then, in step P67, a determination is made as to whether or not the count value of the internal clock counter is not less than the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device.

Next, if the result of the determination in the above-described step P67 is positive, the upstream printing unit group drive control device 40 goes to step P68 and the internal clock counter is not less than the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device.
step P77 as to whether or not an error signal has been sent from the synchronization error determination device 80.

Next, if the result of the determination in the above-described step P77 is positive, the upstream printing unit group drive control device 40 goes to step P79 described later. On the other hand, if the result of the determination is negative, a determination is made in step P78 as to whether or not the synchronized operation stop switch 48 is turned on. If the result of this determination is positive, the upstream printing unit group drive control device 40 goes to step P79 described later. On the other hand, if the result of the determination is negative, the upstream printing unit group drive control device 40 returns to step P65.

Next, in step P68, a count value is read from the counter 55 for detecting the current rotational phase of the upstream printing unit group and stored on the memory M5. Then, in step P69, the current rotational phase of the upstream printing unit group is calculated from the count value of the counter 55 for detecting the current rotational phase of the upstream printing unit group, and stored on the memory M6.

Next, in step P70, the correction value for the rotational phase of the downstream printing unit group is read from the memory M7. Then, in step P71, by adding the correction value for the rotational phase of the downstream printing unit group to the current rotational phase of the upstream printing unit group, an assumed current rotational phase of the downstream printing unit group is calculated to be stored on the memory M8.

Next, in step P72, the set rotational speed is read from the rotational speed setter 52 and stored on the memory M2 for storing a previously set rotational speed. Then, in step P73, the currently set rotational speed and the assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device 60. Subsequently, in step P74, the memory M9 for storing a commanded rotational speed is overwritten with the currently set rotational speed. Then, in step P75, the commanded rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P76, the currently set rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P77, the currently set rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P78, the currently set rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P79, the currently set rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P80, the currently set rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P81, the corrected rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P82, the previously set rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P83, the set rotational speed is read from the rotational speed setter 52 and stored on the memory M2 for storing the currently set rotational speed. Then, in step P84, the assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device 60.

Next, in step P85, the memory M9 for storing a commanded rotational speed is overwritten with the currently set rotational speed. Then, in step P86, the commanded rotational speed is outputted to the upstream drive motor driver 54. Subsequently, in step P87, the currently set rotational speed is stored on the memory M3 for storing a previously set rotational speed.

Next, in step P88, a print stop command is sent to the printing press control device 90. Then, in step P89, a measurement stop command is sent to the synchronization error determination device 80.

Next, in step P90, the internal clock counter (for counting elapsed time) 45 is started counting. Then, in step P91, the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device is read from the memory M4.

Next, in step P92, a count value is read from the internal clock counter 45. Then, in step P93, a determination is made as to whether or not the count value of the internal clock counter is not less than the time interval at which the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device.

Next, if the result of the determination in the above-described step P93 is positive, a count value is read from the counter 55 for detecting the current rotational phase of the upstream printing unit group and stored on the memory M5 in step P94. Then, in step P95, by adding the correction value for the rotational phase of the downstream printing unit group to the current rotational phase of the upstream printing unit group, an assumed current rotational phase of the downstream printing unit group is calculated to be stored on the memory M8.

Next, in step P96, the correction value for the rotational phase of the downstream printing unit group is read from the memory M7. Then, in step P97, by adding the correction value for the rotational phase of the downstream printing unit group to the current rotational phase of the upstream printing unit group, an assumed current rotational phase of the downstream printing unit group is calculated to be stored on the memory M8.

Next, if the result of the determination in the above-described step P93 is positive, a count value is read from the counter 55 for detecting the current rotational phase of the upstream printing unit group and stored on the memory M5. Then, in step P98, the previously set rotational speed is read from the memory M3. Then, in step P99,
an adjustment value for a rotational speed during deceleration is read from the memory M12. Subsequently, in step P100, by subtracting the adjustment value for a rotational speed during deceleration from the previously set rotational speed, an adjusted currently set rotational speed is calculated to be stored on the memory M11.

[0116] Next, in step P101, a determination is made as to whether or not the adjusted currently set rotational speed is less than zero. If the result of the determination is positive, the adjusted currently set rotational speed is replaced by zero in step P102, and then the upstream printing unit group drive control device 40 goes to step P103 described later. On the other hand, if the result of the determination is negative, the upstream printing unit group drive control device 40 goes directly to step P103. Next, in step P103, the adjusted currently set rotational speed is stored on the memory M2 for storing the currently set rotational speed.

[0117] Next, in step P104, the currently set rotational speed and the assumed current rotational phase of the downstream printing unit group are sent to the downstream printing unit group drive control device 60. Then, in step P105, the memory M9 for storing a commanded rotational speed is overwritten with the currently set rotational speed.

[0118] Next, in step P106, the commanded rotational speed is outputted to the upstream drive motor driver 54. Then, in step P107, the currently set rotational speed is stored on the memory M3 for storing a previously set rotational speed. Subsequently, the upstream printing unit group drive control device 40 returns to step P90.

[0119] On the other hand, if the result of the determination in the aforementioned step P93 is negative, the outputs of the F/V converters 57 and 59 connected to the drive motor rotary encoders 8A and 8B of the upstream and downstream printing unit groups 20A and 20B are read through the A/D converters 56 and 58 and stored on the memory M13 in step P108. Then, in step P109, the current rotational speeds of the upstream and downstream printing unit groups are calculated from the outputs of the F/V converters 57 and 59 connected to the drive motor rotary encoders 8A and 8B of the upstream and downstream printing unit groups 20A and 20B, and stored on the memory M14.

[0120] Next, in step P110, a determination is made as to whether or not the current rotational speeds of the upstream and downstream printing unit groups are zero. If the result of the determination is positive, a synchronized operation stop command is sent to the downstream printing unit group drive control device 60 in step P111, and then the upstream printing unit group drive control device 40 returns to step P1. On the other hand, if the result of the determination is negative, the upstream printing unit group drive control device 40 returns to step P91. This operation is then repeated.

[0121] According to the above-described operation flow, the upstream printing unit group drive control device 40 sends a synchronized operation start command and a synchronized operation stop command to the downstream printing unit group drive control device 60, sends a measurement start command and a measurement stop command to the synchronization error determination device 80, and sends a print start command and a print stop command to the printing press control device 90.

[0122] The downstream printing unit group drive control device 60 operates according to the operation flow shown in Figs. 8A and 8B, 9A and 9B, and 10A and 10B.

[0123] Specifically, in step P1, a synchronized operation start command is sent from the upstream printing unit group drive control device 40. In step P2, a home positioning start command is sent from the upstream printing unit group drive control device 40. Subsequently, if the currently set rotational speed (slower operation rotational speed) and an assumed current rotational phase of the downstream printing unit group are sent from the upstream printing unit group drive control device 40 in step P3, the currently set rotational speed (slower operation rotational speed) and the assumed current rotational phase of the downstream printing unit group are received from the upstream printing unit group drive control device 40, and stored on the memory M15 and M16, respectively, in step P4.

[0124] Next, in step P5, a count value is read from the counter 71 for detecting the current rotational phase of the downstream printing unit group, and stored on the memory M17. Then, in step P6, the current rotational phase of the downstream printing unit group is calculated from the count value of the counter 71 for detecting the current rotational phase of the downstream printing unit group, and stored on the memory M18.

[0125] Next, in step P7, by subtracting the current rotational phase of the downstream printing unit group from the assumed current rotational phase of the downstream printing unit group, the current rotational phase difference of the downstream printing unit group is calculated to be stored on the memory M19. Then, in step P8, the absolute value of the current rotational phase difference of the downstream printing unit group is calculated from the current rotational phase difference of the downstream printing unit group, and stored on the memory M20.

[0126] Next, in step P9, a tolerance for the current rotational phase difference of the downstream printing unit group is read from the memory M21. Then, in step P10, a determination is made as to whether or not the absolute value of the current rotational phase difference of the downstream printing unit group is not more than the tolerance for the current rotational phase difference of the downstream printing unit group.

[0127] Next, if the result of the determination in step P10 is positive, the downstream printing unit group drive control device 60 goes to step P17 described later. On the other hand, if the result of the determination is negative, a conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds is read from the memory M23 in step P11.
Next, in step P12, the current rotational phase difference of the downstream printing unit group is read from the memory M19. Then, in step P13, using the conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds, a correction value for the set rotational speed is obtained from the current rotational phase difference of the downstream printing unit group to be stored on the memory M24.

Next, in step P14, the currently set rotational speed (slower operation rotational speed) is read from the memory M15. Then, in step P15, by adding the correction value for the set rotational speed to the currently set rotational speed (slower operation rotational speed), a commanded rotational speed is calculated to be stored on the memory M22. Subsequently, in step P16, the commanded rotational speed is outputted to the downstream drive motor driver 70. After that, the downstream printing unit group drive control device 60 returns to step P3.

Next, in the aforementioned step P17, the currently set rotational speed (slower operation rotational speed) is read from the memory M15. Then, in step P18, the memory M22 for storing a commanded rotational speed is overwritten with the currently set rotational speed (slower operation rotational speed).

Next, in step P19, the commanded rotational speed is outputted to the downstream drive motor driver 70. Then, in step P20, a home positioning completion signal is sent to the upstream printing unit group drive control device 40.

Next, if the currently set rotational speed (slower operation rotational speed) and an assumed current rotational phase of the downstream printing unit group are sent from the upstream printing unit group drive control device 40 in step P21, the currently set rotational speed (slower operation rotational speed) and the assumed current rotational phase of the downstream printing unit group are received from the upstream printing unit group drive control device 40, and stored on the memory M15 and M16, respectively, in step P22.

Next, in step P23, a count value is read from the counter 71 for detecting the current rotational phase of the downstream printing unit group, and stored on the memory M17. Then, in step P24, the current rotational phase of the downstream printing unit group is calculated from the count value of the counter 71 for detecting the current rotational phase of the downstream printing unit group, and stored on the memory M18.

Next, in step P25, by subtracting the current rotational phase of the downstream printing unit group from the assumed current rotational phase of the downstream printing unit group, the current rotational phase difference of the downstream printing unit group is calculated to be stored on the memory M19. Then, in step P26, the absolute value of the current rotational phase difference of the downstream printing unit group is calculated from the current rotational phase difference of the downstream printing unit group, and stored on the memory M20.

Next, in step P27, the tolerance for the current rotational phase difference of the downstream printing unit group is read from the memory M21. Then, in step P28, a determination is made as to whether or not the absolute value of the current rotational phase difference of the downstream printing unit group is not more than the tolerance for the current rotational phase difference of the downstream printing unit group.

Next, if the result of the determination in the above-described step P28 is positive, the currently set rotational speed (slower operation rotational speed) is read from the memory M15 in step P29. Then, in step P30, the memory M22 for storing a commanded rotational speed is overwritten with the currently set rotational speed (slower operation rotational speed). Subsequently, in step P31, the commanded rotational speed is outputted to the downstream drive motor driver 70. After that, the downstream printing unit group drive control device 60 goes to step P38 described later.

On the other hand, if the result of the determination in the above-described step P28 is negative, the conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds is read from the memory M23 in step P32. Then, in step P33, the current rotational phase difference of the downstream printing unit group is read from the memory M19.

Next, in step P34, using the conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds, a correction value for the set rotational speed is obtained from the current rotational phase difference of the downstream printing unit group to be stored on the memory M24. Then, in step P35, the currently set rotational speed (slower operation rotational speed) is read from the memory M15.

Next, in step P36, by adding the correction value for the set rotational speed to the currently set rotational speed (slower operation rotational speed), a commanded rotational speed is calculated to be stored on the memory M22. Then, in step P37, the commanded rotational speed is outputted to the downstream drive motor driver 70.

Next, in the aforementioned step P38, a determination is made as to whether or not the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group have been sent from the upstream printing unit group drive control device 40. If the result of the determination is positive, the downstream printing unit group drive control device 60 goes to step P40 described later. On the other hand, if the result of the determination is negative, a determination is made in step P39 as to whether or not a synchronized operation stop command has been sent from the upstream printing unit group drive control device 40. If the result of this determination is positive, the downstream printing unit group drive control device 60 returns...
to step P1. On the other hand, if the result of the determination is negative, the downstream printing unit group drive control device 60 returns to step P38.

[0141] Next, in the above-described step P40, the currently set rotational speed and an assumed current rotational phase of the downstream printing unit group are received from the upstream printing unit group drive control device 40, and stored on the memory M15 and M16, respectively. Then, in step P41, a count value is read from the counter 71 for detecting the current rotational phase of the downstream printing unit group, and stored on the memory M17.

[0142] Next, in step P42, the current rotational phase of the downstream printing unit group is calculated from the count value of the counter 71 for detecting the current rotational phase of the downstream printing unit group, and stored on the memory M18. Then, in step P43, by subtracting the current rotational phase of the downstream printing unit group from the assumed current rotational phase of the downstream printing unit group, the current rotational phase difference of the downstream printing unit group is calculated to be stored on the memory M19.

[0143] Next, in step P44, the absolute value of the current rotational phase difference of the downstream printing unit group is calculated from the current rotational phase difference of the downstream printing unit group, and stored on the memory M20. Then, in step P45, the tolerance for the current rotational phase difference of the downstream printing unit group is read from the memory M21.

[0144] Next, in step P46, a determination is made as to whether or not the absolute value of the current rotational phase difference of the downstream printing unit group is not more than the tolerance for the current rotational phase difference of the downstream printing unit group. If the result of the determination is positive, the currently set rotational speed is read from the memory M15 in step P47. On the other hand, if the result of the determination is negative, the downstream printing unit group drive control device 60 goes to step P50.

[0145] Next, in step P48, the memory M22 for storing a commanded rotational speed is overwritten with the currently set rotational speed. Then, in step P49, the commanded rotational speed is outputted to the downstream drive motor driver 70. After that, the downstream printing unit group drive control device 60 returns to step P38. This operation is then repeated.

[0146] Next, in the aforementioned step P50, the conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds is read from the memory M23. Then, in step P51, the current rotational phase difference of the downstream printing unit group is read from the memory M19.

[0147] Next, in step P52, using the conversion table between current rotational phase differences of the downstream printing unit group and correction values for set rotational speeds, a correction value for the set rotational speed is obtained from the current rotational phase difference of the downstream printing unit group to be stored on the memory M24. Then, in step P53, the currently set rotational speed is read from the memory M15.

[0148] Next, in step P54, by adding the correction value for the set rotational speed to the currently set rotational speed, a commanded rotational speed is calculated to be stored on the memory M22. Then, in step P55, the commanded rotational speed is outputted to the downstream drive motor driver 70. After that, the downstream printing unit group drive control device 60 returns to step P38. This operation is then repeated.

[0149] According to the above-described operation flow, in response to a synchronized operation start command and a synchronized operation stop command from the upstream printing unit group drive control device 40, the downstream printing unit group drive control device 60 controls the downstream drive motor 1B so that the downstream drive motor 1B may be synchronized with the upstream drive motor 1A.

[0150] The synchronization error determination device 80 operates according to the operation flow shown in Figs. 11A to 11D.

[0151] Specifically, in step P1, zero is stored on the memory M25 for storing a count value N. Then, if a measurement start command is sent from the upstream printing unit group drive control device 40 in step P2, the internal clock counter (for counting elapsed time) 88 is started counting in step P3.

[0152] Next, in step P4, the peripheral speed measurement time interval is read from the memory M26. Then, in step P5, the count value of the internal clock counter 88 is read.

[0153] Next, in step P6, a determination is made as to whether or not the count value of the internal clock counter is equal to the peripheral speed measurement time interval. If the result of the determination is positive, an output is read from the impression-cylinder-side peripheral speed measuring device 6A and stored on the memory M27 in step P7. On the other hand, if the result of the determination is negative, the synchronization error determination device 80 returns to step P4.

[0154] Next, in step P8, an output is read from the transfer-cylinder-side peripheral speed measuring device 6B, and stored on the memory M28. Then, in step P9, the output of the impression-cylinder-side peripheral speed measuring device 6A is read from the memory M27.

[0155] Next, in step P10, the current peripheral speed of the impression cylinder 23 (i.e., the rearmost impression cylinder of the upstream printing unit group 20A, hereinafter used in the same meaning) is calculated from the output of the impression-cylinder-side peripheral speed measuring device 6A, and stored on the memory M29. Then, in step P11, the current peripheral speed of the impression cylinder 23 is stored on the memory M30 for an impression cylinder’s average peripheral speed.

[0156] Next, in step P12, the output of the transfer-
cylinder-side peripheral speed measuring device 6B is read from the memory M28. Then, in step P13, the current peripheral speed of the transfer cylinder 24 is calculated from the output of the transfer-cylinder-side peripheral speed measuring device 6B, and stored on the memory M31.

[0157] Next, in step P14, the current peripheral speed of the transfer cylinder 24 is stored on the memory M32 for storing a transfer cylinder’s average peripheral speed. Then, in step P15, a count value N is read from the memory M25.

[0158] Next, in step P16, one is added to the count value N, and the memory M25 is overwritten with the resultant count value N. Then, in step P17, the internal clock counter (for counting elapsed time) 88 is started counting.

[0159] Next, in step P18, the peripheral speed measurement time interval is read from the memory M26. Then, in step P19, the count value of the internal clock counter 88 is read.

[0160] Next, in step P20, a determination is made as to whether or not the count value of the internal clock counter is equal to the peripheral speed measurement time interval. If the result of the determination is positive, the synchronization error determination device 80 goes to step P22 described later. On the other hand, if the result of the determination is negative, a determination is made in step P21 as to whether or not a measurement stop command has been sent from the upstream printing unit group drive control device 40. If the result of this determination is positive, the synchronization error determination device 80 returns to step P1. On the other hand, if the result of this determination is negative, the synchronization error determination device 80 returns to step P18.

[0161] Next, in the above-described step P22, an output is read from the impression-cylinder-side peripheral speed measuring device 6A, and stored on the memory M27. Then, in step P23, an output is read from the transfer-cylinder-side peripheral speed measuring device 6B, and stored on the memory M28.

[0162] Next, in step P24, the output of the impression-cylinder-side peripheral speed measuring device 6A is read from the memory M27. Then, in step P25, the current peripheral speed of the impression cylinder 23 is calculated from the output of the impression-cylinder-side peripheral speed measuring device 6A, and stored on the memory M29.

[0163] Next, in step P26, the average peripheral speed of the impression cylinder 23 is read from the memory M30. Then, in step P27, by subtracting the average peripheral speed of the impression cylinder 23 from the current peripheral speed of the impression cylinder 23, the speed variation of the impression cylinder 23 is calculated to be stored on the memory M33.

[0164] Next, in step P28, the output of the transfer-cylinder-side peripheral speed measuring device 6B is read from the memory M28. Then, in step P29, the current peripheral speed of the transfer cylinder 24 is calculated from the output of the transfer-cylinder-side peripheral speed measuring device 6B, and stored on the memory M31.

[0165] Next, in step P30, the average peripheral speed of the transfer cylinder 24 is read from the memory M32. Then, in step P31, by subtracting the average peripheral speed of the transfer cylinder 24 from the current peripheral speed of the transfer cylinder 24, the speed variation of the transfer cylinder 24 is calculated to be stored on the memory M34.

[0166] Next, in step P32, by subtracting the speed variation of the transfer cylinder 24 from the speed variation of the impression cylinder 23, a speed deviation is calculated to be stored on the memory M35. Then, in step P33, the peripheral speed measurement time interval is read from the memory M26.

[0167] Next, in step P34, by multiplying the speed deviation by the peripheral speed measurement time interval, a position deviation is calculated to be stored on the memory M36. Then, in step P35, the absolute value of the position deviation is calculated from the position deviation, and stored on the memory M37.

[0168] Next, in step P36, a tolerance for the position deviation is read from the memory M38. Then, in step P37, a determination is made as to whether or not the absolute value of the position deviation is not more than the tolerance for the position deviation.

[0169] Next, if the result of the determination in the above-described step P37 is positive, the synchronization error determination device 80 goes to step P39 described later. On the other hand, if the result of the determination is negative, an error signal is sent to the upstream printing unit group drive control device 40 in step P38. After that, the synchronization error determination device 80 returns to step P1.

[0170] Next, in the above-described step P39, the average peripheral speed of the impression cylinder 23 is read from the memory M30. Then, in step P40, the count value N is read from the memory M25.

[0171] Next, in step P41, by multiplying the average peripheral speed of the impression cylinder 23 by the count value, the total of previously obtained peripheral speeds of the impression cylinder 23 is calculated and stored on the memory M39. Then, in step P42, the current peripheral speed of the impression cylinder 23 is read from the memory M29.

[0172] Next, in step P43, by adding the current peripheral speed of the impression cylinder 23 to the total of previously obtained peripheral speeds of the impression cylinder 23, the current total of peripheral speeds of the impression cylinder 23 is calculated to be stored on the memory M40. Then, in step P44, the count value N is read from the memory M25.

[0173] Next, in step P45, by adding one to the count value N, a count value N+1 is calculated to be stored on
the memory M41. Then, in step P4 6, the average peripheral speed of the impression cylinder 23 is calculated by dividing the current total of peripheral speeds of the impression cylinder 23 by the count value N+1, and the memory M30 is overwritten with the average peripheral speed of the impression cylinder 23.

[0174] Next, in step P47, the average peripheral speed of the transfer cylinder 24 is read from the memory M32. Then, in step P48, the count value N is read from the memory M25.

[0175] Next, in step P49, by multiplying the average peripheral speed of the transfer cylinder 24 by the count value, the total of previously obtained peripheral speeds of the transfer cylinder 24 is calculated to be stored on the memory 42. Then, in step P50, the current peripheral speed of the transfer cylinder 24 is read from the memory M41.

[0176] Next, in step P51, by adding the current peripheral speed of the transfer cylinder 24 to the total of the previously obtained peripheral speeds of the transfer cylinder 24, the current total of peripheral speeds of the transfer cylinder 24 is calculated to be stored on the memory M43. Then, in step P52, the count value N+1 is read from the memory M41.

[0177] Next, in step P53, the average peripheral speed of the transfer cylinder 24 is calculated by dividing the current total of peripheral speeds of the transfer cylinder 24 by the count value N+1, and the memory M31 is overwritten with the average peripheral speed of the transfer cylinder 24. Then, in step P54, the count value N is read from the memory M30. Subsequently, in step P55, one is added to the count value N, and the memory M25 is overwritten with the resultant count value N. After that, the synchronization error determination device 80 returns to step P17. This operation is then repeated.

[0178] According to the above-described operation flow, in response to a measurement start command and a measurement stop command from the upstream printing unit group drive control device 40, the synchronization error determination device 80 obtains the rotational phase difference (position deviation) between the rearmost impression cylinder 23 of the upstream printing unit group 20A and the foremost transfer cylinder 24 of the downstream printing unit group 20B from previous peripheral speeds and peripheral speeds measured at the peripheral surface of the transfer cylinder 24. When the synchronization error determination device 80 determines, based on this rotational phase difference, that there is a synchronization error, the synchronization error determination device 80 sends an error signal to the upstream printing unit group drive control device 40. As a result, the upstream printing unit group drive control device 40 sends a print stop command to the printing press control device 90 to stop the driving of the printing press.

[0179] As described above, in this example, by obtaining the rotational phase difference (position deviation) between the rearmost impression cylinder 23 of the upstream printing unit group 20A rotationally driven by the upstream drive motor 1A and the foremost transfer cylinder 24 of the downstream printing unit group 20B rotationally driven by the downstream drive motor 1B, an instantaneous and quantitative determination can be made as to whether or not there is a synchronization error between the impression cylinder 23 and the transfer cylinder 24. Thus, subsequent handling (the stopping of the printing press, cylinder disengagement, or the like) of the printing press can immediately be performed, and the frequency of occurrence of printing troubles can be reduced to the minimum. Further, the time from an abnormal stop of the printing press to the resumption of the operation thereof can be reduced to improve the operation rate thereof.

[0180] Moreover, the impression-cylinder-side peripheral speed measuring device 6A and the transfer-cylinder-side peripheral speed measuring device 6B for measuring the peripheral speeds of the impression cylinder 23 and the transfer cylinder 24 are provided to face the peripheral surfaces of the bearers 23a and 24a of the impression cylinder 23 and the transfer cylinder 24, and measure the peripheral speeds at the peripheral surfaces of the bearers 23a and 24a. Accordingly, unlike the measurement of the peripheral speeds at the unproper peripheral surfaces of the impression cylinder 23 and the transfer cylinder 24, the peripheral speeds can precisely be measured.

[0181] It should of course be noted that the present invention is not limited to the above-described example, and that various modifications can be made thereto without departing from the spirit of the present invention. For example, though in the shown example the sheet-fed offset printing press including the coating unit 20g and the embossing unit 20i is taken as an example of a processing machine, the present invention can also be applied to a sheet-fed offset printing press including other processing unit and a convertible sheet-fed printing press.

[Reference Signs List]

[0182]

1A UPSTREAM DRIVE MOTOR
1B DOWNSTREAM DRIVE MOTOR
2 GEAR OF IMPRESSION CYLINDER
3 GEAR OF TRANSFER CYLINDER
6A IMPRESSION-CYLINDER-SIDE PERIPHERAL SPEED MEASURING DEVICE
6B TRANSFER-CYLINDER-SIDE PERIPHERAL SPEED MEASURING DEVICE
8A UPSTREAM DRIVE MOTOR ROTARY ENCOD-
for measuring a peripheral speed of the second rotating part (24), and
a rotational phase difference between the first and second rotating parts (23, 24) is obtained
from respective signals from the first and second peripheral speed measuring means (6A, 6B).

2. The method according to claim 1, characterized in that
a speed deviation between the first and second rotating parts (23, 24) is obtained from the respective
signals from the first and second peripheral speed measuring means (6A, 6B), and
the rotational phase difference is obtained by integrating the speed deviation.

3. The method according to claim 2, characterized in that
a speed variation of the first rotating part (23) is obtained from the signal from the first peripheral speed
measuring means (6A),
a speed variation of the second rotating part (24) is obtained from the signal from the second peripheral speed
measuring means (6B), and
the speed deviation is obtained from the difference between the speed variations of the first and second
rotating parts (23, 24).

4. The method according to claim 3, characterized in that
an average speed of the first rotating part (23) is obtained from the signal from the first peripheral speed measuring means (6A),
the speed variation of the first rotating part (23) is obtained from the difference between a peripheral
speed of the first rotating part (23) and the average speed of the first rotating part (23), the peripheral
speed of the first rotating part (23) being obtained from the signal from the first peripheral speed measuring means (6A),
an average speed of the second rotating part (24) is obtained from the signal from the second peripheral speed measuring means (6B), and
the speed variation of the second rotating part (24) is obtained from the difference between a peripheral
speed of the second rotating part (24) and the average speed of the second rotating part (24), the peripheral
speed of the second rotating part (24) being obtained from the signal from the second peripheral speed measuring means (6B).

5. The method according to claim 1, characterized in that the driving of the processing machine is stopped depending on the rotational phase difference.

6. A device for controlling the driving of a processing machine,
the processing machine including:
first driven means (3) driven by first driving means (1A);  
second driven means (2) rotationally driven by the first driving means (1A) through the first driven means (3);  
a first rotating part (23) being rotationally driven by the second driven means (2) and having a notched portion containing a first holding portion for holding a workpiece; and  
a second rotating part (24) being rotationally driven by second driving means (1B) and having a notched portion containing a second holding portion for receiving the workpiece from the first holding portion of the first rotating part (23),  
the device being characterized by comprising:  
first peripheral speed measuring means (6A) for measuring a peripheral speed of the first rotating part (23);  
second peripheral speed measuring means (6B) for measuring a peripheral speed of the second rotating part (24); and  
controlling means (40, 60, 80) for obtaining a rotational phase difference between the first and second rotating parts (23, 24) from respective signals from the first and second peripheral speed measuring means (6A, 6B).

7. The device according to claim 6, characterized in that the controlling means (40, 60, 80) obtains a speed deviation between the first and second rotating parts (23, 24) from the respective signals from the first and second peripheral speed measuring means (6A, 6B), and obtains the rotational phase difference by integrating the speed deviation.

8. The device according to claim 7, characterized in that the controlling means (40, 60, 80) obtains a speed variation of the first rotating part (23) from the signal from the first peripheral speed measuring means (6A), obtains a speed variation of the second rotating part (24) from the signal from the second peripheral speed measuring means (6B), and obtains the speed deviation from the difference between the speed variations of the first and second rotating parts (23, 24).

9. The device according to claim 8, characterized in that the controlling means (40, 60, 80) obtains an average speed of the first rotating part (23) from the signal from the first peripheral speed measuring means (6A),

10. The device according to claim 6, characterized in that the controlling means (40, 60, 80) stops the driving of the processing machine depending on the rotational phase difference.
Fig. 1A

UPSTREAM PRINTING UNIT GROUP
DRIVE CONTROL DEVICE (40)

M1 ~ MEMORY FOR STORING SLOWER OPERATION
      ROTATIONAL SPEED

M2 ~ MEMORY FOR STORING CURRENTLY SET
      ROTATIONAL SPEED

M3 ~ MEMORY FOR STORING PREVIOUSLY SET
      ROTATIONAL SPEED

M4 ~ MEMORY FOR STORING TIME INTERVAL AT WHICH
      CURRENTLY SET ROTATIONAL SPEED AND ASSUMED
      CURRENT ROTATIONAL PHASE OF DOWNSTREAM
      PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM
      PRINTING UNIT GROUP DRIVE CONTROL DEVICE

M5 ~ MEMORY FOR STORING COUNT VALUE OF COUNTER
      FOR DETECTING CURRENT ROTATIONAL PHASE
      OF UPSTREAM PRINTING UNIT GROUP

M6 ~ MEMORY FOR STORING CURRENT ROTATIONAL
      PHASE OF UPSTREAM PRINTING UNIT GROUP

M7 ~ MEMORY FOR STORING CORRECTION VALUE FOR
      ROTATIONAL PHASE OF DOWNSTREAM PRINTING
      UNIT GROUP

M8 ~ MEMORY FOR STORING ASSUMED CURRENT
      ROTATIONAL PHASE OF DOWNSTREAM PRINTING
      UNIT GROUP

CPU

I/O ~ SYNCHRONIZED OPERATION START SWITCH
     Synchronizing Operation Stop Switch

I/O ~ INPUT DEVICES
     DISPLAY DEVICES
     OUTPUT DEVICES (SUCH AS FDD AND PRINTER)

I/O ~ ROTATIONAL SPEED SETTER

I/O ~ UPSTREAM DRIVE MOTOR DRIVER
     UPSTREAM DRIVE MOTOR

I/O ~ COUNTER FOR DETECTING CURRENT
      ROTATIONAL PHASE OF UPSTREAM
      PRINTING UNIT GROUP

I/O ~ ZERO PULSE
     UPSTREAM DRIVE MOTOR
     ROTARY ENCODER
     CLOCK PULSE

41 ~ 42 ~ 43 ~ 44a ~ 44b ~ 44c ~ 44d ~ 47 ~ 48 ~ 49 ~ 50 ~ 51 ~ 52 ~ 53 ~ 54 ~ 55 ~ 1A ~ 8A
Fig. 4A

START

IS SYNCHRONIZED OPERATION START SWITCH TURNED ON?

Y → P4
SEND SYNCHRONIZED OPERATION START COMMAND TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

P5
SEND HOME POSITIONING START COMMAND TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

P6
READ SLOWER OPERATION ROTATIONAL SPEED

WRITE SLOWER OPERATION ROTATIONAL SPEED TO MEMORY FOR STORING CURRENTLY SET ROTATIONAL SPEED AND MEMORY FOR STORING PREVIOUSLY SET ROTATIONAL SPEED

P7

P8
START INTERNAL CLOCK COUNTER (FOR COUNTING ELAPSED TIME) COUNTING

P9
READ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

P10
READ COUNT VALUE OF INTERNAL CLOCK COUNTER
Fig. 4B

1. Count value of internal clock counter ≥ time interval at which currently set rotational speed and assumed current rotational phase of downstream printing unit group are sent to downstream printing unit group drive control device?

2. N

3. Y

P11

P12

P13

P14

P15

P16

P17

P18

P19

P20

Read count value from counter for detecting current rotational phase of upstream printing unit group and store the count value.

Calculate current rotational phase of upstream printing unit group from count value of counter for detecting current rotational phase of upstream printing unit group and store the current rotational phase.

Calculate assumed current rotational phase of downstream printing unit group by adding correction value for rotational phase of downstream printing unit group to current rotational phase of upstream printing unit group, and store the assumed current rotational phase.

Read currently set rotational speed (slower operation).

Read correction value for rotational phase of downstream printing unit group.

Send currently set rotational speed (slower operation) and assumed current rotational phase of downstream printing unit group to downstream printing unit group drive control device.

Overwrite memory for storing commanded rotational speed with currently set rotational speed (slower operation).

Output commanded rotational speed to upstream drive motor driver.

Store currently set rotational speed (slower operation) on memory for storing previously set rotational speed.
Fig. 4C

2

HAS HOME POSITIONING COMPLETION SIGNAL BEEN SENT FROM DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

N 4

P22

READ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

P23

READ COUNT VALUE OF INTERNAL CLOCK COUNTER

P24

COUNT VALUE OF INTERNAL CLOCK COUNTER = TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

N

P25

READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE

P26

CALCULATE CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP FROM COUNT VALUE OF COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE CURRENT ROTATIONAL PHASE

5
Fig. 4D

1. Read correction value for rotational phase of downstream printing unit group

2. Calculate assumed current rotational phase of downstream printing unit group by adding correction value for rotational phase of downstream printing unit group to current rotational phase of upstream printing unit group, and store the assumed current rotational phase

3. Read currently set rotational speed (slower operation)

4. Send currently set rotational speed (slower operation) and assumed current rotational phase of downstream printing unit group to downstream printing unit group drive control device

5. Overwrite memory for storing commanded rotational speed with currently set rotational speed (slower operation)

6. Output commanded rotational speed to upstream drive motor driver

7. Store currently set rotational speed (slower operation) on memory for storing previously set rotational speed

8. Send print start command to printing press control device

9. Send measurement start command to synchronization error determination device
Fig. 5A

START INTERNAL CLOCK COUNTER (FOR COUNTING ELAPSED TIME) COUNTING

READ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

READ COUNT VALUE OF INTERNAL CLOCK COUNTER

COUNT VALUE OF INTERNAL CLOCK COUNTER = TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

READ PREVIOUSLY SET ROTATIONAL SPEED

READ ADJUSTMENT VALUE FOR ROTATIONAL SPEED DURING ACCELERATION

CALCULATE ADJUSTED CURRENTLY SET ROTATIONAL SPEED BY ADDING ADJUSTMENT VALUE FOR ROTATIONAL SPEED DURING ACCELERATION TO PREVIOUSLY SET ROTATIONAL SPEED, AND STORE THE ADJUSTED CURRENTLY SET ROTATIONAL SPEED

READ SET ROTATIONAL SPEED FROM ROTATIONAL SPEED SETTER AND STORE THE SET ROTATIONAL SPEED ON MEMORY FOR STORING CURRENTLY SET ROTATIONAL SPEED

ADJUSTED CURRENTLY SET ROTATIONAL SPEED < CURRENTLY SET ROTATIONAL SPEED?

ERROR SIGNAL BEEN SENT FROM SYNCHRONIZATION ERROR DETERMINATION DEVICE?

Y

N

N

Y

C
READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE

CALCULATE CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP FROM COUNT VALUE OF COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE CURRENT ROTATIONAL PHASE

READ CORRECTION VALUE FOR ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP

CALCULATE ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP BY ADDING CORRECTION VALUE FOR ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP TO CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP, AND STORE THE ASSUMED CURRENT ROTATIONAL PHASE

STORE ADJUSTED CURRENTLY SET ROTATIONAL SPEED ON MEMORY FOR STORING CURRENTLY SET ROTATIONAL SPEED

SEND CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

OVERWRITE MEMORY FOR STORING COMMANDED ROTATIONAL SPEED WITH CURRENTLY SET ROTATIONAL SPEED

OUTPUT COMMANDED ROTATIONAL SPEED TO UPSTREAM DRIVE MOTOR DRIVER

STORE CURRENTLY SET ROTATIONAL SPEED ON MEMORY FOR STORING PREVIOUSLY SET ROTATIONAL SPEED
Fig. 5C

1. Read count value from counter for detecting current rotational phase of upstream printing unit group and store the count value.

2. Calculate current rotational phase of upstream printing unit group from count value of counter for detecting current rotational phase of upstream printing unit group and store the current rotational phase.

3. Read correction value for rotational phase of downstream printing unit group.

4. Calculate assumed current rotational phase of downstream printing unit group by adding correction value for rotational phase of downstream printing unit group to current rotational phase of upstream printing unit group, and store the assumed current rotational phase.

5. Read set rotational speed from rotational speed setter and store the set rotational speed on memory for storing currently set rotational speed.

6. Send currently set rotational speed and assumed current rotational phase of downstream printing unit group to downstream printing unit group drive control device.

7. Overwrite memory for storing commanded rotational speed with currently set rotational speed.

8. Output commanded rotational speed to upstream drive motor driver.

9. Store currently set rotational speed on memory for storing previously set rotational speed.
START INTERNAL CLOCK COUNTER (FOR COUNTING ELAPSED TIME) COUNTING

READ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

READ COUNT VALUE OF INTERNAL CLOCK COUNTER

COUNT VALUE OF INTERNAL CLOCK COUNTER ≥ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

HAS ERROR SIGNAL BEEN SENT FROM SYNCHRONIZATION ERROR DETERMINATION DEVICE?

IS SYNCHRONIZED OPERATION STOP SWITCH Turned ON?

READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE

CALCULATE CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP FROM COUNT VALUE OF COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP, AND STORE THE CURRENT ROTATIONAL PHASE
Fig. 6B

P68
READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE.

P69
CALCULATE CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP FROM COUNT VALUE OF COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP, AND STORE THE CURRENT ROTATIONAL PHASE.

P70
READ CORRECTION VALUE FOR ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP.

P71
CALCULATE ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP BY ADDING CORRECTION VALUE FOR ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP TO CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP, AND STORE THE ASSUMED CURRENT ROTATIONAL PHASE.

P72
READ SET ROTATIONAL SPEED FROM ROTATIONAL SPEED SETTER AND STORE THE SET ROTATIONAL SPEED ON MEMORY FOR STORING CURRENTLY SET ROTATIONAL SPEED.

P73
SEND CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE.

P74
OVERWRITE MEMORY FOR STORING COMMANDED ROTATIONAL SPEED WITH CURRENTLY SET ROTATIONAL SPEED.

P75
OUTPUT COMMANDED ROTATIONAL SPEED TO UPSTREAM DRIVE MOTOR DRIVER.

P76
STORE CURRENTLY SET ROTATIONAL SPEED ON MEMORY FOR STORING PREVIOUSLY SET ROTATIONAL SPEED.

11
Fig. 6C

1C

P81
READ CORRECTION VALUE FOR ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP

P82
CALCULATE ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP BY ADDING CORRECTION VALUE FOR ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP TO CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP, AND STORE THE ASSUMED CURRENT ROTATIONAL PHASE

P83
READ SET ROTATIONAL SPEED FROM ROTATIONAL SPEED SETTER AND STORE THE SET ROTATIONAL SPEED ON MEMORY FOR STORING CURRENTLY SET ROTATIONAL SPEED

P84
SEND CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

P85
OVERWRITE MEMORY FOR STORING COMMENDED ROTATIONAL SPEED WITH CURRENTLY SET ROTATIONAL SPEED

P86
OUTPUT COMMENDED ROTATIONAL SPEED TO UPSTREAM DRIVE MOTOR DRIVER

P87
STORE CURRENTLY SET ROTATIONAL SPEED ON MEMORY FOR STORING PREVIOUSLY SET ROTATIONAL SPEED

P88
SEND PRINT STOP COMMAND TO PRINTING PRESS CONTROL DEVICE

P89
SEND MEASUREMENT STOP COMMAND TO SYNCHRONIZATION ERROR DETERMINATION DEVICE
Fig. 7A

START INTERNAL CLOCK COUNTER (FOR COUNTING ELAPSED TIME) COUNTING

READ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

READ COUNT VALUE OF INTERNAL CLOCK COUNTER

COUNT VALUE OF INTERNAL CLOCK COUNTER ≥ TIME INTERVAL AT WHICH CURRENTLY SET ROTATIONAL SPEED AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP ARE SENT TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

Y

READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF UPSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE

N

READ OUTPUTS OF F/V CONVERTERS CONNECTED TO DRIVE MOTOR ROTARY ENCODERS OF UPSTREAM AND DOWNSTREAM PRINTING UNIT GROUPS, AND STORE THE OUTPUTS

CALCULATE CURRENT ROTATIONAL SPEEDS OF UPSTREAM AND DOWNSTREAM PRINTING UNIT GROUPS FROM OUTPUTS OF F/V CONVERTERS CONNECTED TO DRIVE MOTOR ROTARY ENCODERS OF UPSTREAM AND DOWNSTREAM PRINTING UNIT GROUPS, AND STORES THE CURRENT ROTATIONAL SPEEDS

N

CURRENT ROTATIONAL SPEEDS OF UPSTREAM AND DOWNSTREAM PRINTING UNIT GROUPS = ZERO?

Y

SEND SYNCHRONIZED OPERATION STOP COMMAND TO DOWNSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE

E

P90

P91

P92

P93

Y

P94

P108

N

P95

P109

P96

P110

P97

P111

P12
Fig. 7B

1. Read previously set rotational speed
2. Read adjustment value for rotational speed during deceleration
3. Calculate adjusted currently set rotational speed by subtracting adjustment value for rotational speed during deceleration from previously set rotational speed, and store the adjusted currently set rotational speed
4. Adjusted currently set rotational speed < zero?
   - N: Store adjusted currently set rotational speed on memory for storing currently set rotational speed
   - Y: Replace adjusted currently set rotational speed by zero
5. Send currently set rotational speed and assumed current rotational phase of downstream printing unit group to downstream printing unit group drive control device
6. Overwrite memory for storing commanded rotational speed with currently set rotational speed
7. Output commanded rotational speed to upstream drive motor driver
8. Store currently set rotational speed on memory for storing previously set rotational speed
Fig. 8A

H

START

HAS

SYNCHRONIZED OPERATION
START COMMAND BEEN SENT FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

Y

HAS

P2

HOME POSITIONING START
COMMAND BEEN SENT FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

N

Y

P3

HAVE CURRENTLY SET ROTATIONAL SPEED (SLOWER OPERATION) AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP BEEN SENT FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

N

RECEIVE CURRENTLY SET ROTATIONAL SPEED (SLOWER OPERATION) AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE, AND STORE THE CURRENTLY SET ROTATIONAL SPEED (SLOWER OPERATION) AND THE ASSUMED CURRENT ROTATIONAL PHASE

P4

READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE

P5

CALCULATE CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP FROM COUNT VALUE OF COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP, AND STORE THE CURRENT ROTATIONAL PHASE

P6

CALCULATE CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP BY SUBTRACTING CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP FROM ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP, AND STORE THE CURRENT ROTATIONAL PHASE DIFFERENCE

P7

CALCULATE ABSOLUTE VALUE OF CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP FROM CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP, AND STORE THE ABSOLUTE VALUE

P8

READ TOLERANCE FOR CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP

P9

14
Fig. 8B

14

P10

ABSOLUTE VALUE
OF CURRENT ROTATIONAL
PHASE DIFFERENCE OF DOWNSTREAM
PRINTING UNIT GROUP \( \leq \) TOLERANCE FOR
CURRENT ROTATIONAL PHASE DIFFERENCE
OF DOWNSTREAM PRINTING
UNIT GROUP?

Y

P17

READ CURRENTLY SET ROTATIONAL SPEED
(SLOWER OPERATION)

READ CONVERSION TABLE BETWEEN CURRENT
ROTATIONAL PHASE DIFFERENCES OF DOWNSTREAM
PRINTING UNIT GROUP AND CORRECTION VALUES
FOR SET ROTATIONAL SPEEDS

N

P11

P12

READ CURRENT ROTATIONAL PHASE DIFFERENCE
OF DOWNSTREAM PRINTING UNIT GROUP

P13

OBTAIN CORRECTION VALUE FOR SET ROTATIONAL
SPEED FROM CURRENT ROTATIONAL PHASE
DIFFERENCE OF DOWNSTREAM PRINTING UNIT
GROUP USING CONVERSION TABLE BETWEEN
CURRENT ROTATIONAL PHASE DIFFERENCES OF
DOWNSTREAM PRINTING UNIT GROUP AND
CORRECTION VALUES FOR SET ROTATIONAL
SPEEDS, AND STORE THE CORRECTION VALUE

P14

READ CURRENTLY SET ROTATIONAL SPEED
(SLOWER OPERATION)

P15

CALCULATE COMMANED ROTATIONAL SPEED BY
ADDING CORRECTION VALUE FOR SET ROTATIONAL
SPEED TO CURRENTLY SET ROTATIONAL SPEED
(SLOWER OPERATION), AND STORE THE COMMANDED
ROTATIONAL SPEED

P16

OUTPUT COMMANDED ROTATIONAL SPEED
TO DOWNSTREAM DRIVE MOTOR DRIVER

F

P18

OVERWRITE MEMORY FOR STORING COMMANDED
ROTATIONAL SPEED WITH CURRENTLY SET
ROTATIONAL SPEED (SLOWER OPERATION)

P19

OUTPUT COMMANDED ROTATIONAL SPEED
TO DOWNSTREAM DRIVE MOTOR DRIVER

P20

SEND HOME POSITIONING COMPLETION SIGNAL TO
UPSTREAM PRINTING UNIT GROUP DRIVE
CONTROL DEVICE
Fig. 9A

**P21**

HAVE CURRENTLY SET ROTATIONAL SPEED (SLOWER OPERATION) AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP BEEN SENT FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

**P22**

RECEIVE CURRENTLY SET ROTATIONAL SPEED (SLOWER OPERATION) AND ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE, AND STORE THE CURRENTLY SET ROTATIONAL SPEED (SLOWER OPERATION) AND THE ASSUMED CURRENT ROTATIONAL PHASE.

**P23**

READ COUNT VALUE FROM COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP AND STORE THE COUNT VALUE.

**P24**

CALCULATE CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP FROM COUNT VALUE OF COUNTER FOR DETECTING CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP AND STORE THE CURRENT ROTATIONAL PHASE.

**P25**

CALCULATE CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP BY SUBTRACTING CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP FROM ASSUMED CURRENT ROTATIONAL PHASE OF DOWNSTREAM PRINTING UNIT GROUP AND STORE THE CURRENT ROTATIONAL PHASE DIFFERENCE.

**P26**

CALCULATE ABSOLUTE VALUE OF CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP FROM CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP AND STORE THE ABSOLUTE VALUE.

**P27**

READ TOLERANCE FOR CURRENT ROTATIONAL PHASE DIFFERENCE OF DOWNSTREAM PRINTING UNIT GROUP.
**Fig. 9B**

1. **P28**
   - Absolute value of current rotational phase difference of downstream printing unit group ≤ tolerance for current rotational phase difference of downstream printing unit group

2. **N**
   - Read currently set rotational speed (slower operation)

3. **P29**
   - Read conversion table between current rotational phase differences of downstream printing unit group and correction values for set rotational speeds

4. **P30**
   - Overwrite memory for storing commanded rotational speed with currently set rotational speed (slower operation)

5. **P31**
   - Output commanded rotational speed to downstream drive motor driver

6. **P32**
   - Read current rotational phase difference of downstream printing unit group

7. **P33**
   - Obtain correction value for set rotational speed from current rotational phase difference of downstream printing unit group using conversion table between current rotational phase differences of downstream printing unit group and correction values for set rotational speeds, and store the correction value

8. **P34**
   - Read currently set rotational speed (slower operation)

9. **P35**
   - Calculate commanded rotational speed by adding correction value for set rotational speed to currently set rotational speed (slower operation), and store the commanded rotational speed

10. **P36**
    - Output commanded rotational speed to downstream drive motor driver
Fig. 10A

1. Receive currently set rotational speed and assumed current rotational phase of downstream printing unit group from upstream printing unit group drive control device, and store the currently set rotational speed and the assumed current rotational phase.

2. Read count value from counter for detecting current rotational phase of downstream printing unit group, and store the count value.

3. Calculate current rotational phase of downstream printing unit group from count value of counter for detecting current rotational phase of downstream printing unit group, and store the current rotational phase.

4. Calculate current rotational phase difference of downstream printing unit group by subtracting current rotational phase of downstream printing unit group from assumed current rotational phase of downstream printing unit group, and store the current rotational phase difference.

5. Calculate absolute value of current rotational phase difference of downstream printing unit group from current rotational phase difference of downstream printing unit group, and store the absolute value.

6. Read tolerance for current rotational phase difference of downstream printing unit group.
Fig. 10B

17

P46

ABSOLUTE VALUE
OF CURRENT ROTATIONAL
PHASE DIFFERENCE OF DOWNSTREAM
PRINTING UNIT GROUP \( \leq \) TOLERANCE FOR
CURRENT ROTATIONAL PHASE DIFFERENCE
OF DOWNSTREAM PRINTING
UNIT GROUP?

N

P47

READ CURRENTLY SET ROTATIONAL SPEED

P48

OVERWRITE MEMORY FOR STORING COMMANDED
ROTATIONAL SPEED WITH CURRENTLY SET
ROTATIONAL SPEED

P49

OUTPUT COMMANDED ROTATIONAL SPEED
TO DOWNSTREAM DRIVE MOTOR DRIVER

P50

READ CONVERSION TABLE BETWEEN CURRENT
ROTATIONAL PHASE DIFFERENCES OF DOWNSTREAM
PRINTING UNIT GROUP AND CORRECTION VALUES
FOR SET ROTATIONAL SPEEDS

P51

READ CURRENT ROTATIONAL PHASE DIFFERENCE
OF DOWNSTREAM PRINTING UNIT GROUP

P52

OBTAIN CORRECTION VALUE FOR SET ROTATIONAL
SPEED FROM CURRENT ROTATIONAL PHASE
DIFFERENCE OF DOWNSTREAM PRINTING UNIT
GROUP USING CONVERSION TABLE BETWEEN
CURRENT ROTATIONAL PHASE DIFFERENCES OF
DOWNSTREAM PRINTING UNIT GROUP AND
CORRECTION VALUES FOR SET ROTATIONAL
SPEEDS, AND STORE THE CORRECTION VALUE

P53

READ CURRENTLY SET ROTATIONAL SPEED

P54

CALCULATE COMMANDED ROTATIONAL SPEED BY
ADDING CORRECTION VALUE FOR SET ROTATIONAL
SPEED TO CURRENTLY SET ROTATIONAL SPEED,
AND STORE THE COMMANDED ROTATIONAL SPEED

P55

OUTPUT COMMANDED ROTATIONAL SPEED
TO DOWNSTREAM DRIVE MOTOR DRIVER
Fig. 11A

START

P1

STORE ZERO ON MEMORY FOR STORING COUNT VALUE N

P2

HAS MEASUREMENT START COMMAND BEEN SENT FROM UPSTREAM PRINTING UNIT GROUP DRIVE CONTROL DEVICE?

Y

P3

START INTERNAL CLOCK COUNTER (FOR COUNTING ELAPSED TIME) COUNTING

P4

READ PERIPHERAL SPEED MEASUREMENT TIME INTERVAL

P5

READ COUNT VALUE OF INTERNAL CLOCK COUNTER

P6

COUNT VALUE OF INTERNAL CLOCK COUNTER = PERIPHERAL SPEED MEASUREMENT TIME INTERVAL?

Y

P7

READ OUTPUT FROM IMPRESSION-CYLINDER-SIDE PERIPHERAL SPEED MEASURING DEVICE AND STORE THE OUTPUT

P8

READ OUTPUT FROM TRANSFER-CYLINDER-SIDE PERIPHERAL SPEED MEASURING DEVICE AND STORE THE OUTPUT

P9

READ OUTPUT OF IMPRESSION-CYLINDER-SIDE PERIPHERAL SPEED MEASURING DEVICE

P10

CALCULATE CURRENT PERIPHERAL SPEED OF IMPRESSION CYLINDER FROM OUTPUT OF IMPRESSION-CYLINDER-SIDE PERIPHERAL SPEED MEASURING DEVICE, AND STORE THE CURRENT PERIPHERAL SPEED

P11

STORE CURRENT PERIPHERAL SPEED OF IMPRESSION CYLINDER ON MEMORY FOR STORING IMPRESSION CYLINDER'S AVERAGE PERIPHERAL SPEED
Fig. 11B

19. Read output of transfer-cylinder-side peripheral speed measuring device

P12.

P13. Calculate current peripheral speed of transfer cylinder from output of transfer-cylinder-side peripheral speed measuring device, and store the current peripheral speed

P14. Store current peripheral speed of transfer cylinder on memory for storing transfer cylinder's average peripheral speed

P15. Read count value N

P16. Add one to count value N and overwrite with the resultant count value N

P17. Start internal clock counter (for counting elapsed time) counting

P18. Read peripheral speed measurement time interval

P19. Read count value of internal clock counter

P20. Count value of internal clock counter - peripheral speed measurement time interval?

P21. Has measurement stop command been sent from upstream printing unit group drive control device?

Y

P22. Read output from impression-cylinder-side peripheral speed measuring device and store the output

P23. Read output from transfer-cylinder-side peripheral speed measuring device and store the output

P24. Read output of impression-cylinder-side peripheral speed measuring device

P25. Calculate current peripheral speed of impression cylinder from output of impression-cylinder-side peripheral speed measuring device, and store the current peripheral speed

N

42
Fig. 11C

- Read average peripheral speed of impression cylinder
- Calculate speed variation of impression cylinder by subtracting average peripheral speed of impression cylinder from current peripheral speed of impression cylinder
- Read output of transfer-cylinder-side peripheral speed measuring device
- Calculate current peripheral speed of transfer cylinder from output of transfer-cylinder-side peripheral speed measuring device and store the current peripheral speed
- Read average peripheral speed of transfer cylinder
- Calculate speed variation of transfer cylinder by subtracting average peripheral speed of transfer cylinder from current peripheral speed of transfer cylinder
- Calculate speed deviation by subtracting speed variation of transfer cylinder from speed variation of impression cylinder, and store the speed deviation
- Read peripheral speed measurement time interval
- Calculate position deviation by multiplying speed deviation by peripheral speed measurement time interval, and store the position deviation
- Calculate absolute value of position deviation from position deviation, and store the absolute value
- Read tolerance for position deviation
- If absolute value of position deviation ≤ tolerance for position deviation? (Y/N)
  - Y: Send error signal to upstream printing unit group drive control device
  - N: Proceed with process
Fig. 11D

21

READ AVERAGE PERIPHERAL SPEED OF IMPRESSION CYLINDER

P39

READ COUNT VALUE N

P40

CALCULATE TOTAL OF PREVIOUSLY OBTAINED PERIPHERAL SPEEDS OF IMPRESSION CYLINDER BY MULTIPLYING AVERAGE PERIPHERAL SPEED OF IMPRESSION CYLINDER BY COUNT VALUE, AND STORE THE TOTAL

P41

READ CURRENT PERIPHERAL SPEED OF IMPRESSION CYLINDER

P42

CALCULATE CURRENT TOTAL OF PERIPHERAL SPEEDS OF IMPRESSION CYLINDER BY ADDING CURRENT PERIPHERAL SPEED OF IMPRESSION CYLINDER TO TOTAL OF PREVIOUSLY OBTAINED PERIPHERAL SPEEDS OF IMPRESSION CYLINDER, AND STORE THE CURRENT TOTAL

P43

READ COUNT VALUE N

P44

CALCULATE COUNT VALUE N+1 BY ADDING ONE TO COUNT VALUE N, AND STORE COUNT VALUE N+1

P45

CALCULATE AVERAGE PERIPHERAL SPEED OF IMPRESSION CYLINDER BY DIVIDING CURRENT TOTAL OF PERIPHERAL SPEEDS OF IMPRESSION CYLINDER BY COUNT VALUE N+1, AND OVERWRITE WITH THE AVERAGE PERIPHERAL SPEED

P46

READ AVERAGE PERIPHERAL SPEED OF TRANSFER CYLINDER

P47

READ COUNT VALUE N

P48

CALCULATE TOTAL OF PREVIOUSLY OBTAINED PERIPHERAL SPEEDS OF TRANSFER CYLINDER BY MULTIPLYING AVERAGE PERIPHERAL SPEED OF TRANSFER CYLINDER BY COUNT VALUE, AND STORE THE TOTAL

P49

READ CURRENT PERIPHERAL SPEED OF TRANSFER CYLINDER

P50

CALCULATE CURRENT TOTAL OF PERIPHERAL SPEEDS OF TRANSFER CYLINDER BY ADDING CURRENT PERIPHERAL SPEED OF TRANSFER CYLINDER TO TOTAL OF PREVIOUSLY OBTAINED PERIPHERAL SPEEDS OF TRANSFER CYLINDER, AND STORE THE CURRENT TOTAL

P51

READ COUNT VALUE N+1

P52

CALCULATE AVERAGE PERIPHERAL SPEED OF TRANSFER CYLINDER BY DIVIDING CURRENT TOTAL OF PERIPHERAL SPEEDS OF TRANSFER CYLINDER BY COUNT VALUE N+1, AND OVERWRITE WITH THE AVERAGE PERIPHERAL SPEED

P53

READ COUNT VALUE N

P54

ADD ONE TO COUNT VALUE N AND OVERWRITE WITH THE RESULTANT COUNT VALUE N

P55
**DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
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<tr>
<th>Category</th>
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B41F

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The present search report has been drawn up for all claims

**Place of search**: Munich  
**Date of completion of the search**: 16 December 2009  
**Examiner**: Findeli, Bernard
ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

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