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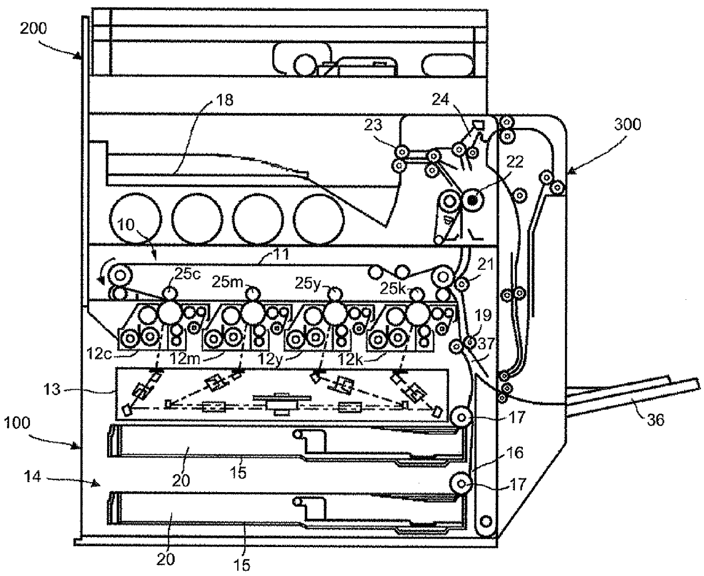
(54) **Fixing device and image forming apparatus**

(57) A fixing device (22) sets a control period and a gap between recording media so that T1 + T2 = C x N is satisfied, where T1 denotes a time from when the leading end of a recording medium reaches a nip to when the trailing end thereof passes through the nip, T2 denotes a time corresponding to the gap between the recording media, C denotes the control period, and N denotes a positive integer; and heat generated by a heat source (5) is supplied to the recording medium in synchronization with a timing at which the recording medium enters the nip. A correction amount is added to an electrification time in each control period and reduced at a predetermined rate in each control period based on temperature information of a pressing member (2) before start of feeding. The correction amount is changed depending on the basis weight of the recording medium.

FIG.1



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to an image forming apparatus, such as a copier, a printer, a facsimile, and a multifunction peripheral (MFP) having functions of these devices and to a fixing device provided to the image forming apparatus.

BACKGROUND OF THE INVENTION

[0002] Conventionally, image forming apparatuses using electrophotography have been developed as a publicly known technology. An image forming process of such an image forming apparatus includes: forming an electrostatic latent image on the surface of a photosensitive drum serving as an image carrier; developing the electrostatic latent image on the photosensitive drum into a visible image with a toner and the like serving as a developer; transferring the image thus developed onto a recording medium (hereinafter, also referred to as a sheet) by a transfer device and causing the image to be carried on the sheet; and fixing the toner image on the sheet by a fixing device that applies heat, pressure, and the like.

[0003] A fixing device is provided with a fixing rotating member formed of facing rollers, a belt, or a combination thereof. Such a fixing device typically fixes a toner image on a sheet by sandwiching the sheet with the fixing rotating member and applying heat and pressure.

[0004] Some of the fixing devices provided to an image forming apparatus as described above have recently achieved low heat capacity by reducing the diameter and the thickness of a fixing roller so as to shorten warm-up time after the start of printing or to reduce power consumption.

[0005] In continuous feeding of sheets in the conventional technology, a drop in the temperature of a pressing roller makes the temperature uneven in the circumferential direction of a fixing roller. The influence of the uneven temperature makes the fixability uneven on a single sheet.

[0006] Japanese Patent Application Laid-open No. 2002-049264, for example, discloses a technology for preventing uneven fixing on a single sheet without causing any deviation in an image. The technology sets the circumference of a heat roller whose peripheral surface comes into contact with a sheet in a direction of carrying the sheet to equal to or larger than a length of short sides of a sheet in a normal size (A4 size) in the direction of conveying the sheet. The technology, however, does not address unevenness in the temperature of a fixing roller due to a drop in the temperature of a pressing roller.

[0007] Therefore, there is a need to a fixing device capable of reducing fluctuation in the temperature of a fixing belt due to a drop in the temperature of a pressing roller and to reduce unevenness in temperature in a single sheet, thereby achieving even fixability on the sheet.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to at least partially solve the problems in the conventional technology.

[0009] According to an embodiment, there is provided a fixing device that includes a rotatable fixing member configured to heat a recording medium carrying a yet-to-be-fixed image thereon; a rotatable pressing member configured to come into contact with the fixing member to form a nip between the fixing member and the pressing member; a heat source configured to heat the fixing member; a first temperature detecting unit configured to detect a temperature of the fixing member; a second temperature detecting unit configured to detect a temperature of the pressing member; and a temperature control unit configured to electrify the heat source at a predetermined control period based on pieces of temperature information received from the first temperature detecting unit and the second temperature detecting unit, respectively. The control period or a gap between recording media is set so that $T1 + T2 = C \times N$ is satisfied, where T1 denotes a time from when a leading end of the recording medium reaches the nip to when a trailing end of the recording medium passes through the nip, T2 denotes a time corresponding to the gap between the recording media, C denotes the control period, and N denotes a positive integer; and heat generated by the heat source is supplied to the recording medium in synchronization with a timing at which the recording medium enters the nip. A correction amount is added to an electrification time in each control period and the correction amount is reduced at a predetermined rate in each control period based on the piece of temperature information of the pressing member before feeding of the recording medium is started. The correction amount is changed depending on a basis weight of the recording medium.

[0010] According to another embodiment, there is provided an image forming apparatus that includes the fixing device according to the above embodiment.

[0011] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a schematic of a configuration of the whole internal mechanism of an image forming apparatus provided with a fixing device according to an embodiment of the present invention;
Fig. 2 illustrates a configuration of the fixing device according to the embodiment;
Fig. 3 illustrates a method for turning ON and OFF a heater of a fixing device provided with a halogen heater;
Fig. 4 illustrates an allowable range of fluctuation in the temperature of a sheet and a toner;
Fig. 5 illustrates a control period and a temperature in a conventional fixing device and the fixing device according to the embodiment;
Fig. 6 illustrates an example of a method for changing the length between sheets according to the embodiment;
Fig. 7 illustrates a method for turning ON and OFF a heater in the conventional fixing device;
Fig. 8 illustrates a method for turning ON and OFF a heater in the fixing device according to the embodiment;
Fig. 9 illustrates duty control for adding different correction amounts depending on difference in the basis weight of sheets;
Fig. 10 illustrates duty control for adding different correction amounts depending on difference in the linear velocity; and
Fig. 11 illustrates duty control for adding different correction amounts depending on difference in the length of a sheet and in the length between sheets.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] An exemplary embodiment according to the present invention is described below in greater detail with reference to the accompanying drawings. Fig. 1 is a schematic of a configuration of the whole internal mechanism of an image forming apparatus provided with a fixing device according to an embodiment of the present invention. The image forming apparatus illustrated in Fig. 1 employs electrophotography and is formed of an image forming apparatus main body 100, an image reading device 200 arranged on top of the image forming apparatus main body 100, and a duplex unit 300 arranged on the right side of the image forming apparatus main body 100. The image forming apparatus main body 100 includes an intermediate transfer device 10. The intermediate transfer device 10 is provided with an endless intermediate transfer belt 11 stretched around a plurality of rollers nearly horizontally to move in a counterclockwise direction.

[0014] Image forming units 12c, 12m, 12y, and 12k of cyan, magenta, yellow, and black, respectively, are provided below the intermediate transfer device 10 in a 4-unit tandem manner along a direction in which the intermediate transfer belt 11 is stretched. The image forming units 12c, 12m, 12y, and 12k are each formed of a charging device, a developing device, a transfer device, and a cleaning device, for example, arranged around a drum-shaped image carrier that rotates in a clockwise direction in Fig. 1. An exposing unit 13 is provided below the image forming units 12c, 12m, 12y, and 12k.

[0015] A feeding device 14 is provided below the exposing unit 13. The feeding device 14 is formed of paper cassettes 15 in which sheets 20 serving as recording media are loaded. The paper cassettes 15 are provided in a two-tiered manner in this example. The paper cassettes 15 are each provided with a paper feeding roller 17 at the upper right corner thereof. The paper feeding roller 17 pulls out the sheets 20 loaded in the paper cassette 15 one by one and feeds the sheet 20 into a sheet conveying path 16.

[0016] The sheet conveying path 16 extends from a lower part to an upper part in the image forming apparatus main body 100 on the right side. The sheet conveying path 16 leads to an internal discharging unit 18 arranged between the image forming apparatus main body 100 and the image reading device 200. The sheet conveying path 16 is provided with a carriage roller 19, a secondary transfer device 21 facing the intermediate transfer belt 11, a fixing device 22, and a discharging device 23 formed of a pair of ejecting rollers, for example, in this order. A feed path 37 is provided on the upstream of the carriage roller 19. The feed path 37 causes the sheet 20 re-fed from the duplex unit 300 or manually fed from a bypass feeding device 36 across the duplex unit 300 to enter into the sheet conveying path 16. A re-feed path 24 leading to the duplex unit 300 is provided on the downstream of the fixing device 22 in a bifurcated manner.

[0017] To make a copy, the image reading device 200 reads a document image, and the exposing unit 13 writes the image to form toner images in the colors on the respective image carriers of the image forming units 12c, 12m, 12y, and 12k. Subsequently, primary transfer devices 25c, 25m, 25y, and 25k sequentially transfer the toner images, thereby forming a color image on the intermediate transfer belt 11.

[0018] One of the paper feeding rollers 17 is selectively rotated to feed the sheet 20 from the paper cassette 15 corresponding to the paper feeding roller 17 thus selected into the sheet conveying path 16. Alternatively, a sheet is manually fed from the bypass feeding device 36 into the feed path 37. The sheet is then conveyed by the carriage roller 19 through the sheet conveying path 16 to a secondary transfer position at a predetermined timing. Subsequently, the color image formed on the intermediate transfer belt 11 as described above is transferred onto the sheet 20 by the secondary transfer device 21. The image transferred onto the sheet 20 is fixed thereon by the fixing device 22. The sheet 20 is then discharged by the discharging device 23 and stacked on the internal discharging unit 18.

[0019] To form an image also on the other side of the sheet 20, the sheet 20 is entered into the re-feed path 24 to be reversed in the duplex unit 300 and is re-fed through the feed path 37. Subsequently, another color image formed on the intermediate transfer belt 11 is secondary transferred onto the sheet 20. The image is fixed on the sheet 20 by the fixing device 22, and the sheet 20 is discharged by the discharging device 23 to the internal discharging unit 18.

[0020] Fig. 2 illustrates a configuration of the fixing device 22 according to the embodiment. The fixing device 22 according to the embodiment includes a fixing roller 1 serving as a rotatable fixing member, a pressing roller 2 serving as a rotatable pressing member, a heating roller 4 containing a heat source, and a fixing belt 3 stretched around the fixing roller 1 and the heating roller 4. A rotating shaft of a first roller of the fixing roller 1 and the pressing roller 2 is fixed, and a rotating shaft of a second roller is provided in a movable manner. The second roller is supported in a manner capable of being brought into contact with and separated from the first roller. In addition, the second roller is biased toward the first roller with a spring, whereby a nip n is formed between the fixing roller 1 and the pressing roller 2 with the fixing belt 3 interposed therebetween. When the sheet 20 passes through the nip n, the fixing roller 1 comes into contact with the sheet 20 on a side with a yet-to-be-fixed image formed thereon and heats the sheet 20. The pressing roller 2 presses the sheet from a side with no image formed thereon. Thus, the yet-to-be-fixed image is fixed on the sheet with heat and pressure.

[0021] The heat source will now be described. A halogen heater 5 is arranged inside of the heating roller 4 and can heat the fixing belt 3. While the halogen heater is used herein as an example, the heat source that heats the fixing belt 3 may be other heat sources, such as a ceramic heater and induction heating (TH).

[0022] A heat control method of the fixing device 22 will now be described. The fixing device 22 illustrated in Fig. 2 is provided with a non-contact temperature sensor 6 serving as a first temperature detecting unit. The non-contact temperature sensor 6 is provided adjacent to the fixing belt 3 to measure the temperature of the fixing belt 3. The fixing device 22 is further provided with a fixing temperature controller 92a. The fixing temperature controller 92a controls electric power applied to the halogen heater 5 by controlling an electrification time per unit time (that is, duty) via a pulse-width modulation (PWM) driving circuit 92b based on information of temperature deviation between a specified target control temperature of the fixing belt 3 and the temperature of the fixing belt 3 detected by the non-contact temperature sensor 6. The fixing temperature controller 92a is a temperature control unit according to the embodiment. The pressing roller 2 is provided with a temperature sensor 7 serving as a second temperature detecting unit that can monitor the temperature of the pressing roller 2. With this configuration, the fixing device 22 controls the electric power for the halogen heater 5 so that a quantity of heat applied to the sheet 20 and the toner passing through the nip n is a predetermined value.

[0023] Fig. 3 illustrates a method for turning ON and OFF a heater of a fixing device provided with a halogen heater. As illustrated in (i) of Fig. 3, for example, an explanation will be made using a fixing device that operates under the following conditions:

Process linear velocity: 105 mm/s
Length of a sheet: 210 mm
Length between sheets: 126 mm
Electric power of a fixing heater: 1200 [W]

[0024] As illustrated in (ii) of Fig. 3, in the conditions of the length of a sheet, the length between sheets, and the linear velocity described above, it takes 2.0 seconds for the sheet to pass by, and it takes 1.2 seconds for a portion between sheets to pass by.

[0025] An economical and ideal method for turning ON and OFF the heater will now be described with reference to (iii) of Fig. 3. An ideal temperature waveform is a waveform illustrated in the lower chart in (iii) of Fig. 3. In other words, to achieve energy saving and enhance image quality, the temperature of the fixing belt 3 is preferably constant at a target temperature. Furthermore, to achieve energy saving, the heater 5 is preferably turned OFF for the portion between sheets.

[0026] As illustrated in the upper chart in (iii) of Fig. 3, an assumption is made that electric power required for heating the sheet and the toner to a target temperature is 300 W. To provide an ideal temperature waveform, the heater is ideally turned ON to output 300 W constantly to the sheet portion and turned OFF to apply no electric power to the portion between sheets.

[0027] The halogen heater 5 provided to the fixing device 22 has the following characteristics ((iv) of Fig. 3). To reduce cost and simplify the device, the halogen heater is directly turned ON using a relay with an alternate-current (AC) power. The relay is also used to perform duty control for switching ON and OFF the heater. A high-power heater is used to reduce a time for recovery after the power is turned ON or from a stand-by state. To apply heat corresponding to 300 W to the sheet using a halogen heater rated at 1200 W, a time during which the halogen heater is being turned ON corresponds to one third of a time during which the halogen heater is being turned OFF.

[0028] An ideal method for turning ON and OFF the heater under the duty control switches the heater ON and OFF as quickly as possible. Switching the heater ON and OFF quickly makes it possible to raise the temperature of the fixing belt close to the target temperature as illustrated in (iii) of Fig. 3.

[0029] However, it is actually difficult to turn the heater ON and OFF quickly for the following reasons. If the heater is quickly switched ON and OFF repeatedly, the temperature of a filament in the halogen heater fails to rise, thereby promoting evaporation of tungsten. As a result, the filament deteriorates to be damaged. Furthermore, fluctuation in voltage applied to the power source causes blinking (flicker) of illumination, for example.

[0030] To address this, it is actually necessary to make a period of time in which the heater is turned ON and time in which the heater is turned OFF (hereinafter, referred to as a control period) sufficiently long as illustrated in (v) of Fig. 3. The upper chart in (v) of Fig. 3 illustrates the case where the control period is set to 0.4 seconds. To apply electric power corresponding to 300 W to the sheet portion in this case, the period of time in which the heater is turned ON is set to 0.1 seconds, and the time in which the heater is turned OFF is set to 0.3 seconds. In this condition, the control period is repeated five times.

[0031] Turning ON and OFF the heater in such a control period increases fluctuation in the temperature of the fixing belt with respect to the target temperature compared with the case where the heater is quickly switched ON and OFF. In other words, the temperature becomes higher than the target temperature when the heater is turned ON, whereas the temperature becomes lower than the target temperature when the heater is turned OFF (the lower chart in (v) of Fig. 3).

[0032] Fig. 4 illustrates an allowable range of fluctuation in the temperature of the sheet and the toner. To achieve energy saving and enhance image quality, the fluctuation in temperature is preferably made as small as possible. If the fluctuation in temperature falls within a range of plus or minus 1.5°C with respect to the target temperature, that is, within a 3°C range, desired image quality can be provided.

[0033] Fig. 5 illustrates a control period and a temperature in a conventional fixing device and the fixing device according to the embodiment. In recently developed image forming apparatuses, a fixing device has been designed to achieve low heat capacity of a fixing member, such as a fixing belt, so as to achieve energy saving in the fixing device by reducing the diameter of a roller, for example. Such a fixing device can achieve energy saving but has quick temperature response of the fixing member to turning ON and OFF of the heater. As a result, it is difficult to maintain a constant temperature.

[0034] In such a fixing device designed to achieve low heat capacity, it is difficult for the conventional method for turning ON and OFF the heater to cause fluctuation in the temperature of the fixing belt to fall within an allowable 3°C range. It is difficult for the conventional method for turning ON and OFF the heater to reduce the fluctuation in the temperature of the fixing belt because the control period is set independently of timings of the sheet and the portion between sheets.

[0035] Illustrated in (i) of Fig. 5 is an ideal waveform of the temperature of the fixing belt. In (i) of Fig. 5, a target temperature is maintained from the leading end to the trailing end of a sheet. Illustrated in (ii) of Fig. 5 is the method for turning ON and OFF the heater in the conventional fixing device. As illustrated in (ii) of Fig. 5, the control period is set independently of the timings of the sheet and the portion between sheets. As a result, there is a gap between a target timing at which heating is to be performed and a timing at which heating is actually performed. This generates a portion in which the temperature of the fixing belt drops and a portion in which the fixing belt is excessively heated. Specifically, the temperature of the fixing belt drops at the trailing end of a first sheet, the leading end of a second sheet, and the leading end of a third sheet. The fixing belt is excessively heated at a portion between sheets after the third sheet passes by.

[0036] To address this, as illustrated in (iii) of Fig. 5, the fixing device 22 according to the embodiment controls duty for turning ON the heater as follows: a relation between a time of "a sheet and a portion between sheets" and the control period satisfies Equation (1) or a relation closer thereto; and heat generated by the heater is supplied to the sheet in synchronization with a timing at which the sheet enters the nip n (after electrification of the heater is started, the heat generated by the heater is supplied to the sheet at a timing at which the leading end of the sheet reaches the nip n).

$$T1 + T2 = C \times N \qquad (1)$$

[0037] T1 (second) corresponds to (Length of Sheet)/(Process Linear Velocity) and denotes a time in which the sheet passes through the nip n from the leading end thereof to the trailing end. T2 (second) corresponds to (Length between Sheets)/(Process Linear Velocity) and denotes a time corresponding to a portion between sheets. C (second) denotes a control period, and N denotes a positive integer.

[0038] A control period C in an electrification cycle of the halogen heater 5 is set in a manner satisfying Equation (1) (e.g., N = 4) in (iii) of Fig. 5. The control period is set independently of T1 + T2 in (ii) of Fig. 5. In (iii) and (ii) of Fig. 5, the length of the sheet, the length between sheets, the process linear velocity, T1, and T2 are made constant during a continuous image forming job, and each of these values is the same in (iii) and (ii) of Fig. 5. Furthermore, each control period in the electrification cycle is set such that the halogen heater 5 is turned ON three times for the sheet 20 conveyed toward the nip n both in (iii) and (ii) of Fig. 5. The control period is made constant during the continuous image forming job. In an actual operation, the duty of electrification for the sheet is variably controlled by the temperature control unit based on temperature information supplied from the temperature sensor 6.

[0039] In (ii) of Fig. 5, the control period in the electrification cycle is set independently of a passing timing T1 + T2 of the sheet 20 passing through the nip n, and T1 + T2 is not equal to an integral multiple of the control period. As a result, along with progress of the continuous image forming job, the start timing of the electrification cycle of the heater lags behind a predetermined timing at which the sheet is conveyed to the nip n. Accumulation of the lag at the start timing of the electrification cycle for each sheet along with the progress of the continuous image forming job decreases or increases the frequency of turning ON the heater (frequency of electrification) for a sheet fed after a certain number of sheets. In (ii) of Fig. 5, the heater is turned ON three times for the first sheet and the second sheet, whereas the heater is turned ON only approximately 2.5 times for the third sheet. As a result, the temperature of the fixing belt 3 at the entrance of the nip n drops at an early stage of the third sheet passing through the nip n. Thus, poor fixing occurs at the leading end of the sheet, thereby causing uneven fixing. The area of the fixing belt 3 corresponding to the timing for turning ON the heater remaining approximately 0.5 times passes through the nip n without coming into contact with the sheet. The heat is not taken away by the sheet, thereby excessively heating the fixing belt 3. In (ii) of Fig. 5, the temperature of the fixing belt 3 also drops at the nip n when the first and the second sheets pass through the nip n in association with the control period. Uneven fixing may possibly occur also in the first and the second sheets depending on the degree of the drop in temperature.

[0040] In (iii) of Fig. 5, the control period C in the electrification cycle of the heater is set in a manner satisfying Equation (1) correspondingly to the passing timing T1 + T2 of the sheet passing through the nip n. As a result, the electrification cycle of the heater is started for all the sheets when the leading end of each sheet reaches the entrance of the nip n (a start point of T1) during the continuous image forming job. This makes the frequency of turning ON the heater (frequency of electrification) the same for all the sheets and causes the temperature of the fixing belt 3 to shift in the same manner at the entrance of the nip n. Thus, it is possible to prevent uneven fixing due to a drop in temperature at the nip and to form a fixed image having excellent fixing quality. It is also possible to prevent the area of the fixing belt 3 heated by turning ON the heater from passing through the nip n without coming into contact with the sheet and from being excessively heated.

[0041] To satisfy Equation (1), a first method may change the control period C depending on T1 + T2 serving as the time of "a sheet and a portion between sheets". Table 1 indicates candidates of the control period C in a condition where paper per minute (PPM) (sheet/minute) varies depending on difference in linear velocities. In Table 1, T1 + T2 serving as the time of "a sheet and a portion between sheets" is obtained by rounding each value to the whole number. A sheet in a size of A4 horizontal is used as the sheet 20.

Table 1

Control periods for models having different linear velocities

PPM [sheet/min]	20	30	40	50
Length of sheet [mm] (A4 horizontal)	210	210	210	210
Length between sheets [mm]	60	60	60	60
Linear velocity [mm/s]	90	135	180	225
Time of "a sheet and a	3	2	1.5	1.2

	portion between sheets" [s]				
N=1	Candidate of control period C [ms]	3000	2000	1500	1200
N=2		1500	1000	750	600
N=3		1000	667	500	400
N=4		750	500	375	300
N=5		600	400	300	240
N=6		500	333	250	200
N=7		429	286	214	171
N=8		375	250	188	150
N=9		333	222	167	133
N=10		300	200	150	120

[0042] There may be a plurality of candidates of the control period C depending on N. As explained with reference to (i) to (v) of Fig. 3, as N is set to a larger value, that is, as the control period C is made shorter, the controllability on the temperature of the fixing belt becomes more excellent. In consideration of deterioration of the filament in the halogen heater 5 and flicker, however, it is necessary to set a sufficiently long control period C. If a control period C of equal to or longer than 600 milliseconds is required, for example, the control periods C hatched in Table 1 may be selected.

[0043] In this example, based on Equation (1), the control periods C thus hatched are as follows: if the linear velocity is 90 mm/s, N is 5, and C is 600 milliseconds; if the linear velocity is 135 mm/s, N is 3, and C is 667 milliseconds; if the linear velocity is 180 mm/s, N is 2, and C is 750 milliseconds; and if the linear velocity is 225 mm/s, N is 2, and C is 600 milliseconds.

[0044] While T1 + T2 serving as the time of "a sheet and a portion between sheets" is determined based on the PPM, the PPM may possibly vary depending on difference in sheet sizes in the same model of the image forming apparatus. In this case, it is preferable that an appropriate control period C be allocated to each PPM. If the allocation is difficult to perform, the control period C may be simply optimized to frequently used sheet sizes, such as A4, A3, and Letter size.

[0045] A second method may set a length between sheets L based on the control period C. Assuming that the PPM can be changed, Table 2 indicates candidates of the length between sheets L in a condition where the control period C is 600 milliseconds and the linear velocity varies. In Table 2, a sheet in a size of A4 horizontal is used as the sheet 20.

[0046] If lengths between sheets L hatched in Table 2 are selected, for example, it is possible to satisfy Equation 1. While a change in the length between sheets L leads to a change in the PPM, changing the length between sheets L is an effective method for a model that can change PPM. In Table 2, candidates of the length between sheets L having a negative value are lengths between sheets that cannot be realized. The lengths between sheets corresponding to the candidates are excluded.

[0047] In this example, the lengths between sheets L thus hatched are as follows: if the linear velocity is 90 mm/s, L is 60 mm, T1 + T2 is 3.0 seconds, and the PPM is 20.0 sheets/minute; if the linear velocity is 135 mm/s, L is 114 mm, T1 + T2 is 2.4 seconds, and the PPM is 25.0 sheets/minute; if the linear velocity is 180 mm/s, L is 114 mm, T1 + T2 is 1.8 seconds, and the PPM is 33.3 sheets/minute; and if the linear velocity is 225 mm/s, L is 60 mm, T1 + T2 is 1.2 seconds, and the PPM is 50.0 sheets/minute.

Table 2

Length between sheets for models having different linear velocities

	Length of sheet [mm] (A4 horizontal)	210	210	210	210
	Linear velocity [mm/s]	90	135	180	225
	Control period C [ms]	600	600	600	600
N=1	Candidates of length between sheets L [mm]	-156	-129	-102	-75
N=2		-102	-48	6	60
N=3		-48	33	114	195
N=4		6	114	222	330
N=5		60	195	330	465
N=6		114	276	438	600
N=7		168	357	546	735
N=8		222	438	654	870
N=9		276	519	762	1005
N=10		330	600	870	1140
N=1	Time T1+T2 of "a sheet and a portion between sheets" [s]	0.6	0.6	0.6	0.6
N=2		1.2	1.2	1.2	1.2
N=3		1.8	1.8	1.8	1.8
N=4		2.4	2.4	2.4	2.4
N=5		3.0	3.0	3.0	3.0
N=6		3.6	3.6	3.6	3.6
N=7		4.2	4.2	4.2	4.2
N=8		4.8	4.8	4.8	4.8
N=9		5.4	5.4	5.4	5.4
N=10		6.0	6.0	6.0	6.0
N=1	PPM [sheet/min]	100.0	100.0	100.0	100.0
N=2		50.0	50.0	50.0	50.0
N=3		33.3	33.3	33.3	33.3
N=4		25.0	25.0	25.0	25.0
N=5		20.0	20.0	20.0	20.0
N=6		16.7	16.7	16.7	16.7
N=7		14.3	14.3	14.3	14.3
N=8		12.5	12.5	12.5	12.5
N=9		11.1	11.1	11.1	11.1
N=10		10.0	10.0	10.0	10.0

[0048] Fig. 6 illustrates a method for changing the length between sheets according to the present invention. If the PPM cannot be changed, changing the time of "a sheet and a portion between sheets" by changing the length between sheets in the fixing process of the sheets makes it possible to satisfy Equation 1 without changing the PPM.

[0049] As illustrated in (i) of Fig. 6, the length between sheets is constant in the conventional technology. As a result, there are gaps between the leading ends of the second and the third sheets, which are target timings at which heating is to be performed, and respective timings at which heating is actually performed. As illustrated in (ii) of Fig. 6, according to the embodiment, the length between sheets L between the first sheet and the second sheet is increased and the length between sheets L between the second sheet and the third sheet is increased. Thus, it is possible to cause the target timing at which heating is to be performed to match with the timing at which heating is actually performed while satisfying Equation (1) without changing the PPM.

[0050] Performing control in this manner makes it possible to reduce fluctuation in the temperature of the fixing belt. This method for turning ON and OFF the heater, however, does not address a drop in the temperature of the fixing belt due to a rapid drop in the temperature of the pressing roller.

[0051] Fig. 7 is a schematic of a method for turning ON and OFF a heater in the conventional fixing device. In the conventional device, if the temperature of the pressing roller is low as illustrated in the left figure of Fig. 7, a drop in the temperature of the pressing roller is small at a timing for feeding a sheet indicated by a vertical dashed line. Because a drop in the temperature of the fixing roller is also small, the conventional method for turning ON and OFF the heater can be employed without problems. If the temperature of the pressing roller is high as illustrated in the right figure of Fig. 7, however, the temperature of the pressing roller significantly drops along with the start of feeding. This causes the temperature of the fixing roller to significantly drop.

[0052] If the temperature of the pressing roller is high, it is effective to expect a drop in the temperature of the pressing roller and change the duty for turning ON the heater correspondingly to the drop besides to set the control period C in synchronization with T1 + T2 serving as the time of "a sheet and a portion between sheets".

[0053] The temperature of the pressing roller is likely to rise when no sheet is fed, that is, when the heat is supplied to no sheet while the fixing belt is maintained at a predetermined temperature, such as a time before feeding and a time during which process control is being performed. A drop in the temperature of the fixing belt is likely to occur in association with a drop in the temperature of the pressing roller in the first sheet fed after the start of feeding and the first sheet fed after the process control is performed.

[0054] The temperature of the pressing roller fluctuates depending on the basis weight of the sheet, the temperature of the sheet, and the ratio between the length of the sheet and the length between sheets besides on a heating temperature before the feeding. This is because the quantity of heat supplied from the pressing roller to the sheet is changed. It is effective to predict fluctuation in the temperature of the pressing roller using feeding information of the sheets and to change the duty for turning ON the heater correspondingly to the fluctuation.

[0055] Fig. 8 illustrates a method for turning ON and OFF the heater in the fixing device according to the embodiment. If the temperature of the pressing roller is low as illustrated in the left figure of Fig. 8, the conventional method for turning ON and OFF the heater can be employed without problems. If the temperature of the pressing roller is high, however, it is necessary to prevent a drop in the temperature of the fixing roller. The fixing device according to the embodiment adds a correction amount to the turning-ON duty at the start of feeding based on the temperature of the pressing roller before the start of feeding as illustrated in the right figure of Fig. 8. In other words, a correction amount is added to a period of time in which the heater is turned ON (electrification time) in each control period. The correction amount to be added to the electrification time in each control period is gradually reduced.

[0056] In the present embodiment, the turning-ON duty, which is a ratio of the electrification time to the control period, is 40% at the start of feeding. A correction amount of 40% is derived by assuming that an initial addition rate is 1 and is added to the turning-ON duty in the first control period. Values are derived by reducing a correction amount of 40% with a reduction rate of 0.25 and are added to the turning-ON duty in the second control period and the control periods subsequent thereto. In other words, the correction amount for the second control period is 40% $\times$ 0.75, the correction amount for the third control period is 40% $\times$ 0.5, the correction amount for the fourth control period is 40% $\times$ 0.25, and the correction amount for the fifth control period is 40% $\times$ 0.

[0057] The reduction rate is preferably set such that the subtraction of the correction amount is finished (the correction amount becomes 0) at around time when the temperature of the pressing roller stops dropping after the start of feeding. The subtraction is not necessarily performed on the first sheet and may be performed on a plurality of sheets depending on the sheet size. This means that a plurality of sheets need to be fed until the temperature of the pressing roller thus decreased is stabilized.

[0058] As illustrated in the left figure of Fig. 8, if the temperature of the pressing roller is low, no addition needs to be performed on the turning-ON duty. It is effective to perform the addition when the temperature of the pressing roller is equal to or higher than a threshold. Performing the corrective addition on the turning-ON duty when the temperature of the pressing roller is equal to or lower than the threshold may possibly cause an overshoot in the temperature of the fixing belt.

[0059] While a threshold T is set to 120°C, for example, the threshold T is not limited thereto. The threshold T is set based on the configuration of the fixing device, and the correction amount is changed depending on the temperature of the pressing roller. By controlling the turning-ON duty appropriately with an appropriate correction amount and reduction rate, it is possible to prevent a drop in the temperature of the fixing roller and to reduce unevenness in the temperature as illustrated in the right figure of Fig. 8.

[0060] The addition is not necessarily performed at the initial stage of the feeding and may be performed when the temperature of the pressing roller rises after the process control operation performed during the feeding as described above. The threshold T may be set as appropriate as described above.

[0061] If the temperature of the fixing belt exceeds a desired target temperature, it is not preferable to perform the corrective addition on the turning-ON duty. If the temperature of the fixing belt overshoots the target temperature by equal to or higher than T3°C, no corrective addition is performed, thereby reducing unevenness in the temperature of the fixing belt. T3 is set to 20°C, for example. Because T3 depends on the amount of decrease in the temperature of the pressing roller, T3 is changed based on the type of the sheet and the feeding conditions.

[0062] If a temperature detecting member is provided to the pressing roller and can detect the temperature of the pressing roller, it is possible to determine whether to perform the corrective addition based on the detected temperature information. If no temperature detecting member is provided to the pressing roller, the temperature of the pressing roller is predicted from the temperature of the fixing belt, a rotational linear velocity, and a time between sheets. Thus, it is possible to determine whether to perform the corrective addition. If a time between sheets of equal to or longer than 5 seconds is caused because of the process control and adjustment of productivity, for example, the temperature of the pressing roller rises, and the corrective addition is to be performed. The number of seconds varies depending on fixing devices and is not limited thereto.

[0063] An explanation will be made of a specific method for performing the corrective addition on the turning-ON duty according to the embodiment. In the embodiment, a correction amount is determined in advance by predicting the amount of decrease in the temperature of the pressing roller in association with the feeding. Fig. 9 illustrates duty control for adding different correction amounts depending on difference in the basis weight of sheets. As illustrated in the upper charts in Fig. 9, as the basis weight increases like 60 g, 90 g, and 120 g, the heat capacity of the sheet also increases. As a result, the quantity of heat taken away from the pressing roller at the nip n increases, thereby increasing the amounts of decrease in the temperature of the pressing roller and the temperature of the fixing roller.

[0064] To address this, the initial addition rate and the correction amount are appropriately changed depending on the basis weight of the sheet as indicated in Table 3. Thus, it is possible to prevent a drop in the temperature of the fixing roller and to reduce unevenness in the temperature as illustrated in the lower charts in Fig. 9. In this example, the initial addition rate is set to 0.75 if the basis weight is equal to or smaller than 60 g/m^2, the initial addition rate is set to 1 if the basis weight is from 61 g/m^2 to 90 g/m^2, and the initial addition rate is set to 1.25 if the basis weight is from 91 g/m^2 to 120 g/m^2. The reduction rate (step) is set to 0.25.

Table 3

Basis weight [g/m^2]	Linear velocity [mm/s]	Size [mm]	Initial addition rate	Step
To 60	200	210	0.75	0.25
61 to 90	200	210	1	0.25
91 to 120	200	210	1.25	0.25

[0065] The correction amount may be changed depending on the temperature of the sheet or the environmental temperature instead of or in addition to depending on the basis weight of the sheet. Similarly, the initial addition rate may also be set correspondingly to the temperature of the sheet. If the temperature of the sheet is low, the amount of decrease in the temperature of the pressing roller increases. In this case, the initial addition rate is set higher.

[0066] As illustrated in Fig. 10, the initial addition rate and the correction amount may be changed depending on the linear velocity (sheet feed rate). The initial addition rate is preferably changed depending on linear velocity information instead of or in addition to depending on the basis weight of the sheet and the temperature of the sheet. As illustrated in the upper charts in Fig. 10, as the linear velocity increases like 100 mm/s, 200 mm/s, and 300 mm/s, the passing amount of the sheet at the nip n per unit time increases. As a result, the temperature of the pressing roller and the temperature of the fixing roller are likely to drop.

[0067] To address this, if the linear velocity is higher, the initial addition rate is set higher and the correction amount is set larger as indicated in Table 4. In this example, the initial addition rate is set to 0.75 if the linear velocity is 100 mm/s, the initial addition rate is set to 1 if the linear velocity is 200 mm/s, and the initial addition rate is set to 1.25 if the linear velocity is 300 mm/s. The reduction rate (step) is set to 0.25. The initial addition rate is set as appropriate in each fixing.

Table 4

Basis weight [g/m^2]	Linear velocity [mm/s]	Size [mm]	Initial addition rate	Step
61 to 90	100	210	0.75	0.25

(continued)

Basis weight [g/m^2]	Linear velocity [mm/s]	Size [mm]	Initial addition rate	Step
61 to 90	200	210	1	0.25
61 to 90	300	210	1.25	0.25

[0068] As illustrated in Fig. 11, the reduction rate (step) is preferably changed depending on difference in the length of the sheet and in the length between sheets. As illustrated in the upper charts in Fig. 11, as the sheet size in a sheet feeding direction increases like 149 mm, 210 mm, and 297 mm, the quantity of heat taken away from the pressing roller increases. As a result, the temperature of the pressing roller and the temperature of the fixing roller are likely to drop.
[0069] To address this, as indicated in Table 5, the reduction rate is changed depending on a value of TA = T1/(T1 + T2), where T1 denotes a time in which the sheet passes through the nip n from the leading end to the trailing end, and T2 denotes a time corresponding to a portion between sheets. If TA is small, the reduction rate is set higher; whereas if TA is large, the reduction rate is set lower. A low reduction rate set in the case where the length of the sheet is small and the length between sheets is large may possibly cause an overshoot in temperature.
[0070] The lower charts in Fig. 11 illustrate the amount of change in the correction amount in the case where the sheets are continuously fed by changing the reduction rate (step) depending on TA and setting the length between sheets constant. Specifically, the reduction rate is set to 0.4 if TA is 0.68, the reduction rate is set to 0.25 if TA is 0.75, and the reduction rate is set to 0.1 if TA is 0.81 as indicated in Table 5. Thus, it is possible to prevent a drop in the temperature of the fixing roller and to reduce unevenness in the temperature as illustrated in Fig. 11.

Table 5

Basis weight [g/m^2]	Linear velocity [mm/s]	Size [mm]	Length between sheets [mm]	T1/(T1+T2)	Initial addition rate	Step
61 to 90	200	149	70	0.68	1	0.4
61 to 90	200	210	70	0.75	1	0.25
61 to 90	200	297	70	0.81	1	0.1

[0071] As described above, the fixing device sets the time of "a sheet and a portion between sheets" to an integral multiple of the control period to control a timing for turning ON or OFF the heater such that the heat of the fixing member is supplied to the sheet in synchronization with a timing at which the sheet enters the nip. If the temperature of the pressing roller is high, the fixing device gradually changes the duty for turning ON the heater correspondingly to a drop in the temperature of the pressing roller caused at the same timing at which the sheet enters the nip. Thus, it is possible to prevent a drop in the temperature of the pressing roller and to reduce unevenness in the temperature of the fixing belt.
[0072] According to the embodiment, the fixing device sets the time of "a sheet and a portion between sheets" to an integral multiple of the control period to reset a timing of the heater control period such that heat is supplied in synchronization with a timing at which the sheet enters the nip. The fixing device gradually changes the duty for turning ON the heater correspondingly to a drop in the temperature of the pressing roller caused at the same timing at which the sheet enters the nip. Thus, it is possible to reduce unevenness in the temperature on the fixing belt due to the drop in the temperature of the pressing roller. This makes it possible to achieve energy saving and to enhance image quality. Because the fixing device changes the correction amount depending on the basis weight of the sheet, it is possible to select an appropriate correction amount.
[0073] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. A fixing device (22) comprising:

a rotatable fixing member (1) configured to heat a recording medium carrying a yet-to-be-fixed image thereon;
a rotatable pressing member (2) configured to come into contact with the fixing member (1) to form a nip between the fixing member (1) and the pressing member (2);
a heat source (5) configured to heat the fixing member (1);

a first temperature detecting unit (6) configured to detect a temperature of the fixing member (1);
a second temperature detecting unit (7) configured to detect a temperature of the pressing member (2); and
a temperature control unit (92a) configured to electrify the heat source (5) at a predetermined control period based on pieces of temperature information received from the first temperature detecting unit (6) and the second temperature detecting unit (7), respectively, wherein
the control period or a gap between recording media is set so that $T1 + T2 = C \times N$ is satisfied, where T1 denotes a time from when a leading end of the recording medium reaches the nip to when a trailing end of the recording medium passes through the nip, T2 denotes a time corresponding to the gap between the recording media, C denotes the control period, and N denotes a positive integer; and heat generated by the heat source (5) is supplied to the recording medium in synchronization with a timing at which the recording medium enters the nip,
a correction amount is added to an electrification time in each control period and the correction amount is reduced at a predetermined rate in each control period based on the piece of temperature information of the pressing member (2) before feeding of the recording medium is started, and
the correction amount is changed depending on a basis weight of the recording medium.

2. The fixing device (22) according to claim 1, wherein the correction amount is changed depending on a temperature of the recording medium.

3. The fixing device (22) according to claim 1 or 2, wherein the correction amount is changed depending on a linear velocity of the recording medium.

4. The fixing device (22) according to any one of claims 1 to 3, wherein the predetermined rate is changed depending on a value of $T1/(T1 + T2)$.

5. The fixing device (22) according to any one of claims 1 to 4, wherein the addition of the correction amount is performed only when the temperature of the pressing member (2) before the feeding of the recording medium is started is equal to or higher than a threshold.

6. The fixing device (22) according to any one of claims 1 to 5, wherein the predetermined rate is set so that subtraction of the correction amount is finished when the temperature of the pressing member (2) stops dropping after the feeding of the recording medium is started.

7. The fixing device (22) according to any one of claims 1 to 6, wherein the control period C is set based on a longitudinal length or a lateral length of the recording medium in any one of A4, A3, and Letter size.

8. The fixing device (22) according to any one of claims 1 to 7, wherein the heat source (5) is not electrified during the time T2 corresponding to the gap between the recording media.

9. An image forming apparatus (100) comprising the fixing device (22) according to any one of claims 1 to 8.

FIG.1

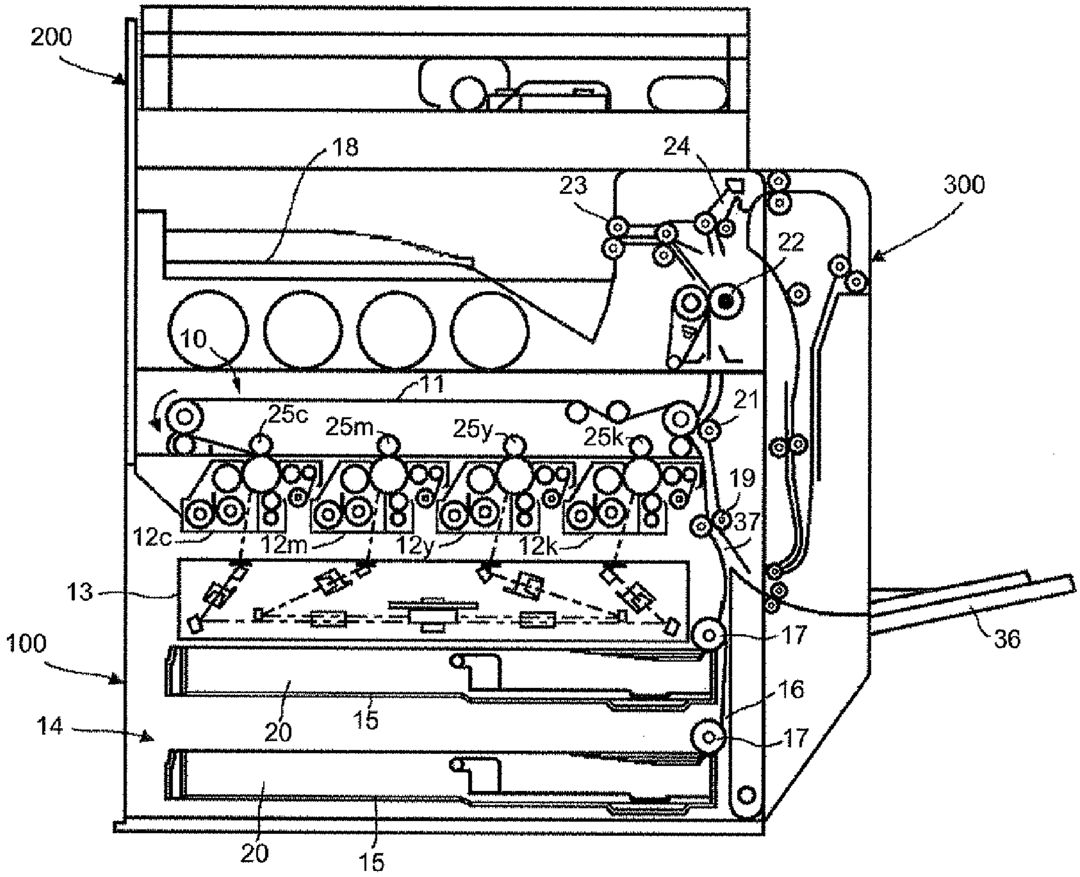

200
18
24
23
300
22
10
11
25c
25m
25y
25k
21
19
37
12c
12m
12y
12k
13
17
36
100
16
14
20
15

FIG.2

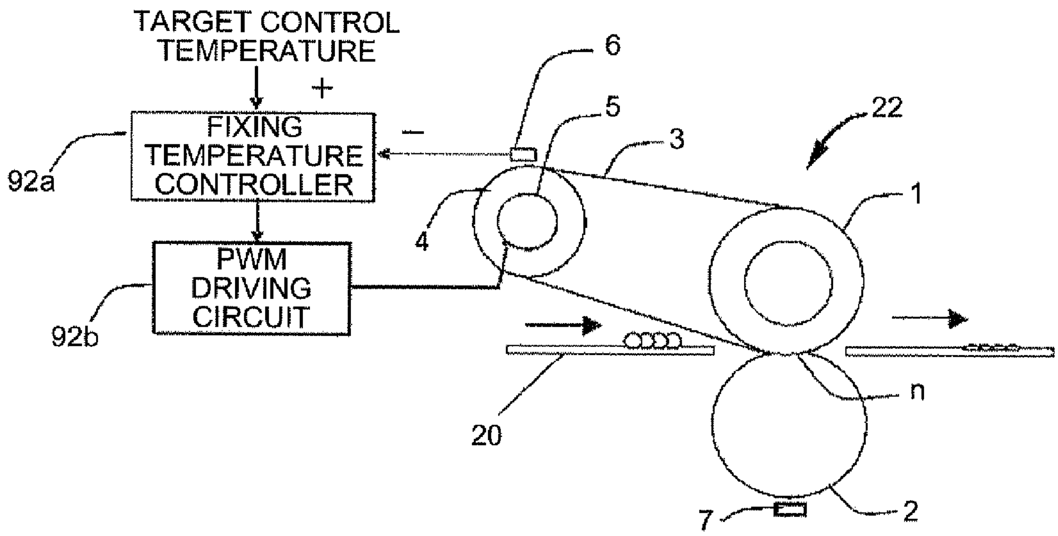

TARGET CONTROL TEMPERATURE
+
−
FIXING TEMPERATURE CONTROLLER
PWM DRIVING CIRCUIT
92a
92b
6
5
3
22
4
1
20
n
7
2

FIG.3

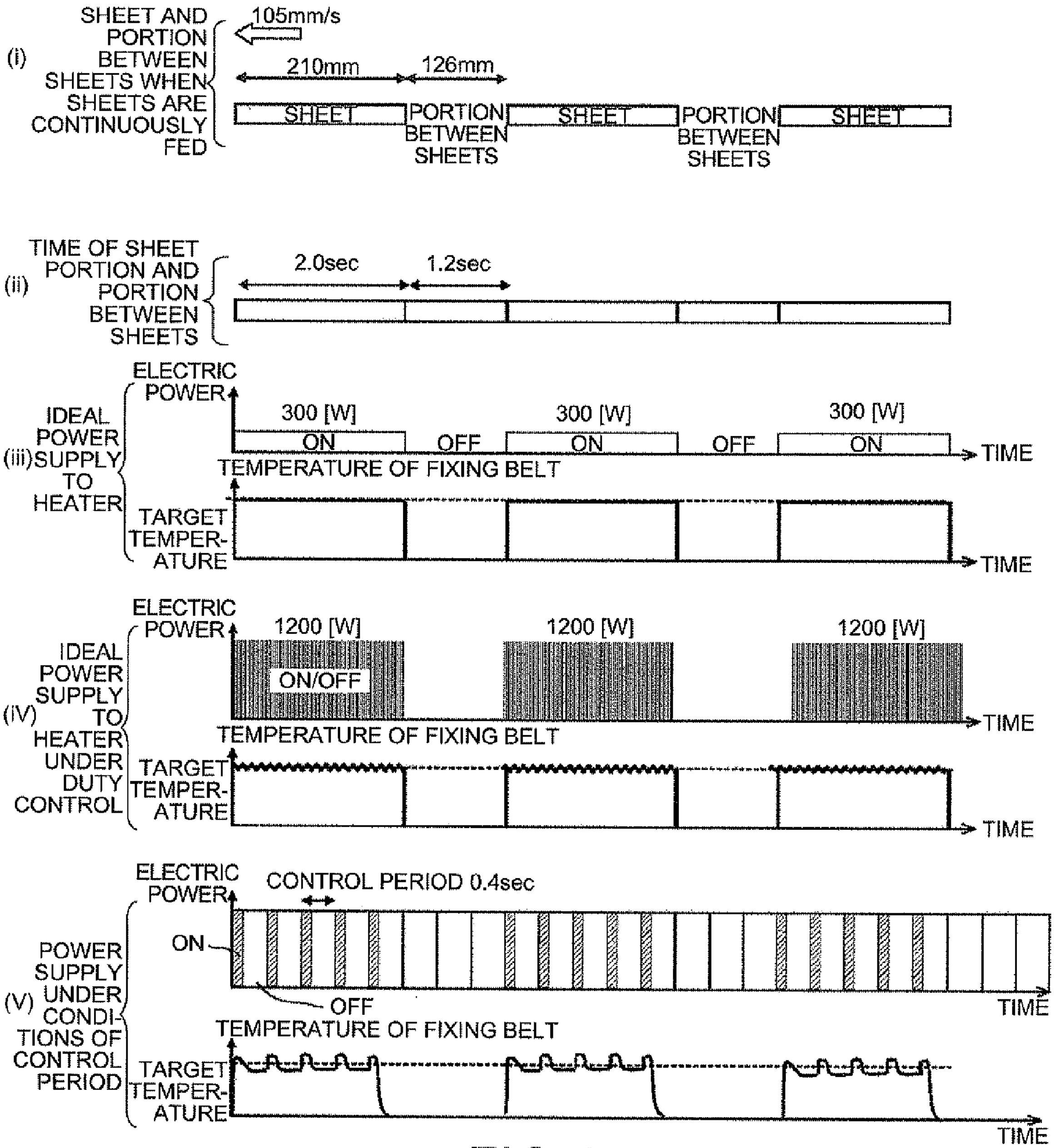

SHEET AND PORTION BETWEEN SHEETS WHEN SHEETS ARE CONTINUOUSLY FED
(i)
105mm/s
210mm
126mm
SHEET
PORTION BETWEEN SHEETS
TIME OF SHEET PORTION AND PORTION BETWEEN SHEETS
(ii)
2.0sec
1.2sec
IDEAL POWER SUPPLY TO HEATER
(iii)
ELECTRIC POWER
300 [W]
ON
OFF
TIME
TEMPERATURE OF FIXING BELT
TARGET TEMPERATURE
IDEAL POWER SUPPLY TO HEATER UNDER DUTY CONTROL
(iV)
1200 [W]
ON/OFF
POWER SUPPLY UNDER CONDITIONS OF CONTROL PERIOD
(V)
CONTROL PERIOD 0.4sec

FIG.4

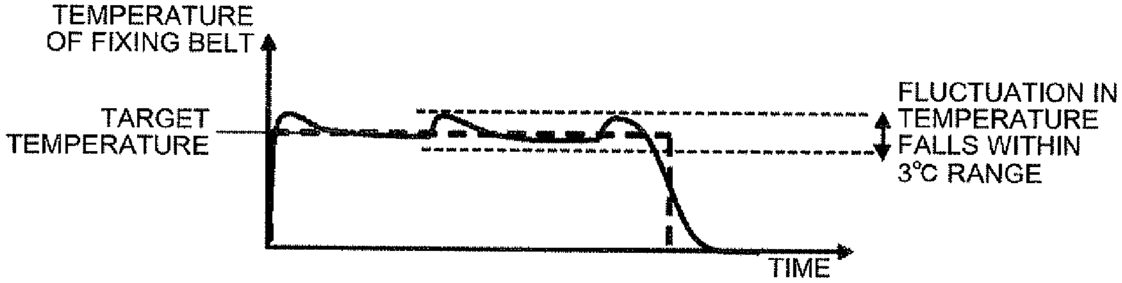

TEMPERATURE OF FIXING BELT
TARGET TEMPERATURE
FLUCTUATION IN TEMPERATURE FALLS WITHIN 3°C RANGE
TIME

FIG.5

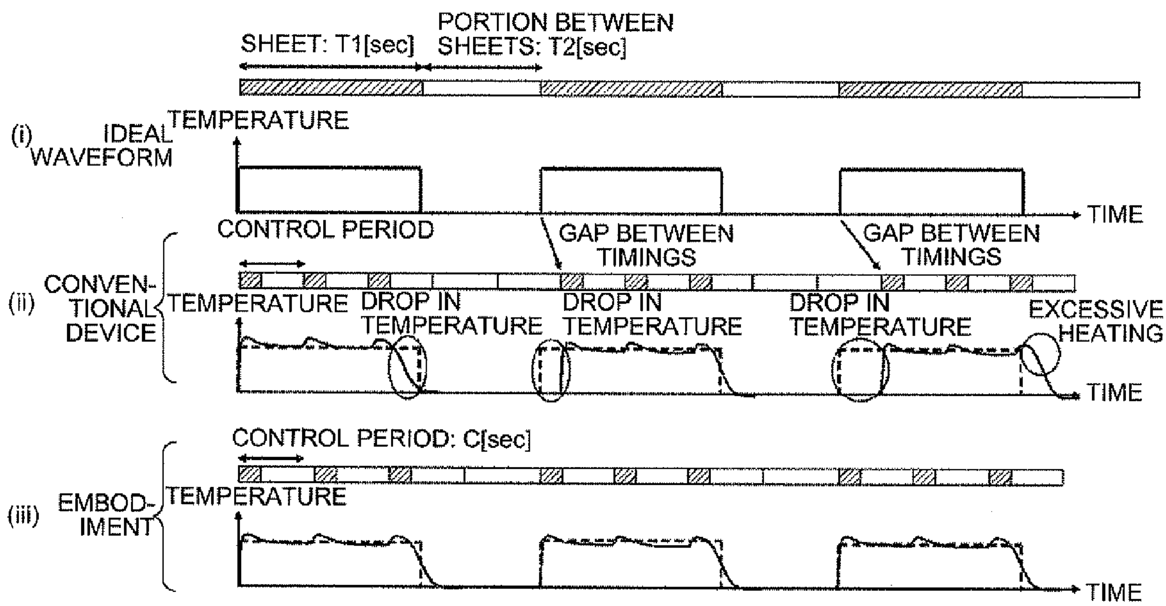

SHEET: T1[sec]
PORTION BETWEEN SHEETS: T2[sec]
(i) IDEAL WAVEFORM
TEMPERATURE
TIME
CONTROL PERIOD
GAP BETWEEN TIMINGS
GAP BETWEEN TIMINGS
(ii) CONVEN-TIONAL DEVICE
TEMPERATURE
DROP IN TEMPERATURE
DROP IN TEMPERATURE
DROP IN TEMPERATURE
EXCESSIVE HEATING
TIME
CONTROL PERIOD: C[sec]
(iii) EMBOD-IMENT
TEMPERATURE
TIME

FIG.6

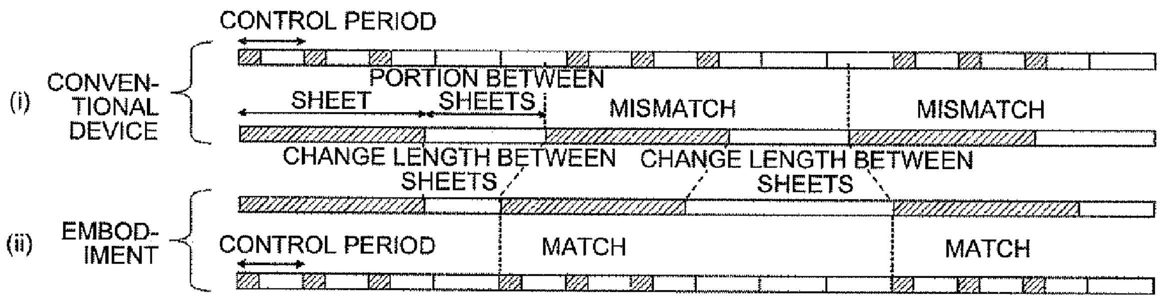

CONTROL PERIOD
(i) CONVEN-TIONAL DEVICE
SHEET
PORTION BETWEEN SHEETS
MISMATCH
MISMATCH
CHANGE LENGTH BETWEEN SHEETS
CHANGE LENGTH BETWEEN SHEETS
(ii) EMBOD-IMENT
CONTROL PERIOD
MATCH
MATCH

FIG.7

CONVENTIONAL DEVICE

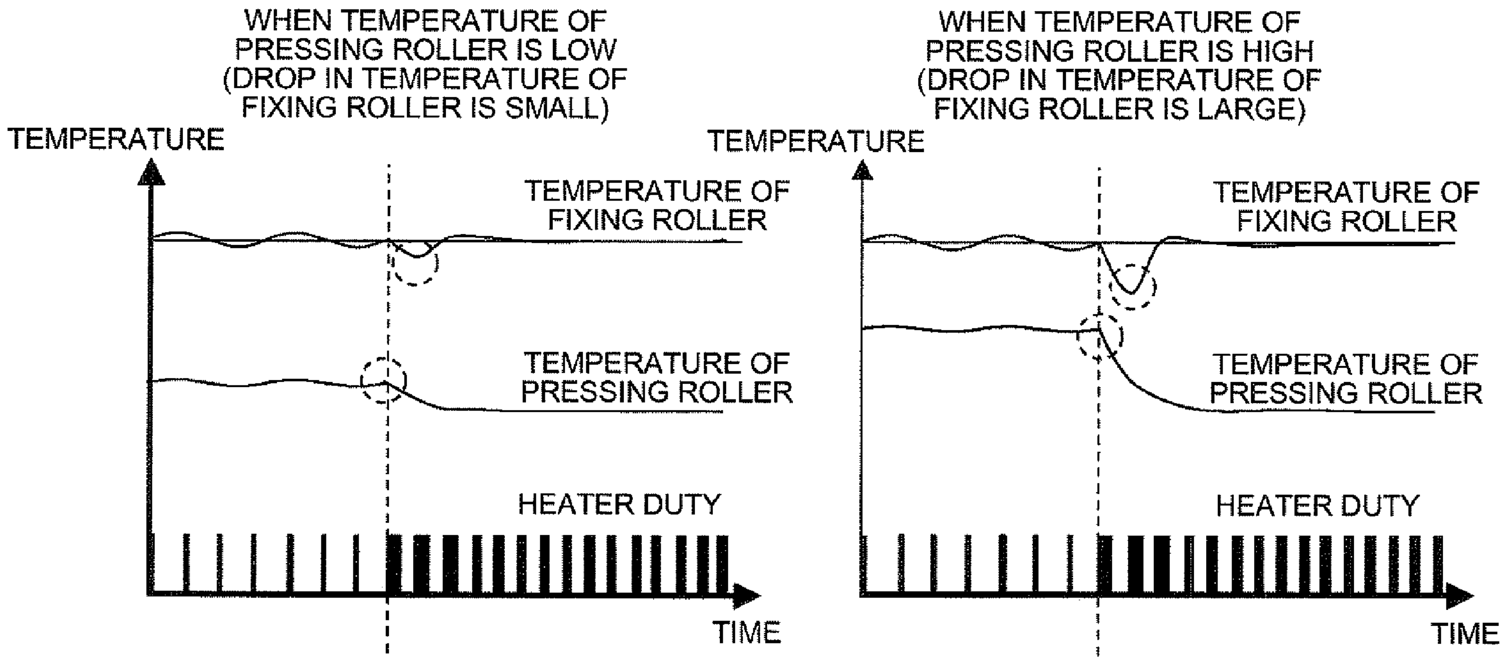


FIG.8

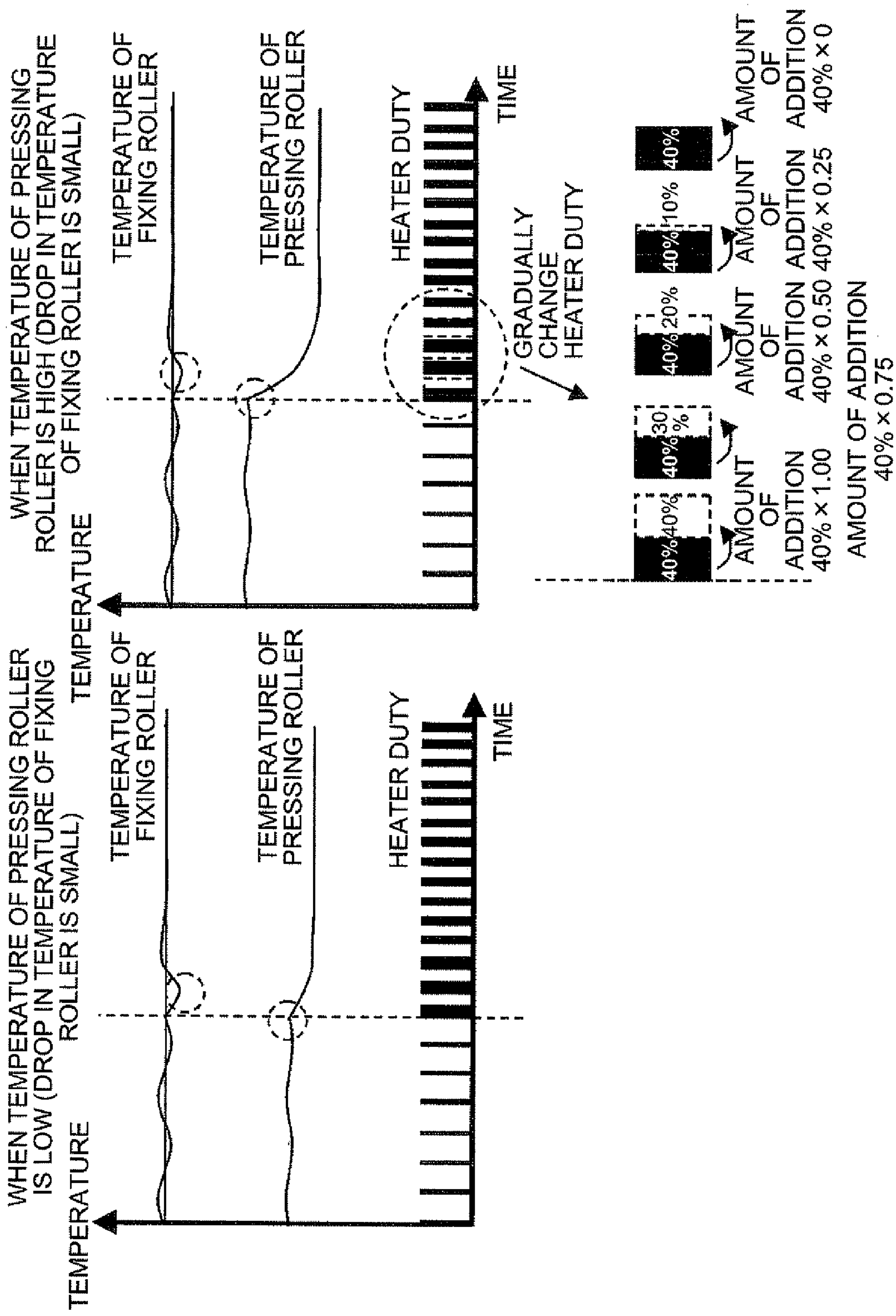

WHEN TEMPERATURE OF PRESSING ROLLER IS HIGH (DROP IN TEMPERATURE OF FIXING ROLLER IS SMALL)
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
GRADUALLY CHANGE HEATER DUTY
40%
40%
30%
20%
10%
AMOUNT OF ADDITION 40% × 1.00
AMOUNT OF ADDITION 40% × 0.75
AMOUNT OF ADDITION 40% × 0.50
AMOUNT OF ADDITION 40% × 0.25
AMOUNT OF ADDITION 40% × 0
WHEN TEMPERATURE OF PRESSING ROLLER IS LOW (DROP IN TEMPERATURE OF FIXING ROLLER IS SMALL)
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME

FIG.9

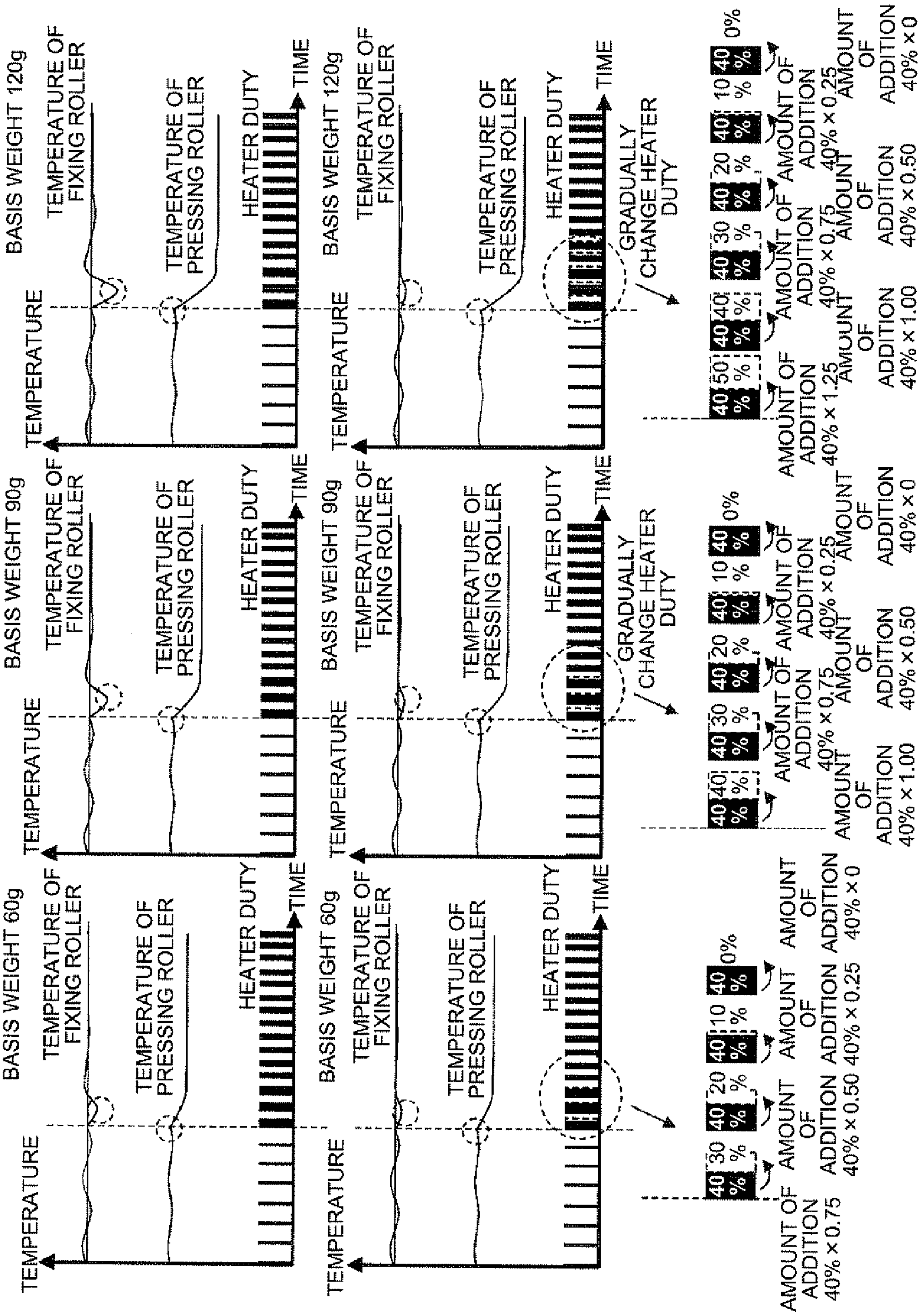
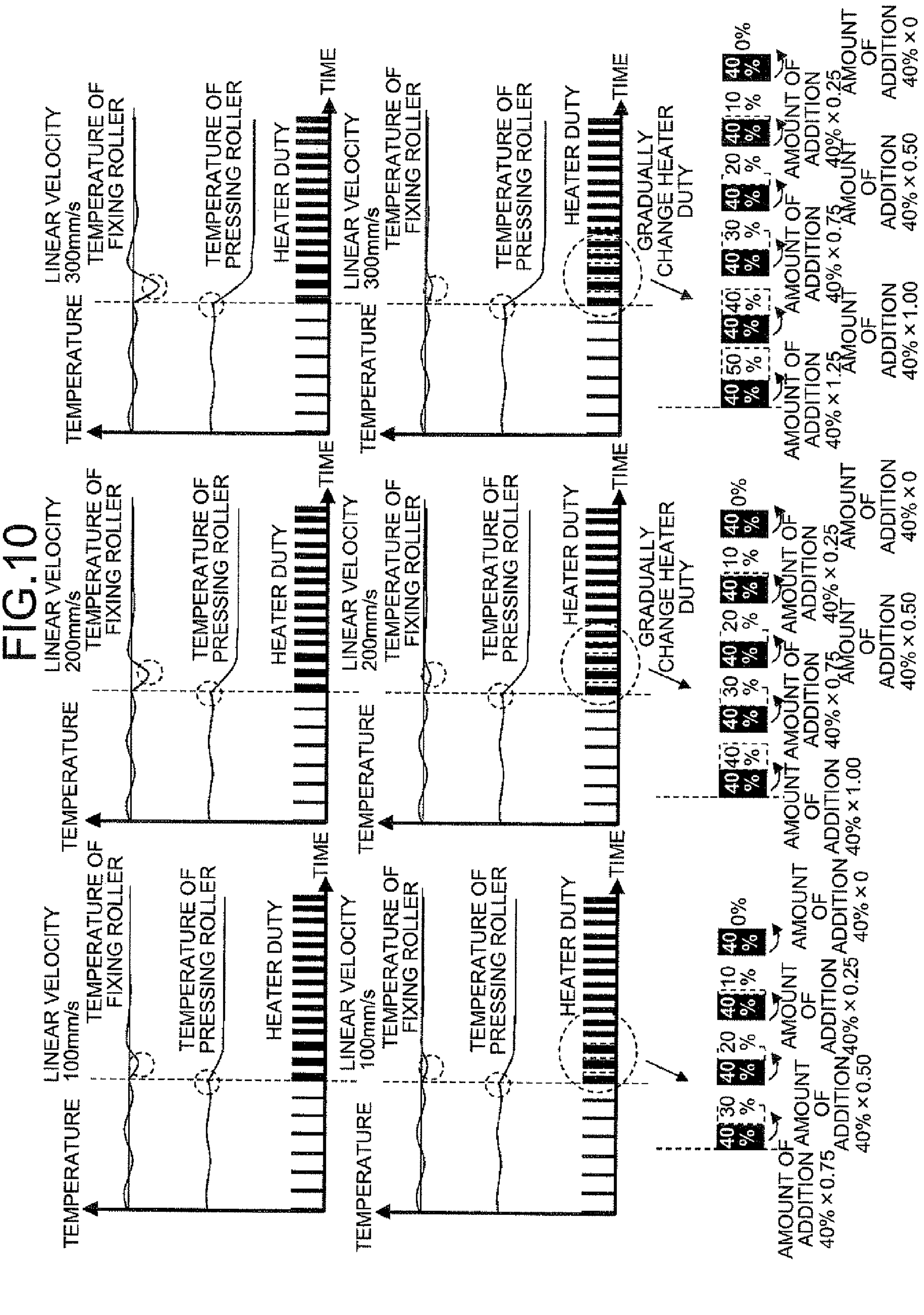

BASIS WEIGHT 60g
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
BASIS WEIGHT 60g
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
40 %
30 %
40 %
20 %
40 %
10 %
40 %
0%
AMOUNT OF ADDITION 40% × 0.75
AMOUNT OF ADDITION 40% × 0.50
AMOUNT OF ADDITION 40% × 0.25
AMOUNT OF ADDITION 40% × 0
BASIS WEIGHT 90g
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
BASIS WEIGHT 90g
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
GRADUALLY CHANGE HEATER DUTY
40 %
40 %
40 %
30 %
40 %
20 %
40 %
10 %
40 %
0%
AMOUNT OF ADDITION 40% × 1.00
AMOUNT OF ADDITION 40% × 0.75
AMOUNT OF ADDITION 40% × 0.50
AMOUNT OF ADDITION 40% × 0.25
AMOUNT OF ADDITION 40% × 0
BASIS WEIGHT 120g
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
BASIS WEIGHT 120g
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
GRADUALLY CHANGE HEATER DUTY
40 %
50 %
40 %
40 %
40 %
30 %
40 %
20 %
40 %
10 %
40 %
0%
AMOUNT OF ADDITION 40% × 1.25
AMOUNT OF ADDITION 40% × 1.00
AMOUNT OF ADDITION 40% × 0.75
AMOUNT OF ADDITION 40% × 0.50
AMOUNT OF ADDITION 40% × 0.25
AMOUNT OF ADDITION 40% × 0

FIG.10


TEMPERATURE
LINEAR VELOCITY 100mm/s
LINEAR VELOCITY 200mm/s
LINEAR VELOCITY 300mm/s
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
GRADUALLY CHANGE HEATER DUTY
AMOUNT OF ADDITION 40% × 1.25
AMOUNT OF ADDITION 40% × 1.00
AMOUNT OF ADDITION 40% × 0.75
AMOUNT OF ADDITION 40% × 0.50
AMOUNT OF ADDITION 40% × 0.25
AMOUNT OF ADDITION 40% × 0
40 %
50 %
30 %
20 %
10 %
0%

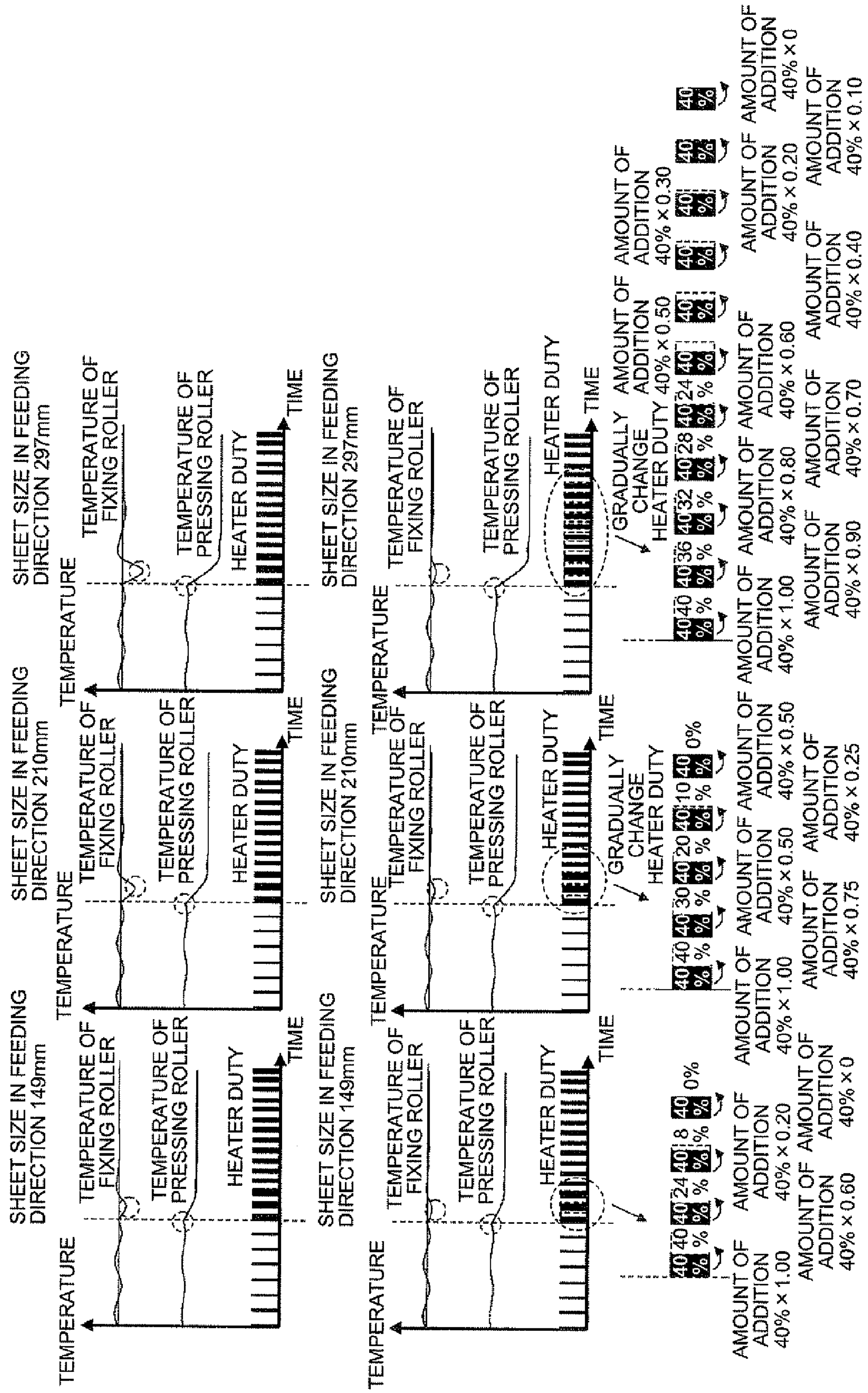

SHEET SIZE IN FEEDING DIRECTION 149mm
SHEET SIZE IN FEEDING DIRECTION 210mm
SHEET SIZE IN FEEDING DIRECTION 297mm
TEMPERATURE
TEMPERATURE OF FIXING ROLLER
TEMPERATURE OF PRESSING ROLLER
HEATER DUTY
TIME
GRADUALLY CHANGE HEATER DUTY
AMOUNT OF ADDITION 40%×1.00
AMOUNT OF ADDITION 40%×0.60
AMOUNT OF ADDITION 40%×0.20
AMOUNT OF ADDITION 40%×0
AMOUNT OF ADDITION 40%×0.75
AMOUNT OF ADDITION 40%×0.50
AMOUNT OF ADDITION 40%×0.25
AMOUNT OF ADDITION 40%×0.90
AMOUNT OF ADDITION 40%×0.80
AMOUNT OF ADDITION 40%×0.70
AMOUNT OF ADDITION 40%×0.60
AMOUNT OF ADDITION 40%×0.40
AMOUNT OF ADDITION 40%×0.30
AMOUNT OF ADDITION 40%×0.20
AMOUNT OF ADDITION 40%×0.10

FIG.11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002049264 A **[0006]**