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(54) CONTINUOUS PAPER FEEDING DEVICE AND PRINTER INCORPORATING THE SAME

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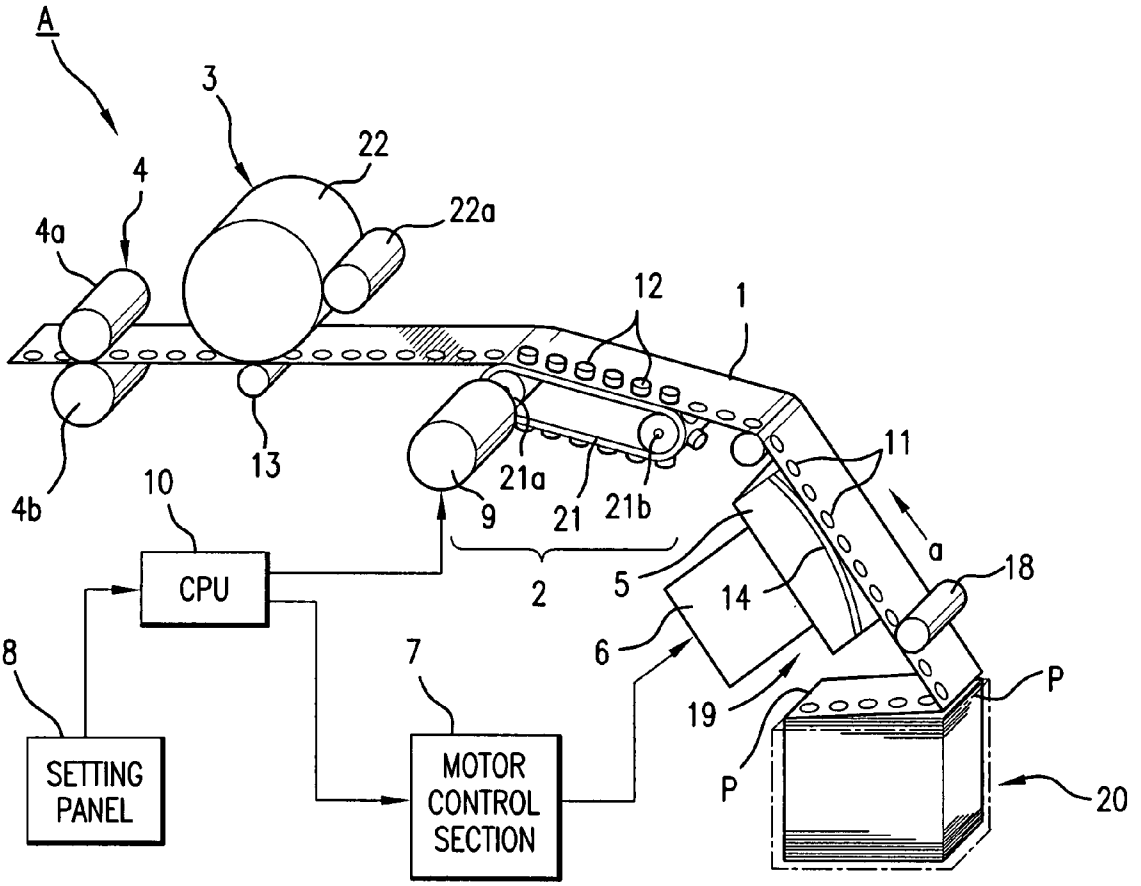
(52) **U.S. Cl.** **226/101**; 271/145

(57) **ABSTRACT**

A tractor feeds a perforated continuous paper sheet to a printing position. The feeding force of a fusing device located downstream of the printing position is set larger than the feeding force of the tractor in order to apply tension to the continuous paper sheet at the printing position. A braking device located upstream of the tractor applies a braking force balancing with the feeding force of the fusing device to the continuous paper sheet. The braking force of the braking device is varied depending upon the properties of the paper sheet or the environmental conditions. This arrangement makes it possible to stabilize the feeding state even under situations where the sheet feeding force is likely to become unstable, thereby realizing printing without any deviation from the predetermined position. Further, this arrangement can also prevent hole breakage to occur.



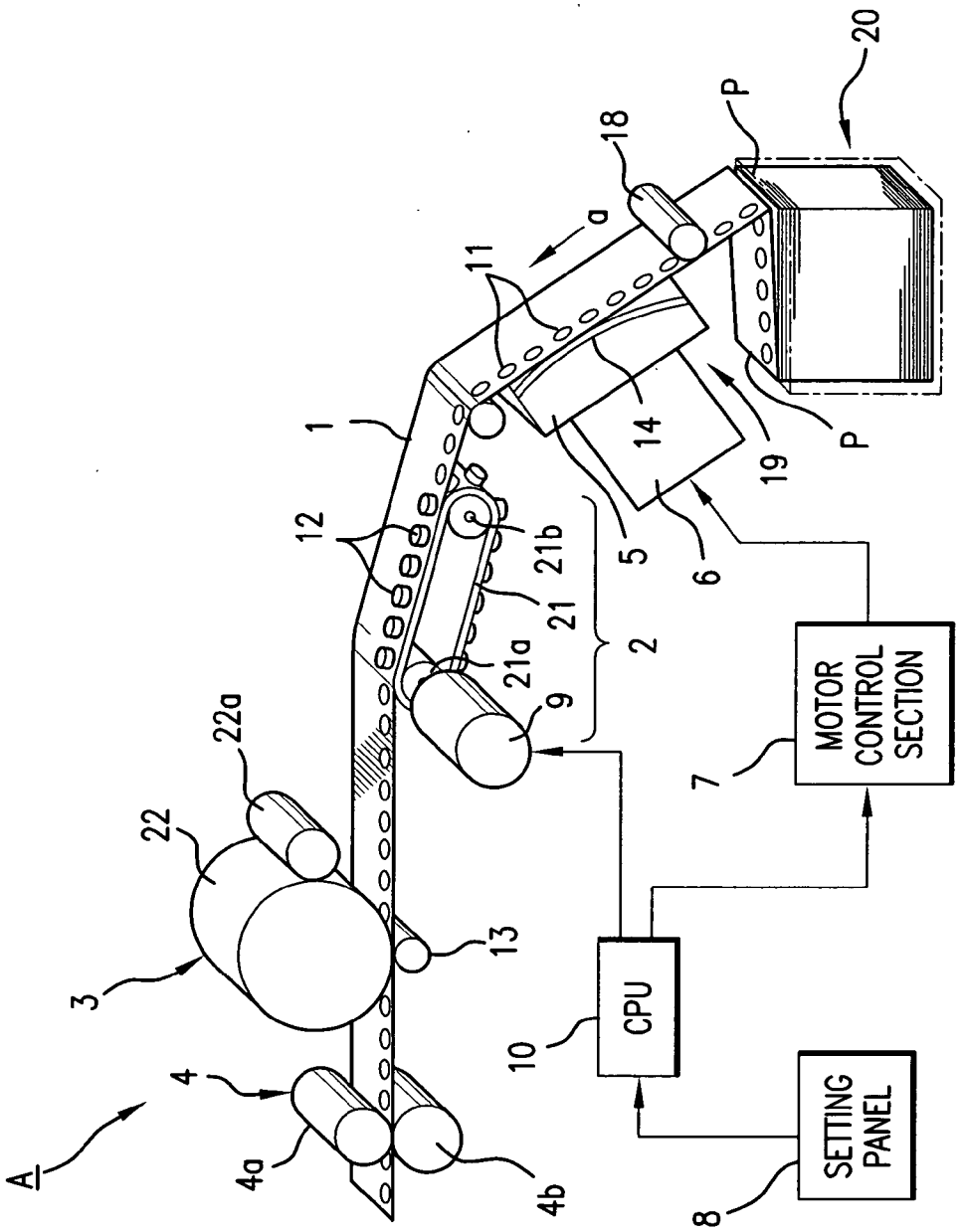

20
P
18
a
11
1
12
14
19
P
5
6
21b
21
21a
9
2
MOTOR CONTROL SECTION
7
22a
22
13
3
CPU
10
4
SETTING PANEL
8
A
4a
4b

FIG. 1

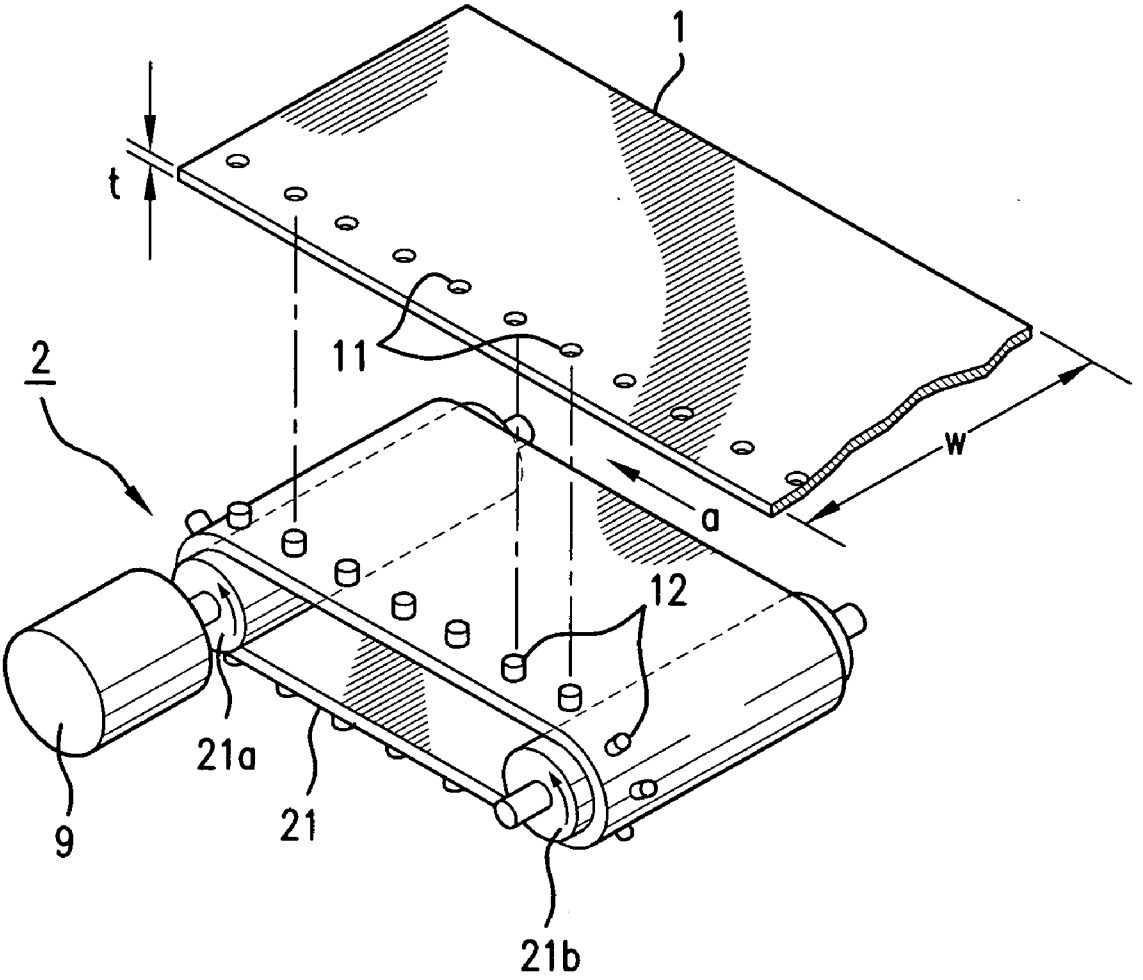


FIG.2

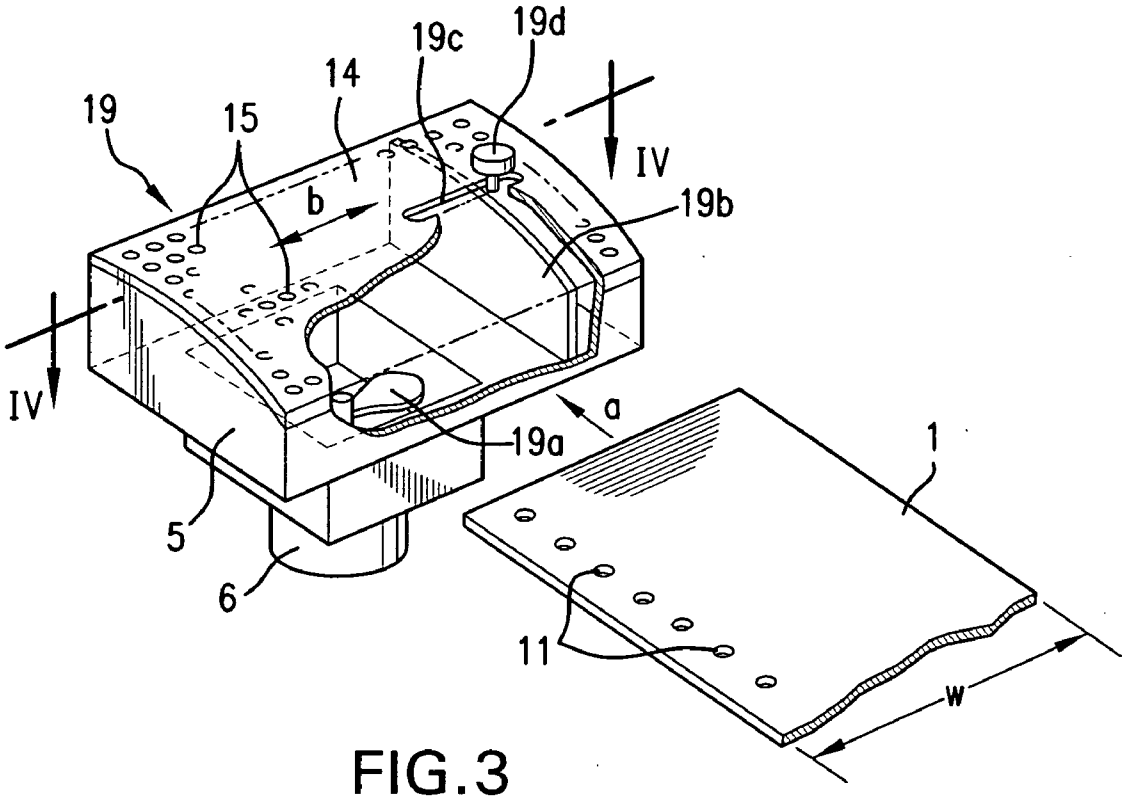

19c
19d
14
19
15
IV
b
19b
IV
a
19a
1
5
6
11
w

FIG.3

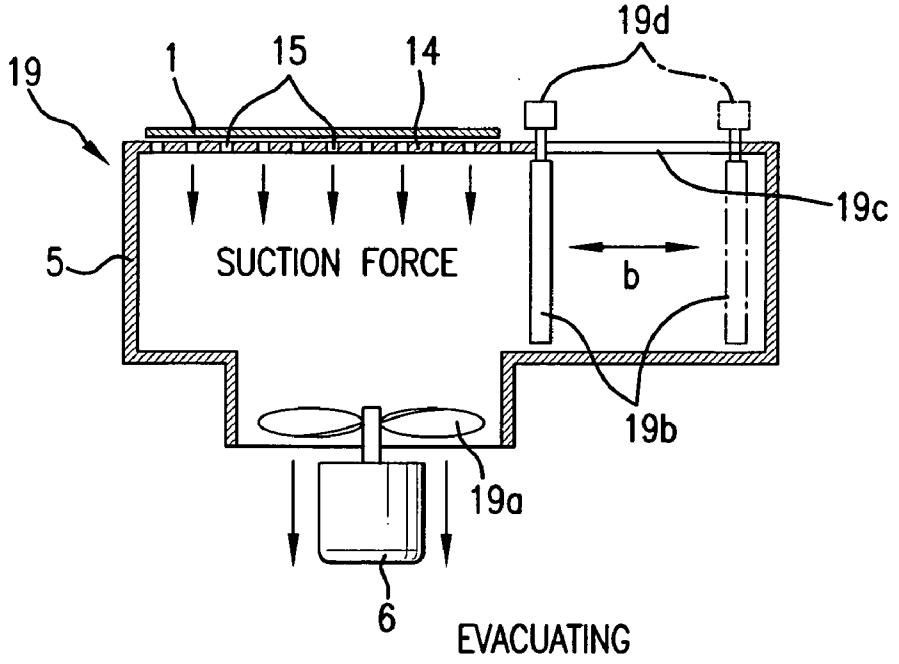

19d
19
1
15
14
19c
5
SUCTION FORCE
b
19b
19a
6
EVACUATING

FIG.4

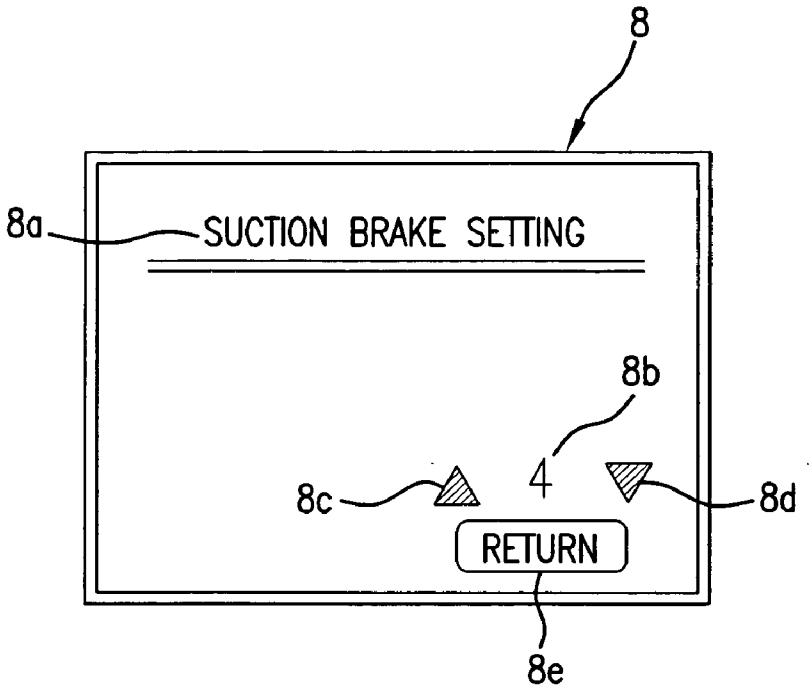

8
8a
SUCTION BRAKE SETTING
8b
4
8c
8d
RETURN
8e

FIG.5

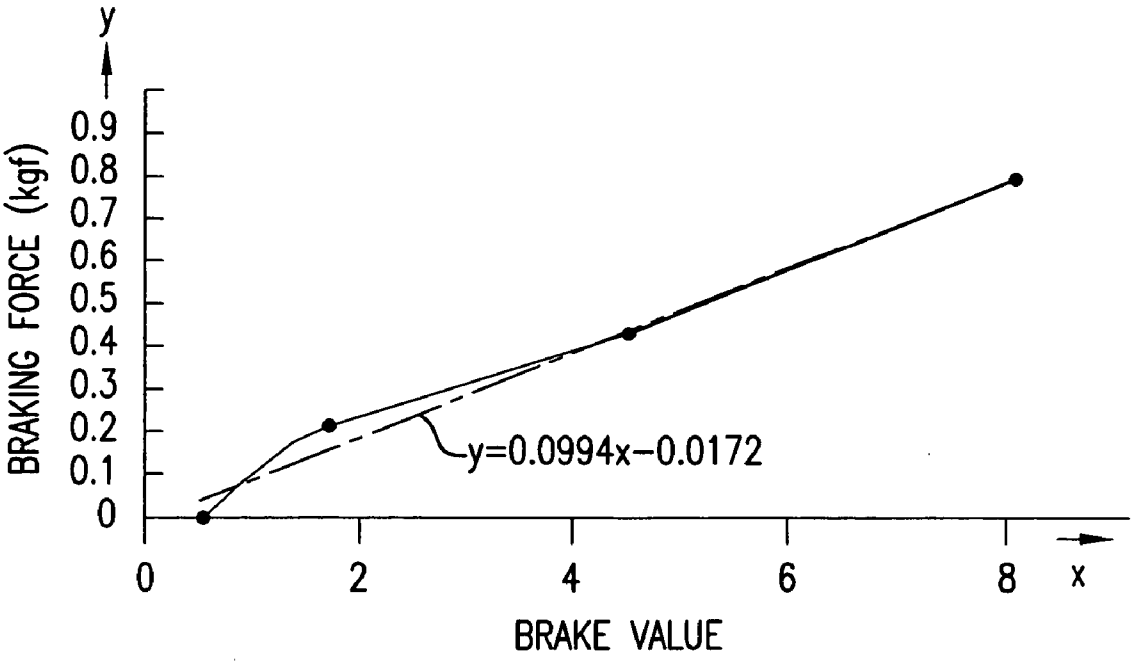

y
BRAKING FORCE (kgf)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
y=0.0994x−0.0172
0
2
4
6
8
x
BRAKE VALUE

FIG.6

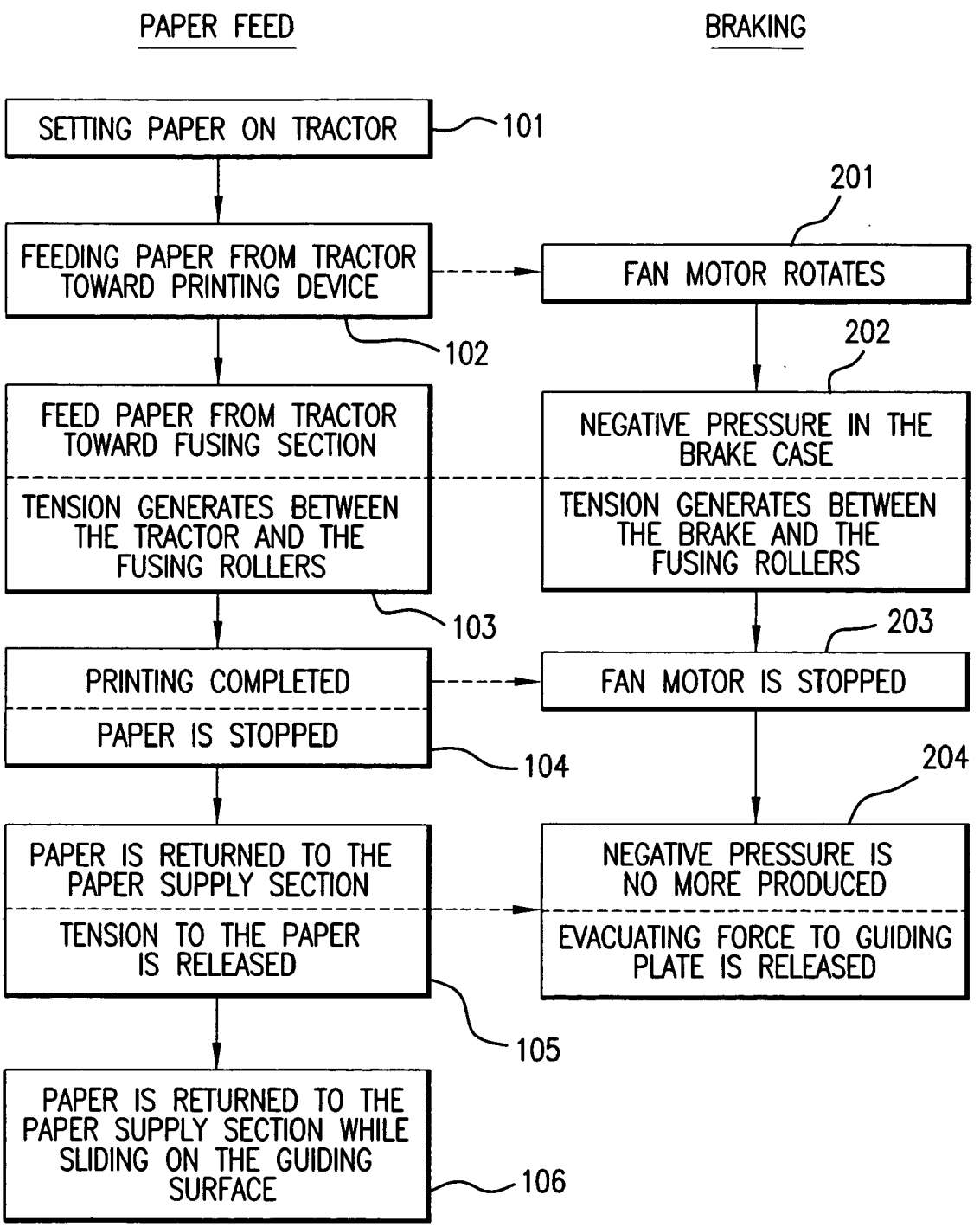

PAPER FEED
BRAKING
SETTING PAPER ON TRACTOR
101
FEEDING PAPER FROM TRACTOR TOWARD PRINTING DEVICE
102
FEED PAPER FROM TRACTOR TOWARD FUSING SECTION
TENSION GENERATES BETWEEN THE TRACTOR AND THE FUSING ROLLERS
103
PRINTING COMPLETED
PAPER IS STOPPED
104
PAPER IS RETURNED TO THE PAPER SUPPLY SECTION
TENSION TO THE PAPER IS RELEASED
105
PAPER IS RETURNED TO THE PAPER SUPPLY SECTION WHILE SLIDING ON THE GUIDING SURFACE
106
201
FAN MOTOR ROTATES
202
NEGATIVE PRESSURE IN THE BRAKE CASE
TENSION GENERATES BETWEEN THE BRAKE AND THE FUSING ROLLERS
203
FAN MOTOR IS STOPPED
204
NEGATIVE PRESSURE IS NO MORE PRODUCED
EVACUATING FORCE TO GUIDING PLATE IS RELEASED

FIG.7

(WIDTH 18 INCH)

THICKNESS (μm)	BRAKE VALUE
58	7
80	4
196	1

FIG.8a

(THICKNESS 80 μm)

WIDTH (INCH)	BRAKE VALUE
6	1
11	8
18	4

FIG.8b

(THICKNESS 80 μm)

HUMIDITY (%)	BRAKE VALUE
80	6
65	4
15	8

FIG.8c

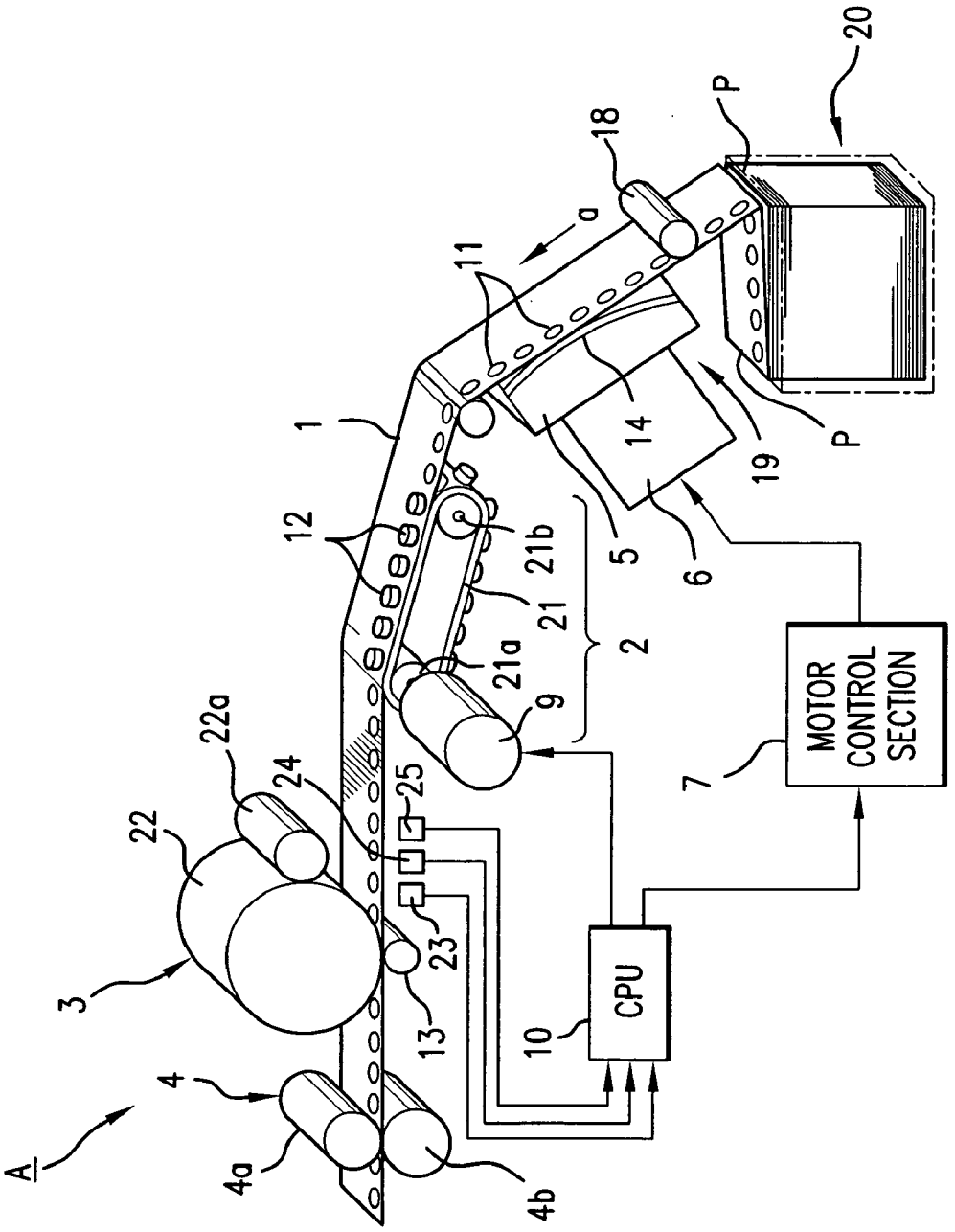

20
P
18
a
11
1
12
14
19
P
5
6
21b
21
21a
2
9
22a
24
25
22
MOTOR CONTROL SECTION
7
3
23
13
10
CPU
4
A
4a
4b

FIG. 9

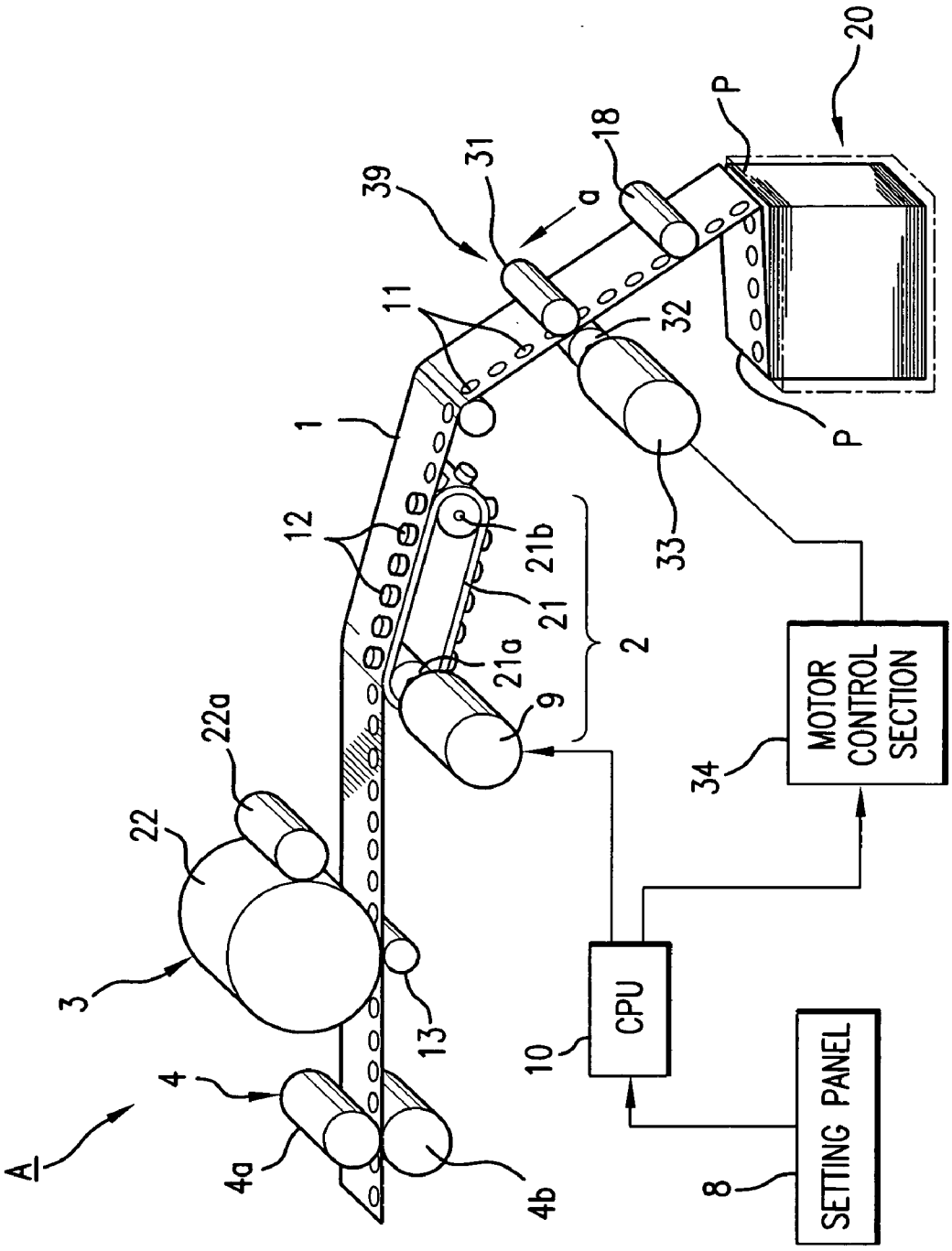

20
P
18
39
31
a
11
32
1
12
21b
21
21a
9
2
33
22a
22
3
13
4
4a
4b
A
MOTOR CONTROL SECTION
34
CPU
10
SETTING PANEL
8

FIG. 10

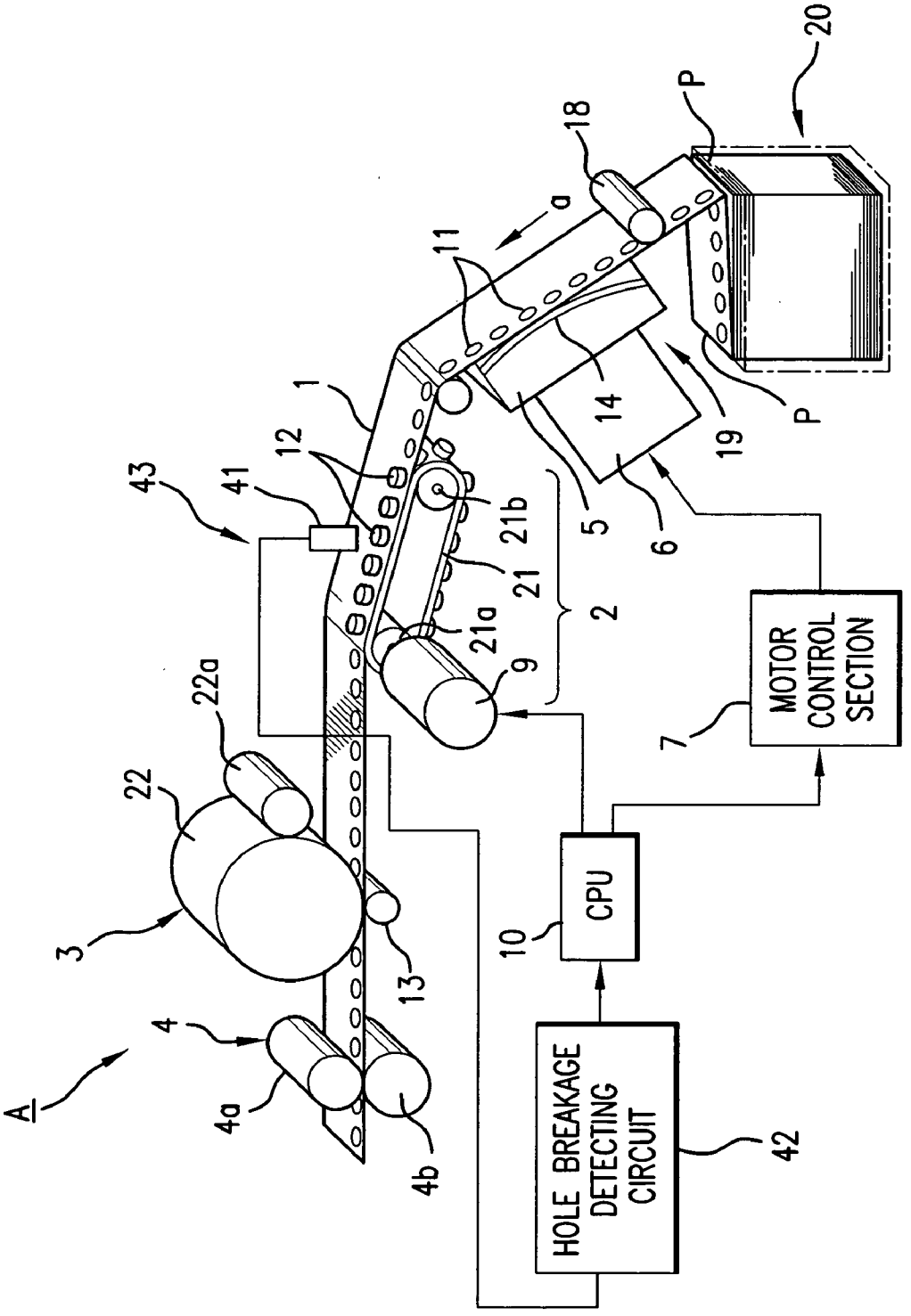

A
3
4
4a
4b
13
22
22a
43
41
12
1
11
a
18
20
P
14
19
5
6
21b
21
21a
9
2
MOTOR CONTROL SECTION
7
CPU
10
HOLE BREAKAGE DETECTING CIRCUIT
42

FIG. 11

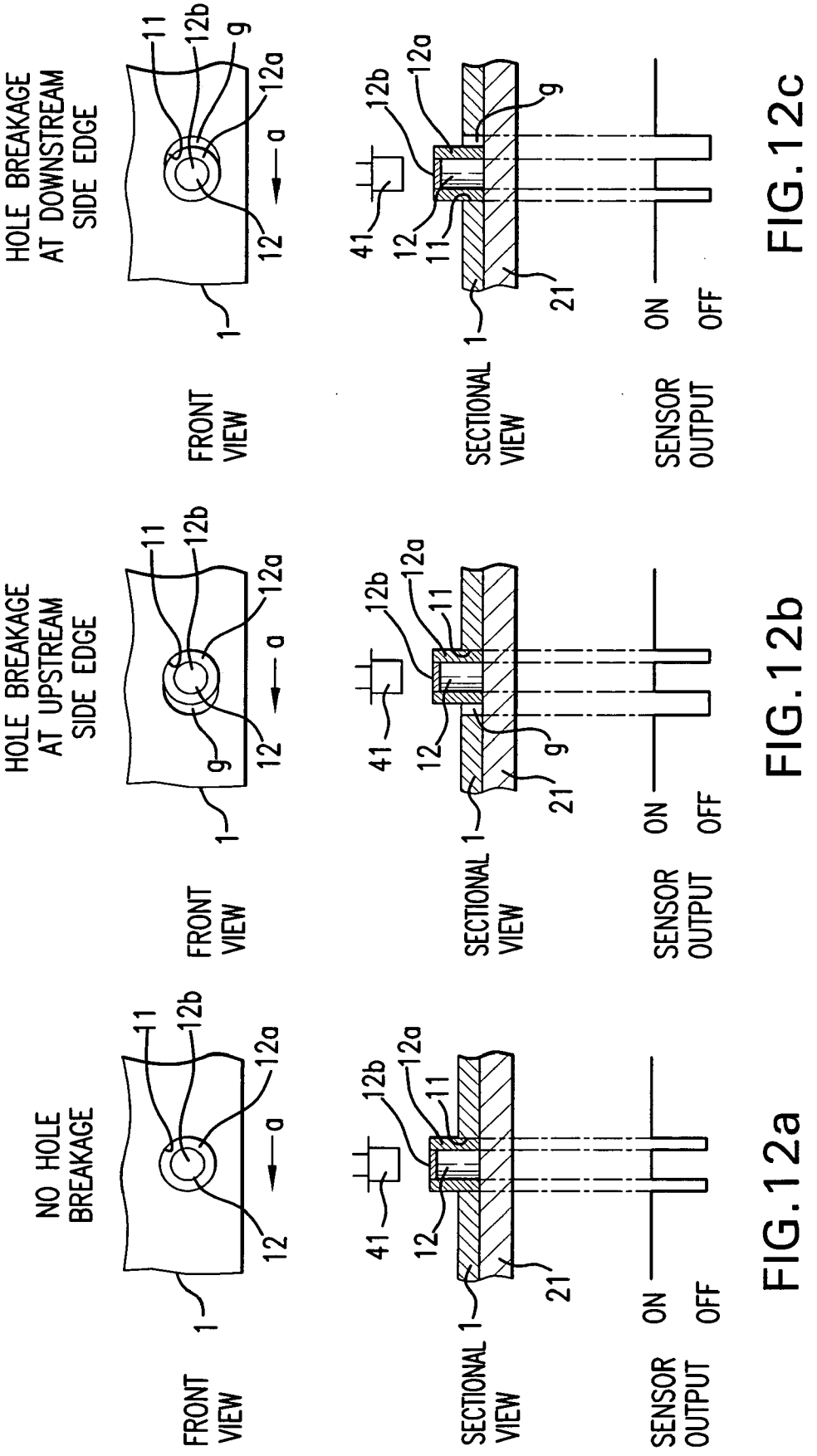


FIG.12a

FIG.12b

FIG.12c

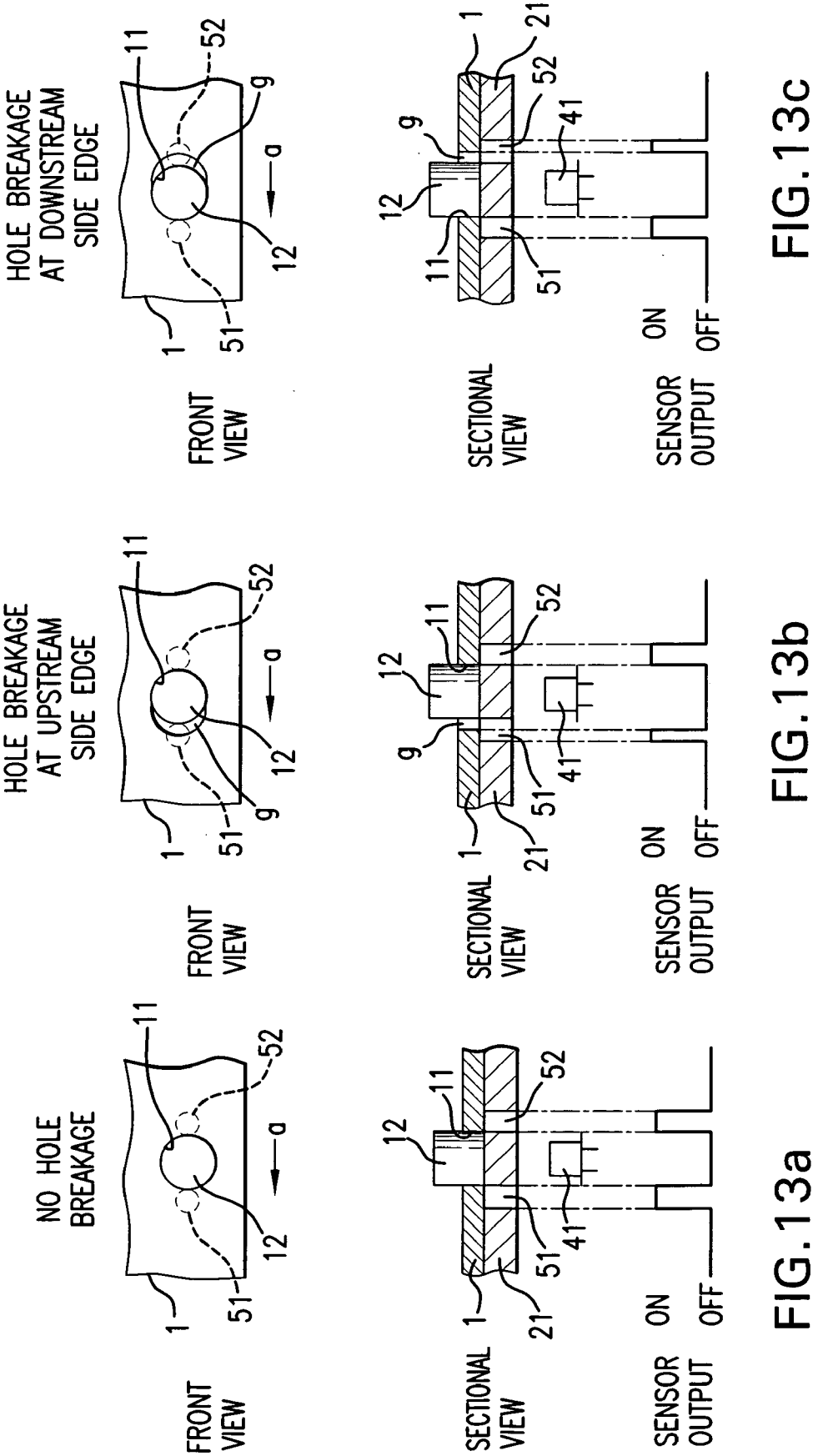


FIG.13a

FIG.13b

FIG.13c

CONTINUOUS PAPER FEEDING DEVICE AND PRINTER INCORPORATING THE SAME

RELATED APPLICATIONS

[0001] The present application claims priority to Japanese Patent Application No. 2000-259553 filed Aug. 29, 2000, the entire content of which is hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

[0002] This invention relates to continuous paper feeding devices for feeding continuous paper sheets, and in particular, to printers for printing images on perforated printing paper sheets.

BACKGROUND OF THE INVENTION

[0003] Conventional printers adapted for printing on continuous paper sheets employ a tractor feeder which is capable of horizontally feeding printing paper sheets as a feeding device for feeding continuous paper sheets in order to realize their downsizing. The tractor feeder is configured to feed a printing paper sheet by causing feed pins of a rotary-driven endless tractor to sequentially engage perforations arranged with a predetermined pitch longitudinally of the printing paper sheet.

[0004] As is often the case with such continuous paper printers, the feeding device is located upstream of the printing device (the printing device including, for example, a photosensitive drum and the like), while another feeding device (such as fusing rollers) is located downstream of the printing device. In this case, it is common practice to set the feeding speed of the downstream feeding device to be slightly higher than that of the tractor. This allows a printing paper sheet under feeding to be brought into close contact with the printing device. For this reason, the tension on the peripheral edge of each perforation is excessive when compared to the rest of the printing paper sheet under feeding. Hence, "hole breakage", which is a perforation enlarging phenomenon, is likely to occur. The occurrence of heavy hole breakage results in feeding the printing paper sheet, thereby causing a deviation from the predetermined printing position.

[0005] Japanese Patent Laid-Open Gazette No. HEI 7-215551 discloses a continuous paper feeding device incorporating a load imposing mechanism located upstream of the tractor for exerting a constant braking force on the printing paper sheet to prevent an excessive tensile stress from working on the peripheral edge of each perforation.

[0006] The continuous paper feeding device disclosed in this Gazette applies a constant braking force to the printing paper sheet, as described above. For this reason, if the balance between the feeding forces respectively working on the upstream and downstream sides of the feeding device, such as the tractor, is lost even slightly, a deviation in the positioning of the paper sheet relative to the photosensitive drum occurs due to such an imbalance, thus resulting in a lowered precision in positioning for printing.

SUMMARY OF THE INVENTION

[0007] The present invention provides a continuous paper feeding device having a higher feeding precision.

[0008] The present invention also provides a continuous paper feeding device which is free from the hole breakage problem.

[0009] The present invention also provides a printer which is capable of printing on a continuous paper sheet with a higher positioning precision.

[0010] In one embodiment of the invention, there is a continuous paper feeding device for feeding a perforated continuous paper sheet. The device includes, for example, a paper supply device configured to supply the continuous paper sheet; a tractor configured to feed the continuous paper sheet supplied from the paper supply device while engaging perforations of the continuous paper sheet; a braking device located between the paper supply device and the tractor and configured to apply a braking force to the continuous paper sheet; a braking force setting device for setting the braking force; and a controller for controlling the braking force applied by the braking device according to the setting made by the braking force setting device.

[0011] With this continuous paper feeding device, when a continuous printing paper sheet supplied from the paper supply device is fed by the tractor, the controller controls the braking force applied by the braking device according to the braking force set by the braking force setting device. Accordingly, a high feeding precision can be ensured because the continuous paper sheet is applied with an optimized braking force, even under such situations as to cause the paper feeding force to become unstable. Further, it is possible to inhibit the occurrence of hole breakage.

[0012] In another embodiment of the invention, there is a printer for printing an image onto a perforated continuous paper sheet. The printer includes, for example, a paper supply device configured to supply the continuous paper sheet; a tractor configured to feed the continuous paper sheet supplied from the paper supply device while engaging perforations of the continuous paper sheet; a printing device configured to print the image onto the continuous paper sheet at a location downstream of the tractor; a braking device located between the paper supply device and the tractor and configured to apply a braking force to the continuous paper sheet; a braking force setting device for setting the braking force; and a controller for controlling the braking force applied by the braking device according to the setting made by the braking force setting device.

[0013] The printer of the above construction is capable of printing images onto a continuous paper sheet with a high positioning precision. The feeding speed on the downstream side of the printing device is desirably made higher than that of the tractor to prevent the continuous paper sheet from slackening at a location adjacent the printing device. Even in this case, the balance between the feeding forces respectively working on the upstream and downstream sides of the tractor can be maintained by the braking force applied by the braking device, thereby ensuring a high print position precision.

[0014] The invention itself, together with further objects and attendant advantages, will best be understood by refer-

ence to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a perspective view showing a principal portion of a continuous paper feeding device as a first embodiment of the present invention.

[0016] **FIG. 2** is a perspective view showing a tractor of the continuous paper feeding device.

[0017] **FIG. 3** is a partially cutaway perspective view showing a braking device of the continuous paper feeding device.

[0018] **FIG. 4** is a sectional view taken along line IV-IV in **FIG. 3**.

[0019] **FIG. 5** is a front elevational view showing a brake value setting picture presented by a setting panel.

[0020] **FIG. 6** is a diagram showing the relationship between a braking force and a set brake value.

[0021] **FIG. 7** is a flowchart of an operational sequence of the continuous paper feeding device.

[0022] **FIG. 8***a* is a table showing a set brake value corresponding to a braking force for each paper sheet thickness.

[0023] **FIG. 8***b* is a table showing a set brake value corresponding to a braking force for each paper sheet width.

[0024] **FIG. 8***c* is a table showing a set brake value corresponding to a braking force for each humidity degree of a printer-installed environment.

[0025] **FIG. 9** is a perspective view showing a principal portion of a continuous paper feeding device as a second embodiment of the present invention.

[0026] **FIG. 10** is a perspective view showing a principal portion of a continuous paper feeding device as a third embodiment of the present invention.

[0027] **FIG. 11** is a perspective view showing a principal portion of a continuous paper feeding device as a fourth embodiment of the present invention.

[0028] **FIG. 12***a* illustrates a perforation free of hole breakage.

[0029] **FIG. 12***b* illustrates a perforation with hole breakage at its peripheral edge on the upstream side.

[0030] **FIG. 12***c* illustrates a perforation with hole breakage at its peripheral edge on the downstream side.

[0031] **FIG. 13***a* illustrates a perforation free of hole breakage.

[0032] **FIG. 13***b* illustrates a perforation with hole breakage at its peripheral edge on the upstream side.

[0033] **FIG. 13***c* illustrates a perforation with hole breakage at its peripheral edge on the downstream side.

[0034] In the following description, like parts are designated by like reference numbers throughout the several drawing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0035] The present invention will now be described in detail by way of embodiments thereof with reference to the drawings.

[0036] **FIG. 1** is a perspective view showing a continuous paper feeding device as a first embodiment of the present invention. In **FIG. 1**, continuous paper feeding device A is incorporated in a laser printer. The continuous paper feeding device A comprises a paper supply section **20** as a paper supply device, a feeding section **2** adapted to feed a continuous printing paper sheet **1** supplied from the paper supply section **20**, a printing device **3** disposed downstream of the feeding section **2**, a fusing section **4** located downstream of the printing device **3**, a braking device **19** disposed upstream of the feeding section **2**, a motor control section **7** for controlling a fan motor of the braking device **19**, and a CPU **10** for controlling each section.

[0037] The paper supply section **20** accommodates the printing paper sheet **1** in a folded state, the paper sheet **1** having perforated lines P along which the paper sheet **1** can be cut at predetermined longitudinal intervals.

[0038] When the printing paper sheet **1** (set on the feeding section **2**) receives a feeding force, the printing paper sheet **1** is delivered our of the paper supply section **20** in a direction indicated by arrow a. As better shown in **FIG. 2**, the printing paper sheet **1** has one widthwise side portion defining multiple perforations **11** arranged in a row, with a predetermined pitch longitudinally of the paper sheet **1**. These perforations **11** are sequentially engageable and disengageable with feed pins (described below).

[0039] The printing device **3** has a photosensitive drum **22**, a transfer roller **13** in rotary contact with the photosensitive drum **22**, and the like. A toner image is formed on the photosensitive drum **22** according to image data by an exposure system (not shown) and a developing device **22***a* and then transferred to a surface of the printing paper sheet **1**.

[0040] The fusing section **4** has a pair of fusing rollers **4***a* and **4***b* pinching and rotary-contacting the printing paper sheet **1** thicknesswise thereof, and functions to fuse the toner image onto the printing paper sheet **1** by heating and pressurizing the printing paper sheet **1**. The fusing rollers **4***a* and **4***b* apply a feeding force to the printing paper sheet **1** because of their rotary contact with the printing paper sheet **1**. The feeding speed at this point is therefore slightly higher than that at the feeding section **2**. The printing paper sheet **1** is thus prevented from slackening at a location adjacent to the printing position of the printing device **3**, thus ensuring favorable transfer of the toner image from the photosensitive drum **3** to the printing paper sheet **1**.

[0041] As shown in **FIG. 2**, the feeding section **2** comprises a tractor feeder having an endless tractor **21** and a motor **9**. The tractor **21** is trained between and around a driving wheel **21***a* and a driven wheel **21***b*, and has one widthwise side portion having feed pins **12** for engagement with the aforementioned perforations **11**. The tractor **21** revolves with rotation of the driving wheel **21***a* (driven by the motor **9**) with the feed pins **12** disengageably engaging the corresponding perforations **11** of the printing paper sheet

1 in sequence. This results in feeding the printing paper sheet 1 toward the downstream side by traction.

[0042] If a portion of the printing paper sheet 1 (which remains unprinted) is left in the feeding section 2 (at the time the printing with respect to the printing paper sheet 1 has been completed), the tractor 21 is revolved backwards by the motor 9 to return the unprinted portion of the printing paper sheet 1 to the paper supply section 20.

[0043] The braking device 19 functions to provide a variable braking force against the feeding force applied to the printing paper sheet 1 by the fusing section 4. The braking device 19, as shown in FIGS. 3 and 4, includes a brake case 5 disposed to face the reverse side of the printing paper sheet 1, an evacuation fan 19*a* for producing a negative pressure in the brake case 5 by evacuating the brake case 5, and a fan motor 6 for driving the evacuation fan 6. The brake case 5 has an upper wall surface serving as a guide surface 14 for guiding the printing paper sheet 1. The guide surface 14 comprises a perforated plate defining a multiplicity of air-suction perforations.

[0044] A guide roller 18 is disposed adjacent to the braking device 19, on the upstream side thereof. The guide roller 18 guides the printing paper sheet 1 so that the sheet 1 is brought into intimate sliding contact with the upper surface 14 of the brake case 5.

[0045] A negative pressure is produced in the brake case 5 by evacuation when the printing paper sheet 1 passes the guide surface 14 of the braking device 19. Hence, a suction force is exerted on the printing paper sheet 1 through the air-suction perforations 15. In this way, the printing paper sheet 1 is applied with a braking force produced by the sliding resistance between the printing paper sheet 1 and the guide surface 14.

[0046] As shown in FIGS. 3 and 4, a partition plate 19*b* is provided within the brake case 5 to adjust the width of the internal space of the brake case 5, according to the width W of the printing paper sheet 1. Attached to the partition plate 19*b* is a thumbscrew 19*d* which protrudes upwardly outwardly from the brake case 5 through a guide slot 19*c* defined in the guide surface 14. The guide slot 19*c* extends widthwise of the printing paper sheet 1 (in the direction indicated by arrow b) to allow the thumbscrew to shift along the guide slot 19*c*, thereby allowing the partition plate 19*b* to shift widthwise of the printing paper sheet 1. Specifically, the thumbscrew 19*d* is moved to position the partition plate 19*b* to a location depicted by the chain line in FIG. 4 when the width W of the printing paper sheet 1 is larger. Alternatively, the thumbscrew 19*d* is moved to position it to a location depicted by the solid line when the width W of the printing paper sheet 1 is smaller. This arrangement causes a suction force to effectively work on the printing paper sheet 1 within a space having a width adjusted to the width of the printing paper sheet 1.

[0047] The CPU 10 controls the operation of the motor 9 of the feeding section 2, sets a braking force according to a set brake value input from a setting panel 8, and controls the motor control circuit 7. The motor control circuit 7 controls revolutions of the evacuation fan 6 to provide a braking force according to the setting.

[0048] FIG. 5 is a front elevational view of the setting panel 8. The setting panel 8 is capable of displaying a "SUCTION BRAKE SETTING" picture 8*a* (as shown in the drawing) on an LCD panel that is operable by touch. For the user to become capable of inputting a desired set brake value, the picture 8*a* has a set brake value display section 8*b* for displaying any one of integers from 1 to 8, an up key (▲ key) 8*c* for displaying a larger integer in the set brake value display section 8*b*, a down key (▼ key) 8*d* for displaying a smaller integer in the set brake value display section 8*b*, and a return key 8*e* for setting the integer displayed in the set brake value display section 8*b* as a set brake value.

[0049] In selecting a desired set brake value, the user causes the display panel to display the "SUCTION BRAKE SETTING" picture 8*a*, presses either the up key (▲ A key) 8*c* to increase the set brake value or the down key (▼ key) 8*d* to decrease the set brake value, and presses the return key 8*e* when the desired set brake value is determined.

[0050] FIG. 6 shows the relationship between set brake value x and braking force y. The CPU 10 controls the motor control circuit 7, based on set brake value x input from the setting panel 8, so that braking force y plotted by the alternate long and short dash line in FIG. 6 is obtained. Braking force y plotted by the alternate long and short dash line is defined by the following formula:

$$y=0.0994x-0.0172$$

[0051] It should be noted that the solid line plots measured braking forces actually obtained.

[0052] The principal operation of the continuous paper feeding device A shown in FIG. 1 is described below with reference to the flowchart shown in FIG. 7.

[0053] First, the printing paper sheet 1 delivered out of the paper supply section 20 is set on the feeding section 2, so that the perforations 11 of the paper sheet 1 engage the corresponding feed pins 12 of the tractor 21 (step 101). With the printing paper sheet 1 in this state, the fusing rollers 4*a* and 4*b* are actuated while, on the other hand, the motor 9 of the feeding section 2 is driven to cause the tractor 21 to revolve. As the tractor 21 revolves, the printing paper sheet 1 is fed toward the printing device 3 (102). Thereafter, the fan motor 6 is caused to rotate (201).

[0054] In the printing device, a toner image on the photosensitive drum 3 is transferred onto the printing paper sheet 1 by the transfer roller 13. Thereafter, the printing paper sheet 1 is fed toward the fusing section 4 (103) where the toner image is fused to the printing paper sheet 1.

[0055] Tension resulting from the feeding force of the fusing rollers 4*a* and 4*b* is not exerted on the printing paper sheet 1 during the passage of the printing paper sheet 1 up to the fusing section 4 through the printing device 3. Hence, any stress is not imposed on the perforations 11 during this period because the paper sheet 1 is fed by the feeding section 2. Accordingly, there is no need to apply any braking force to the printing paper sheet 1 on the upstream side of the feeding section 2. However, taking into account that there is a time lag between the actuation of the fan motor 6 and the buildup of a negative pressure in the brake case 5, the fan motor 6 is preferably actuated before the printing paper sheet 1 reaches the fusing section 4.

[0056] As described above, the feeding speed of the pair of fusing rollers 4*a* and 4*b* is established so as to be slightly higher than that of the feeding section 2. Hence, a tensile

force toward the downstream side is applied to the printing paper sheet **1** on the tractor **21** after the paper sheet **1** has reached the fusing section **4**. This results in a tensile stress is imposed on the perforations **11** (**103**).

[**0057**] At this time, the brake case **5** of the braking device **19** is evacuated by the fan motor **6**, a negative pressure is produced within the brake case **5** and applied to the printing paper sheet **1** passing the guide surface **14** of the brake case **5** (**202**). Accordingly, a suction force is exerted on the reverse side of the printing paper sheet **1** through the air-suction perforations **15**. At the same time, the atmospheric pressure is working on the obverse side of the paper sheet **1**. Thus, the printing paper sheet **1** is fed as pressed against the guide surface **14** of the brake case **5**.

[**0058**] When the printing on the printing paper sheet **1** has been completed (**104**), the rotation of the fusing rollers **4***a* and **4***b* and the feeding of the printing paper sheet **1** are stopped. The revolution of the fan motor **6** is also stopped (**203**). The user can then cut off the printing paper sheet **1** printed with an image fused thereto at a given perforation line P.

[**0059**] Thereafter, if an unprinted portion of the printing paper sheet **1** is left at the feeding section **2**, the unprinted portion is returned to the paper supply section **20** by causing reverse rotation of the motor **9** of the feeding section **2** (**105**). At this time, a negative pressure is no longer produced within the brake case **5** due to stoppage of the fan motor **6**. Hence, the braking force applied to the printing paper sheet **1** is released (**204**). Accordingly, the printing paper sheet **1** is smoothly returned to the paper supply section **20** while sliding on the guide surface **14** without being pressed against the guide surface **14**.

[**0060**] In the embodiment described above, the sliding resistance according to the coefficient of friction between the printing paper sheet **1** and the brake case **5** functions as a braking force. Accordingly, the feeding tension exerted on the printing paper sheet **1**, on the downstream side of the feeding section **2** (on the paper ejecting side), and that exerted on the paper sheet **1** (on the upstream side of the feeding section) are balanced. As a result, the tensile stress imposed on the feed pins **12** of the feeding section **2**, and on the perforations **11** of the printing paper sheet **1**, is suppressed. The occurrence of hole breakage acting to enlarge the perforations **11** is prevented in this way.

[**0061**] Further, the motor control circuit **7** controls revolutions of the fan motor **6** according to the braking force set by the CPU **10**. This causes the braking device **19** to apply an optimized braking force to the printing paper sheet **1**. Accordingly, even when the paper feeding force is unstable, the braking force is adjusted to accommodate the situation. Hence, the tension applied to the printing paper sheet **1** is made constant to ensure stabilized feeding. In this way, the positional precision of the printing paper sheet **1** relative to the printing device **3** can be maintained favorably.

[**0062**] Furthermore, since the braking device **19** is constructed of suction means, the printing paper sheet **1** is not damaged when applied with the braking force.

[**0063**] Although the foregoing embodiment is configured to have the user input a set brake value, the continuous paper feeding device may also be configured to have the user input the properties of a printing paper sheet **1**, such as thickness t or width w, and the environmental conditions, such as the humidity of the atmosphere around the installation site. **FIG. 8***a* is a table showing an example of a set brake value corresponding to a braking force for each paper sheet thickness t, **FIG. 8***b* is a table showing an example of a set brake value corresponding to a braking force for each paper sheet width w, and **FIG. 8***c* is a table showing an example of a set brake value corresponding to a braking force for each humidity degree of a printer-installed environment. These set brake values are previously stored in table form in a storage device incorporated in the printer. Referring to **FIG. 8***a*, when the user inputs, for example, 58 as the paper sheet thickness, the CPU references the table stored in the storage device and establishes a set brake value of 7. Once the set brake value of 7 has been established, the CPU sets braking force y calculated according to the aforementioned formula as in the foregoing embodiment.

[**0064**] By configuring the continuous paper feeding device, so as to have the user input the properties of a printing paper sheet or the environmental conditions as described above, feeding forces respectively working on the upstream and downstream sides of the feeding section **2** are balanced without being influenced by any change in the type of paper sheet or in the conditions of the installation environment. Thus, the continuous paper feeding device is capable of feeding printing paper sheet **1** in a constantly stabilized state, thereby assuredly preventing deviations of the printing position.

[**0065**] The continuous paper feeding device may be configured to have the user input a specific value as one of the properties of a printing paper sheet to be used or as one of the environmental conditions. Alternatively, it may be configured to have the user select one of predetermined levels of a sheet property or an environmental condition, such as "HIGH", "MEDIUM" and "LOW".

[**0066**] **FIG. 9** illustrates a continuous paper feeding device as a second embodiment of the present invention. Like or corresponding parts are designated by like reference numbers throughout **FIGS. 1 and 9** to avoid repetition of description thereof.

[**0067**] While the embodiment shown in **FIG. 1** is configured to set a braking force to be applied by the braking device **19** according to data input from the setting panel by the user, the embodiment shown in **FIG. 9** is configured to cause the CPU to set a braking force automatically.

[**0068**] Specifically, continuous paper feeding device A (shown in **FIG. 9**) is provided with a sensor **23** for judging whether a paper sheet is passing and detecting sheet width W, a sensor **24** for detecting the distance up to a paper sheet and determining sheet thickness t based on the distance thus detected, and a sensor **25** for detecting the humidity of the atmosphere around the printer-installed site. CPU **10** establishes a braking force by making synthetic judgment from all the results output from the sensors **23** to **25**.

[**0069**] In this embodiment, an optimized braking force with respect to printing paper sheet **1** is automatically established even when there is any change in the type of a paper sheet, such as sheet width W or sheet thickness t, or in the humidity of the printer-installed environment.

[**0070**] It should be noted that the locations of the sheet width detecting sensor **23**, sheet thickness detecting sensor

24 and the humidity detecting sensor **25** are not limited to those shown in **FIG. 9** and may be determined as desired. For example, it is possible that the sheet width detecting sensor **23** and sheet thickness detecting sensor **24** may be disposed adjacent to the paper supply section **20**.

[**0071**] **FIG. 10** illustrates a continuous paper feeding device incorporating a braking device **39** of a different type as a third embodiment of the present invention. Like or corresponding parts are designated by like reference numbers throughout **FIGS. 1 and 10** to avoid repetition of description thereof.

[**0072**] The braking device **39** shown in **FIG. 10** comprises a pair of braking rollers **31** and **32** located upstream of the feeding section **2** and holding printing paper sheet **1** therebetween from its obverse and reverse sides. The braking roller **31** is freely rotatable as the printing paper sheet **1** moves. The braking roller **32** is connected to an electromagnetic brake **33** for imposing a load on the braking roller **32** rotating. The electromagnetic brake **33** varies the load on the braking roller **32** according to its electromagnetic force varied by a current control circuit **43** controlling the amount of electric current.

[**0073**] With this arrangement, CPU **10** selects a braking force according to a set brake value established through the setting panel **8**, and the current control circuit **34** controls the amount of current passing through the electromagnetic brake **33**. In this way, the braking rollers **31** and **32** provide an optimized braking force. Accordingly, the printing paper sheet **1** can be applied with a braking force meeting the sheet properties or the environmental conditions. Hence, a stabilized feeding state is maintained thereby ensuring a print without any deviation of the printing position. Further, the continuous paper feeding device, according to this embodiment, has another advantage that the braking device **39** is of a simplified construction because a braking force applied to the printing paper sheet **1** is produced by the pressing force of the braking rollers **31** and **32**.

[**0074**] **FIG. 11** is a perspective view showing a continuous paper feeding device as a fourth embodiment of the present invention. Like or corresponding parts are designated by like reference numbers throughout **FIGS. 1 and 11** to avoid repetition of description thereof.

[**0075**] Continuous paper feeding device A (shown in **FIG. 11**) is provided with hole breakage detection means **43** comprising a hole breakage detecting sensor **41** and a hole breakage detecting circuit **42**.

[**0076**] The hole breakage detecting sensor **41** comprises a reflection type photosensor, the output of which becomes "ON" or "OFF" depending upon whether it receives reflected light of light directed at the perforated region of printing paper sheet **1**.

[**0077**] As shown in **FIG. 12**, a cylindrical non-reflective member **12***a* is fitted over the peripheral portion of each feed pin **12** of the tractor **21**. This prevents the peripheral surface of the feed pin **12** from reflecting light emitted from the hole breakage detecting sensor **41**. On the other hand, a central portion of the top face of each feed pin **21** is provided with a white reflective surface **12***b* for reflecting light from the hole breakage detecting sensor **41**.

[**0078**] When a perforation and a feed pin are engaged and do not face the hole breakage detecting sensor **41** (as shown in **FIG. 12***a*), light from the hole breakage detecting sensor **41** is reflected by a surface of the non-perforated region of the printing paper sheet **1**. The output of the hole breakage detecting sensor **41** receiving the reflected light is in the "ON" state.

[**0079**] When the perforation and the feed pin engaged and are to face with the hole breakage detecting sensor **41**, light from the hole breakage detecting sensor **41** is not reflected at the peripheral portion **12***a* of the feed pin **12**. Hence, the output of the hole breakage detecting sensor **41** becomes "OFF". At the central portion of the top face of the feed pin **12**, light from the hole breakage detecting sensor **41** is reflected by the white reflective surface **12***b*. Hence, the output of the hole breakage detecting sensor **41** receiving the reflected light becomes "ON".

[**0080**] In a normal state where the perforation **11** has no hole breakage (as shown in **FIG. 12***a*), the feed pin **12** is fitted in the perforation **11** with substantially no clearance therebetween. Accordingly, the output of the hole breakage sensor **41** becomes "OFF" when the peripheral portion **12***a* of the feed pin **12** passes the sensor **41**. Since the peripheral portion **12***a* has an equal width on diametrically opposite sides thereof, the respective periods of two "OFF" outputs obtained when one feed pin **12** has passed the hole breakage detecting sensor **41** are equal to each other.

[**0081**] On the other hand, in a state where the perforation **11** has hole breakage at its peripheral edge on the upstream side thereof, and a clearance g is defined downstream of the perforation **11** (as shown in **FIG. 12***b*), or where the perforation **11** has hole breakage at its peripheral edge on the downstream side thereof and a clearance g is defined upstream of the perforation **11** (as shown in **FIG. 12***c*), light directed toward the clearance g from the hole breakage sensor **41** reaches a surface of the tractor **21** through the clearance g. Since the surface of the tractor **21** does not reflect light, the output of the hole breakage detecting sensor **41** becomes "OFF". Accordingly, the "OFF" period of the hole breakage detecting sensor **41** is prolonged by a time period corresponding to the clearance g. Thus, the amount of hole breakage is found from the length of an "OFF" period in an output waveform of the hole breakage detecting sensor **41**, and the location of the hole breakage is determined from whether upstream or downstream of the perforation **11** a longer "OFF" period is located.

[**0082**] The hole breakage detecting circuit **42** forwards an information signal indicative of the amount of hole breakage to the CPU **10** upon receipt of the output from the hole breakage detecting sensor **41**.

[**0083**] The CPU **10** selects a braking force suited to the type of a paper sheet used or to the printer-installed environment from a prestored table of brake forces on the basis of the hole breakage information received from the hole breakage detecting circuit **42**. The CPU **10** then forwards a PWM pulse signal corresponding to the braking force thus selected to the motor control circuit **7**. According to the amount of hole breakage, the motor control circuit **7** controls revolutions of the fan motor **6** so that an appropriate braking force is applied to the printing paper sheet **1**.

[**0084**] More specifically, when hole breakage such that clearance g is defined downstream of the perforation **11** is detected as shown in **FIG. 12***b*, the CPU **10** judges that the

braking force applied by the braking device **19** is smaller than the feeding force of the fusing section **4** and controls the braking device **19** so that a larger braking force is applied. Conversely, when hole breakage such that clearance g is defined upstream of the perforation **11** is detected as shown in **FIG. 12***c*, the CPU **10** judges that the braking force applied by the braking device **19** is larger than the feeding force of the fusing section **4** and controls the braking device **19** so that a smaller braking force is applied. By so doing, the feeding force of the fusing section **4** and the braking force of the braking device **19** become well-balanced thereby preventing the hole breakage from becoming larger, ensuring a satisfactory printing precision.

[**0085**] **FIG. 13** illustrates hole breakage detection means of another type. In **FIG. 13**, the hole breakage detecting sensor **41** is disposed facing the underside of the tractor **21**. At the root of each feed pin **12**, the tractor **21** defines upstream through-hole **51** and downstream through-hole **52** of the same size.

[**0086**] In a normal state where each perforation **11** of the printing paper sheet **1** has no hole breakage (as shown in **FIG. 12***a*), light from the hole breakage detecting sensor **41** is not reflected during a period for which a through-hole free region on the underside of the tractor **21** faces the hole breakage detecting sensor **41**. Accordingly, the output of the hole breakage detecting sensor **41** is in the "OFF" state. On the other hand, during a period for which the through-hole **51** or **52** faces the hole breakage detecting sensor **41**, light from the hole breakage detecting sensor **41** passes through the through-hole **51** or **52** and is reflected by the reverse side of the printing paper sheet **1**. Accordingly, the output of the hole breakage detecting sensor **41** assumes "ON" for a time period for which the sensor receives the reflected light.

[**0087**] In the case where there is no hole breakage, the output of the hole breakage detecting sensor **41** becomes "ON" when the upstream through-hole **51** or the downstream through-hole **52** passes the sensor **41**. Since the two through-holes are of the same size, respective periods of the two "ON" outputs obtained when one feed pin **12** has passed the hole breakage detecting sensor **41** are equal to each other.

[**0088**] On the other hand, in the case where the perforation **11** has hole breakage at its peripheral edge on the upstream side thereof and a clearance g is defined downstream of the perforation **11** (as shown in **FIG. 13***b*), the output of the hole breakage detecting sensor **41** assumes "ON" during a time period for which light penetrating through the upstream though-hole **51** from the hole breakage detecting sensor **41** is being reflected by the reverse side of the printing paper sheet **1**. However, this "ON" period is shortened because light from the hole breakage detecting sensor **41** is not reflected during a time period for which the light is passing through the clearance g. Likewise, in the case where the perforation **11** has hole breakage at its peripheral edge on the downstream side thereof and a clearance g is defined upstream of the perforation **11** (as shown in **FIG. 13***c*), the "ON" period of the hole breakage detecting sensor **41** is shortened because light penetrating through the through-hole **52** from the hole breakage detecting sensor **41** is not reflected during a time period for which the light is passing through the clearance g. Accordingly, the "ON" period of the hole breakage detecting sensor **41** is shortened by a time period corresponding to the clearance g. Thus, the amount of hole breakage is found from the length of an "ON" period in an output waveform of the hole breakage detecting sensor **41**, and the location of the hole breakage is determined from whether upstream or downstream of the perforation **11** a shorter "ON" period is located.

[**0089**] The hole breakage detection means may comprise any other type of sensor than the optical sensor **41** described above, image pick-up means or like means.

[**0090**] While the feeding section **2** is constructed of a tractor feeder in each of the foregoing embodiments, the construction of the feeding section **2** is not limited thereto.

[**0091**] It should be further noted that the braking device **19** or **39** may be of any construction other than described above.

[**0092**] Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to noted that various changes and modifications will be apparent to those skilled in the art. Therefore, unless such changes and modification depart from the scope of the present invention, they should be construed as being included there in.

What is claimed is:

1. A continuous paper feeding apparatus for feeding a perforated continuous paper sheet, comprising:

a paper supply device configured to supply the continuous paper sheet;

a tractor configured to feed the continuous paper sheet supplied from said paper supply device while engaging perforations of the continuous paper sheet;

a braking device located between said paper supply device and said tractor and configured to apply a braking force to the continuous paper sheet;

braking force setting device for variably setting the braking force; and

a controller to control the variable braking force applied by the braking device according to the setting made by said braking force setting.

2. A continuous paper feeding apparatus according to claim 1, further comprising a sensor to detect a perforation enlarging.

3. A continuous paper feeding apparatus according to claim 2, wherein said braking force setting device sets the braking force according to a detecting result of said sensor.

4. A continuous paper feeding apparatus according to claim 1, wherein said braking force setting device sets the braking force according to a type of the continuous paper sheet.

5. A continuous paper feeding apparatus according to claim 1, wherein said braking force setting device sets the braking force according to conditions of an installation environment.

6. A continuous paper feeding apparatus according to claim 1, wherein said braking device includes an evacuating device to evacuate the continuous paper sheet thicknesswise.

7. A continuous paper feeding apparatus according to claim 1, wherein said braking device includes a pressurizing device to pressurize the continuous paper sheet thicknesswise.

8. A printer for printing an image onto a perforated continuous paper sheet, comprising:

a paper supply device configured to supply the continuous paper sheet;

a tractor configured to feed the continuous paper sheet supplied from said paper supply device while engaging perforations of the continuous paper sheet;

a printing device configured to print the image onto the continuous paper sheet at a location downstream of said tractor;

a braking device located between said paper supply device and said tractor and configured to apply a braking force to the continuous paper sheet;

a braking force setting device to set the braking force; and

a controller to control the braking force applied by said braking device according to the setting made by said braking force setting device.

9. A printer according to claim 8, further comprising a sensor to detect a perforation enlarging.

10. A printer according to claim 9, wherein said braking force setting device sets the braking force according to a detecting result of said sensor.

11. A printer according to claim 8, wherein said braking force setting device sets the braking force according to a type of the continuous paper sheet.

12. A printer according to claim 8, wherein said braking force setting device sets the braking force according to conditions of an installation environment.

13. A printer according to claim 8, wherein said braking device includes an evacuating device for evacuating the continuous paper sheet thicknesswise.

14. A printer according to claim 8, wherein said braking device includes a pressurizing device to pressurize the continuous paper sheet thicknesswise.

15. A printer according to claim 8, further comprising a fixing device configured to fix the image onto the continuous paper sheet at a location downstream of said printing device.

16. A printer according to claim 15, wherein said fixing device applies tension to the continuous paper sheet.

17. A continuous paper feeding apparatus, comprising:

a sheet supply device configured to supply a continuous printing paper sheet;

a feeding device configured to feed the printing paper sheet supplied from said sheet supply device;

a braking device configured to apply a braking force to the printing paper sheet fed by said feeding device;

a braking force setting device to set the braking force; and

a controller to control the braking force applied by the braking device according to the setting made by said braking force setting device.

18. A continuous paper feeding apparatus according to claim 17, wherein said braking device is located upstream of said feeding device.

19. A continuous paper feeding apparatus according to claim 17, further comprising a printing device configured to print the image onto the continuous printing paper sheet fed by said feeding device at a location downstream of said feeding device.

20. A continuous paper feeding apparatus according to claim 17, said feeding device includes a tractor having feed pins for engaging perforations of the printing paper sheet.

21. A continuous paper feeding apparatus according to claim 20, further comprising a sensor for detecting a perforation enlarging.

22. A continuous paper feeding apparatus according to claim 21, wherein said braking force setting device sets the braking force according to a detecting result of said sensor.

23. A continuous paper feeding apparatus according to claim 17, wherein said braking force setting device sets the braking force according to a type of the printing paper sheet.

24. A continuous paper feeding apparatus according to claim 17, wherein said braking force setting device sets the braking force according to conditions of an installation environment.

25. A continuous paper feeding apparatus according to claim 17, wherein said braking device includes an evacuating device to evacuate the printing paper sheet thicknesswise.

26. A continuous paper feeding apparatus according to claim 17, wherein said braking device includes a pressurizing device to pressurize the printing paper sheet thicknesswise.

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