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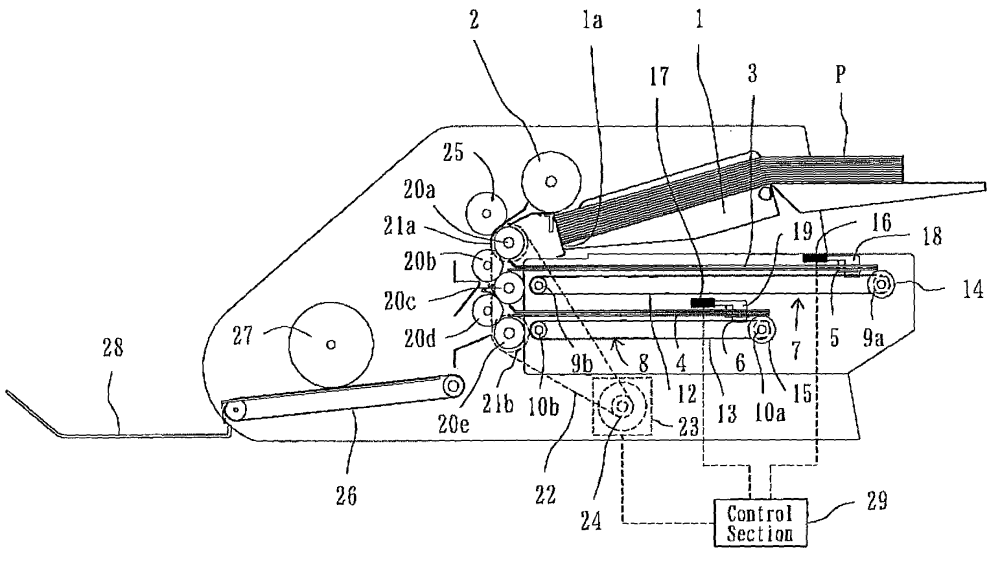
(54) Sheet Folding Apparatus

(57) A buckle (3, 4) is provided with a position adjustable stopper (5, 6) for stopping a sheet (P) by coming into collision with the leading edge of the sheet (P) so as to position the sheet in a fold position. In the inlet of the buckle, there are provided a pair of rotary drive folding rollers (20a, 20b ; 20c, 20d) for taking the sheet in the buckle, and a pair of rotary drive folding rollers (20b, 20c ; 20d, 20e) for folding a portion of the sheet deflecting from the buckle. A sheet detector (16, 17) is arranged in the buckle at a predetermined spacing from the stopper. A control section (29) outputting a signal for deceleration to a driving source of the roller upon reception of a sheet detection signal from the sheet detector and stopping output of the signal for deceleration after elapse of a predetermined time. After the leading edge of the sheet introduced into the buckle passes through the sheet detector, the rotational speed of the roller is reduced to decrease the conveying speed of the sheet, the leading edge of the sheet collides with the stopper at a sufficiently reduced speed, thereafter, the rotational speed of the roller is gradually increased so that the rotational speed before being reduced is recovered when the next sheet is introduced into the buckle.

FIG. 1



EP 1 854 752 A1

Description

Background of the Invention

Field of the Invention

[0001] The present invention relates to a sheet folding apparatus.

Description of the Related Art

[0002] A conventional sheet folding apparatus has at least one buckle in which a sheet to be folded is introduced to a length corresponding to a predetermined fold position. The buckle is provided with a position adjustable stopper for stopping the introduced sheet by coming into collision with the leading edge of the sheet so as to position the sheet in the fold position. Near the inlet of the buckle, a pair of rotating rollers are arranged oppositely to each other for taking the sheet in the buckle and a pair of rotating rollers are arranged oppositely to each other for folding a portion of the sheet deflecting from the buckle.

[0003] The sheet folding apparatus typically folds 100 or more sheets per minute. Each of the sheets collides with the stopper of the buckle at a speed of 900mm per second, and at the same time, is deflected in the buckle to contact with the inner wall surface of the buckle. The noise of the collision and the noise of the contact of the sheet with the inner wall surface of the buckle together with the noise of sheet nipping of the rollers cause a noise problem in the installation location for the sheet folding apparatus such as an office.

[0004] In order to reduce such noise, there is proposed a method of attaching an elastic member for relieving any impact at a time of collision to the front surface of the stopper of the buckle (see Japanese Laid-Open Patent Publication No. H11-106127). There is also proposed a method of reducing the speed of a sheet in such a manner that an elastic slide is arranged ahead of the stopper of the buckle for coming into collision with the leading edge of the sheet (see Japanese Laid-Open Patent Publication No. 2004-345773).

[0005] These methods can reduce the noise of collision of the sheet with the stopper, but cannot reduce the noise of the contact of the sheet with the inner wall surface of the buckle and the noise of sheet nipping of the rollers. Consequently, the noise level at operation cannot be improved much. In addition, the movement of the stopper provided with the elastic member and the elastic slide is not smooth, which brings the result that the stop position of the sheet in the buckle fluctuates, so that the fold position of the sheet can be easily misaligned.

Summary of the Invention

[0006] An object of the present invention is to provide a sheet folding apparatus capable of achieving considerably low level of the noise at operation thereof and ensuring a stable fold position of a sheet.

[0007] In order to achieve the object, in accordance with the present invention, there is provided a sheet folding apparatus having: at least one buckle in which a sheet to be folded is introduced to a length corresponding to a predetermined fold position, the at least one buckle being provided with a position adjustable stopper for stopping the introduced sheet by coming into collision with the leading edge of the sheet so as to position the sheet in the fold position; a pair of rotating rollers arranged near the inlet of the buckle and oppositely to each other for taking the sheet in the buckle; and a pair of rotating rollers arranged near the inlet of the buckle and oppositely to each other for folding a portion of the sheet deflecting from the buckle, the sheet folding apparatus characterized by a sheet detector arranged at a predetermined spacing from the stopper of the buckle toward the inlet of the buckle and detecting passage of the sheet; and a control section outputting a signal for deceleration to a driving source of the roller upon reception of a sheet detection signal from the sheet detector and stopping output of the signal for deceleration after elapse of a predetermined time, whereby, after the leading edge of the sheet introduced into the buckle passes through the sheet detector, the rotational speed of the rollers is reduced to decrease the conveying speed of the sheet, the leading edge of the sheet comes into collision with the stopper at a sufficiently reduced speed, and thereafter the rotational speed of the roller is gradually increased so that the rotational speed before being reduced is recovered when the next sheet is introduced into the buckle.

[0008] Alternatively, in order to achieve the object, in accordance with the present invention, there is provided a sheet folding apparatus having: at least one buckle in which a sheet to be folded is introduced to a length corresponding to a predetermined fold position, the at least one buckle being provided with a position adjustable stopper for stopping the introduced sheet by coming into collision with the leading edge of the sheet so as to position the sheet in the fold position; a pair of rotating rollers arranged near the inlet of the buckle and oppositely each other for taking the sheet in the buckle; and a pair of rotary drive rollers arranged near the inlet of the buckle and oppositely to each other for folding a portion of the sheet deflecting from the buckle, the sheet folding apparatus characterized by a sheet detector arranged upstream of the pair of rollers for taking the sheet in the uppermost stream buckle for detecting passage of the sheet; a rotary encoder mounted on at least one rotating shaft of the rollers arranged near the inlet of the buckle or at least one another rotating shaft rotatable in conjunction with the rotating shaft of the rollers; and a control section starting counting the number of pulses outputted from the rotary encoder upon reception of a sheet detection signal from the sheet detector to measure the conveying distance of the sheet, outputting a signal for deceleration to a driving source of the roller when the sheet

reaches a predetermined position, and stopping output of the signal for deceleration when the sheet reaches the next predetermined position, whereby, after the leading edge of the sheet passes through the sheet detector, the rotational speed of the roller is reduced to decrease the conveying speed of the sheet, the leading edge of the sheet comes into collision with the stopper at a sufficiently reduced speed, and, thereafter, the rotational speed of the roller is gradually increased so that the rotational speed before being reduced is recovered when the next sheet is introduced into the buckle.

Brief Description of the Drawings

[0009]

Fig. 1 is a side view illustrating the configuration of a sheet folding apparatus according to a first embodiment of the present invention;
Fig. 2 is an enlarged side view illustrating the configuration around a buckle of the sheet folding apparatus of Fig. 1;
Fig. 3 (A) is a timing diagram of control of rotational speed of a motor by a control section;
Fig. 3(B) is a diagram illustrating sheet positions at points (i) and (ii) of the timing diagram of Fig. 3(A);
Fig. 4 is a side view illustrating the configuration of the sheet folding apparatus according to another embodiment of the present invention;
Fig. 5(A) is a timing diagram of control of rotational speed of a motor by a control section; and
Fig. 5(B) is a diagram illustrating sheet positions at points (i) and (ii) of the timing diagram of Fig. 5(A).

Detailed Explanation of Preferred Embodiments

[0010] Preferred embodiments of the present invention will be described below with reference to the accompanying drawings. Fig. 1 is a side view illustrating the configuration of a sheet folding apparatus according to a first embodiment of the present invention, and Fig. 2 is an enlarged side view illustrating the configuration around a buckle of the sheet folding apparatus of Fig. 1.

[0011] Referring to Figs. 1 and 2, the sheet folding apparatus of the present invention has a sheet supply table 1 arranged for up-and-down movement and supporting a sheet bundle of sheets P to be folded thereon, a vertical plate 1a disposed ahead of the sheet supply table 1 and aligning the leading edge of the sheet bundle on the sheet supply table 1, and a sheet feed roller 2 sequentially feeding the uppermost sheet P of the sheet bundle on the sheet supply table 1.

[0012] The sheet folding apparatus also has first and second buckles 3 and 4 in which the sheet P is introduced to a length corresponding to a predetermined fold position. As illustrated, the first and second buckles 3 and 4 have a pair of plates 3a, 3b ; 4a, 4b arranged oppositely to each other at a small spacing therebetween.

[0013] The first and second buckles 3 and 4 have stoppers 5 and 6 bringing the leading edge of the sheet P introduced to stop the sheet for positioning the sheet to a fold position, and sheet detectors 16 and 17 detecting passage of the sheet in the positions at a predetermined spacing from the stoppers 5 and 6 toward the inlets of the buckles 3 and 4.

[0014] The stoppers 5 and 6 are attached to belt driving mechanisms 7 and 8 arranged along the first and second buckles 3 and 4. The position of each of the stoppers 5 and 6 is adjustable along a direction of the length of the first and second buckles 3 and 4. The belt driving mechanisms 7 and 8 comprise a pair of horizontal rollers 9a, 9b ; 10a, 10b are arranged at a spacing therebetween in a direction of the length of the buckles 3 and 4 and each extending in a direction of the width of the buckles, endless belts 12 and 13 extended through a pulley 11 between the pair of rollers 9a, 9b ; 10a, 10b, and motors 14 and 15 driving one of the rollers 9a ; 10a.

[0015] The stoppers 5 and 6 are attached to the endless belts 12 and 13. With the rotational motion of the endless belts 12 and 13 by driving of the motors 14 and 15, the stoppers 5 and 6 can be moved in the direction of the length of the buckles 3 and 4.

[0016] The sheet detectors 16 and 17 are connected to the associated stoppers 5 and 6 through support members 18 and 19 and arranged ahead of the stoppers 5 and 6 in such a manner that the sheet detectors 16 and 17 can be moved together with the associated stoppers 5 and 6. In this case, the sheet detectors 16 and 17 may be arranged separately from the stoppers 5 and 6.

[0017] Five folding rollers 20a to 20e are arranged one above the other near the inlets of the first and second buckles 3 and 4 for rotation round horizontal axes extending in a direction of the width of the buckles 3 and 4 in such a manner that the adjacent rollers are contacted with each other. The folding rollers 20a to 20e have the same diameter. Among them, the three middle folding rollers 20b, 20c, and 20d are formed as an idle roller. The uppermost folding roller 20a and the lowermost folding roller 20e are formed as a driving roller.

[0018] A motor 23 is arranged for driving the uppermost folding roller 20a and the lowermost folding roller 20e. A pulley 24 is fixed to the driving shaft of the motor 23. Pulleys 21a and 21b are fixed to the rotational axes of the folding rollers 20a and 20e. An endless belt 22 is extended between the pulleys 21 a and 21b and the pulley 24. The motor 23 drives the folding rollers 20a and 20e, whereby the middle folding rollers 20b to 20d are driven. In this embodiment, the folding rollers 20a to 20e are driven by the single motor 23. The folding rollers 20a to 20e may be driven by plural motors, or, alternatively, the folding rollers 20a to 20e may be driven by independent motors, respectively.

[0019] The folding rollers 20a and 20b function as a pair of rollers for nipping the sheet P so as to introduce it into the first buckle 3. The folding rollers 20b and 20c function as a pair of rollers for nipping a portion of the

sheet P deflecting from the first buckle 3 so as to fold it. The folding rollers 20c and 20d function as a pair of rollers for introducing the folded sheet P received from the folding rollers 20b and 20c into the second buckle 4 with the folded portion in the lead. The folding rollers 20d and 20e function as a pair of rollers for nipping a portion of the sheet P deflecting from the second buckle 4 so as to it.

[0020] A feed roller 25 is arranged for rotation round a horizontal axis. The feed roller 25 is contacted with the uppermost folding roller 20a so as to be rotated with the rotation of the folding roller 20a.

[0021] The positions of the stoppers 5 and 6 are adjusted according to the fold position of the sheet P. For instance, when the sheet P is folded into three equal parts in its longitudinal direction, the stopper 5 is adjusted by actuating the belt driving mechanism 7 in such a manner that two-thirds of the length of the sheet P is introduced into the first buckle 3. In addition, the stopper 6 is adjusted by actuating the belt driving mechanism 8 in such a manner that one-half of the length of the sheet P folded once by the first buckle 3 is introduced into the second buckle 4.

[0022] The uppermost sheet P of the sheet bundle placed on the sheet supply table 1 is fed by the sheet feed roller 2 one by one, nipped between the feed roller 25 and the folding roller 20a and conveyed, and then nipped between the folding rollers 20a and 20b and introduced into the first buckle 3. The sheet P is stopped by the leading edge thereof coming into collision with the stopper 5. The one-third length of the rear of the sheet P is still nipped between the folding rollers 20a and 20b so as to be conveyed to the first buckle 3, so that the sheet P is deflected from the first buckle 3. The top of the deflected portion of the sheet P is nipped between the folding rollers 20b and 20c and folded by them.

[0023] After the sheet P is folded once, the folded sheet P is discharged from between the folding rollers 20b and 20c. When the sheet P is folded twice, the sheet P folded by the folding rollers 20b and 20c is delivered between the folding rollers 20c and 20d and introduced into the second buckle 4 with the folded portion in the lead. The introduced sheet P is stopped by the leading edge thereof coming into collision with the stopper 6. The one-third length of the rear of the sheet P is still nipped between the folding rollers 20c and 20d so as to be conveyed to the second buckle 4, so that the sheet P is deflected from the second buckle 4. The top of the deflected portion of the sheet P is nipped between the folding rollers 20d and 20e and folded by them. The folded sheet P is conveyed from the folding rollers 20d and 20e through a discharge belt 26 and a discharge roller 27 to a discharge tray 28.

[0024] According to the present invention, the sheet folding apparatus has a control section 29 outputting a signal for deceleration to the motor 23 upon reception of a sheet detection signal from the sheet detectors 16 and 17 and stopping output of the signal for deceleration after elapse of a predetermined time.

[0025] Fig. 3(A) is a timing diagram of control of the rotational speed of the motor by the control section, and Fig. 3(B) is a diagram illustrating sheet positions at points (i) and (ii) of the timing diagram of Fig. 3(A). Referring to Figs. 3(A) and 3(B), when the leading edge of the sheet P introduced into the first and second buckles 3 and 4 passes through the sheet detectors 16 and 17 (point (i)), the sheet detection signal is outputted from the sheet detectors 16 and 17 and received by the control section 29. The control section 29 outputs the signal for deceleration to the motor 23 upon reception of the sheet detection signal. The rotational speed of the folding rollers 20a to 20e is gradually reduced to decrease the conveying speed of the sheet P. When the leading edge of the sheet P passes through the sheet detectors 16 and 17 and the predetermined time elapses, the control section 29 stops output of the signal for deceleration. In this embodiment, time from the start to stop of output of the signal for deceleration is set in such a manner that the rotational speed of the folding rollers 20a to 20e is the lowest when the leading edge of the sheet P collides with the stoppers 5 and 6 of the first and second buckles 3 and 4 (point (ii)), that is, that the speed of the motor 23 is the lowest immediately before the leading edge of the sheet P collides the stoppers 5 and 6.

[0026] When output of the signal for deceleration is stopped, the motor 23 gradually increases the rotational speed. When the next sheet is introduced into the first and second buckles 3 and 4, the rotational speed before being reduced is recovered. Along with it, the rotational speed of the rollers 20a to 20e is gradually increased. When the next sheet is introduced into the buckles, the rotational speed before being reduced is recovered.

[0027] The conveying speed of the sheet P introduced into the first and second buckles 3 and 4 is gradually reduced. When it is sufficiently reduced, the sheet P is stopped by the leading edge thereof coming into collision with the stoppers 5 and 6. It is possible to greatly reduce not only the noise of collision of the sheet with the stopper but also the noise of the contact of the sheet with the inner wall surface of the buckle and the noise of sheet nipping of the rollers. The noise level at operation of the sheet folding apparatus is considerably lowered. In addition, the fold position of the sheet is hardly fluctuated.

[0028] Fig. 4 is a side view illustrating the configuration of the sheet folding apparatus according to another embodiment of the present invention and is similar to Fig. 1. The embodiment of Fig.4 is different from the embodiment of Fig. 1 in timing of rotational speed control of the motor. The same constituent elements in Fig.4 as those shown in Fig.1 are indicated by similar numerals and the detailed description is omitted.

[0029] In this embodiment, as shown in Fig. 4, a sheet detector 30 is arranged in the sheet conveying passage between the sheet feed roller 2 and the feed roller 25. A rotary encoder 31 is mounted on the rotating shaft of the uppermost folding roller 20a. In this case, the rotary encoder 31 may be mounted on any one of the rotating shafts of the folding rollers 20b through 20e, or, alternatively, the rotary encoder 31 may be mounted on the drive

shaft of the motor 23 or the rotating shaft of the feed roller 25. The control section 29 starts counting the number of pulses outputted from the rotary encoder 31 upon reception of the sheet detection signal from the sheet detector 30 to measure the conveying distance of the sheet P. The control section 29 outputs the signal for deceleration to the motor 23 when the sheet P reaches a predetermined position, and stops output of the signal for deceleration when the sheet reaches the next predetermined position.

[0030] Fig. 5(A) is a timing diagram of control of the rotational speed of the motor by the control section 29, and Fig. 5(B) is a diagram illustrating sheet positions at points (i) and (ii) of the timing diagram of Fig. 5(A), Referring to Figs. 5(A) and 5(B), when the leading edge of the sheet P fed from the sheet feed roller 2 passes through the sheet detector 30, the sheet detection signal is outputted from the sheet detector 30 and received by the control section 29. The control section 29 starts counting the number of pulses outputted from the rotary encoder 31 upon reception of the sheet detection signal to measure the conveying distance of the sheet. The control section 29 outputs the signal for deceleration to the motor 23 when the leading edge of the sheet P reaches a predetermined position (point (i)) ahead of the stoppers 5 and 6 of the buckles 3 and 4. Thereafter, the control section 29 stops output of the signal for deceleration when the sheet P reaches the next predetermined position (point (ii)), in this embodiment, the position in which the leading edge of the sheet P collides with the stoppers 5 and 6. After the sheet P is introduced into the buckles 3 and 4 to pass through the predetermined position, the rotational speed of the rollers 20a to 20e is gradually reduced to decrease the conveying speed of the sheet P. The leading edge of the sheet P collides with the stoppers 5 and 6 at a sufficiently reduced speed and the sheet P is stopped. Thereafter the rotational speed of the rollers 20a to 20e is gradually increased. The rotational speed before being reduced is recovered when the next sheet P is introduced into the buckles 3 and 4. This embodiment can bring about the same effect as that of the embodiment of Fig. 1.

Claims

1. A sheet folding apparatus having:

at least one buckle (3, 4) in which a sheet (P) to be folded is introduced to a length corresponding to a predetermined fold position, said at least one buckle (3, 4) being provided with a position adjustable stopper (5, 6) for stopping the introduced sheet (P) by coming into collision with the leading edge of the sheet (P) so as to position the sheet (P) in said fold position;
a pair of rotating rollers (20a, 20b ; 20c, 20d) arranged near the inlet of said buckle (3, 4) and oppositely to each other for taking the sheet (P) in said buckle (3, 4); and
a pair of rotating rollers (20b, 20c ; 20d, 20e) arranged near the inlet of said buckle (3, 4) and oppositely to each other for folding a portion of the sheet (P) deflecting from said buckle (3, 4),
the sheet folding apparatus **characterized by**
a sheet detector (16, 17) arranged at a predetermined spacing from said stopper (5, 6) of said buckle (3, 4) toward the inlet of said buckle (3, 4) and detecting passage of the sheet (P); and
a control section (29) outputting a signal for deceleration to a driving source (23) of said roller (20a to 20e) upon reception of a sheet detection signal from said sheet detector (16, 17) and stopping output of said signal for deceleration after elapse of a predetermined time,
whereby, after the leading edge of the sheet (P) introduced into said buckle (3, 4) passes through said sheet detector (16, 17), the rotational speed of said rollers (20a to 20e) is reduced to decrease the conveying speed of the sheet (P), the leading edge of the sheet (P) comes into collision with said stopper (5, 6) at a sufficiently reduced speed, and thereafter the rotational speed of said roller (20a to 20e) is gradually increased so that the rotational speed before being reduced is recovered when the next sheet (P) is introduced into said buckle (3, 4).

2. A sheet folding apparatus having:

at least one buckle (3, 4) in which a sheet (P) to be folded is introduced to a length corresponding to a predetermined fold position, said at least one buckle (3, 4) being provided with a position adjustable stopper (5, 6) for stopping the introduced sheet (P) by coming into collision with the leading edge of the sheet (P) so as to position the sheet (P) in said fold position;
a pair of rotating rollers (20a, 20b ; 20c, 20d) arranged near the inlet of said buckle (3, 4) and oppositely each other for taking the sheet (P) in said buckle (3, 4); and
a pair of rotary drive rollers (20b, 20c ; 20d, 20e) arranged near the inlet of said buckle (3, 4) and oppositely to each other for folding a portion of the sheet (P) deflecting from said buckle (3, 4),
the sheet folding apparatus **characterized by**
a sheet detector (30) arranged upstream of the pair ofrollers (20a, 20b) for taking the sheet (P) in the uppermost stream buckle (3) for detecting passage of the sheet (P);
a rotary encoder (31) mounted on at least one rotating shaft of said rollers (20a to 20e) arranged near the inlet of said buckle (3, 4) or at least one another rotating shaft rotatable in conjunction with said rotating shaft of said rollers

(20a to 20e); and

a control section (29) starting counting the number of pulses outputted from said rotary encoder (31) upon reception of a sheet detection signal from said sheet detector (30) to measure the conveying distance of the sheet (P), outputting a signal for deceleration to a driving source (23) of said roller (20a to 20e) when the sheet (P) reaches a predetermined position, and stopping output of said signal for deceleration when the sheet (P) reaches the next predetermined position,

whereby, after the leading edge of the sheet (P) passes through said sheet detector (30), the rotational speed of said roller (20a to 20e) is reduced to decrease the conveying speed of the sheet (P), the leading edge of the sheet (P) comes into collision with said stopper (5, 6) at a sufficiently reduced speed, and, thereafter, the rotational speed of said roller (20a to 20e) is gradually increased so that the rotational speed before being reduced is recovered when the next sheet (P) is introduced into said buckle (3, 4).

FIG. 1

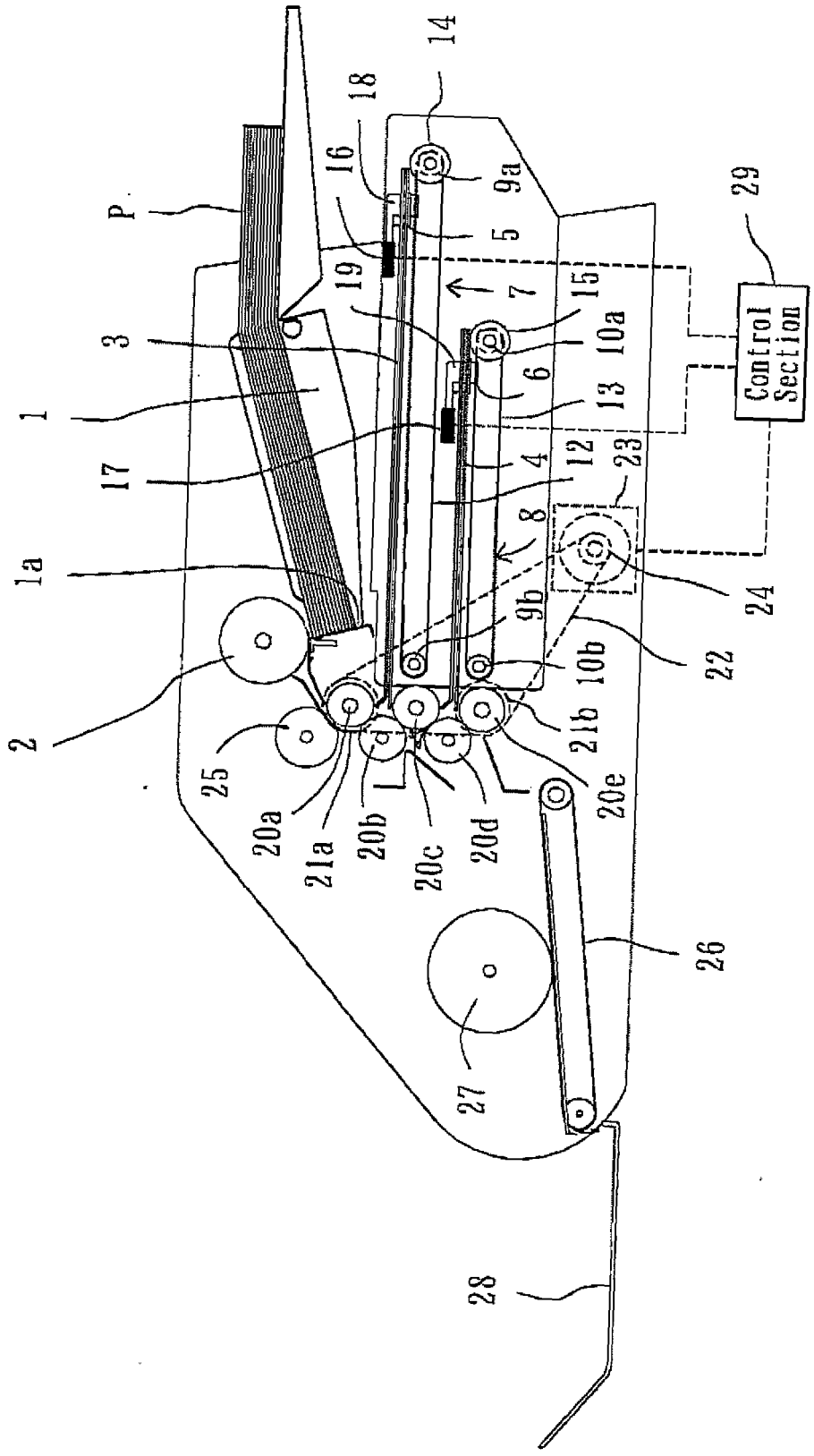

P
1
3
17
1a
2
25
20a
21a
20b
20c
20d
21b
20e
10b
22
9b
8
24
23
12
4
13
6
10a
15
7
5
9a
16
18
19
14
29
Control Section
26
27
28

Fig. 2

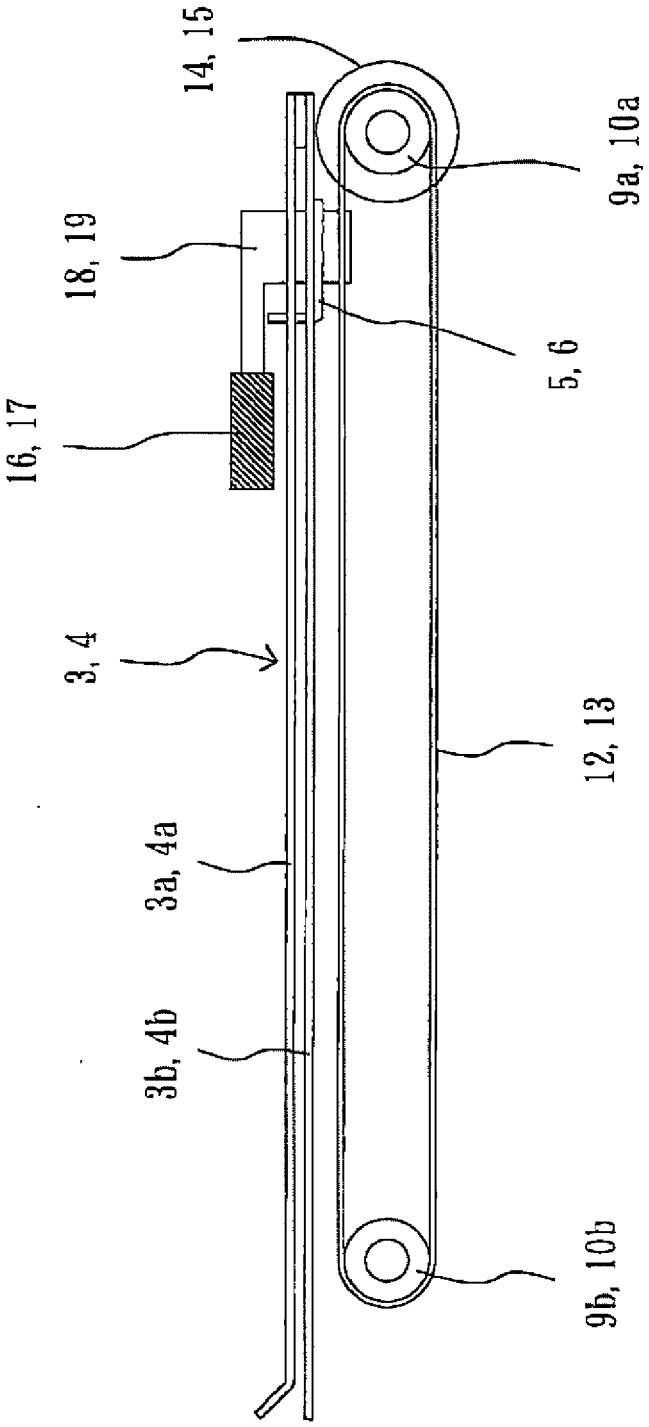
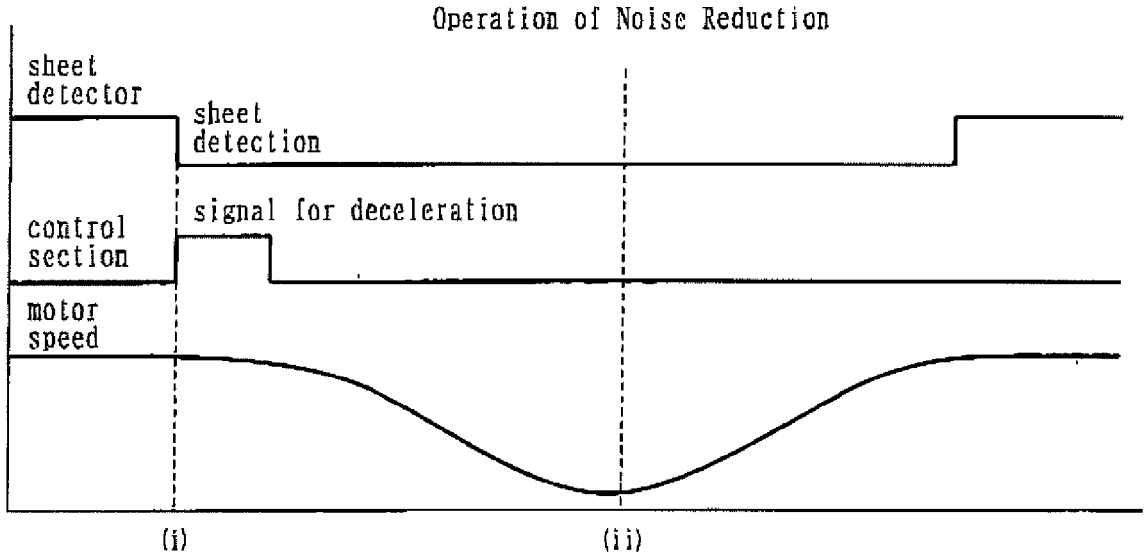
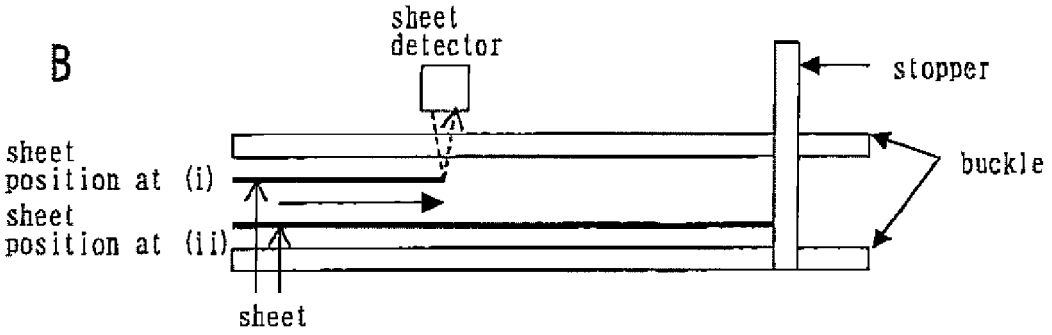


Fig. 3

A


Operation of Noise Reduction
sheet detector
sheet detection
signal for deceleration
control section
motor speed
(i)
(ii)

B


sheet detector
stopper
buckle
sheet position at (i)
sheet position at (ii)
sheet

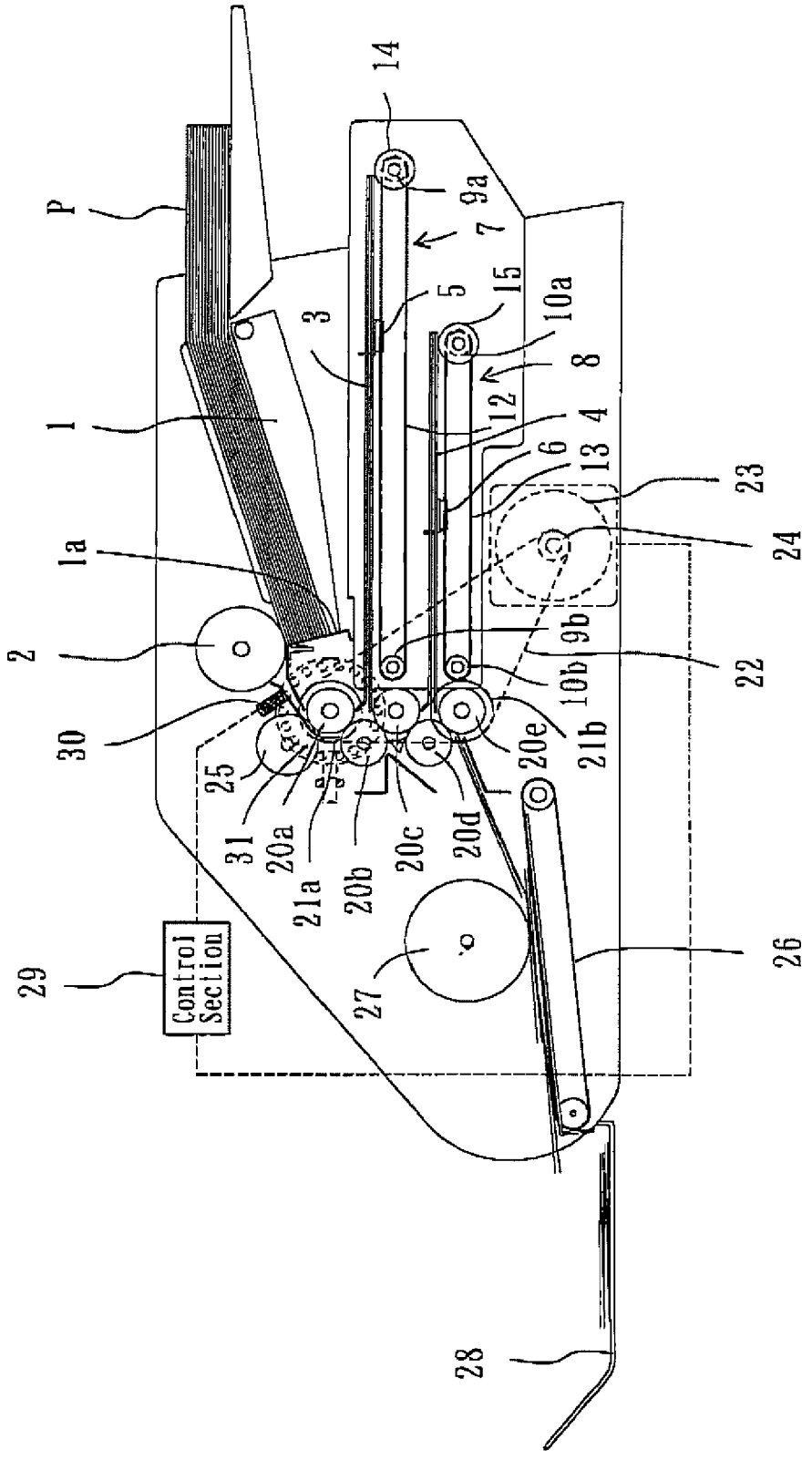
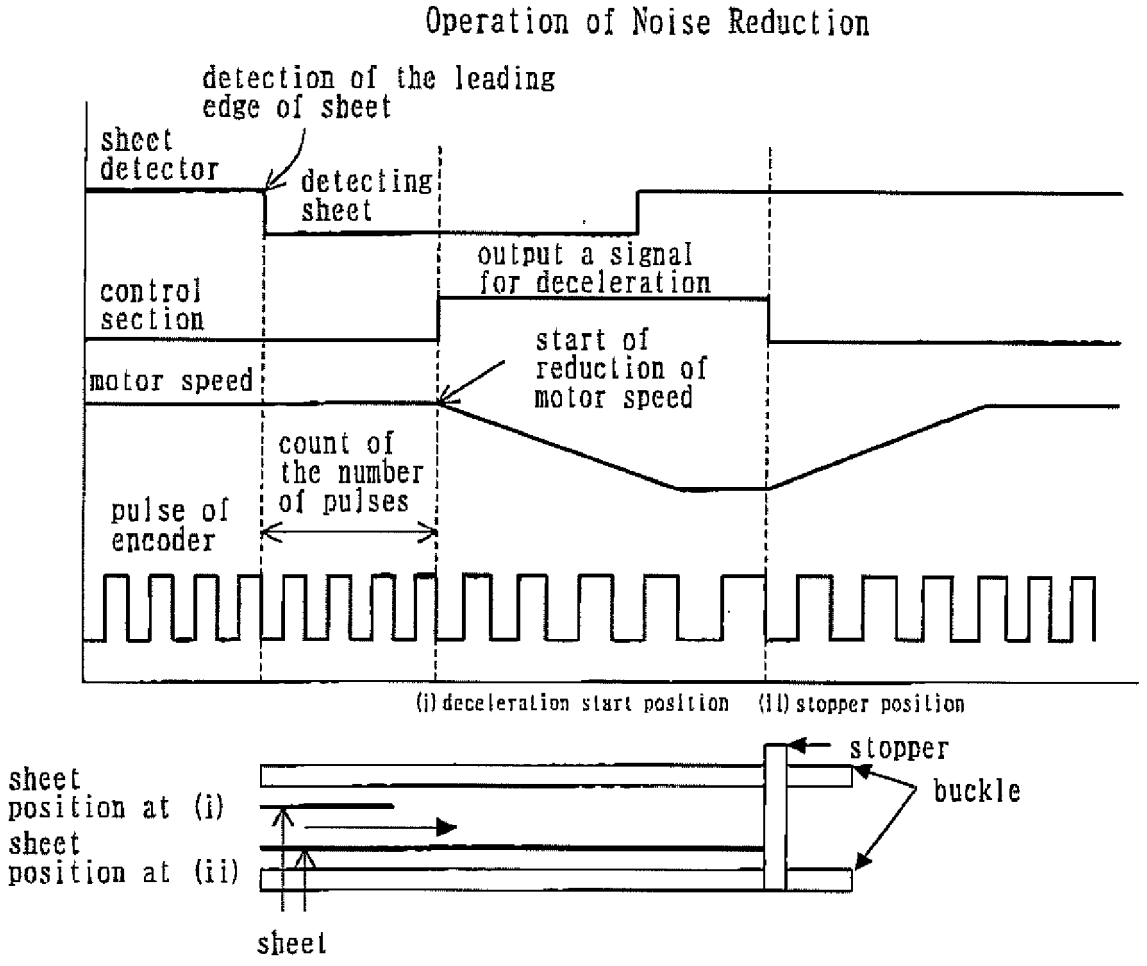

P
1
1a
2
30
25
31
20a
21a
20b
20c
20d
20e
21b
10b
9b
22
23
24
26
27
29
Control Section
28
14
9a
7
5
15
10a
3
8
12
4
6
13

Fig. 4

Fig. 5


Operation of Noise Reduction
detection of the leading edge of sheet
sheet detector
detecting sheet
output a signal for deceleration
control section
start of reduction of motor speed
motor speed
count of the number of pulses
pulse of encoder
(i) deceleration start position
(ii) stopper position
stopper
buckle
sheet position at (i)
sheet position at (ii)
sheet

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 7891

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 967 963 A (GOETTING GEORG) 19 October 1999 (1999-10-19) * the whole document * -----	1,2	INV. B65H45/14
X	EP 1 475 333 A1 (MASCHINENBAU OPPENWEILERBINDER GMBH) 10 November 2004 (2004-11-10)	1	
A	* the whole document * -----	2	
X	EP 1 022 246 A (PITNEY BOWES [US]) 26 July 2000 (2000-07-26)	1	
A	* paragraph [0003] * * paragraph [0008] - paragraph [0016]; figures * -----	2	
			TECHNICAL FIELDS SEARCHED (IPC) B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 September 2007	Raven, Peter

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 10 7891

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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11-09-2007

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REFERENCES CITED IN THE DESCRIPTION

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