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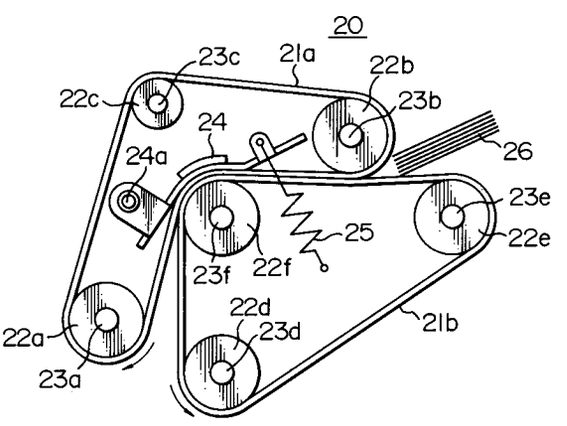
(54) Paper sheet conveying device and automatic cash handling apparatus.

(57) A paper sheet conveying device (1, 10, 20, 30) has at least one pair of endless belts (1a, 1b; 11a, 11b; 21a, 21b; 31a, 31c; 103a, 103b) and at least two pulleys (2a, 2b; 2c, 2d; 12a through 12c; 12d through 12e; 22a through 22c, 22d through 22f; 32a through 32c, 32f through 32g; 104a, 104d; 104b, 104e) around which each of the endless belts extends. The at least one pair of endless belts have runs which oppose each other and which normally move in contact with each other. The runs of the belts hold and convey a paper sheet therebetween. In a preferred embodiment, the one pulley (2a; 12d; 104b; 104d) of the one endless belt is supported in a floating state. The one belt is elastically biased toward the other endless belt by a spring (5). The one pulley is displaceable away from the run of the other belt when the at least one of the at least one pair of endless belts is subjected to a force from paper sheets being conveyed. In another embodiment, the one endless belt (11b, 21a, 31a) is made of an elastic material whose elasticity is used to elastically bias the run of the one belt toward the other belt (11a, 21b, 31c).

FIG. 5



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BACKGROUND OF THE INVENTION

The present invention relates to a conveyance of sheets of paper and, more particularly, to a paper sheet conveying device suitable for use to hold at least one sheet of paper between conveying belts and convey it, as well as to an automatic cash handling apparatus which employs such a paper sheet conveying device.

Among conventional paper sheet conveying devices, the most basic one is disclosed in, for example, Japanese Unexamined Patent Publication No. 62-219098. This conventional paper sheet conveying device is designed to hold sheets of paper one at a time by two belts extending around fixed pulleys and convey them one by one. Japanese Unexamined Patent Publication No. 61-283993 discloses a paper sheet conveying device which conveys a large number of paper sheets in a stack. In the aforementioned devices, the conveying belts for holding and conveying the paper sheets extend around fixed pulleys and a fixed guide is used for guiding the paper sheets. Alternately, conveyance is performed without using the guide.

The conventional paper sheet conveying devices suffer from the following problems regarding the conveyance of a single sheet of paper or a paper stack consisting of a number of paper sheets or of paper sheets having different thicknesses.

In a paper sheet conveying device in which pulleys around which the conveying belts extend are fixed, when a paper stack consisting of a large number of paper sheets passes the pulley, it may stay at that pulley portion or break into respective sheets, making excellent conveyance impossible.

In a paper sheet conveying device in which a fixed guide is mounted for guiding a single sheet of paper, conveyance of a paper stack consisting of a large number of paper sheets through such a guide may cause jamming at that portion. On the contrary, conveyance of a single sheet of paper through a guide mounted such that it guides a paper stack may cause buckling of the paper sheet because the guide cannot serve its function.

In a paper sheet conveying device in which one of the belts is a driving belt while the other belt is a driven belt, a paper stack may break at a bending portion of the belt or the paper sheets constituting the paper stack may be dislodged, making excellent conveyance impossible.

Furthermore, in the case of conveyance of a paper stack consisting of a large number of paper sheets, when the holding of the paper stack is released, as in the case where the paper stack is accommodated in an accommodating box, the stack may expand due to the spring effect thereof, making excellent accommodation impossible.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a paper sheet conveying device which is capable of conveying a single sheet of paper or a paper stack consisting of a number of paper sheets or paper sheets having different thicknesses in an excellent state.

It is another object of the present invention to provide an automatic cash handling apparatus which is capable of excellently and flexibly conveying a single bank note or a bundle of bank notes consisting of a number of notes or notes having different thicknesses.

A paper sheet conveying device according to the present invention includes at least one pair of endless belts, at least two pulleys around which each of the endless belts extends, and a drive source for driving at least one of the pair of endless belts. The at least one pair of endless belts have runs which oppose each other and which normally move in contact with each other. The runs hold and convey a paper sheet supplied therebetween. At least one belt of the at least one pair of endless belts has means for displacing at least a part of the run of the one belt away from the run of the other belt when the one belt is subjected to a force from the paper sheet which is being conveyed.

The one pulley of the one endless belt may be supported in a floating state. The displacing means may comprise elastic means for elastically urging the one pulley toward the other endless belt.

Since the one pulley of the one endless belt is elastically urged toward the other endless belt, when a paper stack consisting of a large number of paper sheets is held between the runs of the two belts and conveyed, the one pulley and the belt extending around that pulley can be displaced away from the other belt. Thus, the paper sheet conveying device according to the present invention is capable of conveying a single sheet of paper or a paper stack consisting of a number of paper sheets regardless of the thickness of the paper. The elastic means may be a spring member or an elastic material which forms the belt.

Since the runs of the pair of endless belts are in contact with each other, even when one of the endless belts is driven by the drive source, the driving force of the drive source is transmitted to the other endless belt. Thus, the paper sheets can be held between the runs of the two belts and conveyed. However, when a large number of sheets of paper are conveyed in a stack, the contact area of the two belts decreases, preventing the driving force of the driving belt to be sufficiently transmitted to the driven belt. In that case, the paper stack to be conveyed may break or convey-

ance thereof may stop. To eliminate such a drawback, driving of the two endless belts by the drive source at the same speed is desirable.

The paper sheets fed to the runs of the pair of belts in a stack can be conveyed separately one by one or in an overlapped relationship by utilizing the phenomenon in which the paper stack breaks to respective sheets during conveyance when the one belt of the pair of endless belts is driven.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side elevational view of an embodiment of a paper sheet conveying device according to the present invention;

Fig. 2 is a schematic side elevational view illustrating the operation of the embodiment shown in Fig. 1;

Figs. 3 and 4 are respectively schematic side elevational views of a second embodiment of the present invention;

Figs. 5 and 6 are respectively schematic side elevational views of a third embodiment of the present invention;

Figs. 7 through 9 are respectively schematic side elevational views of a fourth embodiment of the present invention; and

Figs. 10 through 14 are respectively schematic side elevational views of an automatic cash handling apparatus which employs the first and second embodiments of the paper sheet conveying device according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invention will be described below with reference to Figs. 1 and 2.

A paper sheet conveying device 1 shown in Fig. 1 includes a pair of endless conveying belts 1a and 1b for holding sheets of paper therebetween and conveying them, pulleys 2a, 2b; 2c, 2d around which the belts 1a and 1b extend, respectively, shafts 3a, 3b; 3c, 3d for supporting the pulleys 2a, 2b; 2c, 2d, respectively, a support arm 4 for supporting the displaceable shaft 3a, a spring member 5 for resiliently coupling the support arm 4 to a frame (not shown), a drive source (not shown) which comprises a stepping motor, and a drive mechanism.

The shafts 3b, 3c and 3d are fixed directly to or supported by the frame and are thus not displaceable. The support arm 4 is rotatably mounted at one end thereof on a shaft 4a mounted on the frame and is coupled to the spring member 5 at the other end thereof. The shaft 3a is positioned by the action of the spring member 5 such that the runs of the convey belts 1a and 1b are disposed in face-to-face contact with each other. In this embodiment, the shaft 3c is driven through a timing belt and gears in a direction indicated by an arrow in Fig. 1 by the stepping motor (not shown) which is the drive source. In the vicinity of the pulley 2d, a paper stack 6, consisting of at least one sheet of paper, is fed between the conveying belts 1a and 1b, as shown in Fig. 1. In this embodiment, when the paper stack 6 passes between the pulleys 2b and 2d, the two belts 1a and 1b convey the paper stack 6 without breaking it to respective sheets because the distance between the pulleys 2b and 2d is sufficiently long and because both conveying belts 1a and 1b have a sufficient conveying force. When the paper stack 6 passes between the pulleys 2a and 2c, the support arm 4 supporting the pulley 2a is subjected to a force from the paper stack 6 and is thereby pivotally moved about the shaft 4a in a direction in which it is moved away from the pulley 2c so as to assure passage of the paper stack 6, as shown in Fig. 2. Consequently, the shaft 3a of the pulley 2a is displaced, and this allows the belts 1a and 1b to discharge or convey the paper stack 6 to a subsequent conveying path without breaking it to respective sheets. After the paper stack 6 passes between the pulleys 2a and 2c, the support arm 4 for supporting the pulley 2a is pivotally moved to its original position shown in Fig. 1 by the restoring force of the spring member 5.

A second embodiment of the present invention will be described below with reference to Fig. 3. The second embodiment is differentiated from the embodiment shown in Fig. 1 in that it does not employ a spring member. In this embodiment, a conveying device 10 includes endless conveying belts 11a and 11b made of an elastic material (rubber) and adapted to hold a paper stack therebetween and convey it, pulleys 12a, 12b, 12c; 12d, 12e around which the conveying belts 11a and 11b extend, respectively, shafts 13a, 13b, 13c; 13d, 13e for supporting the pulleys, a support arm 4 for supporting the displaceable shaft 13d, drive means having a timing belt 15 and a timing gear 16 for driving the pulley 12d, a frame, a drive source and a drive mechanism which are not shown.

The shafts 13a, 13b, 13c and 13e are mounted directly on the frame and are thus not displaceable. The shaft 13d is pivotally supported by the support arm 14 which is in turn pivotally mounted on a shaft 14a. The shafts 13a, 13b, 13c, 13d and 13e are mounted such that they have the positional relationship shown in Fig. 3. The pulley 12d is positioned such that it brings the runs of the conveying belts 11a and 12b into contact with each other due to the elastic force of the conveying belt 11b. In this embodiment, the driving force from the

drive source (not shown) is transmitted to the shaft 13d through the timing belt 15, the timing gear 16 and so on to drive the pulley 12d. The timing belt 15 extends so loosely that it does not generate idling, so as to make the shaft 13d displaceable. In this paper sheet conveying device 10, a paper stack 17 consisting of at least one sheet of paper is fed, as shown in Fig. 3. In a case where the stack 17 consists of a plurality of sheets of paper, when it comes near the portion of the belt 11a bent by the pulley 12b, the support arm 14 for supporting the pulley 12d is subjected to a force from the paper stack 17 and is thereby pivotally moved about the rotary shaft 14a in a direction in which it is moved away from the pulley 12b so as to allow the stack 17 to pass past the bent portion, as shown in Fig. 4. As a result, the paper stack 17 is discharged or conveyed to a subsequent conveying path without being broken to respective sheets. After the paper stack 17 passes between the pulleys 12a and 12d, the arm 14 for supporting the arm 12d is returned to its original position shown in Fig. 3 by the elastic restoring force of the conveying belt 11b because the axis of the shaft 13d is closer to the belt 11a than the line which connects the axis of the shaft 13e to the axis of the shaft 14a.

In the second embodiment, only one conveying belt 11b of the pair of convey belts is driven while the other conveying belt 11a is driven by the force of the conveying belt 11b. If the pulley 12a is also driven by the drive source so that both conveying belts 11a and 11b can be driven, more reliable conveyance of the paper stack 17 is ensured. This also applies to the embodiment shown in Fig. 1.

A third embodiment of the present invention will be described below with reference to Fig. 5. In this embodiment, a paper stack convey device 20 includes endless conveying belts 21a, 21b made of an elastic material and adapted to hold the paper stack therebetween and convey it, pulleys 22a, 22b, 22c; 22d, 22e, 22f around which the convey belts 21a, 21b extend, respectively, shafts 23a, 23b, 23c; 23d, 23e, 23f for supporting the pulleys, an arcuate guide 24 for guiding the paper stack conveyed by the belts 21a and 21b, a spring member 25 for coupling the guide 24 to a frame (not shown), a drive source (not shown), and a drive mechanism (not shown). At least one conveying belt 21a of the conveying belts is made of an elastic material.

One end of the guide 24 is pivotally mounted on a shaft 24a mounted on the frame between the shafts 23a and 23b and near the shaft 23f, while the other end the guide 24 is coupled to an end of the spring member 25 whose the other end is mounted on the frame. The normal position of the guide 24 is that at which is ensures guiding of one sheet of paper (see Fig. 5). This normal position is determined by a stopper which is not shown. In this embodiment, the pulleys 22a and 22d are driven by the drive source and the drive mechanism which are not shown, that is, both conveying belts 21a and 22b are driven.

In the paper sheet conveying device 20, a paper stack 26 consisting of at least a single sheet of paper is fed, as shown in Fig. 5. When the paper stack consisting of a plurality of sheets of paper is fed, the guide 24 is subjected to a force from the paper stack 26 and the free end thereof is thereby displaced about the shaft 24a in a direction in which it moves away from the pulley 22f, as shown in Fig. 6, so as to allow the paper stack 26 to pass through the guide 24 and so as to define the direction of conveyance of the paper stack 26. After the paper stack 26 has passed, the guide 24 is returned to its original position shown in Fig. 5 by the restoring force of the spring member 25.

The conveyance devices 1, 10 and 20 described above are suitable to convey a paper stack consisting of a large number of paper sheets or of those having different thicknesses, e.g., thick paper sheets. The conveyance devices 1, 10 and 20 convey, for example, a stack of paper sheets. However, when the number of paper sheets to be conveyed in a stack increases, a conveying belt may readily come off a pulley. In addition, when holding (pressing) force on the paper stack is released during stacking of paper sheets, the stack may expand due to the spring effect thereof, prohibiting an excellent stacking operation of the paper sheets. A fourth embodiment which will be described below is designed to eliminate such a drawback.

Fig. 7 shows the fourth embodiment of the present invention. In this embodiment, a paper sheet conveying device 30 includes three endless conveying belts 31a, 31b, 31c for holding a paper stack therebetween and conveying it, pulleys 32a, 32b, 32c; 32d, 32e; 32f, 32g, shafts 33a, 33b, 33c; 33d, 33e; 33f, 33g for respectively supporting the pulleys, a frame, a drive source and a drive mechanism which are not shown. In this embodiment, the pulley 32a is a driving pulley. At least one conveying belt 31a is made of an elastic material. The conveying belt 31a is a driving belt while the conveying belts 31b and 31c are driven belts which are moved due to the contact with the conveying belt 31a. When a paper stack 34 consisting of a large number of paper sheets is fed into the paper sheet conveying device 30, the paper stack 34 stays between the belts 31a and 31c and at a position in advance of the pulley 32f, as shown in Fig. 8, because the load on the conveying belt 31c deformed in the manner shown in Fig. 8 by the paper stack 34 is increased to cause a slippage

between the belts 31a and 31c at a position a where the conveying belts 31a and 31c are in contact with each other and displace the conveying belts 31a and 31c away from each other at the position of the pulley 32c the belt 31c becomes to be free from the driving force. However, at that time, a conveying force is applied from the conveying belt 31a to the paper stack 34 which is in contact with the conveying belt 31a to convey the paper sheets one by one or in a state where they are partially laid on top of one another, as shown in Fig. 9. Consequently, the sheets of paper are separated from each other or partially laid on top of one another when they pass between the pulleys 32a and 32d, and this makes it possible to convey the paper stack without providing the pivotal pulley shaft support arm, unlike the embodiment shown in Fig. 1. This effect can also be obtained by detecting that the paper stack 34 has arrived at a predetermined position and by stopping the conveying belts 31c by, for example, a brake actuated by a detection signal.

An embodiment of an automatic cash handling apparatus which employs some of the aforementioned paper sheet convey devices will be described below with reference to Figs. 10 through 14. Fig. 10 schematically shows a cash dispenser which employs the paper sheet convey devices 1 and 10 shown in Figs. 1 and 3. This cash dispenser is designed to convey bills set in a cassette 100 to a payment port 102 and pay it back to a customer. In this embodiment, the automatic cash dispenser includes six conveying belts 103a through 103f which form conveying paths, a plurality of pulleys 104 around which the convey belts extend, a guide (not shown), and a convey direction changing gate (not shown). Among the pulleys shown in Fig. 10, the pulleys 104a, 104b and 104c are driving pulleys, that is, the conveying belts 103a, 103b and 103c are driving belts. Also, each of the pulleys 104b and 104d is mounted on a pivotal support arm such as that described above.

In the cash dispenser (the automatic cash handling apparatus) 100, the bills required by the customer are conveyed one by one from the cassette 100 to a stacking portion 105, as shown in Fig. 11. The stacking operation is performed by a stopper 106 or the like provided in the stacking portion 105 to deposit the bills on a bottom plate (not shown) above the convey belt 103b. A double sheet detecting roller 109 checks bills 108 which are not separated at a separating portion 107 in the cassette 100, and the direction changing gate (not shown) provided in a portion B changes the direction of conveyance of the sheets from direction a to direction b to accommodate them in an accommodating box 110.

When the required amount of bills is deposited in the stacking portion 105, the stopper 106 retracts and then the pulley 104e moves in the manner shown in Fig. 12 so that bills 101 to be paid to the customer can be held between the conveying belts 103a and 103b. Subsequently, the conveying path is driven at a low speed to discharge the bills, as shown in Fig. 13. At that time, the pulley 104b is displaced such that it is moved away from the pulley 104a to present the bills 101 to the customer in a stack. When the bills 101 have come to a position where the customer can reach them, the drive of the convey belts 103a and 103b is stopped in a state where the belts 103a and 103b slightly hold the bills 101. The bills 101 presented to the customer may not be taken out by the customer. In that case, when a certain period of time elapses, a control unit recognizes that the customer has forgotten to take the bills, and reverses the direction of drive of the driving source to feed back the bills 101 to the accommodating box 110 (Fig. 14). When the bills 101 are in a stack, as shown in Fig. 14, the support arm of the pulley 104d pivots and thereby permits accommodation of the bills 101 into the accommodating box 110 in a stack.

The paper sheet conveying device according to the present invention is capable of conveying a single sheet of paper or a paper stack consisting of a number of paper sheets or of those having different thicknesses along the same conveying path and thereby prevents an increase in the overall size of the drive and production cost. The automatic cash handling apparatus according to the present invention is capable of excellently and flexibly conveying bank notes having different thicknesses.

Claims

1. A paper sheet conveying device (1, 10, 20, 30) including at least one pair of endless belts (1a, 1b; 11a, 11b; 21a, 21b; 31a, 31c; 103a, 103b), at least two pulleys (2a, 2b; 2c, 2d; 12a through 12c; 12d through 12e; 22a through 22c, 22d through 22f; 32a through 32c, 32f through 32g; 104a, 104d; 104b, 104e) around which each of said endless belts extends, and a drive source for driving at least one of said pair of endless belts, said at least one pair of endless belts having runs which oppose each other and which normally move in contact with each other, said runs holding and conveying a paper sheet therebetween,

wherein the at least one of said at least one pair of endless belts has means for displacing at least a part of the run of the one belt away from the run of the other belt when the one belt is subjected to a force from the paper

sheet being conveyed.

2. A paper sheet conveying device according to Claim 1, wherein the one pulley (2a; 12d; 104b; 104d) of the one endless belt is supported in a floating state, and wherein said displacing means comprises elastic means (5; 11b) for elastically urging the one pulley toward the other endless belt.

3. A paper sheet conveying device according to Claim 2, wherein a shaft (3a) of the one pulley (2a) is supported by a pivotal shaft supporting arm (4), and wherein said elastic means comprises a spring member (5) which acts on said arm.

4. A paper sheet conveying device according to Claim 2, wherein a shaft (13d) of the one pulley (12d) is supported by a pivotal shaft supporting arm (14), and wherein the one endless belt (11b) is made of an elastic material which constitutes said elastic means.

5. A paper sheet conveying device according to Claim 1, wherein the one endless belt (21a) is made of an elastic material which constitutes said displacing means, wherein the one pulley (22f) of the other endless belt (21b) is disposed close to the run of the one endless belt (21a), and wherein a guide (24) is provided close to the one pulley (22f), one end of said guide being pivotally supported while the other end thereof is elastically biased toward the other endless belt (21b).

6. A paper sheet conveying device according to Claim 1, wherein the one endless belt (31a) is made of an elastic material which constitutes said displacing means, wherein said drive source drives the one endless belt (31a), the other endless belt (31c) being driven by the one endless belt (31a) which is driven by said drive source, wherein the one pulley (32f) of the other endless belt (31c) is normally disposed at a position where it ensures that the other endless belt is in contact with the run of the one endless belt, and wherein the two endless belts are arranged such that the paper sheets of the paper stack located close to the one endless belt are successively conveyed by the run of the one endless belt.

7. An automatic cash handling apparatus comprising the paper sheet conveying device defined in any one of Claims 1 through 4.

8. An automatic cash handling apparatus according to Claim 7, further comprising a payment port (102), and a cassette (100) for accommodating bills (101) to be conveyed to said payment port, said paper sheet conveying device constituting at least a part of a paper sheet conveying path extending between said cassette (100) and said payment port (102).

9. An automatic cash handling apparatus according to Claim 8, further comprising an accommodating box (110) disposed at a position offset from said paper sheet conveying path, and a changing gate disposed in the midway of said paper sheet conveying path.

FIG. 1

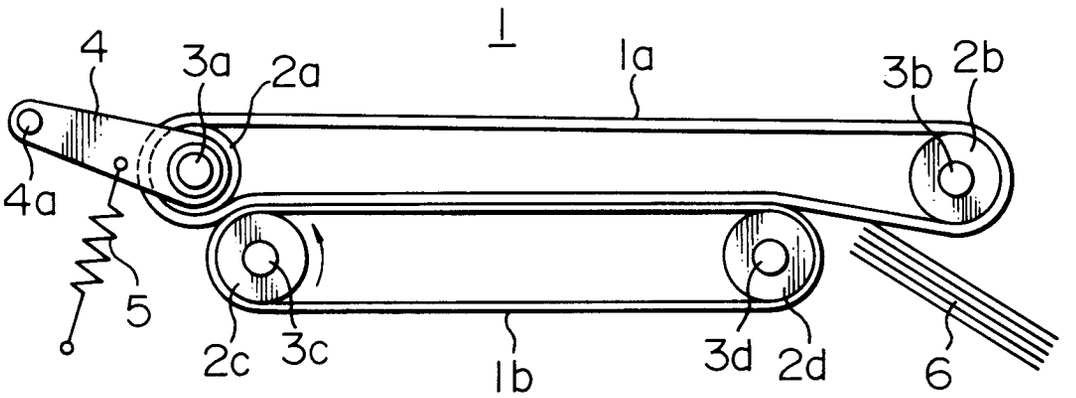
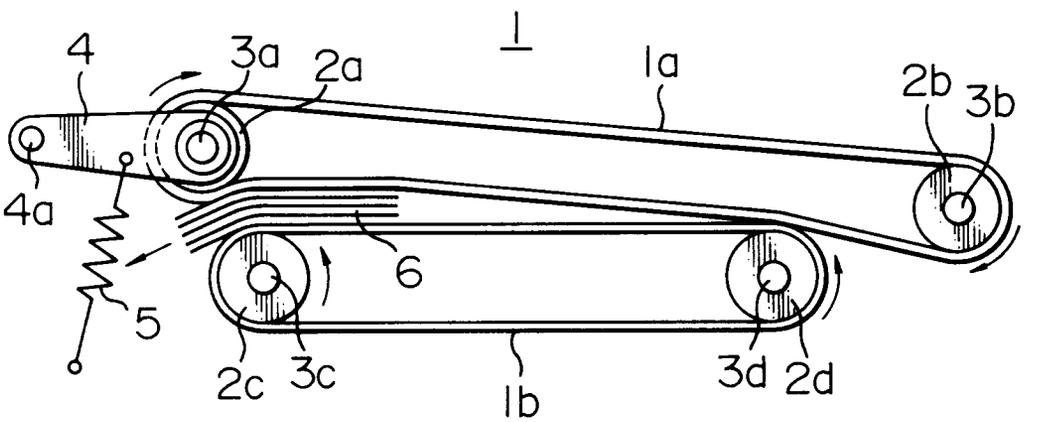

1
4
3a
2a
1a
3b
2b
4a
5
2c
3c
1b
3d
2d
6

FIG. 2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3b
4a
6
5
2c
3c
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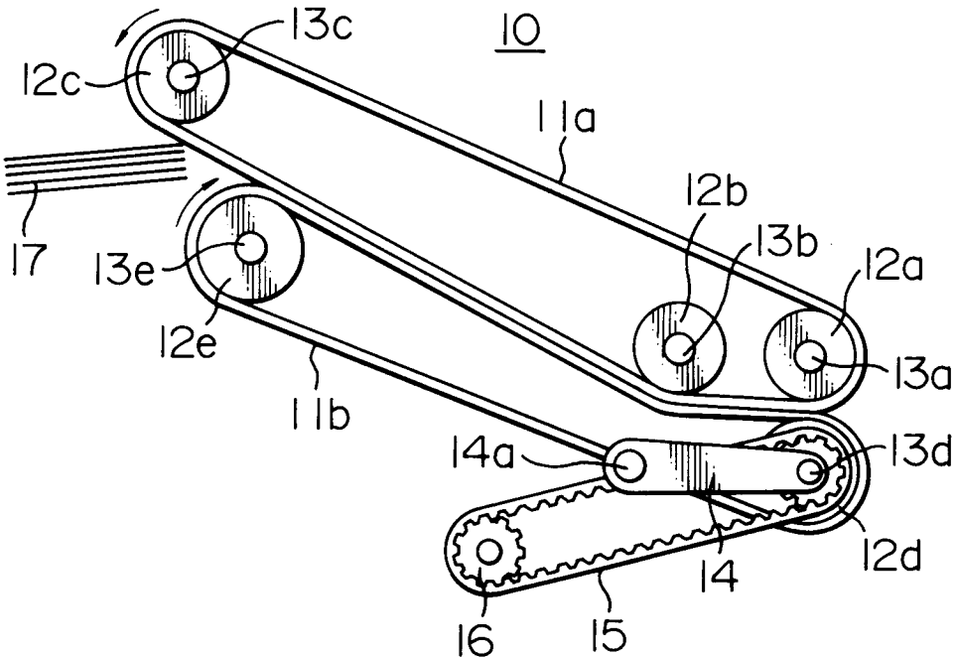
3d
2d

FIG. 3


13c
10
12c
11a
12b
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17
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13d
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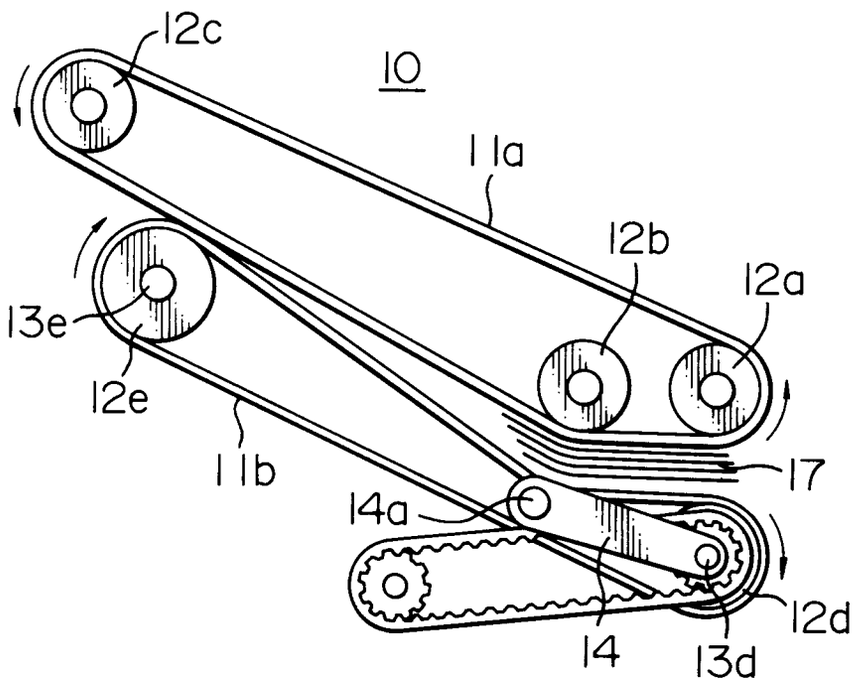
14
16
15

FIG. 4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17
14a
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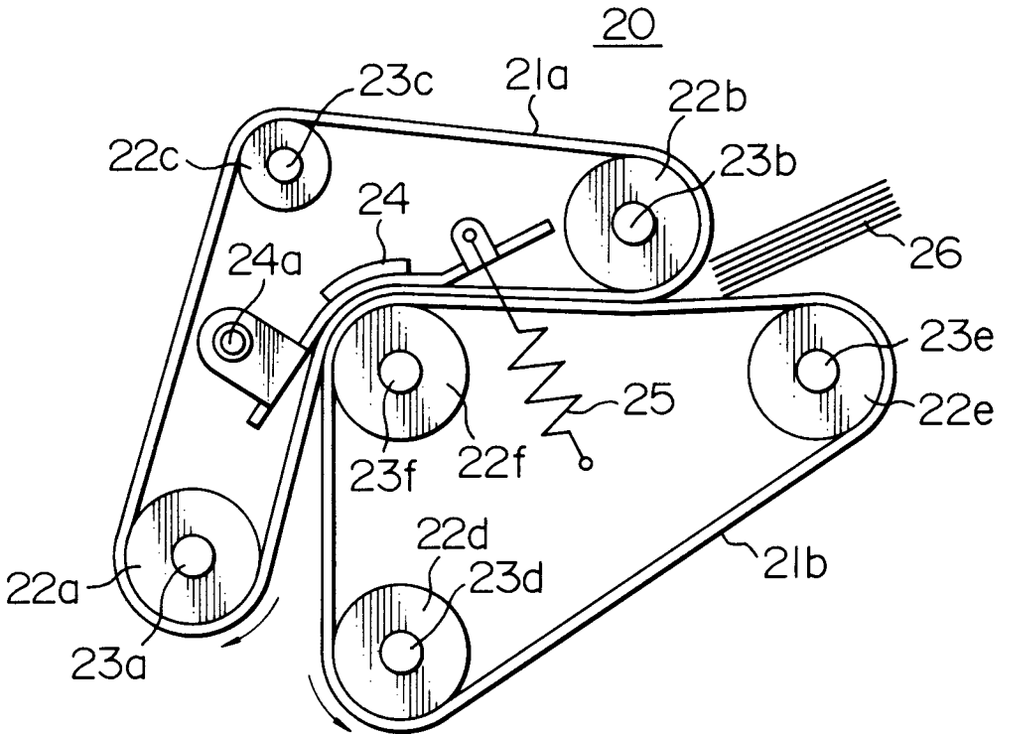
14
13d

FIG. 5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23c
21a
22b
22c
23b
24
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24a
23e
25
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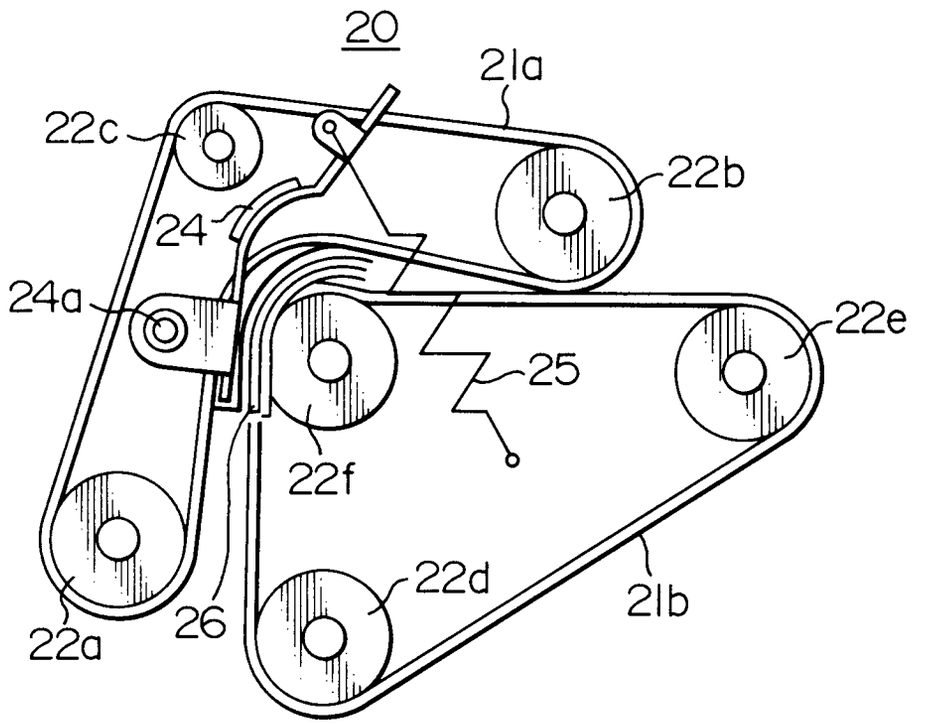
21b
22a
23a

FIG. 6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22a

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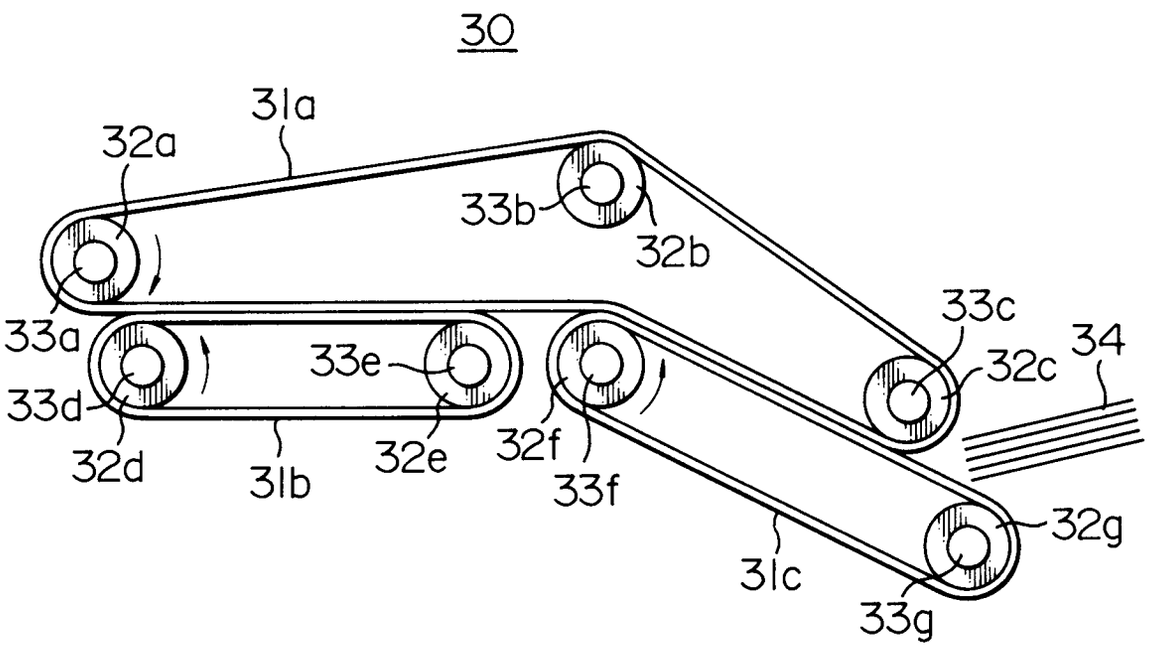
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33b
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33a
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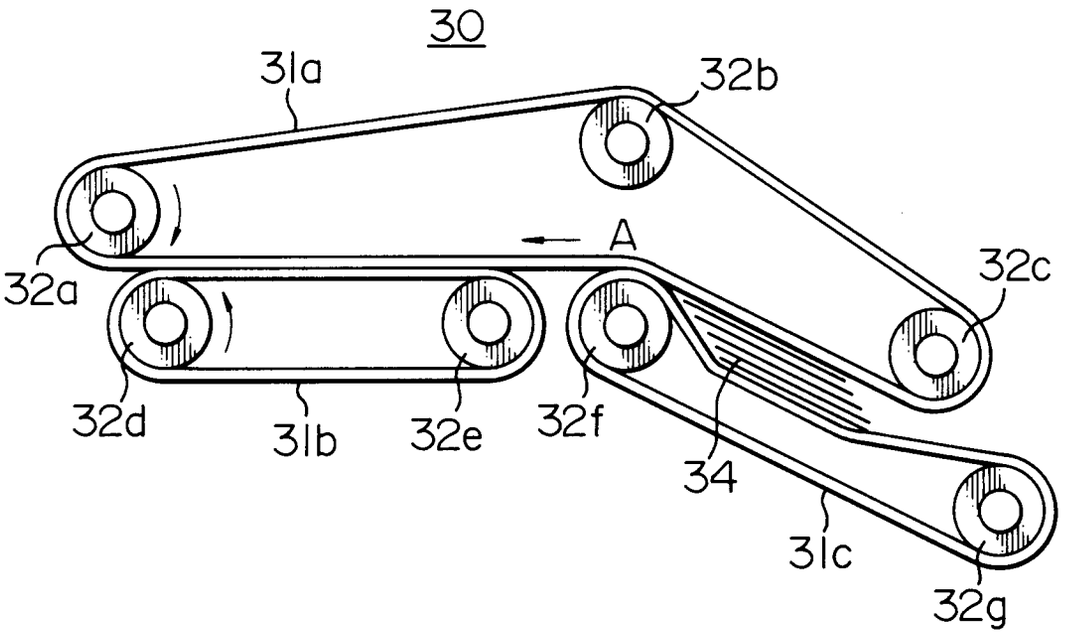
32g
31c
33g

FIG. 8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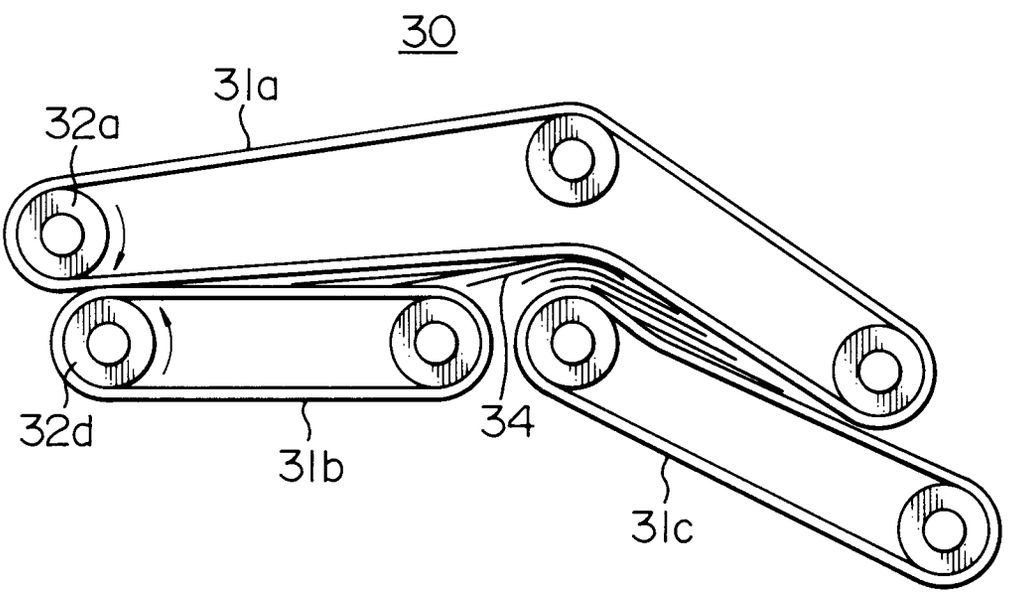
32b
A
32a
32c
32d
31b
32e
32f
34
31c
32g

FIG. 9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31a
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32d
31b
34
31c

FIG. 10

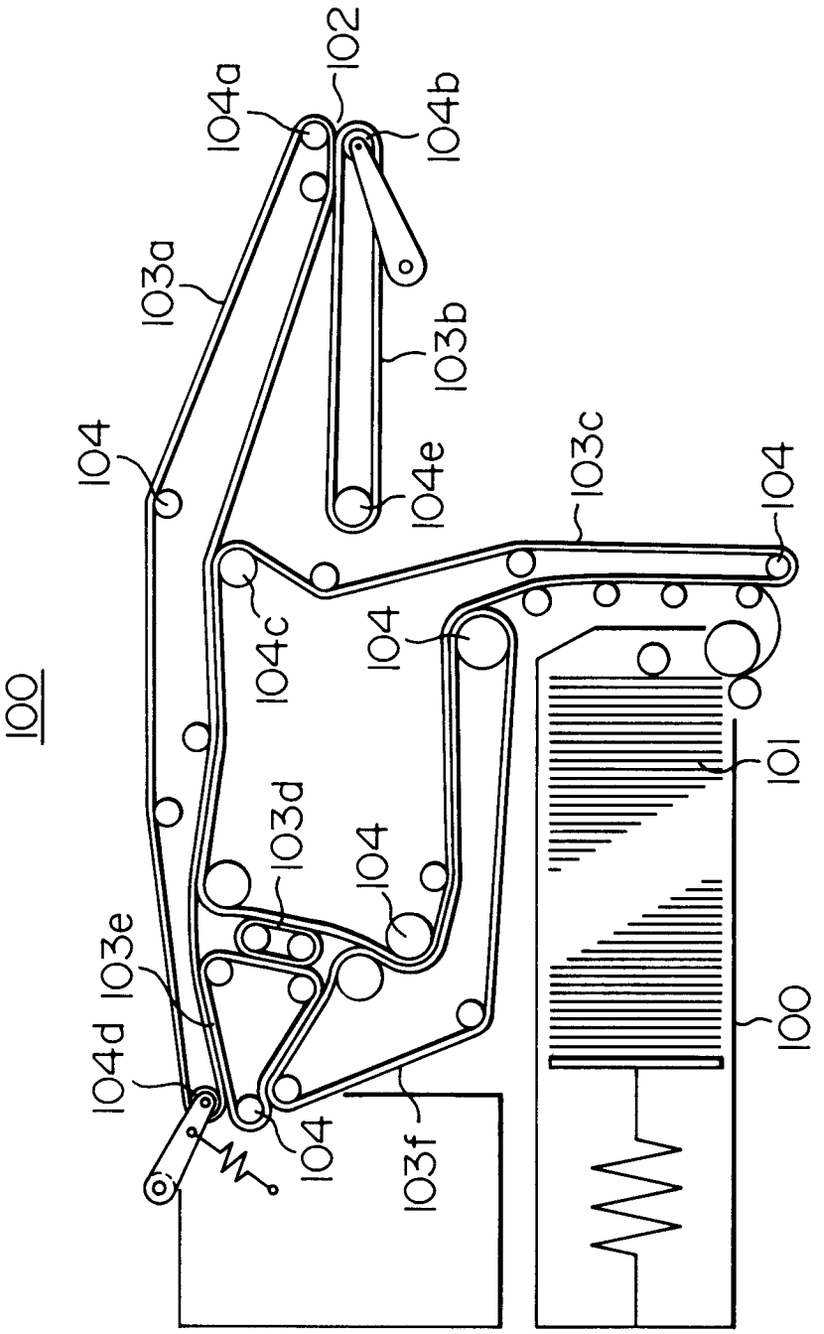
100
102
104a
104b
103a
103b
104
104e
103c
104
104c
104
101
103d
104
103e
104d
104
103f
100

FIG. 11

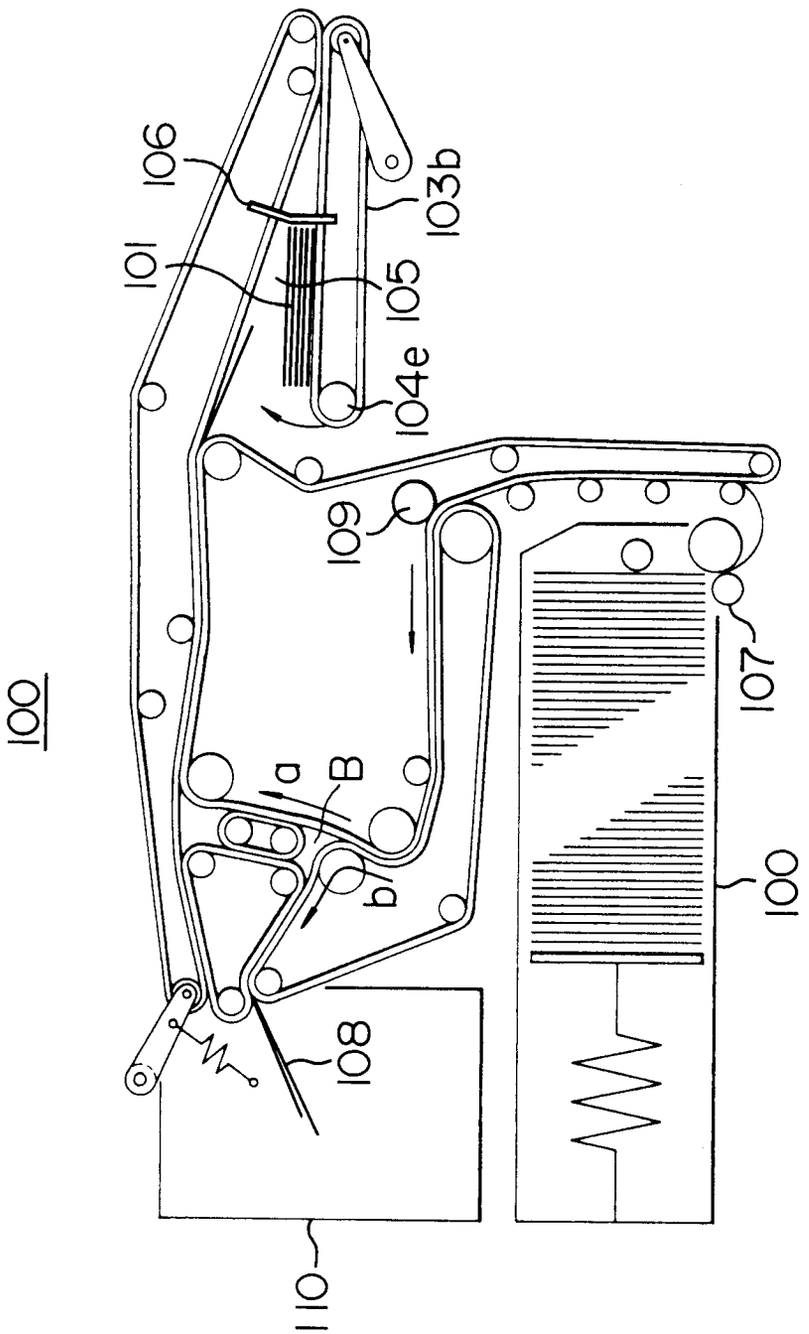

FIG. 12

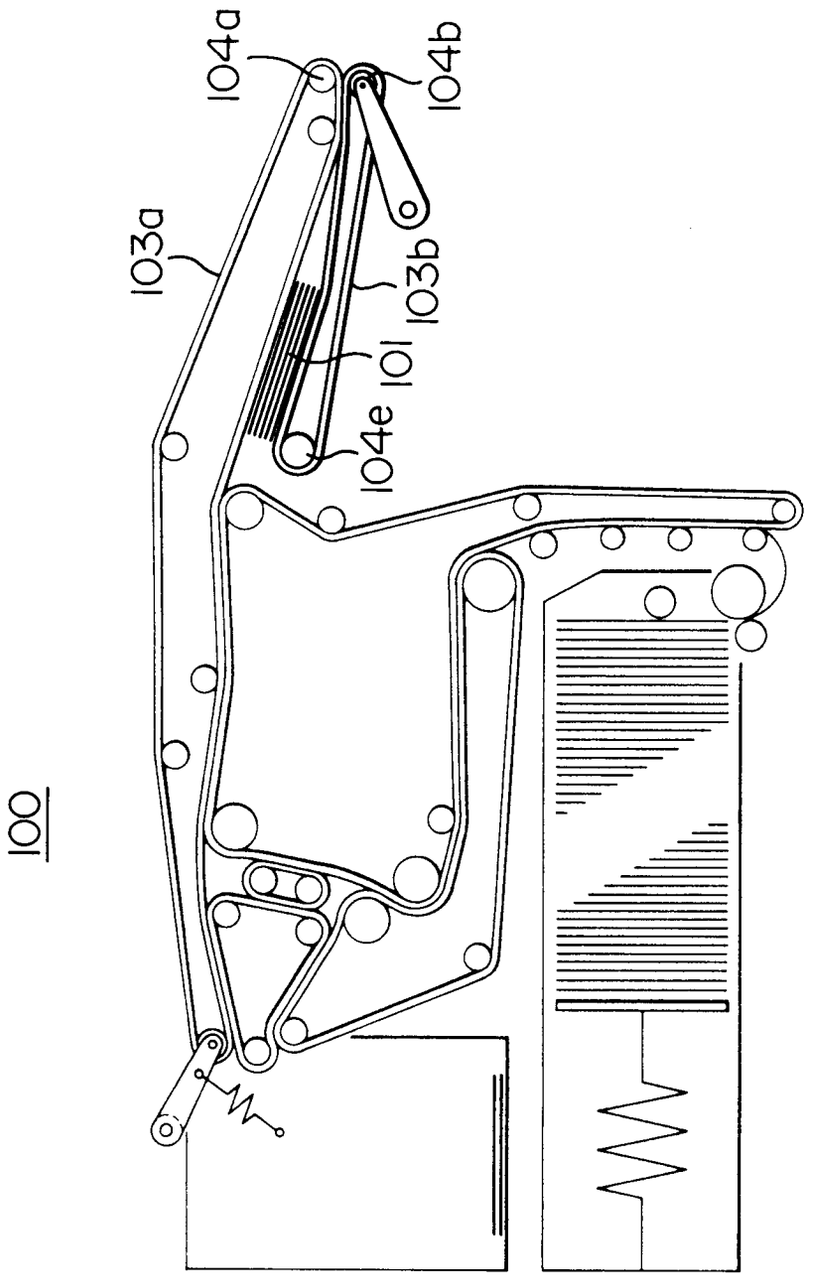

FIG. 13

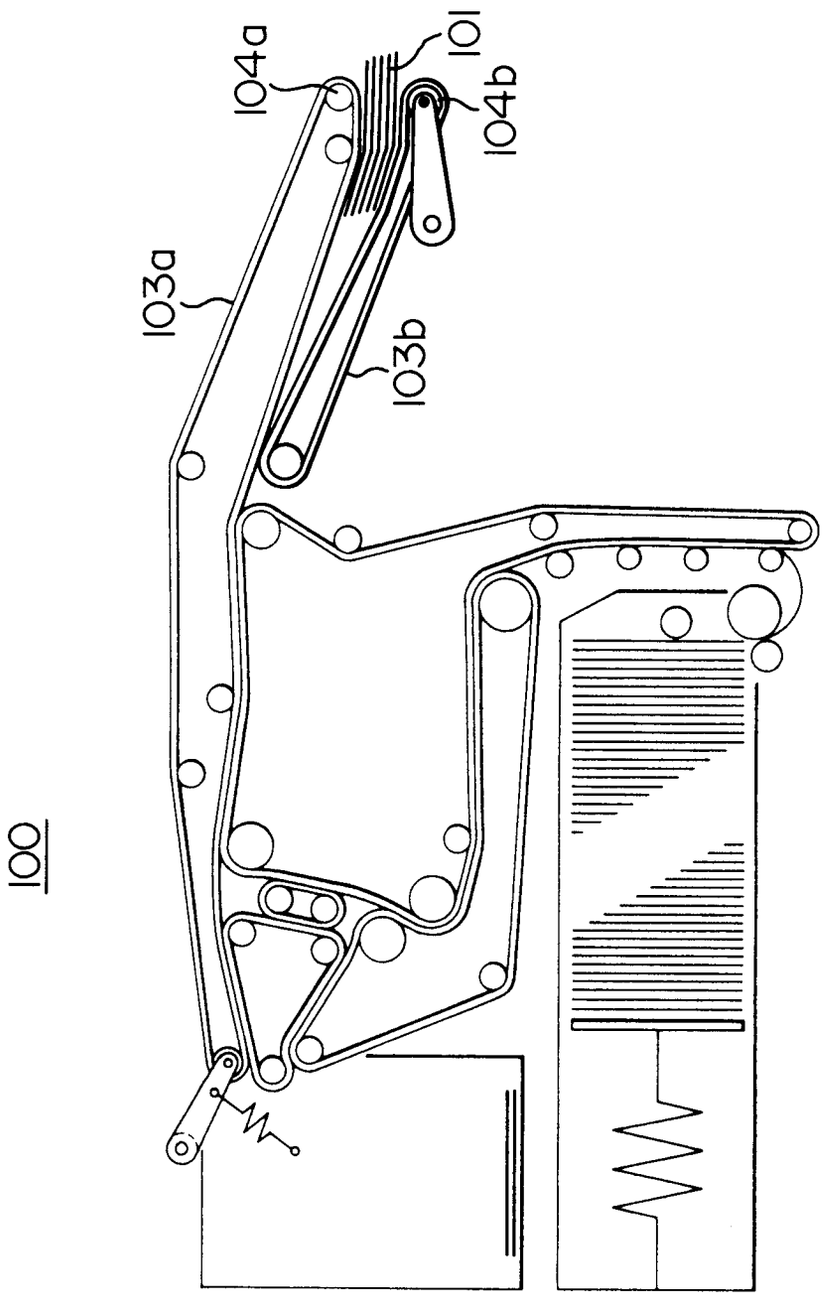

FIG. 14