

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a creasing and folding machine for forming creases on a sheet and folding the sheet along the creases.

BACKGROUND OF THE INVENTION

[0002] A creasing and folding machine is generally configured to form creases on a sheet and fold the sheet along the creases. The conventional creasing and folding machine comprises: a creasing mechanism for forming the creases on the sheet; a folding mechanism for receiving the sheet from the creasing mechanism and folding the sheet along the creases; and a controller for controlling operations of the creasing mechanism and the folding mechanism (see, for example, Patent Document 1).

[0003] The creasing mechanism comprises: a conveying roller for conveying the sheet, and a creasing section for creasing the sheet which is delivered from the conveying roller. The folding mechanism comprises: a plurality of folding knives for pressing the sheet along the creases at their edges; and a plurality of pairs of folding rollers each of which is composed of two folding rollers disposed opposite to each other with a gap therebetween, the gaps being opposite to the edges of the folding knives. The sheet is pressed by the folding knives, and inserted into the gaps, and then folded along the creases.

[0004] There are two ways for folding the sheet along the crease. As shown in Fig. 16A, one way is pressing a recess side of the crease by the folding knife and folding the sheet along the crease in the same direction as the fold direction of the crease. As shown in Fig. 16B, the other way is pressing a protrusion side of the crease by the folding knife and folding the sheet along the crease in a direction opposite to the fold direction of the crease.

[0005] When the sheet is a heavy paper sheet, as shown in Fig. 16A, if the sheet is folded in the same direction as the fold direction of the crease, the appearance of the folded sheet is poor because the sheet is not folded completely. Therefore, preferably as shown in Fig. 16B, the sheet is folded in the opposite direction to the fold direction of the crease so as to fold the sheet completely.

[0006] When the sheet is a thin paper sheet, if the sheet is folded in the opposite direction to the fold direction of the crease, the appearance of the folded sheet is poor because the folded portion of the sheet is not sharp. Therefore, the sheet is preferably folded in the same direction as the fold direction of the crease in such a way that the folded portion of the sheet is sharp.

[0007] In the conventional creasing and folding machine, the creasing section comprises: a convex block opposite to a first surface of the sheet; and a concave block opposite to a second surface of the sheet. The convex and concave blocks move toward each other so as

to form the crease which provides a recess on the first surface of the sheet and a protrusion on the second surface of the sheet. Thus, the creasing section has only one set of the convex and concave blocks. As a result, the creasing section can form only one type of the crease which provides a recess on the first surface of the sheet and a protrusion on the second surface of the sheet.

[0008] In the conventional creasing and folding machine, the folding mechanism is configured to press the second surface of the sheet by first folding knife and further press the first surface of the sheet by second folding knife so as to fold the sheet two times. Thus, the sheet is folded by the first folding knife in a direction opposite to the fold direction of the crease (see Fig. 16B), and further the sheet is folded by the second folding knife in the same direction as the fold direction of the crease (see Fig. 16A). As a result, when the sheet is a heavy paper sheet, the appearance of the folded sheet is poor because the folded portion of the sheet is not folded completely (see Fig. 16A) due to folding the sheet by the second folding knife in the same direction as the fold direction of the crease. When the sheet is a thin paper sheet, the appearance of the folded sheet is poor because the folded portion of the sheet is not sharp due to folding the sheet by the first folding knife in a direction opposite to the fold direction of the crease.

[0009] Patent Document 1: EP 1,425,239 B

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010] It is an object of the present invention to provide a creasing and folding machine which can achieve the folding with good appearance by selecting the press of the protrusion side of the crease or the press of the recess side of the crease depending on both heavy and thin paper sheets.

SOLUTION TO THE PROBLEMS

[0011] In order to achieve the objects, the present invention provides a creasing and folding machine, comprising:

a creasing mechanism for forming a plurality of creases on a sheet;
 a folding mechanism for receiving the sheet from the creasing mechanism and folding the sheet along the creases; and
 a controller for controlling operations of the creasing mechanism and the folding mechanism; wherein the creasing mechanism comprises:

a conveying roller for conveying the sheet; and
 a creasing section for creasing the sheet which is delivered from the conveying roller; wherein

the folding mechanism comprises:

a plurality of folding knives for pressing the sheet along the creases at edges of the folding knives; and
 a plurality of pairs of folding rollers each of which is composed of two folding rollers disposed opposite to each other with a gap therebetween, the gaps being opposite to the edges of the folding knives; wherein

the sheet is pressed by the folding knives so as to be inserted into the gaps and folded along the creases; wherein

the creasing section comprises:

first and second creasing units aligned in a conveying direction of the sheet; wherein

the first creasing unit comprises:

a first convex block opposite to a first surface of the sheet; and
 a first concave block opposite to a second surface of the sheet, the first convex and concave blocks being moved toward each other so as to form a first crease of the creases which provides a recess on the first surface of the sheet and a protrusion on the second surface of the sheet; and wherein

the second creasing unit comprises:

a second concave block opposite to the first surface of the sheet; and
 a second convex block opposite to the second surface of the sheet, the second recess and convex blocks being moved toward each other so as to form a second crease of the creases which provides a protrusion on the first surface of the sheet and a recess on the second surface of the sheet.

[0012] According to a preferred embodiment of the present invention, when the sheet is a heavy paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the folding knives press a protrusion side of the first or second crease.

[0013] According to further preferred embodiment of the present invention, when the sheet is a thin paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the folding knives press a recess side of the first or second crease.

[0014] According to further preferred embodiment of the present invention, the folding mechanism comprises:

the pairs of the folding rollers including two folding roller pairs, a first folding roller pair of the two folding roller pairs composed of a first folding roller and a second folding roller, and a second folding roller pair of the two folding roller pairs composed of the second folding roller and a third folding roller; and the folding knives including first and second folding knives; wherein

a first folding unit is composed of the first folding roller pair and the first folding knife, wherein a second folding unit is composed of the second folding roller pair and the second folding knife, wherein the first folding unit folds the sheet in such a way that the first folding knife presses the first or second crease from the second surface of the sheet to the first surface of the sheet and inserts the sheet into the gap between the first and second folding rollers, wherein

the second folding unit folds the sheet in such a way that the second folding knife presses the first or second crease from the first surface of the sheet to the second surface of the sheet and inserts the sheet into the gap between the second and third folding rollers, and wherein

when the sheet is a heavy paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the second creasing unit forms the second crease after the first creasing unit forming the first crease, and the first folding knife presses the protrusion side of the first crease, and then the second folding knife presses the protrusion side of the second crease.

[0015] According to further preferred embodiment of the present invention, the folding mechanism comprises:

the pairs of the folding rollers including two folding roller pairs, a first folding roller pair of the two folding roller pairs composed of a first folding roller and a second folding roller, and a second folding roller pair of the two folding roller pairs composed of the second folding roller and a third folding roller; and the folding knives including first and second folding knives; wherein

a first folding unit is composed of the first folding roller pair and the first folding knife, wherein a second folding unit is composed of the second folding roller pair and the second folding knife, wherein the first folding unit folds the sheet in such a way that the first folding knife presses the first or second crease from the second surface of the sheet to the first surface of the sheet and inserts the sheet into the gap between the first and second folding rollers, wherein

the second folding unit folds the sheet in such a way that the second folding knife presses the first or second crease from the first surface of the sheet to the

second surface of the sheet and inserts the sheet into the gap between the second and third folding rollers, and wherein

when the sheet is a thin paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the first creasing unit forms the first crease after the second creasing unit forming the second crease, and the first folding knife presses the recess side of the second crease, and then the second folding knife presses the recess side of the first crease.

EFFECT OF THE INVENTION

[0016] According to the present invention, the creasing section comprises first and second creasing units which are aligned in a conveying direction of the sheet. The first creasing unit comprises: a first convex block opposite to the first surface of the sheet; and a first concave block opposite to the second surface of the sheet. The first convex and concave blocks move toward each other so as to form a first crease which provides a recess on the first surface of the sheet and a protrusion on the second surface of the sheet. The second creasing unit comprises: a second concave block opposite to the first surface of the sheet; and a second convex block opposite to the second surface of the sheet. The second concave and convex blocks move toward each other so as to form a second crease which provides a recess on the second surface of the sheet and a protrusion on the first surface of the sheet.

[0017] In case that a folding knife is configured to press the second surface of the sheet, when the first creasing unit forms the crease and provides the protrusion on the second surface of the sheet, the folding knife can press the protrusion side of the crease. Therefore, it is possible to fold a heavy paper sheet with good appearance.

[0018] Further, in this case, when the second creasing unit forms the crease and provides the recess on the second surface of the sheet, the folding knife can also press the recess side of the crease. Therefore, it is also possible to fold a thin paper sheet with good appearance.

[0019] As above described, according to the creasing and folding machine of the present invention, the first and second folding units comprise two pairs of the concave and convex blocks which are disposed in different direction from each other. It is possible to form two types of the creases whose protrusion and recess sides are inverted each other. Thus, the sheet can be folded in two ways: in one way the folding knife presses the protrusion side of the crease, in the other way the folding knife presses the recess side of the crease. In the same way, the sheet can be folded in the direction same as or opposite to the fold direction of the crease. Consequently, it is possible to fold the sheet with good appearance for both heavy and thin paper sheets.

BRIEF DESCRIPTION OF THE DRAWING

[0020]

5 Fig. 1 is a side view schematically showing a creasing and folding machine according to one embodiment of the present invention.

Fig. 2 is a side view schematically showing an operation of a creasing mechanism when a sheet is a heavy paper sheet.

10 Fig. 3 is a side view schematically showing the operation of the creasing mechanism following Fig. 2. Fig. 4 is a side view schematically showing an operation of a folding mechanism following Fig. 3.

15 Fig. 5 is a side view schematically showing the operation of the folding mechanism following Fig. 4.

Fig. 6 is a side view schematically showing the operation of the folding mechanism following Fig. 5.

20 Fig. 7 is a side view schematically showing the operation of the folding mechanism following Fig. 6.

Fig. 8 is a side view schematically showing the operation of the folding mechanism following Fig. 7.

25 Fig. 9 is a side view schematically showing the operation of the creasing mechanism when a sheet is a thin paper sheet.

Fig. 10 is a side view schematically showing the operation of the folding mechanism following Fig. 9.

Fig. 11 is a side view schematically showing the operation of the folding mechanism following Fig. 10.

30 Fig. 12 is a side view schematically showing the operation of the folding mechanism following Fig. 11.

Fig. 13 is a side view schematically showing the operation of the folding mechanism following Fig. 12.

35 Fig. 14 is a side view schematically showing the operation of the folding mechanism following Fig. 13.

Fig. 15 is a side view schematically showing the operation of the folding mechanism following Fig. 14.

40 Fig. 16A is a side view schematically showing a paper folded in the same direction as a fold direction of a crease by a folding knife pressing a recess side of the crease when a sheet is a heavy paper sheet.

Fig. 16B is a side view schematically showing the paper folded in opposite direction to the fold direction of the crease by the folding knife pressing a protrusion side of the crease when the sheet is the heavy

45 paper sheet.

Fig. 16C is a side view schematically showing the paper folded in the same direction as a fold direction of a crease by a folding knife pressing a protrusion side of the crease when a sheet is a thin paper sheet.

DETAILED EXPLANATION OF THE PREFERRED EMBODIMENTS

50 **[0021]** A preferred embodiment of a creasing and folding machine according to the present invention will be explained below with reference to the accompanying drawings.

55 **[0022]** As shown in Fig. 1, the creasing and folding machine comprises a creasing mechanism 1 for forming a plurality of creases on a sheet S. The creasing and folding machine further comprises a folding mechanism

2 for folding the sheet S along the creases. The sheet S is conveyed from the creasing mechanism 1. The creasing and folding machine further comprises a controller 3 for controlling operations of the creasing mechanism 1 and the folding mechanism 2. The creasing mechanism 1 further comprises first and second conveying roller pairs 10, 11 for conveying the sheet S. The first and second conveying roller pairs 10, 11 are aligned in a first conveying direction F of the sheet S. The first conveying roller pair 10 is disposed at the upstream of the first conveying direction F, while the second conveying roller pair 11 is disposed at the downstream of the first conveying direction F.

[0023] The first conveying roller pair 10 comprises a first drive roller 100 and a first idle roller 101. The first drive and idle rollers 100, 101 are disposed adjacent to each other in such a way that the rotation of the first drive roller 100 causes the rotation of the first idle roller 101. The second conveying roller pair 11 comprises a second drive roller 110 and a second idle roller 111. The second drive and idle rollers 110, 111 are disposed adjacent to each other in such a way that the rotation of the second drive roller 110 causes the rotation of the second idle roller 111.

[0024] The first and second idle rollers 101, 111 are disposed opposite to the first surface (upper surface) S1 of the sheet S, while the first and second drive rollers 100, 110 support the second surface (lower surface) S2 of the sheet S thereon.

[0025] The creasing mechanism 1 comprises a creasing section 45 for creasing the sheet S. The creasing section 45 is disposed between the first and second conveying roller pairs 10, 11. The creasing section 45 comprises first and second creasing units 4, 5. The first and second creasing units 4, 5 are aligned in a first conveying direction F of the sheet S. The first creasing unit 4 is disposed at the upstream of the first conveying direction F, while the second creasing unit 5 is disposed at the downstream of the first conveying direction F.

[0026] The first creasing unit 4 comprises first convex and concave blocks 40, 41. The first convex block 40 is disposed opposite to the first surface (upper surface) S1 of the sheet S, while the first concave block 41 is disposed opposite to the second surface (lower surface) S2 of the sheet S. The first convex and concave blocks 40, 41 extend horizontally and perpendicular to the first conveying direction F respectively. The first convex and concave blocks 40, 41 can be engaged with each other. The first convex block 40 is fixed, while the first concave block 41 is reciprocated by a first creasing drive mechanism 42. During reciprocal movement, the first concave block 41 moves toward and away from the first convex block 40. When the first convex and concave blocks 40, 41 are engaged with each other, the sheet S is nipped between the first convex and concave blocks 40, 41 so as to form a first crease 400. The first crease 400 is depressed in the first surface S1 of the sheet S and projected on the second surface S2 of the sheet S. In the same way, the

first crease 400 provides a recess on the first surface S1 of the sheet S and a protrusion on the second surface S2 of the sheet S.

[0027] The second creasing unit 5 comprises second convex and concave blocks 50, 51. The second convex block 50 is disposed opposite to the second surface (lower surface) S2 of the sheet S, while the second concave block 51 is disposed opposite to the first surface (upper surface) S1 of the sheet S. The second convex and concave blocks 50, 51 extend horizontally and perpendicular to the first conveying direction F respectively. The second convex and concave blocks 50, 51 can be engaged with each other. The second concave block 51 is fixed, while the second convex block 50 is reciprocated by a second creasing drive mechanism 52. During the reciprocal movement, the second convex block 50 moves toward and away from the second concave block 51. When the second convex and concave blocks 50, 51 are engaged with each other, the sheet S is nipped between the second convex and concave blocks 50, 51 so as to form a second crease 500. The second crease 500 is projected on the first surface S1 of the sheet S and depressed in the second surface S2 of the sheet S. In the same way, the second crease 500 provides a protrusion on the first surface S1 of the sheet S and a recess on the second surface S2 of the sheet S.

[0028] The folding mechanism 2 comprises first, second and third folding rollers 20, 21, 22. The folding mechanism 2 comprises first and second folding knives 23, 24. The first and second folding rollers 20, 21 are aligned in the first conveying direction F. The first and second folding rollers 20, 21 are disposed adjacent to each other with a small first gap 201 therebetween. An edge 23a of the first folding knife 23 is opposite to the first gap 201. The second and third rollers 21, 22 are aligned in a second conveying direction F'. The second conveying direction F' is arranged at approximately right angle to the first conveying direction F. The second and third folding rollers 21, 22 are disposed adjacent to each other with a small second gap 202 therebetween. An edge 24a of the second folding knife 24 is opposite to the second gap 202.

[0029] The first folding knife 23 is reciprocated by a first knife drive mechanism 230. During the reciprocal movement, the first folding knife 23 moves toward and away from the first gap 201 in a direction perpendicular to the first conveying direction F. The first folding knife 23 presses the creases 400, 500 of the sheet S from the second surface S2 of the sheet S to the first surface S1 of the sheet S.

[0030] The second folding knife 24 is reciprocated by a second knife drive mechanism 240. During the reciprocal movement, the second folding knife 24 moves toward and away from the second gap 202 in a direction perpendicular to the second conveying direction F'. The second folding knife 24 presses the creases 400, 500 of the sheet S from the first surface S1 of the sheet S to the second surface S2 of the sheet S.

[0031] The folding mechanism 2 comprises first, sec-

ond and third press rollers 200, 210, 220. The first folding and press rollers 20, 200 nip the sheet S, the second folding and press rollers 21, 210 nip the sheet S, and the third folding and press rollers 22, 220 nip the sheet S.

[0032] A first folding unit 6 is composed of the first and second folding rollers 20, 21 and the first folding knife 23. A second folding unit 7 is composed of the second and third folding rollers 21, 22 and the second folding knife 24. The creasing mechanism 1 forms the creases 400, 500 on the sheet S, and the first folding unit 6 folds the sheet S along the creases 400, 500, and then the second folding unit 7 folds the sheet S along the creases 400, 500.

[0033] The creasing and folding machine comprises a motor 12 composed of a servomotor, a stepping motor and so on. The motor 12 is connected to the first and second drive rollers 100, 110 and the second folding roller 21 through a first timing belt 121. The drive of the motor 12 causes the rotations of the first and second drive rollers 100, 110 and the second folding roller 21. The first and third folding rollers 20, 22 are connected to each other through a second timing belt 122. The rotation of the second folding roller 21 causes the rotations of the first and third folding rollers 20, 22. The rotation of the motor 12 in a counterclockwise direction causes the counterclockwise rotations of the first and second drive rollers 100, 110 and the second folding roller 21. The rotation of the second folding roller 21 in a counterclockwise direction causes the clockwise rotations of the first and third folding rollers 20, 22.

[0034] The creasing and folding machine comprises position sensors 13, 13 which are disposed at the entrance of the creasing mechanism 1. For example, the position sensors 13, 13 are composed of light emitting and receiving elements for detecting an edge Sa of the sheet S. The position sensors 13, the motor 12, the first and second creasing drive mechanisms 42, 52, and the first and second folding knife drive mechanisms 230, 240 are connected to the controller 3. The controller 3 controls the operations of the creasing and folding mechanisms 1, 2 based on a preinstalled program when the position sensors 13 detect the edge Sa of the sheet S.

[0035] The first and second creasing drive mechanisms 42, 52 comprise, for example, a motor and a cam respectively. The drives of the cams of the first and second creasing drive mechanisms 42, 52 cause the reciprocal movements of the first concave block 41 and the second convex block 50. The first and second creasing drive mechanisms 42, 52 may be composed of a slide crank mechanism, a cylinder mechanism or a feed screw mechanism driven by a motor respectively.

[In case that the sheet is a heavy paper sheet]

[0036] The operation of the creasing and folding machine will be explained below with reference to Figs. 2-8 in which the sheet S is a heavy paper sheet.

[0037] The controller 3 is provided with a program for

handling the heavy paper sheet S. After distances from the edge Sa of the sheet S to the first and second creases 400, 500 are inputted to the controller 3, the operations of the creasing mechanism 1 and the folding mechanism 2 are controlled by the controller 3 as follows.

[0038] As shown in Fig. 2, when the position sensors 13 detect the edge Sa of the sheet S, the sheet S is conveyed in the first conveying direction F in such a way that a position to be provided with the first crease 400 arrives at the first convex and concave blocks 40, 41 by controlling the amount of the rotations of the conveying rollers 10, 11. When the position to be provided with the first crease 400 arrives at the first convex and concave blocks 40, 41, the sheet S is stopped by the stops of the conveying rollers 10, 11. The first concave block 41 moves upwardly toward the first convex block 40. As a result, the first crease 400 is formed on the sheet S. The first crease 400 provides a recess on the first surface (upper surface) S1 of the sheet S and a protrusion on the second surface (lower surface) S2 of the sheet S.

[0039] Then, as shown in Fig. 3, the sheet S is conveyed in the first conveying direction F in such a way that a position to be provided with the second crease 500 arrives at the second convex and concave blocks 50, 51 by controlling the amount of the rotation of the conveying rollers 10, 11. When the position to be provided with the second crease 500 arrives at the second convex and concave blocks 50, 51, the sheet S is stopped by the stops of the conveying rollers 10, 11. The second convex block 50 moves toward the second concave block 51. As a result, the second crease 500 is formed on the sheet S. The second crease 500 provides a protrusion on the first surface (upper surface) S1 of the sheet S and a recess on the second surface (lower surface) S2 of the sheet S.

[0040] Then, as shown in Fig. 4, the sheet S is conveyed in the first conveying direction F in such a way that the first crease 400 arrives at the edge 23a of the first folding knife 23 by controlling the amount of the rotations of the conveying roller 11 and the first folding roller 20. The sheet S is discharged from the second conveying roller 11, and then the discharged sheet S is nipped and conveyed between the first folding and press rollers 20, 200. The second press roller 210 is separated from the second folding roller 21 in order not to convey the sheet S in a direction opposite to the first conveying direction F by an inverse rotation of the second folding roller 21. When the first crease 400 arrives at the edge 23a of the first folding knife 23, the sheet S is stopped by stopping the conveying roller 11 and the first and second folding rollers 20, 21.

[0041] Then, as shown in Fig. 5, the second press roller 210 moves upwardly toward the second folding roller 21, and then the first folding knife 23 moves. The first folding roller 20 rotates in a clockwise direction, while the second folding roller 21 rotates in a counterclockwise direction. The edge 23a of the first folding knife 23 presses the first crease 400. As a result, the first crease 400 is inserted

into the first gap 201 between the first and second folding rollers 20, 21. The edge 23a of the first folding knife 23 presses the protrusion side of the first crease 400. Then, the sheet S is inserted into the first gap 201 and folded along the first crease 400 and discharged from the first and second folding rollers 20, 21. The sheet S is folded in a direction opposite to the fold direction of the first crease 400.

[0042] Then, as shown in Fig. 6, the sheet S is conveyed in the second conveying direction F' in such a way that the second crease 500 arrives at the edge 24a of the second folding knife 24 by controlling the amount of the rotations of the first and second folding rollers 20, 21. The second conveying direction F' is arranged at approximately right angle to the first conveying direction F. The third press roller 220 is separated from the third folding roller 22 in order not to convey the sheet S in a direction opposite to the second conveying direction F' by an inverse rotation of the third folding roller 22. When the second crease 500 arrives at the edge 24a of the second folding knife 24, the sheet S is stopped by stopping the first and second folding rollers 20, 21.

[0043] Then, as shown in Fig. 7, the third press roller 220 moves laterally toward the third folding roller 22, and then the second folding knife 24 moves. The first folding roller 20 rotates in a clockwise direction, the second folding roller 21 rotates in a counterclockwise direction, and the third folding roller 22 rotates in a clockwise direction. The edge 24a of the second folding knife 24 presses the second crease 500. As a result, the second crease 500 is inserted into the second gap 202 between the second and third folding rollers 21, 22. The edge 24a of the second folding knife 24 presses the protrusion side of the second crease 500. Then, the sheet S is inserted into the second gap 202 and folded along the second crease 500 and discharged from the second and third folding rollers 21, 22. The sheet S is folded in a direction opposite to the fold direction of the second crease 500.

[0044] As shown in Fig. 8, the sheet S is folded along the first and second creases 400, 500. As above described, the machine of the present invention can fold the heavy paper sheet S in a direction opposite to the fold directions of the first and second creases 400, 500 (see Fig. 16B). As a result, the sheet S can be folded with good appearance because the sheet S can be folded completely.

[In case that the sheet is a thin paper sheet]

[0045] The operation of the creasing and folding machine will be explained below with reference to Figs. 9-15 in which the sheet S is a thin paper sheet.

[0046] The controller 3 is provided with a program for handling the thin paper sheet S. After distances from the edge Sa of the sheet S to the first and second creases 400, 500 are inputted to the controller 3, the operations of the creasing mechanism 1 and the folding mechanism 2 are controlled by the controller 3 as follows.

[0047] As shown in Fig. 9, when the position sensors 13 detect the edge Sa of the sheet S, the sheet S is conveyed in the first conveying direction F in such a way that a position to be provided with the second crease 500 arrives at the second convex and concave blocks 50, 51 by controlling the amount of the rotations of the conveying rollers 10, 11. When the position to be provided with the second crease 500 arrives at the second convex and concave blocks 50, 51, the sheet S is stopped by stopping the conveying rollers 10, 11. The second convex block 50 moves upwardly toward the second concave block 51. As a result, the second crease 500 is formed on the sheet S. The second crease 500 provides a protrusion on the first surface (upper surface) S1 of the sheet S and a recess on the second surface (lower surface) S2 of the sheet S.

[0048] Then, as shown in Fig. 10, the sheet S is conveyed in the first conveying direction F in such a way that a position to be provided with the first crease 400 arrives at the first convex and concave blocks 40, 41 by controlling the amount of the rotations of the conveying rollers 10, 11. When the position to be provided with the first crease 400 arrives at the first convex and concave blocks 40, 41, the sheet S is stopped by stopping the conveying rollers 10, 11. The first concave block 41 moves upwardly toward the first convex block 40. As a result, the first crease 400 is formed on the sheet S. The first crease 400 provides a recess on the first surface (upper surface) S1 of the sheet S and a protrusion on the second surface (lower surface) S2 of the sheet S.

[0049] Then, as shown in Fig. 11, the sheet S is conveyed in the first conveying direction F in such a way that the second crease 500 arrives at the edge 23a of the first folding knife 23 by controlling the amount of the rotations of the conveying roller 11 and the first folding roller 20. The sheet S is discharged from the second conveying roller 11, then the discharged sheet S is nipped and conveyed between the first folding and press rollers 20, 200. The second press roller 210 is separated from the second folding roller 21 in order not to convey the sheet S in a direction opposite to the first conveying direction F by an inverse rotation of the second folding roller 21. When the second crease 500 arrives at the edge 23a of the first folding knife 23, the sheet S is stopped by stopping the conveying roller 11 and the first and second folding rollers 20, 21.

[0050] Then, as shown in Fig. 12, the second press roller 210 moves upwardly toward the second folding roller 21, and then the first folding knife 23 moves. The first folding roller 20 rotates in a clockwise direction, while the second folding roller 21 rotates in a counterclockwise direction. The edge 23a of the first folding knife 23 presses the second crease 500. As a result, the second crease 500 is inserted into the first gap 201 between the first and second folding rollers 20, 21. The edge 23a of the first folding knife 23 presses the recess side of the second crease 500. Then, the sheet S is inserted into the first gap 201 and folded along the second crease 500 and

discharged from the first and second folding rollers 20, 21. The sheet S is folded in the same direction as the fold direction of the second crease 500.

[0051] Then, as shown in Fig. 13, the sheet S is conveyed in the second conveying direction F' in such a way that the first crease 400 arrives at the edge 24a of the second folding knife 24 by controlling the amount of the rotations of the first and second folding rollers 20, 21. The second conveying direction F' is arranged at approximately right angle to the first conveying direction F. The third press roller 220 is separated from the third folding roller 22 in order not to convey the sheet S in a direction opposite to the second conveying direction F' by an inverse rotation of the third folding roller 22. When the first crease 400 arrives at the edge 24a of the second folding knife 24, the sheet S is stopped by stopping the first and second folding rollers 20, 21.

[0052] Then, as shown in Fig. 14, the third press roller 220 moves laterally toward the third folding roller 22, and then the second folding knife 24 moves. The first folding roller 20 rotates in a clockwise direction, the second folding roller 21 rotates in a counterclockwise direction, and the third folding roller 22 rotates in a clockwise direction. The edge 24a of the second folding knife 24 presses the first crease 400. As a result, the first crease 400 is inserted into the second gap 202 between the second and third folding rollers 21, 22. The edge 24a of the second folding knife 24 presses the recess side of the first crease 400. Then, the sheet S is inserted into the second gap 202 and folded along the first crease 400 and discharged from the second and third folding rollers 21, 22. The sheet S is folded in the same direction as the fold direction of the first crease 400.

[0053] As shown in Fig. 15, the sheet S is folded along the first and second creases 400, 500. As above described, the machine of the present invention can fold the thin paper sheet S in the same direction as the fold-directions of the first and second creases 400, 500 (see Fig. 16A). As a result, the sheet S can be folded with good appearance because the folded portion of the sheet S can be sharp.

DESCRIPTION OF THE REFERENCE CHARACTERS

[0054]

- 1 creasing mechanism
- 2 folding mechanism
- 3 controller
- 45 creasing section
- 4 first creasing unit
- 40 first convex block
- 41 first concave block
- 42 first creasing drive mechanism
- 5 second creasing unit
- 50 second convex block
- 51 second concave block
- 52 second creasing drive mechanism

- 400 first crease
- 500 second crease
- 10 first conveying roller
- 100 first drive roller
- 5 101 first idle roller
- 11 second conveying roller
- 110 second drive roller
- 111 second idle roller
- 6 first folding unit
- 10 7 second folding unit
- 20 first folding roller
- 21 second folding roller
- 22 third folding roller
- 23 first folding knife
- 15 23a edge of the first folding knife
- 230 first folding knife drive mechanism
- 24 second folding knife
- 24a edge of the second folding knife
- 240 second folding knife drive mechanism
- 20 201 first gap
- 202 second gap
- 200 first press roller
- 210 second press roller
- 220 third press roller
- 25 12 motor
- 13 position sensor
- 121 first timing belt
- 122 second timing belt
- S sheet
- 30 S1 first surface of the sheet
- S2 second surface of the sheet
- F first conveying direction
- F' second conveying direction

Claims

1. A creasing and folding machine, comprising:

- 40 a creasing mechanism for forming a plurality of creases on a sheet;
- a folding mechanism for receiving the sheet from the creasing mechanism and folding the sheet along the creases; and
- 45 a controller for controlling operations of the creasing mechanism and the folding mechanism; wherein the creasing mechanism comprises:
 - 50 a conveying roller for conveying the sheet; and
 - a creasing section for creasing the sheet which is delivered from the conveying roller; wherein
 - 55 the folding mechanism comprises:
 - a plurality of folding knives for pressing the

- sheet along the creases at edges of the folding knives; and
 a plurality of pairs of folding rollers each of which is composed of two folding rollers disposed opposite to each other with a gap therebetween, the gaps being opposite to the edges of the folding knives; wherein
- the sheet is pressed by the folding knives so as to be inserted into the gaps and folded along the creases; wherein
 the creasing section comprises:
- first and second creasing units aligned in a conveying direction of the sheet; wherein
- the first creasing unit comprises:
- a first convex block opposite to a first surface of the sheet; and
 a first concave block opposite to a second surface of the sheet, the first convex and concave blocks being moved toward each other so as to form a first crease of the creases which provides a recess on the first surface of the sheet and a protrusion on the second surface of the sheet; and wherein
- the second creasing unit comprises:
- a second concave block opposite to the first surface of the sheet; and
 a second convex block opposite to the second surface of the sheet, the second recess and convex blocks being moved toward each other so as to form a second crease of the creases which provides a protrusion on the first surface of the sheet and a recess on the second surface of the sheet.
2. The creasing and folding machine according to claim 1, wherein
 when the sheet is a heavy paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the folding knives press a protrusion side of the first or second crease.
3. The creasing and folding machine according to claim 1, wherein
 when the sheet is a thin paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the folding knives press a recess side of the first or second crease.
4. The creasing and folding machine according to claim 1, wherein
 the folding mechanism comprises:

- the pairs of the folding rollers including two folding roller pairs, a first folding roller pair of the two folding roller pairs composed of a first folding roller and a second folding roller, and a second folding roller pair of the two folding roller pairs composed of the second folding roller and a third folding roller;
- and
 the folding knives including first and second folding knives; wherein
 a first folding unit is composed of the first folding roller pair and the first folding knife, wherein
 a second folding unit is composed of the second folding roller pair and the second folding knife, wherein
 the first folding unit folds the sheet in such a way that the first folding knife presses the first or second crease from the second surface of the sheet to the first surface of the sheet and inserts the sheet into the gap between the first and second folding rollers, wherein
 the second folding unit folds the sheet in such a way that the second folding knife presses the first or second crease from the first surface of the sheet to the second surface of the sheet and inserts the sheet into the gap between the second and third folding rollers, and wherein
 when the sheet is a heavy paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the second creasing unit forms the second crease after the first creasing unit forming the first crease, and the first folding knife presses the protrusion side of the first crease, and then the second folding knife presses the protrusion side of the second crease.
5. The creasing and folding machine according to claim 1, wherein
 the folding mechanism comprises:
- the pairs of the folding rollers including two folding roller pairs, a first folding roller pair of the two folding roller pairs composed of a first folding roller and a second folding roller, and a second folding roller pair of the two folding roller pairs composed of the second folding roller and a third folding roller;
- and
 the folding knives including first and second folding knives; wherein
 a first folding unit is composed of the first folding roller pair and the first folding knife, wherein
 a second folding unit is composed of the second folding roller pair and the second folding knife, wherein
 the first folding unit folds the sheet in such a way that the first folding knife presses the first or second crease from the second surface of the sheet to the

first surface of the sheet and inserts the sheet into the gap between the first and second folding rollers, wherein

the second folding unit folds the sheet in such a way that the second folding knife presses the first or second crease from the first surface of the sheet to the second surface of the sheet and inserts the sheet into the gap between the second and third folding rollers, and wherein

when the sheet is a thin paper sheet, the controller controls the creasing and the folding mechanisms in such a way that the first creasing unit forms the first crease after the second creasing unit forming the second crease, and the first folding knife presses the recess side of the second crease, and then the second folding knife presses the recess side of the first crease.

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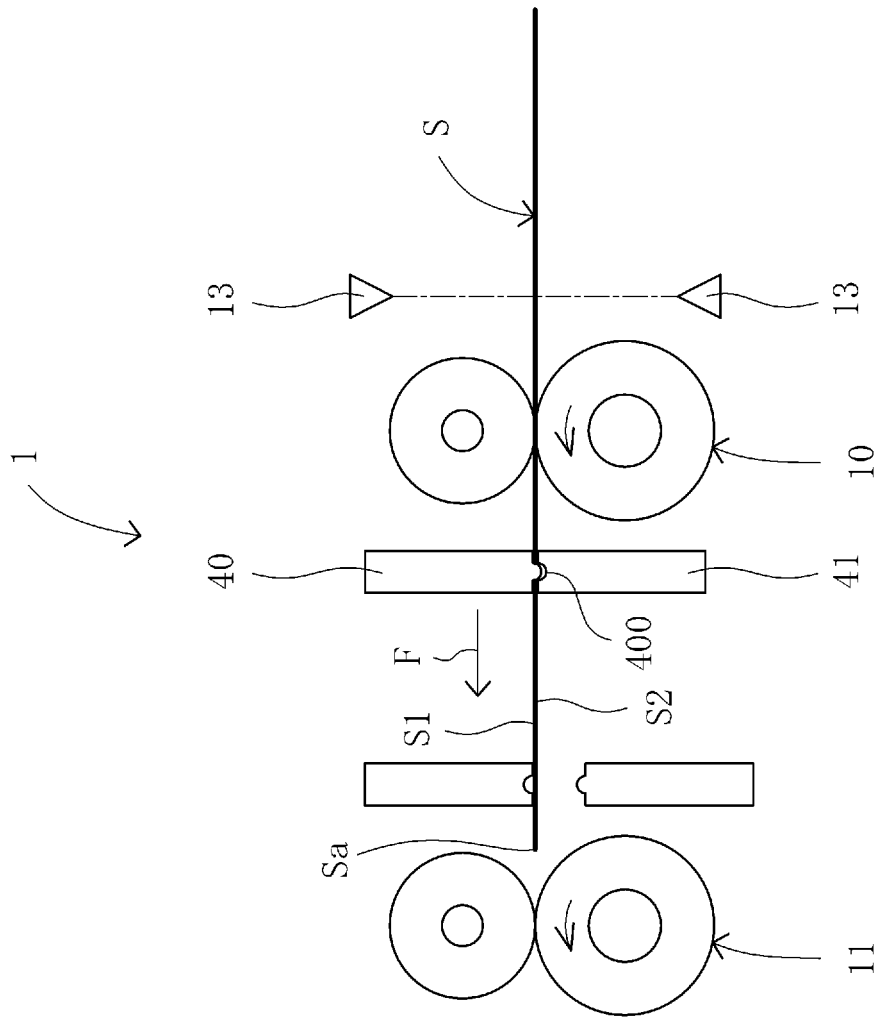


Fig. 2

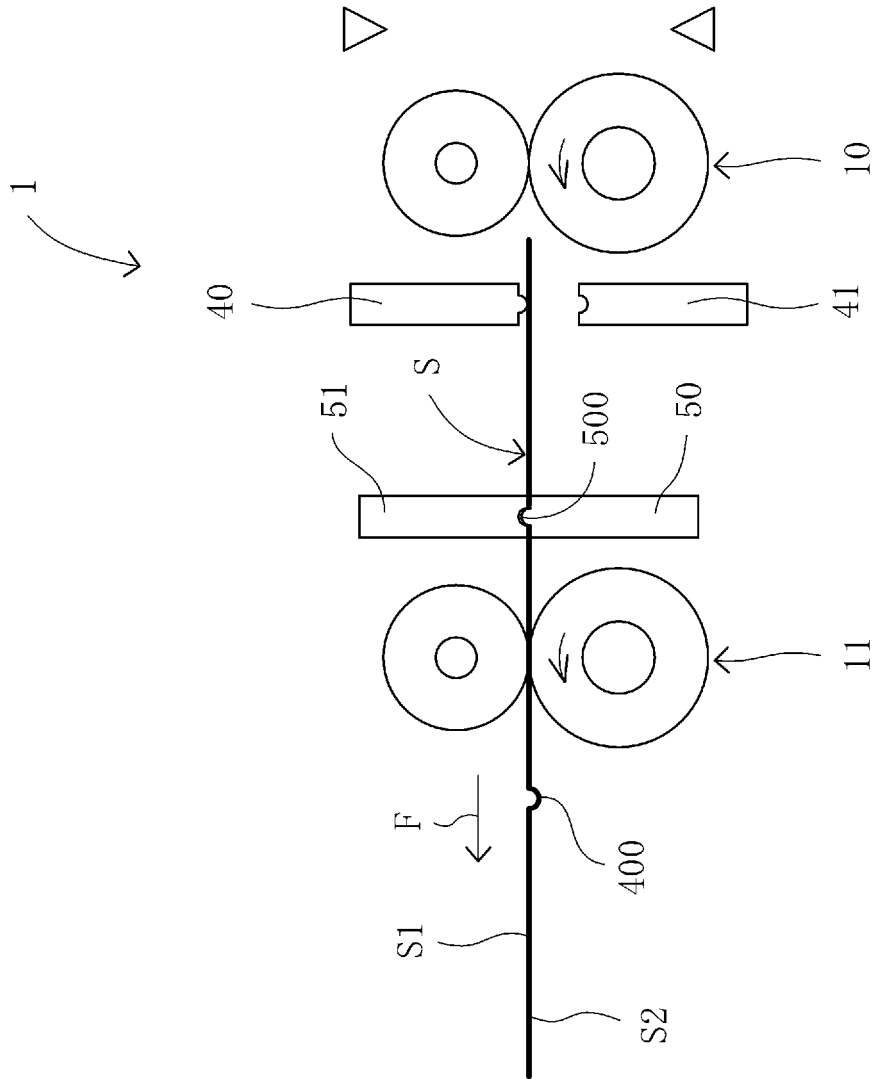


Fig. 3

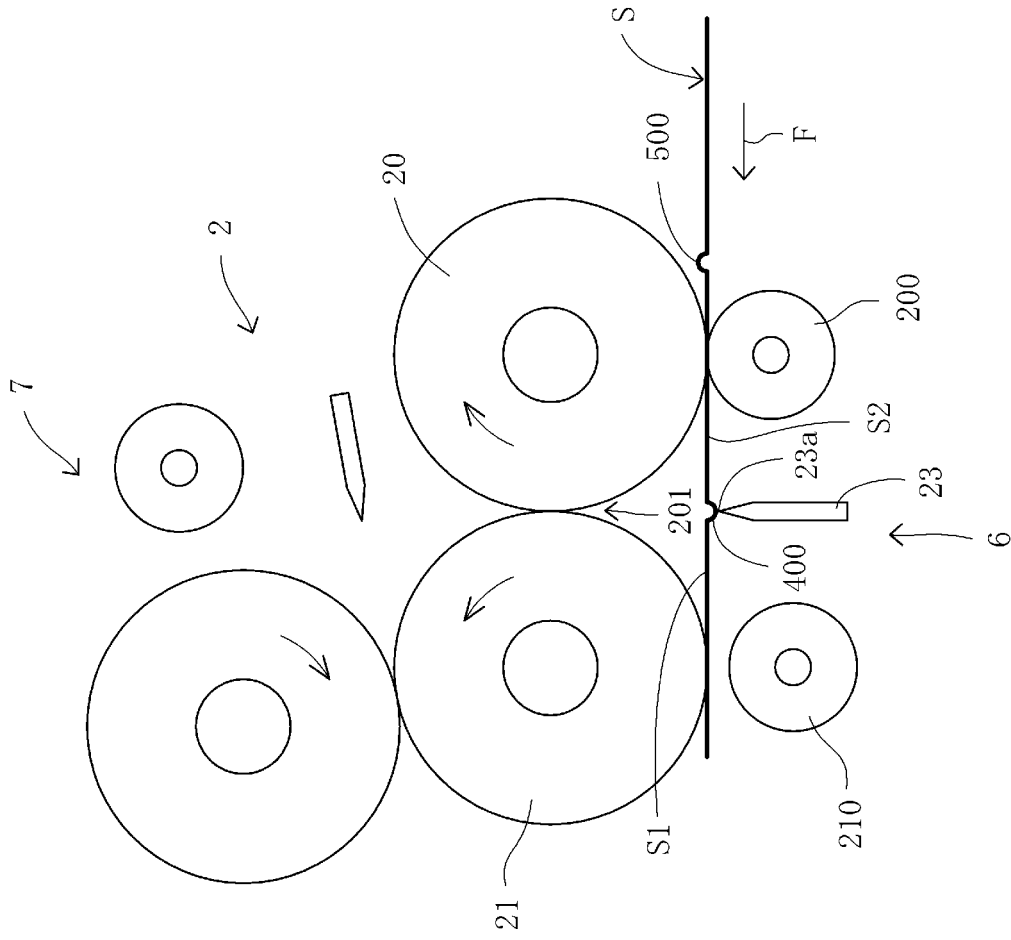


Fig. 4

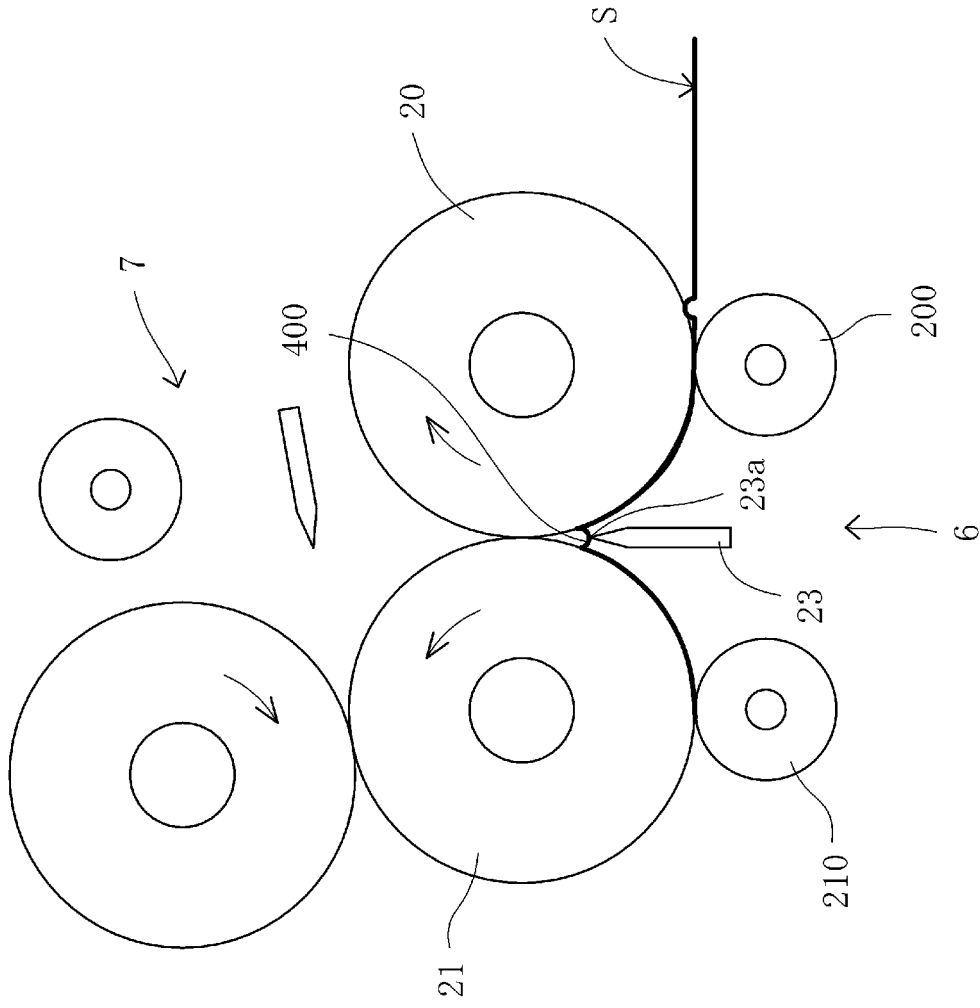


Fig. 5

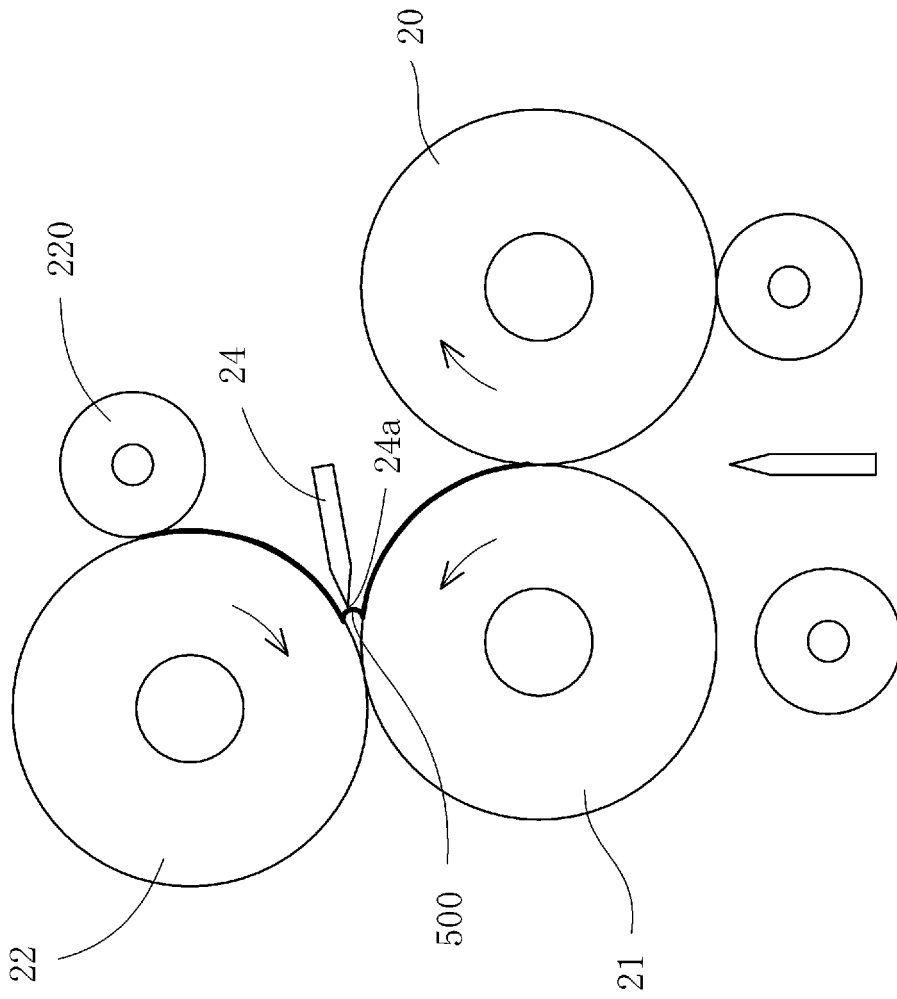


Fig. 7

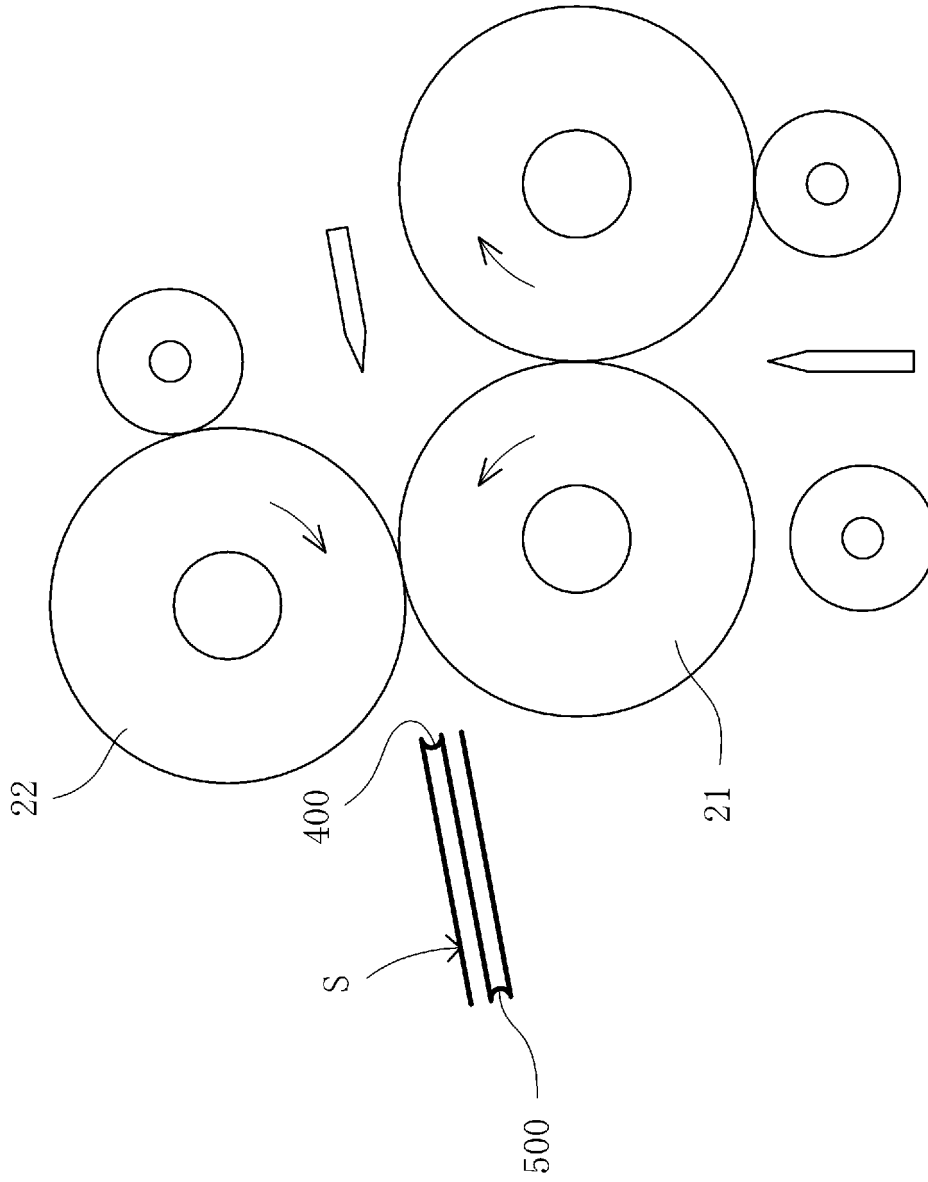


Fig. 8

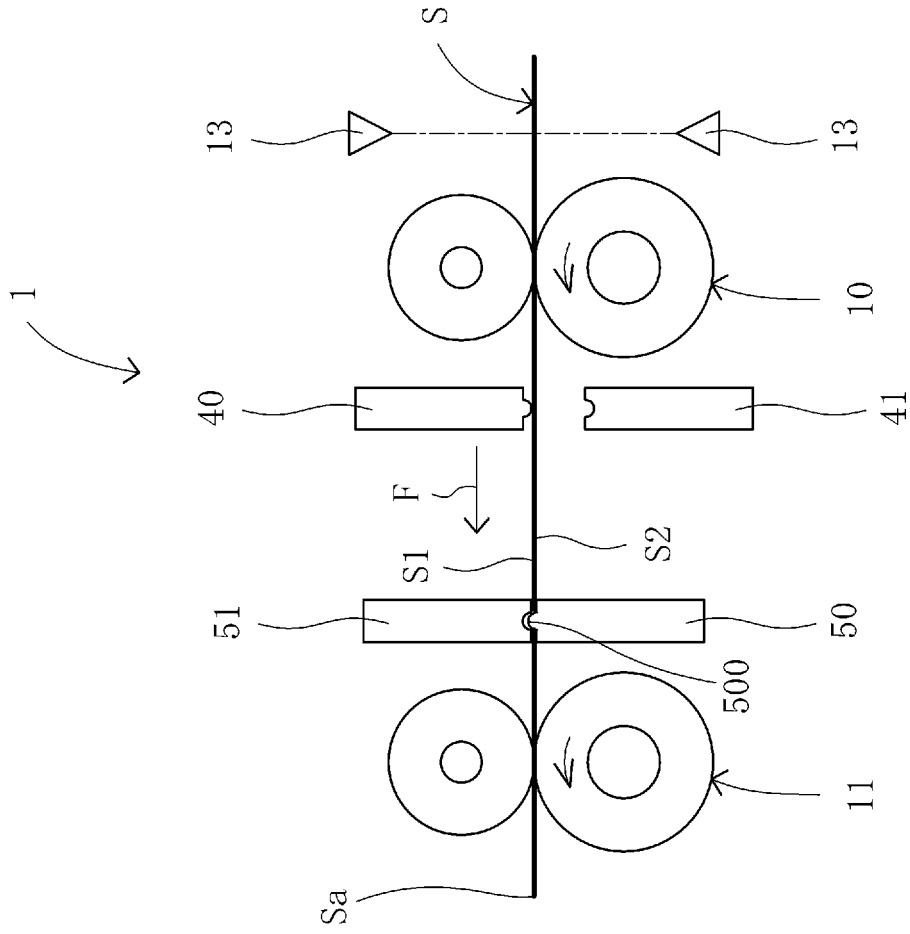


Fig. 9

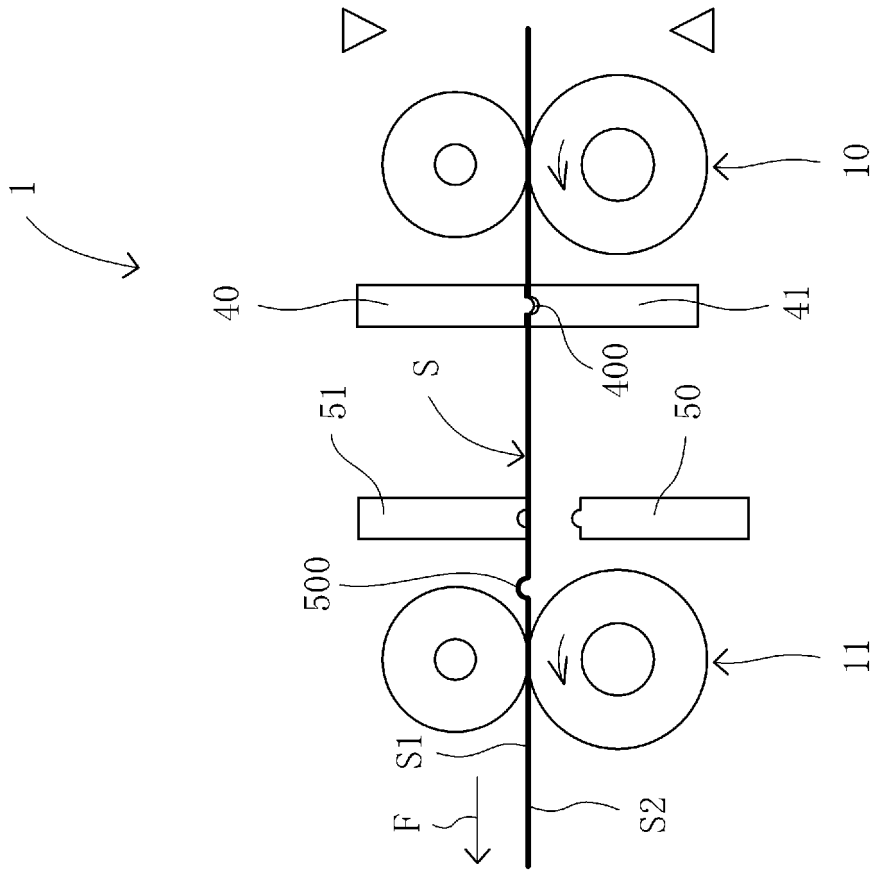


Fig. 10

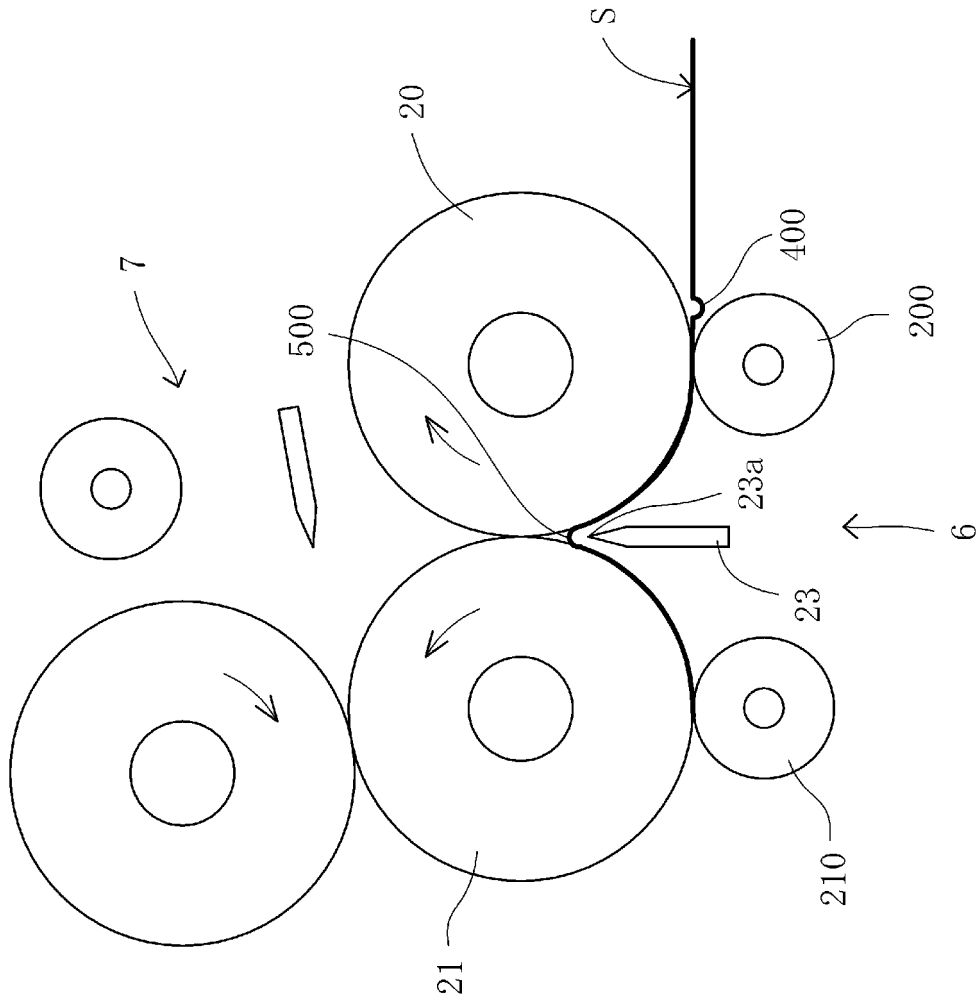


Fig. 12

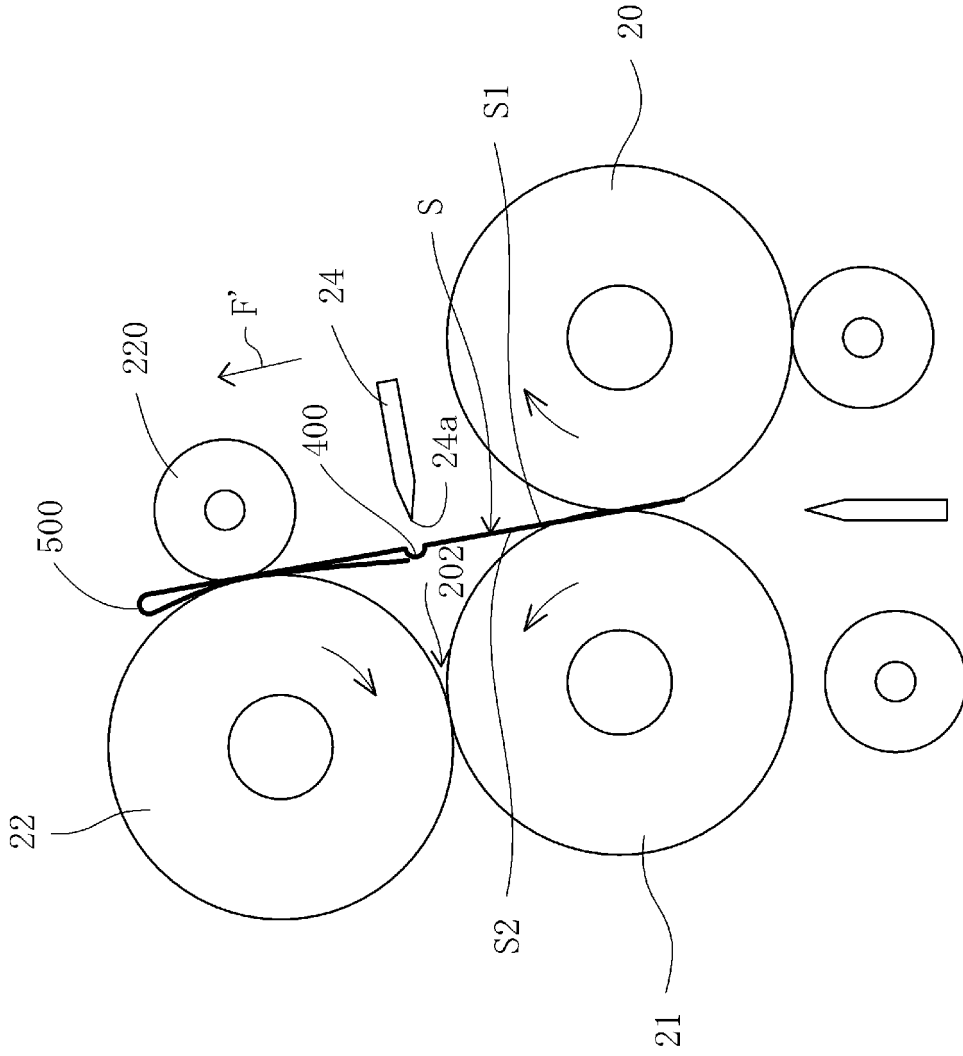


Fig. 13

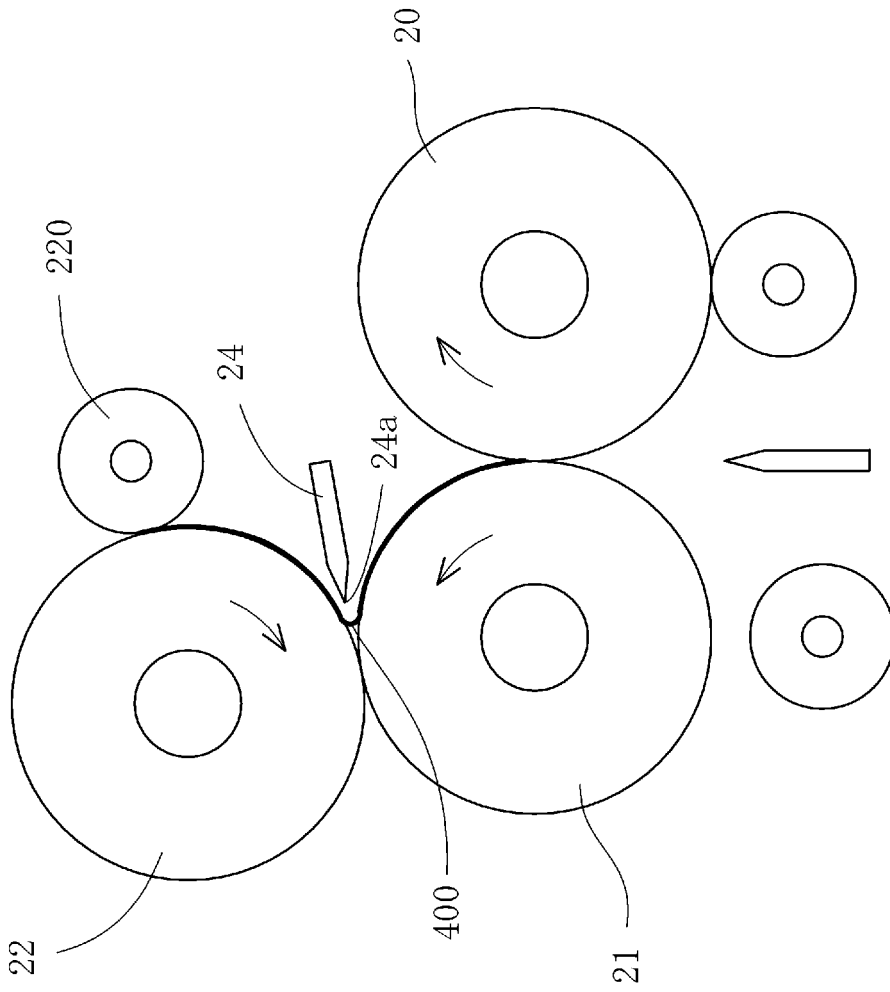


Fig. 14

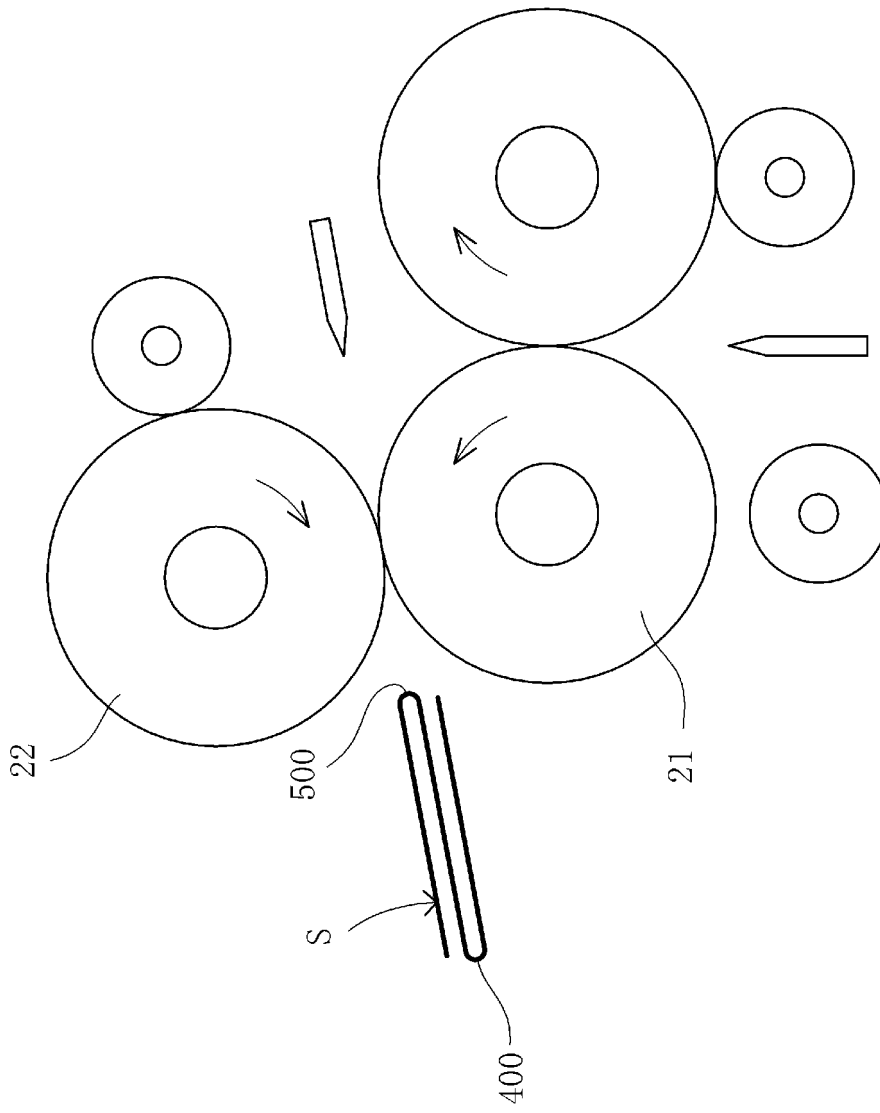
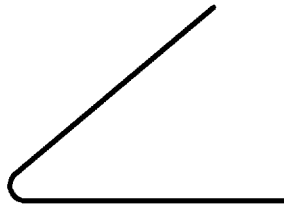


Fig. 15

(A)



(B)

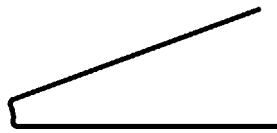


Fig. 16

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/061537

5	A. CLASSIFICATION OF SUBJECT MATTER B65H45/30 (2006.01) i		
	According to International Patent Classification (IPC) or to both national classification and IPC		
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B65H45/30		
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2012 Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012		
20	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
25	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
30	Category*	Citation of document, with indication, where appropriate, of the relevant passages	
35		Relevant to claim No.	
	A	DE 10118133 A1 (WEINMANN Karlheinz), 24 October 2002 (24.10.2002), fig. 1 to 2 (Family: none)	1-5
	A	JP 2011-105494 A (Ricoh Co., Ltd.), 02 June 2011 (02.06.2011), paragraphs [0015] to [0032]; fig. 7 (Family: none)	1-5
40	<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
50	Date of the actual completion of the international search 24 May, 2012 (24.05.12)	Date of mailing of the international search report 05 June, 2012 (05.06.12)	
55	Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.	

Form PCT/ISA/210 (second sheet) (July 2009)

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- EP 1425239 B [0009]