(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 705 429 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.09.2020 Bulletin 2020/37

(21) Application number: **17930316.9**

(22) Date of filing: **02.11.2017**

(51) Int Cl.:
B65H 45/18 *(2006.01)* ***B65H 7/14*** *(2006.01)*
B65H 45/16 *(2006.01)* ***B65H 45/22*** *(2006.01)*

(86) International application number:
PCT/JP2017/039737

(87) International publication number:
WO 2019/087354 (09.05.2019 Gazette 2019/19)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Horizon International Inc.**
Takashima-shi, Shiga 520-1501 (JP)

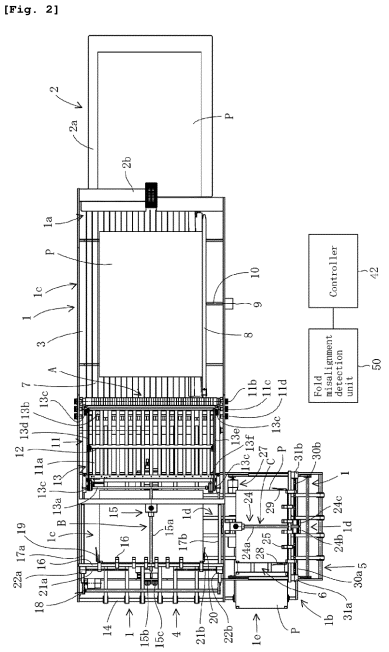
(72) Inventors:
- **YAMAMOTO Hiroki**
  Takashima-shi
  Shiga 520-1501 (JP)
- **WATANABE Shinya**
  Takashima-shi
  Shiga 520-1501 (JP)
- **NAKAMURA Yoshikazu**
  Takashima-shi
  Shiga 520-1501 (JP)
- **WAKIMOTO Shigeru**
  Takashima-shi
  Shiga 520-1501 (JP)
- **TABUCHI Hideaki**
  Takashima-shi
  Shiga 520-1501 (JP)

(74) Representative: **Gritschneder, Sebastian et al**
Abitz & Partner
Patentanwälte mbB
Arabellastraße 17
81925 München (DE)

(54) PAPER FOLDING MACHINE

(57) A paper folding machine comprising folding mechanisms (11, 15, 24) arranged at folding positions (A-C) on a transport path (1), respectively, guides (8, 19, 20, 28, 29) positioning a paper sheet (P) relative to the folding positions by engagement with at least one side edge of the paper sheet, stoppers (12, 16, 25) stopping and positioning the paper sheet at the folding positions by bringing a leading edge of the paper sheet into contact with the stoppers, a fold misalignment detection unit (50) detecting a fold misalignment amount of the paper sheet for each folding position, and a controller (42) controlling positions of the guides and stoppers. The controller calculates, for each folding position, an average fold misalignment amount using detection data corresponding to a predetermined number of sample whenever the number of detection data received from the fold misalignment detection unit reaches, for each folding position, a predetermined number of sample, and adjusts the position of the guide and/or stopper associated with the corresponding folding position so as to correct fold misalignment corresponding to the average fold misalignment amount.

[Fig. 2]



EP 3 705 429 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a paper folding machine designed to fold a printed paper sheet along one or more fold lines preset on a printing surface of the printed paper sheet so as to form a signature.

BACKGROUND ART

[0002] In a bookbinding process, normally, paper sheets printed through imposition are folded along one or more fold lines preset on a printing surface thereof and thereby signatures are formed, and then the signatures are gathered into a book block. In this case, in order to form the signatures from the printed paper sheets, a paper folding machine is used.

[0003] As this kind of paper folding machine, there is one disclosed in, for example, Patent Document 1.

[0004] The paper folding machine disclosed in Patent Document 1 comprises a paper feeding section, a transport section connected to a downstream side of the paper feeding section, and first through third folding sections connected to a downstream side of the transport section.

[0005] The paper feeding section has a shelf arranged for up-and-down movement and supporting a paper stack thereon, and a paper feed rotor feeding the uppermost paper sheet of the paper stack on the shelf one by one to the transport section.

[0006] The transport section has a conveyor belt transporting the paper sheet fed from the paper feeding section to the first folding section, and a positioning ruler arranged parallel with a transport direction for positioning the paper sheet during transport. The conveyor belt is arranged at an angle to the positioning ruler and thereby, the paper sheet is transported by the conveyor belt while one side of the paper sheet being aligned along the positioning ruler. The positioning ruler can be moved by a motor in a direction perpendicular to the transport direction.

[0007] The first folding section folds the paper sheet in a direction perpendicular to the transport direction. The first folding section is provided with a buckle and a set of rollers arranged at an entrance of the buckle and extended in the direction perpendicular to the transport direction. A first stopper is arranged in a paper insertion gap of the buckle for positioning the paper sheet at a predetermined folding position by bringing a leading edge of the paper sheet into contact with the first stopper when the paper sheet is inserted into the buckle.

[0008] A portion from the leading edge to a fold position of the paper sheet is inserted to the buckle, whereas a subsequent portion of the paper sheet is inserted between a pair of the rollers, so that the paper sheet is folded in the direction perpendicular to the transport direction. Thereafter, the paper sheet is fed to the second folding section through a gear for applying a perforated line to the paper sheet.

[0009] The second folding section folds the paper sheet in the transport direction. The second folding section is provided with a first folding knife arranged at a position aligned with the gear for up-and-down movement and extending in the transport direction, a pair of first folding rollers arranged beneath the first folding knife and extended parallel to the first folding knife, and a second stopper arranged downstream of the first folding knife and extending at a right angle to the transport direction so as to contact with a leading edge of the paper sheet fed from the first folding section.

[0010] A position of the second stopper can be adjusted independently in the transport direction and the direction perpendicular to the transport direction.

[0011] First and second guides are attached to both ends of the second stopper and extended parallel with the first folding knife. The first guide functions as a reference guide for positioning the paper sheet in the direction perpendicular to the transport direction, and the second guide pushes the paper sheet fed to the second folding section against the first guide by the elastic biasing force of a spring.

[0012] The paper sheet fed from the first folding section is stopped by the second stopper, and positioned by the first and second guides in a manner such that the perforated line of the paper sheet is aligned with the first folding knife. Thereafter, the first folding knife moves downward and the paper sheet is inserted between the pair of first folding rollers so as to be folded in the transport direction, and the folded paper sheet is fed to the third folding section.

[0013] The third folding section folds the paper sheet fed from the second folding section in a second transport direction (a transport direction perpendicular to the transport direction from the paper feeding section to the second folding section). The third folding section is provided with a second folding knife arranged for up-and-down movement and extended in the second transport direction, a pair of second folding rollers arranged beneath the second folding knife and extended parallel with the second folding knife, and a third stopper arranged downstream of the second folding knife and extended at a right angle to the second transport direction so as to contact with a leading edge of the paper sheet fed from the second folding section.

[0014] A position of the third stopper can be adjusted independently in the second transport direction and the direction perpendicular to the second transport direction.

[0015] Third and fourth guides are attached to both ends of the third stopper and extended parallel with the second

folding knife. The third guide functions as a reference guide for positioning the paper sheet in the direction perpendicular to the second transport direction, and the fourth guide pushes the paper sheet fed to the third folding section against the third guide by the elastic biasing force of a spring.

[0016] The paper sheet fed from the second folding section is stopped by the third stopper, and positioned by the third and fourth guides. Thereafter, the second folding knife moves downward, and the paper sheet is inserted between the pair of second folding rollers and folded in the second transport direction, and a signature is formed. The signature is discharged from the paper folding machine.

[0017] By the way, even if paper sheets are classified into the same standard size, the actual dimensions of the paper sheets are not always the same. Furthermore, in a rotary press such as a rotary offset press, cut positions of a roll paper fluctuate when the roll paper is cut into paper sheets after printing on the roll paper, so that the size of each paper sheet varies.

[0018] In addition, positions of printing surfaces of paper sheets fluctuate during printing of the paper sheets.

[0019] Because of that, a fold misalignment of a paper sheet arises during operation of a paper folding machine. In this case, the obtained signature is considered a finished product when a fold misalignment amount is within the allowable range on the one hand, and the obtained signature is considered a defective product and excluded when the fold misalignment amount exceeds the allowable range. This is carried out by visual inspection of a worker each time the signature is discharged from the paper folding machine.

[0020] Thus whenever the defective product is detected, the paper folding machine is stopped and the positions of the positioning ruler, the first through third stoppers, and the first and third guides are adjusted by the worker. This adjustment is done by adjusting the position(s) of the corresponding one(s) of the positioning ruler, the first through third stoppers, and the first and third guides depending on the fold misalignment amount of the defective product in such a way that the fold misalignment amount becomes as small as possible within the allowable range while considering the degree of the variation in both the dimensions of the paper sheet and the position of printing surface of the paper sheet.

[0021] However, this work takes time and effort. Furthermore, this work is based on the experience and intuition of a worker and therefore, requires skilled workers. Accordingly, this work was an obstacle to productivity increase and cost down.

[0022] In this regard, an apparatus automatically detecting a fold misalignment amount of a paper sheet has been proposed in the prior art. This apparatus has at least one inspection mark provided on a printed paper sheet and extended across at least one fold line, and at least one CCD camera attached to a paper folding machine so as to detect the at least one inspection mark (see, for example, Patent Document 2).

[0023] The at least one CCD camera is arranged at each of at least one folding position of the paper folding machine so as to shoot the at least one inspection mark of the paper sheet folded at the previous folding position each time the paper sheet stops at the folding position.

[0024] Then a position, a length and an area of the inspection mark obtained by the CCD camera are compared with a position, a length and an area of the inspection mark of the paper sheet folded without fold misalignment, respectively and thereby a fold misalignment amount is detected automatically.

[0025] However, even if a fold misalignment amount of a paper sheet is automatically detected, whenever a fold misalignment amount exceeding the allowable range is detected, the corresponding members need to be adjusted manually as before, and therefore productivity does not increase significantly and no significant cost reduction is achieved.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0026]

Patent Document 1: JP 2007-261726 A
Patent Document 2: JP H7-277593 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0027] It is, therefore, an object of the present invention to provide a paper folding machine capable of automatically detecting fold misalignment and automatically carry out adjustment for correction of the fold misalignment.

MEANS FOR SOLVING THE PROBLEMS

[0028] In order to solve the object, the present invention provides a paper folding machine folding a printed paper sheet along at least one fold line preset on a printing surface of the paper sheet so as to form a signature, the paper folding machine comprising: a transport path for the paper sheet having an entrance, an exit and at least one folding position which is provided in an intermediate area of the transport path; at least one transport mechanism transporting the paper sheets one by one along the transport path between the entrance and a most upstream folding position, and between adjacent folding positions, and between a most downstream folding position and the exit; a folding mechanism arranged at each of the at least one folding position so as to fold the paper sheet along the associated fold line while the paper sheet is stopped at the associated folding position; at least one adjustable guide positioning the paper sheet relative to the at least one folding position by bringing at least one side of the paper sheet into contact with the at least one adjustable guide; an adjustable stopper arranged downstream of each of the at least one folding position so as to position and stop the paper sheet at the associated folding position by bringing a leading edge of the paper sheet into contact with the stopper; and a fold misalignment detection unit detecting, for each paper sheet and for each folding position, a fold misalignment amount, wherein the position of the at least one guide and/or the stopper associated with the corresponding folding position is adjusted based on detection data of the fold misalignment detection unit, characterized in that the paper folding machine further comprises: a drive mechanism capable of moving the at least one adjustable guide and the stopper; and a controller operatively connected to the drive mechanism, wherein the controller comprises a data receiving section receiving the detection data from the fold misalignment detection unit, a data counting section counting, for each folding position, the number of the detection data received by the data receiving section, a data storage section storing, for each folding position, the detection data received by the data receiving section, a statistical processing section calculating, for each folding position, an average fold misalignment amount using the detection data corresponding to a predetermined number of sample each time the number of detection data stored in the data storage section reaches, for each folding position, the number of sample, and an adjustment section adjusting the position of the at least one guide and/or the stopper associated with the corresponding folding position so as to correct fold misalignment corresponding to the average fold misalignment amount each time the average fold misalignment amount is calculated by the statistical processing section.

[0029] According to a preferred embodiment of the present invention, the controller further comprises a misalignment tolerance storage section storing, for each folding position, the average fold misalignment amount as a misalignment tolerance, data stored in the misalignment tolerance storage section being updated each time the average fold misalignment amount is calculated by the statistical processing section, and a folding failure check section operatively connected to the at least one transport mechanism and the folding mechanism, and comparing the detection data with the misalignment tolerance each time the detection data is received by the data receiving section, and stopping the at least one transport mechanism and the folding mechanism when the detection data exceeds the misalignment tolerance.

[0030] According to another preferred embodiment of the present invention, the paper folding machine further comprises a collection unit arranged downstream of the most downstream folding position on the transport path or at the exit of the transport path for collecting the paper sheet with folding failure, wherein the controller further comprises a misalignment tolerance storage section storing, for each folding position, the average fold misalignment amount as a misalignment tolerance, data stored in the misalignment tolerance storage section being updated each time the average fold misalignment amount is calculated by the statistical processing section, and a folding failure check section operatively connected to the collection unit, and comparing the detection data with the misalignment tolerance each time the detection data is received by the data receiving section, and collecting the corresponding paper sheet in the collection unit when the detection data exceeds the misalignment tolerance.

[0031] According to further preferred embodiment of the present invention, the statistical processing section of the controller calculates, for each folding position, a standard deviation of the fold misalignment amount using the average fold misalignment amount and the detection data corresponding to the number of sample each time the number of the detection data stored in the data storage section reaches, for each folding position, the number of sample, and further calculates a variation judgement value of fold misalignment based on the standard deviation, wherein the controller further comprises a folding failure check section operatively connected to the at least one transport mechanism and the folding mechanism, and comparing the variation judgement value with a predetermined misalignment tolerance each time the variation judgement value is calculated by the statistical processing section, and stopping the at least one transport mechanism and the folding mechanism when the variation judgement value exceeds the misalignment tolerance.

[0032] According to further preferred embodiment of the present invention, the paper folding machine further comprises a collection unit arranged downstream of the most downstream folding position on the transport path or at the exit of the transport path for collecting the paper sheet with folding failure, wherein the statistical processing section of the controller calculates, for each folding position, a standard deviation of the fold misalignment amount using the average fold misalignment amount and the detection data corresponding to the number of sample each time the number of the detection

data stored in the data storage section reaches, for each folding position, the number of sample, and further calculates a variation judgement value of fold misalignment based on the standard deviation, wherein the controller further comprises a folding failure check section operatively connected to the collection unit, and comparing the variation judgement value with a predetermined misalignment tolerance each time the variation judgement value is calculated by the statistical processing section, and collecting the corresponding paper sheet in the collection unit when the variation judgement value exceeds the misalignment tolerance.

EFFECT OF THE INVENTION

[0033] According to the present invention, the fold misalignment amount of the paper sheet is automatically detected for each folding position during operation of the paper folding machine, and, for each folding position, each time the obtained detection data reaches the predetermined number of sample, the average fold misalignment amount is calculated and the corresponding stopper and/or guide are(is) automatically adjusted using the calculated average fold misalignment amount. Accordingly, the amount of work for workers is greatly reduced and the work does not require skill, and thereby, productivity is dramatically improved and significant cost reductions can be achieved.

[0034] In addition, according to the present invention, the adjustment of the paper folding machine is carried out in a manner such that the fold misalignment amounts are statistically minimized while considering the fold misalignment amount within the allowable range as well as the fold misalignment amount exceeding the allowable range. Consequently, the adjustment accuracy is improved so that the incidence of defective products is further reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

Fig. 1 is a perspective view of a paper folding machine according to an embodiment of the present invention.
Fig. 2 is a plan view of the paper folding machine shown in Fig. 1.
Fig. 3 is a perspective view illustrating a detailed configuration near second and third folding positions of the paper folding machine shown in Fig. 1.
Fig. 4 is a block diagram illustrating a configuration of a fold misalignment detection unit of the paper folding machine shown in Fig. 1.
Fig. 5A is a block diagram illustrating a configuration of a controller of the paper folding machine shown in Fig. 1.
Figs. 5B and 5C are block diagrams illustrating of modified examples of the controller shown in Fig. 5A.
Fig. 6A is a plan view of a paper sheet folded without fold misalignment by the paper folding machine shown in Fig. 1.
Figs. 6B and 6C are plan views of paper sheets folded with fold misalignment by the paper folding machine shown in Fig. 1.

BEST MODE FOR CARRYING OUT THE INVENTION

[0036] A preferred embodiment of the present invention will be explained below with reference to accompanying drawings.

[0037] Generally, there are two types of fold misalignment of paper sheet which occur in a paper folding machine, that is, fold misalignment parallel with a fold line and fold misalignment oblique to the fold line. For simplicity of explanation, in the following, an embodiment in which only the fold misalignment parallel with the fold line occurs will be taken up.

[0038] Fig. 1 is a perspective view of a paper folding machine according to an embodiment of the present invention, and Fig. 2 is a plan view of the paper folding machine shown in Fig. 1. Fig. 3 is a perspective view illustrating a detailed configuration near second and third folding positions of the paper folding machine shown in Fig. 1.

[0039] Referring to Fig. 1 through Fig. 3, a paper folding machine according to the present invention comprises a transport path 1 for the paper sheet having an entrance 1a, an exit 1b. A first folding position (A), a second folding position (B) and a third folding position (C) are provided in an intermediate area of the transport path 1.

[0040] In this embodiment, the transport path 1 is composed of a first portion 1c almost straightly extending from the entrance 1a to the second folding position (B) through the first folding position (A), a second portion 1d extending from the second folding position (B) to the third folding position (C) in a direction perpendicular to the first portion 1c, and a third portion 1e straightly extending from the third folding position (C) to the exit 1b in a direction perpendicular to the second portion 1d.

[0041] In this embodiment, a paper feeding device 2 is connected to the entrance 1a of the transport path 1 so as to supply paper sheets P one by one to the paper folding machine of the present invention.

[0042] The paper feeding device 2 has a shelf 2a arranged for up-and-down movement and supporting a paper stack thereon, and a paper feed rotor 2b feeding the uppermost paper sheet P of the paper stack on the shelf 2a one by one.

[0043] In the present invention, the paper sheet P is printed in page order through imposition and folded along fold lines preset on its printing surface to form a signature.

[0044] Marks (M) for detection of fold misalignment are provided on sides of the paper sheet P which are mountain-folded along the fold lines, and extend across the related fold lines. The marks (M) are printed on a page margin outside the printing surface of the paper sheet when the paper sheet is printed.

[0045] The paper folding machine also comprises a first transport mechanism 3 transporting the paper sheets P one by one along the transport path 1 (the first portion 1c) from the entrance 1a to the first folding position (A), a second transport mechanism 4 transporting the paper sheets P one by one along the transport path 1 (the first portion 1c) from the first folding position (A) to the second folding position (B), a third transport mechanism 5 transporting the paper sheets P one by one along the transport path 1 (the second portion 1d) from the second folding position (B) to the third folding position (C) and a fourth transport mechanism 6 transporting the paper sheets P one by one along the transport path 1 (the third portion 1e) from the third folding portion (C) to the exit 1b.

[0046] The first transport mechanism 3 has a plurality of first conveyor belts 7 extending between the entrance 1a and the first folding position (A) on the transport path 1 (the first portion 1c).

[0047] A first guide (positioning ruler) 8 is arranged at a side of the transport path 1 (the first portion 1c) and extended parallel with the transport path 1 (the first portion 1c). The first guide 8 positions the paper sheet P relative to the first folding position (A) by engaging with a side edge of the paper sheet P transported by the first transport mechanism 3.

[0048] The first conveyor belt 7 adjacent to the first guide 8 of the plurality of the first conveyor belts 7 is inclined to gradually approach to the first guide 8 toward the downstream side, whereas the remaining first conveyor belt(s) 7 extend(s) parallel with the transport path 1 (the first portion 1c).

[0049] Thereby, the paper sheet P is transported by the first conveyor belts 7 while the side edge of the paper sheet P being aligned along the first guide 8.

[0050] The first guide 8 is slidably guided in a direction perpendicular to the transport path 1 (the first portion 1c). An intermediate portion of the first guide 8 is screwed onto a first screw shaft 10 which can be rotated around an axis thereof by a first motor 9. A position of the first guide 8 can be adjusted by forward and reverse rotation of the first motor 9.

[0051] A first folding mechanism 11 is arranged at the first folding position (A) for folding the paper sheet P in a direction perpendicular to the transport direction.

[0052] The first folding mechanism 11 has a buckle 11a and a set of rollers 11b-11d arranged at a bottom entrance of the buckle 11a.

[0053] The buckle 11a is provided with a first stopper 12. The first stopper 12 positions and stops the paper sheet P at the first folding position (A) by bringing a leading edge of the paper sheet P into contact with the first stopper 12 when the paper sheet P is inserted into the buckle 11a.

[0054] The first stopper 12 is attached to the buckle 11a so as to slide in a length direction of the buckle 11a, and attached to a first belt drive mechanism 13. Accordingly, a position of the first stopper 12 is adjustable in the length direction of the buckle 11a.

[0055] The first belt drive mechanism 13 is composed of a pair of horizontal pulley shafts 13a, 13b extending in a width direction of the buckle 11a, a pair of endless belts 13d, 13e extended between the pair of pulley shafts 13a, 13b through pulleys 13c, and a second motor 13f capable of rotating the pulley shaft 13a.

[0056] The first stopper 12 is fixed to the endless belts 13d, 13e and moved in the length direction of the buckle 11a by rotation of the endless belts 13d, 13e caused by drive of the second motor 13f.

[0057] The second transport mechanism 4 has a plurality of second conveyor belts 14 extended along the transport path 1 (the first portion 1c) between the first folding position (A) and the second folding position (B) on the transport path 1 and spaced from each other in a width direction of the transport path 1 (the first portion 1c).

[0058] A second folding mechanism 15 is arranged at the second folding position (B) so as to fold the paper sheet P in the transport direction.

[0059] The second folding mechanism 15 has a folding knife 15a arranged above the second folding position (B) for up-and-down movement and extending in the transport direction, a pair of first folding rollers 15b, 15c arranged beneath and opposite to the folding knife 15a and extended parallel to the folding knife 15a.

[0060] A second stopper 16 is arranged downstream of the second folding position (B) and extending at a right angle to the folding knife 15a (the transport direction) so as to stop and position the paper sheet P at the second folding position (B) by bring a leading edge of the paper sheet P into contact with the second stopper 16.

[0061] The second stopper 16 is slidably attached to a pair of slide guides 17a, 17b extending in the transport direction on both sides of the transport path 1 (the first portion 1c) and attached to a second belt drive mechanism 18. Accordingly, a position of the second stopper 16 is adjustable in the transport direction.

[0062] The second belt drive mechanism 18 is composed of a horizontal pulley shaft 18a arranged downstream of the second stopper 16 and extending at a right angle to the transport direction, pulleys 18b, 18c are attached to both ends of the pulley shaft 18a, pulleys 18d, 18e arranged upstream of and at a distance from the pulleys 18b, 19c, a pair of endless belts 18f, 18g extending between the pulleys 18b, 18c and the pulleys 18d, 18e, a third motor 18h, and an

endless belt 18i extending between a pulley on a drive shaft of the third motor 18h and the pulley 18b.

[0063] Both ends of the second stopper 16 are attached to the endless belts 18f, 18g, and thereby, the position of the second stopper 16 can be adjusted by the endless belts 18f, 18g being rotated by the third motor 18h.

[0064] Second and third guides 19, 20 extend at a right angle to the second stopper 16 from the second stopper 16 to an upstream side of the transport path 1 (the first portion 1c), and are attached to the second stopper 16 so as to slide in a length direction of the second stopper 16.

[0065] The second and third guides 19, 20 position the paper sheet P relative to the second folding position (B) by engaging with side edges of the paper sheet P during transport of the paper sheet P.

[0066] Second screw shafts 21a, 21b each of which extends parallel to the second stopper 16 are attached to both ends of the second stopper 16 so as to be rotatable around axes thereof, and drive shafts of fourth motors 22a, 22b attached to the second stopper 16 are connected to outer ends of the second screw shafts 21a, 21b.

[0067] The second and third guides 19, 20 are screwed onto the second screw shafts 21a, 21b, and positions of the second and third guides 19, 20 can be adjusted by forward and reverse rotations of the fourth motors 22a, 22b.

[0068] The third transport mechanism 5 has a plurality of third conveyor belts 23 extended in the transport direction between the second and third folding positions (B), (C) on the transport path 1 (the second portion 1d) and spaced from each other in a direction perpendicular to the transport direction.

[0069] A third folding mechanism 24 is arranged at the third folding position (C) so as to fold the paper sheet P in the transport direction.

[0070] The third folding mechanism 24 has a folding knife 24a arranged above the third folding position (C) for up-and-down movement and extending in the transport direction, a pair of first folding rollers 24b, 24c arranged beneath and opposite to the folding knife 24a and extended parallel to the folding knife 24a.

[0071] A third stopper 25 is arranged downstream of the third folding position (C) and extending at a right angle to the folding knife 24a (the transport direction) so as to stop and position the paper sheet P at the third folding position (C) by bring a leading edge of the paper sheet P into contact with the third stopper 25.

[0072] The third stopper 25 is slidably attached to a pair of slide guides 26a, 26b extending in the transport direction on both sides of the transport path 1 (the second portion 1d) and attached to a third belt drive mechanism 27. Accordingly, a position of the third stopper 25 is adjustable in the transport direction.

[0073] The third belt drive mechanism 27 is composed of a horizontal pulley shaft 27a arranged downstream of the third stopper 25 and extending at a right angle to the transport direction, pulleys 27b, 27c are attached to both ends of the pulley shaft 27a, pulleys 27d, 27e arranged upstream of and at a distance from the pulleys 27b, 27c, a pair of endless belts 27f, 27g extending between the pulleys 27b, 27c and the pulleys 27d, 27e, a fourth motor 27h, and an endless belt 27i extending between a pulley on a drive shaft of the fourth motor 27h and the pulley 27b.

[0074] Both ends of the third stopper 25 are attached to the endless belts 27f, 27g, and thereby, the position of the third stopper 25 can be adjusted by the endless belts 27f, 27g being rotated by the fourth motor 27h.

[0075] Fourth and Fifth guides 28, 29 extend at a right angle to the third stopper 25 from the third stopper 25 to an upstream side of the transport path 1 (the second portion 1d), and are attached to the third stopper 25 so as to slide in a length direction of the third stopper 25.

[0076] The fourth and fifth guides 28, 29 position the paper sheet P relative to the third folding position (C) by engaging with side edges of the paper sheet P during transport of the paper sheet P.

[0077] Third screw shafts 30a, 30b each of which extends parallel to the third stopper 25 are attached to both ends of the third stopper 25 so as to be rotatable around axes thereof, and drive shafts of fifth motors 31a, 31b attached to the third stopper 25 are connected to outer ends of the third screw shafts 30a, 30b.

[0078] The fourth and fifth guides 28, 29 are screwed onto the third screw shafts 30a, 30b, and positions of the fourth and fifth guides 28, 29 can be adjusted by forward and reverse rotations of the fifth motors 31a, 31b.

[0079] The fourth transport mechanism 6 has a plurality of fourth conveyor belts 32 extended in the transport direction between the third folding position (C) and the exit 1b on the transport path 1 (the third portion 1e), and spaced from each other in a direction perpendicular to the transport direction.

[0080] Thus the paper sheet P supplied from the paper feeding device 2 to the first conveyor belts 7 (the first transport mechanism 3) is transported by the first transport mechanism 3 to the first folding position (A) along the transport path 1 (the first portion 1c). During the transport, the paper sheet P is positioned relative to the first folding position (A) by the first guide (positioning ruler) 8.

[0081] At the first folding position (A), the paper sheet P is inserted into the buckle 11a by a pair of the rollers 11b, 11c, and stopped and positioned at the first folding position (A) by coming into contact with the first stopper 12 at the leading edge thereof. Next, a portion of the paper sheet P extending outward from the entrance of the buckle 11a is inserted between a pair of the rollers 11c, 11d so that the paper sheet P is folded in the direction perpendicular to the transport direction.

[0082] The folded sheet paper P falls on the second conveyor belts 14 (the second transport mechanism 5) and is transported by the second conveyor belts 14 to the second folding position (B).

[0083] The paper sheet P transported by the second conveyor belts 14 is stopped at the second folding position (B) by the second stopper 16 and positioned at the second folding position (B) by the second stopper 16 and the second and third guides 19, 20. Thereafter the folding knife 15a moves downward, and the paper sheet P is inserted between the pair of folding rollers 15b, 15c so as to be folded in the transport direction, and falls on the third conveyor belts 23 (the third transport mechanism 5) and is transported to the third folding position (C) by the third conveyor belts 23.

[0084] The paper sheet P transported by the third conveyor belts 23 is stopped at the third folding position (C) by t he third stopper 25 and positioned at the third folding position (C) by the third stopper 25 and the fourth and fifth guides 28, 29. Thereafter the folding knife 24a moves downward, and the paper sheet P is inserted between the pair of folding rollers 24b, 24c so as to be folded in the transport direction, and falls on the fourth conveyor belts 32 (the fourth transport mechanism 6) and is discharged from the exit 1b of the transport path 1 by the fourth conveyor belts 32.

[0085] The paper folding machine of the present invention further comprises a fold misalignment detection unit 50 detecting, for each paper sheet P and for each folding position (A)-(C), a fold misalignment amount.

[0086] Fig. 4 is a block diagram illustrating a configuration of the fold misalignment detection unit 50.

[0087] Referring to Figs. 4 and 3, the fold misalignment detection unit 50 comprises a first sensor 33 attached to the second stopper 16 of the second folding mechanism 15 so as to detect when the paper sheet P stops at the second folding position (B), first cameras 34 attached to the second stopper 16 so as to shoot the marks (M) associated with the first folding position (A) of the paper sheet P stopped at the second folding position (B), a second sensor 35 attached to the third stopper 25 of the third folding mechanism 24 so as to detect when the paper sheet P stops at the third folding position (C),second cameras 36 attached to the third stopper 25 so as to shoot the marks (M) associated with the second folding position (B) of the paper sheet P stopped at the third folding position (C).

[0088] The first cameras 34 perform shooting operation each time a detection signal is outputted form the first sensor 33, and the second cameras 36 perform shooting operation each time a detection signal is outputted from the second sensor 35.

[0089] The fold misalignment detection unit 50 also comprises a third sensor 37 arranged downstream of the third folding position (C) and above the transport path 1 (the third portion 1e) so as to detect passage of a leading edge of the paper sheet P and third cameras 38 arranged side by side with the third sensor 37 in a width direction of the transport path 1 (the third portion 1e) so as to shoot the marks (M) associated with the third folding position (C) of the paper sheet P.

[0090] The third cameras 38 perform shooting operation each time a detection signal is outputted from the third sensor 37.

[0091] The fold misalignment detection unit 50 further comprises a reference value storage section 39 storing as a reference value a value of area of the mark (M) in each of the images obtained by the first through third cameras 34, 36, 38 when the paper sheet P is folded without fold misalignment, and an image processing section 40 processing each of the images of the paper sheet P shot by the first through third cameras 34, 36, 38 so as to calculate an area of the mark (M) in each of the images of the paper sheet P.

[0092] In this case, the area calculation by the image processing unit 40 can be executed by a known appropriate image processing method. In this embodiment, for example, the mark (M) is separated as a blob from a background in the image using binarization processing and blob processing and then a value of area of the blob is measured.

[0093] The fold misalignment detection unit 50 further comprises a detection section 41 calculating a difference between the value of area calculated by the image processing section 40 and the corresponding reference value so as to detect a fold misalignment amount each time the value of area of the mark (M) is calculated by the image processing section 40, and outputting the detected fold misalignment amount.

[0094] A method of detection of the fold misalignment amount by the detection section 41 will be specifically explained with reference to the drawings.

[0095] Fig. 6A is a plan view of a paper sheet P0 folded without fold misalignment by the first folding mechanism 11. Figs. 6B and 6C are plan views of paper sheets P1, P2 folded with fold misalignment by the first folding mechanism 11.

[0096] Marks M0-M2 shown in Figs. 6A-6C are shot by the first cameras 34 when the paper sheets P0-P2 stop at the second folding position (B), respectively.

[0097] Referring to Fig. 6A, in the reference value storage section 39, a value of the mark (M0) in each of the images of the paper sheet P0 shot by the first cameras 34 is stored as the reference value in advance.

[0098] When the paper sheet P1 shown in Fig. 6B stops at the second folding position (B) and is shot by the first cameras 34, a value of area of the mark (M1) in each of images of the paper sheet P1 is outputted from the image processing section 40. Then the detection section 41 subtracts the corresponding reference value from the value of area of the mark (M1), divides the subtraction value by a width of the corresponding mark (M0), and outputs the division value as a fold misalignment amount.

[0099] In this example, the fold misalignment amount is a positive value because the value of area of the mark (M1) is larger than the reference value. The positive fold misalignment amount indicates that the actual fold line is shifted downstream from the set fold line.

[0100] Also, when the paper sheet P2 stops at the second folding position (B) and is shot by the first cameras 34, a

value of area of the mark (M2) in each of images of the paper sheet P2 is outputted from the image processing section 40. Then the detection section 41 subtracts the corresponding reference value from the value of area of the mark (M2), divides the subtraction value by a width of the corresponding mark (M0), and outputs the division value as a fold misalignment amount.

[0101] In this example, the fold misalignment amount is a negative value because the value of area of the mark (M2) is smaller than the reference value. The negative fold misalignment amount indicates that the actual fold line is shifted upstream from the set fold line.

[0102] The paper folding machine of the present invention further comprises a controller 42 operatively connected to the first motor 9 (a drive mechanism of the first guide 8), the first belt drive mechanism 13 (a drive mechanism of the first stopper 12), the second belt drive mechanism 18 (a drive mechanism of the second stopper 16), a drive mechanism of the fourth motors 22a, 22b (the second and third guides 19, 20), the third belt drive mechanism 27 (a drive mechanism of the third stopper 25), and the fifth motors 31a, 31b (a drive mechanism of the fourth and fifth guides 28, 29).

[0103] Fig. 5A is a block diagram illustrating a configuration of the controller 42.

[0104] The controller 42 is a programmed computer, and comprises a data receiving section 43 receiving detection data from the fold misalignment detection unit 50, a data counting section 44, for each folding position (A)-(C), the number of the detection data received by the data receiving section 43, and a data storage section 45 storing, for each folding position (A)-(C), the detection data received by the data receiving section 43.

[0105] The controller 42 also comprises a statistical processing section 46 calculating, for each folding position (A)-(C), an average fold misalignment amount using the detection data corresponding to a predetermined number of sample each time the number of detection data stored in the data storage section 45 reaches, for each folding position, the number of sample.

[0106] That is to say, assuming that the predetermined number of sample is n and the detection data are $\delta 1$, $\delta 2$, $\delta 3$, ····, δn for each folding position (A)-(C), the statistical processing section 46 calculates, for each folding position (A)-(C), the average fold misalignment amount according to

$$\overline{\delta} = \frac{1}{n}\sum_{i=1}^{n}\delta_i \qquad (1)$$

and outputs the calculated average fold misalignment amount.

[0107] In this case, the predetermined number of sample may be stored as a default value in a memory of the controller 42 in advance, or an appropriate number of sample may be inputted to the controller 42 through an input section which is provided on the controller 42 so as to receive an input of the number of sample.

[0108] The controller 42 further comprises an adjustment section 47 adjusting the position of the guide 8, 19, 20, 28, 29 and/or the stopper 12, 16, 25 associated with the corresponding folding position so as to correct fold misalignment corresponding to the average fold misalignment amount each time the average fold misalignment amount is calculated by the statistical processing section 46.

[0109] Thus, according to the present invention, the fold misalignment amount of the paper sheet P is automatically detected for each folding position (A)-(C) during operation of the paper folding machine, and, for each folding position (A)-(C), each time the obtained detection data reaches the predetermined number of sample, the average fold misalignment amount is calculated and the corresponding stopper 12, 16, 25 and/or guide 8, 19, 20, 28, 29 are(is) automatically adjusted using the calculated average fold misalignment amount. Accordingly, the amount of work for workers is greatly reduced and the work does not require skill, and thereby, productivity is dramatically improved and significant cost reductions can be achieved.

[0110] Furthermore, according to the present invention, the adjustment of the paper folding machine is carried out in a manner such that the fold misalignment amounts are statistically minimized while considering the fold misalignment amount within the allowable range as well as the fold misalignment amount exceeding the allowable range. Consequently, the adjustment accuracy is improved so that the incidence of defective products is further reduced.

[0111] Fig. 5B is a block diagram illustrating a modified example of the controller 42 shown in Fig. 5A.

[0112] In the example shown in Fig. 5B, a controller 42' comprises a misalignment tolerance storage section 48 storing, for each folding position (A)-(C), the average fold misalignment amount as a misalignment tolerance in addition to the configuration shown in Fig. 5A. In this case, data stored in the misalignment tolerance storage section 48 are updated each time the average fold misalignment amount is calculated by the statistical processing section 46.

[0113] In this example, the controller 42' also comprises a folding failure check section 49 operatively connected to the first through fourth transport mechanisms 3-6 and the first through third folding mechanisms 11, 15, 24, and comparing the detection data with the misalignment tolerance each time the detection data is received by the data receiving section 43, and stopping the first through fourth transport mechanisms 3-6 and the first through third folding mechanisms 11, 15, 24 when the detection data exceeds the misalignment tolerance.

[0114] According to the modified example shown in Fig. 5B, not only the adjustment for fold misalignment of the paper folding machine but also the check of folding failure (defective product) is automatically performed.

[0115] Although, in the modified example shown in Fig. 5B, the paper folding machine stops when the folding failure (defective product) is detected, according to another modified example, the paper folding machine not stops but discharges a defective product automatically when the folding failure (defective product) is detected.

[0116] In this case, the paper folding machine further comprises a collection unit arranged downstream of the third folding position (C) on the transport path 1 (the third portion 1e) or at the exit 1b of the transport path 1 for collecting the paper sheet with folding failure. Then the folding failure check section 49 is operatively connected to the collection unit and compares the detection data with the misalignment tolerance each time the detection data is received by the data receiving section 43, and collecting the corresponding paper sheet P in the collection unit when the detection data exceeds the misalignment tolerance.

[0117] Fig. 5C is a block diagram illustrating another modified example of the controller 42 shown in Fig. 5A.

[0118] In the modified example shown in Fig. 5C, not only a controller 42" has the configuration shown in Fig. 5A, but also a statistical processing section 46' further calculates, for each folding position (A)-(C), a standard deviation of the fold misalignment amount using the average fold misalignment amount and the detection data corresponding to the number of sample each time the number of the detection data stored in the data storage section 45 reaches, for each folding position, the number of sample, and calculates a variation judgement value of fold misalignment based on the standard deviation.

[0119] That is to say, assuming that the predetermined number of sample is n and the detection data are $\delta 1$, $\delta 2$, $\delta 3$, ····, δn for each folding position (A)-(C), the statistical processing section 46' calculates, for each folding position (A)-(C), the standard deviation σ according to

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\delta_i - \overline{\delta}\right)^2} \qquad (2)$$

where $\overline{\delta}$ is the average fold misalignment amount defined by the equation (1).

and then calculates the variation judgement value of fold misalignment α based on the standard deviation σ according to a predetermined equation, for example,

$$\alpha = \sigma \times m \ (m = 1 \text{ or } 2 \text{ or } 3) \qquad (3).$$

[0120] The controller 42" also comprises a folding failure check section 49' operatively connected to the first through fourth transport mechanisms 3-6 and the first through third folding mechanisms 11, 15, 24, and comparing the variation judgement value with a predetermined misalignment tolerance each time the variation judgement value is calculated by the statistical processing section 46', and stopping the first through fourth transport mechanisms 3-6 and the first through third folding mechanisms 11, 15, 24 when the variation judgement value exceeds the predetermined misalignment tolerance.

[0121] In this case, the predetermined misalignment tolerance may be stored as a default value in a memory of the controller 42" in advance, or an appropriate misalignment tolerance may be inputted to the controller 42" through an input section which is provided on the controller 42" so as to receive an input of the misalignment tolerance.

[0122] According to the modified example shown in Fig. 5C, not only the adjustment for fold misalignment of the paper folding machine but also the check of folding failure (defective product) is automatically performed.

[0123] Although, in the modified example shown in Fig. 5C, the paper folding machine stops when the folding failure (defective product) is detected, according to another modified example, the paper folding machine not stops but discharges a defective product automatically when the folding failure (defective product) is detected.

[0124] In this case, the paper folding machine further comprises a collection unit arranged downstream of the third folding position (C) on the transport path 1 (the third portion 1e) or at the exit 1b of the transport path 1 for collecting the paper sheet with folding failure. Then the folding failure check section 49' is operatively connected to the collection unit and compares the variation judgement value with the predetermined misalignment tolerance each time the variation judgement value is calculated by the statistical processing section 46', and collecting the corresponding paper sheet P in the collection unit when the variation judgement value exceeds the predetermined misalignment tolerance.

[0125] Although the preferred embodiment of the present invention has been set forth for purposes of illustration, the foregoing description should not be deemed a limitation of the invention herein. Accordingly, various modifications, adaptations and alternatives may occur to one skilled in the art without departing from the spirit and the scope of the present invention.

[0126] For example, although, for simplicity of explanation, the above embodiment is limited to the case where the fold misalignment is parallel to a fold line, the present invention can be applied to not only the case where the fold misalignment is parallel to the fold line but also the case where the fold misalignment is oblique to the fold line.

[0127] When both the fold misalignment parallel to the fold line and the fold misalignment oblique to the fold line arise, not only the first through fifth guides 8, 19, 20, 28, 29 can be moved in the direction perpendicular to the transport direction like the above embodiment but also the inclination angle of those guides 8, 19, 20, 28, 29 with respect to the transport path can be adjusted. In addition, not only the first through third stoppers 12, 16, 25 can be moved in the transport direction like the above embodiment, but also the inclination angle of those stoppers 12, 16, 25 can be adjusted.

[0128] For example, although, in the above embodiment, the paper folding machine has three folding positions (A)-(C), and a buckle-type folding machine is arranged at the first folding position (A), and a knife-type folding machine is arranged at the second folding position (B), a knife-type folding machine is arranged at the third folding position (C), the paper folding machine may have any number of folding positions, and any suitable type of folding machine may be arranged.

DESCRIPTION OF REFERENCE NUMERALS

[0129]

1	Transport path
1a	Entrance
1b	Exit
1c	First portion
1d	Second portion
1e	Third portion
2	Paper feeding device
2a	Shelf
2b	Paper feed rotor
3	First transport mechanism
4	Second transport mechanism
5	Third transport mechanism
6	Fourth transport mechanism
7	First conveyor belt
8	First guide (positioning ruler)
9	First motor
10	First screw shaft
11	First folding mechanism
11a	Buckle
11b-11d	Roller
12	First stopper
13	First belt drive mechanism
13a, 13b	Pulley shaft
13c	Pulley
13d,	13e Endless belt
13f	Second motor
14	Second conveyor belt
15	Second folding mechanism
15a	Folding knife
15b, 15c	Folding roller
16	Second stopper
17a, 17b	Slide guide
18	Second belt drive mechanism
18a	Pulley shaft
18b-18e	Pulley
18f, 18g	Endless belt
18h	Third motor
18i	Endless belt
19	Second guide
20	Third guide
21a, 21b	Second screw shaft

22a, 22b	Fourth motor
23	Third conveyor belt
24	Third folding mechanism
24a	Folding knife
24b, 24c	Folding roller
25	Third stopper
26a, 26b	Slide guide
27	Third belt drive mechanism
27a	Pulley shaft
27b-27e	Pulley
27f, 27g	Endless belt
27h	Fourth motor
27i	Endless belt
28	Fourth guide
29	Fifth guide
30a, 30b	Third screw shaft
31a, 31b	Fifth motor
32	Fourth conveyor belt
33	First sensor
34	First camera
35	Second sensor
36	Second camera
37	Third sensor
38	Third camera
39	Reference value storage section
40	Image processing section
41	Detection section
42, 42', 42"	Controller
43	Data receiving section
44	Data counting section
45	Data storage section
46,	46' Statistical processing section
47	Adjustment section
48	Misalignment tolerance storage section
49, 49'	Folding failure check section
50	Fold misalignment detection unit
A	First folding position
B	Second folding position
C	Third folding position
M, M0, M1, M2	Mark
P, P0, P1, P2	Paper sheet

Claims

1. A paper folding machine folding a printed paper sheet along at least one fold line preset on a printing surface of the paper sheet so as to form a signature, the paper folding machine comprising:

a transport path for the paper sheet having an entrance, an exit and at least one folding position which is provided in an intermediate area of the transport path;
at least one transport mechanism transporting the paper sheets one by one along the transport path between the entrance and a most upstream folding position, and between adjacent folding positions, and between a most downstream folding position and the exit;
a folding mechanism arranged at each of the at least one folding position so as to fold the paper sheet along the associated fold line while the paper sheet is stopped at the associated folding position;
at least one adjustable guide positioning the paper sheet relative to the at least one folding position by bringing at least one side of the paper sheet into contact with the at least one adjustable guide;
an adjustable stopper arranged downstream of each of the at least one folding position so as to position and

stop the paper sheet at the associated folding position by bringing a leading edge of the paper sheet into contact with the stopper; and
a fold misalignment detection unit detecting, for each paper sheet and for each folding position, a fold misalignment amount, wherein
the position of the at least one guide and/or the stopper associated with the corresponding folding position is adjusted based on detection data of the fold misalignment detection unit, **characterized in that**
the paper folding machine further comprises:

a drive mechanism capable of moving the at least one adjustable guide and the stopper; and
a controller operatively connected to the drive mechanism, wherein

the controller comprises

a data receiving section receiving the detection data from the fold misalignment detection unit,
a data counting section counting, for each folding position, the number of the detection data received by the data receiving section,
a data storage section storing, for each folding position, the detection data received by the data receiving section,
a statistical processing section calculating, for each folding position, an average fold misalignment amount using the detection data corresponding to a predetermined number of sample each time the number of detection data stored in the data storage section reaches, for each folding position, the number of sample, and
an adjustment section adjusting the position of the at least one guide and/or the stopper associated with the corresponding folding position so as to correct fold misalignment corresponding to the average fold misalignment amount each time the average fold misalignment amount is calculated by the statistical processing section.

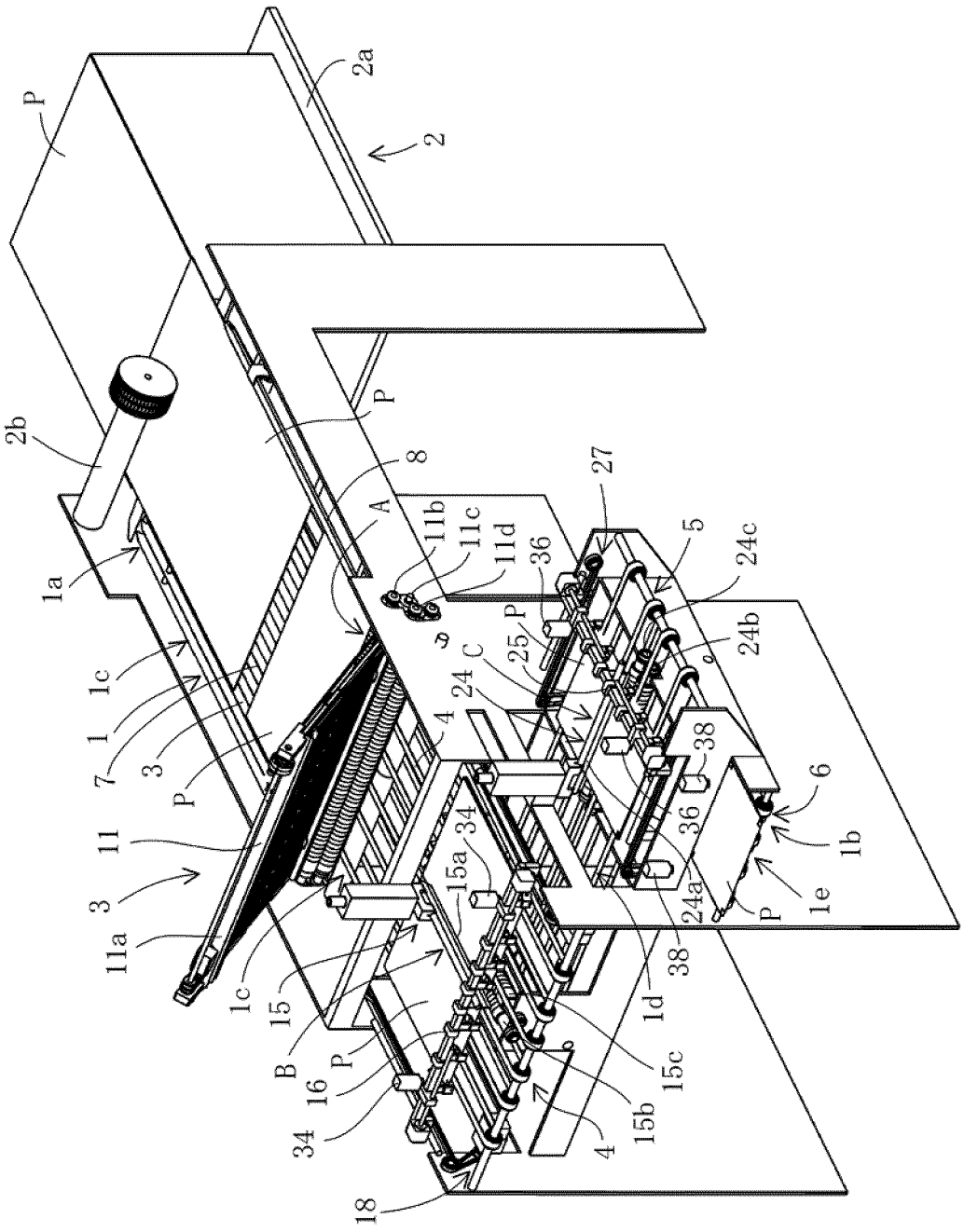
2. The paper folding machine according to Claim 1, wherein the controller further comprises
a misalignment tolerance storage section storing, for each folding position, the average fold misalignment amount as a misalignment tolerance, data stored in the misalignment tolerance storage section being updated each time the average fold misalignment amount is calculated by the statistical processing section, and
a folding failure check section operatively connected to the at least one transport mechanism and the folding mechanism, and comparing the detection data with the misalignment tolerance each time the detection data is received by the data receiving section, and stopping the at least one transport mechanism and the folding mechanism when the detection data exceeds the misalignment tolerance.

3. The paper folding machine according to Claim 1, wherein the paper folding machine further comprises a collection unit arranged downstream of the most downstream folding position on the transport path or at the exit of the transport path for collecting the paper sheet with folding failure, wherein
the controller further comprises
a misalignment tolerance storage section storing, for each folding position, the average fold misalignment amount as a misalignment tolerance, data stored in the misalignment tolerance storage section being updated each time the average fold misalignment amount is calculated by the statistical processing section, and
a folding failure check section operatively connected to the collection unit, and comparing the detection data with the misalignment tolerance each time the detection data is received by the data receiving section, and collecting the corresponding paper sheet in the collection unit when the detection data exceeds the misalignment tolerance.

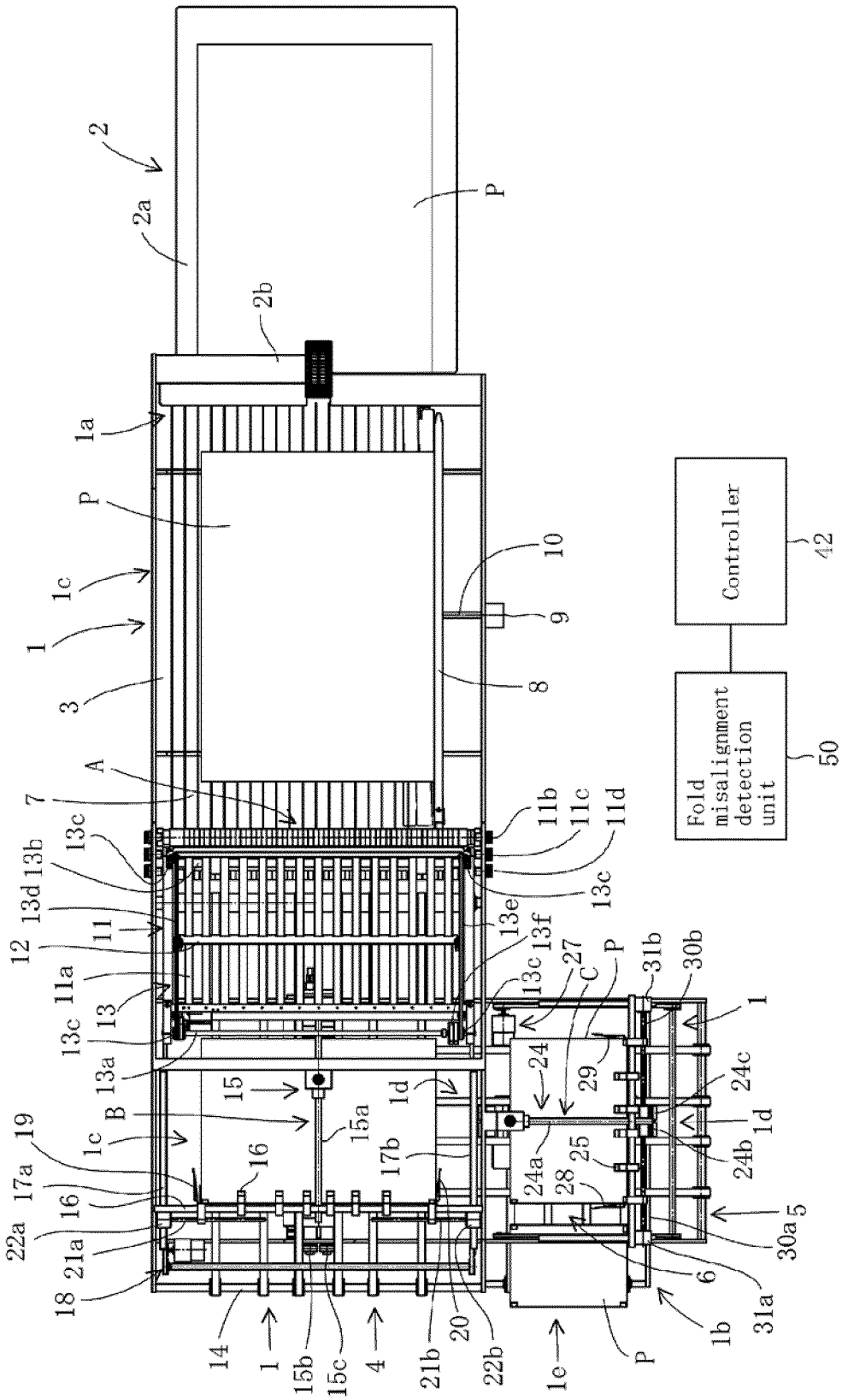
4. The paper folding machine according to Claim 1, wherein the statistical processing section of the controller calculates, for each folding position, a standard deviation of the fold misalignment amount using the average fold misalignment amount and the detection data corresponding to the number of sample each time the number of the detection data stored in the data storage section reaches, for each folding position, the number of sample, and further calculates a variation judgement value of fold misalignment based on the standard deviation, wherein
the controller further comprises
a folding failure check section operatively connected to the at least one transport mechanism and the folding mechanism, and comparing the variation judgement value with a predetermined misalignment tolerance each time the variation judgement value is calculated by the statistical processing section, and stopping the at least one transport mechanism and the folding mechanism when the variation judgement value exceeds the misalignment tolerance.

5. The paper folding machine according to Claim 1, wherein the paper folding machine further comprises a collection unit arranged downstream of the most downstream folding position on the transport path or at the exit of the transport path for collecting the paper sheet with folding failure, wherein
the statistical processing section of the controller calculates, for each folding position, a standard deviation of the fold misalignment amount using the average fold misalignment amount and the detection data corresponding to the number of sample each time the number of the detection data stored in the data storage section reaches, for each folding position, the number of sample, and further calculates a variation judgement value of fold misalignment based on the standard deviation, wherein
the controller further comprises
a folding failure check section operatively connected to the collection unit, and comparing the variation judgement value with a predetermined misalignment tolerance each time the variation judgement value is calculated by the statistical processing section, and collecting the corresponding paper sheet in the collection unit when the variation judgement value exceeds the misalignment tolerance.

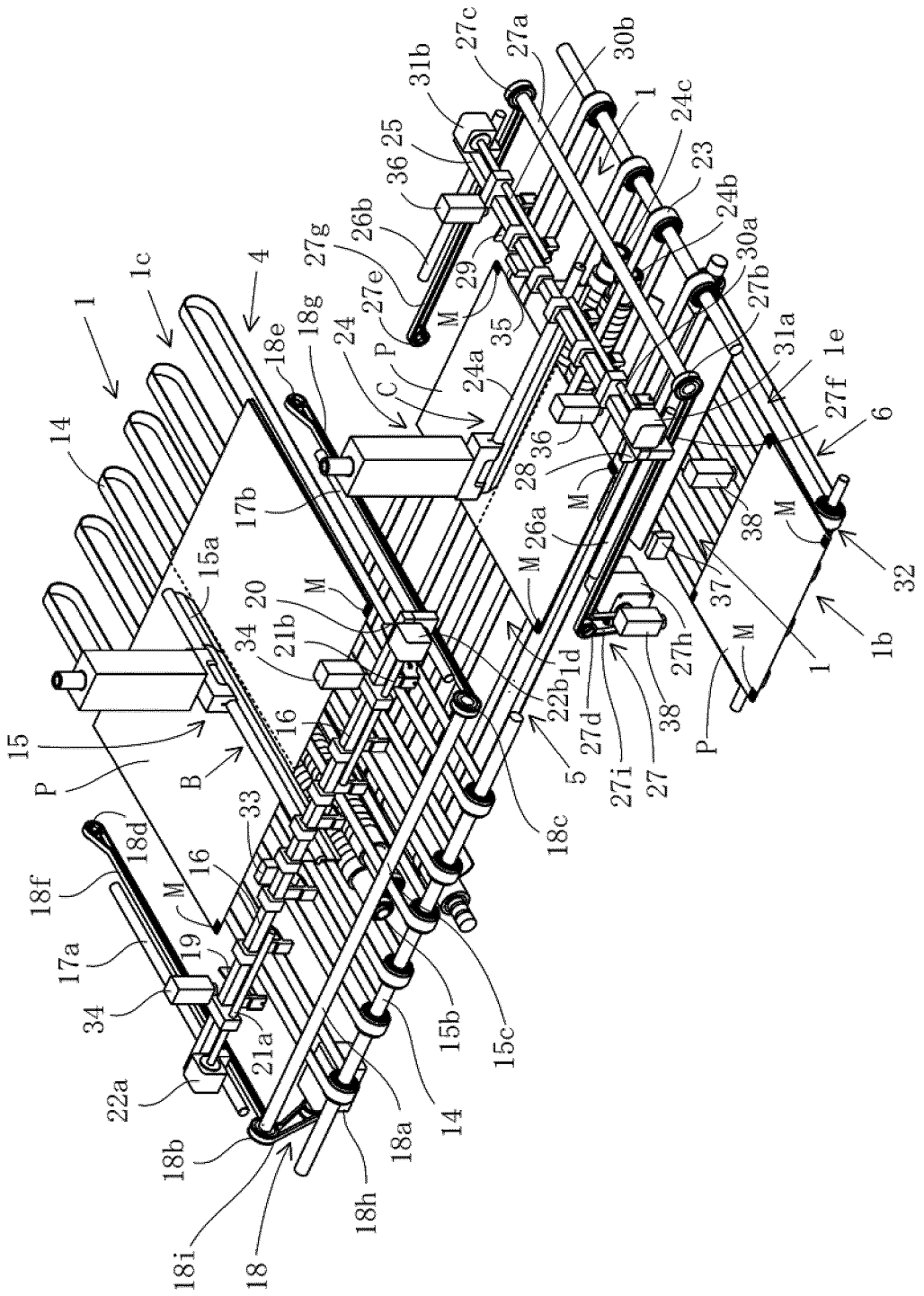
[Fig. 1]


P
2a
2
2b
P
8
A
11b
11c
11d
27
5
24c
36
1a
1c
1
7
3
P
25
P
C
24
24b
4
38
6
11
3
34
36
1b
15a
24a
P
1e
11a
1c
15
38
1d
B
P
16
15c
34
15b
4
18

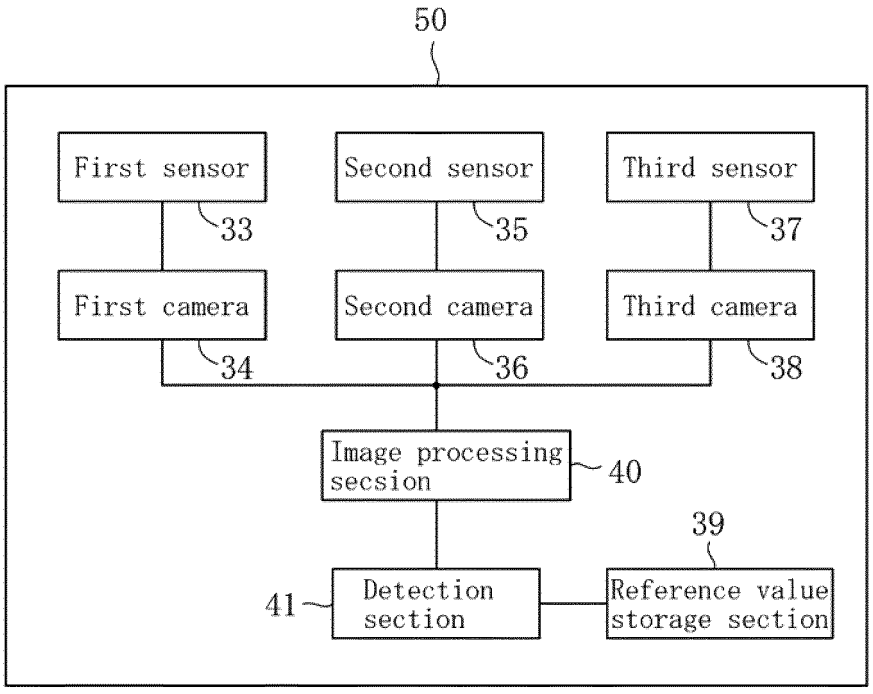
[Fig. 2]


Controller
42
Fold misalignment detection unit
50
2
2a
2b
P
1a
1c
1
3
7
A
B
C
10
9
8
11b
11c
11d
13e
13f
13c
13b
13d
11
12
11a
13
13a
15
15a
1d
16
17b
17a
19
22a
21a
18
14
15b
15c
4
21b
20
22b
1e
24
29
27
31b
30b
24c
24b
24a
25
28
30a
5
6
31a
1b

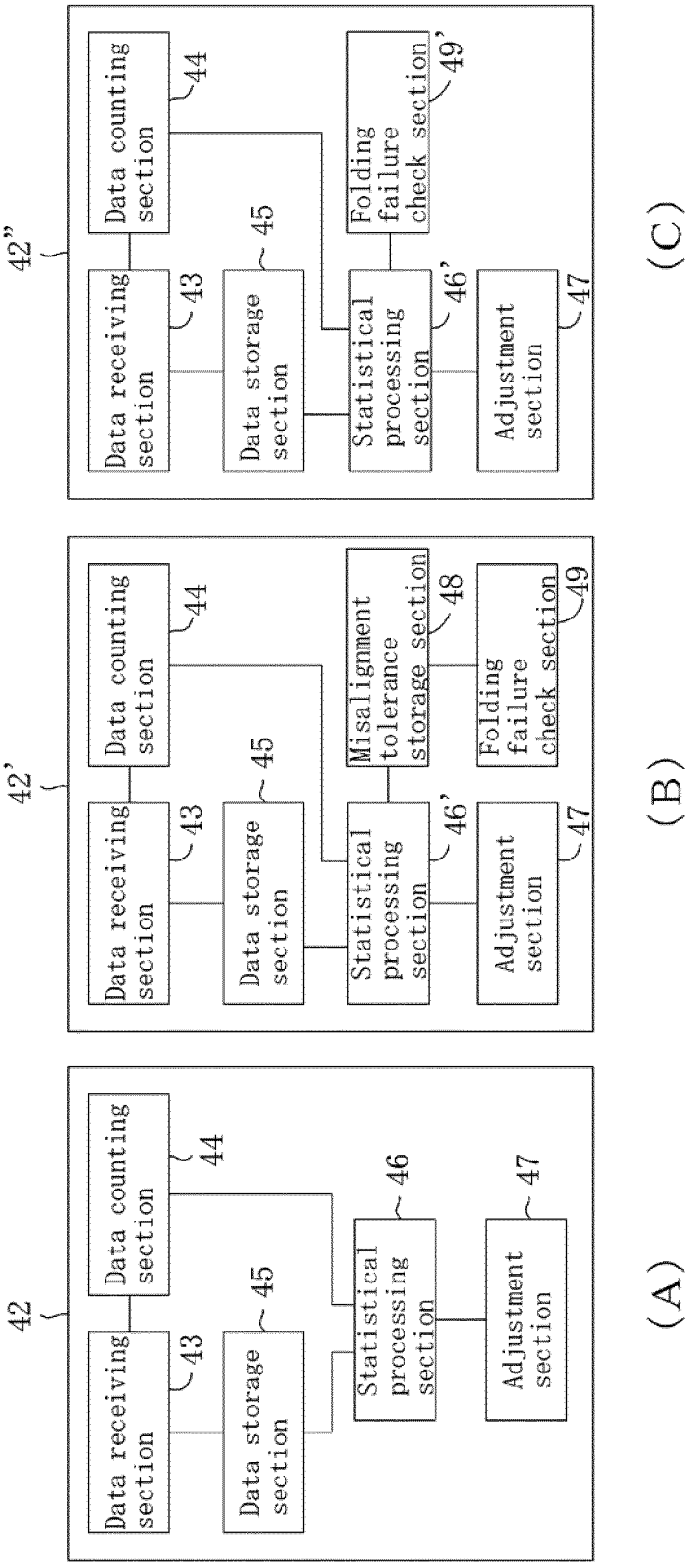
[Fig. 3]


1
1c
4
14
15
P
B
16
33
18d
18f
M
19
17a
34
21a
22a
18b
18i
18
18h
18a
14
15b
15c
18c
5
22b
1d
27d
27i
27
38
P
M
1
1b
32
6
27f
1e
31a
27b
30a
24b
23
24c
1
30b
27a
27c
31b
25
36
26b
27g
18g
18e
24
C
24a
35
29
M
P
17b
15a
20
21b
34
M
M
26a
28
36
M
38
37
27h
M

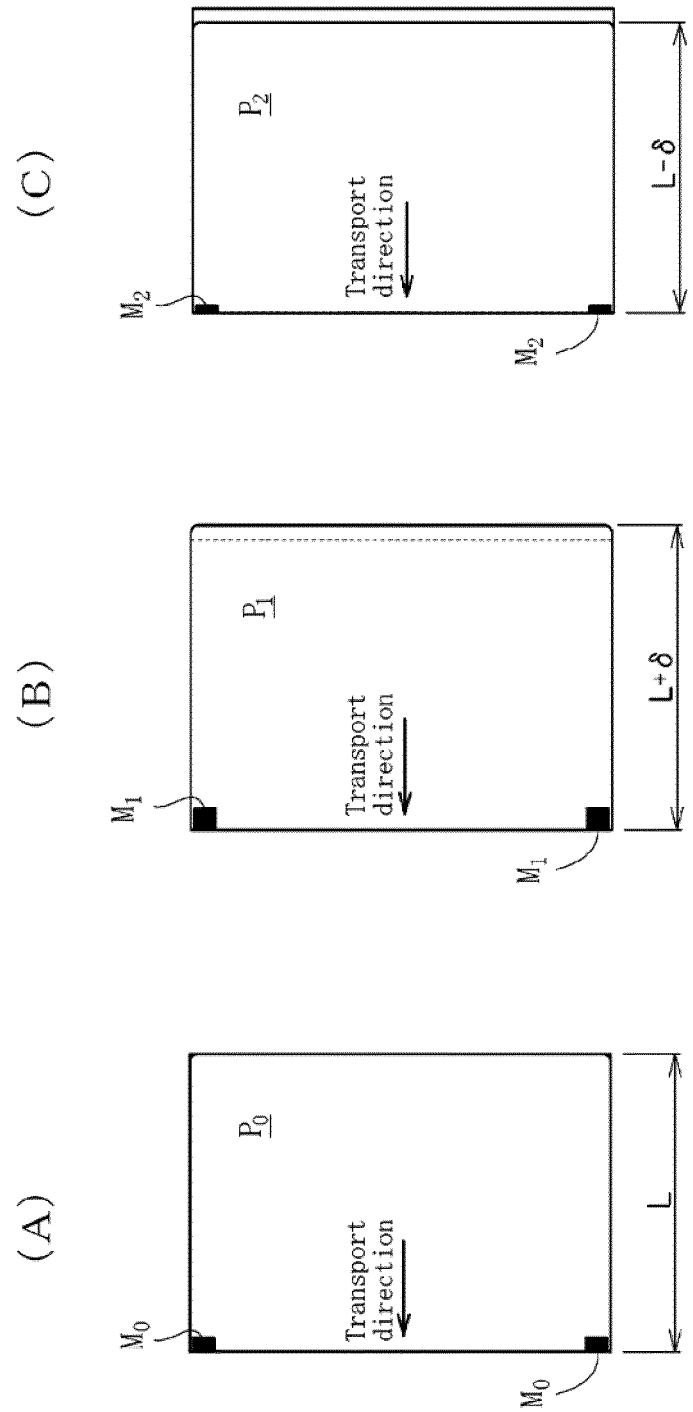
[Fig. 4]


50
First sensor
Second sensor
Third sensor
33
35
37
First camera
Second camera
Third camera
34
36
38
Image processing secsion
40
39
41
Detection section
Reference value storage section

[Fig. 5]


42
Data receiving section
43
Data storage section
45
Data counting section
44
Statistical processing section
46
Adjustment section
47
(A)
42'
Data receiving section
43
Data storage section
45
Data counting section
44
Misalignment tolerance storage section
48
Statistical processing section
46'
Folding failure check section
49
Adjustment section
47
(B)
42"
Data receiving section
43
Data storage section
45
Data counting section
44
Folding failure check section
49'
Statistical processing section
46'
Adjustment section
47
(C)

[Fig. 6]


(C)
P2
Transport direction
L-δ
M2
M2
(B)
P1
Transport direction
L+δ
M1
M1
(A)
P0
Transport direction
L
M0
M0

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/039737

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B65H45/18(2006.01)i, B65H7/14(2006.01)i, B65H45/16(2006.01)i, B65H45/22(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B65H45/00-45/30, B65H7/00-7/20, B65H43/00-43/08, B41F13/56, B42C19/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2013-146896 A (HORIZON INTERNATIONAL INC.) 01 August 2013, paragraphs [0016]-[0021], fig. 2 (Family: none)	1-3 4-5
Y	JP 2008-213968 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 18 September 2008, paragraphs [0053]-[0054], fig. 5 & US 2010/0101438 A1, paragraphs [0251], [0256], fig. 5 & EP 2112111 A1	1-3
Y	JP 2004-203571 A (HORIZON INTERNATIONAL INC.) 22 July 2004, paragraphs [0009], [0010], [0022], [0023], fig. 4, 5 (Family: none)	2-3
A	JP 58-113705 A (VEB KOMBINAT POLYGRAPH "WERNER LAMBERZ" LEIPZIG) 06 July 1983 & US 4578052 A & DE 3234148 A1	4-5

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* 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

Date of the actual completion of the international search	Date of mailing of the international search report
09 January 2018 (09.01.2018)	23 January 2018 (23.01.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2007261726 A **[0026]**
- JP H7277593 A **[0026]**