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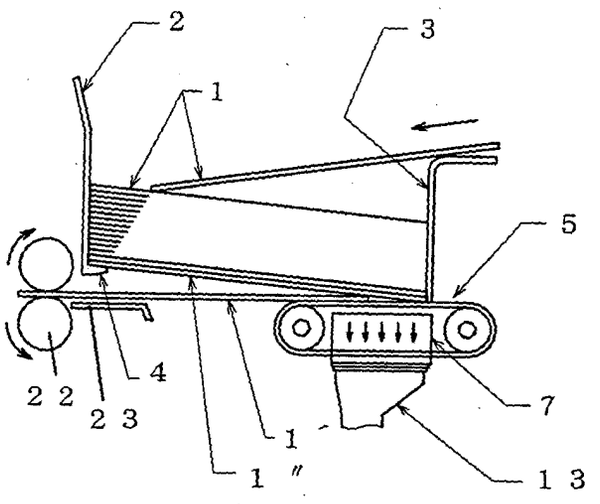
(54) Paper feeding method and apparatus

(57) A method and apparatus are provided for feeding the bottommost paper sheet one by one to a succeeding paper-processing step such as printing as extracted from a stack of paper sheets (1). The paper stack is supported by a front guide (2) having a pawl (4) at the lower end and a back gate (3) as inclined toward the back gate (3) and the bottommost paper sheet is attracted to a reversibly movable suction belt (5) while the remaining paper stack is pushed up by a lift table (15) to avoid contacting with the suction belt (5). Thus, one and only one paper sheet is extracted from the paper stack and conveyed by the suction belt (5) to be received by a pair of pinching rollers for feeding to the succeeding step.

FIG. 1



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Description

[0001] The present invention relates to an improved method with regard to a so-called bottom feeder in which a paper sheet located bottommost in a stack of paper sheets is extracted one by one and is fed to a succeeding processing step and a paper feeding apparatus used for the same.

[0002] There is known an apparatus, i.e. a so-called bottom feeder, wherein a paper sheet located bottommost in a stack of paper sheets is extracted one by one and is fed to a printing apparatus or a punching apparatus.

[0003] For example, a paper feeding apparatus proposed by Japanese Patent Publication No. 55-1210 comprises a supporting block having a wall portion for restricting the front edge in the feeding direction of paper sheets to be fed and a hook portion for stopping the front end portion in the feeding direction of paper sheets located at the forefront portion on the extraction side, a picker whose attracting face portion keeps facial contact with the rear portion of paper sheets located on the forefront portion on the extracting side in which the front end in the paper feeding direction of this supporting block is supported, the picker being supported such that it is capable of swinging in the back and forth direction along the paper feeding direction by an elastic member, a narrow path forming block which restricts the rear edge in the paper feeding direction of the paper sheets to be fed and allows a sheet of paper located on the forefront portion on the extracting side to pass on the attracting face portion of the picker, a guide plate which is provided in a curved form to separate the paper sheet picked up by the picker from other paper sheets and introduce it between feeding rollers of a paper feeding port, an air spouting portion which is provided, between the narrow path forming block and the supporting block, opposite to the edge portion of the paper sheets, spouts air to the side edge portion of the paper sheets to provide a gap between the paper sheets while curving the paper sheets picked up by the picker from the supporting block along the guide plate and a means which is driven by paper pickup instructions and reciprocates the picker at a specified distance in the paper feeding direction.

[0004] Japanese Patent Kokai No. 61-114937 has proposed a bottom feeder for feeding stacked sheets successively from the bottom, in which a center guide for stopping the bottom end of the front portion of the stacked sheets is provided and a gate for allowing a sheet to pass through is formed below the back guide for guiding the rear side of the sheet while the sheet located bottommost is released from the stopping by the center guide to drop downward.

[0005] Japanese Patent Kokai No. 9-194058 has proposed a bottom feeder which includes a laminated sheet held between a front guide and a back gate and a suction box for attracting the bottom face of a sheet located bottommost of the laminated sheets and making it move once backward and then forward in order to feed successively the bottommost sheet, wherein the suction box has an absorbing portion on the top face facing the sheet and a feeding roller is provided such that a part of it is protruded upward from the top face.

[0006] However, because usually the surface of the feeding roller is covered with rubber layer in order to raise friction force between a paper sheet and a roll, these bottom feeders have such a disadvantage that the friction on the top surface is excessive.

[0007] If the surface is formed of a material having a high rigidity, for example, ceramic in order to improve this disadvantage, the contact area between the paper sheet and the roller decreases so that a sufficient friction force cannot be obtained. In the bottom feeder, it is unavoidable to use a rubber roll having a low surface rigidity to flatten the roll surface with a load so that the contact area increases to ensure a specified friction force.

[0008] In the case of using such a rubber roller, until a paper sheet on the bottommost portion passes the roller completely, the next-coming paper sheet is stopped from coming into the rollers because, when the next-coming paper sheet comes into the roller portion immediately after the rear end portion of a paper sheet located on the bottommost of a stack of paper sheets passes the feeding roller, it makes contact with the rear end of the bottommost portion of the next-coming paper sheet or makes contact with the feeding roller so that it is given a flow or part of printed portion is eliminated or the surface of the rubber roll is worn due to erasing phenomenon.

[0009] However, even if the roll or motor is stopped, the abrasion or the erasing phenomenon cannot be avoided for a specified time interval due to inertia. If this abrasion phenomenon is continued, the roll surface is worn out so that the outer diameter of the roll or the circumferential length changes and the moving amount and moving velocity of the paper sheet per single rotation of the roll decrease. Consequently, timing of transfer to a succeeding printing or punching process turns into disorder thereby causing reduction in printing accuracy and punching out precision.

[0010] Because a plurality of roller columns need to be controlled in order to stop each feeding roller one by one, the apparatus becomes complicated and power consumption increases thereby leading to increase of manufacturing cost.

[0011] In view of such situations, an object of the present invention is to provide a bottom feeder capable of suppressing reduction of the accuracy due to wear of the roll accompanied by a rubber roll, occurrence of flaw on the surface of the sheet, increase of maintenance cost accompanied by wear of the roll and rise of manufacturing cost due to complicacy of the apparatus.

[0012] As a result of accumulated researches for restricting various kinds of troubles originating from use of the rubber roller in the bottom feeder, the inventors of the present invention have found out that the object can

be achieved by using a combination of a suction belt which attracts and feeds the bottom face of a paper sheet and a lift table provided with a cam, when extracting a paper sheet one by one from the bottommost portion of a stack of paper sheets, and has accomplished the present invention based on such a knowledge.

[0013] According to an aspect of the present invention, there is provided a paper feeding method wherein, by extracting, from a stack of paper sheets, one and only one paper sheet located bottommost in the stack for feeding to a succeeding paper processing step, the bottom end of the stack is held between a front guide having a pawl or claw formed in the lower end of the front guide and a back gate as inclined toward the direction of the back gate, the bottommost paper sheet is disengaged from the pawl by sucking and is fed to a succeeding processing step of printing or die cutting with simultaneous pushing up of the remaining stack by lift tables for extraction of the bottommost paper sheet under prevention of contacting between the bottommost paper sheet and the next-coming paper sheet in the stack.

[0014] According to another aspect of the present invention, there is provided a paper feeding apparatus comprising a front guide of which the lower end is bent inwardly to form a pawl and a back gate in parallel each standing upright, a reversibly rotatable suction belt facing the lower end of the back gate with a gap to permit passing of only one paper sheet, a lift table to push up a paper stack above the suction belt for preventing contacting of the paper stack and the suction belt, a cam means for up and down movement of the lift table and a pair of rollers to receive a paper sheet from the suction belt as positioned at an extension of the suction belt.

[0015] According to the present invention, since the bottommost paper sheet is fed as attracted to the suction belt, no relative slippage occurs between the paper sheet and the suction belt and until the suction belt stops at a specified position, the subsequent paper sheets to the bottommost paper sheet are supported by a lift table so that they are kept from making contact with the bottommost paper.

[0016] Accordingly, because the wear of the belt is very small, the accuracy of conveyance never drops even if it is used over a long period, no flaws are generated in the surface (bottom face) of the paper sheets, and further, because the belt bears long term usage, maintenance cost decreases and because this apparatus can be driven with a single servo motor, its structure is simple and an inexpensive prices is ensured and a high reliability is secured.

[0017] In the drawings:

FIG. 1 is a cross sectional side view of an embodiment of the apparatus of the present invention;
FIG. 2 is a plan view of FIG. 1;
FIG. 3 is a partial enlargement of FIG. 1;
FIG. 4 is a cross sectional view with a partial perspective for explaining the paper sheet extracting mechanism of the present invention;
FIG. 5 is a side view for explaining the operation of the apparatus of the present invention;
FIG. 6 is a side view for explaining the operation of the apparatus of the present invention;
FIG. 7 is a side view for explaining the operation of the apparatus of the present invention;
FIG. 8 is a side view for explaining the operation of the apparatus of the present invention; and
FIG. 9 is a side view for explaining the operation of the apparatus of the present invention.

[0018] Although the preferred embodiments of the present invention will be described with reference to the accompanying drawings, the present invention is never limited thereby.

[0019] FIG. 1 is a cross sectional side view of a first embodiment of the present invention. FIG. 2 is a plan view thereof. FIG. 3 is a partial enlargement of FIG. 1. FIG. 4 is a cross sectional view with a partial perspective view for explaining the paper sheet extracting mechanism of the present invention.

[0020] Referring to FIG. 1, the front end portion of a stack of paper sheets 1 is supported by a front guide 2 and the rear end portion thereof is supported by a back gate 3.

[0021] The bottom portion of this front guide 2 is bent to the rear side to form a receiving pawl 4. The receiving pawl 4 supports the bottommost paper sheet 1" to prevent it from falling down. The bottom end of the back gate 3 is disposed below the bottom end of the front guide 2 and, consequently, the rear end portion of the stack of paper sheets 1 is kept below the front end portion.

[0022] The rear end portion of the paper sheet 1' is supported by the top face of a plurality of suction belts 5 (four in this example) and a suction hole 6 is made in the suction belt 5. A suction box 7 having a suction hole 7' is provided below the suction belt 5 to support the weight of the stack of paper sheets 1 and the suction belt 5. The suction belt 5 is advanced forward and backward by rotation of a drive pulley 8 and a driven pulley 9.

[0023] Further, as the suction belt 5, an endless toothed belt is used and meshes with teeth on the surfaces of the drive pulley 8 and the driven pulley 9 in order to prevent a slippage between the drive pulley 8 and the suction belt 5. The drive pulley 8 is supported by a bearing 10 rotatably and connected to a servo motor 12 through a coupling 11.

[0024] The suction box 7 is connected to a suction blower 14 through a duct 13 in order to maintain the interior of the suction box 7 in a negative pressure. Thus, the paper sheet 1' on the bottommost layer is sucked by the suction belt 5 through the suction hole in the suction belt 5.

[0025] A plurality of lift tables 15 are provided between the suction belts 5 (three in this example). This lift table 15 repeats a lifting operation in which the top face 18 of

the lift table 15 is raised above the top face of the suction belt or descended below corresponding to a rotation of a cam 17 around a supporting point 16 as referred to FIG. 4. The bottom portion of the lift table 15 keeps a rolling contact with the cam 17 on which a cam follower 19 is mounted.

[0026] The cam 17 is rotated and driven by a motor 21 which rotates continuously in a single direction at a specified velocity through a drive shaft 20.

[0027] FIGS. 5 to 9 are side views for explaining the operation of the apparatus of the present invention.

[0028] Referring to FIG. 5, the suction blower 14 is started and a paper sheet on the bottommost layer is sucked by the suction belt 5 through the duct 13, the suction box 7, the suction hole 6 in the suction belt 5. The suction holes 6 in the suction belt 5 are provided only in part of the entire circumference of the belt (two positions in this example) so that the paper sheet is attracted by only a portion having the suction hole.

[0029] Next, referring to FIG. 6, the drive pulley 8 is rotated by the servo motor 12 so as to drive the suction belt 5 in the direction of the arrow a and consequently, the sucked paper sheet 1' is retracted backward (rightward in the Figure). The front end portion of this paper sheet 1' is disengaged from the receiving pawl 4 and drops on an under guide plate 23. When the rear end portion of the paper sheet is retracted at a specified distance from a gap between the back gate 3 and the suction belt 5, the servo motor 12 is stopped to stop the retraction of the paper sheet 1'. At this time, the top face of the lift table 15 is located below the top face of the suction belt 5.

[0030] Referring to FIG. 7, the suction belt 5 is driven by the servo motor 12 in an opposite direction, that is, in the direction of the arrow b to move the attracted paper sheet 1' forward (leftward in the Figure). When the paper sheet is advanced at a specified distance, the top face of the lift table 15 is lifted corresponding to a rotation of the cam 17 so that it is raised over the top face of the suction belt 5 to support the weight of the next-coming paper sheet 1" on the second position from the bottommost layer and the sheets in the upper layers in order to prevent the paper sheet 1" drop due to the weight of the paper sheets in the upper layers and contact with the suction belt. Because the suction belt 5 moves while only the paper sheet 1' on the bottommost layer is attracted to the suction hole 6 in the suction belt 5, the second paper sheet 1" is not yet attracted at this time.

[0031] Next, in FIG. 8, the suction belt 5 continues to advance and the lift table 15 is kept in the lifted condition and the front end of the paper sheet 1' arrives at the feed rolls 22 so that it is nipped by the feed rolls 22 (the feed rolls 22 are always rotating in a direction in which the paper sheet advances). When the rear end of the paper sheet 1' is released from engagement with the suction belt 5, the top face of the lift table 15 maintains its position holding a position higher than the top face of the suction belt 5 by the amount of a specified dimension while preventing the next-coming paper sheet 1" from making contact with the suction belt 5 still running.

[0032] Finally in FIG. 9, when the position of the suction hole 6 (a part of suction holes at two positions) in the suction belt 5 advances to a specified position, that is, the bottom of the rear end portion of the paper sheet 1 ", the servo motor 21 is stopped and the suction belt is also stopped. After the suction belt 5 is stopped, the lift table 15 is brought down so that the next-coming paper sheet 1" is also attracted to the suction belt 5 and the state shown in FIG. 5 is kept.

[0033] As such an operation is repeated, the paper sheets in the lower part of the stack of paper sheets are fed out successively to the feed rolls side one by one.

[0034] The method and apparatus of the present invention are suitably used when paper sheets are fed to a printing apparatus or die cutting and punching apparatus one by one from the bottom of a stack of paper sheets.

Claims

1. A paper feeding method wherein, by extracting, from a stack of paper sheets (1), one and only one paper sheet (1 ") located bottommost in the stack (1) for feeding to a succeeding paper processing step, the bottom end of the stack is held between a front guide (2) having a pawl (4) formed in the lower end of the front guide (2) and a back gate (3) as inclined toward the direction of the back gate (3), the bottommost paper sheet (1 ") is disengaged from the pawl (4) by sucking and is fed to a succeeding processing step with simultaneous pushing up of the remaining stack by lift tables (15) for extraction of the bottommost paper sheet (1 ") under prevention of contacting between the bottommost paper sheet (1") and the next-coming paper sheet in the stack (1).

2. A paper sheet feeding apparatus comprising a front guide (2) of which the lower end is bent inwardly to form a pawl (4) and a back gate (3) in parallel each standing upright, a reversibly rotatable suction belt (5) facing the lower end of the back gate (3) with a gap to permit passing of only one paper sheet, a lift table (15) to push up a paper stack above the suction belt (5) for preventing contacting of the paper stack (1) and the suction belt (5), a cam means (17) for up and down movement of the lift table (15) and a pair of rollers to receive a paper sheet (1) from the suction belt (5) as positioned at an extension of the suction belt (5).

FIG. 1

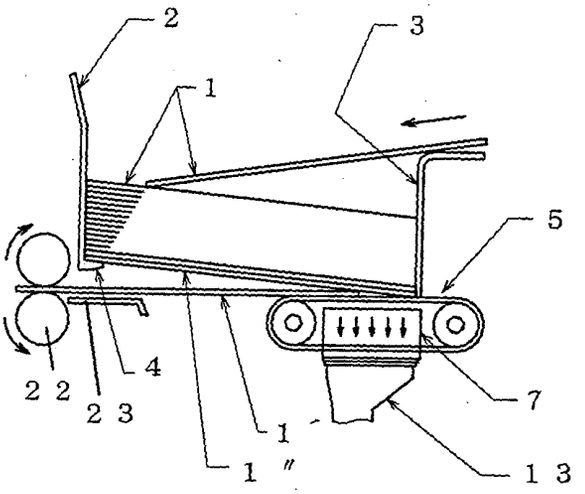

FIG. 2

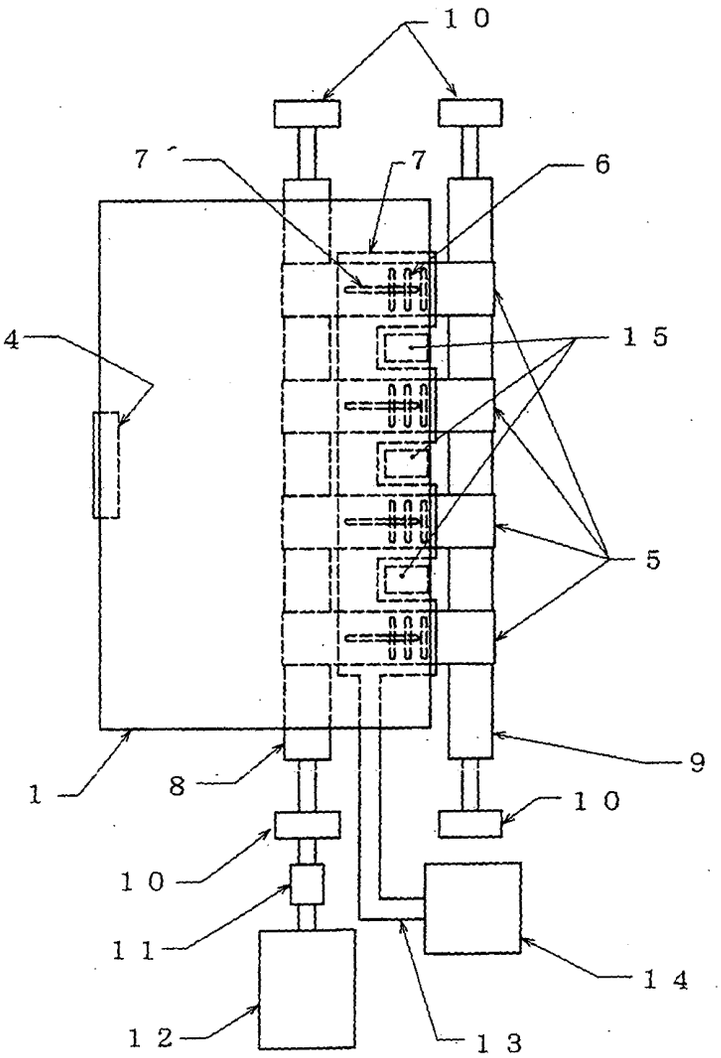

FIG. 3

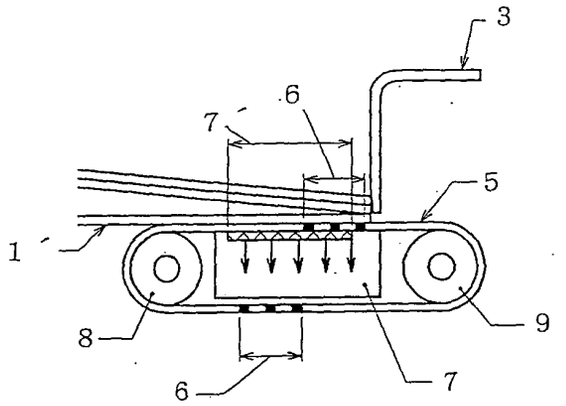

FIG. 4

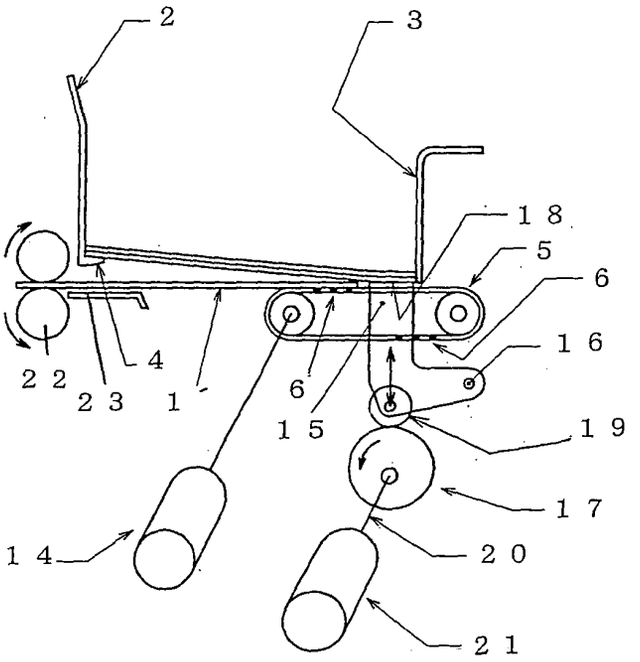

FIG. 5

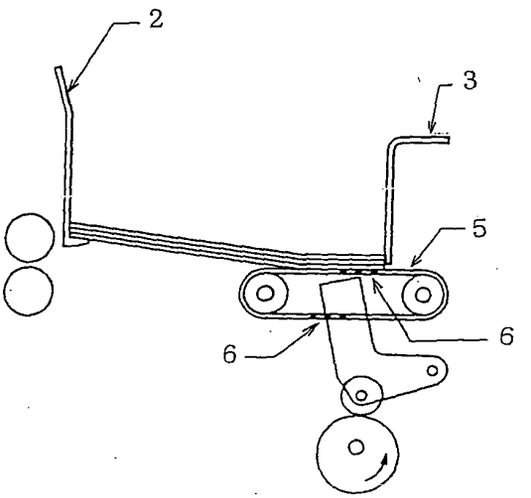

FIG. 6

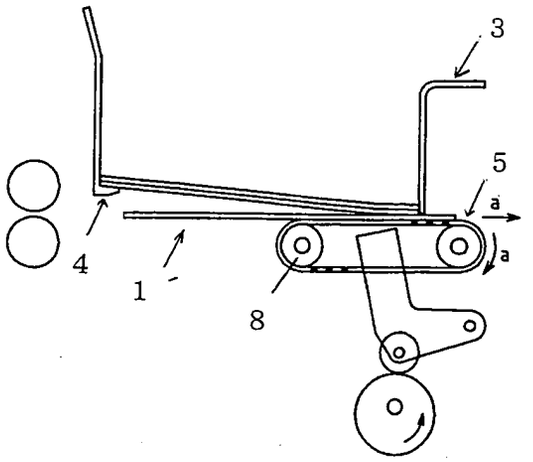

FIG. 7

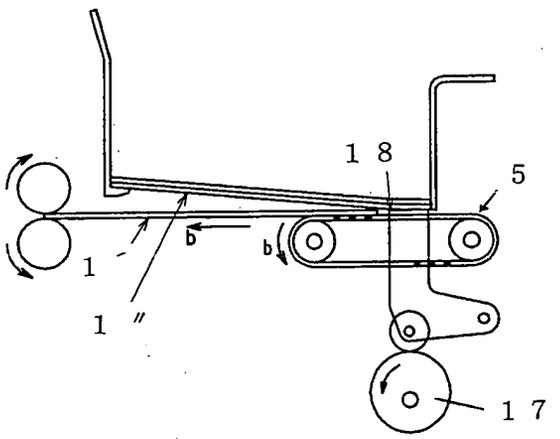

FIG. 8

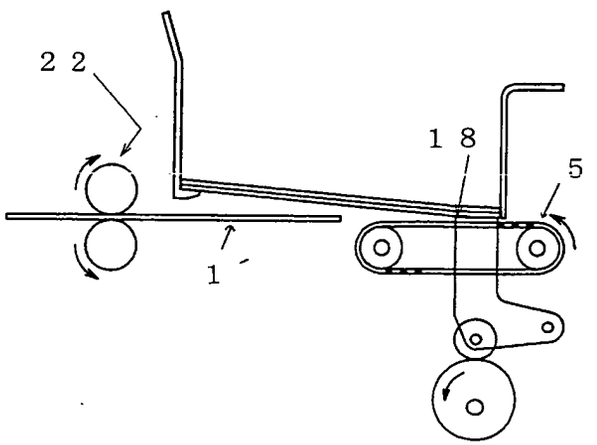

FIG. 9