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(54) **Stack of paper sheets processing apparatus**

(57) According to an embodiment, a paper sheet processing apparatus includes a stacking device which stacks paper sheets and a wrapping device which wraps a stacked paper sheet bundle by winding a band thereon. The wrapping device includes a band winding device which winds the band on the stacked paper sheet bundle and tightens it, a hand assembly (96) which grasps the stacked paper sheet bundle by holding an end thereof,

a hand assembly drive mechanism (98) which draws the bundle to an arbitrary position by reciprocating the hand assembly in a direction perpendicular to the bundle stacking direction, detectors (118a, 118b, 118c) which detect a plurality of drawn-in positions of the hand assembly, and a control unit which stops the hand assembly at an arbitrary drawn-in position detected by the detectors and adjusts a band winding position on the bundle.

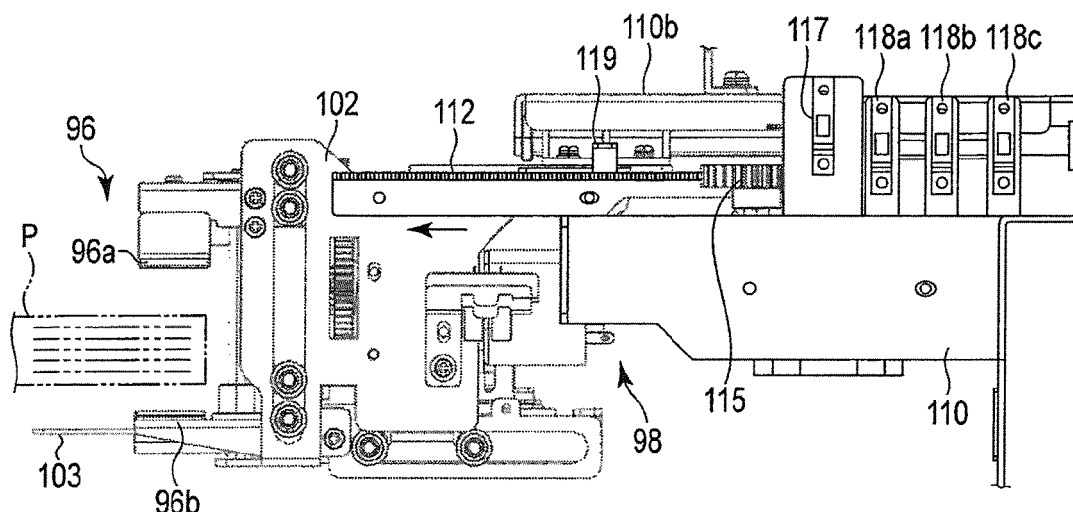


FIG. 10

Description

FIELD

[0001] Embodiments described herein relate to a paper sheet processing apparatus capable of stacking and wrapping paper sheets, such as bills, securities, etc.

BACKGROUND

[0002] In recent years, a large number of bills have been handled on a daily basis in the fields of banking business, large-scale retail trade, etc. There is a service to classify and arrange bills according to denomination and fitness (degree of damage). In handling a large number of bills, each 100 bills are normally wrapped or bound for safekeeping. A paper sheet processing apparatus is proposed as a system for automating such a bill arrangement service. The paper sheet processing apparatus comprises a hopper unit configured to stack and accommodate unclassified bills, a transport mechanism configured to pick up the bills one by one from the hopper unit, an inspection unit configured to inspect the transported bills for denomination and fitness levels, pocket units configured to classify the inspected bills by denomination and the like and stack them therein, a stacking/wrapping apparatus configured to wrap or bind the bills stacked in piles of, for example, 100, etc.

[0003] The stacking/wrapping apparatus comprises a stacking device configured to stack bills in units of, for example, 100 bills and a wrapping device located below the stacking device. The wrapping device winds a band around the stacked bills and then pulls and tightens the band, thereby obtaining a force with which to bundle the stacked bills.

[0004] However, the stacking/wrapping of the paper sheet processing comprising the above-described structure, is not still capable of adjust the position of winding the band, and there are mechanical restraints that a band can be wound only at a fixed location from an end of the stacked bills. For this reason, it is conventionally difficult to meet the needs that the band-winding location can be varied depending on the type of bill which differs from one country from another. Examples of the mechanical restrains are that the location of the band wound on stacked bills is fixed, and the position of the band winding device is fixed.

[0005] The embodiments described herein have been proposed in consideration of the above-described drawbacks, and an object thereof is to provide a paper sheet processing apparatus capable of winding a band onto paper sheets at any location without causing the apparatus to increase in size.

BRIEF DESCRIPTION OF THE DRAWING

[0006]

FIG. 1 is a sectional view showing a bill processing apparatus according to a first embodiment;

FIG. 2 is a block diagram schematically showing the bill processing apparatus;

FIG. 3 is a sectional view showing a stacking/wrapping module of the bill processing apparatus;

FIG. 4A is a plan view showing a first stacking device of the stacking/wrapping module;

FIG. 4B is a plan view showing a second stacking devices of the stacking/wrapping module;

FIG. 5 is a perspective view briefly showing an entire wrapping device of the stacking/wrapping module;

FIG. 6 is a front view showing an entire band-winding device when a hand assembly of the wrapping device is held, an upper clasper is descended at a press position, and a second band holder and a heater are moved to the pressing position and a heat sealing position, respectively;

FIG. 7 is a perspective view showing the hand assembly and a hand-driving mechanism;

FIG. 8 is another perspective view showing the hand assembly and the hand-driving mechanism;

FIG. 9 is a front view showing the hand and the hand-driving mechanism at a release position;

FIG. 10 is a front view showing the hand assembly and hand drive mechanism in an advanced position;

FIG. 11 is a front view showing the hand assembly and hand drive mechanism in a drawn-in position;

FIG. 12A is a plan view schematically showing the hand assembly and drawn-in position sensor in a first drawn-in position;

FIG. 12B is a plan view schematically showing the hand assembly and drawn-in position sensor in a second drawn-in position;

FIG. 12C is a plan view schematically showing the hand assembly and drawn-in position sensor in a third drawn-in position;

FIG. 13 is a perspective view showing a ring gear of the band winding device, band catcher and open/close mechanism;

FIG. 14 is a perspective view showing a first band retainer of the band winding device, second band retainer, heater, first and second clasper drive mechanisms;

FIG. 15 is a side view of the stacking/wrapping apparatus schematically illustrating stacking and wrapping operations;

FIG. 16 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 17 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 18 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 19 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and

wrapping operations;

FIG. 20 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 21 is a perspective view showing how the bill bundle is received by the hand assembly;

FIG. 22 is a perspective view showing how the bill bundle is drawn into a binding position by the hand assembly;

FIG. 23 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 24 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 25 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 26 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 27 is a front view showing how the bill bundle and a wrapper band are retained by the upper clamper and first band retainer;

FIG. 28 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 29 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 30 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 31 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations;

FIG. 32 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations; and

FIG. 33 is a side view of the stacking/wrapping apparatus schematically illustrating the stacking and wrapping operations.

DETAILED DESCRIPTION

[0007] Various embodiments will be described herein after with reference to the accompanying drawings. In general, according to one embodiment, a paper sheet processing apparatus comprises: a supply unit configured to store a plurality of stacked paper sheets; a pick-up mechanism configured to pick up the paper sheets from the supply unit; an inspection device configured to inspect paper sheets which have been picked up; a stacking device configured to stack a predetermined number of paper sheets which have been inspected; and a wrapping device configured to wind a band around a stacked paper sheet bundle and wrap the stacked paper sheet bundle. The wrapping device comprises a clamp mechanism

configured to curve the stacked paper sheet bundle by pressing both side portions of the stacked paper sheet bundle; a band winding device configured to wind a wrapper band around the curved stacked paper sheet bundle, and to pull and tighten the wrapper band; and a heater configured to heat-seal an end of the wrapper band which has been wound. The clamp mechanism comprises a press member configured to adjust a degree of curvature of the stacked paper sheet bundle.

[0008] FIG. 1 is a sectional view schematically showing an outline of a bill processing apparatus according to an embodiment.

[0009] As shown in FIG. 1, the bill processing apparatus for processing bills as paper sheets comprises a main module 10, sorting module 30, stacking/wrapping module 60 for use as a stacking/wrapping apparatus, and large-capacity stacking module 174. These modules are arranged in a line and connected electrically and mechanically to one another. The main module 10 comprises a main control unit 12 configured to control the operations of the main module and the entire apparatus.

[0010] As shown in FIGS. 1 and 2, the main control unit 12 is disposed on a control board in the main module 10. The main control unit 12 comprises a CPU 12a and memory 12b. The CPU 12a controls the operations of the individual modules and calculates the efficiency of the operating state and the like. The memory 12b stores various data, control programs, management information, etc. The various data include print information printable on a wrapper band, such as an operator ID, date/time, serial number, assignment information, bank logo, administrator's signature image, font of language characters, etc., a plurality of processing speeds for the paper sheets, the various winding positions of the bundling band, which comply with the types of paper sheets, and the like, which are stored in the memory 12b.

[0011] The main control unit 12 is connected with a controlling element 17, configured to input various information to the apparatus, and a monitor 15 for use as a display device for displaying input information, operating state of the apparatus, processing state, etc. The sorting module 30 and stacking/wrapping module 60 comprise sub-control units 31a and 61a, respectively, for controlling the operations of the modules. These sub-control units are LAN-connected to the main control unit 12 through an interface and cable, neither of which is shown. The main control unit 12 is connected to a host computer (not shown) such that information is transferred and arranged between them.

[0012] Various operation settings for the processing apparatus are achieved by an operator's operation through the controlling element 17 connected to the main control unit 12. These settings include setting of methods of transactions, such as receipt of money, arrangement service, etc., loading into a loading chamber, inspection of bills in the loading chamber, setting of stacking chambers that accommodate processed bills P, setting of stacking and wrapping processes, setting of the fitness

levels or discrimination levels for bills, and the like.

[0013] Based on processing information from an inspection device 18 (described later), moreover, the main control unit 12 calculates management data, including the processing efficiency per unit time, processing efficiencies for a plurality of days, processing efficiency for each operator ID, and total number of bills processed, loads them into the memory 12b, and displays them on the monitor 15.

[0014] As shown in FIG. 1, the main module 10 comprises a supply unit 11, pick-up mechanism 14, and transport path 16. A large number of bills P are stacked in the supply unit 11. The pick-up mechanism 14 picks up the bills P one by one from the supply unit 11. The bills P picked up by the pick-up mechanism 14 are transported through the transport path 16. A plurality of sets of endless conveyor belts (not shown) extend with the transport path 16 between them. The picked-up bills P are transported between the conveyor belts.

[0015] The supply unit 11 comprises a support surface 11a, extending inclined at an arbitrary angle to the vertical direction, mounting surface 11b extending substantially perpendicular to the support surface 11a, and a pair of guide walls 11c set up along the opposite sides of the mounting surface 11b. An output port through which the bills P are introduced into the apparatus is formed at the boundary between the support surface 11a and mounting surface 11b.

[0016] A plurality (e.g., 2,000 or more) of bills P can be stacked in the supply unit 11. The lowermost one of the stacked bills P is placed on the mounting surface 11b, and the bills P are slantingly mounted on the mounting surface 11b in such a manner that, for example, their longer side edges are arranged along the support surface. The stacked bills P are introduced one after another into the apparatus through an output port 11e, the lowermost one first, by the pick-up mechanism 14.

[0017] The supply unit 11 comprises a backup plate 21 configured to move the stacked bills P to the pick-up side or toward the mounting surface 11b. The backup plate 21 is movable along the support surface 11a so that it can be accommodated in the support surface.

[0018] The pick-up mechanism 14 that picks up the bills P one by one from the supply unit 11 comprises a plurality of pick-up rollers 24, separation rollers 25, and drive motor 26. The pick-up rollers 24 are arranged so that they can abut the bills P on the mounting surface 11b, and the separation rollers 25 are arranged in rolling contact with the pick-up roller 24 on the pick-up port side. The drive motor 26 rotates the pick-up rollers 24 at a predetermined speed.

[0019] As the pick-up rollers 24 rotate, they pick up the lowermost bill P and deliver it to the transport path 16 through the output port 11e. As this is done, the second and subsequent bills P are separated from the picked-up bill by the separation rollers 25. In this way, the bills P are picked up one by one from the supply unit 11 and delivered to the transport path 16.

[0020] As shown in FIG. 1, a pitch correction unit 13 configured to correct the transport pitch of the bills P transported through the transport path 16, the inspection device 18 configured to inspect the bills P with the corrected transport pitch one by one, and a barcode reader 19 are arranged along the transport path 16. The inspection device 18 is located above the output port of the supply unit 11 with respect to the vertical direction. The inspection device 18 detects the denomination, shape, thickness, side (obverse or reverse), authenticity, fitness, double pick-up, etc., of the delivered bills P. The fitness detection is based on discrimination between bills fit for recirculation and unfit bills, which are soiled or damaged and unfit for recirculation. In the case where a batch card is used, for example, the barcode reader 19 reads barcodes affixed to the batch card or casino ticket passed through the inspection device 18 and delivers the read information to the main control unit 12.

[0021] The transport path 16 first extends downward from the pick-up mechanism 14 and the output port and then extends upward to the inspection device 18 at an angle to the vertical direction. The transport path 16 connects with the sorting module 30, which will be described later. According to the present embodiment, the transport path 16 extends substantially along the support surface 11a of the supply unit 11, that is, inclined in the same manner as the support surface 11a. Alternatively, the transport path 16 may extend obliquely upward relative to and directly from the output port without first extending downward therefrom. The inspection device 18 also obliquely extends along the transport path 16. An exit is formed at the lowermost part of the transport path 16, and a foreign matter collection box 27 is disposed below the exit. Foreign matter dropping along the transport path 16 is discharged through the exit and collected in the collection box 27.

[0022] In the main module 10, as shown in FIG. 1, two rejection units 20a and 20b are disposed along the transport path 16, and a plurality of stacking chambers 22a, 22b, 22c and 22d in which the bills are stacked are arranged side by side. The bills P passed through the inspection device 18 are classified into two groups, rejected bills and processable bills, by a gate (not shown). The rejected bills are those which are determined to be counterfeit or unidentifiable, due to a fold, break, skew, double pick-up, etc., by the inspection device 18. The rejected bills are distributed and stacked in the rejection unit 20a or 20b. All the rejected bills stacked in the rejection unit 20a or 20b, except counterfeit ones, are reset and re-introduced into the supply unit 11 or included into enumeration data by manual input. Results of inspection of the transacted amount of money, number of bills, etc., by the inspection device 18 are delivered to and stored in the main control unit 12 and displayed on the monitor 15.

[0023] The processable bills are those which are determined to be fit or unfit authentic bills by the inspection device 18. The processable bills are delivered to and

stacked in the stacking chambers 22a to 22d. For example, the processable bills are distributed and stacked in one of the stacking chambers 22a to 22d corresponding to each denomination, while the unfit bills are collectively stacked in one of the stacking chambers.

[0024] In the case where a batch card is used, it is delivered to and stacked in the rejection unit 20a or 20b after passing through the inspection device 18 and bar-code reader 19.

[0025] The main module 10 comprises various sensors, as well as a drive mechanism and power supply (not shown) for driving the pick-up mechanism 14, the inspection device 18, a transport mechanism, etc.

[0026] As shown in FIG. 1, the sorting module 30 comprises a transport path 31, sorting mechanism 32, inverting device 34, and stacking chambers 36a, 36b, 36c and 36d. The transport path 31 serves to transport the bills P delivered from the main module 10. The sorting mechanism 32 is disposed upstream relative to the transport path 31. The inverting device 34 is disposed downstream relative to the sorting mechanism 32 along the transport path 31. The stacking chambers 36a to 36d are arranged side by side along the transport path 31.

[0027] The bills P delivered from the sorting mechanism 32 or those lined up and delivered from the inverting device 34 are fed to the stacking/wrapping module 60 through the transport path 31 or fed to and stacked in one of the stacking chambers 36a to 36d. The stacking chambers 36a to 36d of the sorting module 30 can be used as chambers in which the bills are stacked for each denomination. Alternatively, the stacking chambers 36a to 36d can be used as rejected or unfit bill chambers in which the rejected or unfit bills removed from the main module 10 are stacked.

[0028] In the case where a wrapping process is set, on the other hand, the fit or unfit bills removed from the main module 10 or sorting module 30 are delivered to the stacking/wrapping module 60 through the transport path 31 of the sorting module 30 and stacked and wrapped in a predetermined number at a time.

[0029] FIGS. 3, 4A, and 4B are front and plan views, respectively, of the stacking/wrapping module 60 for use as a stacking/wrapping apparatus. As shown in FIGS. 1, 3, 4A, and 4B, the stacking/wrapping module 60 comprises a transport path 62, first and second stacking devices 64a and 64b, wrapping device 68, and transport mechanism 70. The transport path 62 communicates with the transport path 31 of the sorting module 30. A predetermined number of bills delivered through the transport path 62 are stacked in each of the first and second stacking devices 64a and 64b. The wrapping device 68 wraps a predetermined number (e.g., 100) of bills in a bundle stacked by each stacking device with a wrapper band. The transport mechanism 70 transports the bundles of bills stacked by the first and second stacking devices 64a and 64b to the wrapping device 68. Further, a discharge unit 73 that receives and stacks the bill bundles wrapped by the wrapping device 68 is disposed below the wrap-

ping device 68.

[0030] The first and second stacking devices 64a and 64b are offset vertically and horizontally from each other. The second stacking device 64b is offset obliquely downward relative to the first stacking device 64a at an angle θ of, for example, about 10 to 80°, partially overlapping the first stacking device 64a in the vertical direction. The wrapping device 68 is located below the second stacking device 64b.

[0031] Each of the first and second stacking devices 64a and 64b comprises a temporary stacking unit 65 and impeller stacking device 66 configured to stack a predetermined number of delivered bills P one by one in the temporary stacking unit 65. An impeller 66a of the impeller stacking device 66 comprises a plurality of blades incorporated around an axis of rotation and is rotated synchronously with the transport of the bills P so that the bills P can be received between the blades. By means of the impeller 66a, the kinetic energy of the quickly transported bills P is absorbed as the bills are aligned and stacked in the temporary stacking unit 65.

[0032] The temporary stacking unit 65 of the first stacking device 64a comprises a first shutter 67 capable of, for example, opening and closing horizontally. The bills P are stacked on the first shutter 67 in a closed position. The temporary stacking unit 65 comprises a horizontal support block 72a on which the bills P are stacked and a second shutter 72b configured to abut the long sides of the stacked bills, thereby aligning the transverse position of the bills. The second shutter 72b is pivotable between an alignment position where it aligns the bills P and an open position where it allows the passage of the stacked bill bundle.

[0033] Further, each of the first and second stacking devices 64a and 64b comprises an indicator 71, such as an LED, configured to display processing states of the apparatus, such as errors, coefficient states, etc., of the stacking devices. These indicators 71 are disposed in positions where they can be easily viewed from the outside when an external cover of the stacking/wrapping module 60 is opened, for example. The indicators 71 inform the operator of various processing states of the stacking devices, such as the need of bill recharge, occurrence of errors, and identity of bills, by flickering, lighting, extinction, or different colors.

[0034] As shown in FIG. 3, the transport mechanism 70, which transports the bill bundles between the wrapping device 68 and the first and second stacking devices 64a and 64b, comprises a pair of guide rods 74, drive belts 76, motor 78, base carrier 80, and sheet carrier (transport tray) 82. The guide rods 74 are set up vertically. The drive belts 76 extend along the guide rods in the vertical direction. The motor 78 drives the drive belts 76 in the up-and-down directions. The base carrier 80 can ascend and descend along the guide rods 74. The sheet carrier 82 is disposed for horizontal reciprocation on the base carrier 80. The base and sheet carriers 80 and 82 constitute a transport carrier.

[0035] The base carrier 80 is in the form of a substantially rectangular tray, one end portion of which is supported by the guide rods 74 and guided for up-and-down motion along the guide rods. The base carrier 80 extends substantially horizontally. Further, the base carrier 80 is connected to the drive belts 76 by a pair of brackets 83. As the motor 78 is driven forward or reverse, the drive belts 76 vertically run, thereby causing the base carrier 80 to ascend and descend. The base carrier 80 is moved up and down between a first position where it is adjacently opposed to the first shutter 67 of the first stacking device 64a from below, a second position where it laterally faces the support block 72a of the second stacking device 64b, and a third position where it laterally faces a release table 84 (described later) of the wrapping device 68. Position sensors, such as photo-interrupters, are disposed individually in these positions. As the base carrier 80 is detected by these position sensors, it can be moved to and located in one of these positions.

[0036] On the other hand, the sheet carrier 82 is in the form of, for example, a rectangular plate larger than each bill P and is configured to carry the stacked bills thereon. The sheet carrier 82 is disposed for horizontal reciprocation on the base carrier 80. Specifically, the sheet carrier 82 is disposed on the base carrier 80 so that it can reciprocate between a standby position and an advanced position, across the movement direction of the base carrier 80, that is, horizontally. In the standby position, the sheet carrier 82 is superposed on the base carrier 80. In the advanced position, the sheet carrier 82 extends substantially horizontally from the front end of the base carrier. The base carrier 80 carries thereon a drive source 87, such as a motor or plunger, configured to horizontally move the sheet carrier 82.

[0037] The sheet carrier 82 is provided with a plurality of bill claspers 88 configured to hold each bill bundle on the sheet carrier. These bill claspers 88 are pivoted between an open position where they are separated from the support surface of the sheet carrier 82 and a clamping position where they press the bill bundle against the sheet carrier 82 from above, thereby holding the bill bundle in a sandwiching manner.

[0038] The stacking of the bills by the first and second stacking devices 64a and 64b and the transport of the bill bundles by the transport mechanism 70 are performed in the following manner. For example, a predetermined number (e.g., 100) of bills of the same denomination are stacked on the first shutter 67 by the first stacking device 64a. When this is done, the base carrier 80 is kept on standby in the first position such that the sheet carrier 82 thereon is adjacently opposed to the first shutter 67 from below. If the 100 bills P are stacked on the first shutter 67, the first shutter moves to its open position, whereupon the stacked bills P are placed on the sheet carrier 82. After the stacked bill bundle is then pressed and held on the sheet carrier 82 by the bill claspers 88, the base carrier 80 is lowered to the third position. Thereafter, the first shutter 67 is returned to its original stacking

position.

[0039] Then, the sheet carrier 82 is advanced from the standby position to the advanced position, whereupon the stacked bill bundle is moved to a region above the release table 84 of the wrapping device. Subsequently, one longitudinal end portion of each stacked bill bundle is held by a hand assembly of a grasping/drawing mechanism (described later) of the wrapping device 68, and the bill claspers 88 are opened to release the hold. Thereafter, the sheet carrier 82 is moved from the advanced position to the standby position. In this way, the bundle of stacked bills P is delivered to the wrapping device 68.

[0040] After the 100 bills are stacked by the first stacking device 64a, on the other hand, the 101-st and subsequent bills are delivered to the second stacking device 64b, and a predetermined number (e.g., 100) of bills are stacked on the support block 72a by the second stacking device 64b. When this is done, the second shutter 72b is in the illustrated alignment position, where it aligns the transverse position of the stacked bills. Further, the base carrier 80 is kept on standby in the second position where it laterally faces the support block 72a. If the 100 bills P are stacked on the support block 72a, the sheet carrier 82 advances from the standby position to the advanced position, whereupon it is nested into the support block 72a and located below the stacked bills P. Subsequently, the second shutter 72b is pivoted to the open position, where it allows the passage of the stacked bill bundle P.

[0041] After the stacked bills P are pressed and held on the sheet carrier 82 by the bill claspers 88 in this state, the sheet carrier 82 is returned to the standby position, and the sheet carrier 82 and stacked bills are moved onto the base carrier 80. Then, the sheet and base carriers 82 and 80 are lowered to the third position. The second shutter 72b is returned to its original alignment position.

[0042] Subsequently, in the third position, the sheet carrier 82 is advanced from the standby position to the advanced position, whereby the stacked bill bundle is moved to the region above the release table 84 of the wrapping device. Then, one longitudinal end portion of the stacked bill bundle P is held by the hand assembly of the grasping/drawing mechanism of the wrapping device 68, and the bill claspers 88 are opened to release the hold. Thereafter, the sheet carrier 82 is moved from the advanced position to the standby position. In this way, the stacked bills P are delivered to the wrapping device 68.

[0043] The following is a description of the wrapping device 68. FIG. 5 is a perspective view schematically showing the entire wrapping device 68, FIG. 6 is a perspective view showing a band feeder of the wrapping device 68, and FIGS. 7 and 8 each are a front view showing a binding mechanism of the wrapping device.

[0044] As shown in FIG. 5, the wrapping device 68 comprises the substantially rectangular release table 84, which is declined relative to a horizontal plane, and a

band feeder 90 configured to deliver a wrapper band. The stacked bill bundle P is introduced into a region above the release table 84. The band feeder 90 comprises a band reel 92 wound with a wrapper band 91 for wrapping the stacked bill bundle and a band feed mechanism 94 configured to draw out the wrapper band 91 from the band reel 92 and deliver it in a loop. The band feed mechanism 94 will be described in detail later.

[0045] As shown in FIGS. 5 and 6, a binding mechanism 95 of the wrapping device 68 comprises a movable hand assembly 96, hand drive mechanism 98, and band winding device 100. The hand assembly 96 pinches the center of one longitudinal end portion of the stacked bill bundle P transported to the region above the release table 84 by the sheet carrier 82 (transport carrier) and draws the bill bundle into a predetermined binding position. The hand drive mechanism 98 opens and closes the hand assembly 96 in the stacking direction of the bill bundle and reciprocates the bill bundle at right angles to the stacking direction. The band winding device 100 winds the wrapper band around the stacked bill bundle P drawn into the binding position.

[0046] As the wrapper band 91 is wound around the stacked bill bundle P by the wrapping device 68 after it is grasped by the hand assembly 96, the sheet carrier 82 moves to a receiving position where it faces the first or second stacking device 64a or 64b and receives the next stacked bill bundle from the stacking device.

[0047] FIGS. 7, 8, 9, 11 and 12 each show the hand assembly 96 and the hand drive mechanism 98. As shown in FIGS. 6 to 9, the hand assembly 96 comprises upper and lower hands 96a and 96b, which are opposed to each other in substantially parallel relation with a gap therebetween and individually supported to be ascendable/descendable (in the stacking direction of the stacked bills) by a support frame 102. These upper and lower hands 96a and 96b are substantially in the form of plates extending substantially horizontally. An upwardly concave pressure pad 97a is mounted on the lower surface of the upper hand 96a. An upwardly convex pressure pad 97b is mounted on the upper surface of the lower hand 96b. As will be described below, when the end of a stacked bill bundle is seized by the hand assembly 96, the pressure pads 97a and 97b having the above-mentioned shape come into contact with the upper and lower surfaces of the stacked bill bundle, curving the bill bundle to a certain degree. Accordingly, the curving operation of the bill bundle can be performed easily by a clamp mechanism (described later). It should be noted that the pressure pads 97a and 97b are not limited to be an arcuate convex or concave; they may be a trapezoidal convex or concave instead.

[0048] A support plate 103, which serves as an ironing board (described later), is disposed on the lower surface side of the lower hand 96b, extending substantially horizontally from the lower hand. The support plate 103 is made of, for example, stainless steel.

[0049] The hand drive mechanism 98 comprises a first

motor 104 mounted on the support frame 102, large and small coaxial gears 106a and 106b, and first and second racks 108a and 108b. The small gear 106b is smaller in diameter than the large gear 106a. The gears 106a and 106b are rotated about the same axis, that is, a horizontal axis in this case, by the first motor. The first rack 108a is connected to the upper hand 96a and meshes with the large gear 106a. The second rack 108b is connected to the lower hand 96b and meshes with the small gear 106b. The racks 108a and 108b individually extend vertically and are located parallel to each other with the respective rotating shafts of the gears 106a and 106b between them.

[0050] As the large and small gears 106a and 106b are rotated in one direction (or clockwise direction) by the first motor 104, as shown in FIG. 9, the upper and lower hands 96a and 96b ascend and descend, respectively, and move away from each other to their respective open positions. Further, as the large and small gears 106a and 106b are rotated in the other direction (or counterclockwise direction) by the first motor 104, in contrast, the upper and lower hands 96a and 96b descend and ascend, respectively, and move toward each other to their respective closed positions.

[0051] Since the upper and lower hands 96a and 96b are driven up and down by the large and small gears 106a and 106b, respectively, as described above, the amount of up-and-down motion of the upper hand 96a is greater than that of the lower hand 96b. Thus, the operating quantity of the upper hand is greater than that of the lower hand, so that thick or swollen bills can be easily received and reliably clamped.

[0052] As shown in FIGS. 7 to 10, the support frame 102 supporting the hand assembly 96 is supported to be reciprocable in the horizontal direction (which is perpendicular to the stacking direction) by a guide rail 110b of a base frame 110. Further, a horizontally extending rack 112 is secured to the support frame 102. The hand drive mechanism 98 comprises a second motor 114 (pulse motor) mounted on the base frame 110, gear train 115 engaging with the rack 112 and the shaft of the motor, and a rotational position sensor 117 configured to detect the rotational position of the motor. A detection disk 113 is coaxially secured to the rotational shaft of the second motor 114, so as to rotate integrally with the second motor 114. A number of notches are formed in an outer circumferential portion of the detection disk 113, such as to be arranged along the circumferential direction at equal intervals all along the entire circumference of the disk. Further, the rotational position sensor 117 is located to face the outer circumferential portion of the detection disk 113 with use of, for example, a photo-interrupter. As the detection disk 113 is rotated in synchronism with the second motor 114, the rotational position sensor 117 senses the notches in the circumferential portion of the detection disk and detects the rotational position of the motor. Then, by sensing with the rotational position of the second motor, the horizontal position of the hand assembly 96 after the movement can be detected.

[0053] The hand drive mechanism 98 comprises a plurality of, for example, three drawn-in position sensors 118a, 118b and 118c configured to detect the horizontal position of the support frame 102 after the movement, and a detection rib 119, for example, secured on the rack 112 and detectable by the drawn-in position sensors. The drawn-in position sensors 118a, 118b and 118c are provided side by side along the movement path of the rack 112 and the detection rib 119 and in the horizontal direction such as to be apart from each other at predetermined intervals. The drawn-in position sensors 118a, 118b and 118c detect the detection rib 119 with use of, for example, a photo-interrupter, as the detection rib 119 crosses the drawn-in position sensors to shield the detection light (dark). By detecting the detection rib 119 with the drawn-in position sensors 118a, 118b and 118c, the drawn-in position of the hand assembly 96 (the end position of its movement) can be detected. In this case, three types of drawn-in positions can be set.

[0054] As the second motor 114 is rotated in one direction, as shown in FIG. 10, the rack 112 and support frame 102 are driven to move the upper and lower hands 96a and 96b to their advanced position (reference position A) where they grasp the stacked bill bundle P. The movement of the hand assembly 96 to the advanced position is monitored by a position sensor (not shown), and when the movement is detected, the second motor 114 is stopped.

[0055] Further, as the second motor 114 is rotated in the other direction after the stacked bill bundle P is grasped by the hand assembly 96, as shown in FIG. 11, the rack 112 and support frame 102 are driven to move the upper and lower hands 96a and 96b to their drawn-in position where they draw the grasped stacked bill bundle P into the binding position. Here, when the detection rib 119 is detected by any one of the drawn-in position sensors 118a, 118b and 118c, the second motor 114 is stopped so as to adjust the drawn-in position of the hand assembly 96.

[0056] As shown in FIG. 12A, the position where the stacked bill bundle P is grasped by the hand assembly 96 is assigned as the reference position A, and when the hand assembly 96 is stopped at the first drawn-in position where the detection rib 119 is detected by the drawn-in position sensor 118a with respect to the reference position, the stacked bill bundle P is drawn-in by a distance d_1 from the reference position A. In this manner, the winding position of the wrapper band 91 on the stacked bill bundle P is set at the first winding position, which is most close to the end of the drawn-in side of the stacked bill bundle P.

[0057] As shown in FIG. 12B, the position where the stacked bill bundle P is grasped by the hand assembly 96 is assigned as the reference position A, and when the hand assembly 96 is stopped at the second drawn-in position where the detection rib 119 is detected by the drawn-in position sensor 118b with respect to the reference position, the stacked bill bundle P is drawn-in by a

distance d_2 ($> d_1$) from the reference position A. In this manner, the winding position of the wrapper band 91 on the stacked bill bundle P is set at the second winding position, which is away from the end of the drawn-in side of the stacked bill bundle P.

[0058] As shown in FIG. 12C, the position where the stacked bill bundle P is grasped by the hand assembly 96 is assigned as the reference position A, and when the hand assembly 96 is stopped at the third drawn-in position where the detection rib 119 is detected by the drawn-in position sensor 118b with respect to the reference position, the stacked bill bundle P is drawn-in by a distance d_3 ($> d_2$) from the reference position A. In this manner, the winding position of the wrapper band 91 on the stacked bill bundle P is set at the third winding position, which is further away from the end of the drawn-in side of the stacked bill bundle P.

[0059] The types and lengths of bills and their band winding positions are stored in advance in the main control unit 12 and a sub-control unit 61a, and according to the information, the drawn-in position of the stacked bill bundle P is set in advance at one of the first to third drawn-in positions. The hand drive mechanism 98 drives the second motor 114 according to the set drawn-in position.

[0060] As described above, the position of the band winding device 100 (described later) is fixed, and therefore the wrapper band winding position on the stacked bill bundle P can be adjusted by adjusting the drawn-in position of the stacked bill bundle P with respect to the band winding device 100.

[0061] It should be noted that the drawn-in position of the hand assembly 96, that is, the movement amount, can be detected by sensing the rotational position of the second motor 114 with the rotational position sensor 117. In other words, the stop position and the drawn-in position of the hand assembly 96 can be controlled based on the sensing of the rotational position of the second motor 114 with the rotational position sensor 117. In this case, the drawn-in position of the hand assembly 96 can be set at any position, and therefore the position is not limited to the first, second or third position only, but can be set more finely at even more drawn-in positions. Further, the rotational position of the second motor 114 can be detected not only by the combination of the detection disk 113 and the rotational position sensors, but also by detecting the number of pulses of the motor with an encoder or the like.

[0062] FIG. 13 shows the band winding device 100, which winds the wrapper band around the stacked bill bundle P drawn into the binding position. As shown in FIGS. 5, 6 and 13, the band winding device 100 comprises a ring gear 120, band catcher 122, and band drive mechanism. The ring gear 120 is supported on an annular support frame 116, and the band catcher 122 is mounted on the ring gear. The band drive mechanism rotates the ring gear 120 and delivers the wrapper band 91 from the band feeder 90 with the leading end of the wrapper band clamped by the band catcher, thereby forming a looped wrapper band along the ring gear in the binding position.

[0063] The ring gear 120 has its outer peripheral surface supported by a plurality (e.g., three) of guide pulleys 124, which are rotatably mounted on the support frame 116. Thus, the ring gear 120 is supported on the support frame 116 for rotation about a horizontal axis, that is, an axis parallel to the direction of reciprocation of the hand assembly 96. Further, the ring gear 120 is located so as to externally cover the hand assembly 96 with a gap therebetween. Thus, the hand assembly 96 is movable inside the ring gear 120.

[0064] A gear 120a is formed on the inner peripheral surface of the ring gear 120. The band drive mechanism comprises a third motor 125 mounted on the support frame 116, and a gear train 126 meshes between the gear 120a and the rotating shaft of the third motor 125. As the third motor 125 is driven, the ring gear 120 is rotated in a predetermined direction, e.g., counterclockwise, about a horizontal axis.

[0065] The band catcher 122 is mounted on the ring gear 120 so that it can rotate together with the ring gear 120 about the horizontal axis. The band catcher 122 comprises a pair of catch arms 128a and 128b. These catch arms 128a and 128b extend forward from the ring gear 120 in parallel relation to the horizontal axis. Further, they are supported by the ring gear 120 for pivotal motion about a pivot 133 between a closed position and an open position. In the closed position, the arms 128a and 128b contact each other to clamp the wrapper band. In the open position, they are spaced apart from each other to release the wrapper band. The catch arms 128a and 128b are urged to the closed position by a spring.

[0066] As shown in FIG. 13, the support frame 116 is provided with an opening mechanism 135 that opens the band catcher 122 to the open position. The opening mechanism 135 comprises a plunger 134, push arm 136, and pressure roller 137. The push arm 136 is pivotable by the plunger. The pressure roller 137 is mounted on the distal end of the push arm 136 and presses the press lug 131 of the catch arm 128a. In winding the wrapper band 91, the band catcher 122 is kept on standby in a clamping position (e.g., corresponding to the 5-o'clock position of the hour hand). As the push arm 136 is pivoted by the plunger 134 of the opening mechanism 135, moreover, the band catcher 122 is kept on standby in the open position where the wrapper band 91 is allowed to pass.

[0067] As shown in FIGS. 5 and 6, the band feed mechanism 94 of the band feeder 90 comprises a plurality of guides arranged along the transport path, a plurality of transport rollers, and a fourth motor for driving the transport rollers. The band feed mechanism 94 transports the wrapper band 91 interposed between the transport rollers, draws it out from the band reel 92, and delivers the wrapper band to the band catcher 122 kept on standby in its initial position. A printer is disposed in the middle of the transport path, and it prints desired print information on the wrapper band 91. A cutter 148 is disposed between an end of the transport path for the wrapper band 91 and the band catcher 122. The wrapper band 91 is

delivered to the band catcher 122 through a space between teeth of the cutter 148.

[0068] In the band winding device 100 and band feed mechanism 94 constructed in this manner, as shown in FIGS. 6 and 13, the wrapper band 91 is drawn out of the band reel 92 by the band feed mechanism 94 with the band catcher 122 kept on standby in the clamping position and with the catch arms 128a and 128b opened by the opening mechanism 135. Then, the leading end of the wrapper band is delivered to the space between the catch arms of the band catcher 122 through the cutter 148. Thereafter, a press by the opening mechanism 135 is released, and the leading end of the wrapper band 91 is clamped by the band catcher 122. Subsequently, the wrapper band 91 is delivered by the band feed mechanism 94 as the ring gear 120 is rotated counterclockwise by a predetermined angle, whereby the band catcher 122 is moved to a standby position. Thereupon, the wrapper band 91 is drawn out in a loop along the ring gear 120 and located around the binding position. In this state, the bill bundle P is grasped by the hand assembly 96 and drawn into the looped wrapper band 91. In the standby position, the band catcher 122 and looped wrapper band 91 are located off a draw-in path for the stacked bill bundle P and kept from hindering the draw-in operation.

[0069] While the stacked bill bundle P is being transported from the stacking devices 64a and 64b to the wrapping device 68 by the transport carrier, the band winding device 100 and band feed mechanism 94 previously form the looped wrapper band 91 in the binding position. The time required for the winding operation can be reduced by thus previously setting the wrapper band 91.

[0070] After the stacked bill bundle P is drawn into the binding position, the ring gear 120 is further rotated counterclockwise, whereupon the band catcher 122 is moved to the vicinity of the clamping position. In this way, the looped wrapper band 91 is located around the binding position for the stacked bill bundle P and in a position where it covers the support plate 103 on the hand assembly 96. In this state, the wrapper band 91 is pulled back a certain distance by the band feed mechanism 94 such that the size of its loop is reduced, whereby the wrapper band is loosely wound around the bill bundle P and support plate 103.

[0071] As shown in FIGS. 6 and 14, the band winding device 100 comprises a first band retainer 152, upper clasper 160, first clasper drive mechanism 162, second band retainer 170, heater 180, and second clasper drive mechanism 190. The first band retainer 152 presses the wrapper band 91 against the support plate 103 of the hand assembly 96, thereby preventing dislocation of the band. The upper clasper 160 presses the wrapper band 91 and stacked bill bundle P from above in the binding position and depresses the opposite longitudinal side portions of the bill bundle toward the support plate 103, thereby curving the entire bill bundle. The first clasper drive mechanism 162 causes the upper clasper 160 to ascend and descend synchronously with the first band

retainer 152. The second band retainer 170 presses and holds the tightened wrapper band 91 against the stacked bill bundle P. The heater 180 heats and seals a seam of the pressed wrapper band 91. The second clamper drive mechanism 190 moves the second band retainer 170 and heater 180 in association with each other to a position where they abut the wrapper band 91.

[0072] The first band retainer 152 is pivoted by a first clamper drive mechanism 162 between a standby position where it is located off the transport paths for the wrapper band 91 and stacked bill bundle P and a retaining position where it abuts the lower surface of the support plate 103 of the hand assembly 96 and presses the wrapper band 91 against the support plate (ironing board) 103.

[0073] The upper clamper 160 comprises a rotatable arm 160b shaped in the form of an elongated rod, and two or two sets of press members 160a (right and left press members) coupled to the rotatable arm and configured to press the upper surface of a bill bundle P. The two or two sets of press members 160a are provided in such a manner that one is located at the extended end of the rotatable arm 160b and the other is at the proximal end of the rotatable arm 160b. The press members 160a are shaped like a plate, for example, and are coupled to respective sides of the rotatable arm 160b. The lower portion of each press member 160a is a press portion projecting downward from the rotatable arm 160b. The press portion of each press member 160a includes a central portion, which is the greatest portion, and slant portions, which decline to the right and left, so that the press portion pushes the stacked bill bundle P from above and curves the whole of the bill bundle P.

[0074] The proximal end portion of the upper clamper 160 is pivotably supported on a support frame 166 of the first clamper drive mechanism 162. The upper clamper 160 is pivoted by the first clamper drive mechanism 162 between an up position where it is located off the transport paths for the stacked bill bundle P and wrapper band 91 and a down-press position, shown in FIG. 6, where it presses the stacked bill bundle P grasped by the hand assembly 96 and the wrapper band 91 from above. The positions of the press members 160a are adjustable according to the width of the bill bundle P. Further, by moving the press members 160a, the degree of curvature of the bill bundle P can be adjusted. For example, when two of the press members 160a are moved in directions respectively to be close to each other, the degree of curvature of the bill bundle P can be increased.

[0075] As described above, the first band retainer 152 and upper clamper 160 are driven synchronously by the first clamper drive mechanism 162. In winding the wrapper band 91, for example, the first band retainer 152 is pivoted from the standby position to the retaining position by the first clamper drive mechanism 162. In synchronism with this, the upper clamper 160 is pivoted from the up position to the down-press position.

[0076] As shown in FIGS. 6 and 14, the second band retainer 170 is a substantially flat plate-like arm, the prox-

imal end portion of which is supported by the support frame 166 for pivotal motion. The second band retainer 170 is pivoted by the second clamper drive mechanism 190 between a standby position where it is located off the transport paths for the wrapper band 91 and stacked bill bundle P and a retaining position where it abuts a corner portion of the lower surface of the stacked bill bundle P and presses and holds the wrapper band 91 against the bill bundle P.

[0077] The heater 180 is an elongated bar, the distal end portion of which constitutes a heating section 180a. The heater 180 is supported for linear reciprocation by the support frame 166. Thus, the heater 180 can reciprocate between a standby position where it is located off the transport paths for the wrapper band 91 and stacked bill bundle P and a heat-sealing position where it presses the wrapper band 91 against the lower surface of the support plate (ironing board) 103 to heat-seal the wrapper band, as shown in FIG. 6.

[0078] As shown in FIGS. 6 and 14, as the upper clamper 160 is pivoted to the down-press position, the second band retainer 170 presses and holds the wrapper band 91 against the lower right corner of the stacked bill bundle P with the upper clamper 160 pivoted to the press position. The press member 161 on the upper clamper 160 is located opposite the second band retainer 170 with the bill bundle P therebetween and presses and holds the wrapper band 91 against the upper surface of the bill bundle P. In this way, the wrapper band 91 can be prevented from slackening as it is cut. The press member 160a presses the wrapper band 91 from above in such a manner that it is not very resistive when it tightens the wrapper band and that it becomes more resistive when the wrapper band is cut and naturally slackens.

[0079] After the trailing end side of the wrapper band 91 is then cut by the cutter 148, the heater 180 is moved from the standby position to the heat-sealing position. As this is done, the trailing end portion of the wrapper band 91 is pushed up to the position of the support plate 103 by the heater 180 and pressed against the wound wrapper band in an overlapping manner. In this state, the overlapping portion of the wrapper band 91 is heat-sealed by the heater 180. After the wrapper band 91 is heat-sealed, the first band retainer 152, upper clamper 160, second band retainer 170, and heater 180 are returned to their respective standby or up positions and kept apart from the stacked bill bundle P.

[0080] Next, a stacking operation and a wrapping operation with the wrapper band of the stacking/wrapping module 60 constructed as described above will now be described. As shown in FIG. 15, for example, a predetermined number (e.g., 100) of bills of the same denomination are stacked by the first stacking device 64a. When this is done, the base carrier 80 of the transport carrier is kept on standby in the first position such that the sheet carrier 82 thereon is adjacently opposed to the first shutter 67 from below.

[0081] While the bills are being stacked, the band

catcher 122 of the wrapping device 68 is kept on standby in the clamping position (e.g., corresponding to the 5-o'clock position of the hour hand) and in the open position where the wrapper band is allowed to pass.

[0082] While the predetermined number of bills are being stacked, as shown in FIG. 16, the wrapping device 68 delivers the wrapper band 91 by means of the band feed mechanism 94 of the band feeder and feeds it to the band catcher 122 through the cutter 148. Then, the band catcher 122 grasps the leading end of the fed wrapper band 91. In this case, the leading end of the wrapper band 91 is not folded back. It is seized by the band catcher 122 while maintaining the flat state.

[0083] If the 100 bills P are stacked in the first stacking device 64a, as shown in FIGS. 17 and 18, the stacked bills P are delivered from the first stacking device 64a onto the sheet carrier 82. After the stacked bill bundle P is then pressed and held on the sheet carrier 82 by the bill clampers 88, the base carrier 80 is lowered to the third position.

[0084] During the delivery and transport of the stacked bill bundle P, the wrapping device 68 rotates the ring gear 120 counterclockwise through the predetermined angle to move the band catcher 122 from the clamping position to the standby position, while delivering the wrapper band 91 by means of the band feed mechanism 94. Thereupon, the wrapper band 91 is drawn out in a loop along the ring gear 120 and located around the binding position. In this way, the looped wrapper band 91 is previously formed in the binding position as the stacked bill bundle P is transported from the first stacking device 64a to the wrapping device 68 by the transport carrier. Processing time for the entire stacking and wrapping operations can be reduced by previously setting the wrapper band 91 in a loop.

[0085] Then, as shown in FIG. 19, the sheet carrier 82 advances from the standby position to the advanced position to move the stacked bill bundle P to a region above the release table 84 of the wrapping device. After the 100 bills are stacked by the first stacking device 64a, on the other hand, the 101-st and subsequent bills are stacked in parallel by a second stacking device 64b.

[0086] Subsequently, as shown in FIGS. 20 and 21, one longitudinal end portion of the stacked bill bundle P is held by the upper and lower hands 96a and 96b of the hand assembly 96, and the bill bundle P is received from the transport carrier. After the bill clampers 88 are then opened to release the hold, the sheet carrier 82 is moved from the advanced position to the standby position. In this way, the stacked bill bundle P is delivered to the wrapping device 68.

[0087] Thereafter, as shown in FIG. 22, the hand assembly 96 is moved from the advanced position to the drawn-in position, whereupon the bill bundle P is passed through the looped wrapper band 91 and drawn into the binding position. The length of the bills is detected by the inspection device 18 and stored in the main control unit 12 and sub-control unit 61a. To the main control unit 12

and sub-control unit 61a, the drawn-in position according to the winding position of the wrapper band is preset. The sub-control unit 61a stops the movement of the hand assembly 96 at the time when the set drawn-in position is detected with the drawn-in position sensor, and thus the winding position (binding position) is adjusted.

[0088] When the bill bundle P is moved to the binding position, the looped wrapper band 91 is located around the predetermined binding position of the bill bundle P. The support plate 103, which extends from the lower hand 96b, is located overlapping a sealing position for the bill bundle P. During the draw-in operation for the bill bundle P, the band catcher 122 and looped wrapper band 91 are located off the draw-in path for the bill bundle P and kept from hindering the draw-in operation.

[0089] After the stacked bill bundle P is drawn into the binding position, as shown in FIG. 23, the ring gear 120 is further rotated counterclockwise to move the band catcher 122 to the vicinity of the clamping position. The band catcher 122 is pivoted to the substantially horizontal position by the guide plate 150. In this way, the leading end of the wrapper band 91 clamped by the band catcher 122 gets in below the bill bundle P and is held there. The looped wrapper band 91 is located around the binding position for the stacked bill bundle P and in the position where it covers the support plate 103 on the hand assembly 96. Thus, the position of the band catcher 122 can be regulated by only rotating the ring gear 120. On the other hand, the base carrier 80 of the transport carrier is moved to and kept on standby in the second position where it faces the second stacking device 64b.

[0090] Subsequently, as shown in FIG. 24, the wrapper band 91 is pulled back a certain distance by the band feed mechanism 94 such that the size of its loop is reduced, whereby the wrapper band is loosely wound around the bill bundle P and support plate 103.

[0091] Then, as shown in FIGS. 25 and 26, the first band retainer 152 is pivoted from the standby position to the retaining position by the first clasper drive mechanism 162, and the wrapper band 91 is pressed and held against the lower surface of the support plate 103 by the first band retainer. Since the surface hardness of the first band retainer 152 is higher than that of the support plate 103, frictional force can be produced by scratching (or forming small dents in) the lower surface of the support plate 103 so that the wrapper band 91 can be gripped without slipping, as shown in FIG. 27.

[0092] As shown in FIG. 27, moreover, the upper clasper 160 is pivoted in association with the first band retainer 152 from the up position to the down-press position by the first clasper drive mechanism 162. In the up position, the upper clasper 160 is located off the transport paths for the stacked bill bundle P and wrapper band 91. In the down-press position, the upper clasper 160 presses the stacked bill bundle P grasped by the hand assembly 96 and the wrapper band 91 from above. The upper clasper 160 presses the stacked bill bundle P and wrapper band 91 from above so that the opposite side portions

of the bill bundle P are curved downward. As this is done, the press member 161 in the upper clasper 160 abuts and presses the wrapper band 91 against the bill bundle P, thereby preventing slackening. In this state, the wrapper band 91 is further pulled back a certain distance by the band feed mechanism 94 to tighten the wrapper band wound around the bill bundle P.

[0093] Then, as shown in FIGS. 28 and 29, the second band retainer 170 is pivoted from the standby position to the retaining position by the second clasper drive mechanism 190, whereupon it presses and holds the trailing end portion of the wrapper band 91 against the lower right corner of the bill bundle P. In this state, the trailing end of the wrapper band 91 is cut by the cutter 148.

[0094] Subsequently, as shown in FIG. 30, the heater 180 is moved in association with the second band retainer 170 from the standby position to the heat-sealing position by the second clasper drive mechanism. The heater 180 moves to the heat-sealing position while pushing up the trailing end portion of the cut wrapper band 91 and presses the trailing end portion of the wrapper against the support plate 103 to overlap with the wound wrapper band. In this state, the overlapping portion of the wrapper band 91 is heat-sealed by the heater 180.

[0095] After the wrapper band 91 is heat-sealed, as shown in FIG. 31, the first band retainer 152, upper clasper 160, second band retainer 170, and heater 180 are returned to their respective standby or up positions and kept apart from the stacked bill bundle P. As a press by the upper clasper 160 is released, the bill bundle P is restored from a curved state to a flat state. Thus, the wrapper band 91 can be tightened more firmly, so that the bill bundle P can be wrapped more securely.

[0096] When the wrapping of the stacked bill bundle P with the wrapper band 91 is finished, the hand assembly 96 grasping the stacked bill bundle P is moved forward, that is, toward the release table 84, from the drawn-in position at the predetermined speed by the hand drive mechanism 98 as shown in FIG. 32. When the hand assembly 96 is advanced to the predetermined position, it is opened (or released) so that the hold on the bill bundle P is released. Thereupon, the bill bundle P is thrown out onto the release table 84. Then, the trailing end of the stacked bill bundle P on the release table 84 is pressed by an ejection lever (not shown). Thus, the stacked bill bundle P on the release table is discharged to the outside of the apparatus.

[0097] After the bill bundle P is thrown out onto the release table 84, as shown in FIG. 33, moreover, the next wrapper band 91 is delivered by the band feed mechanism 94 of the band feeder and its leading end is grasped by the band catcher 122. Then, the ring gear 120 is pivoted counterclockwise to move the band catcher 122 from the clamping position to the standby position, thereby forming the looped wrapper band 91. As this is done, the stacked bill bundle P is received from the second stacking device 64b by the transport carriers 80 and 82, and moreover, it is transported to a position where it faces

the wrapping device 68.

[0098] Thereafter, the bill bundle P is delivered to the wrapping device 68, whereupon the wrapper band 91 is wound around the bill bundle P to wrap it in the same manner as described above.

[0099] Thus, the stacking/wrapping module 60 stacks and wraps fit or unfit bills from the main module 10 and sorting module 30 in a predetermined number at a time, according to denomination and fitness, and feeds bundles (or wads) of bills. The wrapped bill bundles are discharged into and successively stacked in layers in the discharge unit 73 below the stacking/wrapping module.

[0100] As shown in FIG. 1, the large-capacity stacking module 174, which is disposed downstream relative to the stacking/wrapping module 60, comprises a transport path 141 and large-capacity stacking chamber 175. The bills P fed from the stacking/wrapping module 60 are transported through the transport path 141. A fixed number of bills individually transported through the transport path 141 can be stacked in the stacking chamber 175.

[0101] A safety pocket 176 is disposed most downstream of all the modules. If there is any bill having failed to be processed during the transport through the modules, it is discharged into the safety pocket 176 and removed from the apparatus.

[0102] According to the bill processing apparatus constructed in this manner, paper sheets can be picked up so stably that its reliability can be improved. In the bill processing apparatus, moreover, the first and second stacking devices are offset obliquely relative to each other and the bills stacked by the first and second stacking devices are transported to the wrapping device by means of the common transport mechanism. Thus, the stacking/wrapping apparatus can be made space-saving and miniaturized.

[0103] The looped wrapper band can be previously formed while the bill bundle is being transported by the transport carrier so that the wrapper band can start to be wound immediately after its delivery. Thus, the transport carrier can immediately start to receive the next bill bundle, so that the processing time can be reduced.

[0104] According to the wrapping device, the drawn-in position of the hand assembly can be adjusted to a plurality of locations, and thus the wrapper band can be wound at any position of paper sheets in accordance with the needs. When it is done, the band winding mechanism of the binding device, the cutter, heater and the like are disposed at fixed positions, and the movement amount of the hand assembly, that is, the drawn-in amount of the stacked bill bundle, is adjusted. In this manner, it becomes possible to change the winding position of the wrapper band on the stacked bill bundle. Thus, the winding position can be arbitrarily set without making the apparatus complicated or increased in scale.

[0105] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the

scope of the inventions. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

[0106] For example, in the embodiment described above, the upper clasper of the clamp mechanism comprises two or two sets of press members. This structure is in no way restrictive, and the upper clasper is required to comprise at least one push member capable of pressing a bundle of paper sheets. In addition, the shape of the press members is not limited to that described in connection with the above embodiment; it may be determined arbitrarily. For example, the press portion of the press member need not have a linearly slanted shape but may have an arcuate curved shape.

Claims

1. A paper sheet processing apparatus comprising:

a stacking device (64, 64b) configured to stack paper sheets by a predetermined number of sheets; and
a wrapping device configured to wrap a stacked paper sheet bundle by winding a band thereon, **characterized in that** the wrapping device further comprises:

a band winding device (100) configured to wind the band on the stacked paper sheet bundle and tighten the band, a hand assembly configured to grasp the stacked paper sheet bundle by holding an end thereof, a hand assembly drive mechanism (98) configured to draw the stacked paper sheet bundle to an arbitrary position with respect to the band winding device by reciprocating the hand assembly in a direction perpendicular to a stacking direction of the paper sheet bundle, detectors (118a, 118b, 118c) configured to detect a plurality of drawn-in positions of the hand assembly, and a control unit (12) configured to stop the hand assembly at an arbitrary drawn-in position detected by the detectors and adjust a band winding position on the paper sheet bundle.

2. The paper sheet processing apparatus of Claim 1, **characterized in that** the wrapping device (68) further comprises a clamp mechanism configured to curve the stacked paper sheet bundle by pressing both side portions of the stacked paper sheet bundle;

and a heater (180) configured to heat-seal an end of the wound wrapper band.

3. The paper sheet processing apparatus of Claim 2, **characterized in that** the band winding device (100) comprises a ring gear (120) rotatable about an axis parallel to a direction of reciprocation of the hand assembly, a band feeder (90) configured to deliver the wrapper band to the vicinity of the ring gear and pull back the wrapper band, a band catcher (122) mounted on the ring gear so as to be rotatable together with the ring gear and configured to clamp a leading end of the wrapper band delivered from the band feeder, and a band drive mechanism configured to rotate the ring gear and deliver the wrapper band from the band feeder with the leading end of the wrapper band clamped by the band catcher, thereby forming a looped wrapper band along the ring gear in the binding position, and the hand assembly is configured to draw the paper sheet bundle into the looped wrapper band.

4. The paper sheet processing apparatus of Claim 2, **characterized in that** the band feeder (90) is configured to pull back the wrapper band a certain distance to tighten the paper sheet bundle with pressing the wrapper band and paper sheet bundle at the binding position by the clamp mechanism, and the wrapping device (68) comprises a band retainer (70) configured to press and hold the tightened wrapper band against the paper sheet bundle, and a clasper drive mechanism (190) configured to move the band retainer and the heater in association with each other to a position where the band retainer and the heater abut the wrapper band.

5. The paper sheet processing apparatus of any one of Claims 1 to 4, **characterized in that** the detectors (118a, 118b, 118c) comprise a plurality of position sensors arranged side by side along a movement path of the hand assembly (96) at intervals, and a detection rib (119) provided on the hand assembly drive mechanism such as to be movable in association with the hand assembly, and detectable by the plurality of position sensors.

6. The paper sheet processing apparatus of any one of Claims 1 to 4, **characterized in that** the hand assembly drive mechanism (98) comprises a motor configured to reciprocate the hand assembly (96) and the detectors (118a, 118b, 118c) comprise a rotational position sensors configured to detect a rotational position of the motor.

7. The paper sheet processing apparatus of Claim 1, **characterized in that** the band winding device (100) comprises a ring gear (120) rotatable about an axis parallel to a direction of reciprocation of the hand

assembly, a band feeder (90) configured to deliver the wrapper band to the vicinity of the ring gear and pull back the wrapper band, a band catcher (122) mounted on the ring gear so as to be rotatable together with the ring gear and configured to clamp a leading end of the wrapper band delivered from the band feeder, and a band drive mechanism configured to rotate the ring gear and deliver the wrapper band from the band feeder with the leading end of the wrapper band clamped by the band catcher, thereby forming a looped wrapper band along the ring gear in the binding position, and the hand assembly is configured to draw the paper sheet bundle into the looped wrapper band.

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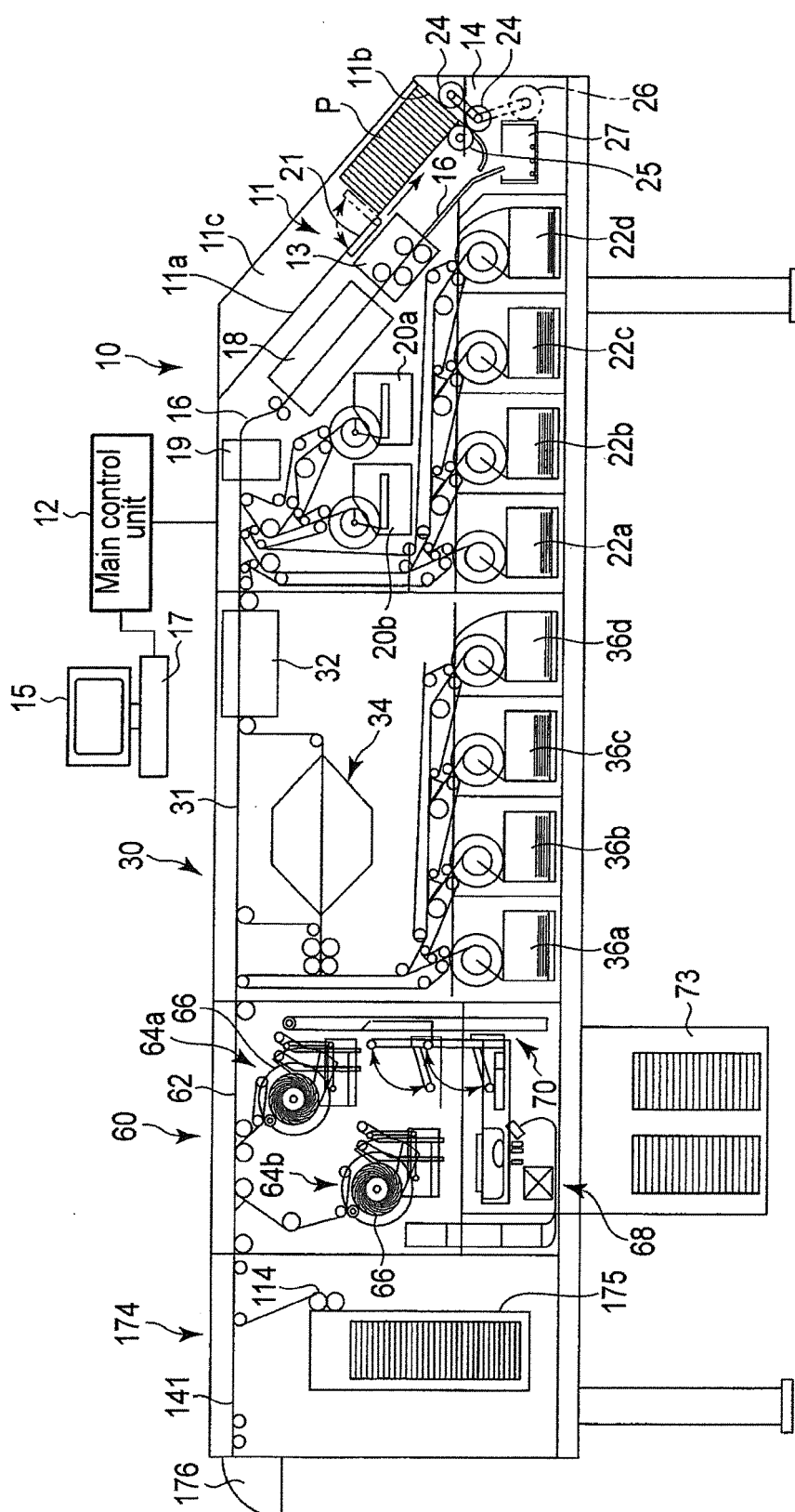


FIG. 1

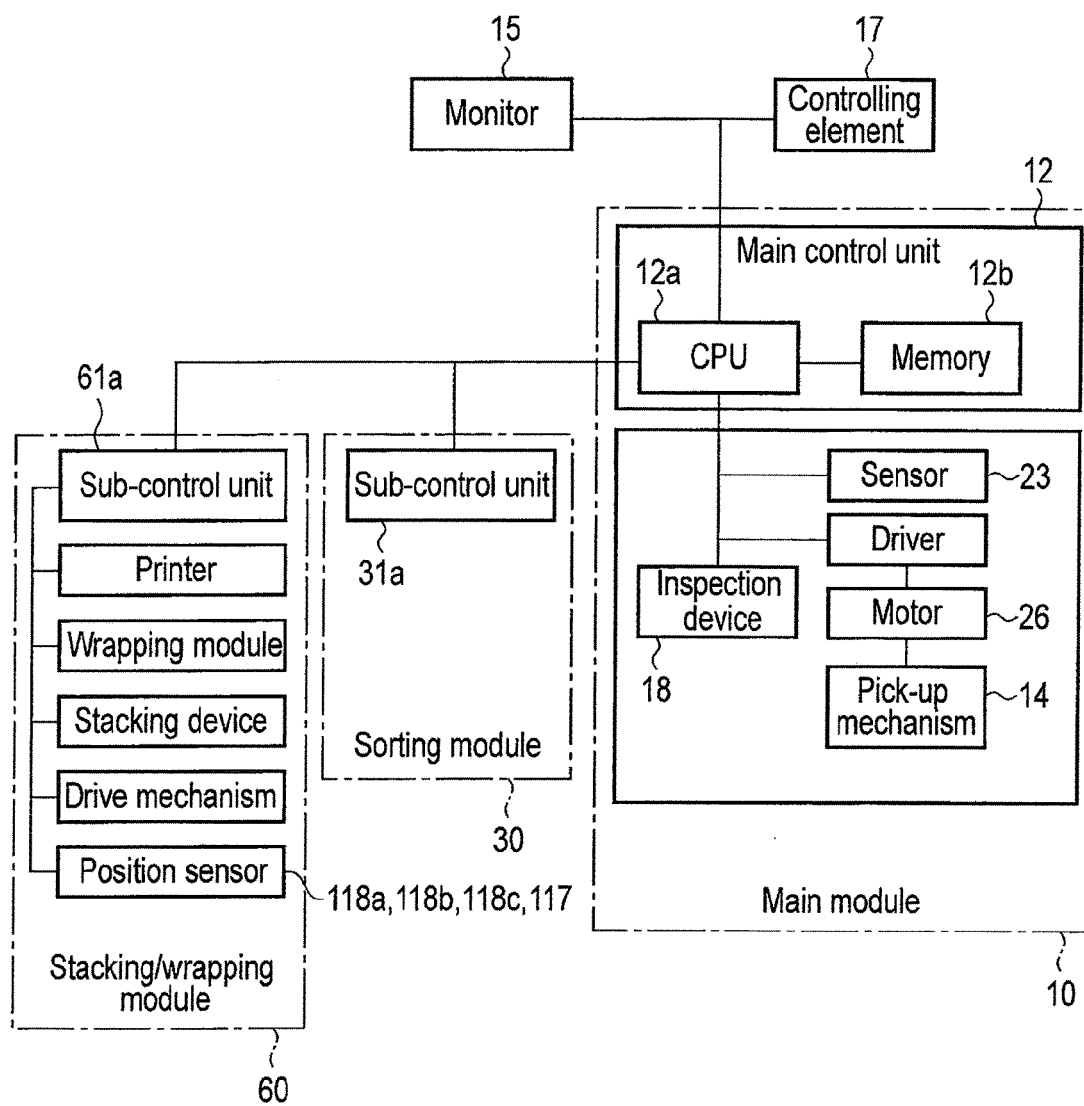


FIG. 2

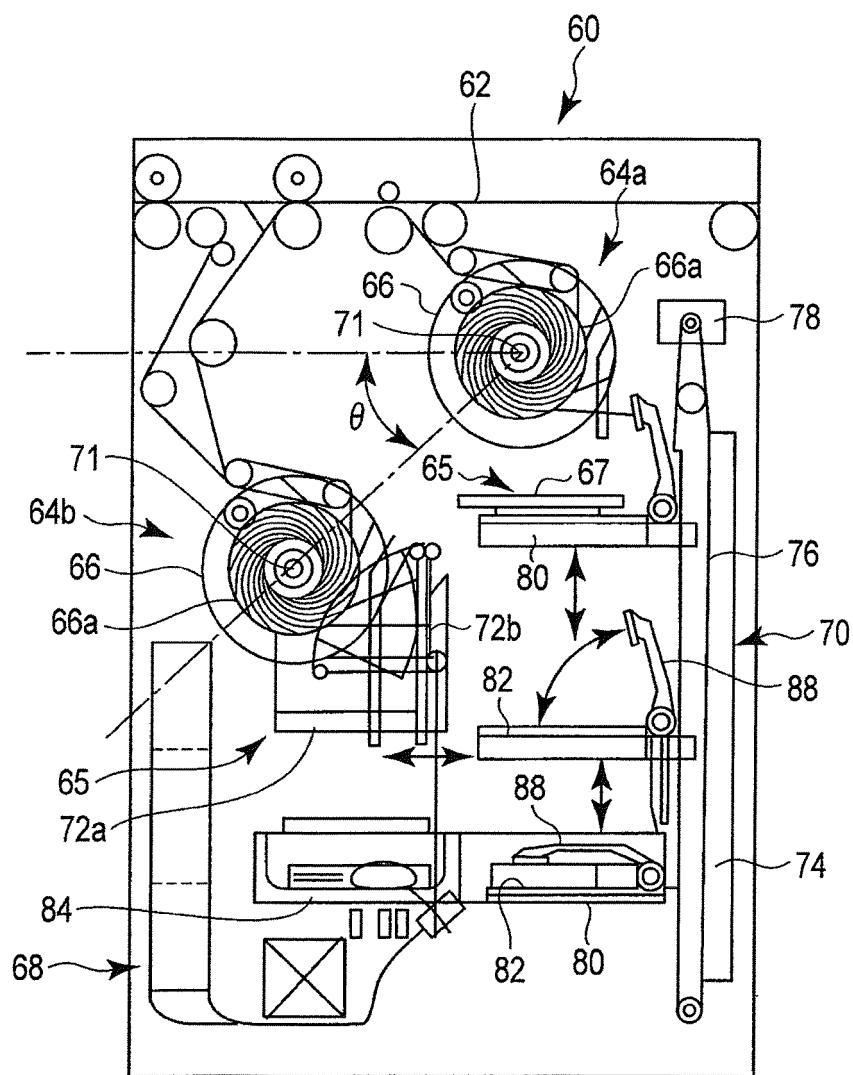


FIG. 3

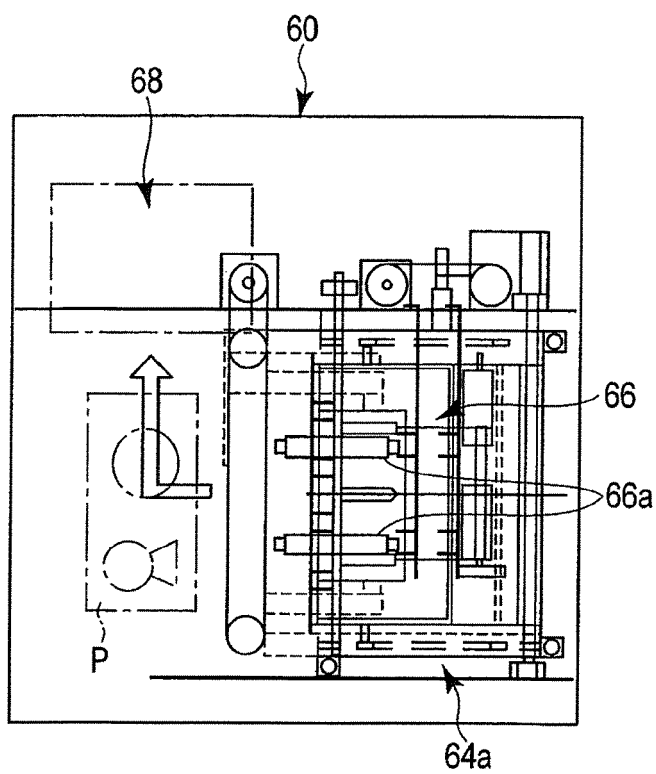


FIG. 4A

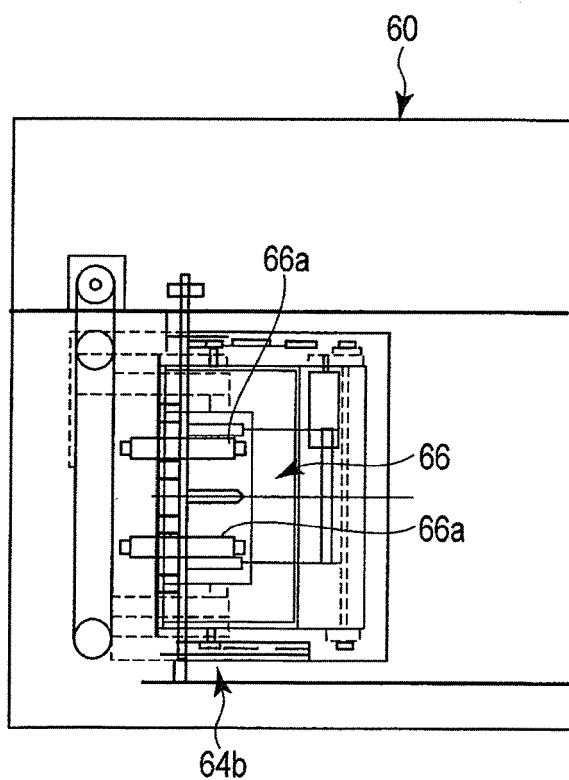


FIG. 4B

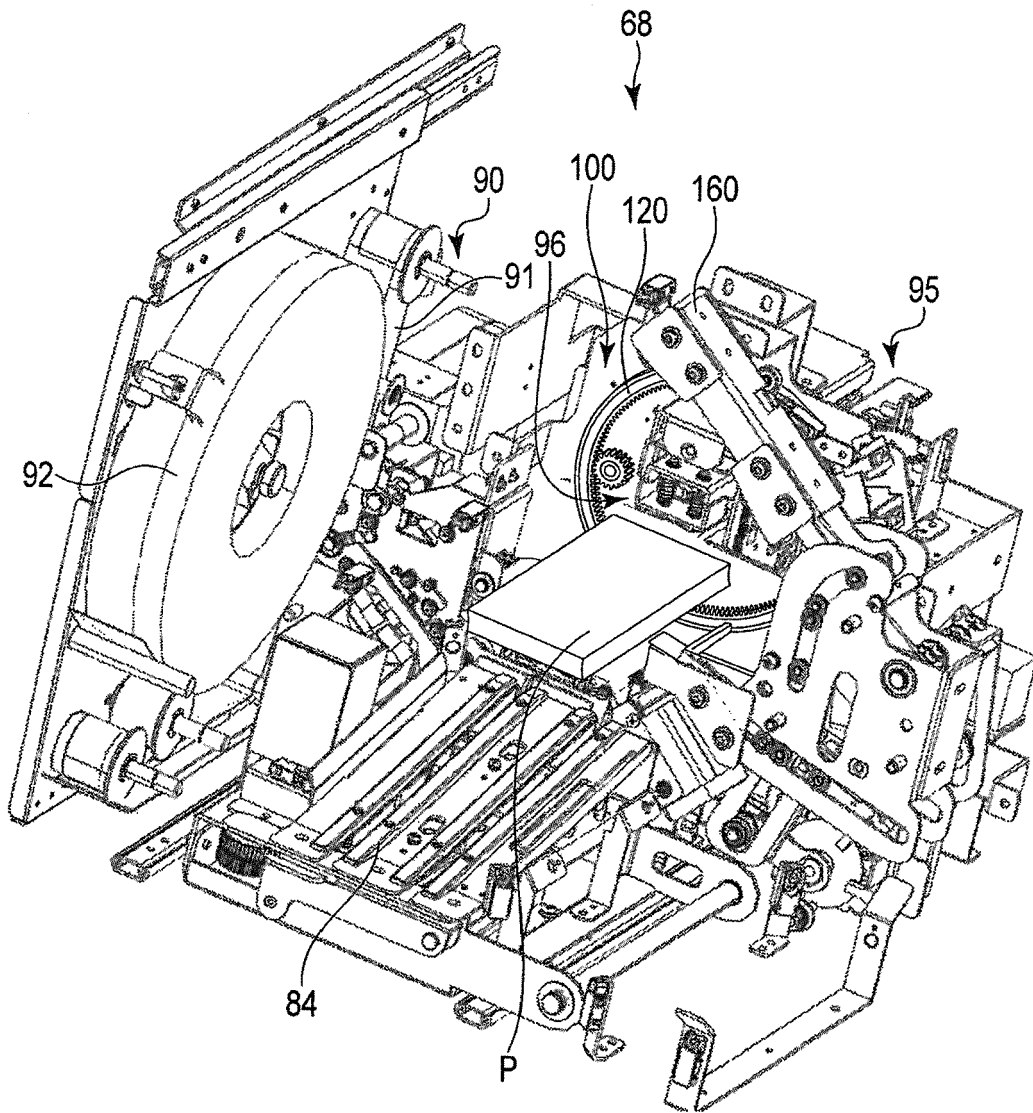
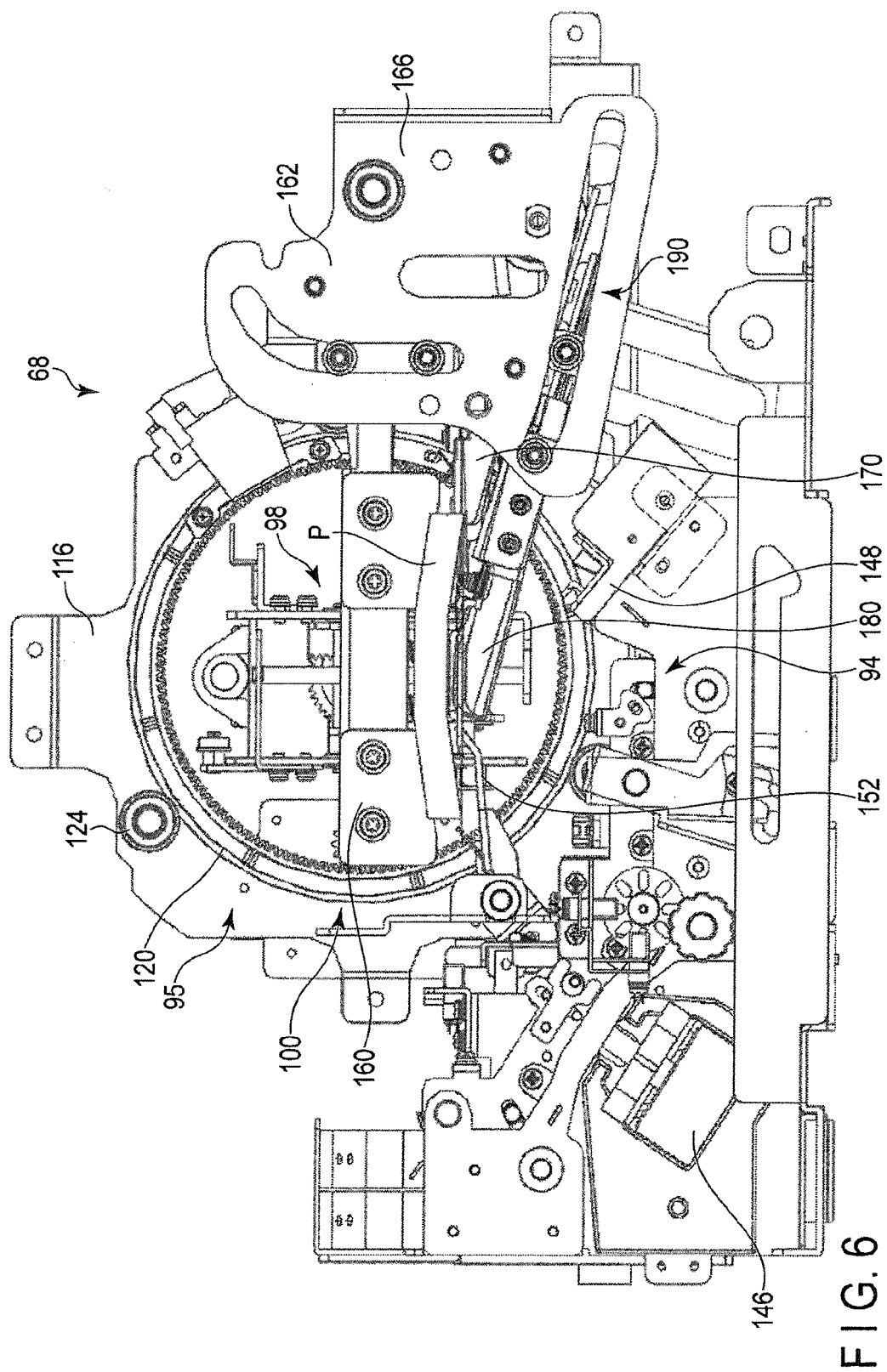


FIG. 5



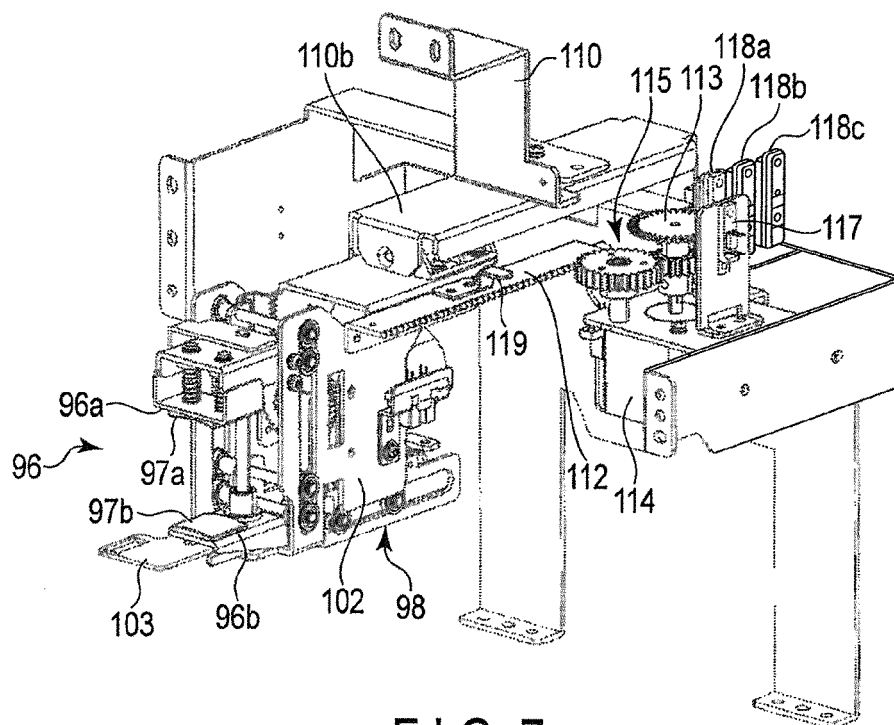


FIG. 7

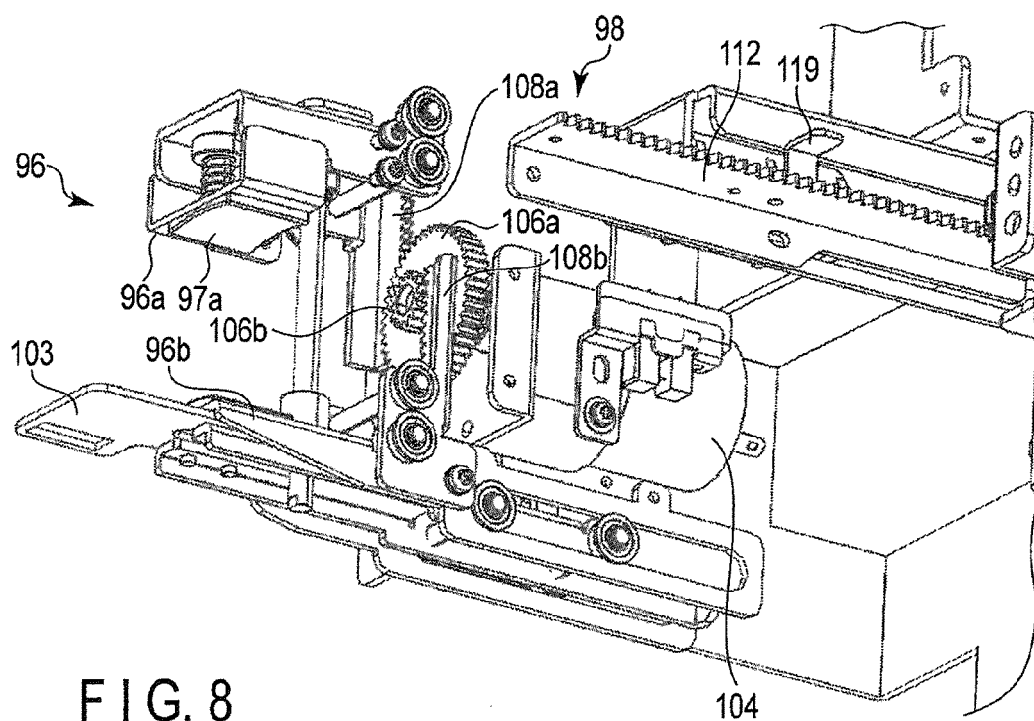


FIG. 8

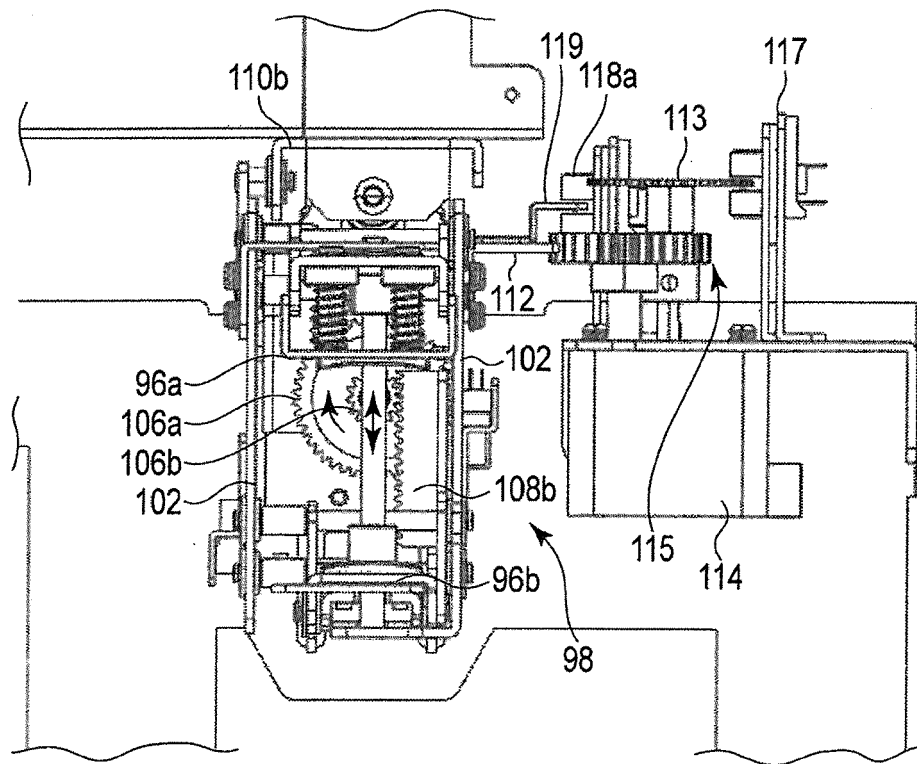


FIG. 9

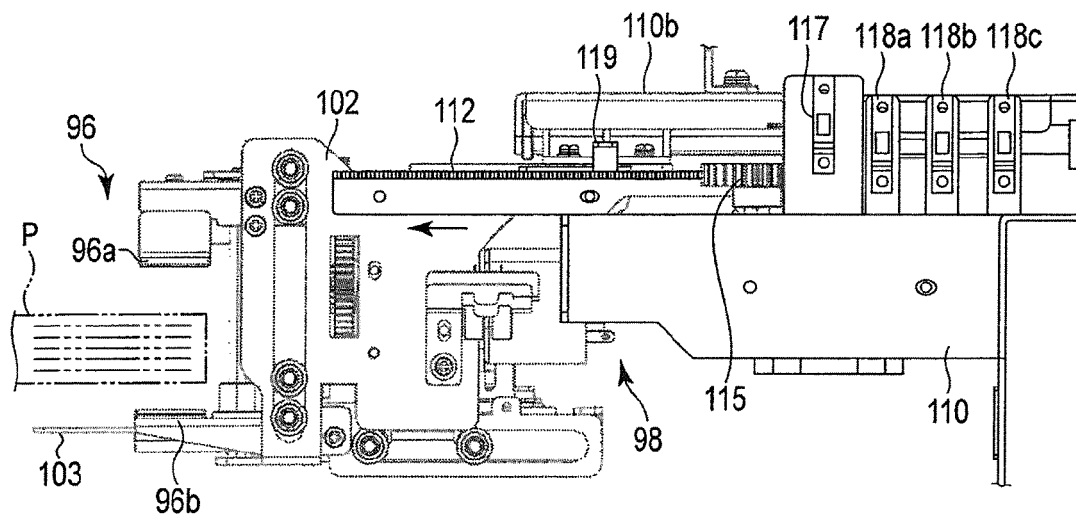


FIG. 10

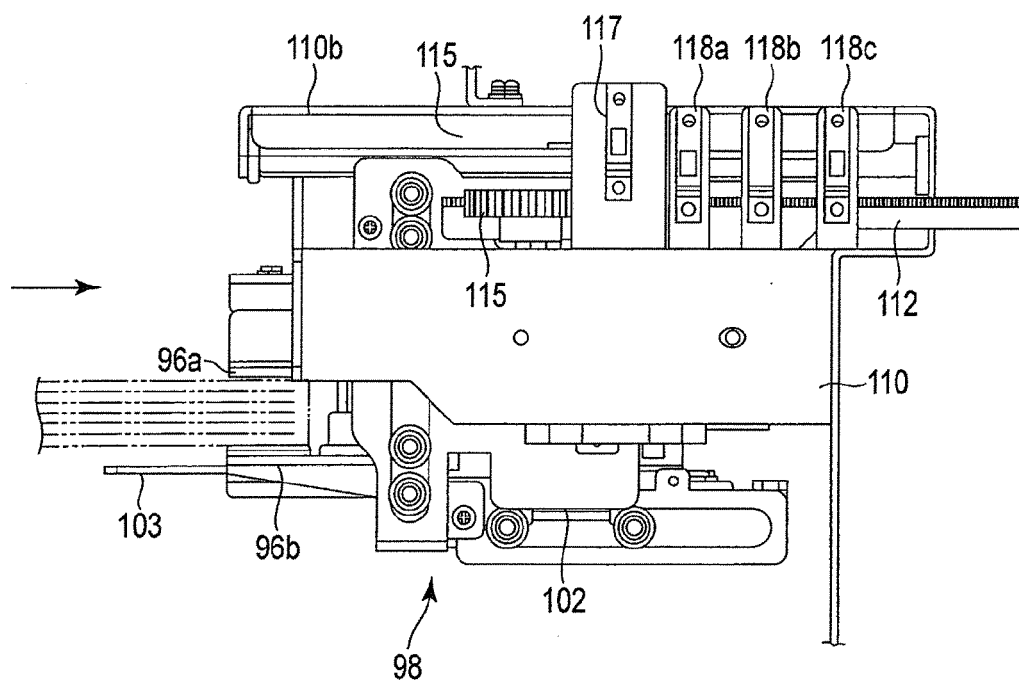
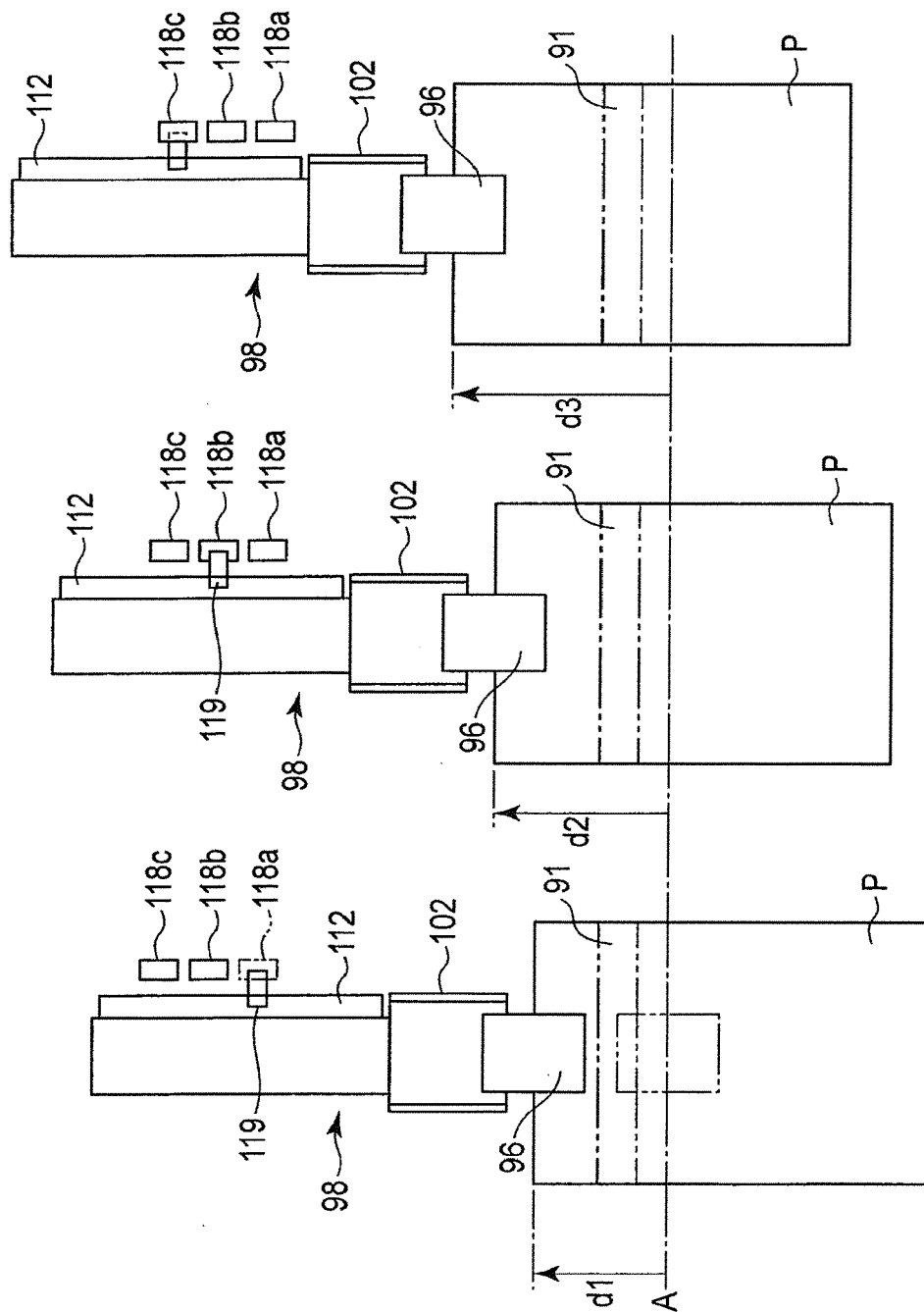


FIG. 11



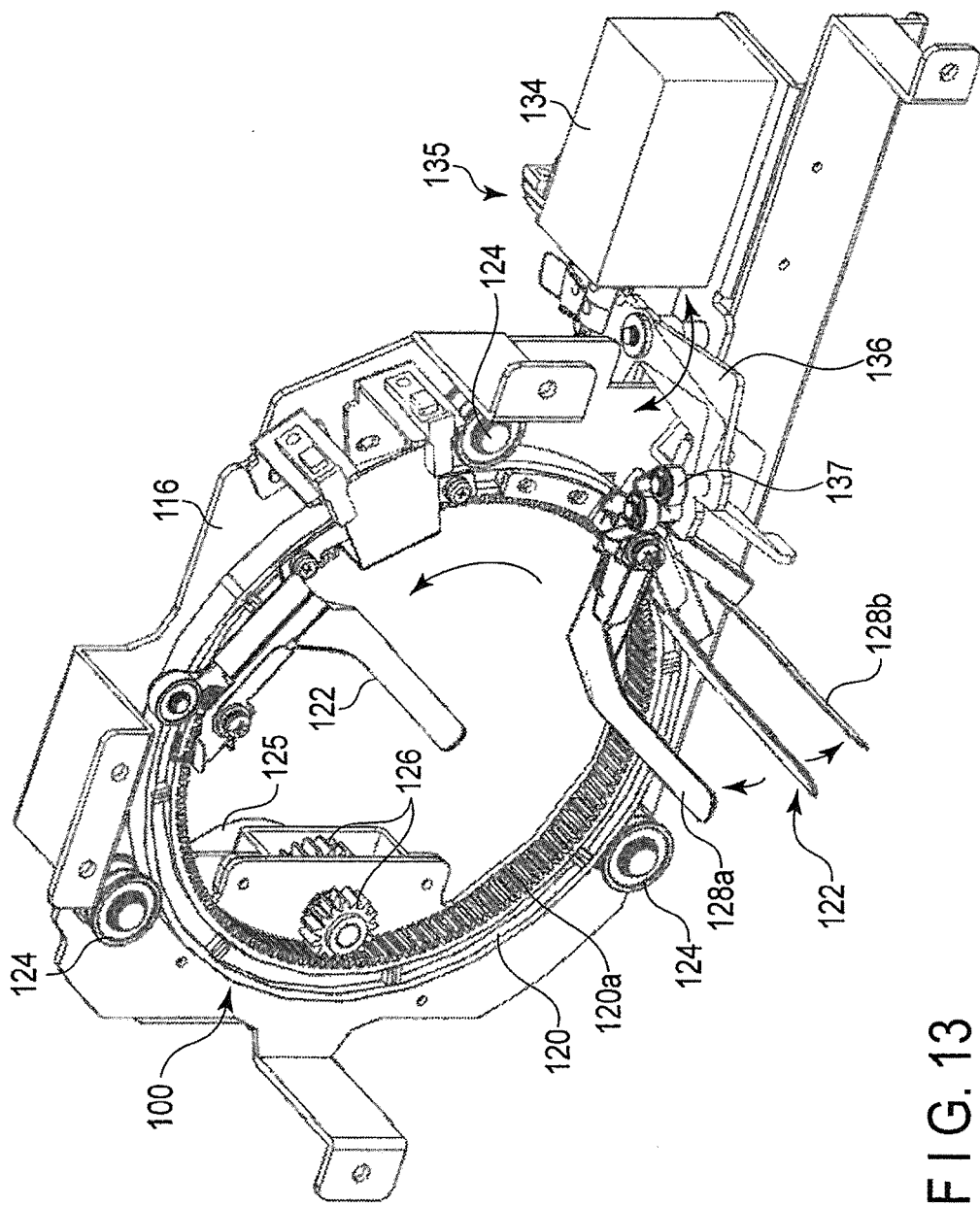


FIG. 13

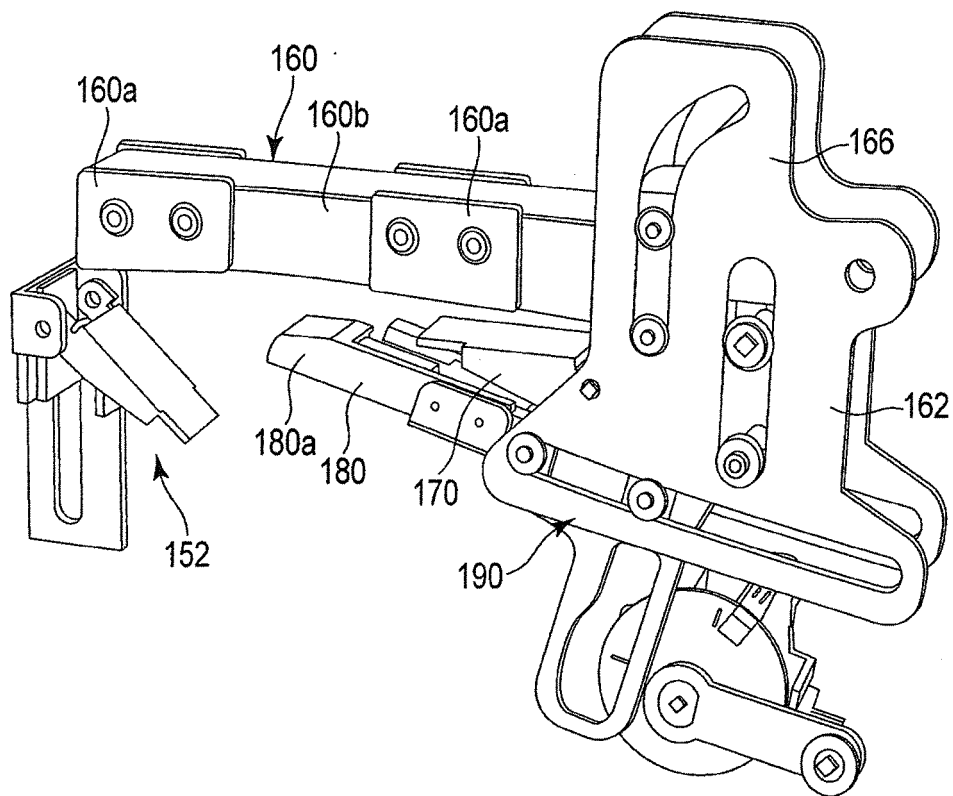


FIG. 14

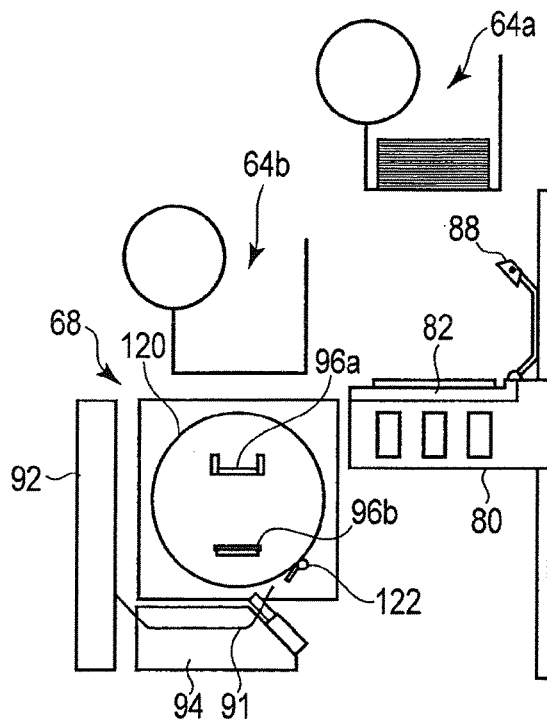


FIG. 15

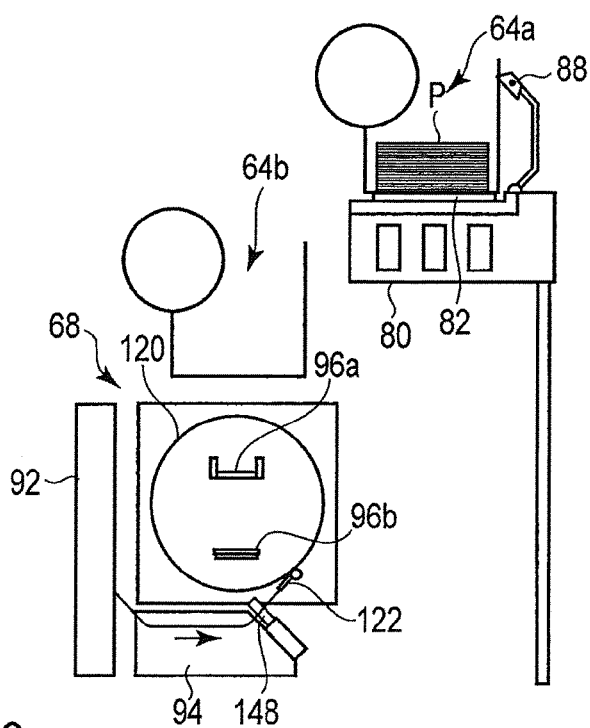


FIG. 16

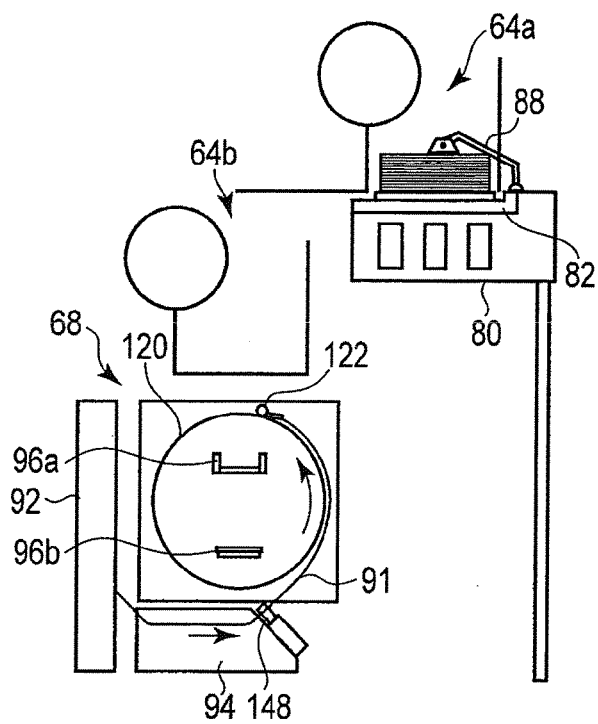


FIG. 17

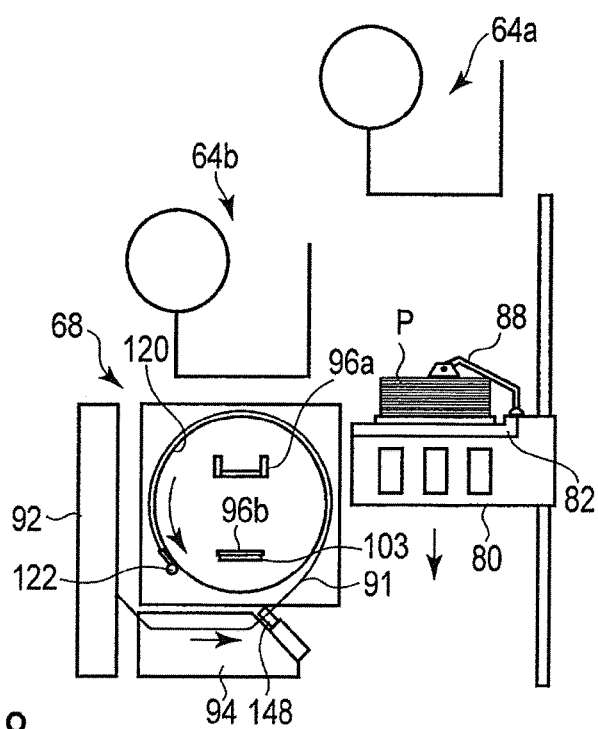


FIG. 18

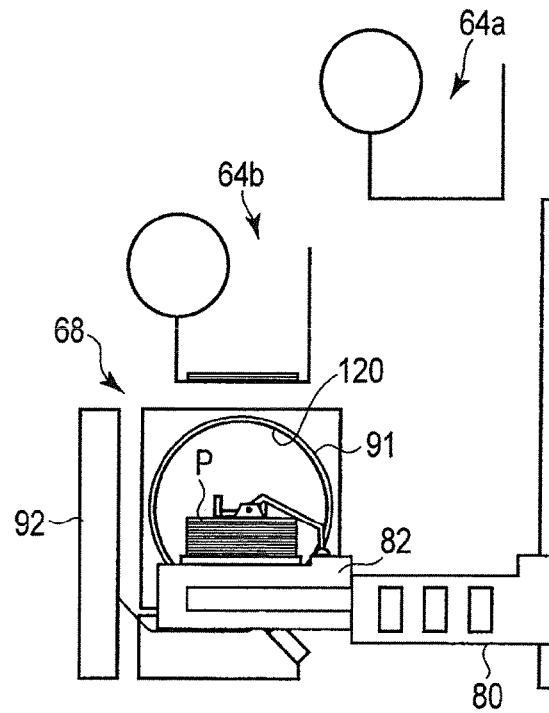


FIG. 19

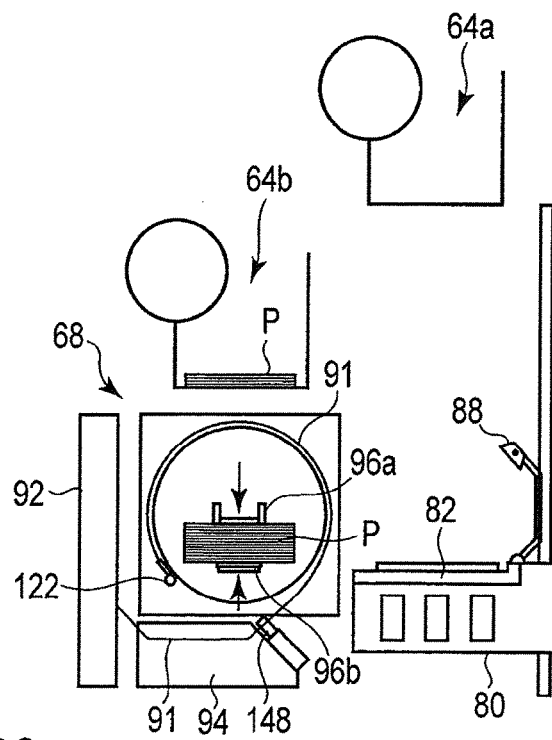


FIG. 20

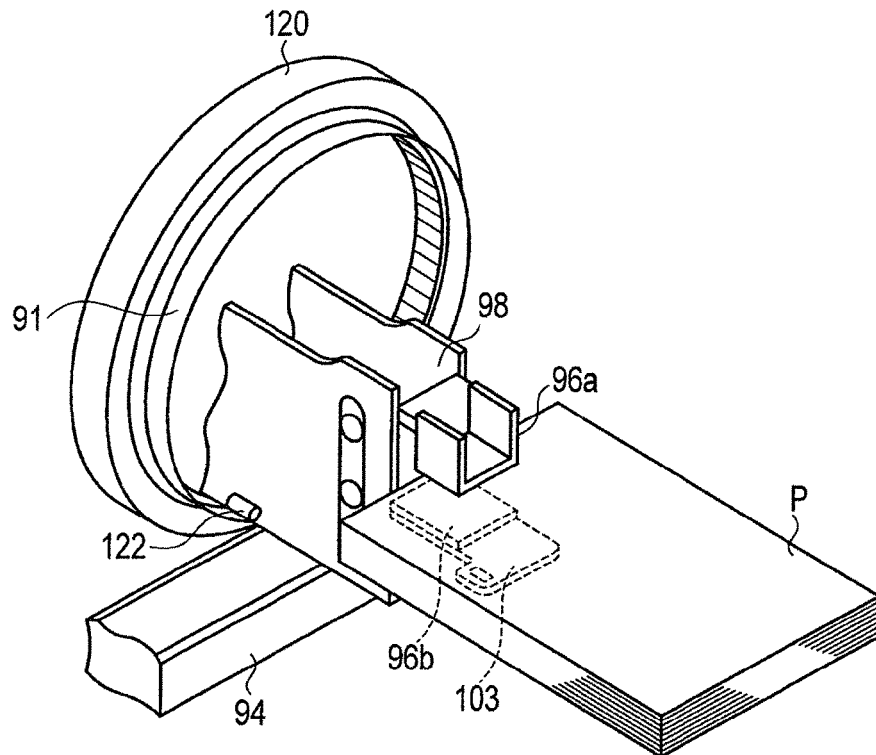


FIG. 21

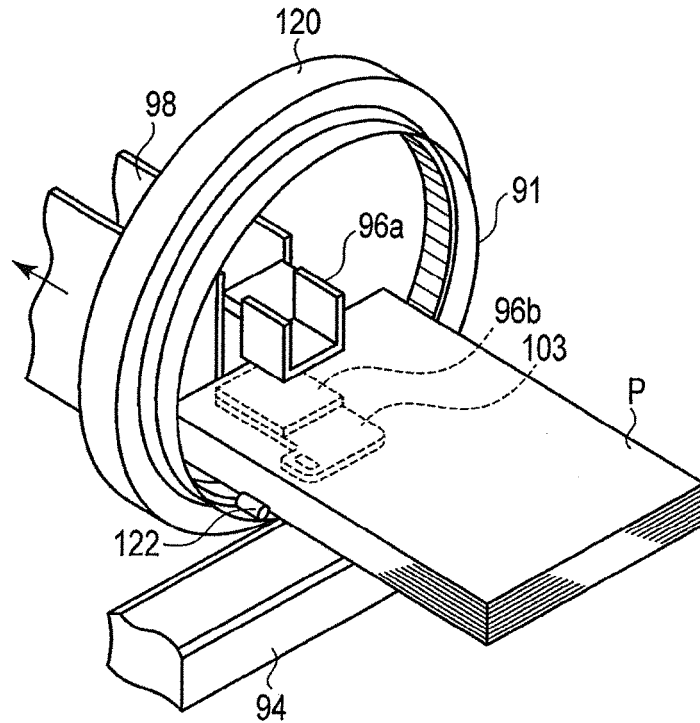


FIG. 22

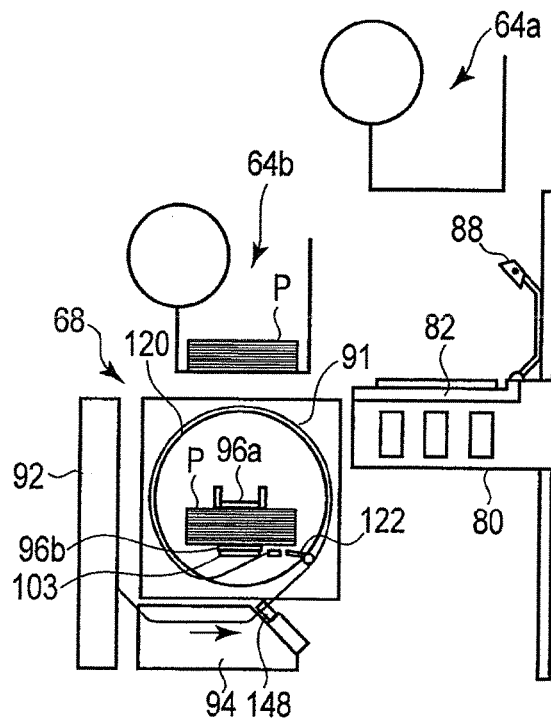


FIG. 23

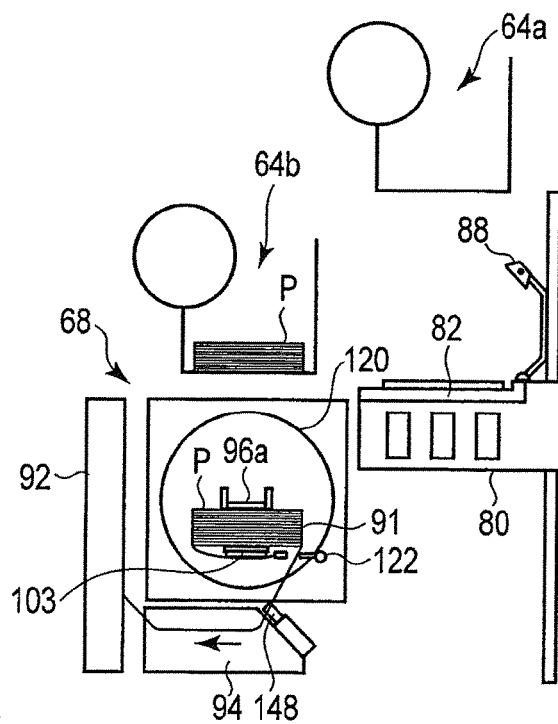


FIG. 24

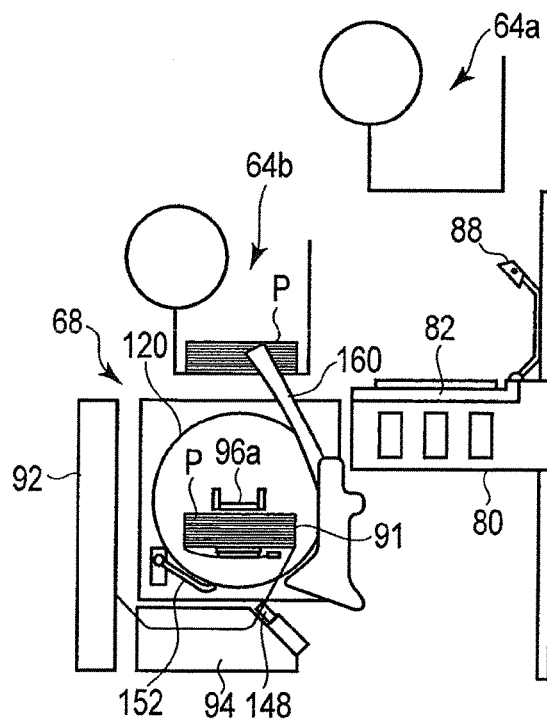


FIG. 25

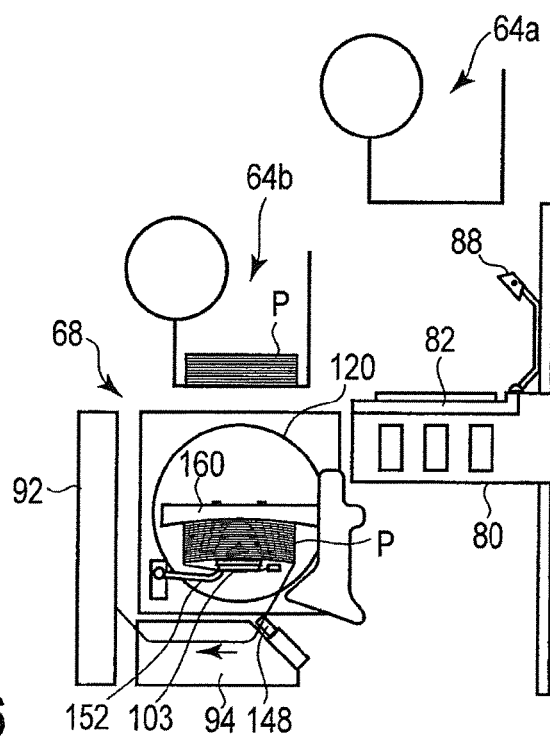


FIG. 26

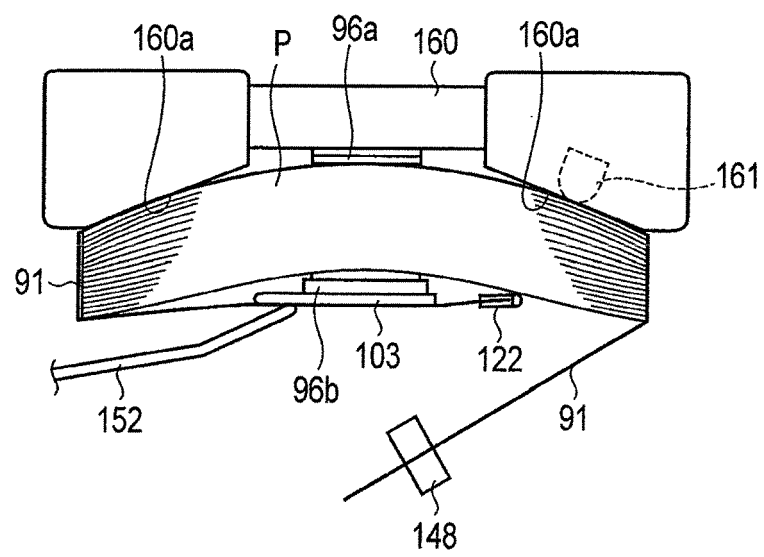


FIG. 27

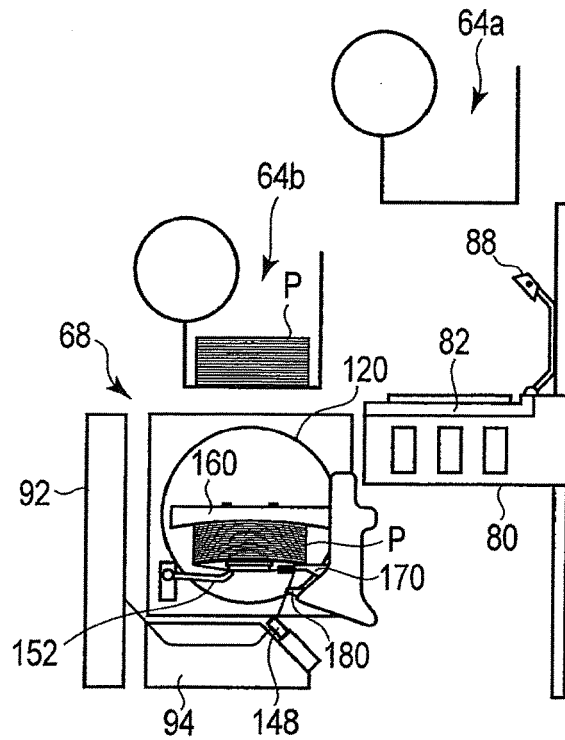


FIG. 28

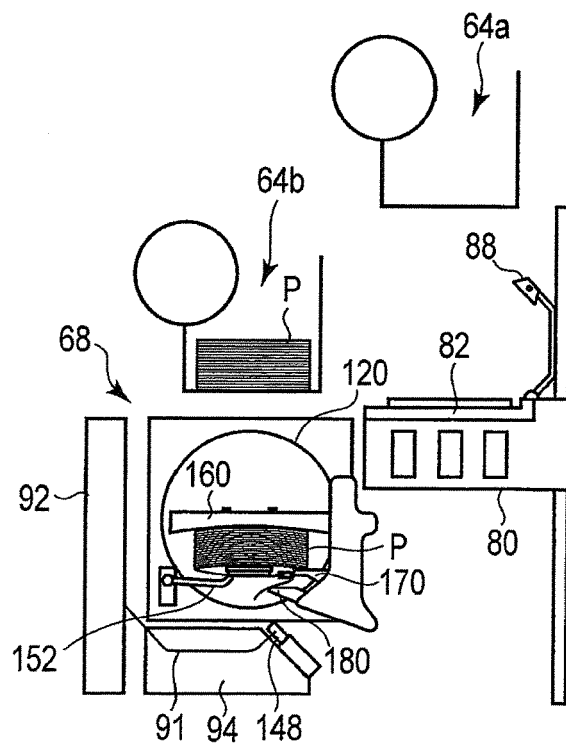


FIG. 29

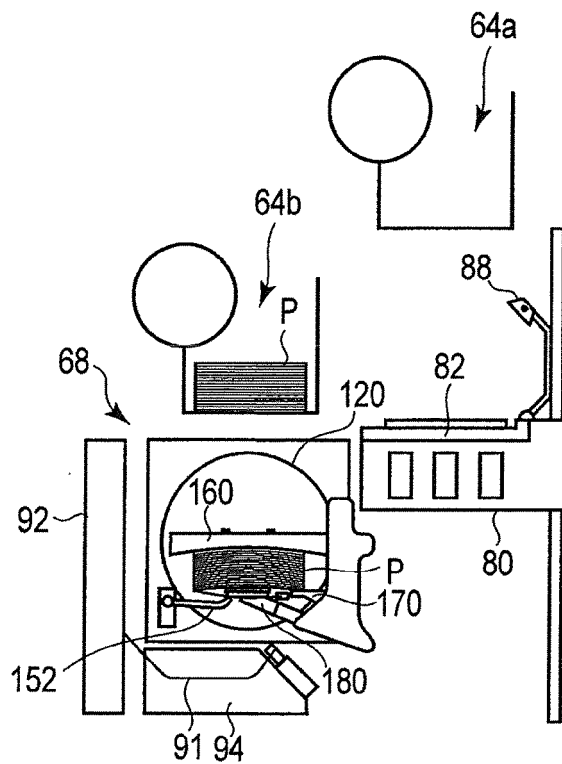


FIG. 30

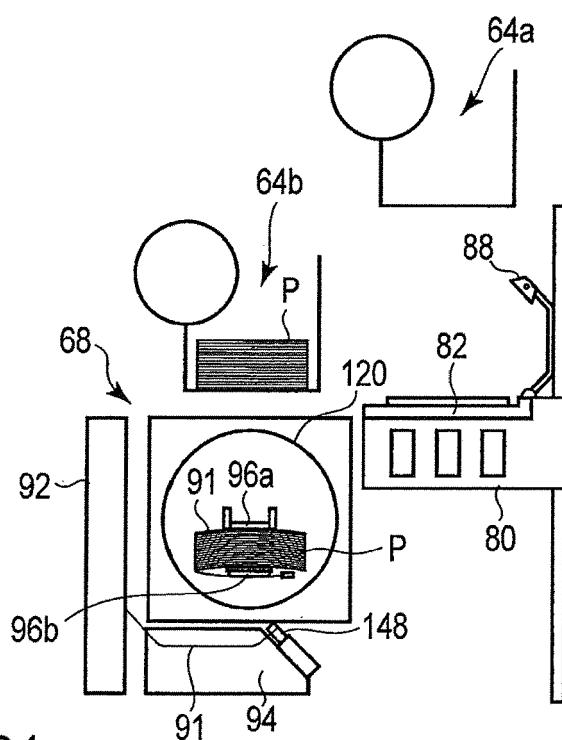


FIG. 31

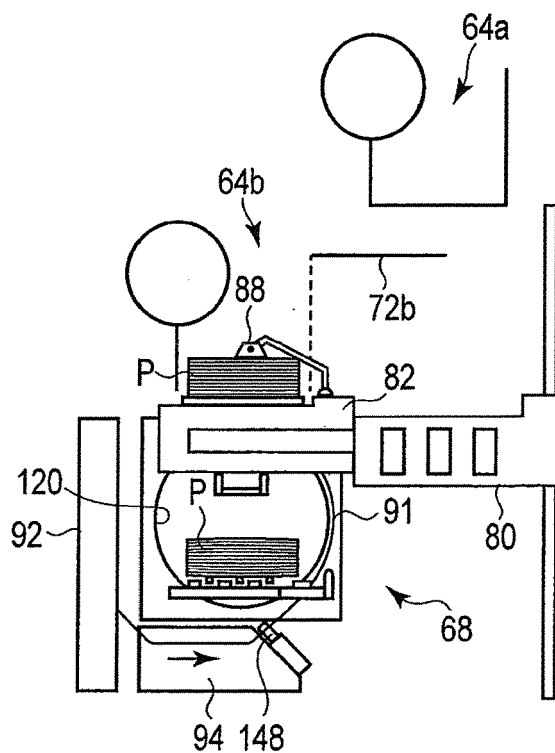


FIG. 32

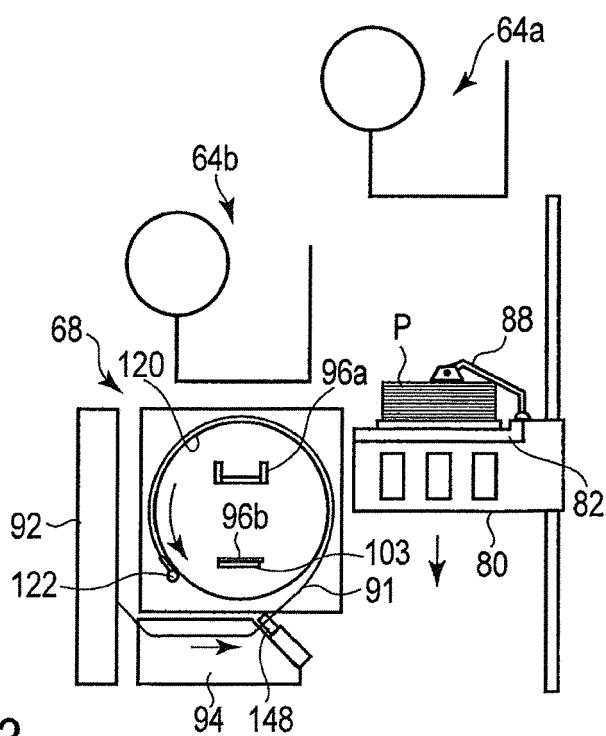


FIG. 33