(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 November 2008 (20.11.2008)

PCT

(10) International Publication Number
WO 2008/139209 A2

(51) International Patent Classification:
B65H 5/38 (2006.01) *F16B 5/06* (2006.01)

(21) International Application Number:
PCT/GB2008/001701

(22) International Filing Date: 16 May 2008 (16.05.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PCT/GB07/001774 16 May 2007 (16.05.2007) GB

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

WO 2008/139209 A2

(54) Title: DOCUMENT HANDLING APPARATUS

(57) Abstract: A document handling apparatus is disclosed for the handling of documents such as banknotes. The apparatus has an input module for feeding documents one-by-one into the apparatus from a stack. Characteristics of each document are detected by a series of detectors. From the detectors, the document passes along an output transport path to one of two output pockets selected by a controller based on signals from the detectors. The document is directed to one or other of the pockets by a diverter. A stacker is provided in each output pocket to form a stack of output documents for presentation to a user.

Document Handling Apparatus

This invention relates to a document handling apparatus for sorting, counting, authenticating or otherwise handling documents such as banknotes.

The invention provides a document handling apparatus substantially as hereinafter described with reference to the accompanying drawings.

In framework structures such as those on which conventional document handling machines are based, it is common to have side walls supporting one or more cross pieces such as shafts therebetween. The cross pieces typically support a number of functional components such as rollers and/or are configured to act as guide surfaces. Conventionally, such cross piece as assembled into the structure using fixings such as screws or bolts at either end. This can be cumbersome and time consuming to use, since it is difficult for a single operator to both hold a cross piece accurately in position whilst manipulating screws, bolts etc.

In accordance with a first aspect of the present invention, a structure for a document handling apparatus comprises first and second side walls, laterally spaced from one another and substantially parallel, each side wall being provided with a first keying feature, and a cross beam extending between the first and second side walls, the cross beam being provided with a resilient arm at each of its ends, each resilient arm extending substantially perpendicular to the axis of the cross beam and having a chamfer therein defining a first region of the resilient arm adjacent the cross beam and a second region of the resilient arm towards the distal end of the resilient arm, such that the second region is displaced away from the cross beam in the axial direction of the cross beam, and a second keying feature is provided in the second region of each resilient arm, the second keying feature being adapted to couple with the first keying feature in use.

By providing the cross beam with resilient arms in this way, the component can be slid into position straightforwardly and without the need for any extra fixing components. The chamfers allow the component to be inserted without the user needing to flex the arms to fit over the keying features themselves, which can be

difficult and may have health and safety consequences. Instead, by pulling the component such that the keying features pass over the chamfers, the keying components themselves are able to flex the arms to the position necessary. Once the first and second keying features are aligned, the arms can return to their original position and the cross beam is held in position.

Preferably, the first keying feature comprises a boss, and the second keying feature comprises an aperture. Advantageously, the resilient arms are integrally formed with the cross beam.

In a particularly preferred example, the cross beam is shaped so as to provide a guide surface for guiding documents in the document handling apparatus.

Preferably, the cross beam and resilient arms are formed of sheet metal.

In document handling machines it is often advantageous if one or more parts of the machine are openable in order to provide access to the transport path for jam clearance. However, the moveable parts are often heavy due to the transport components mounted therein and may also be delicate if they contain sensors or electronics. It is therefore desirable that such openable parts, generally plates, are prevented from opening so far as to cause damage, either to a machine, its surroundings or the user. However in some cases this position may not always provide sufficient access to the machine interior.

In accordance with a second aspect of the present invention, a detent assembly is provided for arresting rotation of a plate pivotably mounted to a wall of a structure for a document handling apparatus, the detent assembly including a detent device comprising a mounting shaft affixed to the wall of the structure, a stop body slidably supported on the mounting shaft, and spring means arranged to urge the stop body into a first position, the assembly further comprising a first feature arranged on the plate to align with the stop body in its first position, such that when the first feature contacts the stop body in its first position, rotation of the plate is arrested at a first stop angle, the body and first feature being arranged such that, when the stop body is displaced into a second position, the first feature ceases to align with the stop body

and the plate is permitted to rotate past the first stop angle to a second stop angle in which a second feature provided on the plate contacts the stop body.

It will be appreciated that the term "plate", used here, is construed generally to include sections of transport or detector housings etc. By providing a detent assembly which can be moved between first and second positions and is urged towards its first position, upon opening, the plate is generally "caught" by the stop body in its first position. However, should additional access be necessary, the stop body can be slid against the resilient means to allow the plate to open further to a second position.

Preferably, the stop body is arranged to be non-rotatable relative to the mounting shaft. This may be achieved by arranging contact between the stop body and the structure of the document handling apparatus or by mounting the stop body to the shaft in a non-rotatable manner, for example.

Advantageously, the stop body is provided with first and second arresting surfaces, the first arranged to align with the first feature of the plate when the stop body is in its first position, and the second arranged to align with the second feature of the plate when the stop body is in its second position. Preferably, the first arresting surface is provided by a boss protruding from the stop body parallel to the axis of the mounting shaft. In a particularly preferred example, the boss is arranged to space the stop body from the wall of the structure. This aids the user in gripping the stop body to slide it between positions.

In other examples, an openable panel may also need to be removable and it is preferred that disassembly and reassembly be achieved with few or no additional fixing parts. It is also desirable that the panel can be opened by an amount without automatic detachment.

In accordance with a third aspect of the invention, a fixing assembly is provided for removably mounting a first plate pivotably to a second plate, the first plate comprising an aperture and having a shaft extending partially across the aperture, the second plate comprising a protrusion arranged to extend into the aperture in use and to receive the shaft such that the second plate is pivotably mounted to the first, and the

second plate further comprising a tab extending from the protrusion and having at least one substantially planar surface, the tab being arranged such that, at one or a maximum of two rotational positions, the planar surface of the tab is spaced from and substantially parallel to the first plate such that the second plate may be slid along the axial direction of the shaft without obstruction by the tab, and at all other rotational positions the tab prevents sliding of the second plate relative to the first.

In this way, the second plate can be pivoted away from the first to open the assembly, and will remain attached to the first plate. Only when the planar surface of the tab is aligned parallel to the first plate by rotation the second plate to a certain position can the two be disengaged.

In one preferred example, the shaft lies in the plane of the first plate, and the tab is spaced from the axis of rotation. In other preferred examples, the shaft lies parallel to but spaced from the plane of the first plate, and the tab intersects the axis of rotation.

Advantageously, the first plate and tab are arranged such that the tab prevents sliding of the first plate when the plates are at the base of their rotation, under the influence of gravity. This prevents the plates from separating automatically upon the influence of gravity.

Preferably, the first plate is fixedly supported in the structure of a document handling assembly, and the second plate comprises a panel which is openable for access to the interior of the document handling assembly. In a particularly preferred embodiment, the panel forms part of a control panel and supports one or more of a PCB, a display and input keys.

In conventional document handling apparatus, upon start up, the user configures the machine to carry out the desired tasks by selecting from a number of settings options. These may include: sorting modes, counting modes, currency, denomination etc as well as user preferences such as volume, language etc. If only a single user operates the machine, it may be sufficient to store his settings and implement them each time the apparatus is initiated. However, in other cases several users may be required to use the machine at different times and, perhaps, for

different tasks. Conventionally, each user would be required to reconfigure the machine upon start up each time.

In accordance with a fourth aspect of the invention, a document handling apparatus comprises a controller and a memory, the memory being adapted to store one or more setting, each setting being associated with a user identifier and comprising one or more parameters for determining the operation of the document handling apparatus, the controller being adapted to, upon input of a user identifier by a user, retrieve the corresponding setting from the memory and configure the document handling apparatus to operate according to the parameters of that setting.

By storing each user's settings in this way, the user input required at start up is substantially reduced.

Preferably the one or more parameters relate to one or more of: selection of a process mode, selection of currency and/or denomination, selection of language, remote display configuration, user access to functions and user access to detectors.

Advantageously the controller is further adapted to prevent modification of a user's setting by that user. This increases security and accuracy, since the user is not able to change the saved settings. For example, this could prevent a user inadvertently selecting the wrong count or sort mode, or currency. The saved settings need not include all the machine functionality so the user may still be able to adjust personal preferences, for example.

Preferably the controller is further adapted to, upon input of a supervisor identifier, permit modification of a user's setting by the supervisor, and to store the modified setting in the memory. Hence the saved settings can be amended as required by a supervisor (with a higher permissions level than that of the user).

In particularly preferred examples, at least one of the settings stored in the memory is associated with more than one user identifier. Thus, settings can be "shared" between multiple users, leading to a further decrease in the set up time and enhanced security and consistency.

The fourth aspect of the invention further provides a method of configuring a document handling apparatus having a controller and a memory, the method comprising:

receiving an input user identifier at the controller;

retrieving a corresponding setting stored in the memory, the setting comprising one or more parameters for determining the operation of the document handling apparatus; and

configuring the document handling apparatus to operate in accordance with the parameters of the retrieved setting.

In preferred examples the method further comprises:

receiving a supervisor identifier at the controller;

receiving data relating to modifications of a user's setting and modifying the setting accordingly;

storing the modified setting in the memory.

Conventional document handling apparatus are often configured such that one or more points on the document transport path are accessible to a user by opening panels in the structure. This however is time-consuming and may not be successful if the jammed document is not close to one of the accessible points.

Therefore, a fifth aspect of the invention provides a method of clearing a jam in a document handling apparatus having an input module for feeding documents into the apparatus, an output module for outputting documents from the apparatus, and a document transport path therebetween, the method comprising:

inputting a jam clearance sheet into the input module, the jam clearance sheet being of dimensions no larger than those of the documents to be handled by the apparatus and being formed from a relatively stiff material;

actuating the apparatus to convey the jam clearance sheet through the apparatus; and

retrieving the jam clearance sheet and any jammed document debris from the output module.

This technique enables a jam to be cleared without requiring opening of the document handling apparatus.

Preferably, the jam clearance sheet is formed from laminated plastics material, although other stiff but resilient materials would also be suitable.

One problem often encountered in document handling apparatus comprising transport belts is that of belt "tracking" – i.e. maintaining the belt in position along the desired transport path. Typically belts are supported and driven by one or more rollers and it is desirable that the belts remain centred on each roller. Problems can occur when the rotational axis of the roller is not accurately positioned.

In accordance with a sixth aspect of the invention, a mounting assembly for supporting a transport belt in a document handling apparatus comprises a base plate fixed to the structure of the document handling apparatus, and a bracket affixed to the base plate by releasable retaining means, the bracket supporting a shaft and a roller rotatably mounted on the shaft, wherein an aperture is provided in the base plate adjacent an edge of the bracket, the edge of the bracket having a keying feature therein for coupling with an adjustment tool in use, the aperture being sized to receive the adjustment tool and having an edge feature arranged to provide a pivot point for pivoting of the adjustment tool thereon in use, whereby, in use, an adjustment tool inserted into the aperture and coupled with the edge of the bracket can be pivoted to adjust the position of the bracket relative to the base plate.

The provision of an adjustment means in this way makes it possible to execute fine adjustments of the roller position by pivoting the supporting bracket in a controlled manner. This allows the belt tracking to be easily and accurately controlled.

Preferably, the keying feature comprises a notch for receiving the adjustment tool in use. Advantageously, at least one positioning mark is provided on the base plate adjacent an edge of the aperture, corresponding to a predetermined position of the bracket. Preferably, the positioning mark comprises a notch in the edge of the aperture.

Advantageously, the releasable retaining means are configured to permit pivoting of the bracket relative to the base plate when released.

In a particularly preferred example, the aperture comprises a substantially triangular region, one side of which being arranged adjacent the keying feature in the edge of the bracket, and the opposing corner provides the pivot point.

Preferably, the roller comprises a crown roller.

The sixth aspect of the invention further provides a method of adjusting the positioning of a transport belt in a document handling apparatus, the transport belt being supported by a mounting assembly as already described, the method comprising:

releasing the releasable retaining means,

inserting an adjustment tool into the aperture and coupling to the keying feature provided on the edge of the bracket;

pivoting the adjustment tool about the pivot point to thereby adjust the position of the bracket and roller supported thereon relative to the base plate;

securing the releasable retaining means to fix the position of the bracket;

withdrawing the adjustment tool from the aperture.

Advantageously, the adjustment tool comprises a screwdriver, preferably a flat blade screwdriver.

Preferably, the document handling apparatus is operated such that the transport belt is running during the adjustment steps.

Where a document handling situation is to be used in a public or commercial application, it may not be possible desirable for anyone but the operator to view data displayed on the apparatus itself. For example, where the apparatus is situated behind a security screen at a counter, it may most conveniently face toward the operator but away from a customer. The customer may not be able to view any data displayed and in certain circumstances this may be desirable, for example if the machine detects a counterfeit document and the customer is suspected of fraud.

Therefore, in accordance with a seventh aspect of the invention, a document handling apparatus comprises an input module, at least one output module, a transport path therebetween, the transport path being provided with one or more

detectors for sensing characteristics of the documents, and a controller adapted to receive signals from the sensors and to generate output data therefrom, the apparatus further comprising a display panel integral therewith for display of first selected output data, and a remote display panel for display of second selected output data, wherein the controller is further adapted to identify and display the first and second selected output data on the integral and remote display panels respectively according to predefined criteria.

The provision of a second, remote display makes it possible to display a second set of data as desired. For example the remote display could face the customer at a counter to enable him to view the result. The nature of the data displayed would depend on the application.

In a particularly preferred example, the predefined criteria require that the first selected output data be different to the second selected output data. This can be used in a variety of ways: to simplify the data presented or to increase security.

Preferably, the document handling apparatus comprises more than one output module, and the predefined criteria require that the first selected output data comprises data relating to the contents of each output module individually, and the second selected output data comprises data relating to the contents of all output modules collectively.

In a particularly preferred example, the predefined criteria require that the first and/or second selected output data comprise a value of documents or a number of documents.

Preferably, the predetermined criteria include a delay time for which the controller displays the first and/or second output data on the integral or remote display panel respectively.

The seventh aspect of the invention further provides a method of handling documents using a document handling apparatus as described above, comprising:

feeding one or more documents into the transport path;

conveying the one or more documents through the transport path to the one or more output modules;

detecting characteristics of each document and generating output data based on the detected characteristics;

displaying first selected output data on the integral display panel in accordance with predetermined criteria; and

displaying second selected output data on the remote display panel in accordance with predetermined criteria.

An example of a document handling apparatus will now be described with reference to the accompanying drawings, in which:-

Figures (i) and (ii) provide an overview of the apparatus in perspective and cross-sectional views;

Figures 1A to 1D depict the framework of the apparatus;

Figures 2A to 2Q show the input module;

Figures 3A to 3H show the detectors and the transport path therethrough;

Figures 4A to 4K show the output transport path;

Figures 5A to 5E depicts the diverter assembly;

Figures 6A to 6P show the stacker modules;

Figures 7A to 7G depict the electronics and control elements; and

Figures 8A to 8E illustrate machine operation.

0. Overview

This disclosure relates to a document handling apparatus 1 such as that shown in Figure (i) of the accompanying drawings. The apparatus is particularly well adapted for the handling of documents of value such as banknotes but could alternatively be used to handle any other type of sheet document, including cheques, certificates etc. For this reason, the description below will focus mainly on the use of the apparatus for handling banknotes, but it will be appreciated that the apparatus is not limited to this function.

The apparatus 1 is particularly suited for sorting, counting, authenticating, fitness testing or otherwise handling banknotes. A stack of banknotes to be sorted, for

example, is placed into the input module 200 which feeds each banknote into the apparatus and onto the transport path TP (See Figure ii). The input module 200 will be described in further detail in Section 2.

Each note then passes a series of detectors located in the detector transport path 300. The detectors perform a series of functions including one or more of identifying the banknote in terms of its currency and/or denomination, determining its orientation, judging authenticity of the banknote, testing the banknote for fitness to be returned into circulation and detecting any skewed, doubled or overlapped banknotes which could otherwise lead to errors. This will be described in Section 3 below.

From the detector region, the banknotes enter the output transport path 400 which includes a diverter 500. These are detailed in Sections 4 and 5 respectively. The diverter 500 directs each banknote towards one of two stacker assemblies 600a and 600b, otherwise known as output pockets P1 and P2. The diverter is controlled by control system 700, part of which is shown in Figure (ii), in accordance with the output from the detectors 300.

The two output pockets P1 and P2 can be used to receive sorted banknotes in a number of ways. For example, banknotes deemed to be genuine can be output to the first pocket P1, whereas those suspected of being counterfeit can be separated and diverted to pocket P2 for easy removal and further testing. In alternative embodiments the two pockets can be used to separate denominations or to remove banknotes which are no longer fit for circulation. Further details of operational modes will be given in Section 8 below.

The apparatus is based on a metal framework encased in a plastics housing as will be described in Section 1.

1. Housing and Structure 100

The metal housing that forms the main structure of the document handling apparatus 1 is illustrated in Figures 1A to 1C. Turning to Figure 1A, the housing 100 comprises a right side panel 101 and a left side panel 102. The two side panels are laterally spaced between front cylindrical tube 103b and rear support bar 121 at the base of the Apparatus 1 and between support panel 105 at the top or apex of the Apparatus 1.

Front cylindrical tube 103b is secured between the two side panels using a screw at each end of the tube, wherein each screw passes through an aperture in each respective side plate. The rear support bar 121 is secured between the two side panels using two screws at each end of the bar, wherein the two screws pass through two apertures in each side plate. The support panel 105 is also secured between the two side panels using two screws at the front and rear of the support panel. Each screw passes through a respective aperture within one of the side panels and is screwed firmly into screw fittings 105e attached to the support panel 105.

The support panel 105 further comprises an indented portion 105c, at the top of which is located a cylindrical handle feature 105d. This cylindrical handle feature 105d complements the cylindrical tube 103b at the front of the apparatus 1. Between them cylindrical handle feature 105d and cylindrical tube 103b provide hand grips for carrying the document handling apparatus.

Turning to Figure 1B the housing 100 further comprises base plate 103 and removable back plate 104. Both these plates are manufactured from sheet metal. The base plate 103 is fastened to the side panels 101 and 102 by means of four screws and four threaded apertures 124a-d present in each corner of the base plate. The base plate 103 further comprises feet 123a-d. The feet can be made from moulded rubber or plastic.

The removable back plate 104 comprises a series of two or three tabs 104a located at the base of the plate. These tabs 104a are designed to fit into two or three

elongate apertures 103a. These elongate apertures are visible at the rear of base plate 103 in Figure 1C. The top of the rear plate 104 contains a sprung movable latch (not shown). The top of this latch is designed to sit behind the bottom rear section of support panel 105. The movable latch is mounted within an aperture in the top of rear plate 104 and has an integrated coil spring at the base of the latch. One of the arms of the coil spring is fixed within the latch and the other arm is connected to the rear plate 104. The aperture in the rear plate extends beyond the section of the latch mounted within the aperture. Hence, when the movable latch is pressed downwards the latch moves downwards within the aperture against the force of the coil spring. To insert the removable back plate 104 the back plate 104 must first be orientated at approximately 45 degrees in order to locate tabs 104a within elongate apertures 103a. Then the removable back plate 104 is pivoted clockwise whilst depressing the sprung movable latch. By depressing the sprung latch, the top of the latch is able to pass under the rear lower edge of support panel 105. The latch is then released and the top of the latch locks behind the rear plate of the support panel 105. To generate a signal signifying that removable back plate 104 is in place, a microswitch 120 is attached to the top of the right side panel. When the removable back panel 104 is secured in place, as described above, a tab upon the right-hand side of the back plate 104 pushes against microswitch 120.

Turning back to Figure 1A, the housing 100 also comprises an additional number of sheet metal panels located between the left side panel 102 and right side panel 101. These include: feed plate 201, stacker top plate 680, upper guide plate 404, lower stacker guide plate 601, and rear U-turn structural plates 403 and 416 (visible in Figure 1B). Turning to Figure 1C there is also a cover 405 located behind stacker top plate 680 and upper guide plate 404. Feed plate 201 provides support for banknotes deposited on top the feed hopper assembly and is secured to each side plate using two screws: one screw is fastened into screw fitting 201z and the other into a threaded aperture upon flange 201y. Stacker top plate 680 is also attached to each side panel by way of screws fastened within upper threaded aperture 680y and lower screw fitting 680z. Stacker top plate 680 further comprises air vent 681 which is used to cool the document sorter in a manner that will be described at a later point. Upper guide plate 404, U-turn lower guide plate 403, cover 405 and the lower stacker guide plate 601 are also secured to each side panel using multiple threaded

apertures located in lateral flanges. The lower section of lower stacker guide plate 601 is fastened to cylindrical tube 103b. U-turn structural guide plate 416 comprises three guide members. The top of each member is attached to support bar 135 which is then secured to each side panel with two screws. The left and right sections are each attached to the side panels via screws fastened within threaded flanges and screw fittings.

At the rear of the apparatus 1, as seen in Figure 1C, is an interface panel 112 which is attached to right side panel 101. The interface panel 112 comprises three RS232 ports 112a to 112c, a power switch 112d and a power socket 112e. The interface panel 112 is attached to a printed circuit board (PCB) housing transport controller 111 (see Figure 1A) and a switch mode power supply 113 which is also attached to right side panel 101. The switch mode power supply 113 comprises an independently housed power module which is connected on one side to power switch 112d and power socket 112e. The switch mode power supply 113 is also connected to the transport controller 111 to provide power to the apparatus 1.

The side panels 101 and 102 provide mounting holes for transport shafts located along the transport path. The left side panel 102 provides a reference plane for the apparatus 1. Each shaft or axle that is mounted to the left side panel 102 sits within a flange bearing, the flange of the flange bearing resting flush against the left side panel 102. The opposite end of each shaft or axle is mounted within a bearing on the right side panel 101. A circular sprung washer is placed over the bearing and sits between the outer face of right side panel 101 and a washer. The washer is held in place by a circlip fastened at the end of the shaft or axle. The circular sprung washer thus allows relative movement of the side panels 101,102, for example due to thermal expansion, yet each shaft or axle remains referenced to the left side panel 102.

Figure 1D illustrates a completed document handling apparatus complete with right 101A and left 102B moulded plastic side panels. These moulded plastic side panels 101A and 102A fit over respective metal side panels 101 and 102. They are affixed using three screws: one fastening into each of upper flanges 140, and two fastening into each set of lower flanges 122. Within the right plastic side panel 101A are small

apertures for stack position bicolour light emitting diodes (LEDs) 150: LED 150A for lower stack pocket P1 and LED 150B for upper stack pocket P2.

2. Input Module 200

The primary exterior features of the input module 200 are shown in Figure 2A. Figure 2B shows a cross-section through the machine, depicting the key interior components making up the input transport path.

In use, a stack of banknotes is placed onto a feed plate 201, resting against a back plate 204 such that the stack leans at an angle of approximately 30° from vertical. The notes are centred by a back plate in-feed mechanism described in Section 2.1.

The lowermost banknote in the stack is nudged forward by rollers 210 extending through the feed plate 201 into a first pinch point defined between feed rollers 220 and dancer 241 which stream-feeds the notes into the apparatus, as described in Section 2.2. The size of the gap at the pinch point through which notes enter the apparatus is determined by the feed guide assembly 240 as detailed in Section 2.3. Notes are then snatched one by one from the continuous stream by snatch rollers 230 mounted at the top of the detector region 300. The snatch rollers 230 accelerate each note away from the continuous stream, thereby providing a gap between each note such that they may be processed individually. This is detailed in Section 2.4.

Drive is provided to the input module from the transport motor 499, described in Section 4 below. A clutch 235 and brake 226 are provided to isolate the feeder drive from the rest of the transport system during start up. This will be described in Section 2.5.

2.1 Back plate in-feed

The back plate in-feed supports and guides the stack of banknotes placed on the plate 201 as they are fed into the apparatus. The back plate in-feed consists of metal support plate 105 shaped to provide a support surface and complete the framework of the apparatus (see Section 1). The support plate 105 can be seen most clearly in Figures 2C(i) and Figure 2E. The base of the plate 105 is curved to act as a guide for directing banknotes into the apparatus and includes a cut-out

203A through which a dancer extends in use (see Section 2.2). The cut-out 203A also supports one half of a transmissive optical sensor 202 used to detect the presence of notes on the feed plate 201.

The rear of the support plate 105 is shaped to act as a handle 105D and, optionally, to support ventilation fans 209A and 209B on a lateral bracket 209 (Figure 2E). The ventilation fans may be omitted if desired.

On the front of support plate 105 is provided a guide structure which consists of a plastic guide plate 204 having elongate slots 206A and 206B through which protrusions on mounting arms 208A and 208B extend in use. These components are best shown in Figures 2C and 2D. An edge guide 205A and 205B is mounted onto each respective mounting arm 208A and 208B. The edge guides 205 extend perpendicularly away from the guide plate 204 so as to constrain the (short) edges of the banknotes in the stack.

In order that the distance between the edge guides 205 can be adjusted (and so accommodate different sizes of banknotes), the mounting arms 208A and 208B are slidable along slots 206A and 206B. As shown most clearly in Figure 2C(iii), the reverse of guide plate 204 is moulded with channels which retain the mounting arms 208A and 208B to slide laterally. Each mounting arm 208 has on one side a series of teeth (a rack gear) which engage with a central gear 207A which is rotatably mounted through an aperture 204A in guide plate 204. Each mounting arm 208A and 208B engages the gear 207A on opposite sides such that lateral motion of one mounting arm 208 causes the gear 207A to rotate, thereby moving the other mounting arm 208 in the opposite direction to the first. In this way, when either one of the edge guides 205A or 205B is moved by a user, the other edge guide 205A or 205B moves by an opposite and equal amount. Where the guides are initially laterally centred about the transport path, the assembly ensures they remain centred as they are adjusted, such that the stack of notes is fed centrally into the transport path.

However, in certain situations it is desirably to off-set incoming notes from the centre of the transport path. For example, where it is expected that the notes will include a

certain security feature in a known area of the note, it may be advantageous to align this feature with particular detectors in detector region 300. This is made possible by disengaging the gear 207A from the mounting arms 208A and 208B. The gear 207A forms part of a button 207 which extends through the aperture 204A in guide plate 204 and, in its default position, is urged into engagement with the mounting arms 208A and 208B by spring 207B. The gear 207A can be disengaged by depressing the button 207, enabling each mounting arm (and the edge guides supported thereon) to be moved independently of one another.

2.2 Feed Plate

The feed plate 201 on which the stack of banknotes is placed is shown in Figure 2F(i). The plate 201 comprises a flat surface for supporting the banknote stack which is provided with a cut-out 201A shaped to accommodate nudger rollers 210 and feed wheels 220 in use. Either side of the cut-out 201A, the plate 201 is curved to act as a guide directing the input banknotes towards the snatch rollers 230.

In between the nudger rollers 210, the feed plate 201 supports one half of a transmissive sensor 202 for detecting the presence of banknotes on the feed plate 201. The sensor components 202A are shown in Figure 2F(ii) and comprise an infrared light source mounted on a PCB, together with a transparent cover which protects the light source in use and engages with an aperture in the feed plate 201 to transmit radiation therethrough. When the input module is empty, the transmitted radiation is detected by a receiver 202B mounted on the support plate 203 (see Section 2.1 above). The signal output by the sensor 202 is used in controlling the start of each feed operation, as described in Section 7.

Figure 2G shows the main transport components of the assembled feeder module. A pair of nudger rollers 210A and 210B are mounted on a nudger shaft 211 and extend through cut-out 201A in feed plate 201. As shown in Figure 2H(i), each nudger roller 210A and 210B comprises a metal core and high-friction exterior which is shaped to provide two protrusions separated from each other by 180°. In use, as the shaft 211 is driven, the nudger rollers 210A and 210B rotate such that their protrusions "nudge" each banknote successively towards the in-feed gap (between

the feed plate 201 and the support plate 105). The two nudger rollers 210A and 210B are laterally spaced on shaft 211, arranged such that the protrusions on each roller 210A and 210B are aligned. The shaft 211 is mounted within the metal framework of the apparatus between the two side walls 101, 102 through bearings 214A and 214B, referenced to the left side wall 102 of the apparatus by spring 213 which is fitted between the outside of the side wall 101 on the right hand side and a flange on bearing 214B. Clips 215A and 215B secure the shaft in position.

Notes are pushed by the nudger rollers 210A and 210B towards feed wheels 220A and 200B which are non-rotatably mounted onto feeder shaft 221 using grub screws. The two feeder wheels 220A and 220B are mounted adjacent to either side of a central roller 222 (see Figure 2H(ii)). The central roller 222 is fixedly mounted to the shaft 221 via pin 222A.

The two feeder rollers 220A and 220B comprise metal cores with a high-friction polymer surround having a grooved surface to increase friction between the wheel surface and a banknote. The central roller 220C has a smooth surface.

When assembled, each of the feeder wheels 220A and 220B opposes a stripper pad 242A and 242B, just visible in Figure 2(I). The central roller 220C is opposed by a dancer assembly 241 which is urged towards the note path. The construction of the dancer assembly 241 and stripper pads 242 will be detailed in Section 2.3 below.

In use, rotation of the feeder wheels 220A and 200B and central roller 220C imparts motion to the lowermost banknote in the stack received from the nudger rollers 210A and 210B, drawing it into the transport system. The stripper pads 242A and 242B and the dancer assembly 241 act to separate other notes from the lowermost note such that a single note is fed at a time.

The manner in which the nudger rollers 210 and feeder wheels 220 are driven will be described in Section 2.5 below.

2.3 Feed Guide

The feed guide assembly 240 is depicted in exploded view in Figure 2J(i) and assembled in Figure 2J(ii). The feed guide assembly 240 has two main functions: firstly, it acts as a guide for directing the incoming banknote along the transport path, and secondly it supports dancer assembly 241 and stripper pads 242. Together with the feeder wheels 220, these provide the first pinch point and separate the banknote being fed into the system from other notes in the stack.

The feed guide assembly comprises a cross beam 243, shaped so as to curve around the feeder wheels 220 and thereby guide incoming notes into the system. The cross beam 243 is mounted into the framework of the apparatus via two integral arms 243A and 243B provided at each end of the beam. Apertures 243'A and 243'B located at the end of the arms 243A and 243B respectively engage with pegs provided on the interior of the side walls 101, 102 of the apparatus (see Figure 2N(ii)). The cross beam 243 is made of a sufficiently resilient material such as sheet metal that the arms 243A and 243B can flex relative to the rest of the beam in order to clip them onto the pegs provided in the framework. Compared to conventional apparatus in which a similar component might be screwed into the framework, this allows for fast and easy assembly, and reduces the part count.

Particularly advantageous is the provision of a chamfer 243"A,B in each arm located between the aperture 243'A,B and the body of the cross beam. The chamfer displaces the region of the arm including the aperture (shown hatched in Figure 2J) away from the body of the cross beam in its axial direction. This allows for quick and easy fitting of the cross beam component since the item can be placed in its approximate position by a user, with the pegs provided on the side walls adjacent the first (unhatched) region of each arm, without necessarily making contact. The component 243 can then be pulled into position, causing the pegs to slide over the chamfer 243"A,B and displacing the arm towards the cross beam by a small amount. When the peg comes into register with the aperture 243'A, B, the arm springs back, causing the keying features to couple and securing the cross beam in position.

The cross beam 243 is thus pivotally mounted into the framework at points 243'A and 243'B. At its other extremity, the beam 243 supports dancer assembly 241

between two supports 244A and 244B. Each support comprises a shaped polymer arm which is fixedly attached to the cross beam 243 using screws along the length of the arm. Each support arm has a 'shoulder', extending away from the cross beam 243, provided with an aperture to receive a shaft 246 onto which the dancer assembly 241 is mounted.

The dancer assembly 241 is shown most clearly in Figures 2K(i) and 2K(ii) and consists of a polymeric dancer having a support bracket 246A and integral head 241A which acts as a support for idler rollers 241C. The idler rollers are rotatably mounted to the support 241A via spacers 241B using pins 241E. Rubber O-rings 241D are fitted to each roller 241C to ensure good contact with the note stack. The shaft 246 passes through two apertures in the support bracket 246A to rotatably mount the dancer assembly to the cross beam 243. A spring 249 is provided between the shaft 246 and the dancer head 241A to urge the dancer assembly toward the note path. In use, the idler rollers 241C define the first pinch point by opposing the feeder wheels 220. The dancer head 241A is shaped such that it is recessed between the idler rollers 241C where they make contact with the lowermost note from the stack. The dancer head 241A retains other notes in the stack and helps to create a "wedge"-shaped stack for effective feeding.

Each of the support arms 244A and 244B also carries a stripper pad 242A and 242B which sideably engages a keying protrusion provided on a platform of each support arm 244A and 244B. Each stripper pad 242 is made of a high friction material so as to effectively prevent all but the lowermost note passing. Each stripper pad 242B is provided with a shield 242'A and 242'B for preventing excessive wear.

When assembled, the two stripper pads 242A and 242B extend through elongate cut-outs in the cross beam 243 towards the note path. This is most clearly seen in Figure 2L(i).

As noted above, the feed guide 240 is pivotably mounted within the apparatus 1. However, in order that the dancer assembly 241 and stripper pads 242 can carry out their function effectively, it is of key importance that the feed guide assembly 240 is held rigidly in position giving a precise, predetermined distance between the feed

rollers 220 and the stripper pads 242. This is achieved by an eccentric shaft 250, shown in Figures 2M(i) and 2M(ii).

The eccentric shaft 250 is mounted between the side walls 101, 102 of the apparatus' framework (see section 1), above the feed guide assembly 240. A spring clip 253 is mounted onto the eccentric shaft 250 which engages the dancer shaft 246 to retain the feed guide assembly 240 in position. This ensures the cross beam 243 is in the correct position for guiding the notes into the transport path and gives an approximate alignment of the dancer assembly and stripper pads with the feeder wheels. However, more precise adjustment of the pitch between the stripper pads and feeder wheels is necessary to ensure correct feeding and in order to compensate for wear occurring during use. In order to achieve this, each of the support arms 244A and 244B are provided with grub screws 245A and 245B which extend through the 'shoulder' of each support arm, adjacent to the dancer shaft 246 (see Figure 2J(i)). In use, the grub screws 245A and 245B extend out of the support arms towards the eccentric shaft 250. This is shown most clearly in Figure 2L(i) and Figure 2B. Each grub screw can be accessed via the rear of the support arms (shown in Figure 2M(ii)) in order to adjust the distance it extends from the support arm. In doing so, the reaction of the grub screws against the eccentric shaft 250 allows fine adjustment of the position of the stripper pads 243 and dancer assembly 241 relative to the feed wheels 220. Moreover, since each grub screw 245A and 245B can be adjusted individually, the left and right sides of the pinch point can each be tuned to ensure no skew is introduced.

Further adjustment can be achieved by rotation of the eccentric shaft 250. To enable this, the shaft 250 is provided with a cap 252 non-rotatably fitted to the shaft 250 via spring 251, which can be turned by an operator to rotate the shaft. The eccentric axis of the shaft causes the grub screws resting on it to move towards or away from the centre of the shaft by a small amount, thereby enabling very fine adjustment of the position of the feed guide 240.

To secure the position of the eccentric shaft such that it cannot rotate during use, a locking plate 254 is provided on the inside of the side wall 101 adjacent to cap 252, abutting a flat edge of cap 252 (which typically has a hexagonal cross-section). The

cap 252 can be slid along the axis of the eccentric shaft, compressing spring 251, to bring it out of engagement with the lock plate 254 so that the eccentric shaft can be rotated. The spring 251 then returns the cap 252 to its locked position. The locking plate 254 is fixed in position using two elongate slots 255 provided in the lock plate through which screws attach the lock plate 254 to the interior side wall.

2.4 Snatch Rollers

The feed wheels 220 input a continuous stream of banknotes to the transport path. However, in order that each note can be accurately counted, its characteristics detected and output to one or other of the stacker modules 600, it is necessary to introduce a gap between each note and the next. This is achieved by three snatch rollers 230.

As shown in Figure 2B, the snatch rollers 230 are mounted on a shaft 231 and extend towards the transport path below the feed plate 201. Figure 2G shows the snatch rollers in position. The three snatch rollers 230A, 230B and 230C are laterally spaced from one another along shaft 231 to which they are fixedly mounted using grub screws. The shaft 231 is mounted in bearings between the side walls 101, 102 of the apparatus framework through which is extended on the left hand side to carry a belt pulley 232 and an O-ring pulley 233. As shown in Figure 2B, the snatch rollers 230 are each opposed by an idler roller 280 mounted in the movable plate 390 (to be described in Section 3). The idler rollers 280 are each mounted on individual shafts 281 within the movable plate 390 which are sprung towards the note path. The snatch rollers and idler rollers thereby provide the next pinch point in the transport system.

The snatch rollers 230 are driven by the transport motor 499 (as will be described in Section 2.5 below) at a speed greater than that of the nudger rollers and feed wheels 220. As a result, each note of the continuous stream is "snatched" and accelerated into the detector region 300, leaving a gap between it and the next note.

Each snatch roller 230 consists of a metal core and high friction polymer surround in order to impart drive to the banknotes. The shaft 231 is referenced to the left hand side of the apparatus in the same manner as shafts 211 and 221.

2.5 Input Module Drive

The three driven roller shafts 211, 221 and 231 which convey notes through the input module 200 receive drive from the transport motor 499 via timing belt 260 (see Figures 2N and 2P(i)). This drives a pulley 233 fixedly mounted to snatch shaft 231. The use of timing belts as opposed to O-rings is preferred since it can be guaranteed that the snatch rollers are driven synchronously with and at the same speed as the rest of the transport system. However, in some embodiments the use of one or more O-rings (a set of three is shown in the Figures) has advantages since it may allow for some slippage, which can be beneficial if the accuracy of the motor is low. A timing wheel 265 is provided on the far end of snatch shaft 231 in order to monitor the transport speed (described in Section 7 below).

The snatch shaft 231 is further provided with a clutch 235 mounted thereto alongside a bracket 234 passing over the end of the shaft. To the clutch is connected with a pulley 236 closed by a washer 237 and clamp 238 which is tightened onto shaft 231 using screw 238A (see Figure 2Q). In this way, the clutch 235 can be used to alternately engage and disengage drive between the shaft 231 and the pulley 236. Drive from pulley 236 is transferred to pulley wheel 229 mounted on the end of drive wheel shaft 221 (see Figures 2N and 2P) sized so as to rotate at a slower speed than the snatch shaft. Also mounted on drive wheel shaft 221 is a second pulley 228 which transfers drive to the nudger shaft 211 via O-rings 217 and pulley 216 mounted on the end of nudger shaft 211. The drive wheel shaft 211 is also provided with a brake 266 spaced from pulley 228 by spacer 227 which can be activated to halt the drive wheel shaft 221 and, via O-rings 217, the nudger shaft 211.

Thus, whilst the snatch rollers 230 are driven continuously when the main transport is active, the drive wheels 220 and nudger wheels 210 can be isolated, and therefore remain stationary, by disengaging the clutch 235. This is preferable since it allows the transport system to reach its optimum transport speed after start up before

engaging the feeder shafts. In this way, it can be ensured that all systems are running at the correct speed before any notes are fed into the system. Further, the feeder shafts can be halted suddenly without needing to stop the rest of the transport system. This is useful, for example, where a large stack of banknotes is placed on the feed plate 201, but it is desired to have separate batches of, for example, 100 notes output for bundling or loading into a cassette or machine. As the apparatus 1 outputs each batch, the feeder is stopped to halt feeding whilst the user collects the output batch. Feeding can resume once the batch has been taken from the stacker modules 600.

Once all notes have been fed, the system is purged by running both the main transport and the feeder sections, to ensure no notes remain in the feeder module.

3. Detector Transport Path 300

Figure 3A illustrates what is referred to as the detector transport path. This is the path taken by a banknote or article of value through the document handling apparatus 1. Upon each side of the detector transport path are a series of detectors that measure the properties of the banknote or article of value. In Figure 3A, the detector transport path is shown in area 300. It begins with the snatch rollers 230, which form the exit of the feed section, and ends with the U-turn belt section. The detector transport path is constructed from two main structural components: a "fixed plate" that forms the front-most side of the transport path and a "movable plate" that forms the rear-most side of the transport path.

3.1 Fixed Plate 301

The fixed plate is illustrated in Figure 3B. The plate 301 is constructed from a single zinc alloy die-cast component. The fixed plate 301 is attached to side panels 101 and 102 by four screws. These screws pass through apertures in side plates 101 and 102 to mate with threaded fittings 303a to 303b in each corner of the plate. These screws are all easily accessible upon the side panels 101 and 102 (once cosmetic body panels have been removed). In order to provide access to the screws located behind transport controller 111 apertures within the circuit board are provided. As the fixed plate can easily be removed from the apparatus 1, it is easy to completely replace the fixed plate 301 and the sensors within for service or repair. To remove the fixed plate 301 the upper feed guide 243 and the screws fixing the plate in place must first be removed. The fixed plate 301 can then be taken out by pivoting the plate about the top edge and pulling the lower edge. Once the plate 301 is orientated at a close angle to the horizontal it may then simply be drawn out from the rear of the apparatus 1.

The die-cast panel has two cut-out sections 304 within which the snatch rollers 230 driven by the transport drive system reside. Between the cut-out sections two photodiodes are located. The photodiodes form part of the double-detect / track sensor set 340. Each photodiode fits within aperture 341 and is mounted upon control circuitry 342. The control circuitry is fastened to the fixed plate 301 and

black insulating strips may be taped over the back of the photodiodes to prevent the shaft from shorting the PCB.

Below the snatch wheels are three sets of driven transport rollers 352a to c which propel the notes along the detector transport path. The apertures that receive these transport rollers are labelled 351a to c in Figure 3B. The spacing between successive transport rollers is typically no more than 45 mm. This is because the smallest Euro banknote has a short edge length of just over 45 mm.

Below the apertures for the first set of transport rollers 351a is a windowed aperture 331 within which the contact image sensor (CIS) lamp 330 is located. The CIS lamp 330 is fastened to the fixed plate 301 via four screws; a screw being present at each end of each elongate side-face of the lamp. Two securing latches 302 are fastened to the fixed plate at the lateral edges of the plate beyond the ends of the CIS lamp. These securing latches 302 are used to set the height of the transport path as will be described in the subsequent section. Below the CIS lamp aperture 331 are a series of successive smaller apertures 361 within which the detector heads for the ultrasound receiver 360b are located. The PCB to which the detector heads are fixed is mounted to the fixed plate through two screws located at each lateral end. Finally, at the lowermost portion of the fixed plate 301 are two cut out sections 305 within which the two transport belts reside.

3.2 Moveable Plate 390

Figure 3C illustrates the movable plate section which forms the rearmost side of the detector transport path. Like the fixed plate 301 the movable plate 390 is constructed from a single zinc alloy die-cast component. However, unlike the fixed plate 301, the movable plate 390 is adapted to pivot around the bottom rear corner of the apparatus 1. This allows the transport path to be accessed for cleaning or in the case of a jam. The movable plate 390 pivots around a pivot point formed by apertures 393 and a pair of stub axels connected to the side panels 101 and 102. In operation, the movable plate 390 is held in place a set distance from the fixed plate 301 using plastic latches 302 on fixed plate 301 and respective tabs 394 on movable plate 390. The plastic latches 302a and 302b function as leaf springs fixed about

their bottom. In an operational position tabs 394 rest behind respective notches on plastic latches 302. To release the movable plate the plastic latches 302 are pushed outwards i.e. in the direction of side panels 102 or 101. As plastic latches 302 are easily replaceable components, the height of the transport path can be easily altered by reconfiguring the location of the notches on these latches. Typically, the height or width of the transport path, i.e. the distance between the fixed and movable plates, is typically set to be 4mm.

The movable plate 390 is also designed to have two different opening configurations. This is achieved using a stopper mechanism or "detent" 398 positioned at the lateral ends of rear support bar 121. The stopper mechanism located at the bottom left corner of the apparatus is shown in Figure 3G. A similar mechanism is also found in the bottom right corner. The stopper mechanism 398 is slidably mounted on shaft 398d with cut-out section 398i making contact with the rear support bar 121. The stopper mechanism 398 comprises a body 398a with apertures 398f and 398j and thumb depression 398h. Within aperture 398f is mounted axle stub 398b. In use, when plastic latches 302 are released, the movable plate is allowed to pivot clockwise about apertures 393 until movable plate ridge 390a comes into contact with stub axle 398b. This forms the first opening configuration which allows access to the top of the detector transport path around the snatch rollers 230.

Within aperture 398j is located shaft 398d. The rightmost end of the shaft 398d is connected to the right side panel 101. The leftmost end of the shaft projects from body 398a, at the end of which is located a circlip 398e. A coil spring 398c encircles shaft 398d and is held in tension between circlip 398e and the left face of body 398a. To fully open the transport path and provide the second opening configuration a user pushes thumb depression 398h to the left against the force of coil spring 398c. This then moves stub axle 398b to the left and removes the force holding the movable plate ridge 390a at the first opening configuration. If a similar operation has been performed with regard to the right mechanism then the movable plate 390 is free to rotate fully under gravity and rest at an extended position supported by curved section 398g. The second configuration then allows access to the U-turn and drive belt mechanisms.

Beginning from the top of movable plate 390 as illustrated in Figure 3C, the plate comprises three apertures 391 for three sprung idler rollers 280. The idler rollers 280 oppose snatch rollers 230 and are mounted upon shaft 281 which is fixed between two end plates 395. The end plates 395 are mounted within apertures 397. The apertures are elongate to allow the end plates to move perpendicular to the movable plate 390. Each end plate 395a,b is attached to a spring 396a,b which is in turn also mounted within aperture 397a,b. The sprung idler rollers 280 are thus able to move perpendicular to the transport direction when the plate is closed to provide a "pinch" between the two rollers and a banknote or article of value passes.

In between the first and second and second and third idler roller apertures 391 are located two photosensors 394 and their attached PCBs for use in track and double detection. These photosensors are typically visible or infra-red (IR) light emitters and form one half of the double-detect / track sensor. Below the idler roller apertures 391 are located the first set of free-rolling, sprung transport rollers 302a which are positioned to compliment the first set of driven transport rollers positioned within apertures 351a on the fixed plate 301. These free rolling sprung transport rollers can be seen in Figure 3D. Each of the rollers comprise metallic roller 382 which is allowed to freely rotate around shaft 381 via a ball bearing ring. The ends of shaft 381 are retained by leaf spring 383 which is fastened to the movable plate 390. Thus the transport rollers 382 can be displaced perpendicularly to the transport path when a note passes.

Returning to Figure 3C, below the first pair of sprung transport rollers is located an aperture window for the CIS detector 320. Like the CIS lamp 330, the CIS detector is fastened to the movable plate via two sets of screws on each elongate side face. In alternative configurations, the CIS detector may be located by leaf springs. Below the CIS detector 320 is located an ultra violet (UV) / paper property detector (PPD) sensor 370 which is located in between another two free-rolling transport rollers 382. Below the UV / PPD detector 370 are located a series of small apertures 371 within which the ultrasound transmitter heads are located. The PCB upon which the transmitter heads are mounted is attached to the movable plate using two screws:

one at each lateral end of the ultrasound transmitter PCB. Below the ultrasound transmitter heads are located a further pair of free-rolling sprung transport rollers.

Finally, at the base of the movable plate 390 are located two apertures 392 within which the belts of the transport system reside. Shaft 418 and metal rollers 419 form part of the U-turn assembly described in section 4 below. Shaft 418 sits within apertures 418A and belts 401A and 401B pass around respective metal rollers 419A and 419B.

Figures 3E and 3F illustrate the detector processing box attached to the rear of the movable plate 390. The detector processing box is also referred to as the Secure Document Analysis (SDA) unit. To protect the electronics of the detector controller 310 from interference a shield plate 313 is first attached to the movable plate 390. On top of the shield plate 313 is mounted the detector or SDA box which comprises front detector box plate 312, detector box controller PCB, which houses the SDA controller 310, SDA power management circuitry 314, which provides power to the SDA controller 310 and detectors, and rear detector box plate 311. The SDA controller typically includes RS232 interface ports 310a and a USB port 310b. The USB port can be used to connect personal or laptop computer systems to the SDA controller for interrogation of operation and firmware updates. The base of front detector box plate 312 is secured to the shield plate 313 and the upper portion of the front detector box plate is angled so that the detector box controller PCB and its interfaces are orientated at a near vertical angle. Aperture 312a in front detector box plate 312 allows cables associated with the detectors upon the movable plate to enter the detector processing box and interface with the SDA controller 310.

At the base of the movable plate 390 is located a PCB 315 containing three visible or IR photoemitters 315a, 315b and 315c, for example comprising three light emitting diodes, which collectively form one half of a skew / track sensor.

In certain embodiments, the components of the double detect / track sensor, CIS and ultrasound detectors come as part of a matched pair. This means that the components on the fixed plate, for example the CIS lamp 330, must be matched with the components on the movable plate, for example the CIS detector 320. This

allows each sensor to be accurately calibrated before being incorporated into the apparatus 1. However, this also means that in certain circumstances both sensor components will need to be replaced together after failure. By designing the fixed and movable plates as easily removable structures it is easy for a service engineer to replace both sensor components in the field by replacing both the fixed and movable plates in their entirety.

3.3 Track Sensor/ Double Detector

Typically the double detect/track sensor comprises a pair of transmissive optical sensors. Each transmissive optical sensor within the pair comprises a visible light or infrared emitter located upon the movable plate 390 and a corresponding detector, typically in the form of a photodiode, located on the fixed plate 301. When a note passes between the emitter and the detector in each optosensor, a path of light is broken between the two sensor elements. The sensor can also be used to detect overlapping or "double" banknotes by looking at the level of light received by each detector. If photodiodes are used then an analogue signal will be recorded that is proportional to the level of light received by each photodiode. In a similar manner to the UV / PPD sensor described below, the analogue signal from each photodiode is typically pre-amplified by circuitry connected to the photodiodes to provide a high level signal that is less susceptible to noise.

3.4 Contact Image Sensor (CIS)

The contact image sensor (CIS) is an optical line scan sensor, which produces a digital image of a note by measuring the intensity of light transmitted through the surface of the note as it passes between the CIS lamp 330 and the CIS detector 320. In certain embodiments the line scan apparatus comprises CIS components from Mitsubishi Electric. A transmissive image can be used by pattern recognition or validation routines, for example to denominate the note, and can also detect the presence of threads and foils or watermarks. In some embodiments the CIS image can be used to detect double or overlapping notes. Attached to the CIS detector 320 is a control circuit board 320a which performs preliminary analysis of the line

scan signal. The control circuit board 320a is then connected to more advanced signal processing circuitry within SDA controller 310.

As a note passes between the CIS components, a single pixel line, one pixel wide in the transport direction, will be captured. This line will extend across the long edge of the note in a direction perpendicular to note transport. As the note passes and subsequent lines are scanned, a complete image of the note is generated. Typically, the signal making up the line data is digitised before further processing and the resolution of the captured image in the transport direction is between 30 and 200dpi depending on the speed of the note transport drive mechanism. Across the transport direction, the resolution is generally higher, varying from around 100dpi to 200dpi depending on the configurations used. This image can be passed to image processing algorithms for pattern recognition or validation tasks.

It is also possible to extend the CIS apparatus to operate in two different illumination modes: visible and infrared. In visible illumination mode, a light source within the line scan apparatus will illuminate the note using light of visible wavelengths. Typically, best results are obtained with a limited colour combination. In some examples, a combination of green and blue in the approximate ratio 25:75 is used, which provides a resultant note image with clearly defined visual features. In other cases only blue or only green light might be used. The use of a limited colour combination also simplifies the CIS apparatus and reduces the number of illumination sources needed within CIS lamp 330.

An infrared light source within CIS lamp 360 can also be provided together with an infrared line scan detector housed in CIS detector 320. The CIS detector 320 can include a separate line scan detector for each illumination mode, or, more commonly, a single line scan detector for all illumination wavelengths. When using an IR light source, one line scan will capture one line of an infrared image of a note. By recording a plurality of lines the complete infrared image of a note can be generated. This can be used in advanced pattern recognition and validation, for example on banknotes with IR features such as the Euro. The IR image can also be analysed to detect IR patterns within ink printed onto the note or to detect IR properties of the note paper. When both visible and IR sources are used with a

single line scan detector, the illuminated colour is altered with every line, i.e. the source alters between visible and IR on alternate lines. Even though, as a consequence, this reduces the sampling frequency for each single colour to half of the maximum scanning frequency of the CIS apparatus, in turn halving the maximum possible pixel resolution in the transport direction, the reduction in data is compensated for by subsequent detection and analysis algorithms allowing a high operating speed. In order to further increase the speed of operation of the note transport the data can also be down sampled after capture. In the present apparatus, it is preferred that the CIS sensor uses a blue visible source in combination with the IR source.

To calibrate the CIS sensors there are defined static and dynamic calibration tests. The static tests involve examining white paper in situ under the sensors, wherein the properties of the paper are well documented. To further test intensity levels and other properties a section of foam is also pressed against the note transport surface of the sensor to provide a set reference. In the dynamic tests a series of paper and polymer notes are passed through the note handling apparatus and the properties of the notes are recorded. These properties are then compared with well defined reference values for the paper and polymer notes and any discrepancies are used to alter the sensor configurations.

3.5 UV / PPD Sensor

The document handling apparatus 1 typically uses UV detector systems based on two common methods: measuring the fluorescence of a banknote under UV radiation and measuring the amount of reflected UV light.

Common copy paper has the property that it emits radiation in the visible blue spectrum under illumination from a UV source. This is due to the presence of excitable compounds within the paper. In order to prevent counterfeiting most banknotes are printed on security paper that is designed to emit a very low level of visible blue radiation under UV illumination. These differing fluorescence levels can thus be detected using suitable sensors and can be used as the basis of an authenticity test.

The UV fluorescence detector comprises a suitable UV source for illuminating a section of the banknote and a photodiode for measuring the visible blue fluorescence: if a low level of fluorescence is detected then the base paper is UV "dull" and is likely to be genuine; if a high level of fluorescence is detected then the base paper is UV "bright" and is likely to be counterfeit. Such a decision can be made using standard logic or probabilistic methods known in the art, a preferred approach using a threshold applied to the photodiode signal. Typically the photodiode signal is also amplified several times within a PCB attached to the UV fluorescence detector to obtain a higher signal to noise ratio, before being sampled and digitalised by a sensor signal-processing unit located on the SDA controller 310 PCB.

The monitoring of the visible blue radiation intensity is carried out by a data processing and detector control processor connected to the sensor signal processing unit and illumination control unit. The processor receives pulses at a rate of 1kHz and uses these pulses to sample the intensity in an integrate-and-dump manner. Alternatively, the processor can receive encoded pulses from the main or transport controllers, allowing the processor to monitor the speed of movement of a banknote and hence appropriately control sampling of the sensor output signals.

Often banknotes contain additional fluorescent security features that emit radiation in other visible bands. These features allow additional authentication when a banknote is manually inspected under UV light. However, these features can interfere with the detection of blue fluorescence as a UV "bright" signal can be recorded from a fluorescent security feature even if the banknote is genuine and composed of UV "dull" security paper. The document handling apparatus 1 addresses this problem in two ways: one, by providing an optical filter stack in front of the photodiode; and two, by analysing the photodiode signal as a banknote passes and ignoring a "bright" response that is only present for a fraction of the short edge length of the banknote. The former acts as a tight narrowband filter, only passing visible light in the blue bandwidth appropriate to copy paper fluorescence.

Preferably, a 380nm UV LED provides the UV source. The UV source may either provide a constant illumination level or, for detectors that are required to work in noisy conditions, stray light etc, then the illumination source may be modulated. The control of a source can be provided by an illumination control unit mounted within the SDA controller 310 or dedicated processing circuitry attached to the UV / PPD sensor housing. A reference offset is also used to compensate for background blue light. This is calculated by switching off the UV source and recording the signal received at the photodiode. This offset can then be subtracted from the measured signal when using the detector.

The second method of authentication using UV radiation monitors the amount of UV light reflected from a banknote. This is referred to as a paper property detection (PPD) system. From experimental tests it has been determined that genuine banknotes reflect a higher level of UV radiation than counterfeit notes. The difference in reflected UV is significant in the 350nm to 400nm wavelength band.

The UV reflectance or PPD detector thus comprises a UV source and a photodiode adapted to measure the intensity of reflected UV radiation. These components are mounted upon a PCB that performs much of the low-level processing. The UV illumination source is again typically a 380nm UV LED, which allows a longer wavelength of UV radiation to be used within a smaller wavelength range, when compared to standard UV lamps. Typically an optical filter is also placed before the photodiode to filter out any visible light that may affect the measurement of UV radiation.

In some embodiments, the PPD detector will determine the amount of UV reflected from the first banknote in a batch. This intensity signal will then be locally amplified and fed to the sensor signal processing unit and illumination control unit within SDA controller 310. This unit will record the level of reflectance and use this as a reference for the other notes. Thus on the feeding of the next banknote in the batch, the unit will check that the intensity of the reflected UV light lies within a user defined range centred on the recorded reference intensity. If the banknote lies outside of this range then a counterfeit error will be signalled.

In other embodiments, if the first banknote in a batch can be denominated then a typical value of UV reflectance, or a typical range of UV reflectance, can be retrieved from the memory of the document handling apparatus 1 based on the current currency and detected denomination. Subsequent banknotes can then be analysed to see whether the level of UV reflectance falls within a range based on the retrieved data. Alternatively, when operating with mixed denominations each note is denominated and then the recorded UV reflectance value is checked against a retrieved range for the chosen denomination.

Additionally, the reference used in the two processing methods need not be obtained from the first banknote alone, but can be determined dynamically and/or cumulatively based on the detected reflectance value for a plurality of processed banknotes.

The two UV detectors described above can be combined into a single assembly that uses one UV source and two photodiodes: one to measure the fluorescence of the banknote and the other to measure the reflected UV. Two sets of optical filters are also placed in front of the two photodiodes as described previously. Both detectors remain independent but the use of a single UV LED reduces power consumption.

Typically, the UV LED and the two photodiodes are contained within a single assembly 370 located between two free-rolling transport rollers. In certain embodiments, the plane of the assembly face is orientated so that the upper section of such an assembly is indented below the surface of the movable plate 390 and the lower section of the assembly protrudes from the same surface. The indentation and protrusion are typically of no more than a few millimetres, preferably less than 1mm. A note passing through the transport path will meet the indentation before the protrusion, and thus the orientation of the assembly face prevents notes becoming snagged upon the sensors and aids note transfer through the detector transport path.

Where only a reflected UV detector is provided, authenticity will typically be confirmed if the amount of reflected UV exceeds a threshold or lies within a predetermined range. Where a fluorescence detector is also provided then an

additional test can be made, the document being confirmed as genuine only if the level of fluorescence falls below a predetermined threshold.

Where two detectors are provided, the UV LED current is calibrated to be the same for the operation of both detectors. For some system calibrations, the calibration process involves: inserting a special calibration document with known UV fluorescence and reflectance properties; calibrating the UV fluorescence detector to set the LED current and amplifier gain using the fluorescence calibration value for the document; and calibrating the reflectance amplifier gain using the reflectance calibration value for the document, noting that the LED current remains the same as for the UV fluorescence. This procedure could also be performed in reverse, i.e. calibrating the reflectance first. The calibration settings (LED current and amplifier gain) will remain as calibrated until the next calibration is performed by a service engineer.

Further details of a combined UV detector can be found in European Patent EP1254435.

3.6 Ultrasound Detector

The ultrasound detector comprises ultrasonic transmitting and receiving transducers arranged on opposite sides of the detector transport path and a processing system for monitoring ultrasound signals received by the receiving transducer. This apparatus allows the monitoring of banknotes in order to provide an indication of thickness (including the presence of "double" or overlapped banknotes) or an indication of the presence of tape (i.e to detect adhesive tape used to repair a tear in a note). The ultrasound detector can also be used for: watermark detection and inspection (i.e. detection of the presence or absence of a watermark and its pattern); tear detection (both closed, where the tear does not extend to the edge, and open, where the tear does extend to the edge); corner fold detection; and the detection of security threads. However these functions could alternatively be performed by the CIS detector. The principle of operation of these systems is to detect the intensity of ultrasound signals either transmitted through or reflected back from a banknote from which certain information about the banknote can be deduced.

The transmitting and receiving transducers are illustrated in Figures 3B and 7C respectively. Beginning with the transmitting transducers 360a illustrated in Figure 3C, each detector comprises 16 channels, each channel being provided by an ultrasonic transducer, for example type MA200D made by Murata Manufacturing Co. Ltd. Each transducer is mounted at a set angle within a plastic mounting below the processing PCB to help route unwanted reflections away from the sensors, for example, back into the apertures 371 of moveable plate 390. The transducers are connected to processing PCB 361a which is in turn connected to more advanced processing within the SDA controller 310.

On the other side of the transport path to the transmissive transducers illustrated in Figure 3C are mounted the receiving transducers 360b illustrated in Figure 3B. The receiving transducers 360b are mounted at an angle to face the transmissive transducers on the other side of the transport path. Each transducer 360b is held within plastic mounting 362b and is connected to a limited processing PCB forming the upper surface of the receiver assembly. The ultrasound receiver is then connected to the SDA controller 310.

A single ultrasound channel will comprise a transmitter 360a and receiver 360b transducer pair. The signal received by each receiving transducer in each channel will be sampled and digitised in order to produce an ultrasound "pixel". As the note passes the 16 channels that make up each row produce a line scan of the ultrasonic properties of a note. By combining multiple lines an ultrasonic "image" of the note can be generated which can be analysed to check for the presence or absence of the features described earlier. Examples of similar ultrasonic detector systems which use angled sensors are given in GB patent application number 0526381.9 and US patent application number 60/706,753.

To calibrate the ultrasound detector two test documents are passed through the note handling apparatus. Each document will have well known but different acoustic properties which can be used to interpret the measured sensor output. Typically, one document is a foil document and the other is a plastic/foil document.

3.7 Detector Transport Drive System

The drive system for the detector transport path 300 is illustrated in Figure 3H. The drive system comprises three sets of driven transport rollers 350 a to c that project through apertures 351 on fixed plate 301. Each set of driven transport rollers comprises three rubber rollers 352 mounted upon a drive shaft 350. Each drive shaft 350 is driven from the main transport motor 499 described in more detail in section 4.

The drive shafts receive power from the drive train illustrated in Figure 3H. Second exit drive shaft 475 is driven by belt 402 in a manner described in more detail in section 4 below. Toothed pulley 494 is attached to second exit drive shaft 475 and drives a timing belt 260 which provides power to snatch roller shaft 231.

First drive shaft 350a is attached to a first two-level pully 300v. The lower level of the first two-level pulley 300v is driven by snatch roller shaft 231 via timing belt 270. This in turn rotates the first drive shaft 350a and driven transport rollers 352a. The upper level of the first two-level pulley 300v drives a first detector transport timing belt 300x. Said first detector transport timing belt 300x in turn transfers power to the upper level of a second two-level pulley 300u. Second two-level pulley 300u is attached to drive shaft 350b and rotates driven transport rollers 352b. The lower level of the second two-level pulley 300u drives gear 300z via second detector transport timing belt 300y. Gear 300z is attached to drive shaft 350c and rotates driven transport rollers 352c. Through the use of timing belts each set of driven transport rollers 352 are synchronised with the rotation and control of transport motor 499.

4. Output Transport Path 400

Having been conveyed past the detectors 300, the banknote passes into the output transport path 400. Figure 4A shows the main components of the output transport path from the left hand side of the apparatus 1 with the fixed and movable plates 301 and 390 (see Section 3) removed for clarity. Figure 4B(i) shows a rear perspective view of the output transport path with the movable plate 390 in position, to show the interaction between the two modules. Figure 4C shows a cross section through the apparatus.

The main function of the output transport path is to convey each banknote away from the detectors 300 to the selected output pocket P1 or P2. The output transport path 400 consists of a U-turn region 410, a pre-diverter path 430 and the first and second exit paths 450 and 470. Each note is directed along either the first or second exit path by diverter 500 which will be described in Section 5 below.

One of the key requirements of the output transport path is that, after exiting the detector module 300, each note takes a sufficient length of time to reach the diverter 500, in order that the control system may process the detector output, reach a decision on which output pocket the note should be directed to, and operate the diverter accordingly. Sufficient time is achieved by having the output note path incorporate a U-bend 410 and curved pre-diverter path 430 to increase the path length prior to reaching the diverter 500. These path sections will be described in Sections 4.1 and 4.2 below, and further details as to the timing of the control process are set out in Section 7.3. The first exit path 450 guides banknotes from the diverter 500 towards output pocket P1. This is described in Section 4.3 below. The second exit path 470 guides notes from the diverter 500 to the second output pocket P2 and is described in Section 4.4 below. Section 4.5 describes how the output transport path is driven.

4.1 U-Turn 410

Banknotes from the detector region 300 enter the output transport path between two opposing pairs of transport belts 401 and 402. Each pair of belts consist of two

laterally spaced, high-friction continuous belts mounted on a set of rollers. Belt pair 401 (consisting of left and right belts 401A and 401B) extends between rollers 419A and 419B mounted in the movable plate 390 and first exit rollers 451A and 451B mounted in the first exit path 450. This is most clearly depicted in Figure 4C. Transport wheels 411 are mounted on transport shaft 412 adjacent to rollers 419 in order to create a first pinch point therebetween. The second pair of transport belts 402 passes around the transport wheels 411, opposing the first pair of transport belts 401, and extends to the second exit rollers 471 in the second exit path 470. The first and second pairs of transport belts 401 and 402 contact and oppose each other around approximately half the circumference of transport wheels 411 to define the note path therebetween.

The first pair of transport belts 401 is held taut by a series of rollers 426, 431 and 456 in addition to the rollers 419, 411 and 451 already identified. Rollers 426A and 426B are mounted on individual shafts supported by brackets 425A and 425B on a cross beam of the apparatus framework. Rollers 431 are supported on shaft 432 which extends between the side plates of the framework beneath the transport wheels 411. Rollers 456 are mounted on shaft 455 which extends between the two sides of the framework adjacent the diverter 500.

A number of measures are provided to ensure accurate belt tracking, i.e. maintaining the belts on their intended path, centred on each support roller. First, one or more of the support rollers are crown rollers having a diameter which increases towards their centre. In this example, at least rollers 426A and 426B are crown rollers.

It is also important to ensure the rotational axis of the roller is precisely positioned perpendicular to the intended direction of belt transport. This is aided by providing a the roller mounting assembly with adjustment means, as shown in Figure 4B(ii). The bracket 425A,B upon which each roller 426A,B is supported via a shaft is affixed to the base cross bar 121 by releasable retaining means in the form of two bolts 428 A,B. An aperture 427A,B through the base 121 is provided adjacent an edge of each bracket 425A,B (which may be an edge of an aperture in the bracket), and a keying

feature such as a notch 425'A,B is formed in that edge. The keying feature is arranged to couple with an adjustment tool such as a flat screwdriver.

The aperture 427A,B is sized so as to receive the adjustment tool and shaped to provide a pivot point on which the tool can be rested and accurately pivoted whilst being coupled to the keying feature in the bracket, to thereby pivot the bracket. In the example shown, the aperture is substantially triangular, one side of the triangle being adjacent to the keying feature in the bracket, and the opposite corner acting as the pivot point.

One or more positioning marks may also be provided adjacent the aperture to assist in positioning the bracket. In this example, a single mark in the form of a notch 427'A,B is provided in the side of the aperture.

To perform adjustment, the bolts 428A,B are loosened to enable pivoting of the bracket 425A,B. An adjustment tool 429 is inserted into aperture 427 as shown in Fig 4B(ii) and the machine is operated to run the transport belts. The belt tracking is adjusted by pivoting the tool in the required direction. Once the belt is tracking centrally, the bolts 428A,B are tightened to secure the bracket in position.

The second pair of transport belts 402 is held taut by rollers 476 and 420 in addition to transport wheels 411 and the second exit rollers 471 already identified. Rollers 476 are mounted on a shaft 475 between the side plates of the apparatus adjacent to the diverter 500. Rollers 420 are mounted on shaft 421 in bearings 423 (see Figure 4E(ii)) above the transport belts 402 to maintain tension. A guard plate 405 having a ridge for receiving the roller shaft 421 and its rollers 420 is provided above the belts 402 and rollers 420 to separate them from the interior components of the fixed plate 301 (see Section 3).

The rollers 419, mounted in the movable plate 390, are pivotable relative to the remainder of the output transport path 400. As already described in Section 3, the movable plate 390 is pivotable to allow access to the detectors and the note path therethrough. Pivoting the movable plate 390 open moves the first pair of transport belts 401 away from the transport wheels 411, thereby reducing the curvature of the

transport belts 401. In order to prevent loss of tension in the belt, the rollers 426A and 426B are precisely positioned at the centre of curvature of the locus of rollers 419 formed when the movable plate is pivoted open. This prevents the transport belts 401 slipping under reduced tension and enables banknotes to be removed when the movable plate 390 is pivoted open simply by reversing the transport belts.

A series of guide plates are provided to define the path to be followed by each banknote and support the sheets across its full area. The incoming banknotes are guided around the first portion of the U-turn 410 by the curved region of the movable plate 390 and a set of opposing guide members 416A, 416B and 416C, depicted in Figures 4G and 4H. The three curved guide members 416 are spaced from each other so as to allow the transport wheels 411 and the transport belts 412 mounted thereon to extend between the guides. Each of the guide members 416A, 416B and 416C has a cut-out, used to mount one half of a transmitted optical sensor pair 418. These combine with the optical receivers 315 described in Section 3 to form the pre-diverter sensors. The three guide members 416A, 416B and 416C are mounted into the structure by means of bar 417 which is fixed between the two side plates of the apparatus.

The guide members 416 and movable plate 390 guide the banknote around the U-turn until it reaches the start of the pre-diverter section 430.

4.2 Pre-diverter Transport Path 430

As each banknote completes the U-turn around transport wheel 411, the path defined between the transport belt 401 and 402 becomes substantially linear, leading the banknote towards the diverter 500. Having exited the movable plate 390, the banknote is now guided by a lower guide plate 403, which sits underneath transport wheels 411, and an upper guide plate 404 which meets the guide members 416 to continue the opposing guiding surface. Each guide plate 403 and 404 is mounted between the two side plates of the apparatus framework.

The lower guide plate 403 extends from beneath the transport wheels 411 upward past the diverter 500. Immediately before the diverter point, the guide plate 403

includes apertures through which rollers 456 extend, with the transport belts 402 mounted thereon, to ensure that the note is correctly positioned and sufficient drive is transferred to it as it meets the diverter. The plate 403 also has a series of apertures for receiving the blades of the diverter (see Section 5) when it is positioned to direct banknotes towards the second pocket P2. In this way, it is not possible for a note to inadvertently take the wrong exit path since here the transport path is eliminated by the blades of the diverter intermeshing with the guide plate.

Likewise, the upper guide plate 404 continues past the diverter towards the second pocket P2. The upper guide plate is depicted in Figure 4D(ii) and it will be seen that the guide plate includes apertures through which rollers 476 extend and additional apertures for receiving the blades of the diverter when it is positioned to allow notes to pass to pocket P1 (as shown in Figure 4C). Again, this prevents any notes taking the wrong path since the second exit path is eliminated by the interaction between the diverter and guide plate 404. The diverter itself will be described in greater detail in Section 5.

Each of the roller shafts is mounted between the two side plates of the framework in bearings and referenced to the left hand side of the apparatus using a spring washer. For example, as shown in Figure 4D(i), the roller pair 476 are laterally spaced on a shaft 475 which is supported in bearings 478A and 478B in the side walls 101, 102 of the apparatus. On the right hand side, a spring washer 477 is inserted between the side wall and a flange provided on the bearing 478A so as to urge the left hand end of the shaft into position. A similar construction is used on each of the shafts on the output transport path.

4.3 First Exit Path 450

With the diverter in the position shown in Figure 4C, the banknote passes under the diverter towards the first output pocket P1 along the first exit path 450. Here, the first pair of transport belts 401 separate from the second pair of transport belts and are instead opposed by rollers mounted on the underside of the second stacker module 600B. The note is guided by the base plate of the first stacker module 600A, through which the first exit rollers 451 protrude (see Section 6). These rollers,

opposed by a transport belt mounted in the underside of the second stacker module 600B (see Section 6) provide the last pinch point and the note exits into output pocket P1 where it is stacked by stacker module 600A.

4.4 Second Exit Path 470

With the diverter 500 in its downward position (not shown), a note arriving at the diverter 500 passes over the diverter, carried by the second pair of transport belts 402 toward the second output pocket P2. The notes are opposed by a series of rollers mounted in the back of the second stacker module 600B. The notes are guided along a first portion of the exit path by the extension of upper guide plate 404 and this function is then taken over by the top plate of the second stacker module 600B. The second exit rollers 471 protrude through the top plate of the second stacker module opposing a set of rollers in the second stacker module 600B (see Section 6) to provide a last pinch point from which the note exits into the pocket P2.

4.5 Output Transport Drive

The drive chain is shown in Figure 4K. The transport motor 499 is mounted to the left side wall 102 of the apparatus and drives a pulley via drive shaft 498. Timing belt 496 transfers drives to pulley 495 fixedly mounted on the transport wheel shaft 412. Thus drive is transferred to both the first and second pairs of transport belts 401 and 402 (see Figure 4C). All of the rollers supporting belts 401 and 402 are driven by the rotation of the respective belt 401 or 402. This includes the second exit rollers 471, mounted on shaft 472. At its extremity, this shaft is provided with a pulley 494 from which a timing belt 260 transfers drive to the snatch rollers 230 described in Section 2. From here, the input module is driven via a clutch and brake system. Drive is also taken from the snatch rollers 230 via timing belt 270 to pulley 300v, driving the transport through the detector region 300 (see Section 3).

In this way, all of the rollers making up the output transport path, as well as those conveying the note into and through the detector region are driven synchronously by a single motor. The use of timing belts as opposed to O-rings ensures drive is

transmitted accurately, without slippage, thereby ensuring that all shafts are rotated at the appropriate speed.

The transport motor 499 is provided with a current limiter which limits the current drawn by the motor when it approaches a pre-determined limit, e.g. 5 Amps. This prevents the motor overheating. In some embodiments, a feedback circuit may be provided to switch off the motor if the limit is reached. However, in practice, a jam scenario will be identified first by the sensors (see sections 3 and 7), and the controller 700 will react by stopping the transport. The motor 499 is further designed to stall before inflicting any damage on any transport components (e.g. stripping the timing belts or pulleys).

5. Diverter 500

Figure 5A shows a front perspective view of the document handling machine 1 with its framework and second stacker module 600B removed for clarity. The diverter 500 is provided at the point at which the first and second exit paths 450 and 470 (see Section 4) diverge from one another. This is shown in a further perspective view in Figure 5B.

A more detailed view of the sheet diverter assembly 500, removed from the machine, is shown in Figure 5C. The diverter assembly 500 comprises a shaft 511 that is journalled in bearings 512A, 512B that are housed in opposite sides of the document handling machine.

The shaft 511 is referenced to the left hand side of the apparatus by spring 513 and clips 514A and 514B in the same manner as the transport shafts described in Section 4. A plurality of diverter vanes 510A-510H are non-rotatably mounted on the shaft 511. In this case, the vanes are all integrally formed as a single moulding 510. The diverter vanes are typically made from a lightweight but rigid material, for example glass-reinforced plastic. Alternative materials include carbon-fibre-reinforced plastic or aluminium. These materials can be useful, as they are electrically conductive, for dissipating static charge from a bank note.

At one end of the shaft 511, there is mounted a diverter shaft pulley 596 (see Figure 5A) which is coupled to a diverter motor 599 (typically a DC motor) via a resilient drive belt 597 and a drive motor pulley 598. The diverter shaft pulley is retained on the shaft by an e-ring and a protrusion may be provided on the core of the pulley extending into the gap of the e-ring to prevent rotation thereof relative to the pulley. The resilient drive belt 597 is typically a rubber O-ring stretched over the diverter shaft pulley 596 and the drive motor pulley 598. An end stop 590 is mounted on a fixed plate (the side wall 102 of the apparatus) such that the end stop 590 protrudes through a slot 591 in the diverter shaft pulley 596. In this way, the rotation of the shaft 511 is constrained to an arc defined by the size of slot 591. As such, the end stop 590 in conjunction with the slot 591 defines first and second positions of the diverter vanes 590.

Alternatively, the end stop 590 could be mounted on a sub-plate that can be moved relative to the rest of the assembly. As such, the position of the end stop 590 can be adjusted, for example to compensate for variability in the positioning of a note by the rest of the transport as it is directed at the sheet diverter assembly 500.

By rotating these diverter vanes 510 to the first of two positions the note can be diverted along the first exit path 450 to the first output pocket P1, whilst in the second position the note passes along the second exit path to the second output pocket, P2. Figures 5A and 5B show the diverter in this second position.

Figures 5D(i) and (ii) show side views of the diverter shaft pulley 596 in the first and second positions respectively. In Figure 5D(i), the diverter shaft pulley 596 and hence, diverter shaft 511 and diverter vanes 510 have been rotated as far clockwise as possible such that the left hand end of slot 591 is pressing against end stop 590. The diverter vanes 590 are positioned such that a sheet passing through the nip formed between rollers 456 and 476 (see Figure 5B and Section 4) is diverted along the bottom edge of diverter vane 510 into the first pocket P1.

Conversely, in Figure 5D(ii) the diverter shaft pulley 596 has been rotated as far anti-clockwise as possible such that the right hand end of slot 591 is pressing against end stop 590. A sheet document passing through the nip formed between rollers 456 and 476 will then be diverted by the top edge of diverter vanes 510 such that it continues along the second exit path 470 towards the second output pocket P2.

When the diverter vanes are in the first position, allowing notes to pass to pocket P1, the blades of each vane extend through apertures provided in guide plate 108 (see Figure 5B and Section 1) to seal off the second exit path. This ensures that no banknotes can accidentally pass the incorrect side of the diverter assembly 500. When the diverter vanes 510 are moved into the second position, as shown in Figure 5B, the blades of the vanes pass through the corresponding apertures provided in the guide plate 403 to obstruct the first exit path.

The two exit paths which transport the note from the diverter to the selected output pocket P1 or P2 are described in Section 4.3 and 4.4.

The operation of the diverter assembly will now be described with reference to Figure 5E. In this Figure, a timing diagram showing the relative timing of a divert signal and the motor current is shown.

The transport controller 111 is used to control the operation of the diverters in response to signals received from detector region 300. These sensors and the signals received from them are described in Sections 3 and 7.

In Figure 5E, a decision has been made by the controller 111 to divert a particular note into the first pocket P1. As a result, the divert signal is asserted at T0 and this causes a motor driver incorporated within the controller to drive the motor 599 at a current IMAX. For example, IMAX may be 1.5 amperes. After a time ΔT, the motor current is reduced to IHOLD which for example may be 0.5 amperes. The time ΔT is chosen to guarantee that the diverter vanes 510 can move from one position to the other position before the current is reduced from IMAX to IHOLD. By driving the motor 599 in this way, the diverter vane is moved into position 1 as shown in Figure 5D(i) and the note is diverted into pocket P1.

The actual time taken for the diverter vane 510 to move from one position to the other will typically depend on several factors, for example the friction in the bearings 512A and 512B and the inertia of the motor and diverter assembly. Thus, ΔT is chosen to be significantly larger than this actual time to guarantee that the diverter vanes has sufficient time to change position.

At time T1, the controller 111 makes a decision that another note is to be diverted to pocket P2 and the divert signal is correspondingly switched. As a result of this the motor current polarity is reversed and set to a magnitude of -IMAX. This causes the diverter to revert to position 2 as shown in Figure 5D(ii). Again, at a time ΔT after T1 the motor current is reduced to -IHOLD, at which value it continues to flow. It is important to realise that the time ΔT could, in fact, be different for each direction of operation of the diverter.

This method of motor control allows the diverter vanes 510 to change position quickly but the motor current is then reduced to a level, IHOLD, that holds the diverter shaft pulley 596 against the end stop 590 but which will not be sufficient to overheat and hence, damage the motor 599. This reduced current, IHOLD, can be applied to the motor indefinitely.

A surprising advantage of reducing the motor current to a holding current in this way is that the reaction speed of the diverter is increased when the motor current polarity is changed because the magnetic field associated with the holding current, IHOLD, is lower than that of the maximum current, IMAX, and so there is a lower magnitude magnetic field to overcome. Thus, the diverter responds quickly when the diverter vane 590 is required to change position.

In a typical example, the value of IMAX is 1.5A and this is applied for 30ms (i.e. ΔT=30ms) before reducing the motor current to a value of IHOLD = 0.5A. Furthermore, the act of continuing to drive the motor 599 prevents the drive belt 597 from relaxing and allowing the diverter vane 510 from being inadvertently moved. The motor 599 does not continue to rotate but instead is stalled and as such applies a constant torque to the drive motor pulley 598 thereby holding the diverter vane 510 firmly in place.

When the diverter vane 510 is required to change position, the resilient drive belt 597 is placed under tension since the motor 599 begins to move before the inertia of the diverter assembly 500 has been overcome. For example, if the motor 599 is rotated in an anti-clockwise direction to change from position 1, as shown in Figure 5D(i), to position 2, as shown in Figure 5D(ii), then the drive belt 597 will be tensioned on its left hand side. As a result of this, the drive belt 597 stores energy during rotation of the diverter shaft 511 and diverter vane 510 and this energy is input into the system after the right hand end of slot 591 strikes end stop 590 and mitigates the rebound of diverter vane 510 from the end stop 590. In essence, the energy stored in the drive belt 597 attempts to pull the diverter shaft pulley 596 past the end stop 590 and this prevents the diverter shaft pulley 596 from rebounding from the end stop 590.

During a banknote sorting operation, on assertion of the divert signal, the controller 111 causes an output driver to drive motor 599 at current IMAX for ΔT such that the diverter vanes 510 are moved so as to divert banknotes towards pocket P1. After ΔT, the controller causes the output driver to reduce the motor current to IHOLD. This holding current is maintained, as previously described, until a decision is made by the controller to divert a banknote to pocket P2. Then, the controller causes the output driver to drive motor 599 at current -IMAX for ΔT rotating the diverter vane 510 to its second position such that it diverts banknotes to the second output pocket P2. After ΔT, the current is reduced to -IHOLD at which value it remains until the controller decides to send an oncoming banknote to pocket P1 again.

Whilst the use of a motor actuator has been discussed above, it will be appreciated that one or more solenoids could be used as the actuator. Therefore, in a further example, the drive motor pulley 598 may be coupled directly to a solenoid so as to move the drive motor pulley 598 between two positions which, in turn, cause movement of the diverter vane 510 between the respective diverter positions.

A single solenoid (biased towards a non-energised position) may be used for this purpose, or two solenoids could be used, working in a complementary manner.

In another example, rather than using a pulley arrangement, one or more solenoids could be coupled directly to the diverter assembly (such as to the vanes 510 or a modified part of the shaft 511). In this case, the resilient coupling could take the form of a spring or piece of resilient material such as rubber, either being arranged to transmit the force of the solenoid(s) to the diverter assembly.

6. Stacker Modules 600

Each output pocket P1 and P2 is provided with a respective stacker module 600A and 600B which receives the notes diverted to it from the output transport path 400 and arranges them into a stack for presentation to the user.

Figure 6A shows a perspective view of the apparatus with both stacker modules 600A and 600B in position. The lowermost stacker module 600A largely comprises a fixed stacker base unit which is an integral part of the apparatus' framework. The upper stacker module 600B, on the other hand, is built around a removable access module 620 which can be slid out of the apparatus by a user to gain access to the diverter region. Figure 6B shows a perspective view of the apparatus with the access module 620 removed. Above the access module 620, the upper stacker module 600B is completed by a top plate 680 which divides the stacker module region from the interior of the apparatus.

The operation of the lower stacker module 600A will be described in Section 6.1, including its interaction with the underside of the access module 620.

Further details of the access module 620 including its construction and interaction with the output transport path 400 will be described with reference to the upper stacker module 600B in Section 6.2.

6.1 Lower Stacker Module 600A

The lower stacker module 600A receives notes from the first exit path 450 entering the first output pocket P1. The note path can be viewed most clearly in Figure 6C which is a cross section through the apparatus. Here, the diverter 500 is shown in its first position in which notes are directed towards the lowermost stacker module 600A. The notes are conveyed from the diverter point by transport belt pair 401 towards the output pocket P1. First exit rollers 456 (see Section 4) are opposed by a pair of transport belts 664 mounted in a support roller module 650 disposed at the rear of access module 620. These components will be described in Section 6.2 below.

As the note exits the nip between rollers 456 and belts 664, the note passes a lower post-divert sensor 604. This comprises an optical receiver 604A and emitter 604B disposed opposite one another on either side of the transport path. The receiver 604A is mounted to the underside of base plate 601, shown in Figures 6D and 6E. The emitter 604B is mounted above the base plate of the access module 620, shown in Figure 6I.

The note then follows base plate 601 which is provided with two elongate apertures 602A and 602B through which stacker wheels 610A and 610B extend. The base plate 601 is also provided with cut-outs 603A and 603B which accommodate the rollers 456 at its upper edge.

The two stacker wheels 610A and 610 B are non-rotatably mounted to a stacker shaft 611 which is held in a bracket 615B mounted on the base of the apparatus 103 (Figure 6F). The bracket 615 is a U-shaped structure having a cut-out 615A on one arm for receiving motor boss 619 therein, and an aperture 615B on the other for securing the other end of the stacker shaft. The bracket 615 is also used to support a first stacker motor 619 via a mounting plate 618. The motor 619 is directly coupled to the stacker shaft 611 and secured thereto to coupling 612A and clip-in bearing 612B. The stacker motor 619 is driven directly by the transport controller 111 to rotate the stacker wheels towards the user.

Each stacker wheel comprises a solid core and a plurality of curved vanes extending from the core in a spiralled manner. The gaps defined by the vanes are open-ended towards the transport roller 456 such that they can receive notes from the first exit path 450.

As each note leaves the first exit path 450, it is received by the stacker wheels 610 and turned through approximately 90° as the stacker wheels rotate. The note exits the stacker wheel at the point where the vanes carrying the note move through apertures 602A and 602B and behind the base plate 601. The banknote is left resting against base plate 601, which is provided with tabs 607 and guides 627' to support the growing banknote stack in this position. A first stacker sensor 606 is

located such that the light beam will be intersected by banknotes which have been stacked. To this end, an receiver 606B is mounted between the tabs 607A and 607B on a plastics housing 605A. A LED emitter 606C is mounted in an aperture 605A (see Figure 6D) in the base plate 601 between the stacker wheels 610A and 610B. The signal from the sensor 606 provides an indication to the control system that notes are present in the lower stacker module 600A. The completed banknote stack is then ready for collection by a user.

6.2 Upper Stacker Module 600B

The upper stacker module 600B receives and stacks notes directed to the second output pocket P2 by the diverter 500. The majority of the functional components making up the upper stacker module are mounted within access module 620, shown in Figure 6H. The upper stacker module 600B is completed by a top plate 680 (Figure 6A)which divides the stacker region from the interior transport.

The access module 620 comprises an access module base 628 (shown in Figure 6J), which supports the stacker module components, a support roller module which completes the first and second exit paths of the transport path (see Figure 6N), and a guide plate 621 which encloses the access module and receives the stack of output banknotes.

The access module base plate 628, shown in Figure 6J, is shaped with a flat base which acts as a support for the stacker module components and also as an upper surface completing the lower stacker module 600A. The rear of the access module base plate 628C is curved so as to guide notes along the end of the first exit path into the first output pocket P1. A cut-out 628A is provided to enable transport belt 664 (see below) to extend therethrough. A tab 628B supports the emitter portion of first post-divert sensor 604 (see Section 6.1 above). Along its front edge, the access module base plate 628 has an upward flange 628D which meets the guide plate 621, when assembled, to complete the enclosure.

Mounted at each side of the access module base plate 628 are access module side panels 629A and 629B, which extend perpendicularly between the base plate 628

and the guide plate 621. Each side panel is provided with two elongate slots 642 and 642 (see Figures 6I and 6L). In use, each of these slots co-operates with a corresponding support roller mounted on a peg provided on the interior side wall of the apparatus. Figure 6L shows the interior right hand wall 101 of the apparatus, provided with upper support roller 644B and lower support roller 645B. The upper support roller 644B extends through the upper slot 642B provided in the right side panel 629B of the access module 620. The lower support roller 645B extends through the lower slot 643B. Corresponding support rollers 644A and 645A and slots 642A and 643A are provided on the left hand side wall 102 of the apparatus.

The slots 642, 643 and pegs 644, 645 are arranged relative to one another such that, when both support rollers are engaged with both slots, the access module is constrained to follow one path. When the access module 620 is fully retained in the apparatus, the support rollers 644, 645 meet the front end of the respective slot 642, 643 which takes the form of a dog-leg (see Figure 6L). This, together with a latch 641 (see below) prevents the access module sliding unintentionally. To move the access module out of the apparatus, the user must release the latch 641 and tilt the access module down such that the support rollers can exit the dog-legs and enter a linear portion of each slot. The access module is now able to slide relative to the framework away from the transport region of the apparatus.

The upper slot 642 is open at its rear end and shorter than the lower slot 643. When the access module has been slid out approximately halfway, the upper slot thereby releases the upper support roller 644 and the access module is now only retained by the lower support roller 645 on each side. This allows the access module to pivot downwards for access to the diverter region. The lower slot 643 is closed at its rear end so that the access module cannot be slid out more than a predetermined amount and to prevent accidental disengagement.

Spacer blocks 640A and 640B are mounted immediately under each of the lower slots 643A and 643B to ensure the access module 620 does not make direct contact with the side walls 101, 102 of the apparatus as it moves.

Provided near the front of each side panel 629A and 629B is a spring-mounted latch assembly 641A and 641B (see Figure 6I). This comprises a latch component 641' rotatably mounted on a pin to the respective side panel. A spring 641'' urges the front end of each latch 641' down, causing the opposite end to engage a the lower support rollers 645 provided on the interior surface of the apparatus' side wall, thereby preventing the access module 620 being moved. To unlock the latch, the user presses each latch upwards, thereby releasing the latches from the side walls.

At the rear of the access module 620 is located a roller support module 650 (see Figures 6M to 6P). This module completes the first and second exit paths which convey each note to the selected output pocket from the diverter 500.

As shown in Figure 6I, the roller support module 650 is mounted to a cross beam 648 extending between the side plates 629A and 629B at the rear of the access module 620. A support body 651 is affixed to the cross beam 649 via a mounting plate 648 (Figure 6N). The position of the mounting plate can be adjusted by loosening the screws and sliding the roller support module up or down. This helps to achieve central belt tracking. The support body 651 (shown in Figure 6M) comprises a body portion through which three pairs of bearings 651', 651'' and 651''' extend. Two arms 651A and 651B extend from the body portion towards the base of the access module 620.

Four roller pairs are mounted to the support body 651 as depicted in Figure 6N. Starting from the top, a first roller shaft 652 extends through the bearings 651' and carries crown rollers 654A and 654B. Crown rollers (which have an increased diameter at their central portion compared to their two ends) are used to provide belt tracking. When the access module is in position, these rollers oppose the transport belts 402 where they are mounted on second exit rollers 476 (see section 4), providing the last pinch point in the second exit path.

A second roller shaft 656 extends through the bearings 651'', and supports crown rollers 657A and 657B. When in position, these are located just above the diverter 500 and are opposed by the transport belts 402, helping to maintain their position and ensure contact between the note and the belts.

Between bearings 651'' and 651''', the support body is shaped in a concave manner to guide notes and accommodate the diverter 500 and allow for its movement. A third roller shaft 658 extends through the bearings 651''' and supports crown rollers 660A and 660B. In use, these are positioned just in front of the diverter 500.

The final pair of rollers 662A and B are supported on individual shafts 661A and B mounted in apertures provided on arms 651A and B respectively of the support body and secured by grub screws 665. The rollers 662A and 662B are plain rollers. A pair of third transport belts 664 extend between the third and fourth rollers 660 and 662 on each side of the arms 651A and 651B. In use, the third transport belts 664 oppose the first transport belts 401 where they are mounted on the first exit rollers 456, thereby providing the last pinch point in the first exit path.

The path taken by notes conveyed to the upper stacker module 600B can be seen most clearly in the cross section of Figure 6C. The notes are conveyed from the diverter point by transport belt pair 402 towards the output pocket P2 and exit through the pinch point defined between second exit rollers 476 and the uppermost crown rollers 653.

The note then passes an upper post-divert sensor 624. This comprises an optical emitter 624A and receiver 624B disposed opposite one another on either side of the transport path. The emitter 624A is mounted to the underside of guide plate 621, shown in Figure 6K. The receiver 624B is mounted above the top plate 680 of the second stacker module 600B, shown in Figures 6A and 6B.

The note then follows guide plate 621 which is provided with two elongate apertures 622A and 622B through which stacker wheels 630A and 630B extend. The base plate 601 is also provided with cut-outs 623A and 623B which accommodate the rollers 653 at its upper edge.

The two stacker wheels 630A and 630B mounted via a bracket arrangement identical to that depicted in Figure 6F to the access module base plate 628. As in the case of the lower stacker module 600A, the stacker wheels 630 in the upper stacker module

600B are driven directly by a dedicated motor, in accordance with commands from controller 111.

The stacker wheels 620 receive notes from the second exit path and form a stack for presentation to the user as previously described with reference to the lower stacker module 600A. As each note is rotated by the stacker wheels, it passes vent 681 (see Figures 6A and 6B) which is provided in top plate 680 underneath the control panel. The movement of the note past the vent circulates air and so aids convection cooling in the apparatus' interior.

Tabs 627 and guides 627' are provided to support the growing banknote stack. A second stacker sensor 626 is located such that the light beam will be intersected by banknotes which have been stacked by the upper stacker module. To this end, an receiver 626B is mounted between the tabs 627A and 627B on a plastics housing 626A. A LED emitter 626C is mounted in an aperture 625A (see Figure 6H) in the guide plate 621 between the stacker wheels 630A and 630B. The signal from the sensor 626 provides indication to the control system that notes are present in the upper stacker module 600B. The completed banknote stack is then ready for collection by a user.

7. Electronics and Control 700

7.1 Front Panel 701

The front control panel is illustrated in Figure 7A. The panel comprises moulded plastic casing 701 to which a front label panel 706 is affixed. Front label panel 706 contains text and/or graphics relating to the function of polymer keys 702a. The polymer key panel 702 typically comprises moulded polymer or rubber keys 702a with integrated carbon pills. These keys project through apertures 701a within the front panel casing 701. When a key 702a is pressed, the integrated carbon pills make contact with the main controller PCB 704. This forms an electrical connection and generates a signal that can be used by a main processing controller. The keys 702a are designed to offer suitable resistance to pressure from a human operator, allowing the operator to appreciate that a key has been pressed.

The main controller PCB 704 further comprises liquid crystal display (LCD) screen 705. The display 705 is visible behind an optional protective screen 706 and can be viewed through aperture 701b in the front panel casing 701. Control of the LCD screen 705 and processing of keyed input is performed by the main controller PCB 704.

The polymer key panel 702 comprises three main key sections: numeric keypad 708, elongate navigation keys 709 and miscellaneous function keys 707. Miscellaneous function keys 707 further comprise start/stop key 707a, scroll keys 707b and miscellaneous function keys 707c. Elongate navigation keys 709 comprise four functional keys that can be used to select icons and menus displayed on LCD screen 705, wherein the function of each navigation key will typically relate to the icon and/or menu located directly above the respective key. Scroll keys 707b are used to navigate menus provided on display 705 and they can also be used to select options displayed on the screen. Start/stop key 707a can be used as a one touch key to start and/or stop the operation of the document sorter.

7.1.1 Removal of Front Panel

To provide ease of disassembly and reassembly, and to allow access to the electronics therein, front panel 701 further comprises a unique pivoting system which not only allows the front panel to pivot down (i.e. pivot so that the panel is approximately horizontal) but also allows the whole panel to be removed for repair or replacement.

Figure 7B shows the components of the pivoting system that form part of the front panel moulded plastic casing. The rear rim of the panel 701v contains two laterally spaced moulded structures 701y and 701w. The right structure 701y comprises a location tab 701z consisting of a projecting flange inclined at an angle to the horizontal. The left side of structure 701z comprises a closed cavity or socket 701x (see Figure 7C).

In use the front casing is attached to the top plate 680 of the upper stacker module as shown in Figure 7C. Top plate 680 comprises a first cut-out section 680r wherein a rectangular section of the plate has been removed. Top plate 680 also comprises a second cut-out section 680s wherein a rectangular section of the plate has been removed from the corner of said plate. Both cut-out sections have an associated pin 680t which is fixed to the right side of each cut-out area and projects laterally into each area. Each pin 680t is designed to fit within sockets in structures 701y and 701w. When the front panel 701is fixed in place it can pivot about the pins 680t in order to provide access to the electronics 710 within. When the document handling apparatus is operational the top of front panel 701 is fastened into place with two screws which pass through feed plate apertures 201t into threaded mountings on flanges 701u.

When in place and allowed to pivot front panel 701 is prevented from being detached by the presence of pins 680t within sockets 701x. The front panel 701 is also prevented from moving laterally by location tab 701z, as shown in Figure 7D. In most orientations each location tab is orientated at a non-zero angle to top plate 680. This means that the contact between tabs 701z and the top plate 680 keeps

front panel 701 from sliding to the left. However, when the front panel 701 is pivoted open to a set angle, typically around 45 degrees above the horizontal, the location tabs 701z align with the angle of the top plate, i.e. are substantially parallel with the top plate. At this angle the location tab 701z projects below the top plate 680. In this position the front panel 701 can slide laterally to the left. A lateral movement to the left disengages pins 680t from their respective sockets in structures 701y and 701w which in turn allows the front panel 701 to detach from the top plate 680. The front panel can then be removed by pulling the panel away from the apparatus. After the front panel 701 has been removed, the procedure can be repeated in reverse to reattach the same or another panel.

As the main controller circuit board (described below) is located within the front panel casing 701 then the pivoting action allows easy access to this board and its interfaces for servicing and repair. If the main controller is damaged or requires updating then the old front panel containing said controller can simply be removed and replaced with another in the manner described above. As the front panel is small and light weight multiple panels can be brought into the field and there is no need to remove and replace the whole apparatus.

7.2 Control Structure

The organisation of the electronic hardware components is schematically illustrated in Figure 7E. The control system 700 comprises a main controller PCB 704, which is located within front panel casing 701; and transport controller PCB 111 which is affixed to the right hand side of the document sorter (as is visible in Figure 1A). Reference is made below to the functional aspects of each controller, both of which are implemented in appropriate hardware upon their respective PCBs. The main controller 704 maintains control over the transport controller 111 and SDA controller 310 and communicates with said controllers via a controller area network (CAN) interface or via a system bus. Each of the main controller 704, transport controller 111 and SDA controller 310 is connected to the system bus and messages put onto the bus by any one of the controllers can be read from the bus by any one of the other controllers. The main controller 704 acts as the CAN master. A global reset

signal can also be communicated over the system bus, typically from the main controller.

7.2.1 Main Controller 704

The main controller 704 controls display 705 and keypad 702. The display driver can address any of the pixels in the liquid crystal display 705. The main controller 704 is provided with power at 7.8 volts from switcher circuits within the system power module 712 of transport controller. This 7.8 volt supply is further regulated by a 5 volt regulator to supply 5 volts to the circuitry of the main controller 704 and the LCD screen.

In some embodiments, the document handling apparatus may be provided with a remote display which can be connected to the main controller 704 via a suitable port such as one of the RS232 ports 112a to 112c. Any one of the same ports 112a to 112c may also be used to download new software to the transport controller 111. An example of a remote display 705' is shown in Figure 7D(i). The display 705' may be mounted where desired (typically away from the apparatus itself) using a mounting arm 705''. The controller displays first selected data on the integral display 705 (section 7.1) in accordance with the operational mode. Second selected data may also be displayed on the remote display 705', and in many cases this will differ from that displayed on the integral display 705. For example, the integral display 705 may show data relating to each output pocket, whereas the remote display 705' may show data relating to all pockets collectively.

The data displayed on the remote display 705 may comprise any of that generated in the chosen operational mode, as described in section 8.4. The data may be displayed on the remote display for a predetermined time (set by the user or supervisor), or could remain on show until the next pass of documents, or until it is cleared by an operator.

The main controller 704 also controls stack-position bicolour LEDs 150. Each of the upper and lower stack pockets will have an associated stack-position bicolour LED (150B and 150A respectively) which is typically located to the right of each pocket

and is affixed to side panel 101A. Typically the bicolour LEDs 150 provide red and green illumination, although other colour combinations can be used. In use they provide an indication as to the result of the document processing performed by the document handling apparatus. For example, if a plurality of banknotes have been counted successfully then the stack position bicolour LED 150 can be illuminated green. If a counterfeit or unrecognised note fails a detector test, it can be delivered to a stack pocket and the stack position bicolour LED 150 can be illuminated red to indicate that the processing operation was unsuccessful.

The main controller 704 can also interface with a printer 714 or a remote cash management system 713 via one or more of RS 232 ports 112c and 112b. Both ports will be connected to appropriate RS232 interface circuitry. Port 112b can also be used to download new software to the main controller 704. These downloads can be in the form of firmware updates which allow the control systems to be updated in the field. Alternatively, port 112b can be used by service engineers to interrogate the operation of the main controller 704 and other aspects of the control system 700. The same port 112b can also be used to connect the document sorter to a remote personal computer. The remote personal computer can then run a cash management system which can retrieve processing details or exercise remote control. In alternate embodiments the connections to remote systems are also provided by Ethernet ports and interfaces.

7.2.2 Transport Controller 111

The transport controller 111 is implemented on a printed circuit board attached to side panel 101. The transport controller 111 receives power from switch mode power supply 113. The transport controller 111 receives power at 32 volts from the switch mode power supply 113. This 32 volt signal is then switched to 7.8 volts for supply to one or more of the main controller 704, transport controller 111 or any peripheral device. A regulator upon the transport controller then further regulates the 7.8 volt power supply to 5 volts using a 5 volt regulator. This 5 volt output is used to power the circuitry that comprises the transport controller 111. The transport controller 111 also provides power at 32 volts to the SDA controller 310 via the system bus. The transport controller 111 further comprises a series of

removable fuses which can be removed and replaced after a current surge. The switch mode power supply 113 is connected to the power switch and socket 112d and 112e. The close location of the switch mode power supply 113 to the transport controller PCB reduces power cabling and power loss.

The transport controller 111 controls both the transport sensors 717 and the transport drive system 718. The transport controller 111 is also connected to the SDA controller 310 (via the main controller and system bus). The transport controller 111 communicates with the SDA controller 310 via the CAN bus 711. The SDA controller 310 is in communication with the SDA detector sensors 715 and additional advanced processing circuitry 716. The advance processing circuitry 716 is either located amongst the SDA circuitry 310 or within additional printed circuit boards mounted to the SDA detectors themselves and is typically used for detector-specific pre-processing.

The transport controller 111 is configured to provide three main functions in regard to the transport sensors 717: to receive sensor signals, to supply power, and to send configuration signals to control and calibrate the sensors. The transport controller 111 is connected in turn to five main sensor sets along the transport path: feed hopper transmissive sensor 202 (formed of element 202A in Figure 2I and element 202B in Figure 2E), double detector/track sensor 340 (of which one side is visible in Figure 3A), pre-divert/skew sensor set 315 and 418, post-divert sensors 604, 624 located in both the upper and lower stack pocket transport paths, and stack pocket sensors 606, 626 again located within both the upper and lower stack pockets. Each sensor set 717 is connected to the transport controller circuitry via a multi-pin connector and cable. This allows each sensor to be easily disconnected from the transport controller for removal or replacement.

The transport controller 111 also comprises a transport timing wheel 265 mounted upon the end of the snatch roller shaft 231 and integrated into the transport controller circuitry. The timing wheel comprises a series of slots provided in the outer circumference of the wheel orientated parallel to the axis of rotation. Typically, 32 slots are distributed around the circumference. These slots rotate between a slotted optosensor comprising a light emitting device and a light sensitive sensor.

By analysing when the leading edge of the timing wheel passes between the two components of the slotted optosensor an accurate measurement of the speed of the operation of the document sorter can be calculated. The use of parallel slots enables simpler construction components and further allows the use of a reactive centrifugal force to dislodge dirt and grime which has become caught within the slots of the wheel. The timing wheel signal is sampled every few millimetres of note transport and this signal can be further interpolated to achieve greater accuracy.

The transport controller 111 is also responsible for controlling the transport drive systems 718. The transport drive system 718 comprises transport motor 499, diverter motor 599, stacker motors in the upper and lower stack pockets 619, 639, and the feed drive system comprising clutch 235 and brake 226. The transport motor 499 and the stacker motors 619, 639 are actuated using a pulse width modulation (PWM) drive system. The transport motor and diverter motor are supplied with power at 32 volts via the transport controller 111 and the stacker motors are supplied with further down-regulated supplies of 24 volts. The speed of the stacker motors is varied depending on the speed of the transport motor 499. In preferred embodiments, the speed of the stacker motors is proportional to the speed of the transport motor with no feedback. The brake 226 and clutch 235 are provided with 24 volts from the transport controller 111 and are controlled using a flip-flop circuit. This means that when the brake is on the clutch is off and vice versa. The transport controller 111 provides 24 volts for powering each of these elements. A flip-flop circuit is used to prevent the brake being used to stop the full force of the transport drive which would be transferred through an operational clutch.

The document handling apparatus can also comprise a number of optional fans 209 to cool the apparatus in environments with high ambient temperatures. These fans 209 are also controlled and powered by the transport controller 111. In certain embodiments, the fans 209 are run at a speed proportional to that of the transport motor. The transport controller 111 can further be configured to only supply power to the fans 209 when power is supplied to the transport motor and roller system.

The transport controller 111 is also connected to a microswitch which provides a safety cutout when the rear panel 104 is removed. Back panel 104 further

comprises a tab near the top of the panel which, when the panel is fixed into place, actuates a microswitch which provides a signal to the transport controller 111 In normal operation with the back or rear panel 104 closed, the microswitch is also closed and the drive systems can operate as usual. When the panel is removed or not in place properly then the microswitch will not close as the tab located on the rear panel 104 is not able to depress the microswitch. If the transport controller 111 detects that the microswitch is not closed then all of the motors will be disabled. This improves safety and prevents the motor drive systems from running when the rear panel is removed.

7.3 Document Transport Control

The monitoring and control of the document as it moves within the document handling apparatus 1 is provided by a number of transport sensors 717 that are controlled by a combination of the aforementioned transport controller 111 and main controller 704. The operation of the sensor systems are best explained by following the route of a typical document, in this case a banknote, through the apparatus 1.

Notes are first placed upon the near horizontal surface of the feed hopper 201, with a stack of banknotes being located within guide members 205 and supported by support plate 204. The feed hopper 200 contains a transmissive optical sensor 202 that comprises a visible light or infrared emitter 202B and a corresponding detector 202A. When the path of light emitted by the light emitter and received by the corresponding detector is broken, for example by the placement of banknotes within the feed hopper, this is detected by transport controller 111 as a change in the sensor signal. Typically the emitter will be an LED and the detector will be a phototransistor configured to generate a digital sensor signal. The main controller 704 is then informed of this change and a decision can be made to start the document processing sequence. The note can then be fed into the apparatus 1 as described in section 2.

After the document or banknote has been fed into the system, the document or banknote will pass by a double detect or track sensor 340 located between snatch rollers 230. Typically the double detect/track sensor comprises a pair of

transmissive optical sensors. Each transmissive optical sensor within the pair comprises a visible light or infrared emitter located upon the movable plate 390 and a corresponding detector, typically in the form of a photodiode, located on the fixed plate 301. When a note passes between the emitter and the detector in each optosensor, the path of light will be broken which will be detected by transport controller 111. The sensors can also be used to detect overlapping or "double" banknotes by looking at the level of light received by each detector. If photodiodes are used then an analogue signal will be supplied to the transport controller 111 that is proportional to the level of light received by each photodiode. As stated in section 3.3 this analogue signal is typically pre-amplified by circuitry connected to the photodiodes to provide a high level signal that is less susceptible to noise.

The double detect sensors can be calibrated so that when the light detected at the detectors in each optical sensor falls below a set threshold this can be taken as a sign that two banknotes are blocking the path of light between the emitter and the detector. Alternatively, more advanced pattern recognition or signal processing can be performed on the received analogue signal. In their function as track sensors optical sensors 340 also provide a reference point in time for the leading edge of a note as it passed through the transport system. This reference point is then used to synchronise future timing and detector operation as the note continues along the transport path.

After the banknote has passed the detectors that comprise the detector transport path (discussed in section 3) the banknote will pass a predivert or skew sensor 720. This sensor arrangement is illustrated schematically in Figures 7F and 7G. The predivert or skew sensor 720 comprise three transmissive optosensor pairs, each pair comprising a visible light or infrared emitter 315a-c and a corresponding detector 418a-c. The three sensors are laterally spaced and the sequence of signal changes from these three optosensors can be used to detect the skew of a banknote 730 before it enters the U-turn section.

Figure 7G shows a banknote, travelling in direction 733, that is skewed by an angle Ø. The receivers of each optosensor pair are typically arranged in a line with a left sensor 418a, centre sensor 418b, and right sensor 418c. In the example shown if

Figure 7F, the light path 731a between the left emitter and the left detector is broken by the banknote before the centre sensor pair or the right sensor pair which signifies that the banknote is skewed with the top left corner of the banknote forming the leading section of the note. Hence, in Figure 7F, when the signal from detector 418a changes, the timing reference point for the leading edge of the note is set as virtual line 732. The information from the predivert /skew sensor can then be used to correctly actuate the diverter section. If the note is found to be skewed then the prediction of when the leading edge of the note is going to reach the diverter will have to be recalibrated using newly calculated timing reference point.

As well as the example illustrated in Figure 7G, three other states are also possible. If the right mode sensor 418c detects a change in right light beam signal 731c before the other two sensors then the transport and main controllers are able to determine that the note is travelling with the top right corner as the leading section of a note and recalibrate the leading edge reference point accordingly. If all three sensors detect a change in signal at approximately the same time then the leading edge of a note is substantially perpendicular to the transport path. If none of the sensor pairs experience a change in signal within a set time window calculated using the signal from the double detect / track sensor and the speed of the transport motor the main controller 704 detects that a jam has occurred between the double detect / track sensor and the skew sensor. This information is communicated to a user upon display 705, typically with an icon indicating the position at which a jam is thought to have occurred. The information from the detector systems integrated with the SDA controller 310 can also optionally be used to calibrate timing windows and/or jam locations. The predicted position of a note or document may take account of the degree of slip which that type of note or document experiences with respect to the transport. The predefined tolerance may similarly be varied for different types of document.

After the banknote has successfully passed the skew sensor 720 it will continue around the U-turn section as described in section 4. After the note has passed through the diverter section, as described in section 5, and is on its way to either the upper or lower stack pocket, it will further pass a post divert optosensor, either 604 or 624, comprising a transmitter sensor with a visible light or infrared emitter 604B or

624A and a corresponding detector 604A or 624B. These sensors are used to confirm that a note has successfully exited the diverter and U-turn sections, i.e. to detect note jams. For example if the diverter has been actuated to transport a note to the upper stack pocket, and it is known that the note has passed the predivert/skew sensor 720, then if the signal produced by the upper post divert sensor 624 does not change within a set time window then it is likely that a note or document has become jammed within the diverter or U-turn section. As before, the time window is calculated based on the last know detection time at the skew sensor 720, the speed of the transport motor 499, and the known distances of the transport pathway. A similar series of events also applies for when the note is due to pass the lower post divert sensor 604.

After the note passes post-divert sensors, it is fed into the rotating stacker wheels in one of the two stack pockets, as described in section 6. The stacker wheels then deposit the note into one of the two stack pockets. Within each stack pocket resides a stack pocket optosensor. Each sensor comprises a transmissive optosensor pair 606, 626 whose function it is to detect notes present in each stacker pocket. Each transmissive optosensor pair comprises a visible or infrared emitter 606B, 626B and a corresponding detector 606C, 626C. Each detector 606C, 626C typically comprises a phototransistor. When the path of light between each emitter 606B, 626B and detector 606C, 626C is broken then it can be inferred that at least one note is resident in the stack pocket. The signals from each stack pocket optosensor are fed to the transport controller 111 where they can be used by the main and transport controllers. The main controller 704 has access to all the sensor signals via the CAN system bus.

To ensure reliable operation the amount of current supplied to each emitter can be automatically and periodically adjusted when no document is present to ensure reliable operation. This technique may be used to compensate for the presence of dust that has not been removed by the passage of notes on the windows, or to compensate for an emitter whose light output is diminishing with age, or where the detector's sensitivity changes with age.

8. Machine Operation

The document handling apparatus 1 is operated by means of the keypad elements 707 to 709 and information is provided to the user via the display 705. The display 705 is typically a 192 x 64 pixel liquid crystal display (LCD). Each of the pixels is individually addressable and the display may therefore be used to display graphics and text.

8.1 Start Up

The document handling apparatus is switched on by toggling power switch 112d. The behaviour of the document handling apparatus 1 when switched on depends upon the security settings that are currently active. In an exemplary embodiment there are four main security levels: supervisor, engineer, operator and guest. Each of these security levels has an associated mode of operation. If guest-mode is enabled then anyone can use the apparatus on start up. If supervisor or operator modes are enabled then a login is typically required and the login procedure is activated on start up. A login screen is displayed on display 705 requesting the user to input a user password. When the password is correctly entered the document handling apparatus 1 loads up normally.

In a particularly preferred embodiment, the apparatus stores each user's settings in a memory. When a user logs in, his identifier his used to retrieve the correct settings from the memory and the machine is configured to operate accordingly. The settings might include any of: available process mode(s), currency, denomination, function and key access and, if the apparatus includes a remote display (see section 7.2.1), criteria for displaying data. Such settings may be set by a supervisor or engineer and the user may not have permission to make changes. The user settings may also include preferences such as language, volume (key"beep") etc., and these may be changeable by a user.

Certain settings may also be shared between users, i.e one setting is associated with multiple user identifiers. This makes it easy and quick to configure a machine for use by several operators whilst remaining operation secure and consistent.

If any one of keys 707, 708 or 709 are held down during a period at start-up in which an initial "blank" screen is displayed, then the LCD screen 705 will display a language selection menu. Using this menu the operational language can be cycled through by scrolling up and down using scroll keys 707b and then can be selected using one of the navigational keys 709. This then provides a method to change the operational language to a native language without navigating menus in a non-native language.

After loading up, the document handling apparatus defaults to an idle mode. When in idle mode, if the document handling apparatus 1 is configured to start automatically, the document handling apparatus 1 will begin to sort banknotes that are placed on the feeder hopper. Alternatively, if the document handling apparatus 1 is in a manual mode of operation, the start key 707a must be pressed.

8.2 Keypad 702

The document handling apparatus has a number of operation modes. These modes are typically switched on and off by pressing one of the keys of the numeric keypad 708. Each numeric key will have an associated mode. Figure 8A shows a schematic layout of front panel keypad 702. In a preferred embodiment the operation modes comprise: piece mode 708a; currency mode 708b; denomination mode 708c; face mode 708d; orientate mode 708e; issue mode 708f; fitness mode 708g; counterfeit authentication (CDA) mode 708h; and a banknote recycling framework (BRF) mode 708i. These modes are described below. Zero key 708j clears all toggled modes and returns the document handling apparatus to a default configuration. This default configuration can either be set at the factory or by a supervisor during use.

Miscellaneous function keys 707 are also used in conjunction with the operational modes. These keys typically comprise: user key 707c1; program key 707c2; system key 707c3; batch key 707c4; total key 707c5; detector key 707c6; and clear key 707c7. The function of these keys will also be described below.

8.3 Stack Pockets

In normal use the stack pockets are allotted certain roles: the upper pocket P2 is used for rejected or suspected counterfeit notes and the lower pocket P1 is used for good or successfully validated notes. In other embodiments the roles of the pockets may be reversed.

Each stack pocket has an associated stack pocket bicolour LED 150. Typically these bicolour LEDs have one of four states based on the results of the detectors:

- Flashing green: a processed note has passed all detector validation checks yet does not meet user-defined criteria. These criteria may be based on, amongst others, currency, denomination, orientation, face or issue.
- Constant green: a processed note has passed all detector validation checks and has meet user-defined criteria. These criteria again may be based on, amongst others, currency, denomination, orientation, face or issue.
- Constant red: a processed note is not recognised by the document processing apparatus.
- Flashing red: a processed note has been identified by the detectors as a suspected counterfeit note.

8.4 Operational Modes

8.4.1 Piece Mode

This is the simplest mode of operation and will simply count any banknotes or documents placed onto the feed hopper 201. No value will be attributed to any banknote and the total number of items counted will be displayed on LCD display 705. Figure 8B shows an exemplary screen related to this mode. The current mode is displayed in the title area 812 and the displayed count screen comprises a row for each stack pocket: one row for the lower stack pocket P1 represented by icon 810 and another row for the upper stack pocket P2 represented by icon 811. The number of items counted and resident in the lower and upper stack pockets are then

displayed by respective totals 814 and 813. During operation, the total key 707c5 can be pressed to display the number of notes counted by the apparatus so far. The running total displayed may be cleared after all notes have been removed from the stacker pockets by pressing the clear key 707c7 when in a "totals" mode. The totals relating to culled notes may or may not also be cleared at this time, depending on the current configuration. When not in piece mode various detectors can be turned on using the detector key 707c6 but typically no currency-specific verification will be available.

8.4.2 Currency Mode

Currency mode processes banknotes placed on the feed hoppers and checks to see whether they are valid banknotes for a selected currency. For example, a certain currency may have a uniquely identifiable set of infra-red (IR) images embedded within the banknotes; these images can then be detected using the CIS detector.

Within currency mode a specific currency is selected by pressing and holding the currency mode key, using scroll keys 707b1 and 707b2 to scroll through the available currencies and then selecting a displayed currency using navigational keys 709. The available currencies will depend on which data tables have been loaded into the memory of the document handling apparatus 1.

An exemplary currency screen is shown in Figure 8C. Similarly to the piece mode screen there are two rows: one for each stack pocket. Each row is identified by a stack pocket icon 810, 811. In currency mode as well as displaying the total number of validated notes for the selected currency in total 823 and the total number of unrecognised or suspected counterfeit notes in total 822, the display also informs the user of the total value of the notes in each stack pocket. The value of validated notes in the bottom stack pocket is displayed as total 821 and the value of notes in the top stack pocket is displayed as total 820.

The document handling apparatus 1 keeps a record of the processing performed on each sorted banknote, e.g. the results of the selected detector tests. By using

keypad elements 707 to 709 a user can display the reasons why a note was sent to the top (cull) pocket on LCD screen 705. Each note in the pocket can be stepped through and all the reasons for each note can be viewed. This interrogation is also available for other the sorting modes (as listed above and below).

8.4.3 Denomination Mode

In denomination mode valid notes of a selected denomination will be counted and supplied to the lower stack pocket P1. Notes of other denominations and rejected or suspected counterfeit notes will be sent to the upper stack pocket P2. A denomination is selected by pressing and holding the denomination key 708c. This will bring up a number of denomination options that can be scrolled through using scroll keys 707b and selected using navigational keys 709. Typically these options will include all of the recognised denominations for the currently selected currency and an "auto" option. The "auto" option takes the selected denomination to be that of the first note fed into the document handling apparatus 1. For example, a user could select 10<euro> as their required denomination and the apparatus will sort all the valid 10<euro> notes into stack pocket P1. Alternatively, the user could begin by placing a stack of banknotes topped by a 10<euro> note onto the feed plate 201.

The displayed screen for denomination mode is similar to that displayed for currency mode. The number and value amount of valid notes of the selected denomination will be shown in respective totals 823 and 821. Likewise, the number and value amount of rejected or suspected counterfeit notes, or notes of other denominations, will be shown in respective totals 822 and 820

8.4.4 Face, Orientate and Issue Modes

Face, orientate and issue modes refer to sorting options that can be toggled on and off by pressing one of respective keys 708d, 708e or 708f. Each of these modes operates in a similar manner to denomination mode but wherein the criteria to send a banknote to the "good" P1 stack pocket is based on the following respective properties of the note: what side or face of the banknote is facing upwards; what

orientation the banknote is in when on the feed hopper (e.g. lower edge of the note as the leading or trailing edge of the note); or what bank issue the banknote is part of. Again the exact criteria in each mode is set by pressing and holding the required key 708d to 708f and options are selected using scroll keys 707b and navigation keys 709. Similar to denomination mode the number and value amount of valid notes which meet the selected criteria will be shown in respective totals 823 and 821. Likewise, the number and value amount of rejected or suspected counterfeit notes, or notes which fail the selected criteria, will be shown in respective totals 822 and 820.

It is possible to cumulatively build criteria sets by toggling any of keys 708c to 708f and 708g and 708i. For example, if a denomination criterion is set then the additional criteria that notes of a certain denomination are orientated in a certain manner can be set by toggling key 708e. All criteria options are cleared by pressing the zero-key 708j.

8.4.5 Fitness Mode

The fitness mode switches on and configures one or more detectors in order to generate a fitness measurement when processing a note. This fitness measurement is then used to sort notes that meet a predefined fitness profile. By having one key to switch on and correctly configure all the detectors responsible for generating a fitness measurement a user can quickly and conveniently sort fit and unfit notes. Notes that match the fitness profile will be sent to the lower stack pocket P1 while notes that do not meet the fitness profile will be sent to upper stack pocket P2. For example, when entering fitness mode, the UV / PPD detector can be switched on to look at the level of UV fluorescence. If the banknotes do not meet a set level of UV fitness they will be sent to the upper stack pocket. The fitness profile is set by pressing and holding the fitness key 708g which displays the detector options available. These options can be scrolled through and modified using scroll keys 707b and navigational keys 709.

Alternatively, the detector options can also be set by pressing the detector key 707c6. This allows a fitness profile to be manually set by switching on and configuring any required detectors.

8.4.6 CDA Mode

Toggling this mode switches on and configures one or more detectors to provide a counterfeit measurement. This counterfeit measurement can then be used to determine whether a note is counterfeit, e.g. meets a counterfeit note profile stored upon the document handling apparatus.

8.4.7 BRF Mode

BRF mode is selected by pressing the BRF key 708i. In select optional embodiments this mode may alternatively be called ATM (Automated Teller Machine) mode and may be adapted to sort notes suitable for filling ATMs. Each mode has a set standard that a processed banknote must meet. Typically this standard is based on a national or international specification drawn up by government or a monetary organisation. If the document handling apparatus is configured to have an ATM mode then this will switch on all detectors, and select all criteria, that are required for notes to be delivered to ATMs (e.g. lacking holes or tape, as detected by the ultrasound detector). If the document handling apparatus is configured to have a BRF mode then a set of detector configurations will be loaded so that notes which meet a BRF minimum standard are sent to the lower stack pocket P1 and notes that fail to meet said standard are sent to the upper stack pocket P2.

Whilst in BRF mode it is not possible to change the detector settings, however the other modes (including fitness) may be toggled on and off. This is so users of the apparatus can be confident that the minimum standard is correctly set, as represented by the detector configurations. However, when BRF mode is switched off (by subsequently pressing key 708i) all the detector settings for BRF mode remain. This then allows the BRF detector settings to be customised for particular jobs. One advantage of this is that typically UV / PPD authentication tests are not

part of the BRF standard; the UV / PPD detectors are only used to detect the notes fitness. This is because if a banknote is put through a washing machine its UV properties will change, even if it is a genuine note, due to the presence of UV brighteners or enhancers within common washing powders. However, a user may still wish to use UV / PPD authentication tests together with the BRF standard to provide a high quality banknote sort. In this case the user can simply toggle BRF mode on then off, which will retain the BRF settings yet allow detector options to be modified, and then select the UV / PPD authentication tests to be operational (e.g. via detector key 707c6).

An example of the use of BRF mode to perform a frequently used sort will now be described. The sort is to be performed on a number of banknotes of varying quality provided to a user. The user first clears all active modes by pressing the zero key 708j and selects BRF mode by pressing the BRF key 708i. The user then toggles fitness mode by pressing key 708g and processes the notes through the apparatus 1 to sort all notes that meet the BRF standard and that are fit (for recirculation) to the lower stack pocket P1. All other notes are sorted to upper stack pocket P2. The notes from each pocket are then removed and placed in two stacks: a "good" stack from stack pocket P1 and a "bad" stack from stack pocket P2. The user then toggles off fitness mode by pressing key 708g and toggles on CFA mode by pressing key 708h. The user then processes each of the two stacks of notes.

When processing the "good" stack, notes that are authenticated (and pass the BRF standard although this has already been tested) are sent to the lower stack pocket P1 and notes that fail the authentication test (or fail the BRF standard although as this has already been tested this should not occur) are sent to the upper stack pocket P2. The notes from each pocket are then removed and placed in two further stacks: a stack from stack pocket P1 containing fit, authenticated notes that meet the BRF standard and a stack from stack pocket P2 containing fit notes that meet the BRF standard yet that fail authentication. The former stack contains high quality notes for recirculation and the latter stack is useful to analyse for counterfeit prevention.

When processing the "bad" stack, notes that are authenticated and pass the BRF standard are sent to the lower stack pocket P1 and notes that fail the authentication test or fail the BRF standard are sent to the upper stack pocket P2. The notes from each pocket are then removed and placed in two further stacks: a stack from stack pocket P1 containing unfit yet authenticated notes that meet the BRF standard and a stack from stack pocket P2 containing unfit, unauthenticated notes or notes that fail to meet the BRF standard. The former stack can be supplied to a bank as unfit yet genuine notes and the latter stack are typically counterfeit or extremely poor quality notes.

8.5 Operational Screen

A typical root-menu screen is shown in Figure 8D. A screen such as this would be shown when the document handling apparatus is not processing notes, for example when the above modes are being selected. In other embodiments of the present invention this screen may have different elements or a different layout.

The display comprises three rows of information. The top row displays information related to the currently selected mode, typically in the form of icons. For example, in Figure 8D BRF mode has been selected as witnessed by the presence of the BRF icon 830. The currently selected currency is shown by icon 831, in this example Euros. In the top right-hand corner icons 832 representing other possible modes are displayed. For example, starting from the left of the five icons, icons 832 represent: fitness mode, denomination mode, issue mode, face mode and orientate mode.

The centre row 836 displays information in the form of text to the user. This row also displays available selections when navigating on-screen menus, for example selecting detectors. When navigating menus, the lower row 837 displays options associated with the navigational keys 709. In the example shown in Figure 8D, key 709a continues the operation, key 709b has no function, key 709c cancels the operation and key 709d displays the available detectors.

When not navigating menus, i.e. in an idle mode, the detectors and/or criteria that are currently active are optionally displayed as icons on an idle screen of the LCD display 705. This is shown in an example in Figure 8E where icons related to the current active detectors and/or banknote processing criteria are shown in row 840. If there are more icons than there is space on the row, the scroll keys 707b can be used to scroll up and down through the additional rows of icons. However, these icons need not be displayed in a preferred embodiment of the present invention.

8.6 Function Keys 707c

8.6.1 User key 707c1

The user key allows the user to select and change a number of options associated with the user of the apparatus; for example specifying the user password and/or specifying a system password to be used to prevent unauthorised users from changing configuration data. In certain optional embodiments, the user key may be replaced by a mode key that allows the user select a mode of operation without using numeric keypad 708. When the user (or mode) key is pressed a suitable menu of available options is displayed on screen. This menu is navigated using scroll keys 707b and options are selected using navigational keys 709.

8.6.2 Program key 707c2

The program key allows a user to store or recall a specific set of detector settings and/or sort criteria. After cumulatively selecting the current sort criteria using numeric keypad 708 or mode key 707c1 the program key 707c2 can be pressed which brings up an option allowing the user to save the current setup. This option can then be selected using navigational keys 709.

Saved setups or programs can be retrieved by pressing the program key and scrolling through the saved programs using scroll keys 707b. Once a required program has been found it can be loaded or deleted by pressing the appropriate one of navigational keys 709.

The machine may be configured so that different operators may use the same saved programs or, alternatively, may have independent saved programs.

8.6.3 System key 707c3

When in idle mode, the document handling apparatus can be caused to enter the configuration mode by depressing the system key 707c3. In this mode, the operator can change the configuration operations of the document handling apparatus. These include, amongst others, selection of automatic or manual feeding, setting the sorting speed, configuring the detection of double notes, setting whether a beeper is used to alert the user to system events and key presses, setting the current language, configuring communication ports such as 112a to 112c, configuring external devices, sharing and managing stored programs, and setting guest access configurations (e.g the number of guests allowed and the available options). Furthermore, the current configuration parameters may be saved as a user-defined mode. A default or factory configuration may also be loaded to replace the current configuration.

If the current user has identified themselves as an engineer (e.g. logged in as a known engineer user as described in section 8.1) the system menu displayed after depressing the system key 707c3 may also allow the user to access diagnostic menus and tests. These include testing the transport, stack pocket and diverter motors and the brake and clutch system, displaying an error log, and displaying a keyboard test screen. The system menu may also be used by an engineer to access feed diagnostic procedures such as those described in PCT/GB2008/001404. The keyboard test screen is similar to the schematic illustration of Figure 8A; when each key is pressed the respective schematic counterpart on screen will be toggled between a black fill and an unfilled illustration; in this manner a user can check that all the keys are operating correctly. A further diagnostic screen will provide an iconic illustration of the document handling apparatus on the LCD display 705. Areas of the apparatus in which a blockage or jam have been detected will be highlighted upon the iconic illustration using a small flashing block icon.

8.6.4 Batch key 707c4

This key brings up a menu to allow the user to set the maximum batch quantity that each output stack pocket may contain. Typically, each stack pocket is configured to hold a maximum of 200 notes.

8.6.5 Total key 707c5

The key relates to an information mode which is entered from the idle mode by pressing the total key 707c5. In this mode, information such as the total number of notes sorted or their value may be displayed on the display 705 or transmitted to a PC.

8.6.6 Detector key 707c6

This keys allows various detectors and test criteria to be switched on and off. The current operational detectors and/or tests will be shown as icons as shown in Figure 8E.

8.6.7 Clear key 707c7

This key clears any displayed or selected data, e.g. displayed totals.

8.7 Purge Operation

Due to the clutch and brake mechanism it is sometimes possible for notes to be fed into the feed system 200 and yet not reach the detector transport pathway. This could occur when the apparatus is stopped after a note has been fed but before it has reached the snatch rollers 230. To purge such a note from the transport pathway the document handling apparatus may be adapted to perform a purge operation. The purge operation may be performed at the start of apparatus

operation, after notes have been removed from one or both of the stack pockets and/or after detection of an error. Typically an empty pocket will be detected by one of the stack pocket sensors 606 or 626 which will instruct the transport controller 111 to run the transport motor 499 for a short period of time with the brake 226 operational to prevent further feeding of notes. This time period can be such to allow for a note within the transport pathway to be purged to one of the stack pockets. If a note was present in the transport pathway the purged note can then be taken from one of the stack pockets and re-placed upon the feed hopper 201.

8.8 Jam Clearance

As described above, the document handling apparatus is arranged to provide the operator with easy access to the transport path at several points, including at the movable plate 390 and at the access module 620. In this way, if a jam should occur and a document becomes lodged in the path, it is reasonably straight forward to open the apparatus and remove it.

However, if the document becomes stuck at certain positions, it may still be difficult to reach, even with the transport open, and it can take time to open and close the machine.

Therefore, in preferred examples, a jam clearance tool is provided to assist in clearing jams. The tool generally comprises a sheet member of approximately the same or similar size to the documents to be processed and is formed from a relatively stiff, resilient material such as laminated plastic.

To clear a jam, any as-yet unfed documents are removed from the input stack and the jam clearance tool is inserted in their place. The machine is run, drawing the clearance tool into and through the transport path and helping to dislodge the jammed document. The document may either be nudged forward to a point more easily accessed on opening the machine, or to an output pocket. The jam debris and clearance tool can then be removed.

Claims

1. A structure for a document handling apparatus, the structure comprising first and second side walls, laterally spaced from one another and substantially parallel, each side wall being provided with a first keying feature, and a cross beam extending between the first and second side walls, the cross beam being provided with a resilient arm at each of its ends, each resilient arm extending substantially perpendicular to the axis of the cross beam and having a chamfer therein defining a first region of the resilient arm adjacent the cross beam and a second region of the resilient arm towards the distal end of the resilient arm, such that the second region is displaced away from the cross beam in the axial direction of the cross beam, and a second keying feature is provided in the second region of each resilient arm, the second keying feature being adapted to couple with the first keying feature in use.

2. A structure according to claim 1, wherein the first keying feature comprises a boss, and the second keying feature comprises an aperture.

3. A structure according to claim 1 or claim 2, wherein the resilient arms are integrally formed with the cross beam.

4. A structure according to any of the preceding claims, wherein the cross beam is shaped so as to provide a guide surface for guiding documents in the document handling apparatus.

5. A structure according to any of the preceding claims, wherein the cross beam and resilient arms are formed of sheet metal.

6. A detent assembly for arresting rotation of a plate pivotably mounted to a wall of a structure for a document handling apparatus, the detent assembly including a detent device comprising a mounting shaft affixed to the wall of the structure, a stop body slidably supported on the mounting shaft, and spring means arranged to urge the stop body into a first position, the assembly further comprising a first feature arranged on the plate to align with the stop body in its first position, such that when the first feature contacts the stop body in its first position, rotation of the plate is arrested at a first stop angle, the body and first feature being arranged such that,

when the stop body is displaced into a second position, the first feature ceases to align with the stop body and the plate is permitted to rotate past the first stop angle to a second stop angle in which a second feature provided on the plate contacts the stop body.

7. A detent assembly according to claim 6 wherein the stop body is arranged to be non-rotatable relative to the mounting shaft.

8. A detent assembly according to claim 6 or claim 7 wherein the stop body is provided with first and second arresting surfaces, the first arranged to align with the first feature of the plate when the stop body is in its first position, and the second arranged to align with the second feature of the plate when the stop body is in its second position.

9. A detent assembly according to claim 8 wherein the first arresting surface is provided by a boss protruding from the stop body parallel to the axis of the mounting shaft.

10. A detent assembly according to claim 9 wherein the boss is arranged to space the stop body from the wall of the structure.

11. A fixing assembly for removably mounting a first plate pivotably to a second plate, the first plate comprising an aperture and having a shaft extending partially across the aperture, the second plate comprising a protrusion arranged to extend into the aperture in use and to receive the shaft such that the second plate is pivotably mounted to the first, and the second plate further comprising a tab extending from the protrusion and having at least one substantially planar surface, the tab being arranged such that, at one or a maximum of two rotational positions, the planar surface of the tab is spaced from and substantially parallel to the first plate such that the second plate may be slid along the axial direction of the shaft without obstruction by the tab, and at all other rotational positions the tab prevents sliding of the second plate relative to the first.

12. A fixing assembly according to claim 11 wherein the shaft lies in the plane of the first plate, and the tab is spaced from the axis of rotation.

13. A fixing assembly according to claim 11 wherein the shaft lies parallel to but spaced from the plane of the first plate, and the tab intersects the axis of rotation.

14. A fixing assembly according to any of claims 11 to 13 wherein the first plate and tab are arranged such that the tab prevents sliding of the first plate when the plates are at the base of their rotation, under the influence of gravity.

15. A fixing assembly according to any of claims 11 to 14 wherein the first plate is fixedly supported in the structure of a document handling assembly, and the second plate comprises a panel which is openable for access to the interior of the document handling assembly.

16. A fixing assembly according to claim 15 wherein the panel forms part of a control panel and supports one or more of a PCB, a display and input keys.

17. A document handling apparatus comprising a controller and a memory, the memory being adapted to store one or more setting, each setting being associated with a user identifier and comprising one or more parameters for determining the operation of the document handling apparatus, the controller being adapted to, upon input of a user identifier by a user, retrieve the corresponding setting from the memory and configure the document handling apparatus to operate according to the parameters of that setting.

18. A document handling apparatus according to claim 17 wherein the one or more parameters relate to one or more of: selection of a process mode, selection of currency and/or denomination, selection of language, remote display configuration, user access to functions and user access to detectors.

19. A document handling apparatus according to claim 17 or 18 wherein the controller is further adapted to prevent modification of a user's setting by that user.

20. A document handling apparatus according to any of claims 17 to 19 wherein the controller is further adapted to, upon input of a supervisor identifier, permit

modification of a user's setting by the supervisor, and to store the modified setting in the memory.

21. A document handling apparatus according to any of claims 17 to 20 wherein at least one of the settings stored in the memory is associated with more than one user identifier.

22. A method of configuring a document handling apparatus having a controller and a memory, the method comprising:

receiving an input user identifier at the controller;

retrieving a corresponding setting stored in the memory, the setting comprising one or more parameters for determining the operation of the document handling apparatus; and

configuring the document handling apparatus to operate in accordance with the parameters of the retrieved setting.

23. A method according to claim 22, further comprising:

receiving a supervisor identifier at the controller;

receiving data relating to modifications of a user's setting and modifying the setting accordingly;

storing the modified setting in the memory.

24. A method according to claim 22 or 23, wherein the one or more parameters relate to one or more of: selection of a process mode, selection of currency and/or denomination, selection of language, remote display configuration, user access to functions and user access to detectors.

25. A method of clearing a jam in a document handling apparatus having an input module for feeding documents into the apparatus, an output module for outputting documents from the apparatus, and a document transport path therebetween, the method comprising:

inputting a jam clearance sheet into the input module, the jam clearance sheet being of dimensions no larger than those of the documents to be handled by the apparatus and being formed from a relatively stiff material;

actuating the apparatus to convey the jam clearance sheet through the apparatus; and

retrieving the jam clearance sheet and any jammed document debris from the output module.

26. A method according to claim 25 wherein the jam clearance sheet is formed from laminated plastics material.

27. A mounting assembly for supporting a transport belt in a document handling apparatus, the mounting assembly comprising a base plate fixed to the structure of the document handling apparatus, and a bracket affixed to the base plate by releasable retaining means, the bracket supporting a shaft and a roller rotatably mounted on the shaft, wherein an aperture is provided in the base plate adjacent an edge of the bracket, the edge of the bracket having a keying feature therein for coupling with an adjustment tool in use, the aperture being sized to receive the adjustment tool and having an edge feature arranged to provide a pivot point for pivoting of the adjustment tool thereon in use, whereby, in use, an adjustment tool inserted into the aperture and coupled with the edge of the bracket can be pivoted to adjust the position of the bracket relative to the base plate.

28. A mounting assembly according to claim 27 wherein the keying feature comprises a notch for receiving the adjustment tool in use.

29. A mounting assembly according to claim 27 or claim 28 wherein at least one positioning mark is provided on the base plate adjacent an edge of the aperture, corresponding to a predetermined position of the bracket.

30. A mounting assembly according to claim 29 wherein the positioning mark comprises a notch in the edge of the aperture.

31. A mounting assembly according to any of claims 27 to 30 wherein the releasable retaining means are configured to permit pivoting of the bracket relative to the base plate when released.

32. A mounting assembly according to any of claims 27 to 31 wherein the aperture comprises a substantially triangular region, one side of which being arranged adjacent the keying feature in the edge of the bracket, and the opposing corner provides the pivot point.

33. A mounting assembly according to any of claims 27 to 32 wherein the roller comprises a crown roller.

34. A method of adjusting the positioning of a transport belt in a document handling apparatus, the transport belt being supported by a mounting assembly according to any of claims 27 to 31, the method comprising:

releasing the releasable retaining means,

inserting an adjustment tool into the aperture and coupling to the keying feature provided on the edge of the bracket;

pivoting the adjustment tool about the pivot point to thereby adjust the position of the bracket and roller supported thereon relative to the base plate;

securing the releasable retaining means to fix the position of the bracket;

withdrawing the adjustment tool from the aperture.

35. A method according to claim 34 wherein the adjustment tool comprises a screwdriver, preferably a flat blade screwdriver.

36. A method according to claim 34 or 35 wherein the document handling apparatus is operated such that the transport belt is running during the adjustment steps.

37. A document handling apparatus comprising an input module, at least one output module, a transport path therebetween, the transport path being provided with one or more detectors for sensing characteristics of the documents, and a controller adapted to receive signals from the sensors and to generate output data therefrom, the apparatus further comprising a display panel integral therewith for display of first selected output data, and a remote display panel for display of second selected output data, wherein the controller is further adapted to identify and display the first and second selected output data on the integral and remote display panels respectively according to predefined criteria.

38. A document handling apparatus according to claim 37 wherein the predefined criteria require the first selected output data to be different to the second selected output data.

39. A document handling apparatus according to claim 37 or claim 38 comprising more than one output module, wherein the predefined criteria require that the first selected output data comprises data relating to the contents of each output module individually, and the second selected output data comprises data relating to the contents of all output modules collectively.

40. A document handling apparatus according to any of claims 37 to 39 wherein the predefined criteria requires that the first and/or second selected output data comprise a value of documents or a number of documents.

41. A document handling apparatus according to any of claims 37 to 40, wherein the predetermined criteria include a delay time for which the controller displays the first and/or second output data on the integral or remote display panel respectively.

42. A method of handling documents using a document handling apparatus according to any of claims 37 to 41, comprising:

feeding one or more documents into the transport path;

conveying the one or more documents through the transport path to the one or more output modules;

detecting characteristics of each document and generating output data based on the detected characteristics;

displaying first selected output data on the integral display panel in accordance with predetermined criteria; and

displaying second selected output data on the remote display panel in accordance with predetermined criteria.

43. A method according to claim 42 wherein the predefined criteria require the first selected output data to be different to the second selected output data.

44. A method according to claim 42 or claim 43 wherein the predefined criteria require that the first selected output data comprises data relating to the contents of

each output module individually, and the second selected output data comprises data relating to the contents of all output modules collectively.

45. A method according to any of claims 42 to 44 wherein the predefined criteria requires that the first and/or second selected output data comprise a value of documents or a number of documents.

46. A method according to any of claims 42 to 45 wherein the predetermined criteria include a delay time for which the first and/or second output data is displayed on the integral or remote display panel respectively.

47. A document handling apparatus substantially as hereinbefore described with reference to the accompanying drawings.

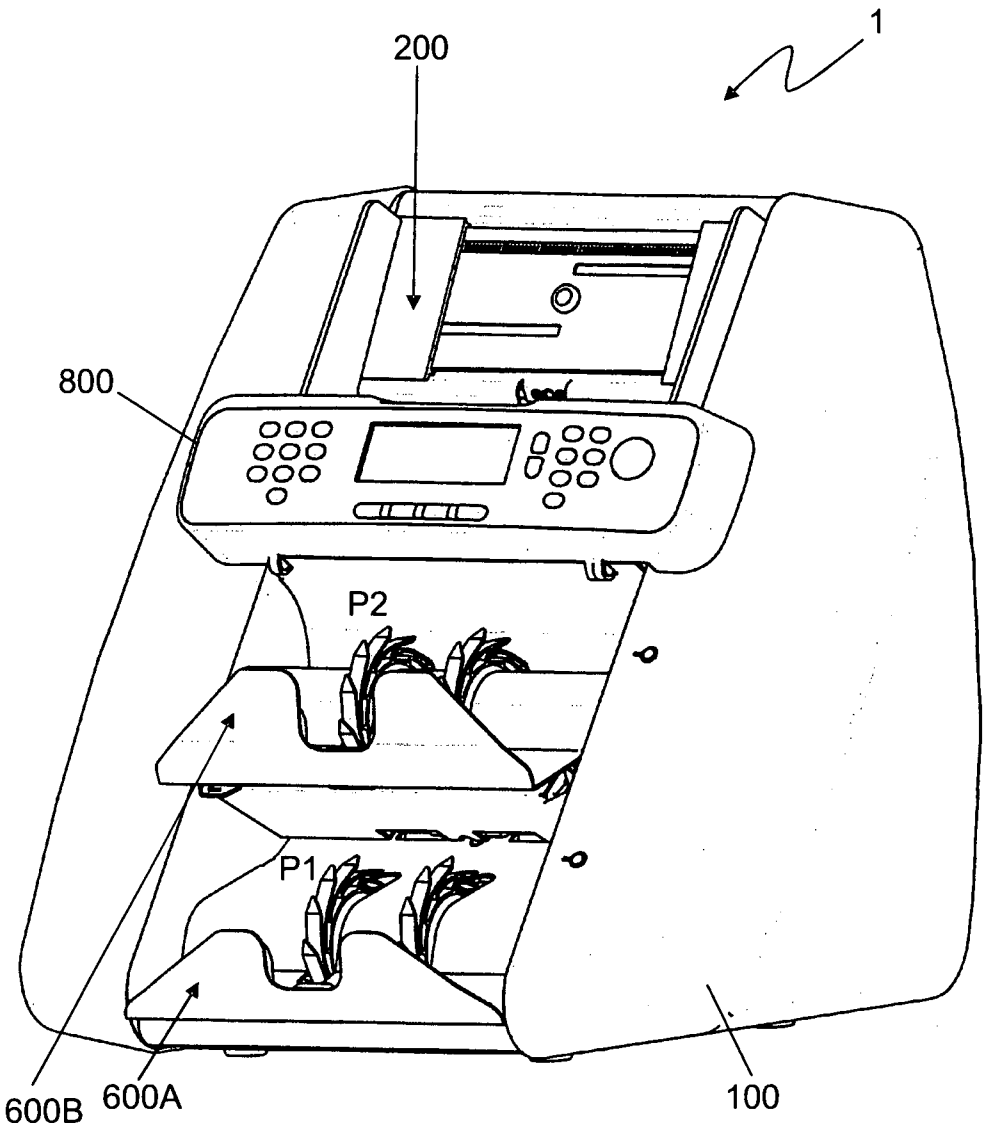


Figure (i)

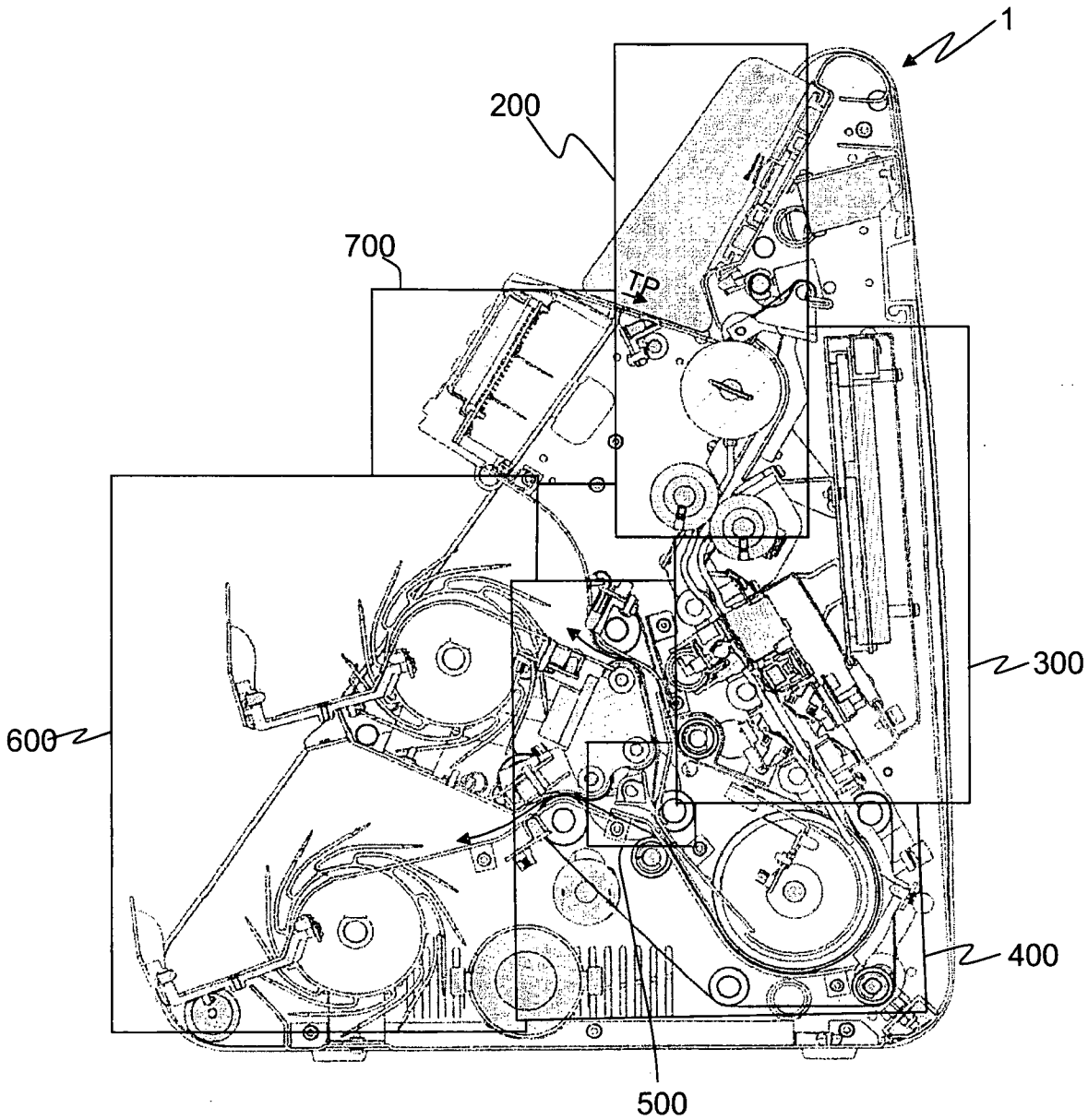


Figure (ii)

Figure 1A

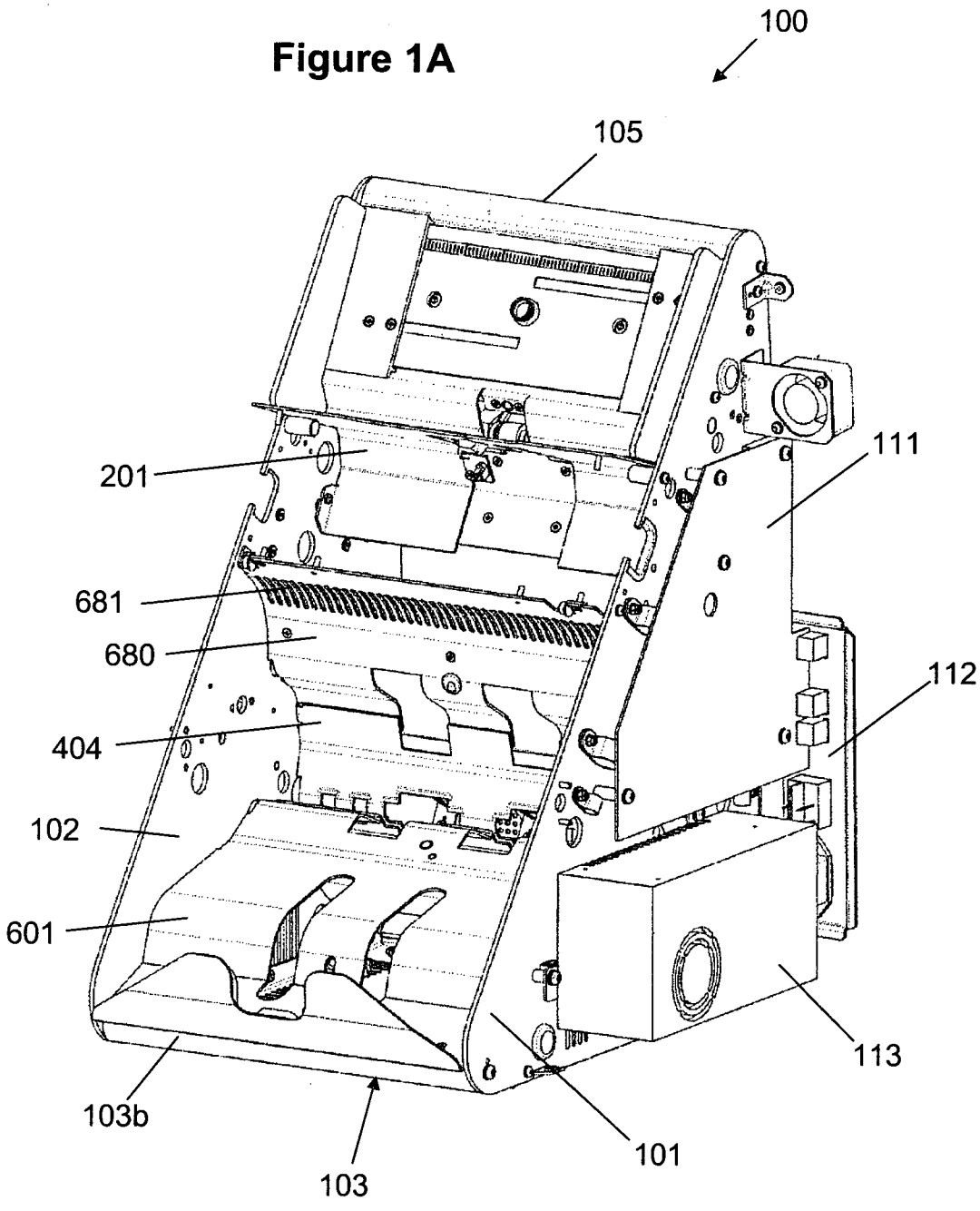


Figure 1B

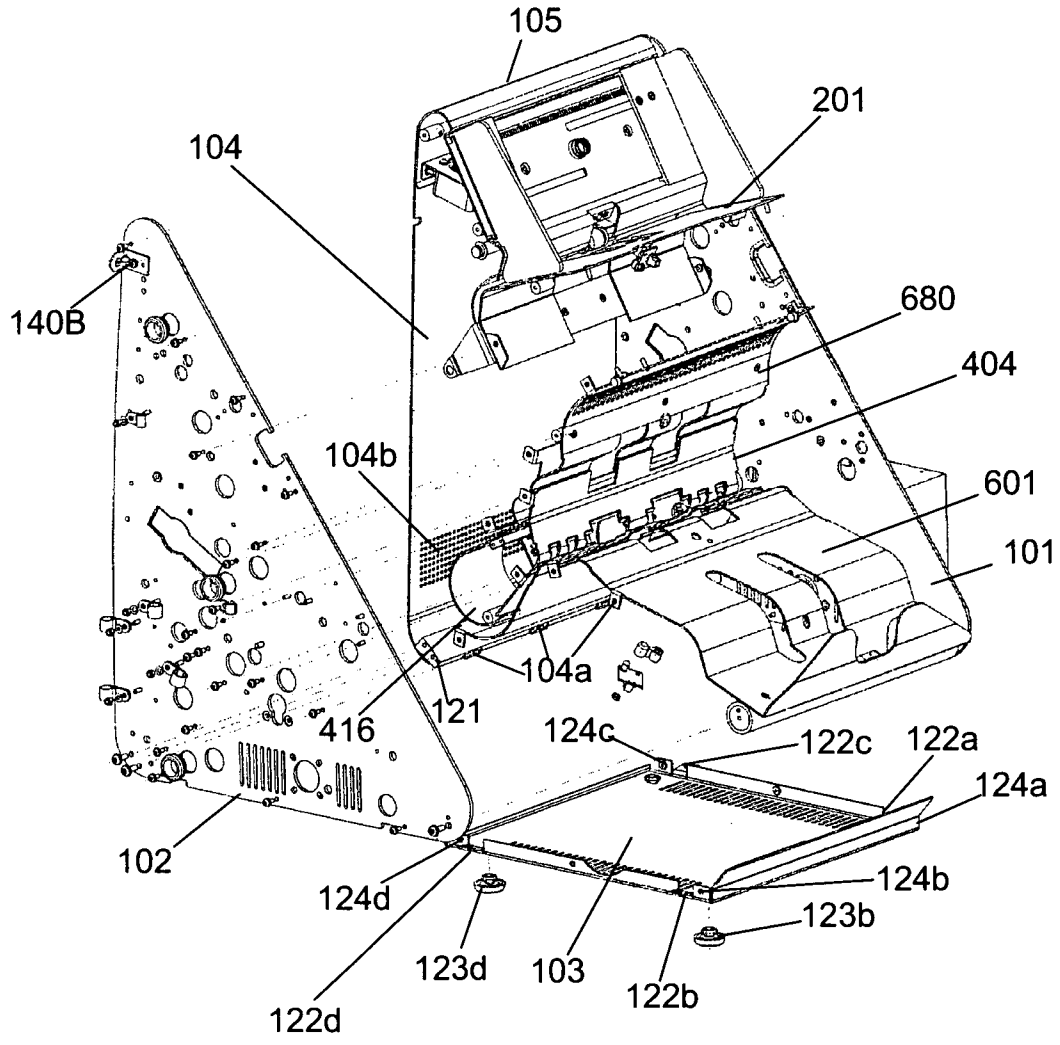
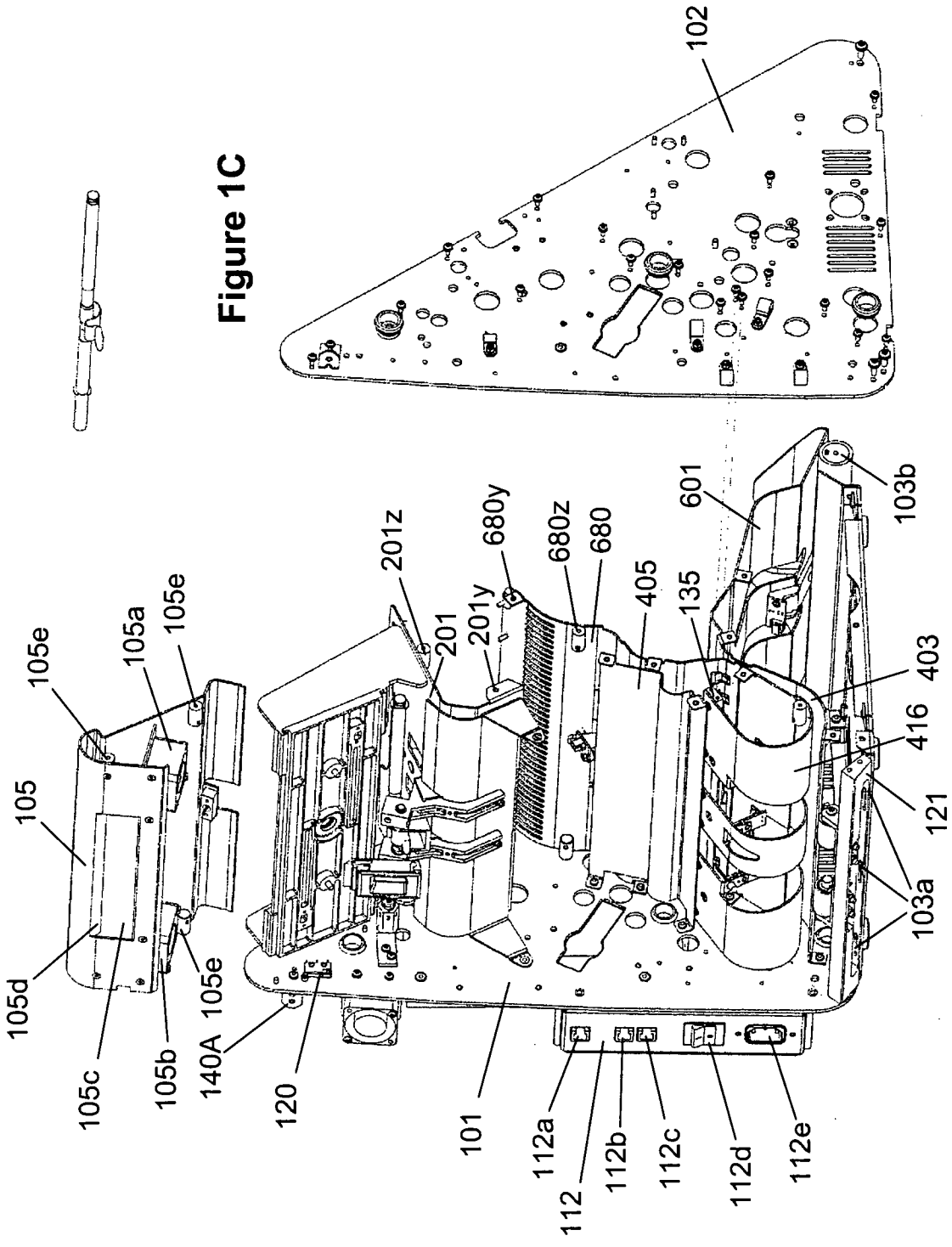

105
201
104
140B
680
404
104b
601
101
104a
121
416
124c
122c
122a
124a
102
124d
124b
123b
123d
103
122b
122d

Figure 1C


102
103b
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680z
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201z
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201y
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416
121
103a
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105e
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101
112a
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112b
112c
112d
112e

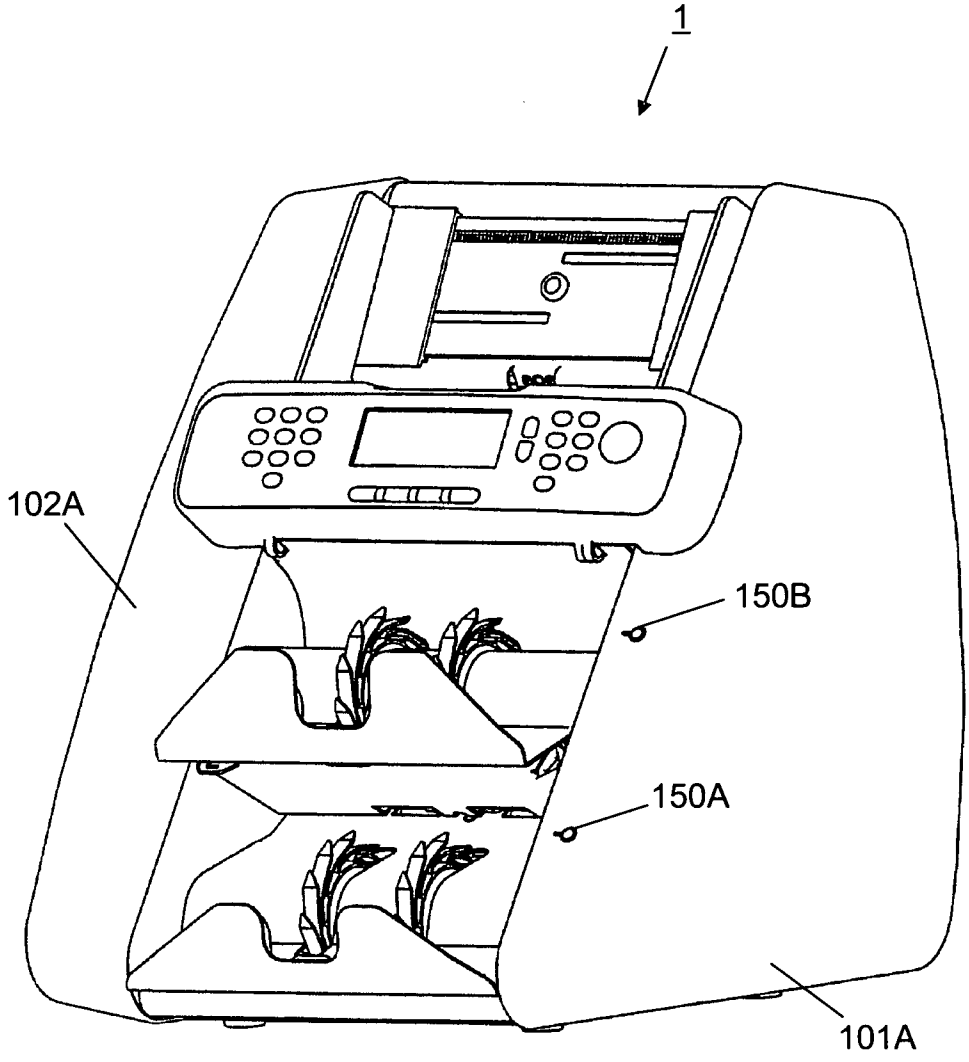
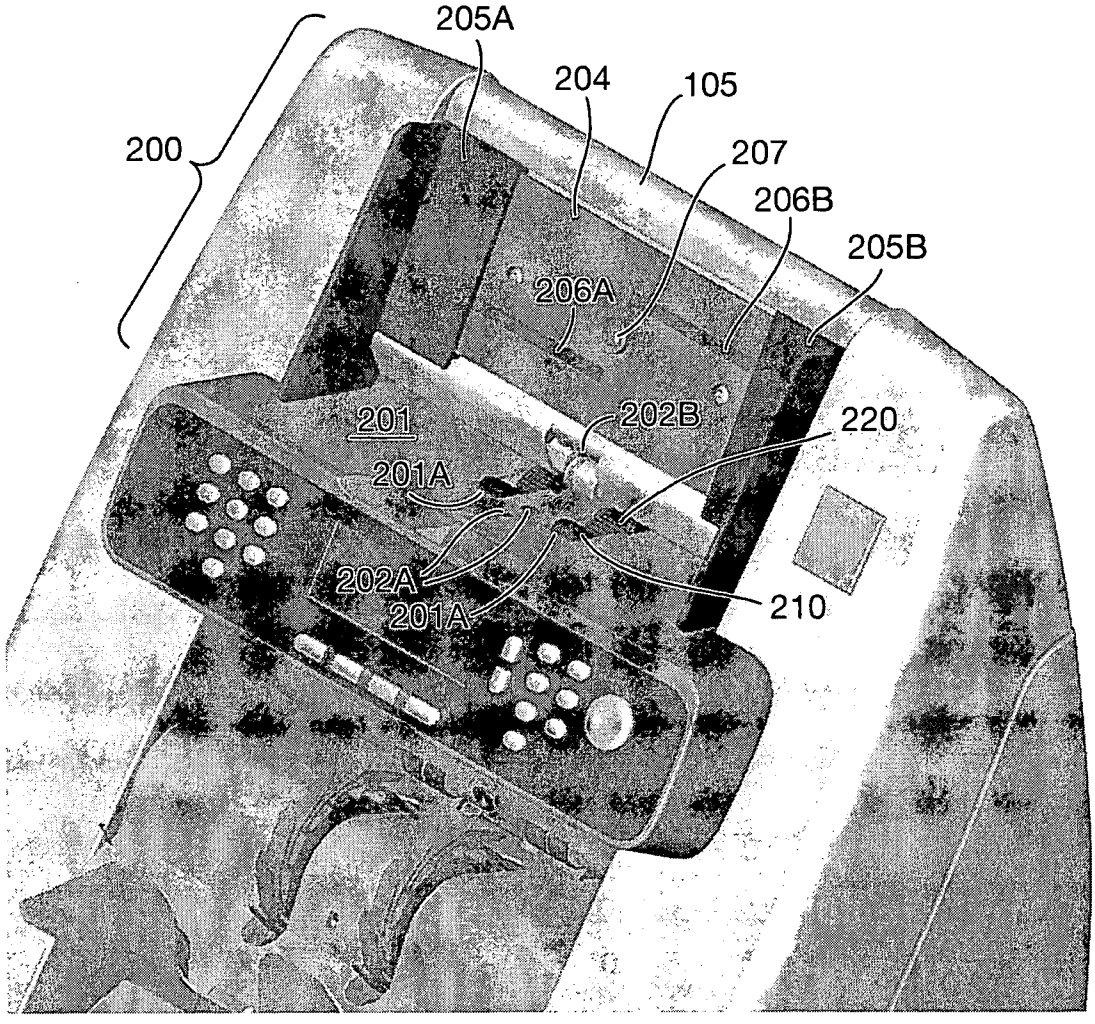


Figure 1D

Figure 2A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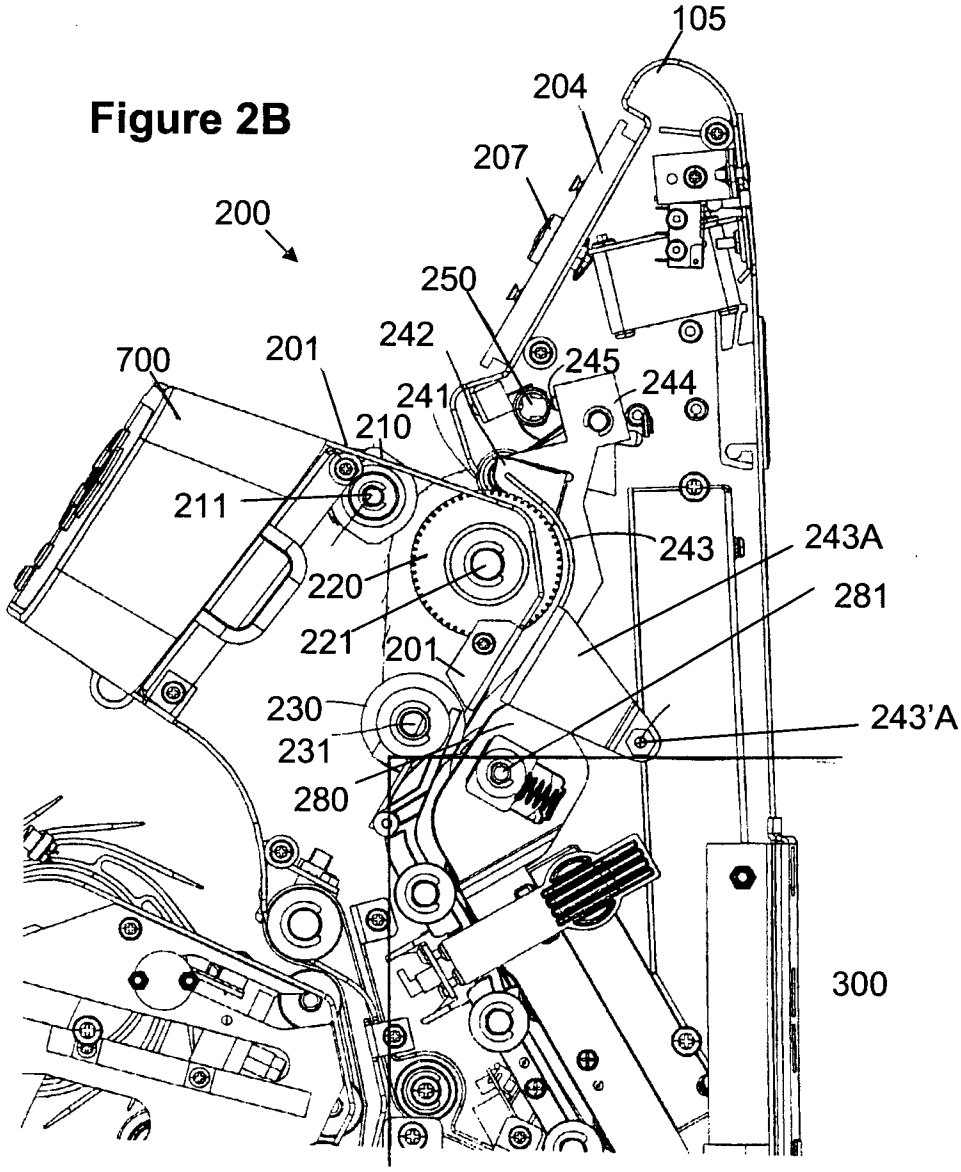
204
105
200
207
206B
205B
206A
201
202B
220
201A
202A
201A
210

Figure 2B


105
204
207
200
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242
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210
211
243
243A
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281
221
201
230
243'A
231
280
300

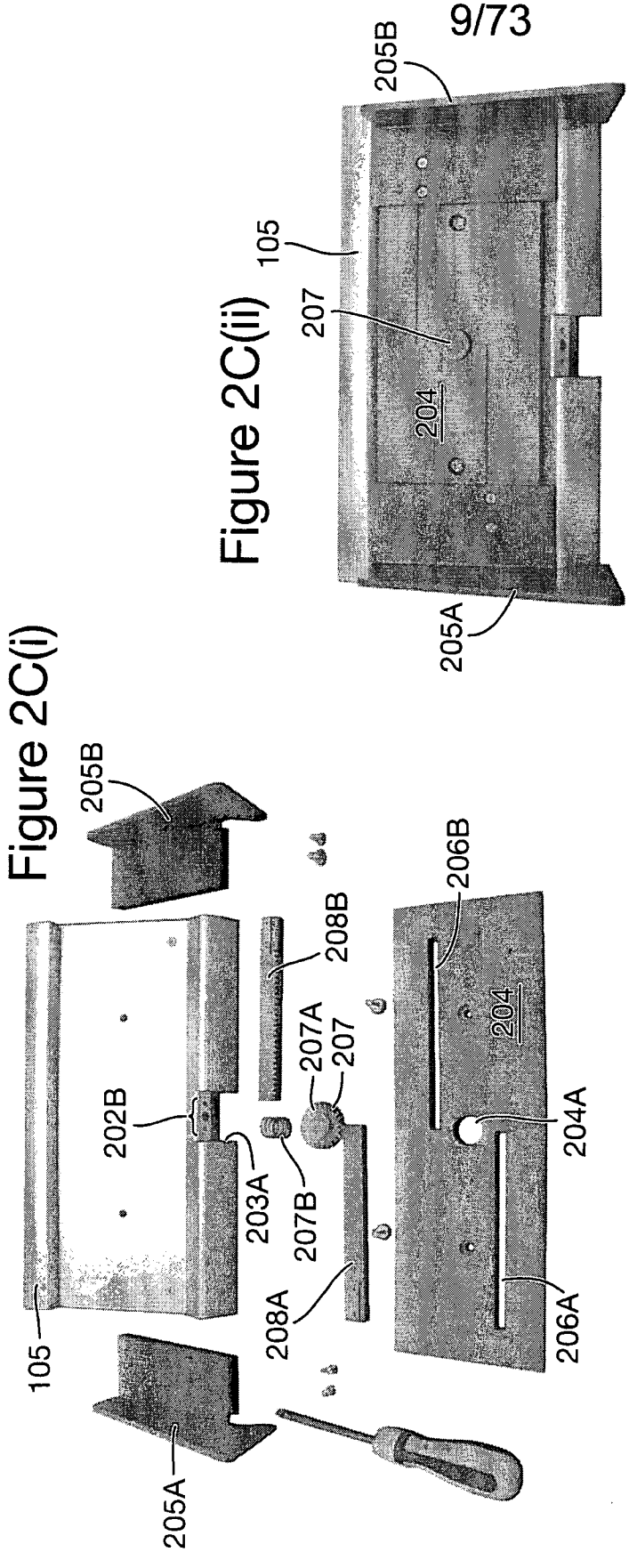
Figure 2C(i)
205B
208B
206B
202B
207A
207
204
203A
207B
204A
208A
206A
105
205A

Figure 2C(ii)
205B
105
207
204
205A

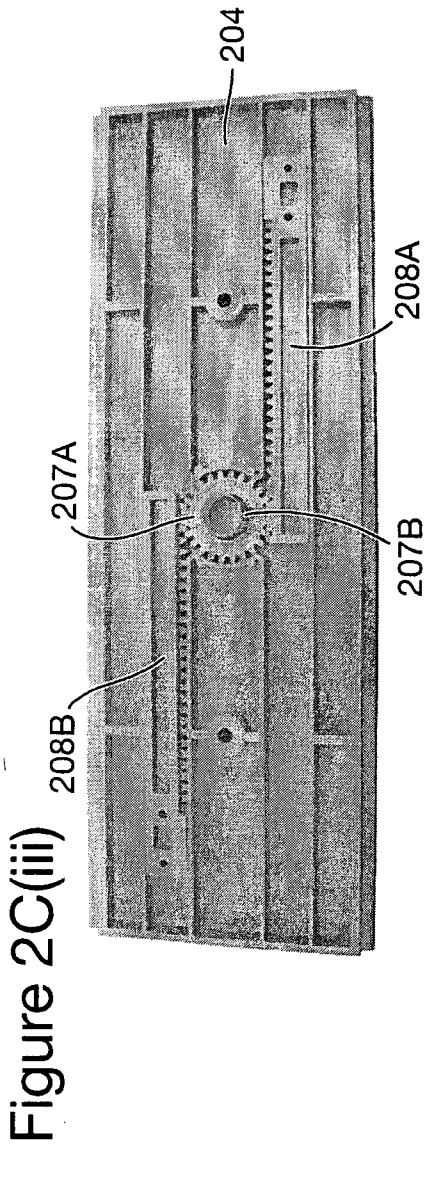
Figure 2C(iii)
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208A
207A
207B
208B

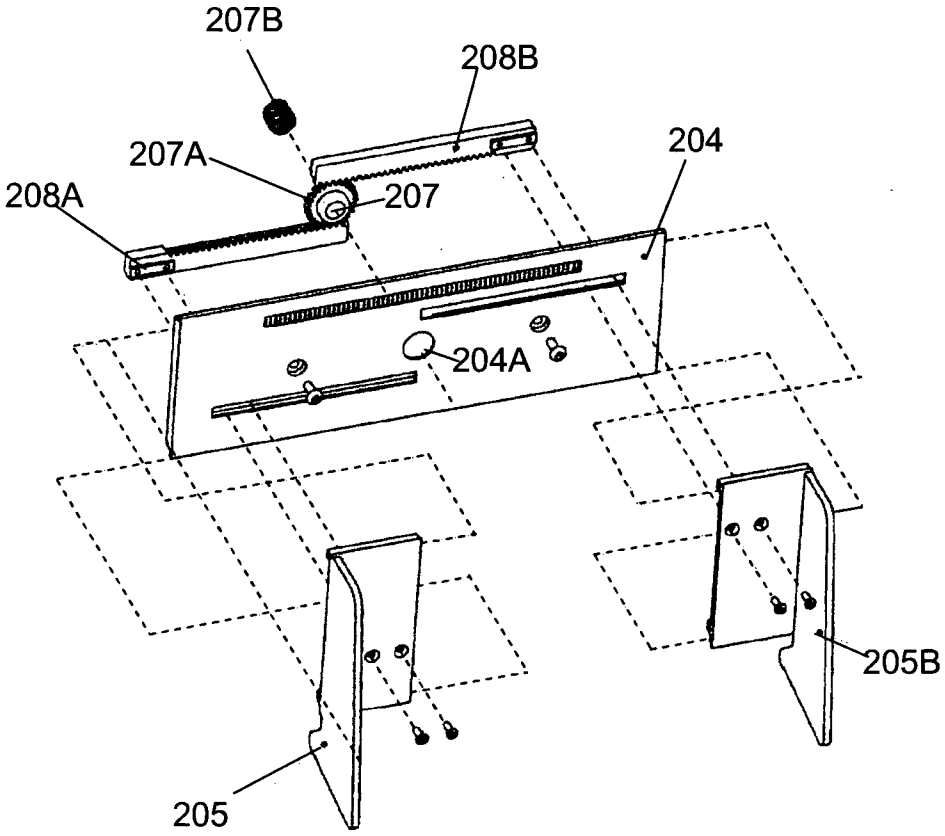


Figure 2D

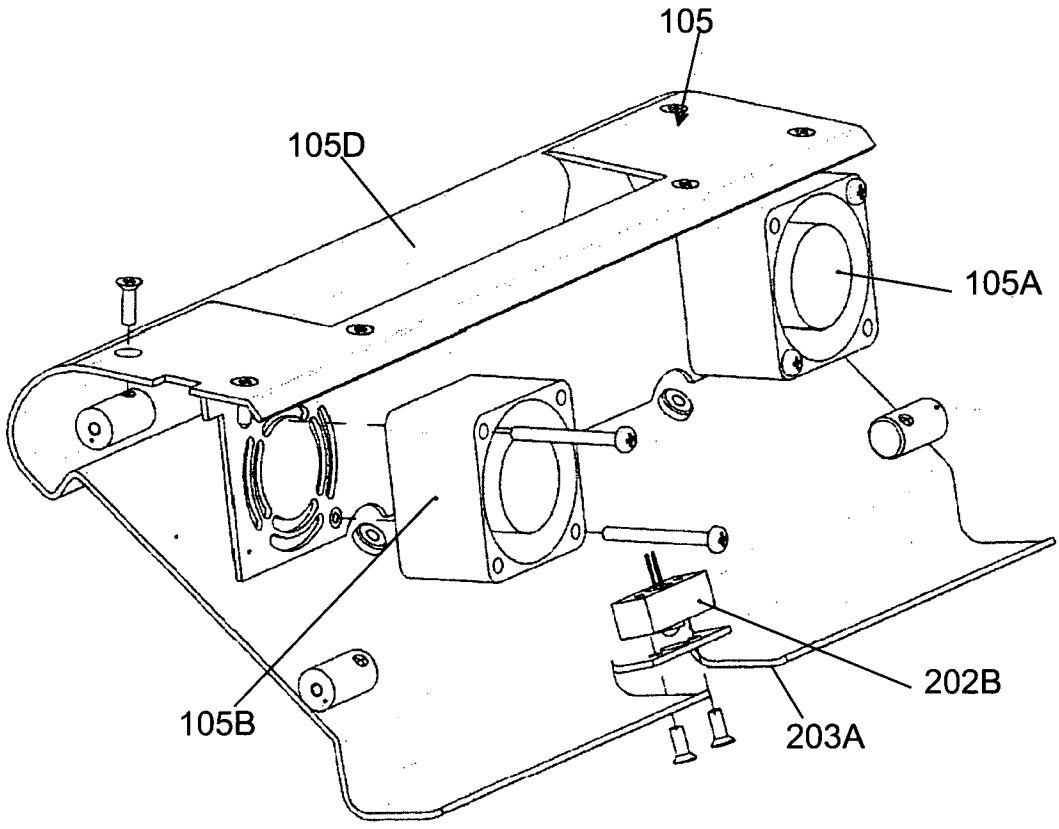


Figure 2E

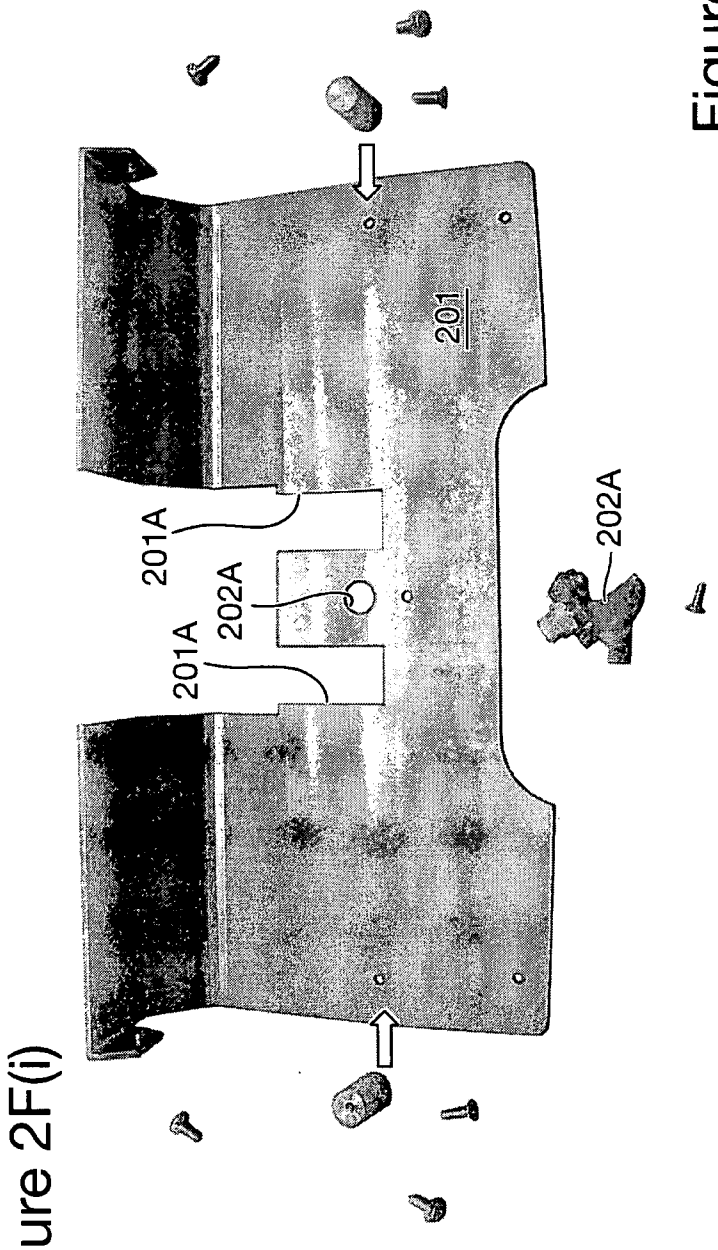


Figure 2F(i)

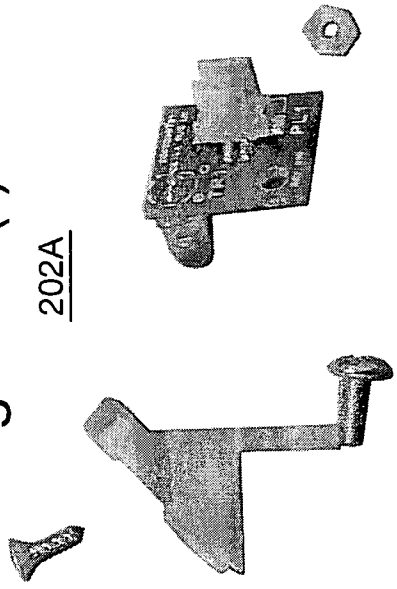
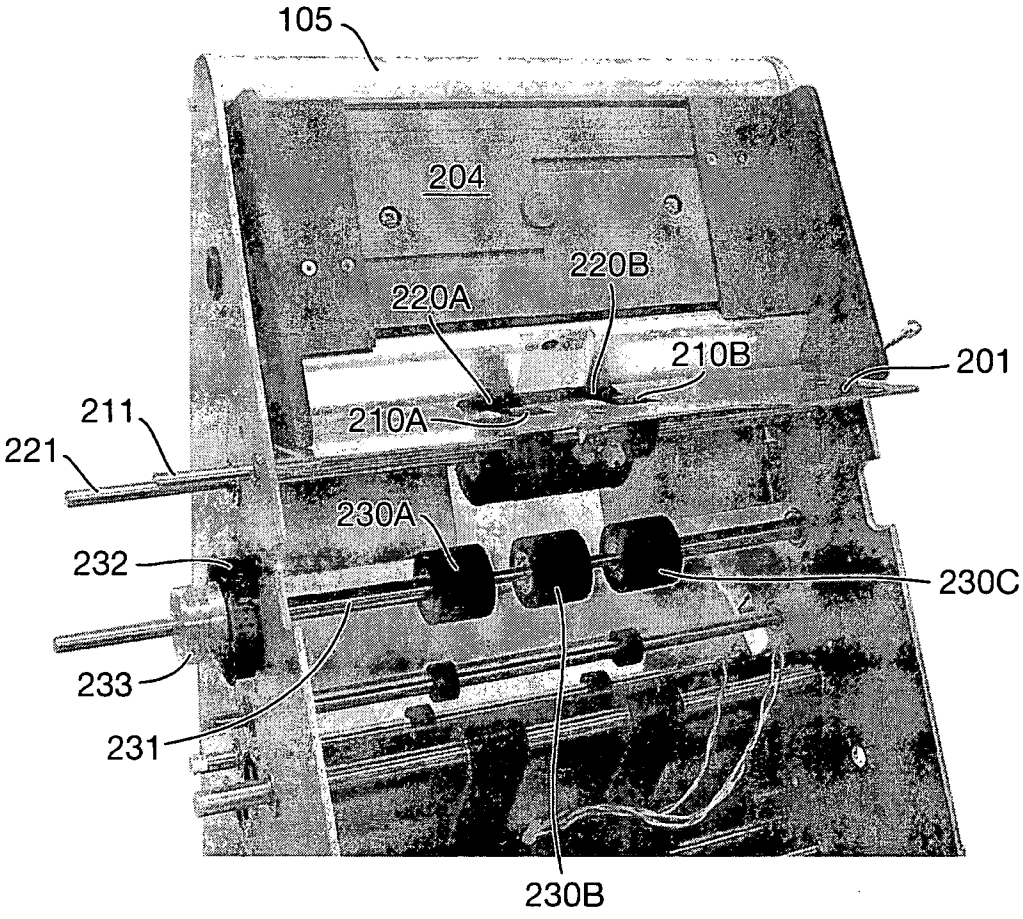


Figure 2F(ii)

Figure 2G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204
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210A
230A
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230C
233
231
230B

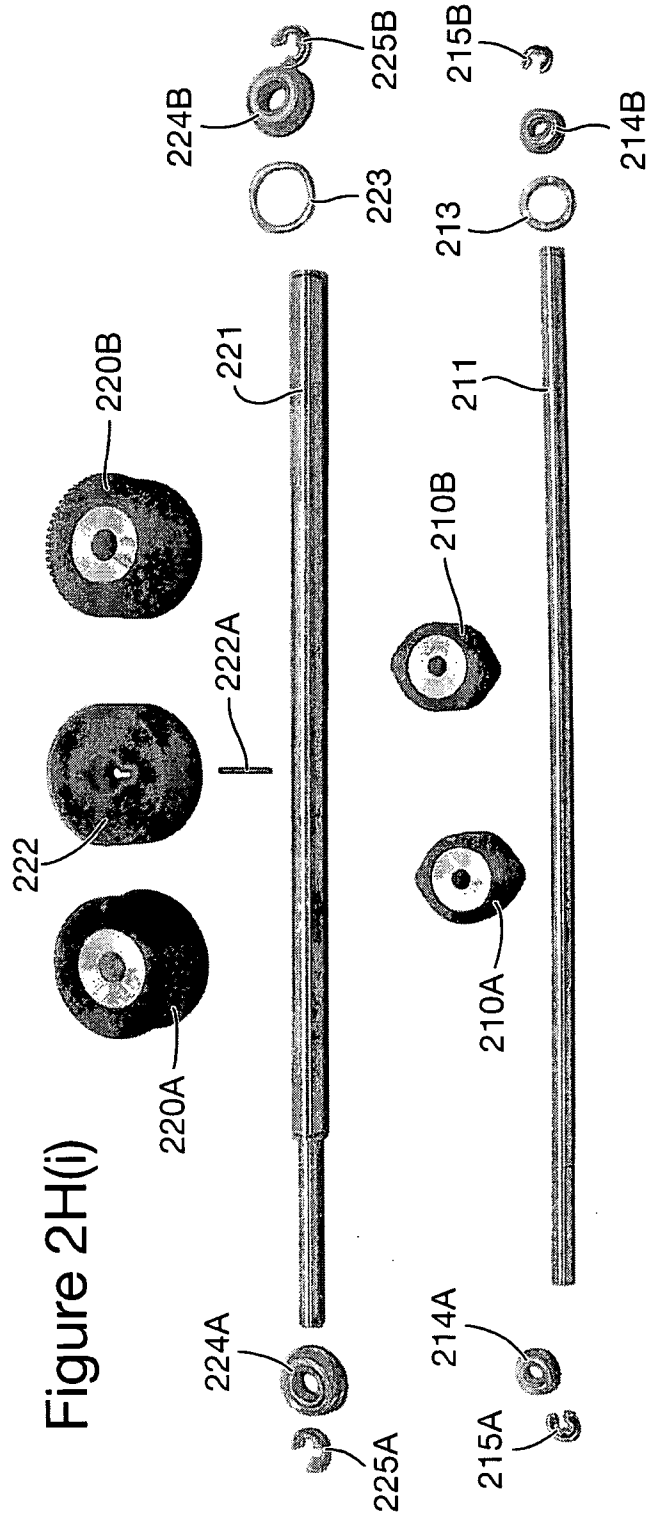


Figure 2H(i)

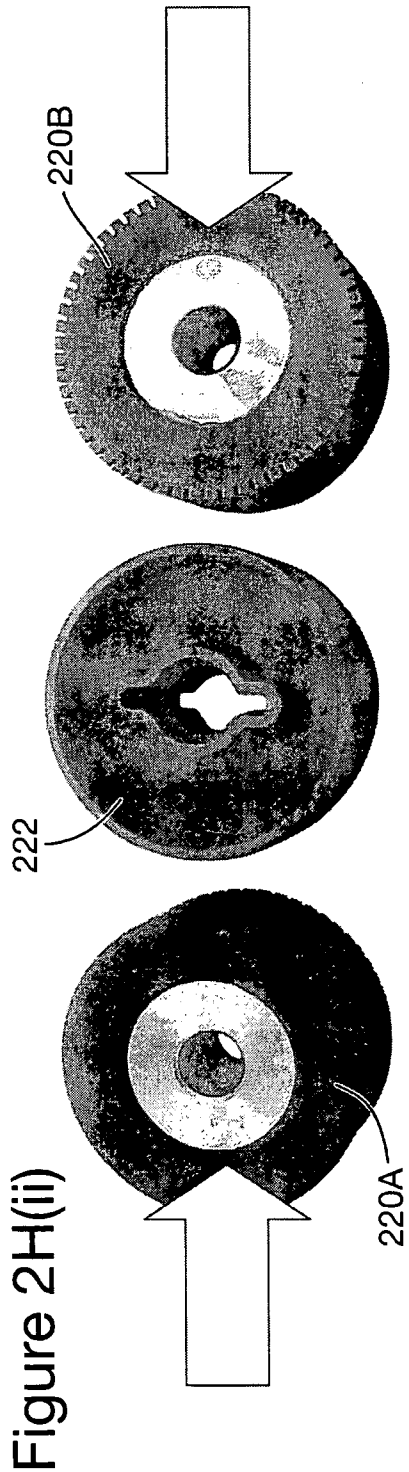
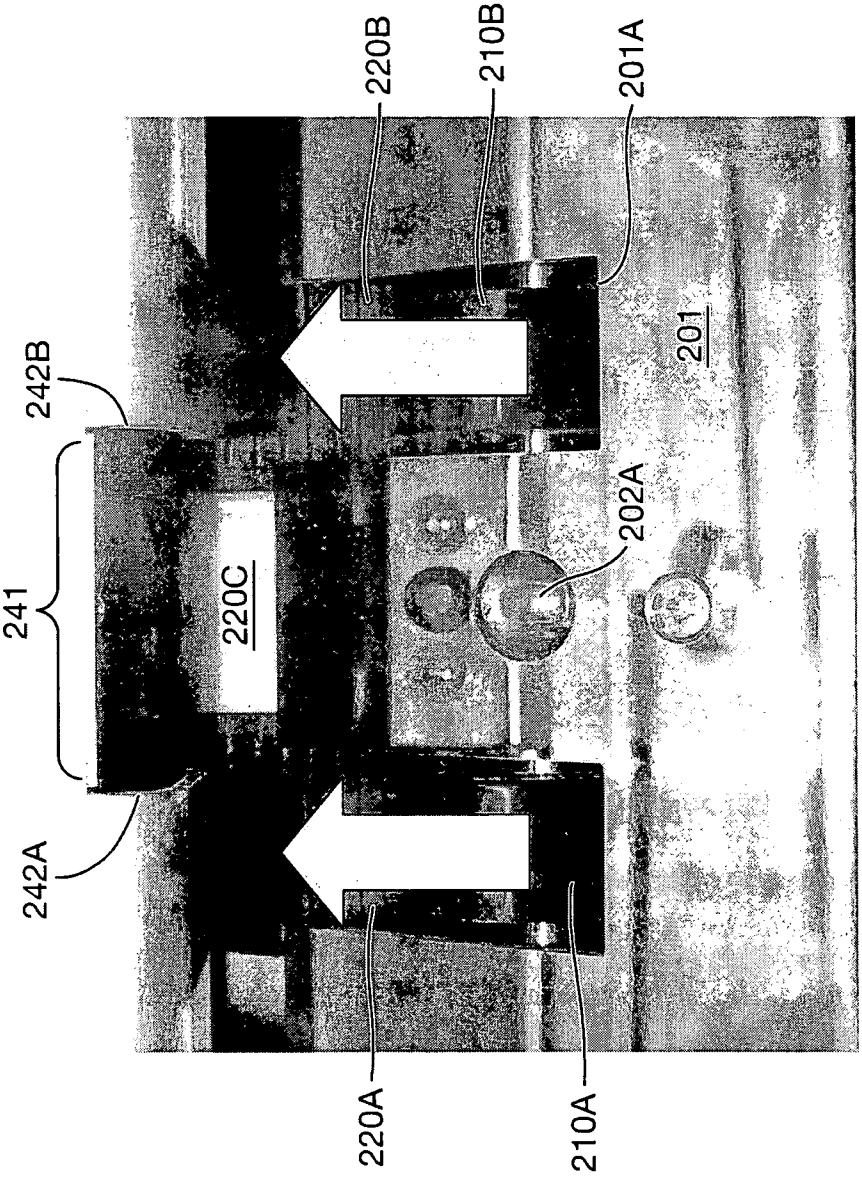
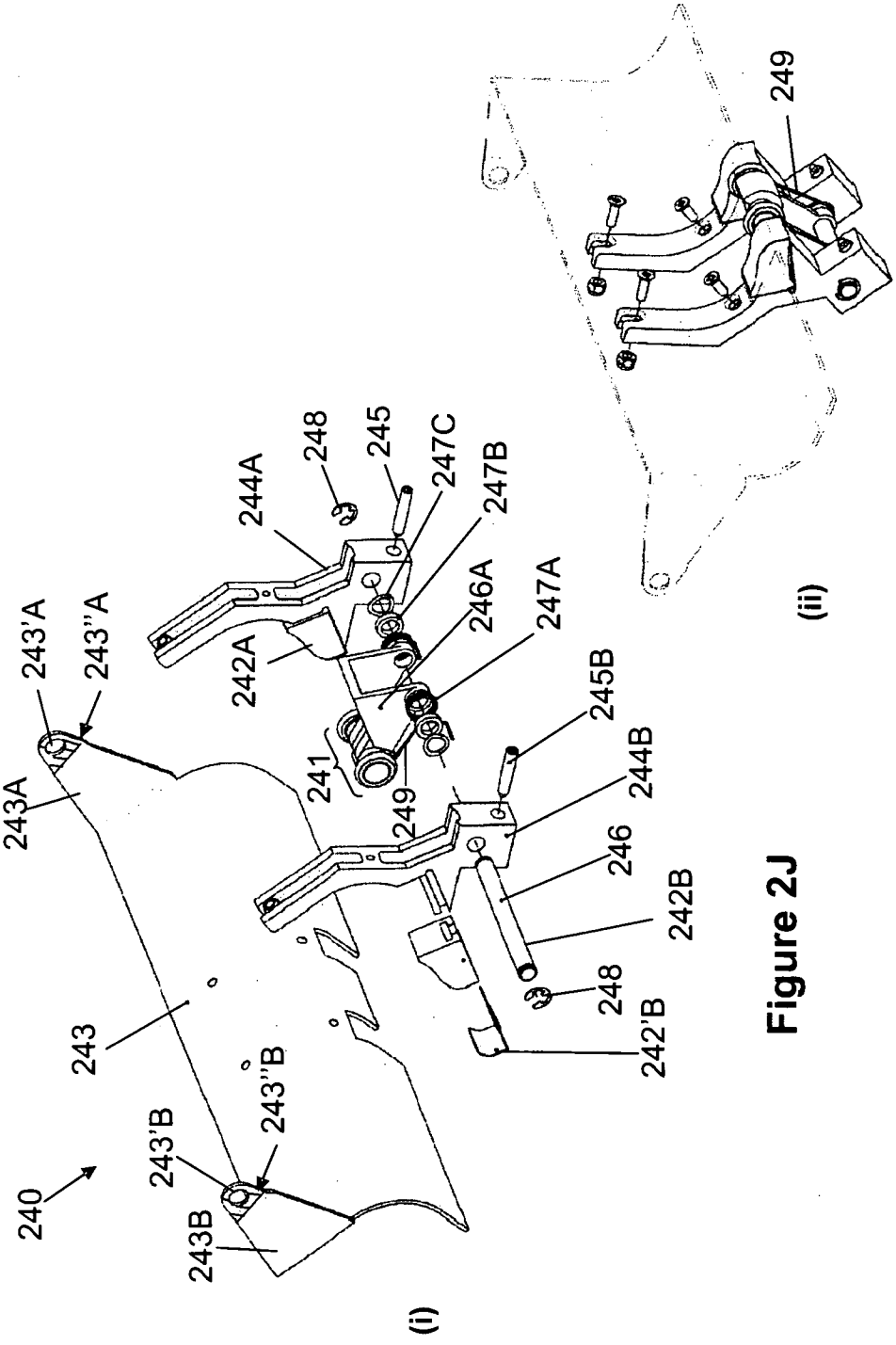


Figure 2H(ii)

Figure 2I




249
(ii)
248
245
247C
247B
244A
246A
247A
242A
243'A
243''A
245B
244B
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243A
246
242B
248
242'B
243
243''B
243'B
240
243B
(i)

Figure 2J

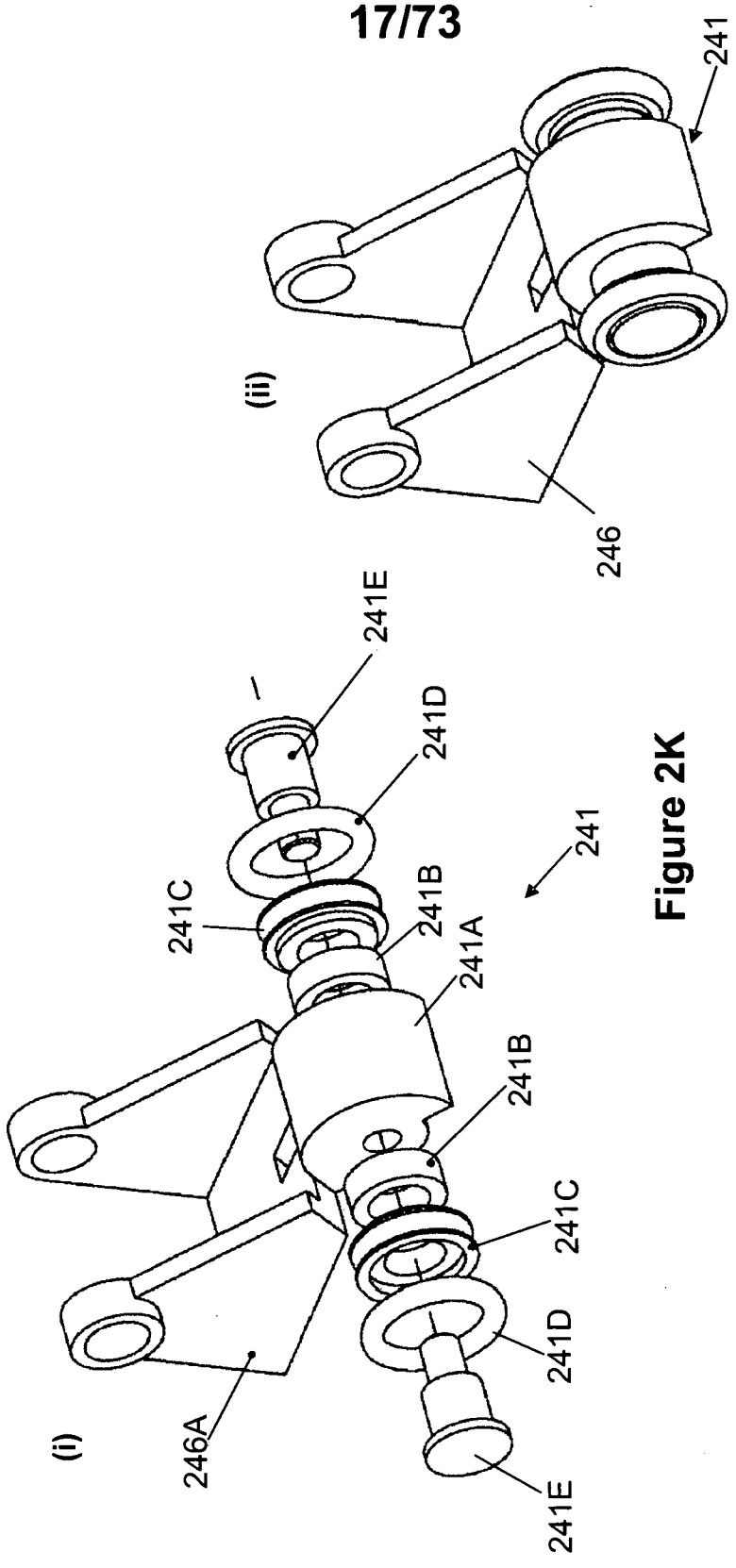

(i)
246A
241E
241D
241C
241B
241A
241B
241C
241D
241E
241
(ii)
246
241

Figure 2K

Figure 2L(ii)

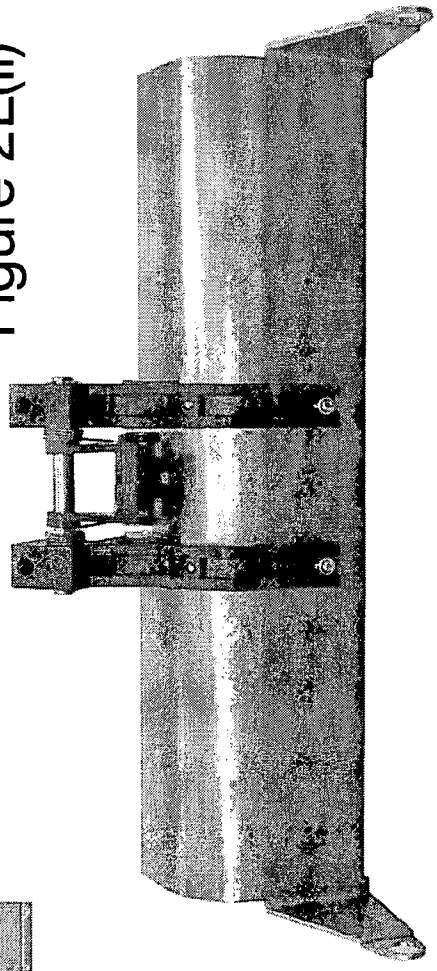
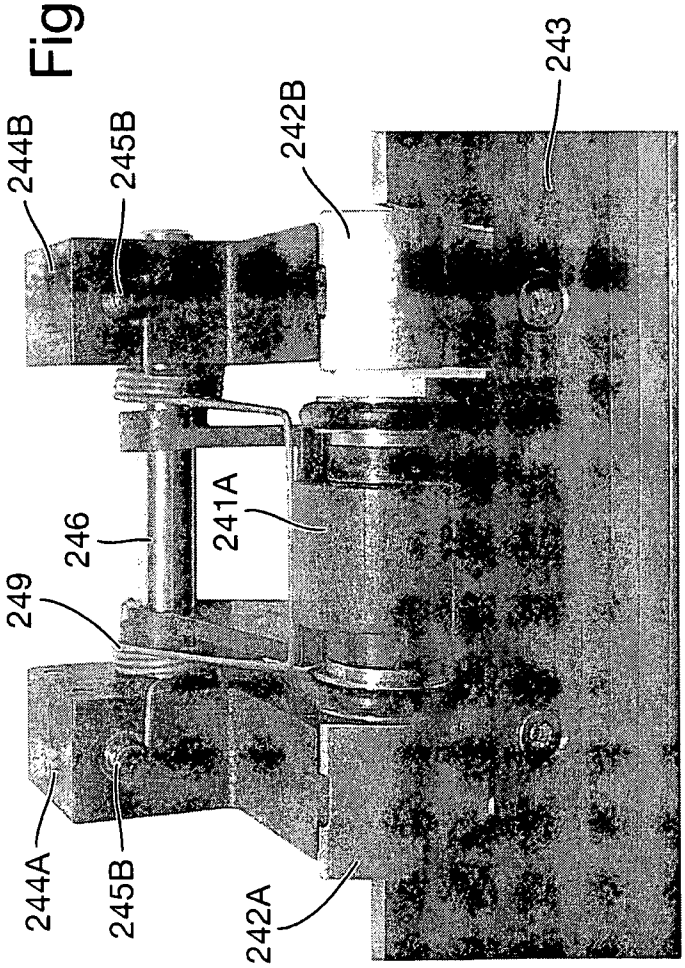


Figure 2L(i)



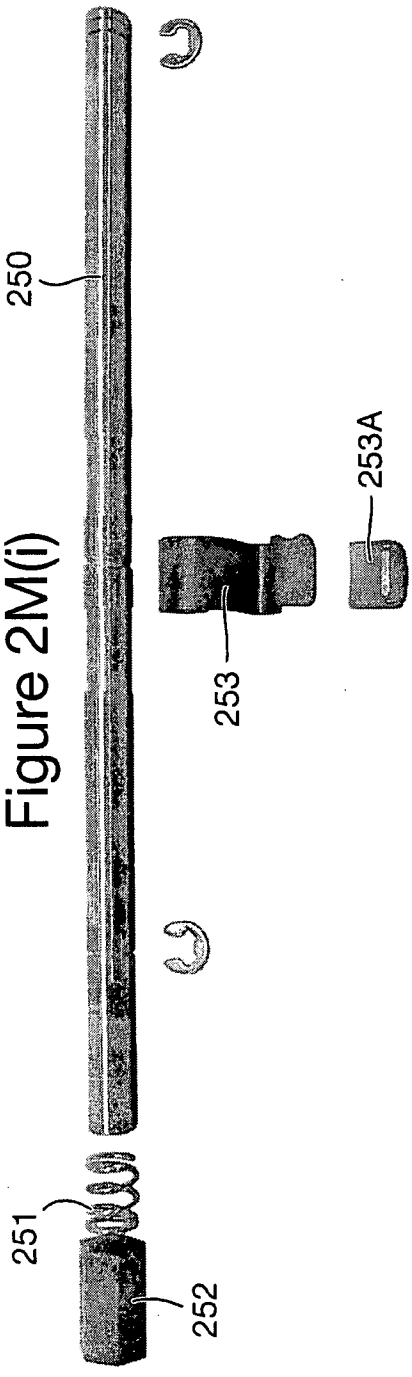


Figure 2M(i)

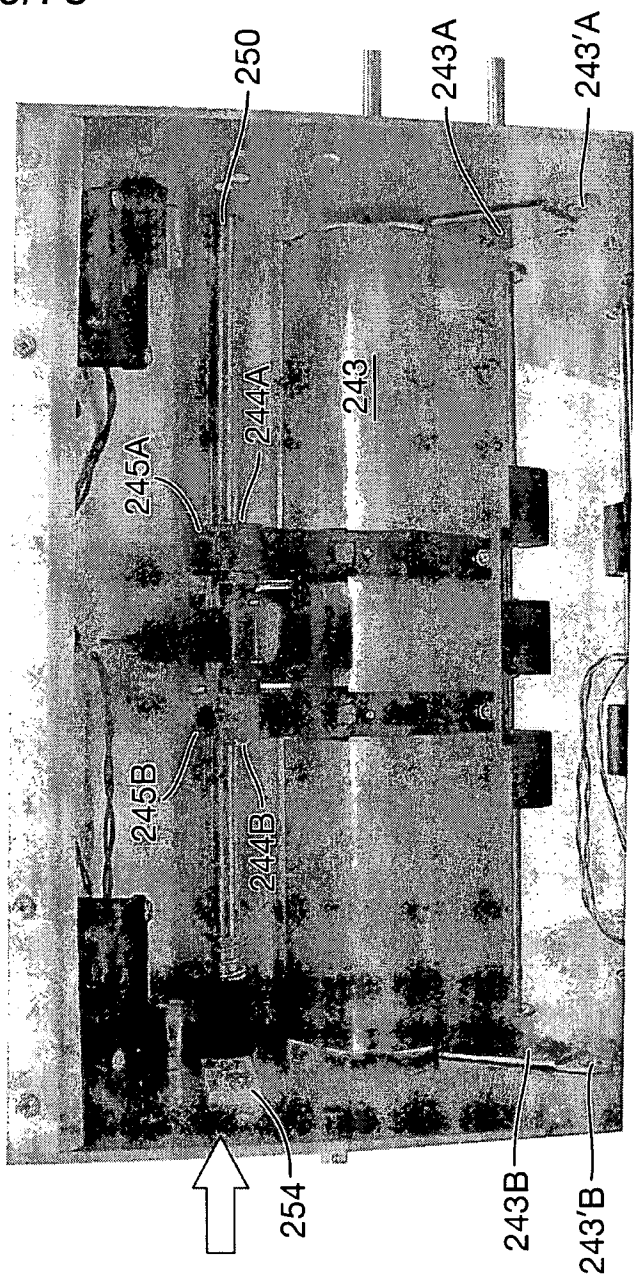


Figure 2M(ii)

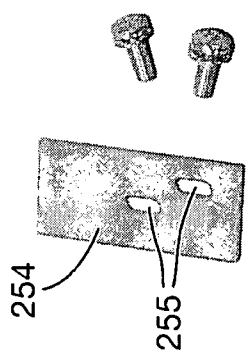
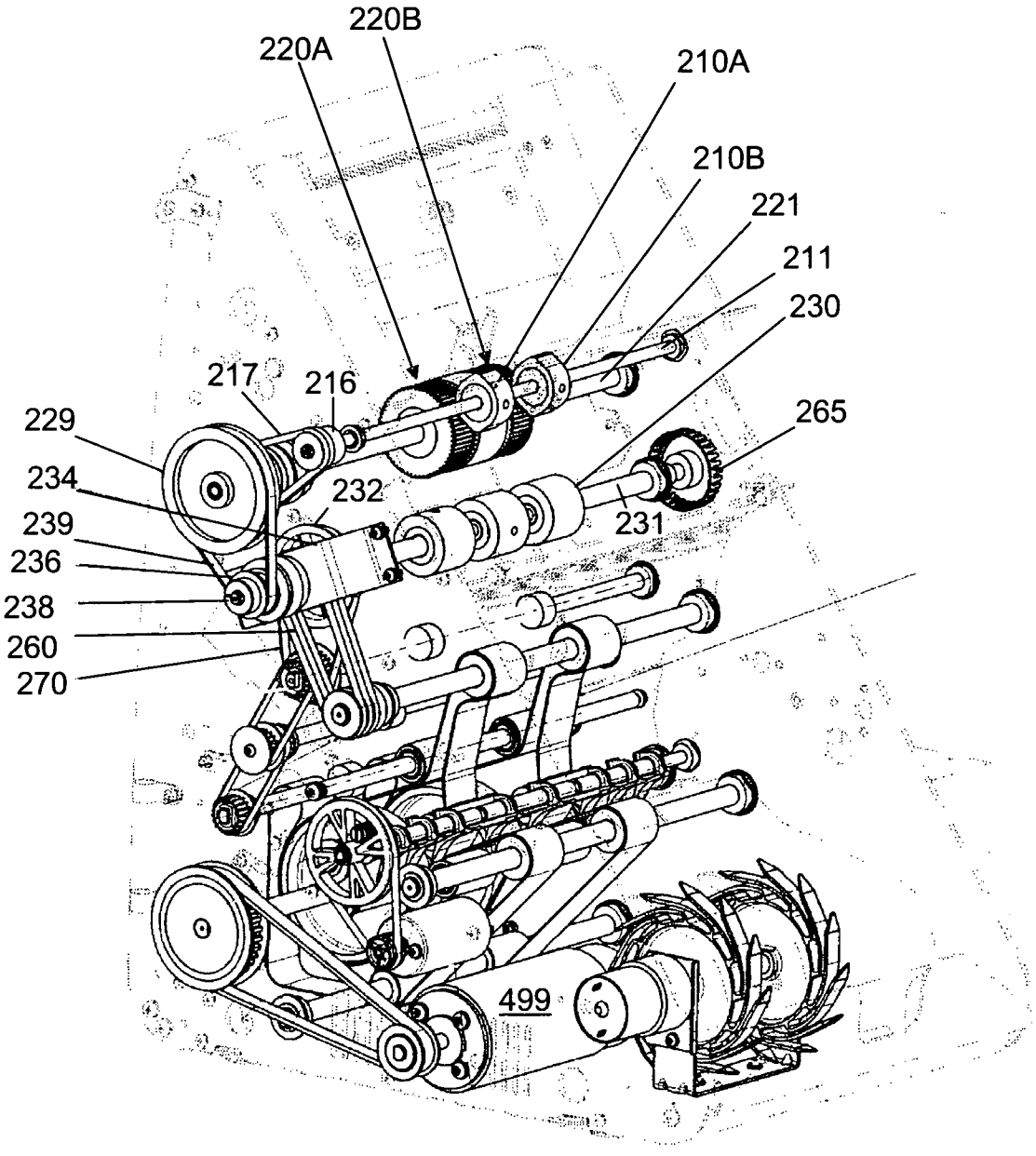


Figure 2M(iii)


220B
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260
270
499

Figure 2N

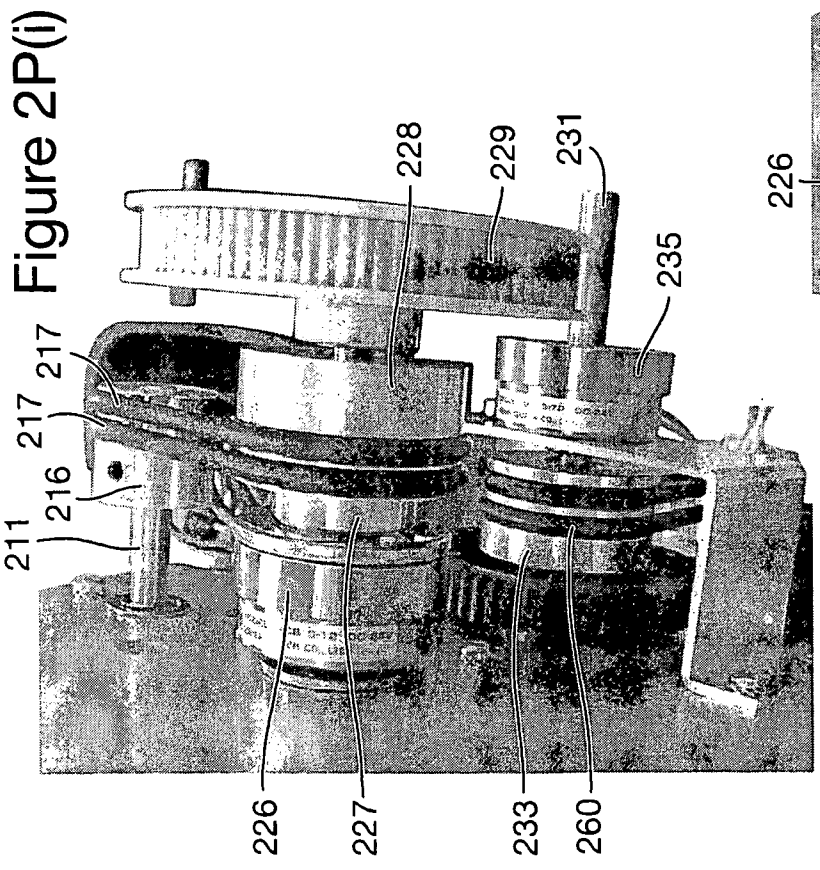


Figure 2P(i)

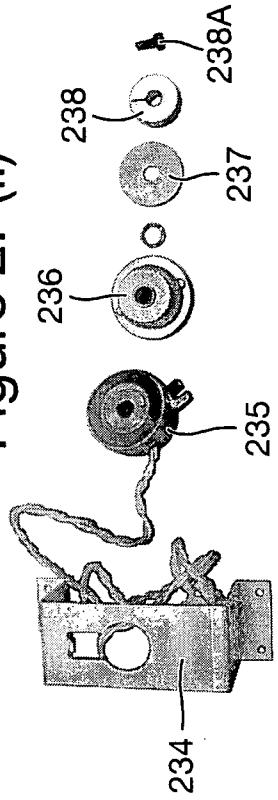


Figure 2P(ii)

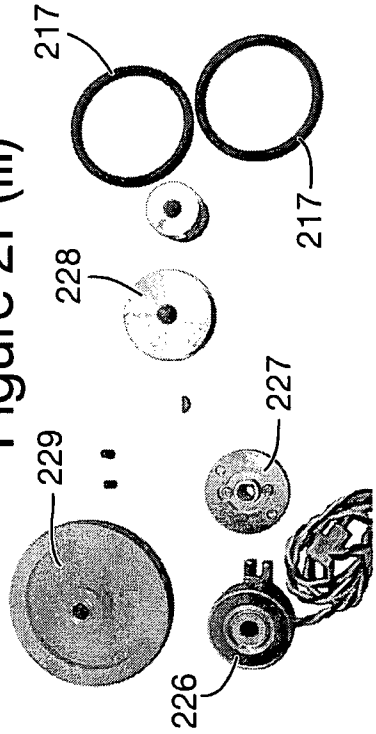


Figure 2P(iii)

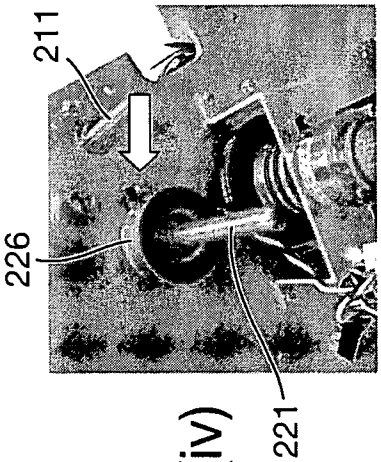


Figure 2P(iv)

Figure 2Q

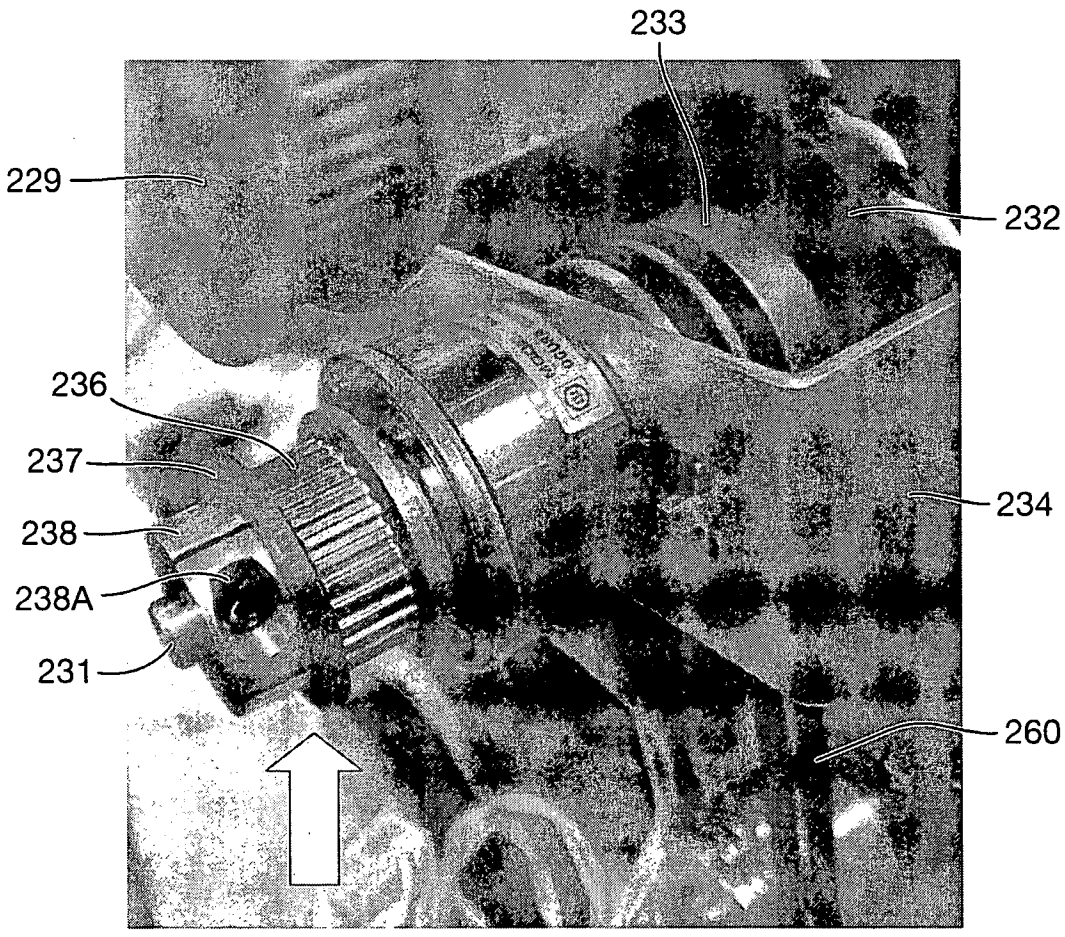
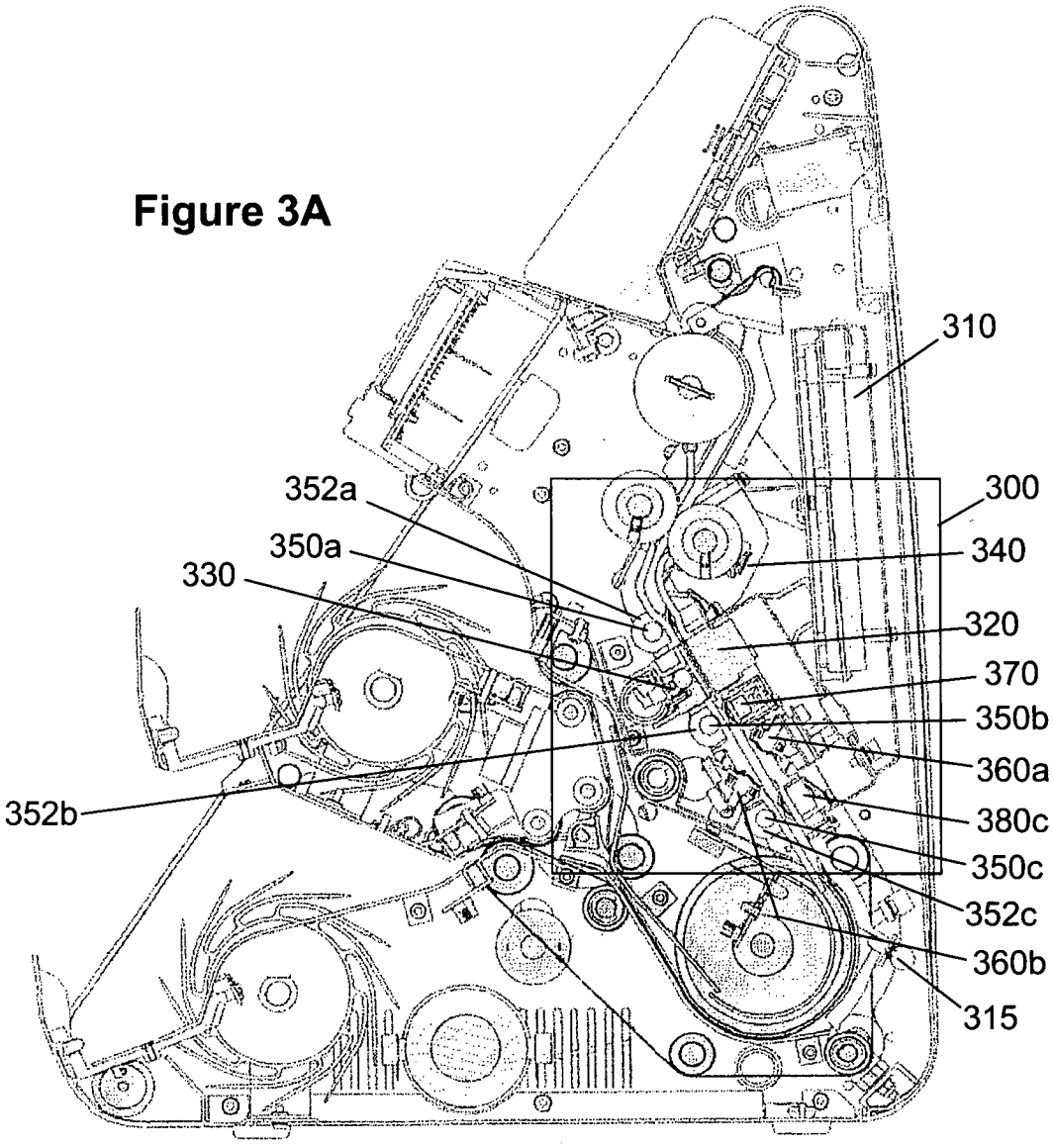


Figure 3A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350a
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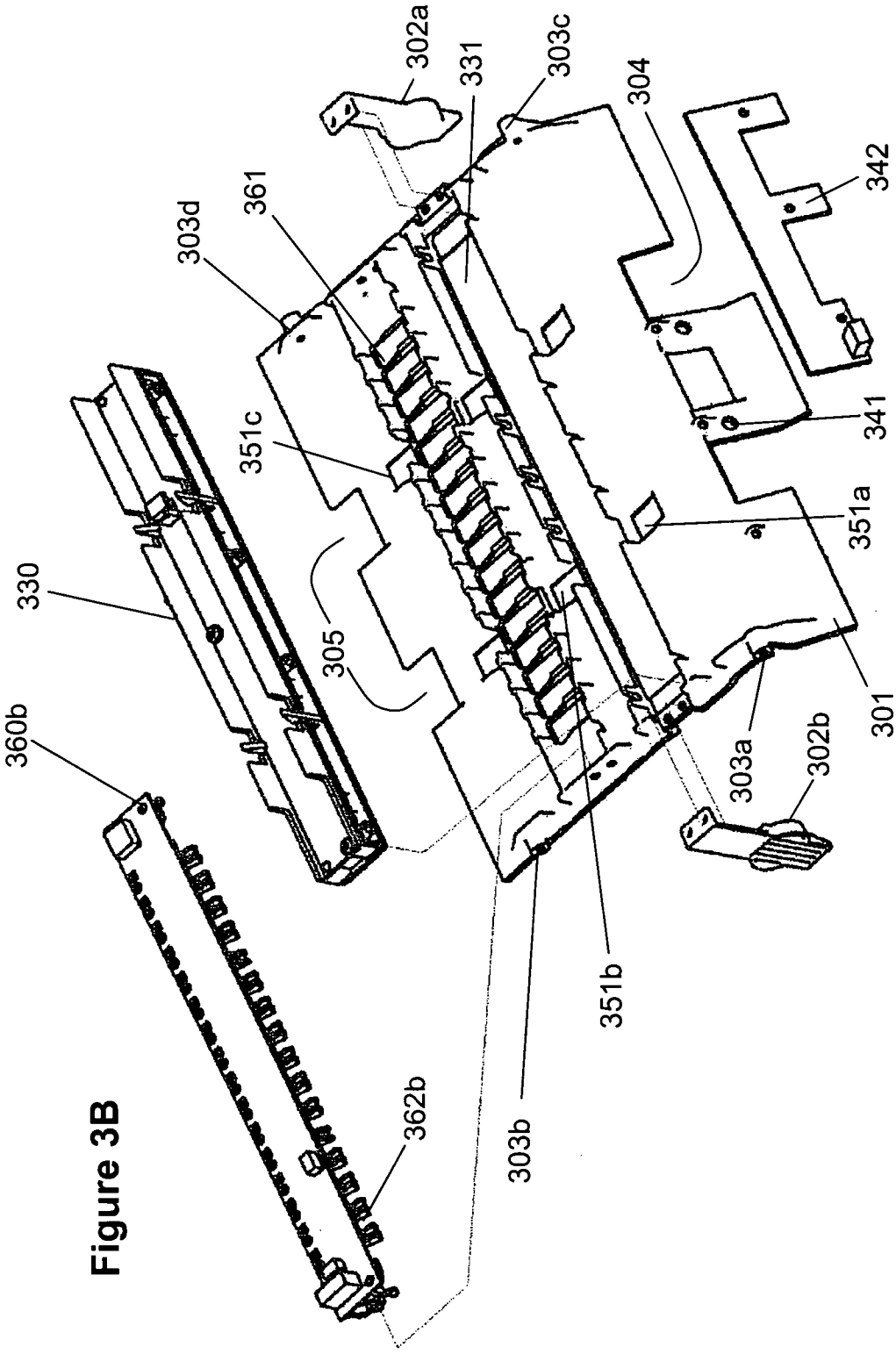
370
350b
360a
352b
380c
350c
352c
360b
315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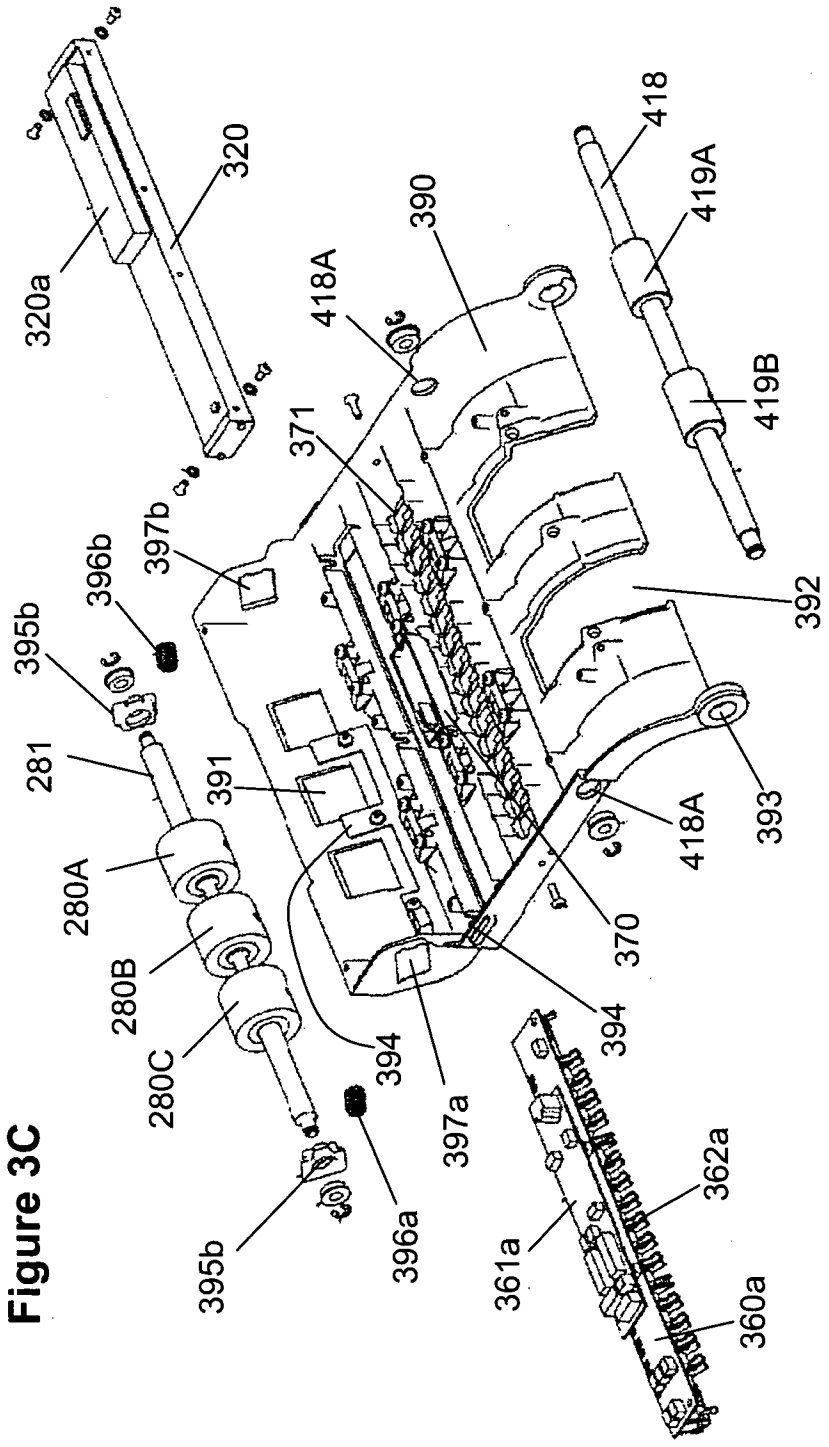
303b

Figure 3B


320
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397b
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395b
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391
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280B
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280C
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394
397a
362a
396a
361a
395b
360a

Figure 3C

Figure 3D

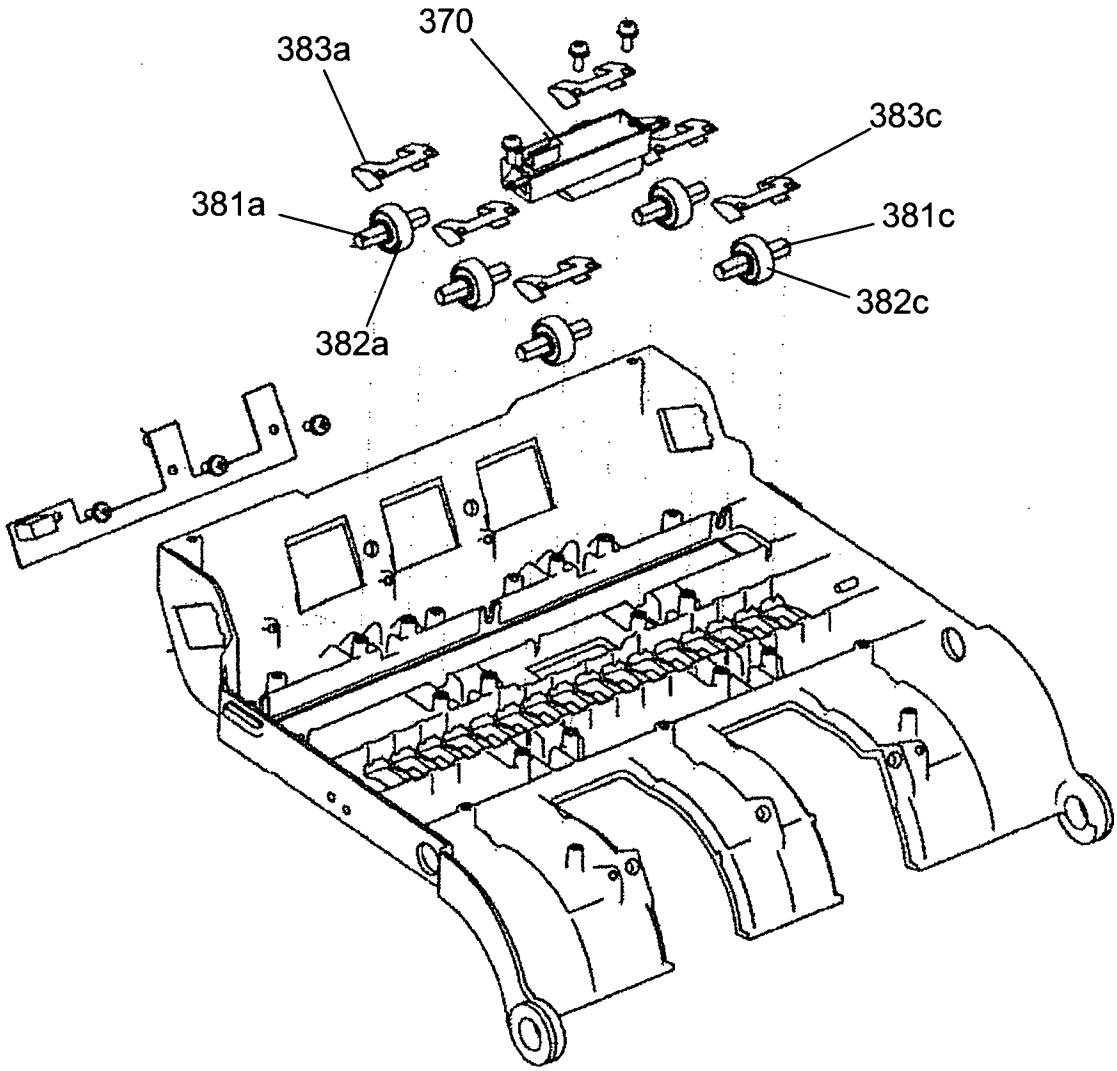


Figure 3E

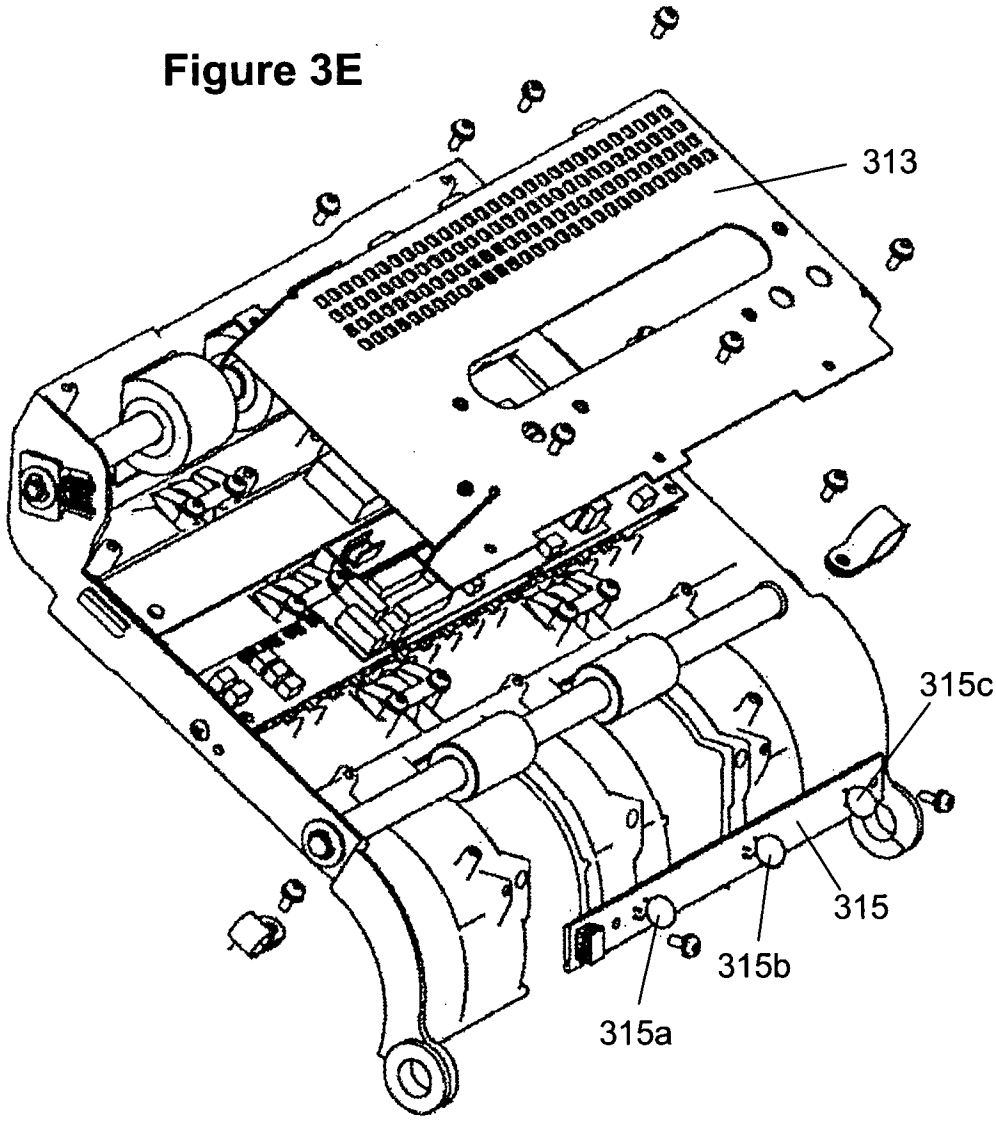


Figure 3F

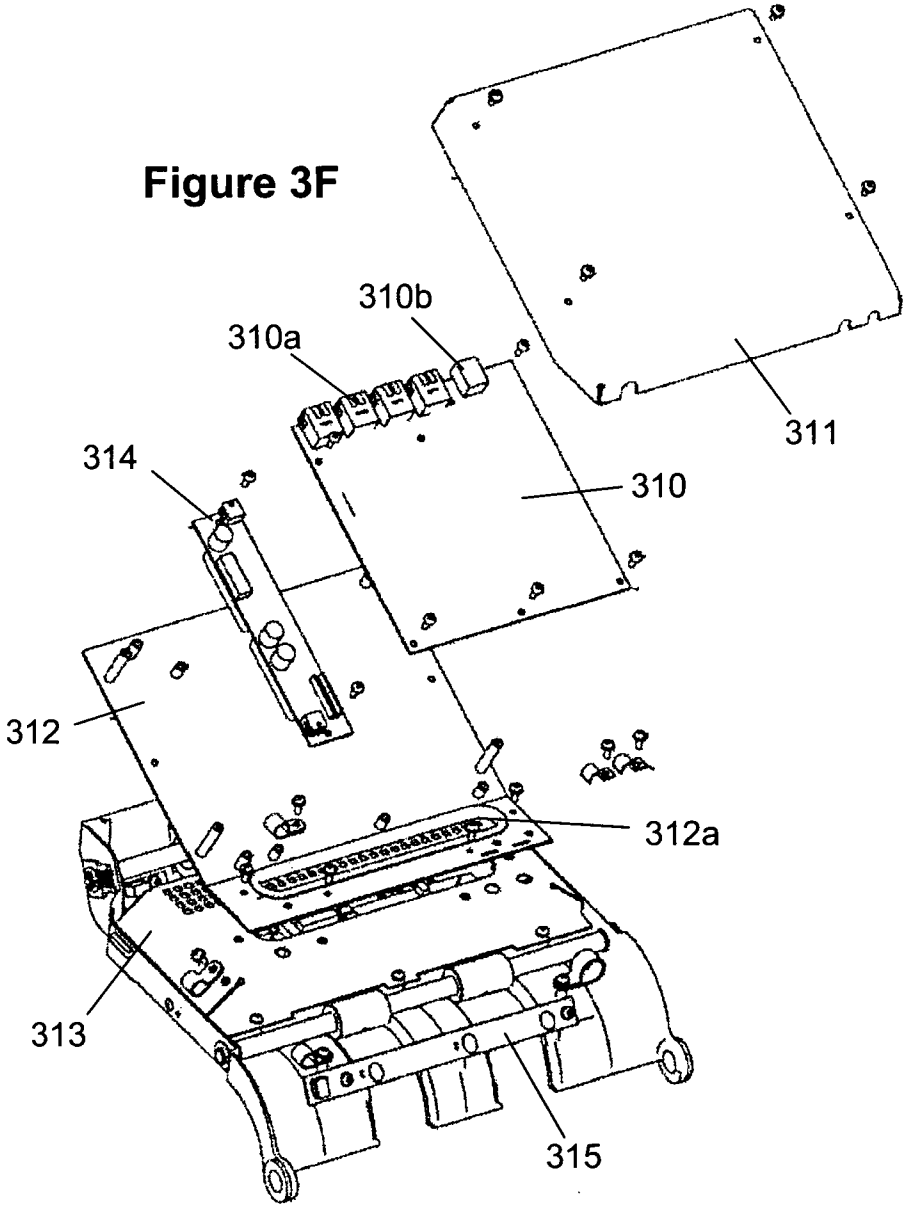
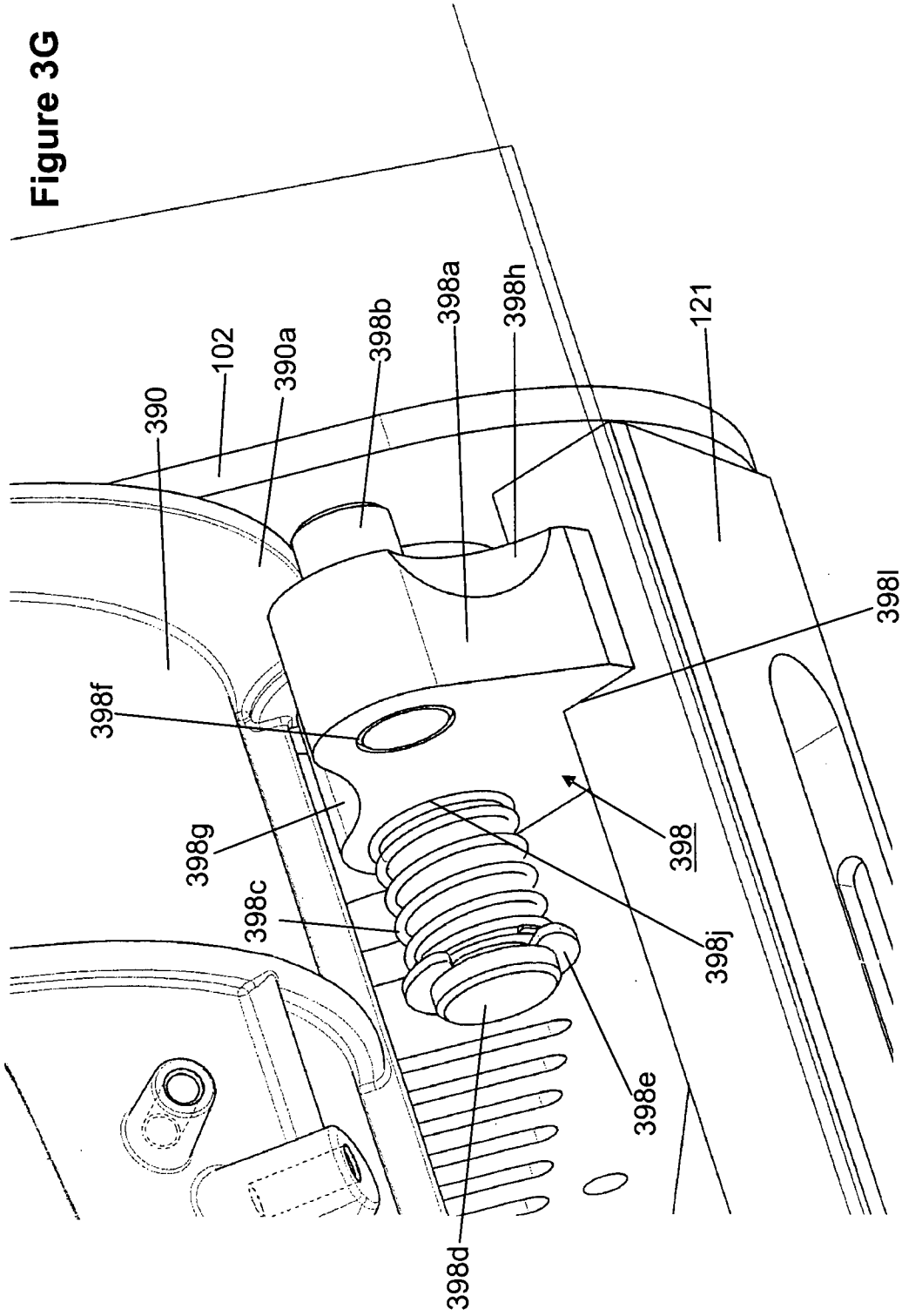


Figure 3G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398h
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398g
398c
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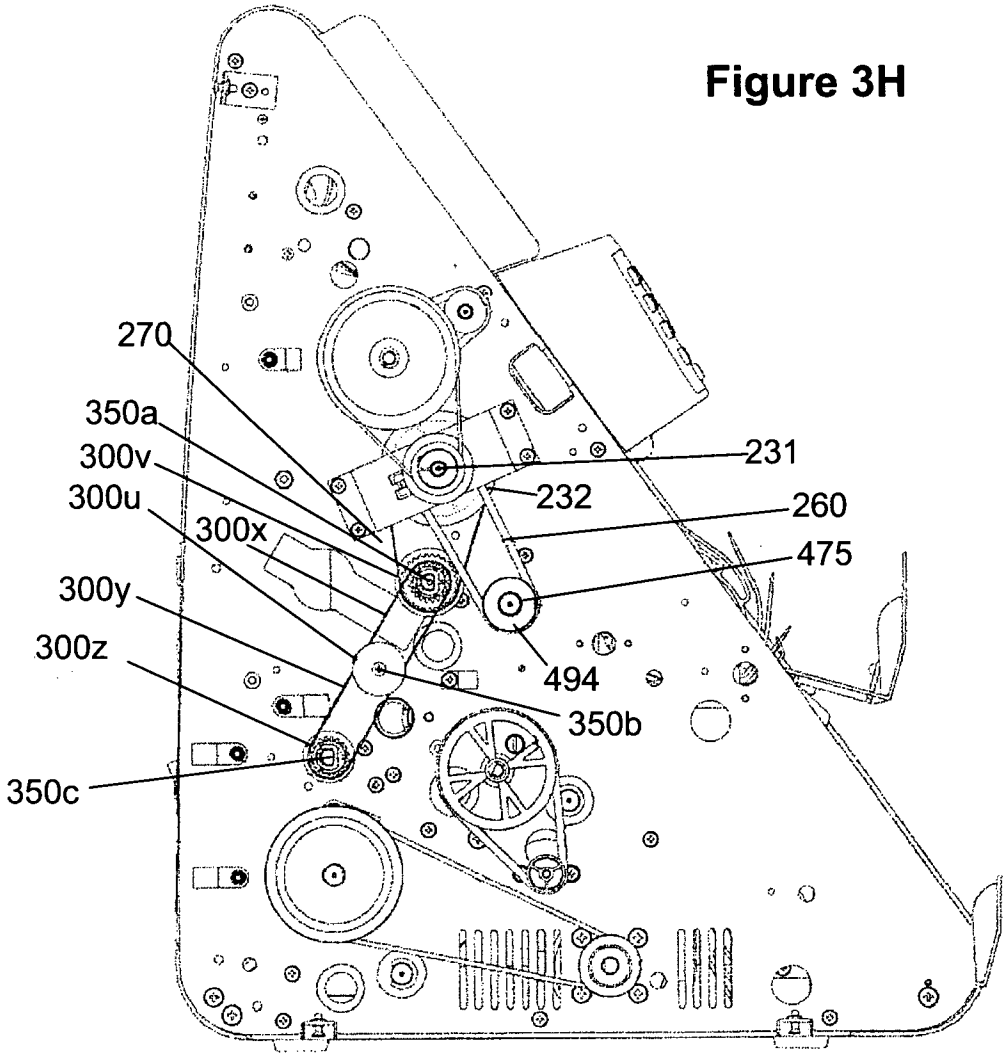
398e
398d

Figure 3H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350c
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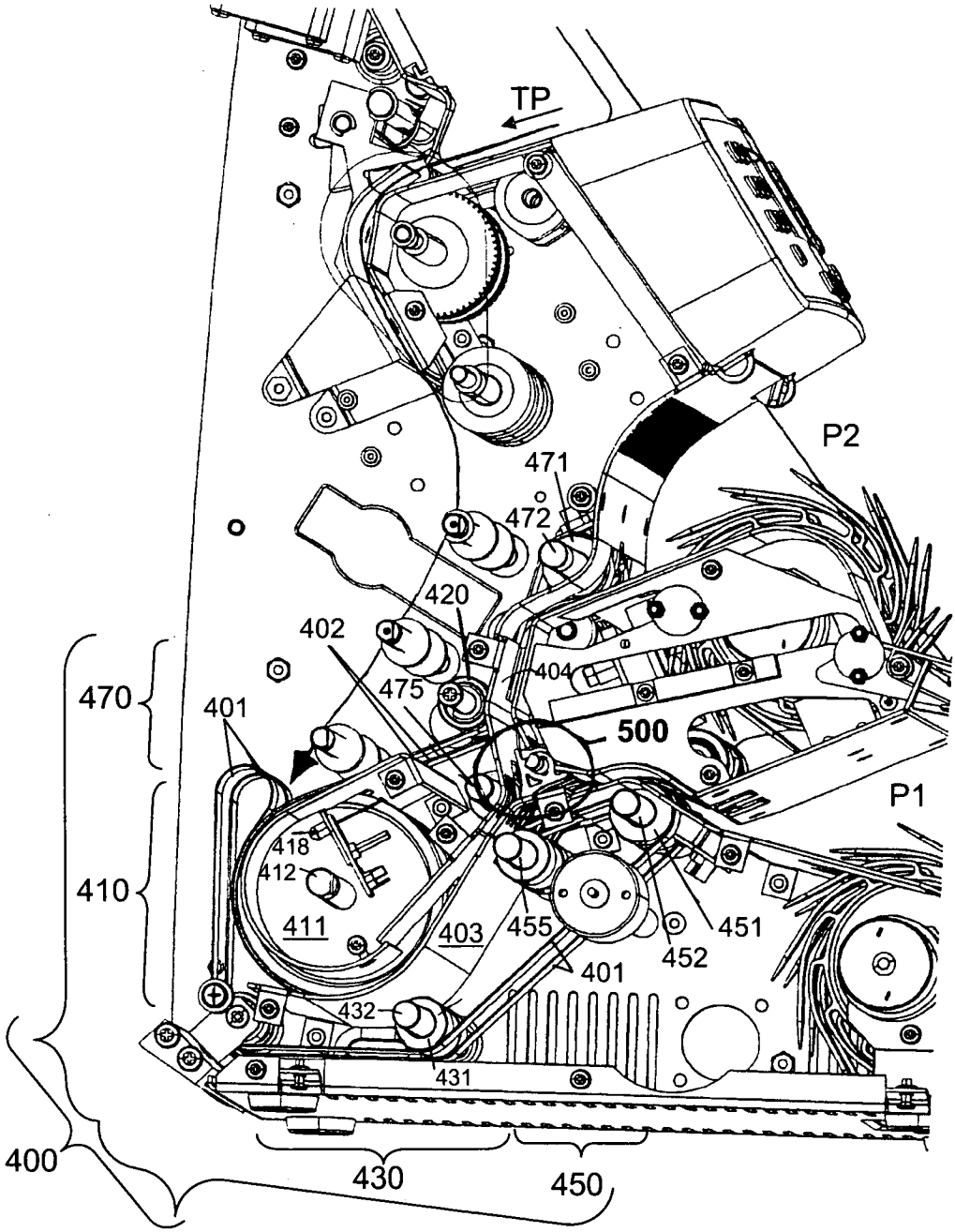
475
494
350b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401
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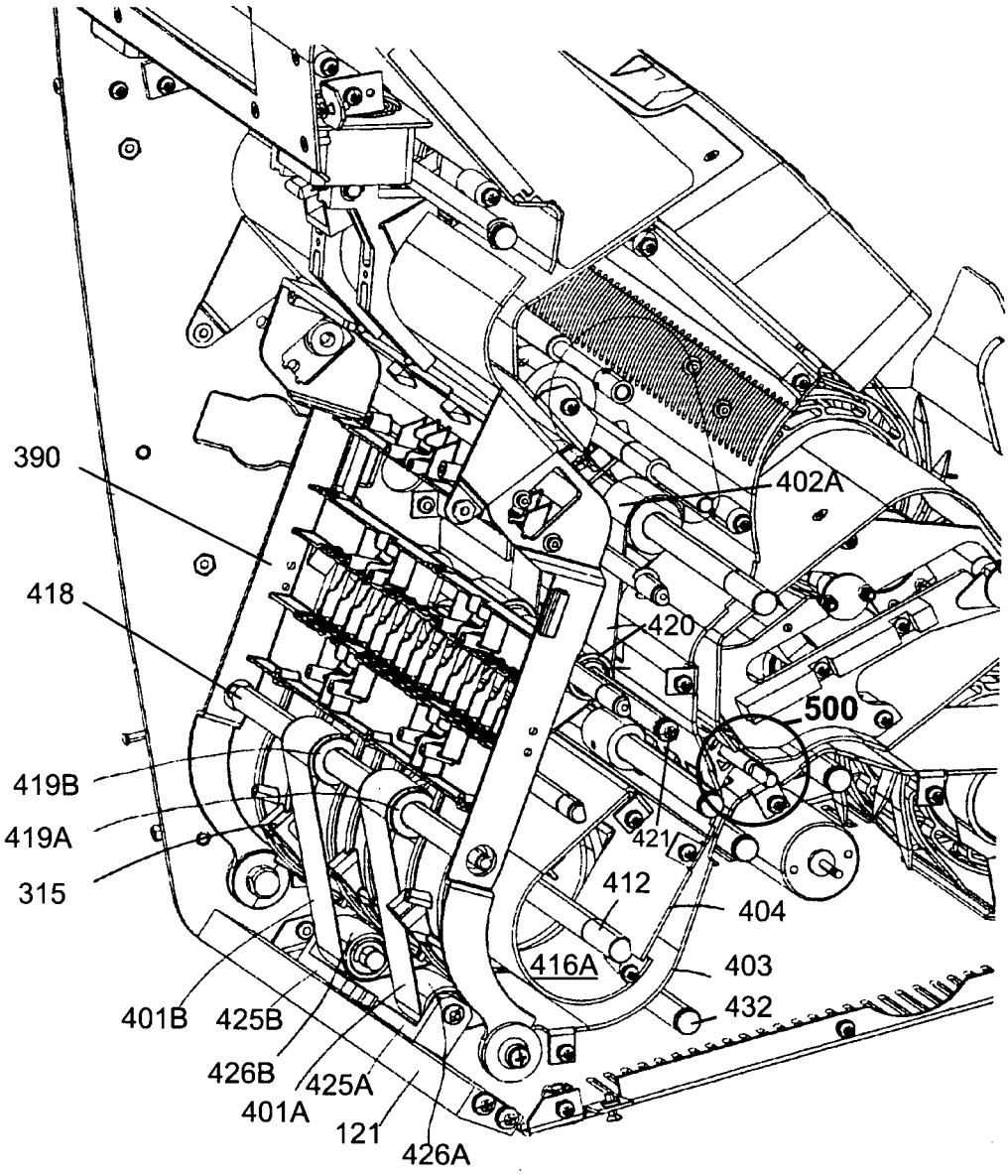
430
450

Figure 4A


390
418
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426A
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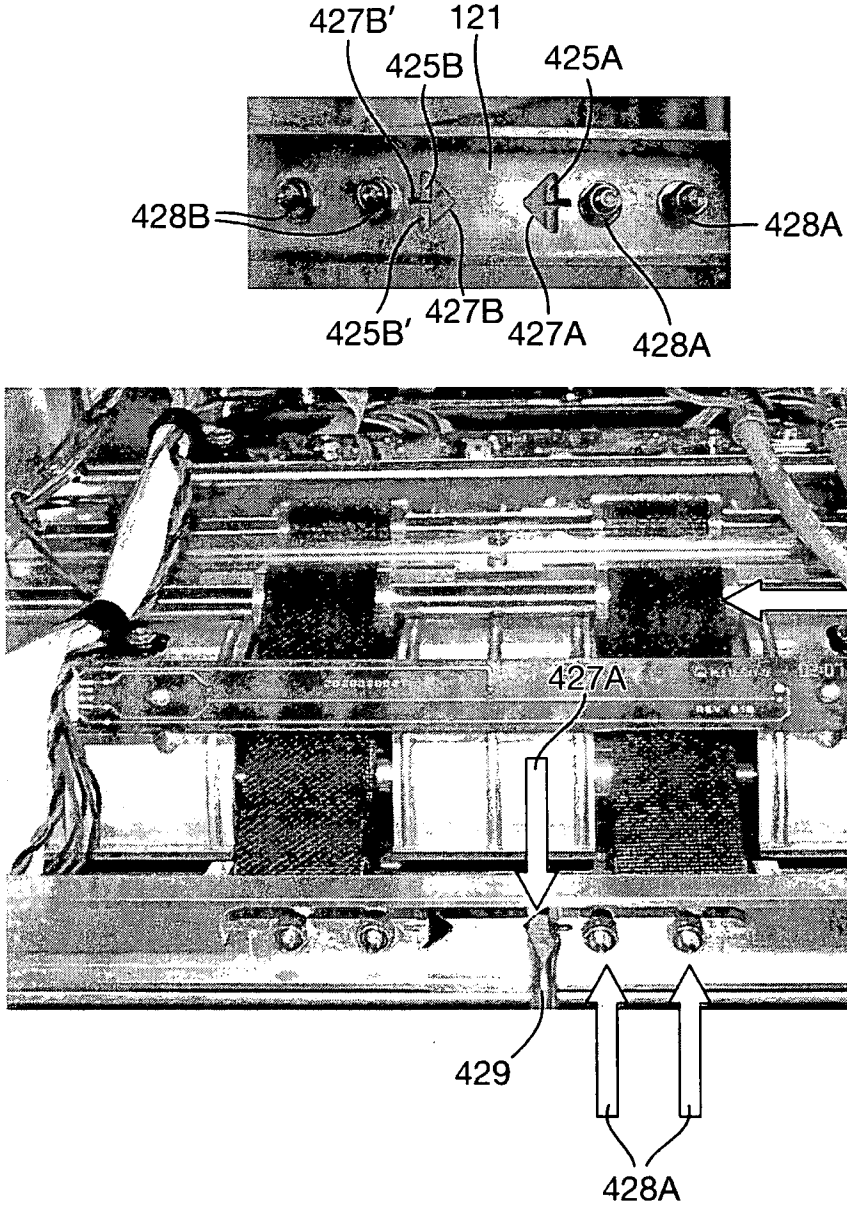
416A
403
432

Figure 4B(i)

Figure 4B(ii)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425A
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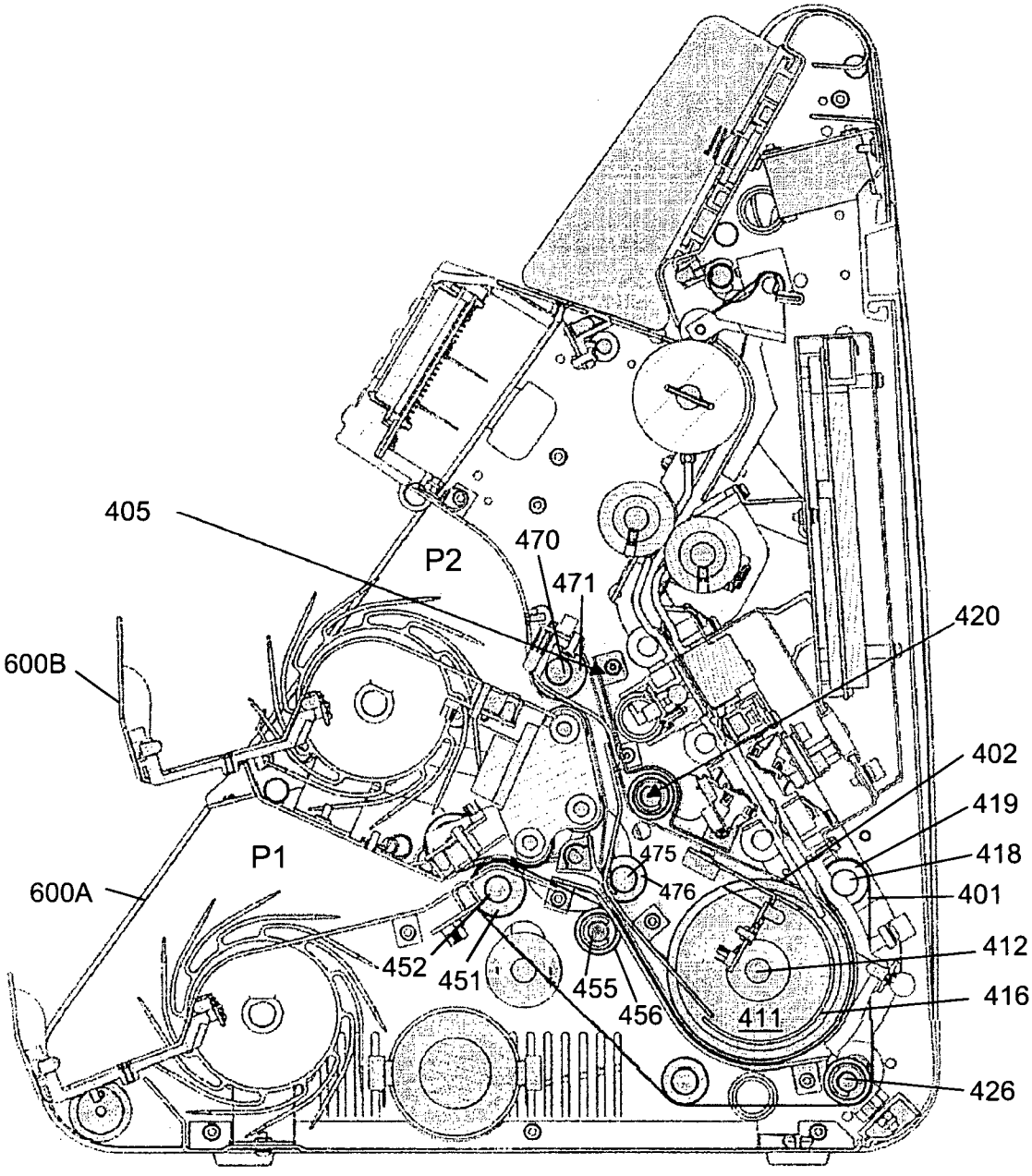
428A
425B'
427B
427A
428A
427A
429
428A


405
470
P2
471
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P1
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411
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426

Figure 4C

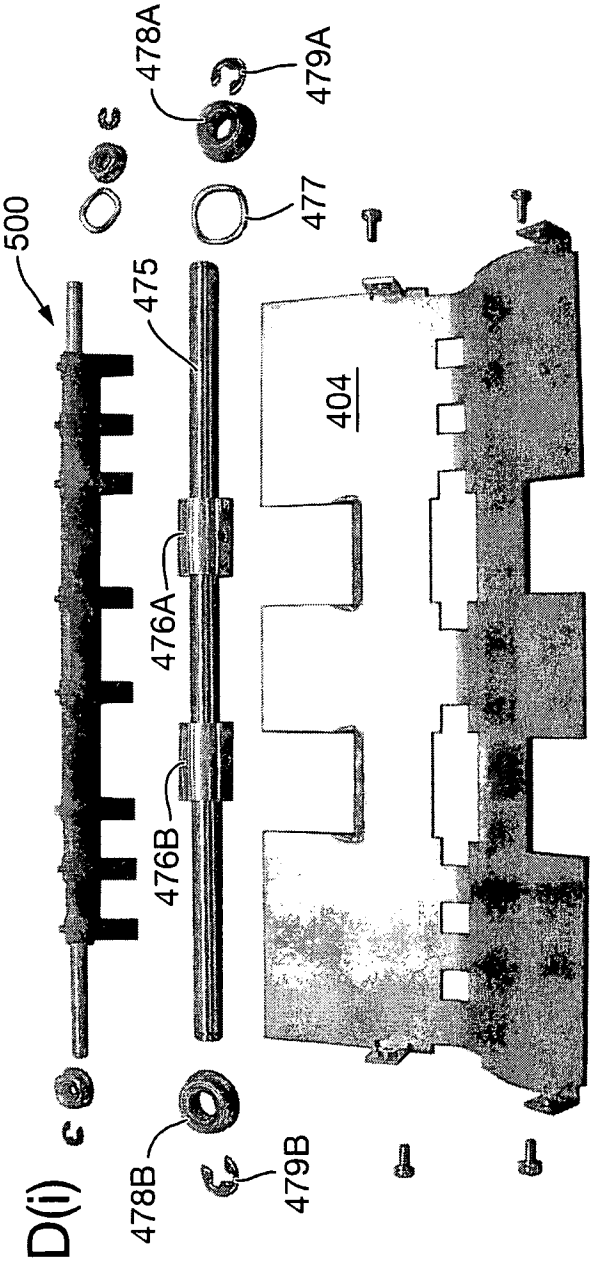


Figure 4D(i)

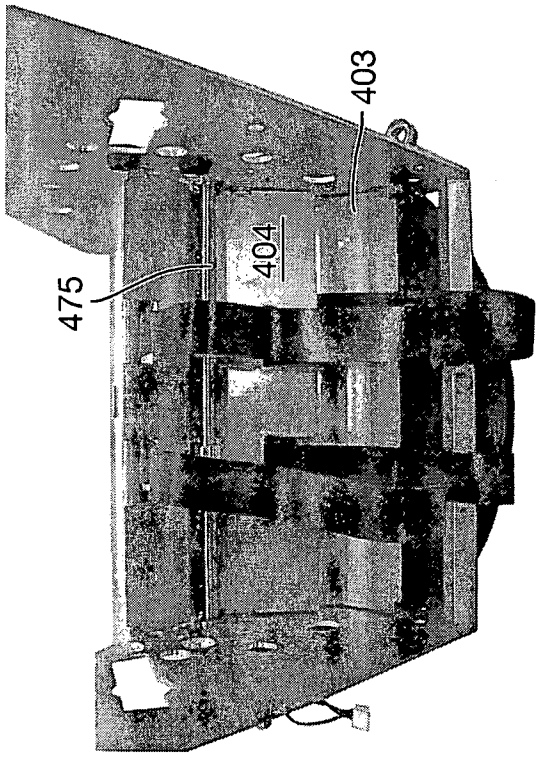


Figure 4D(ii)

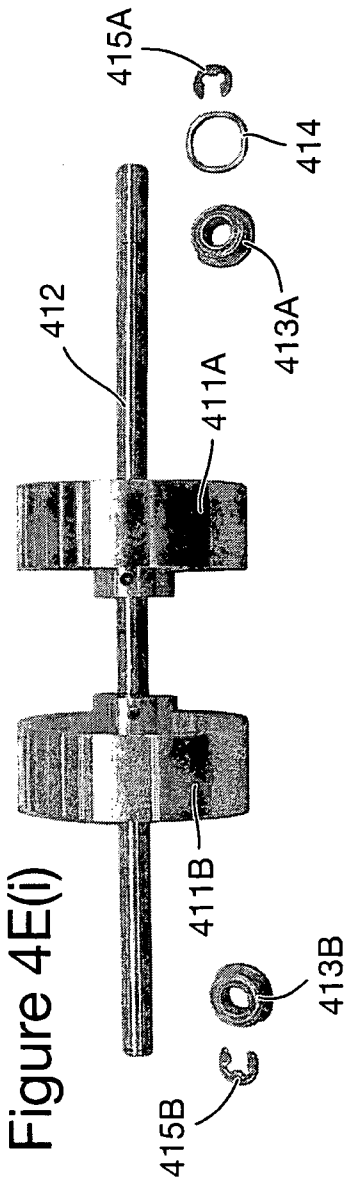


Figure 4E(i)

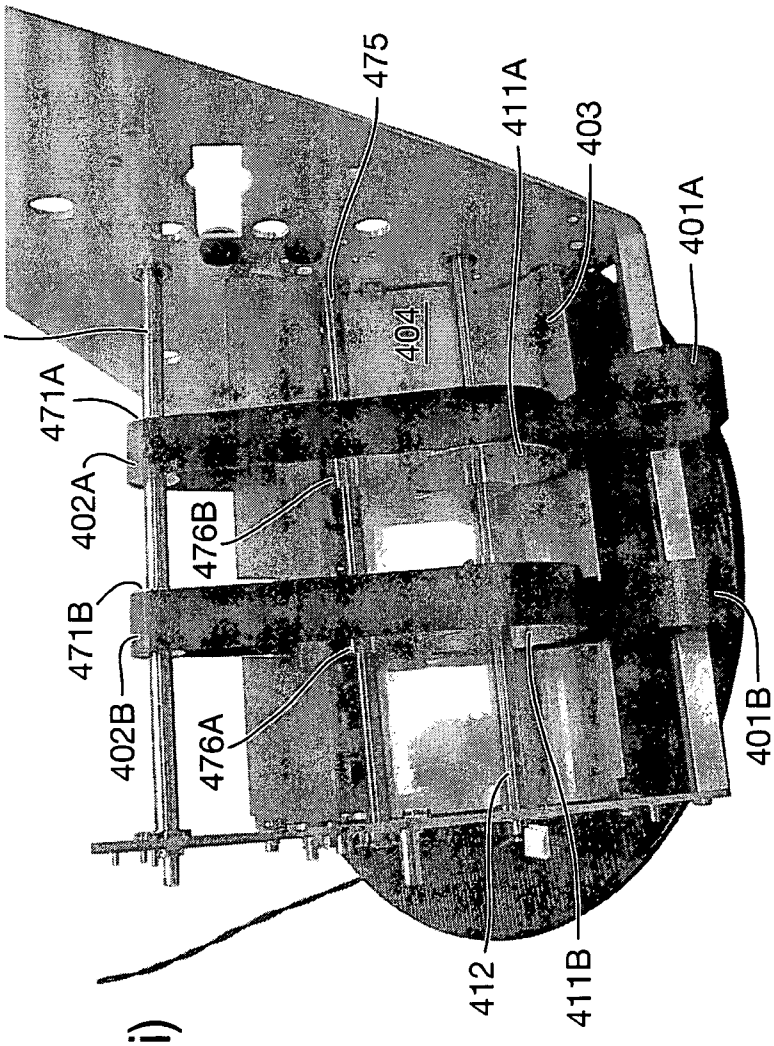


Figure 4E(ii)

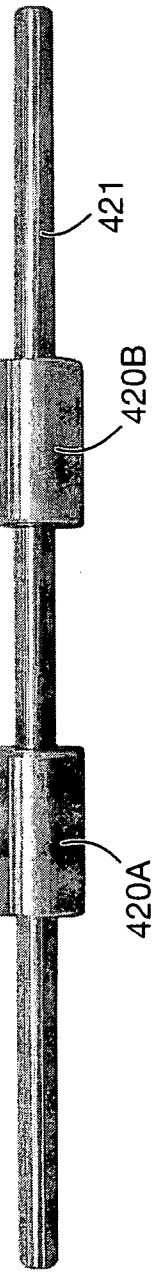


Figure 4F(i)

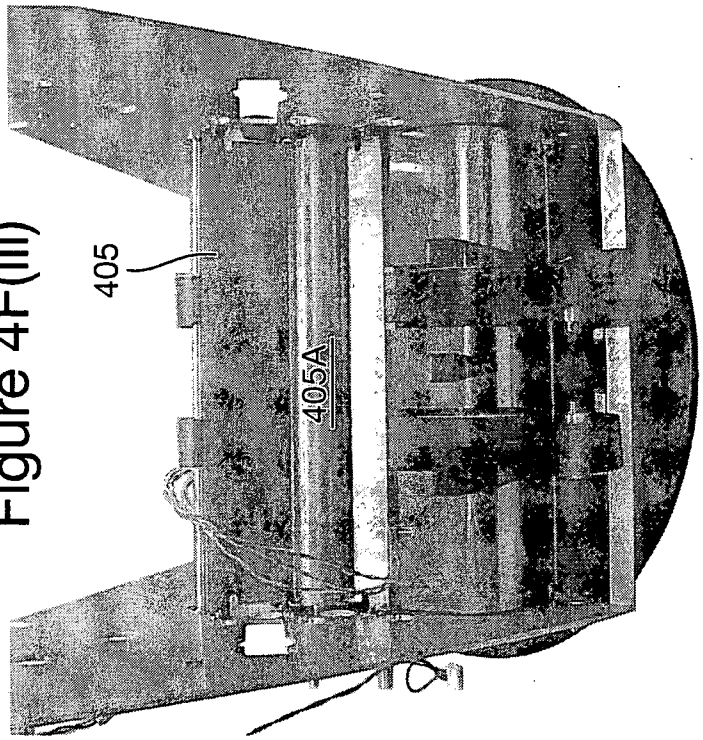


Figure 4F(iii)

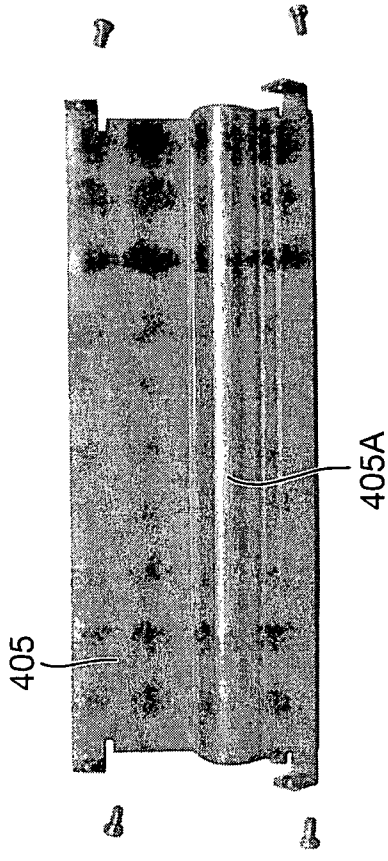
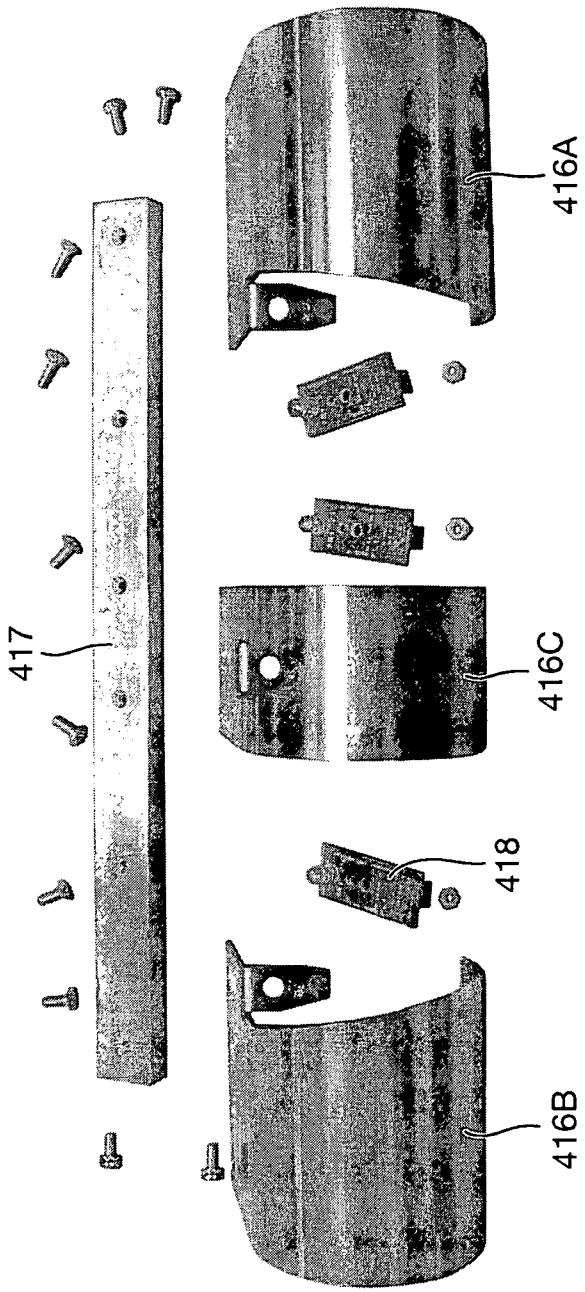


Figure 4F(ii)

Figure 4G



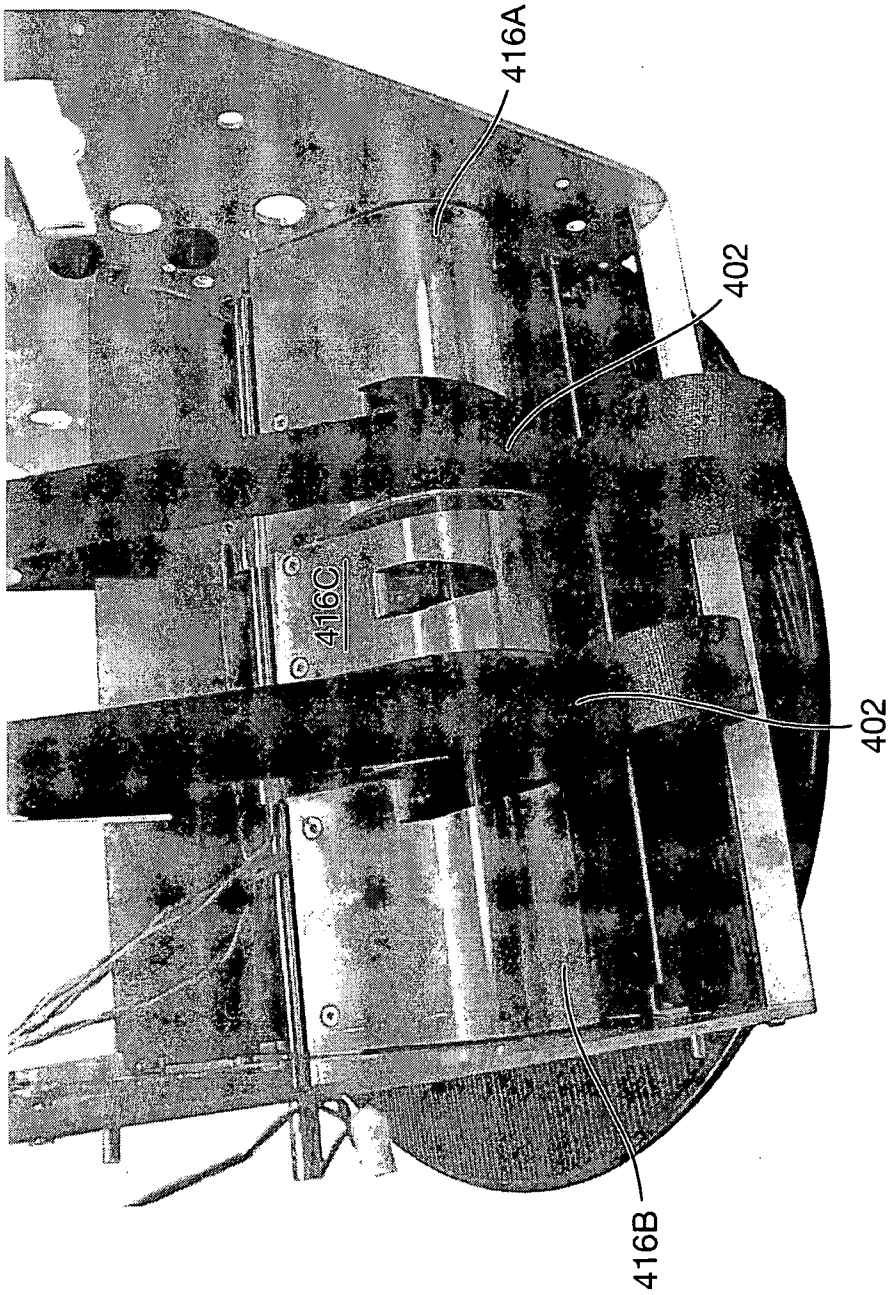


Figure 4H

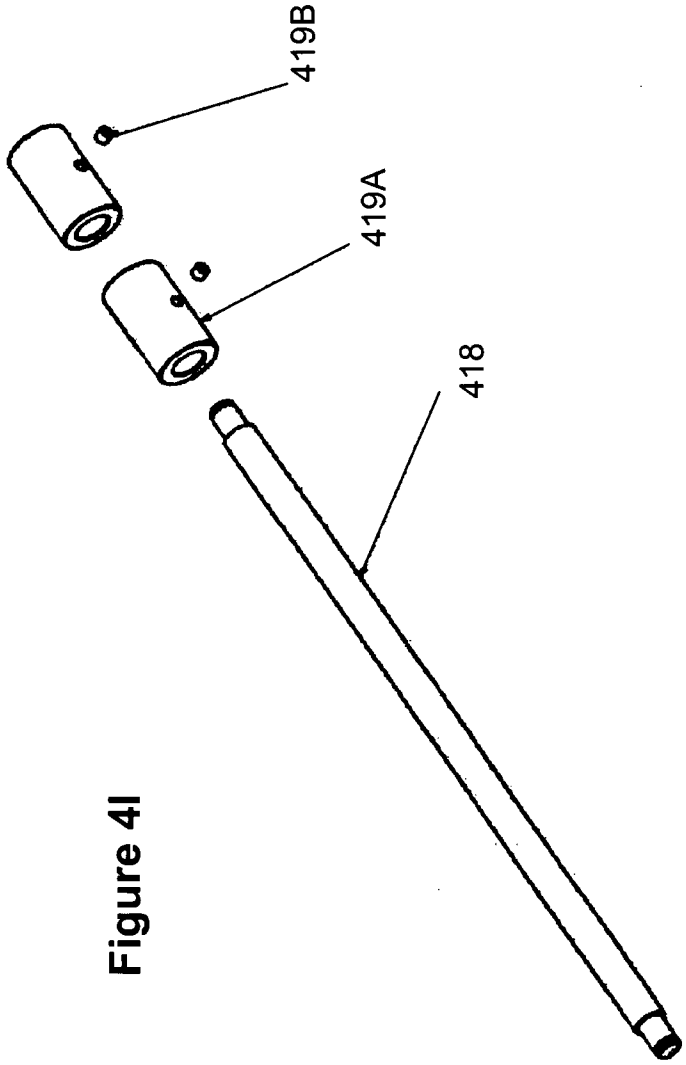
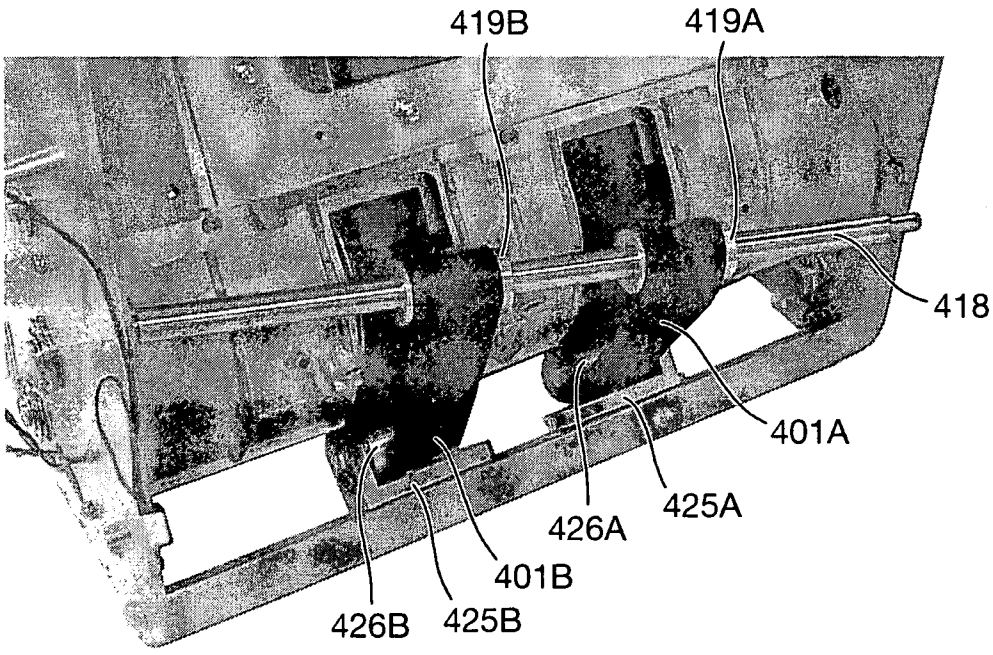


Figure 4I

Figure 4J



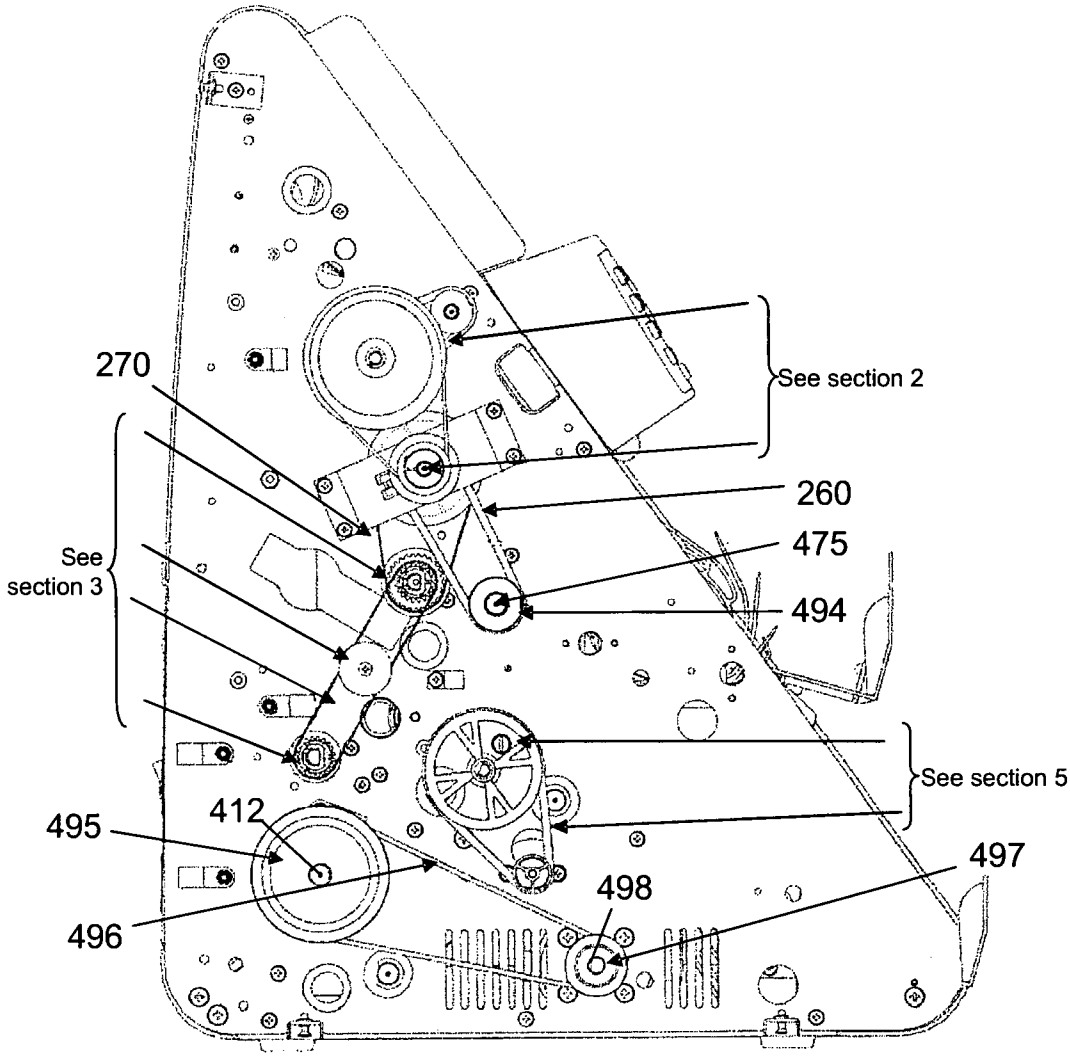

270
See section 2
260
See section 3
475
494
See section 5
412
495
497
498
496

Figure 4K

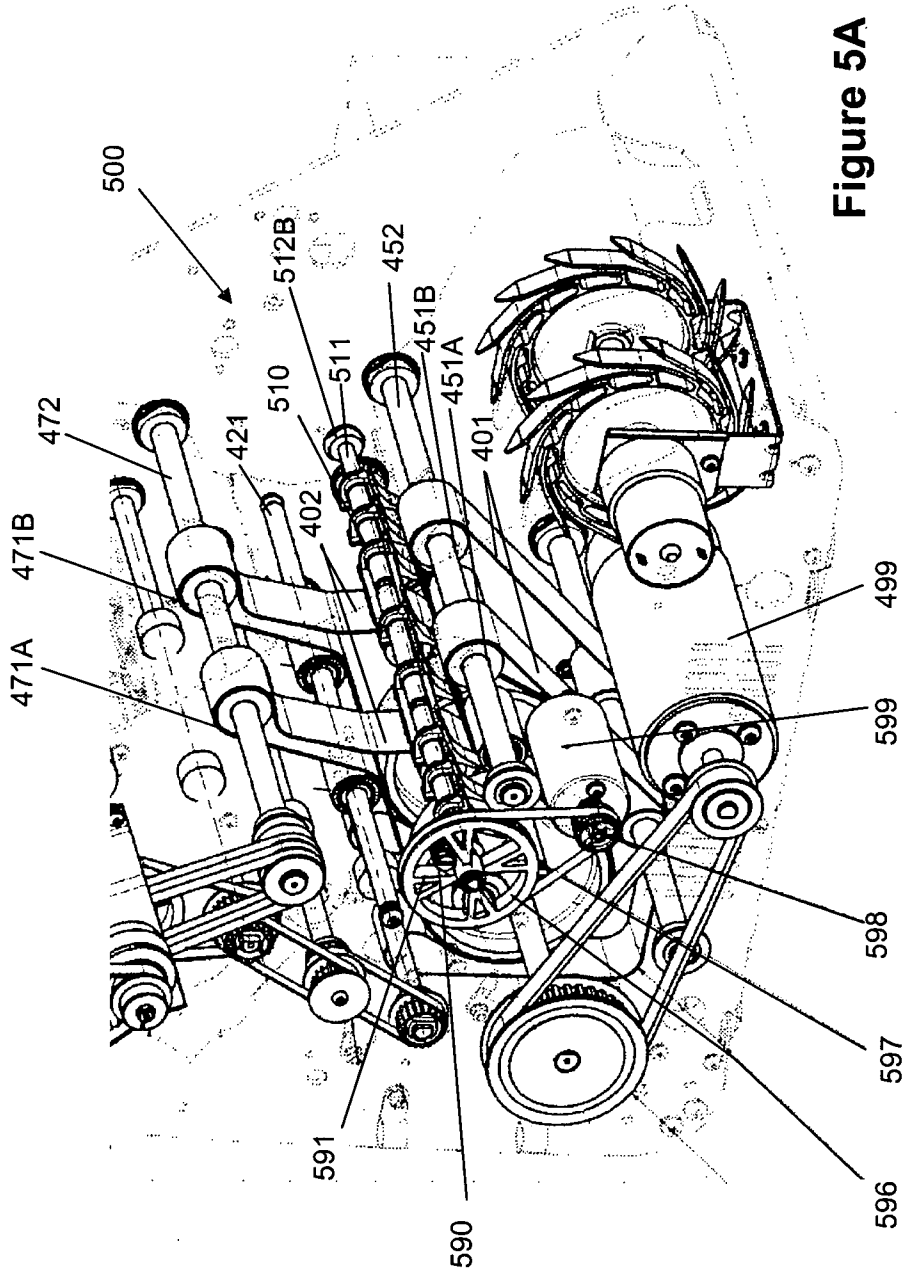
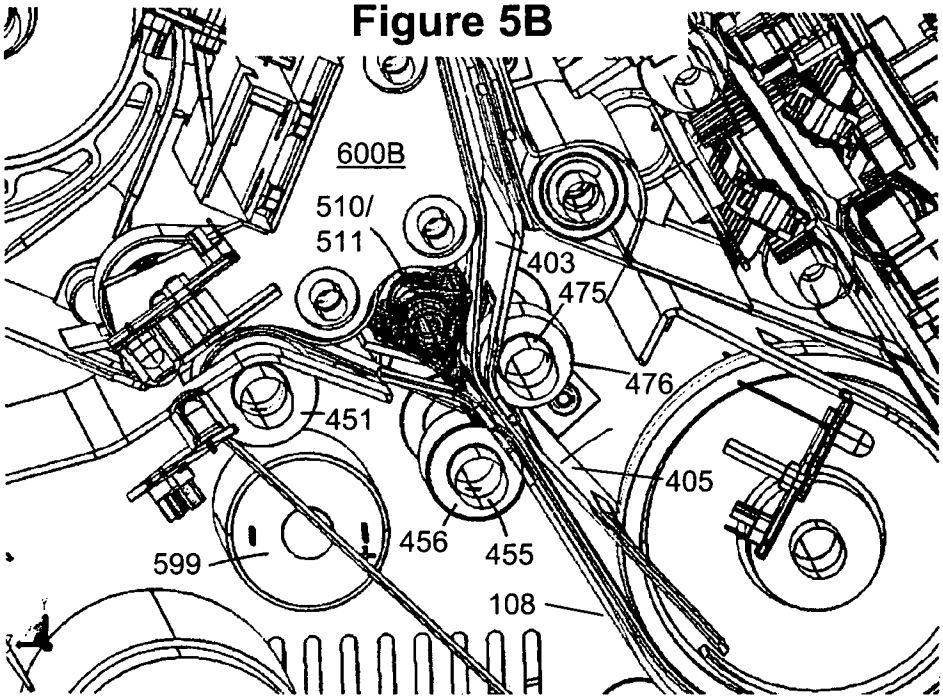

500
512B
452
451B
511
451A
510
401
421
472
402
471B
471A
499
599
598
597
596
591
590

Figure 5A

Figure 5B



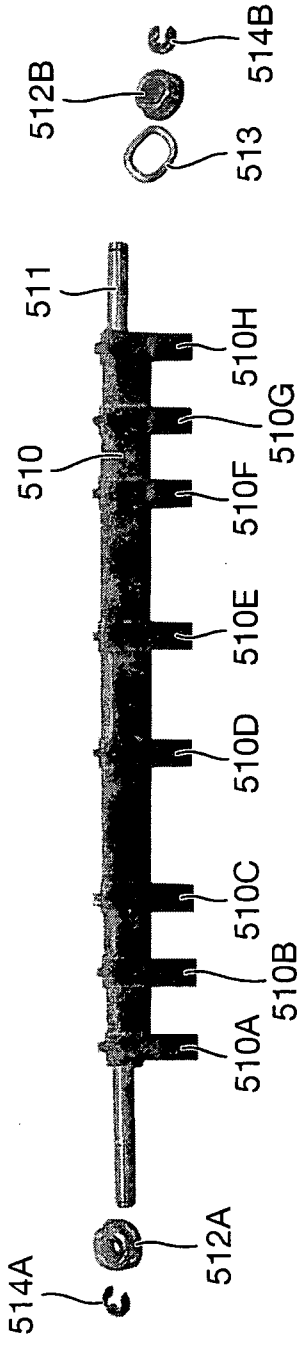

514B
512B
513
511
510H
510G
510
510F
510E
510D
510C
510B
510A
512A
514A

Figure 5C

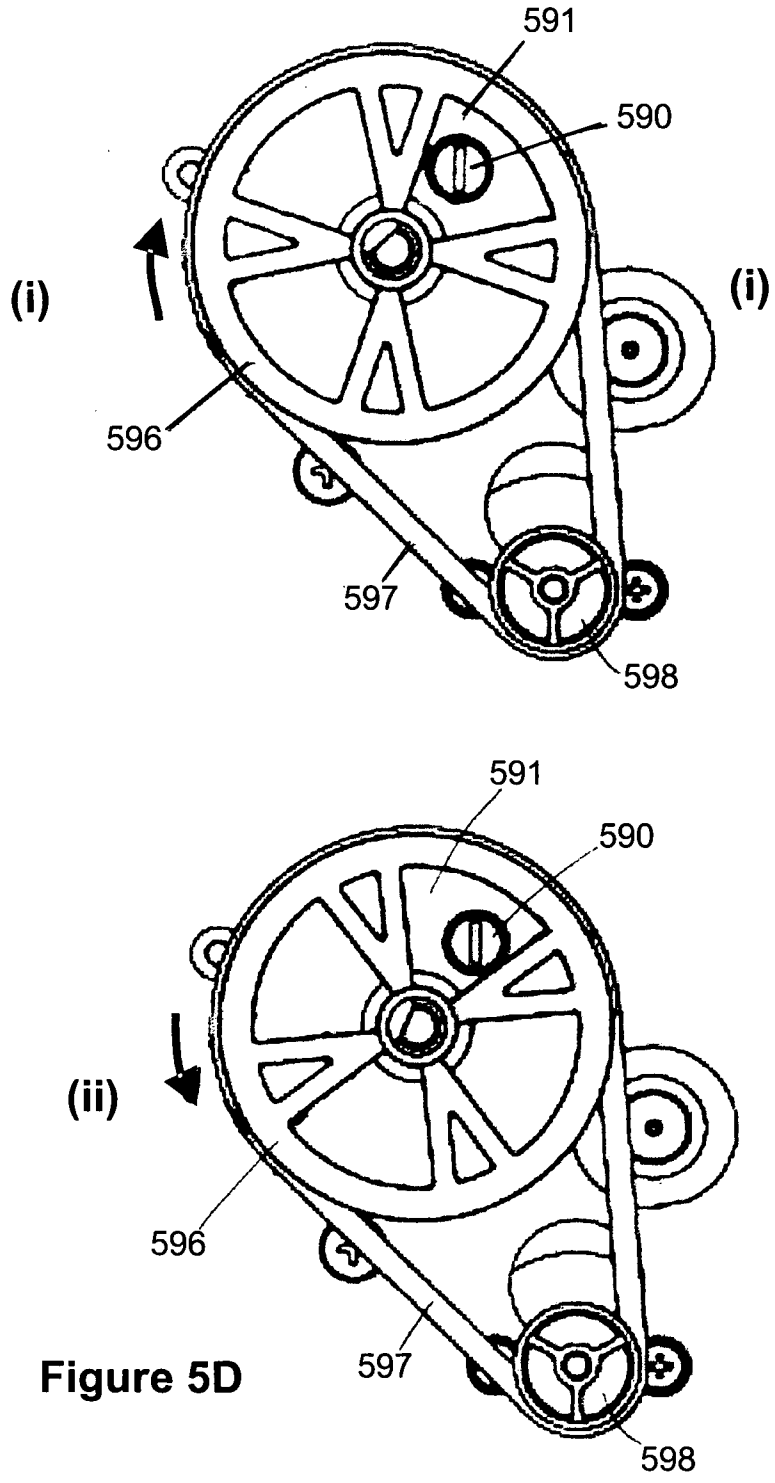


Figure 5D

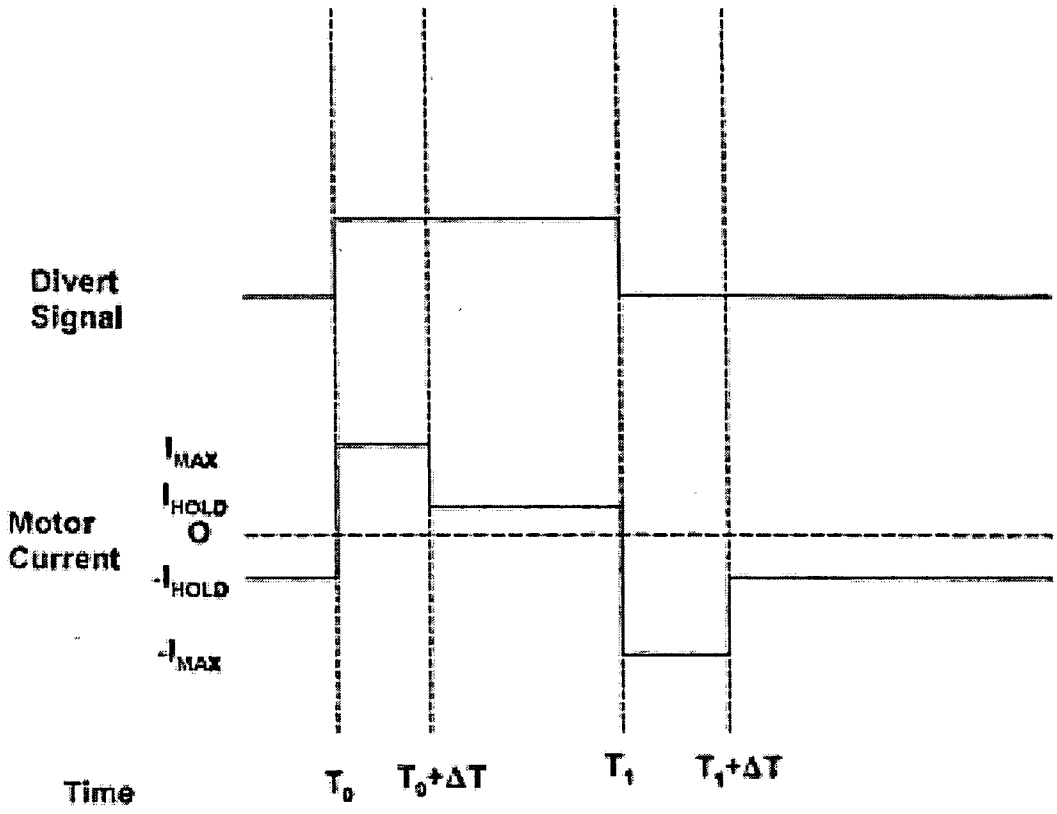
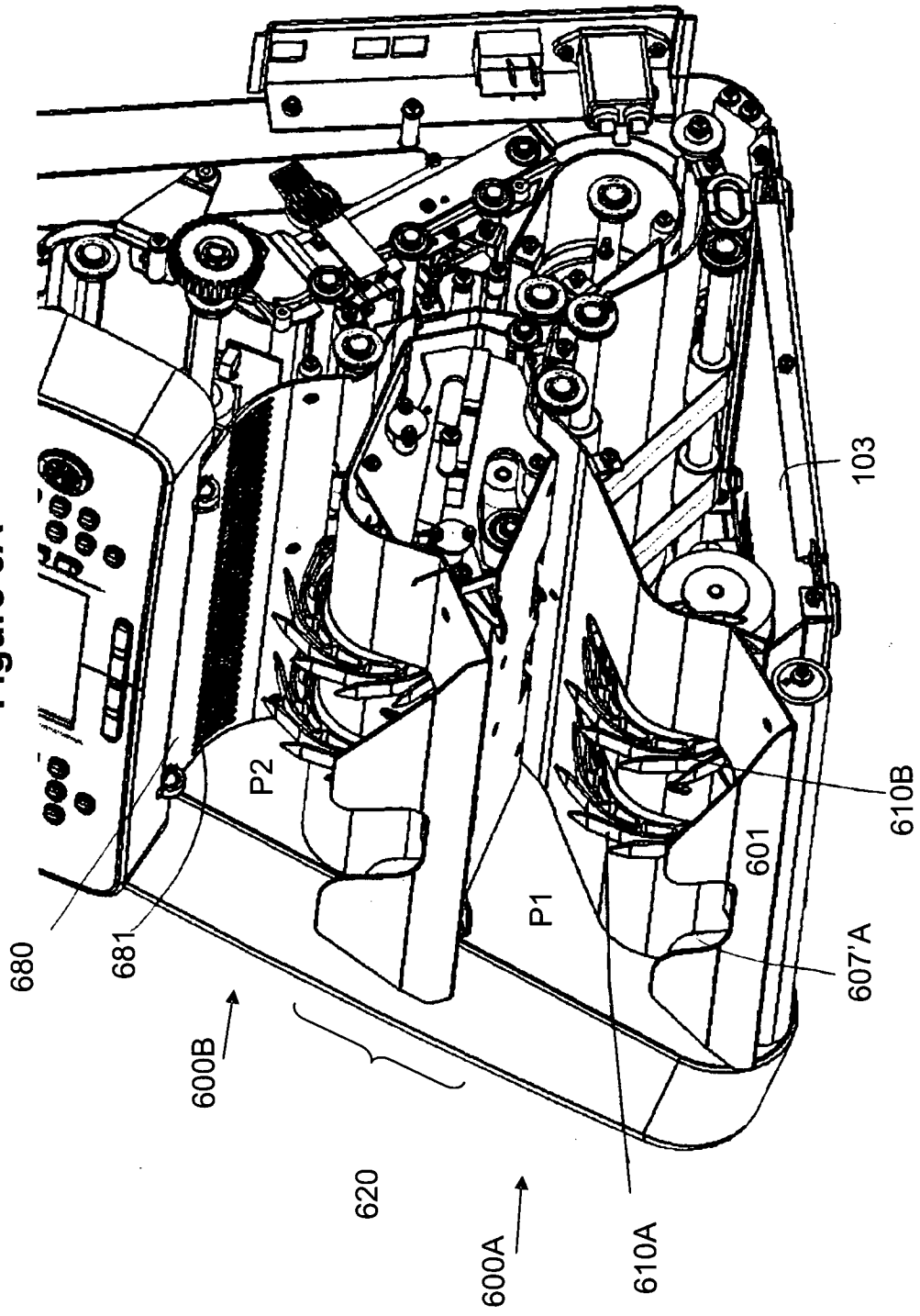

Divert Signal
Motor Current
I_{MAX}
I_{HOLD}
0
$-I_{HOLD}$
$-I_{MAX}$
Time
T_0
$T_0+\Delta T$
T_1
$T_1+\Delta T$

Figure 5E

Figure 6A



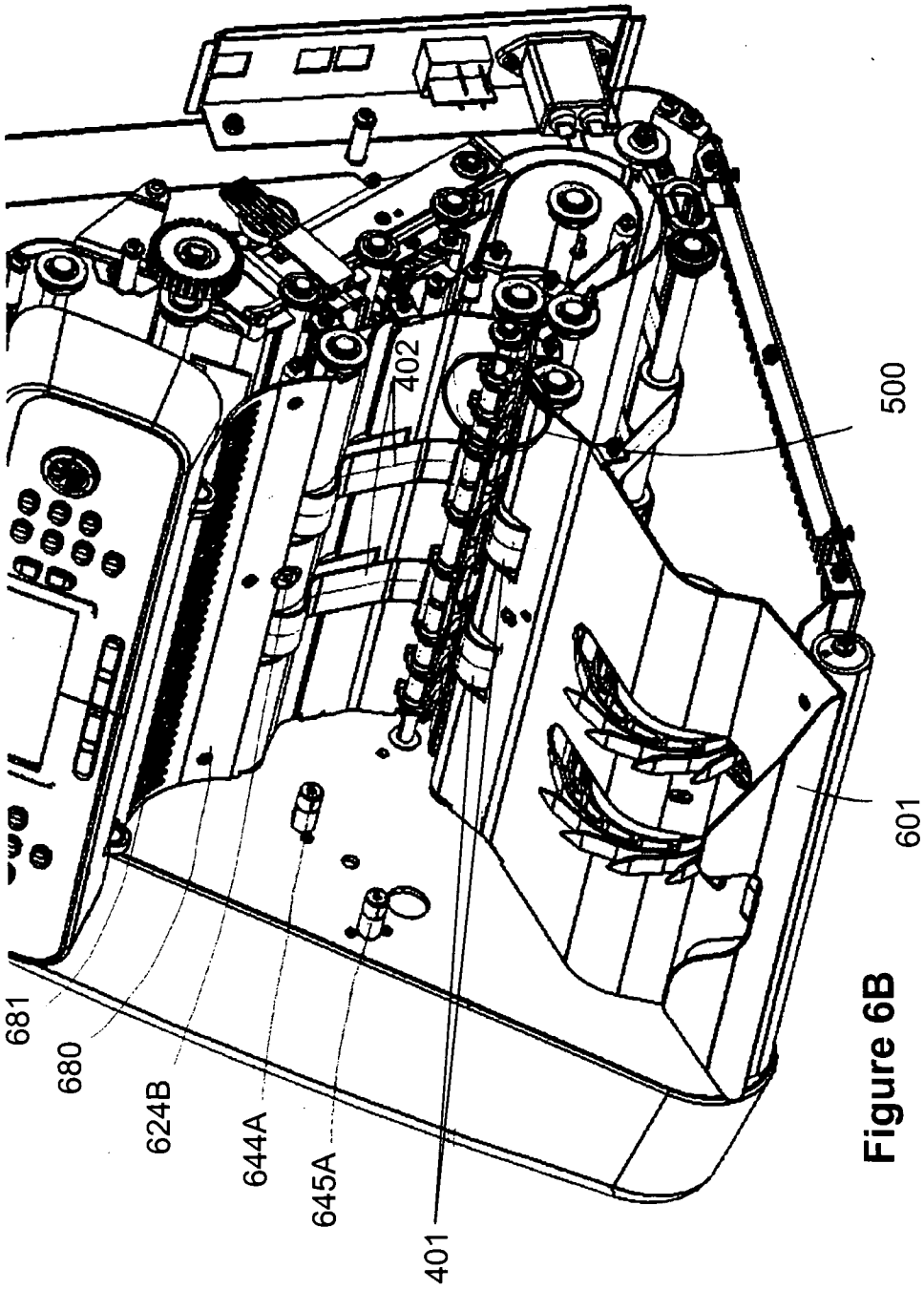


Figure 6B

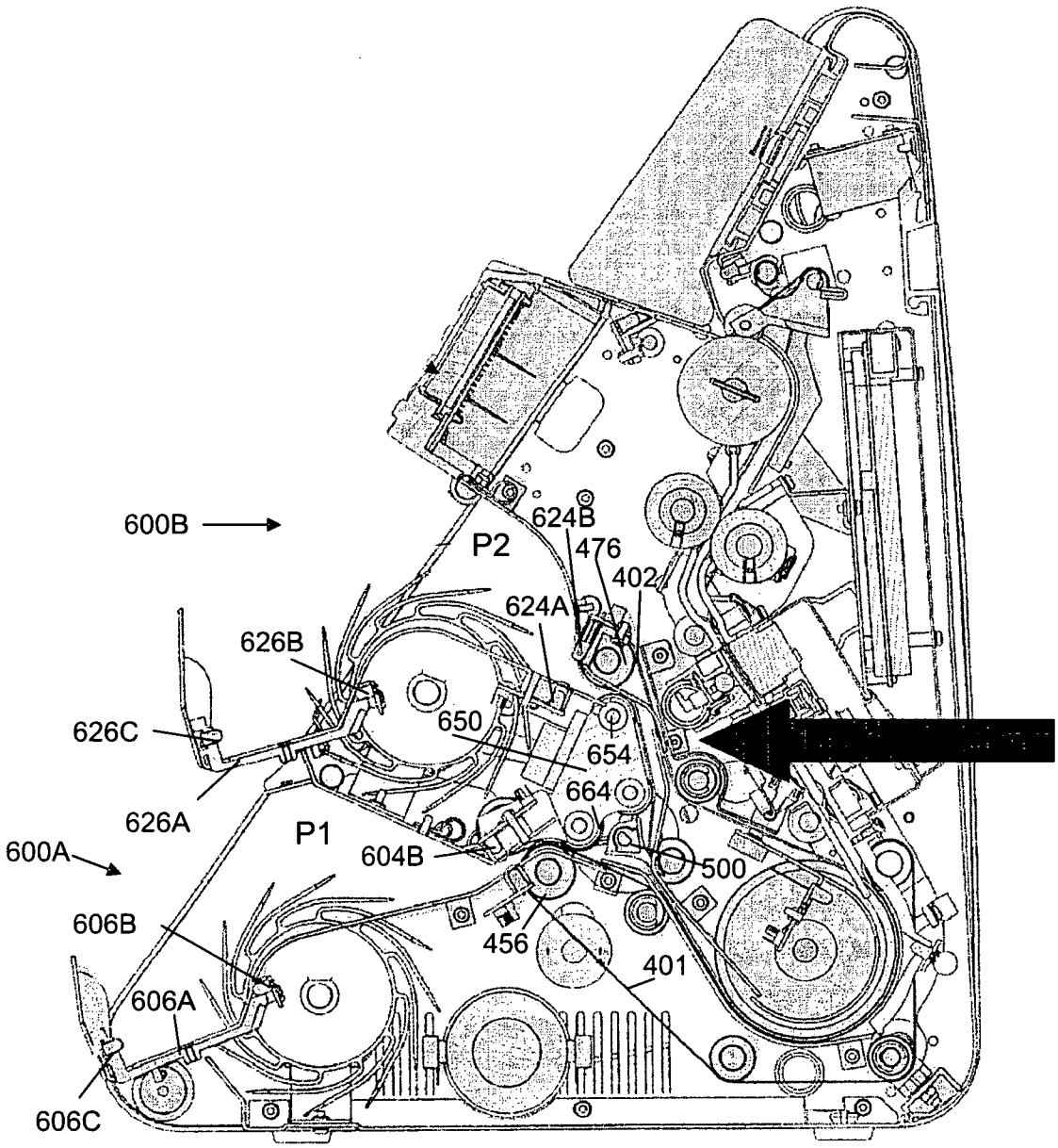

600B
624B
P2
476
402
624A
626B
626C
650
654
664
626A
P1
600A
604B
500
606B
456
401
606A
606C

Figure 6C

Figure 6D

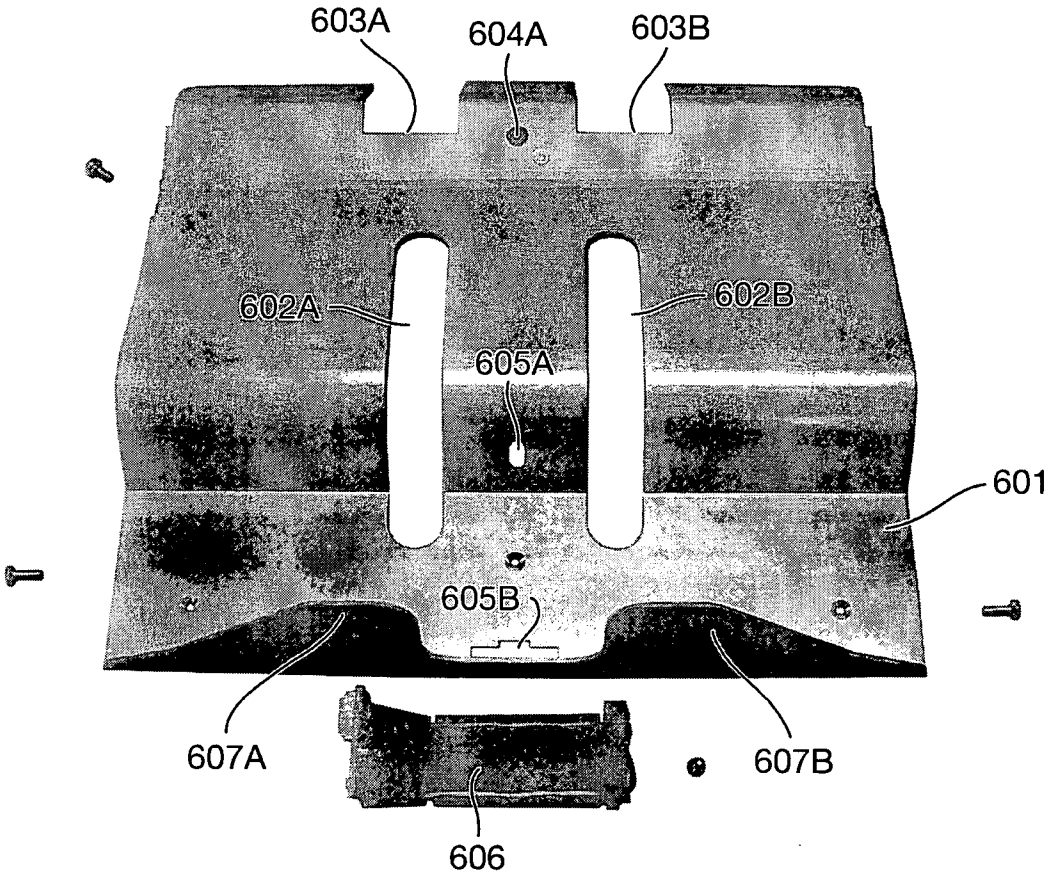


Figure 6E(ii)

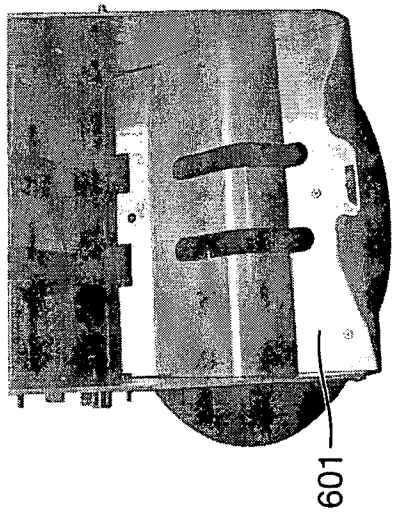
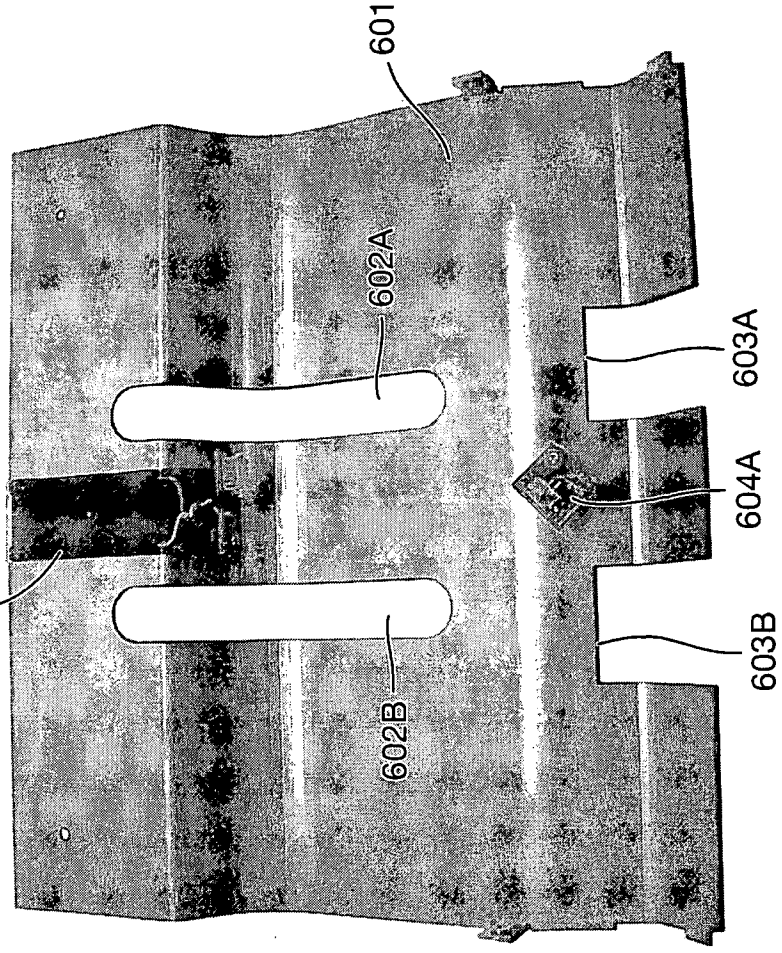


Figure 6E(i)



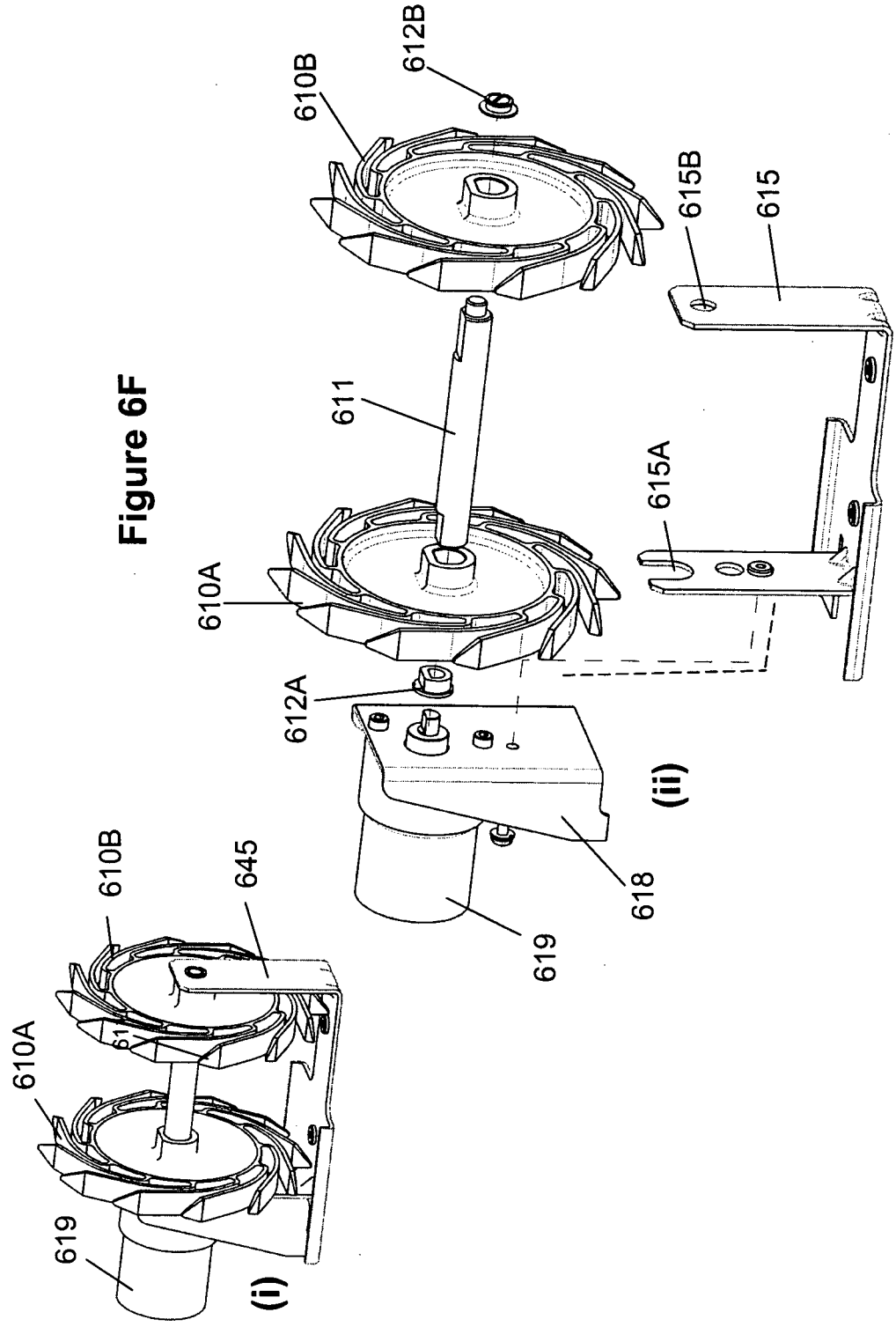
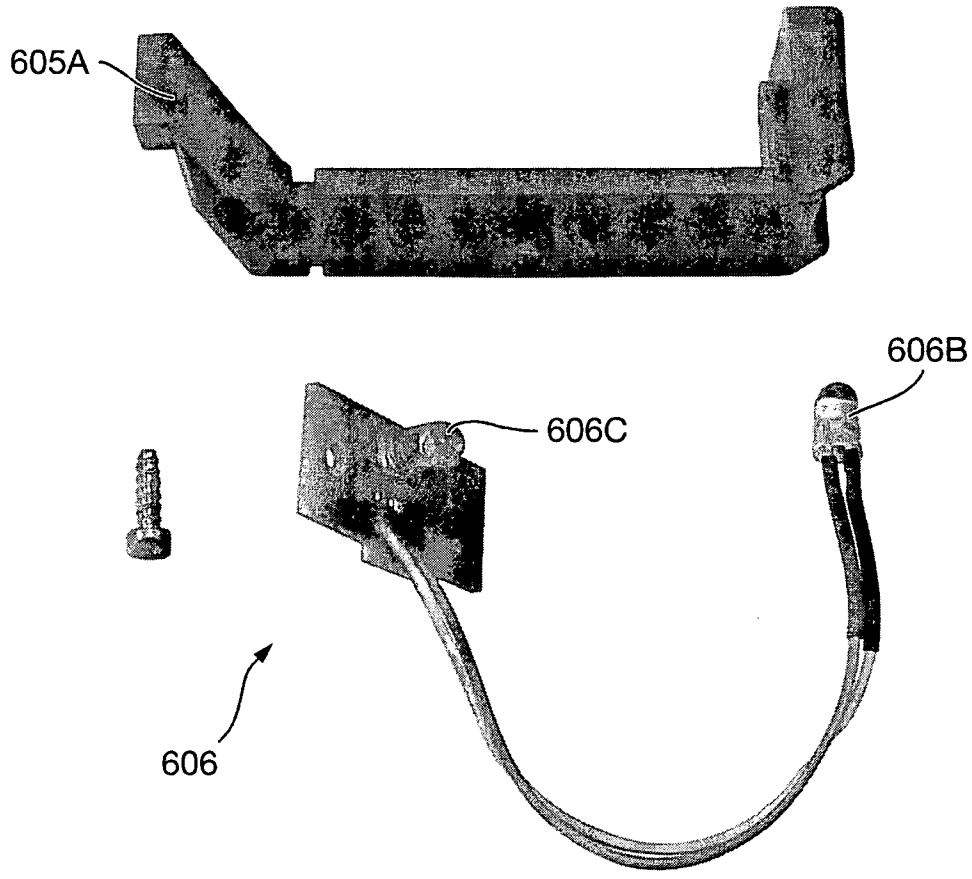

612B
610B
615B
615
611
615A
610A
612A
(ii)
618
619
645
610B
610A
619
(i)

Figure 6F

Figure 6G



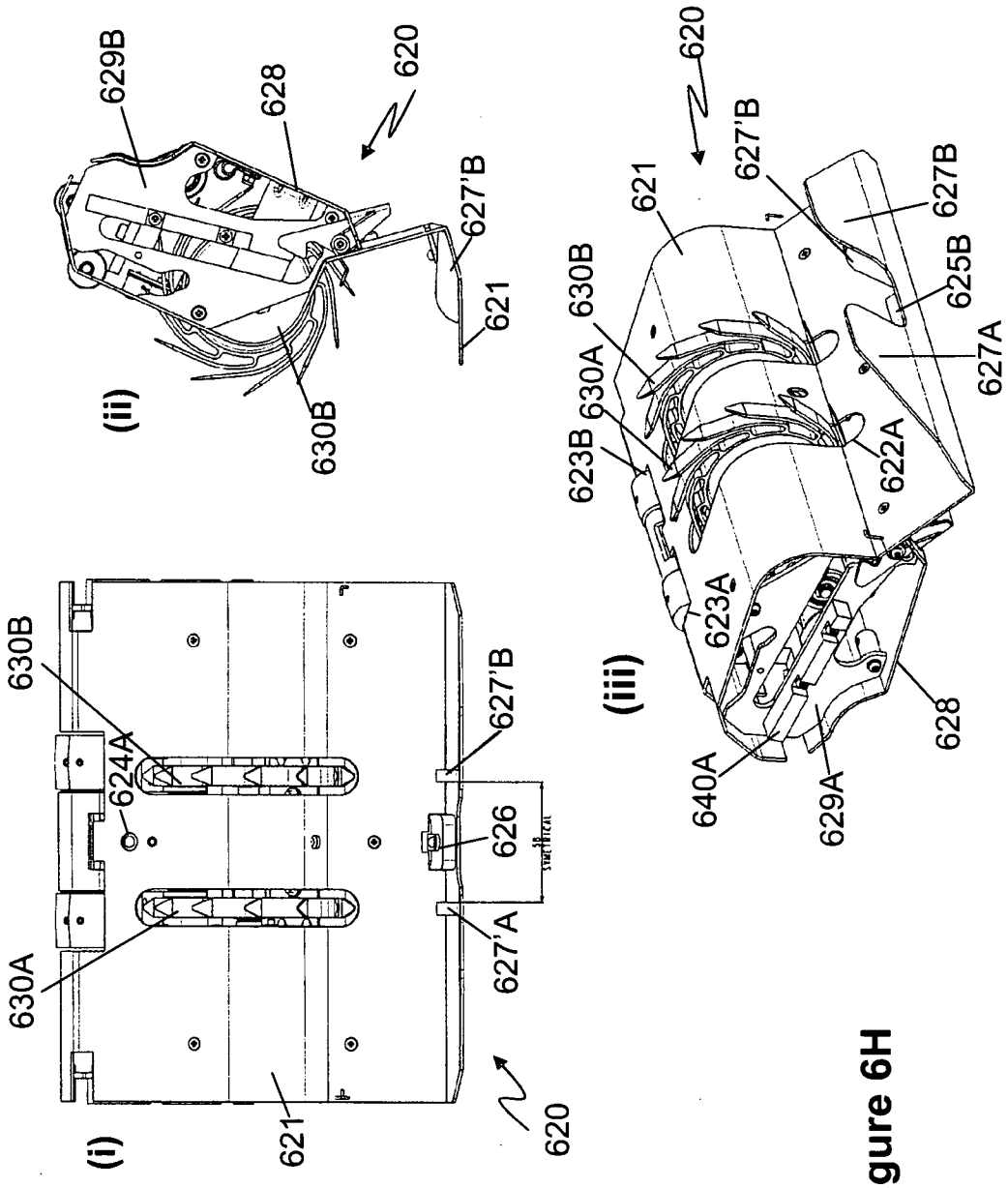

629B
628
620
627'B
621
630B
(ii)
620
621
627'B
627B
630B
625B
630A
627A
623B
622A
623A
(iii)
628
640A
629A
630B
627'B
624A
626
630A
627'A
621
(i)
620

Figure 6H

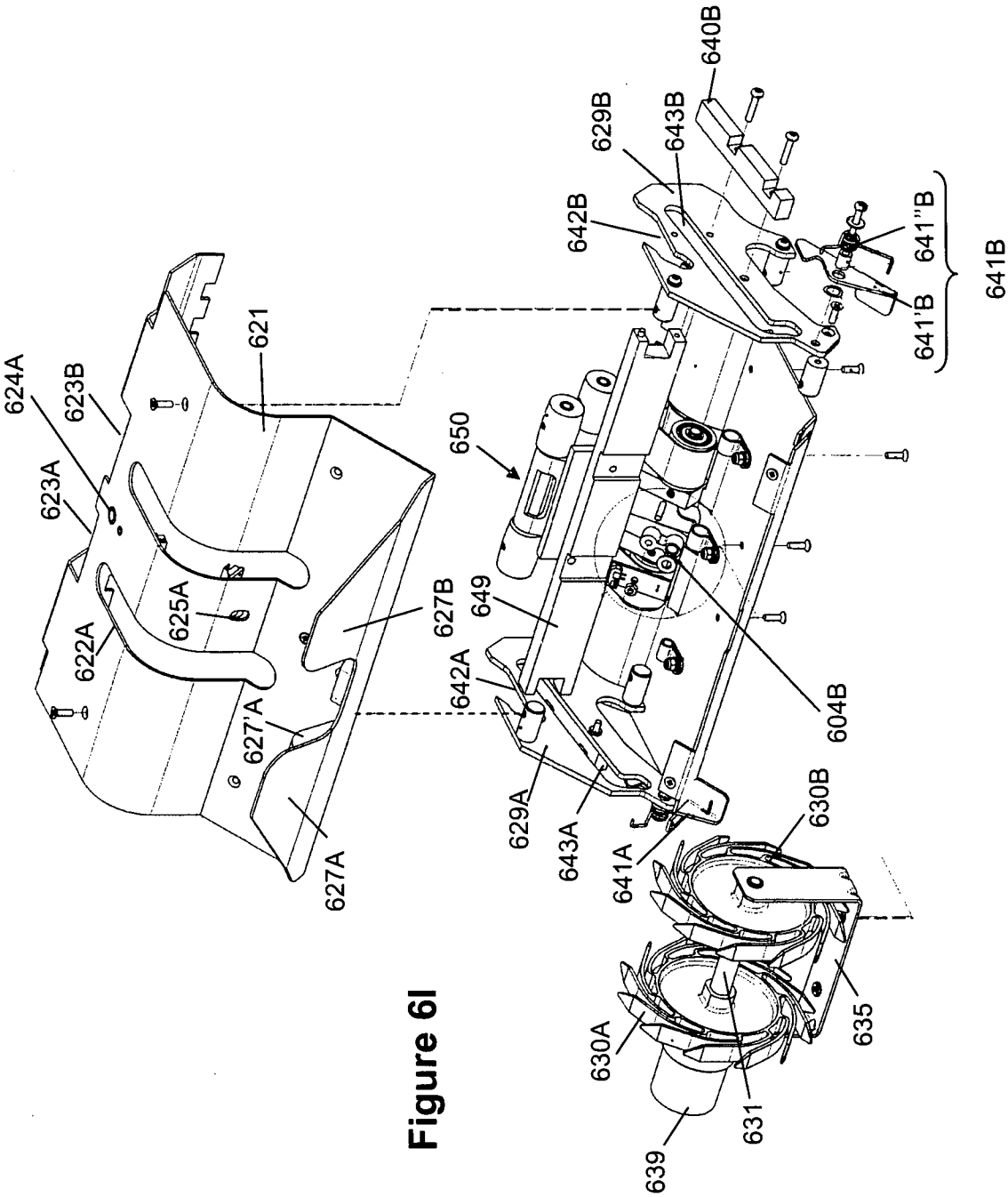

624A
623B
623A
622A
625A
621
627'A
627A
627B
649
642A
650
629A
643A
641A
642B
629B
643B
640B
641"B
641'B
641B
604B
630B
635
630A
631
639

Figure 6I

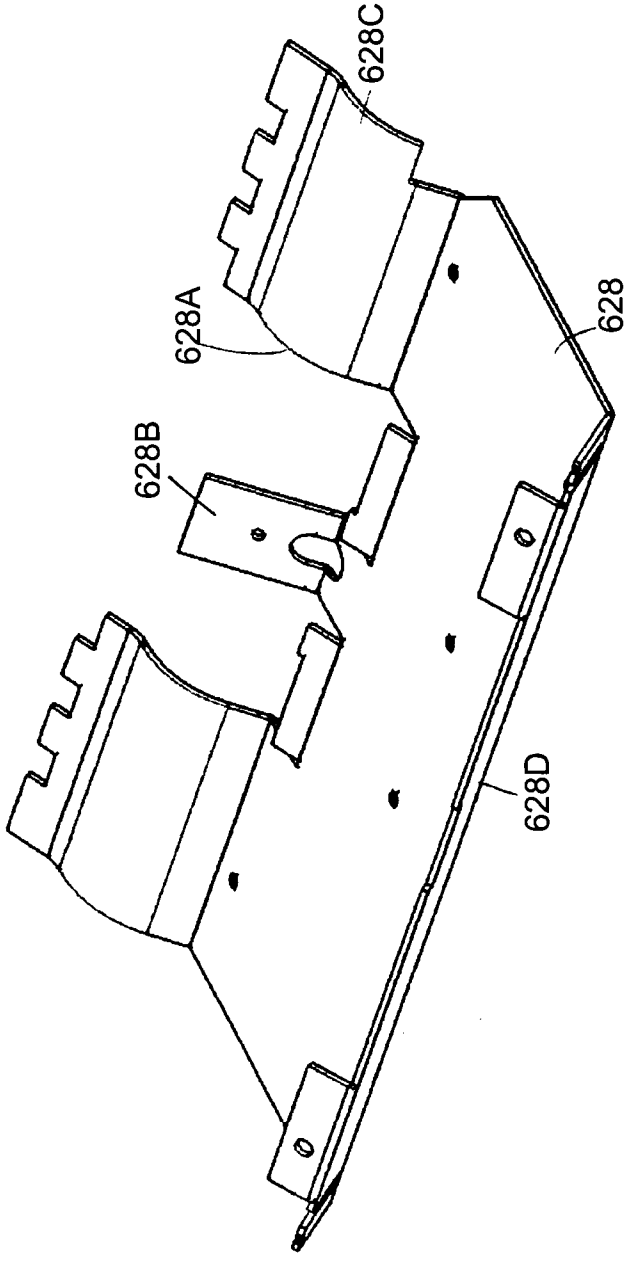


Figure 6J

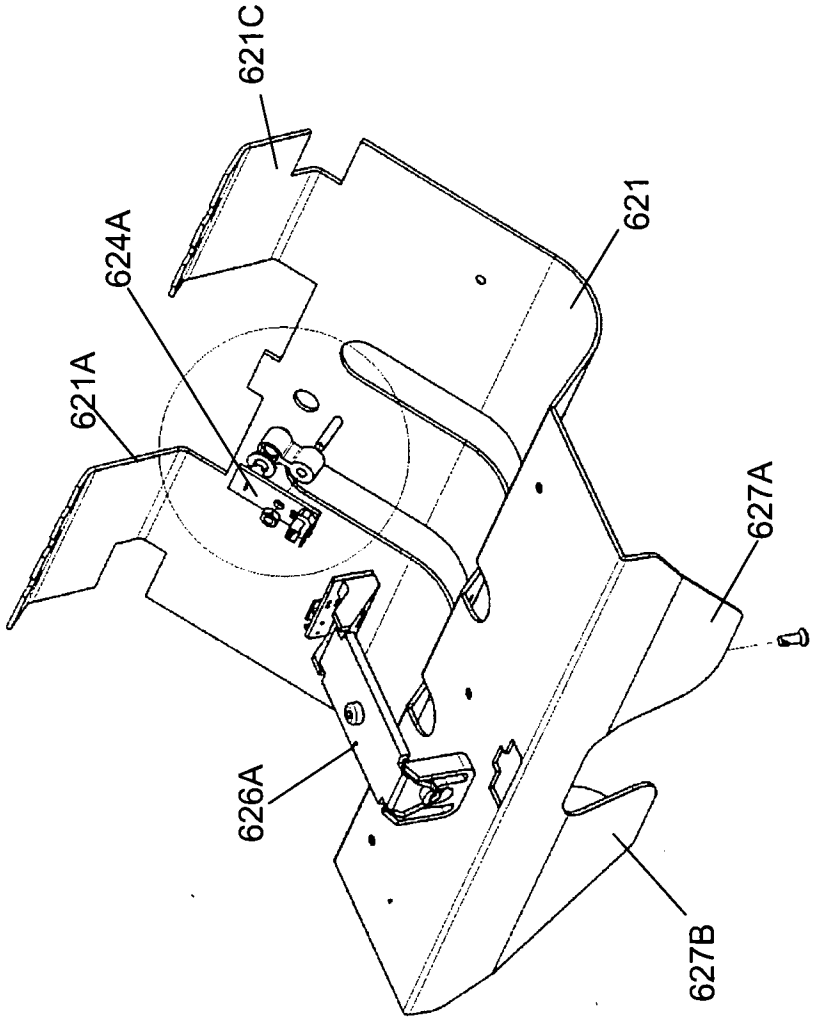


Figure 6K

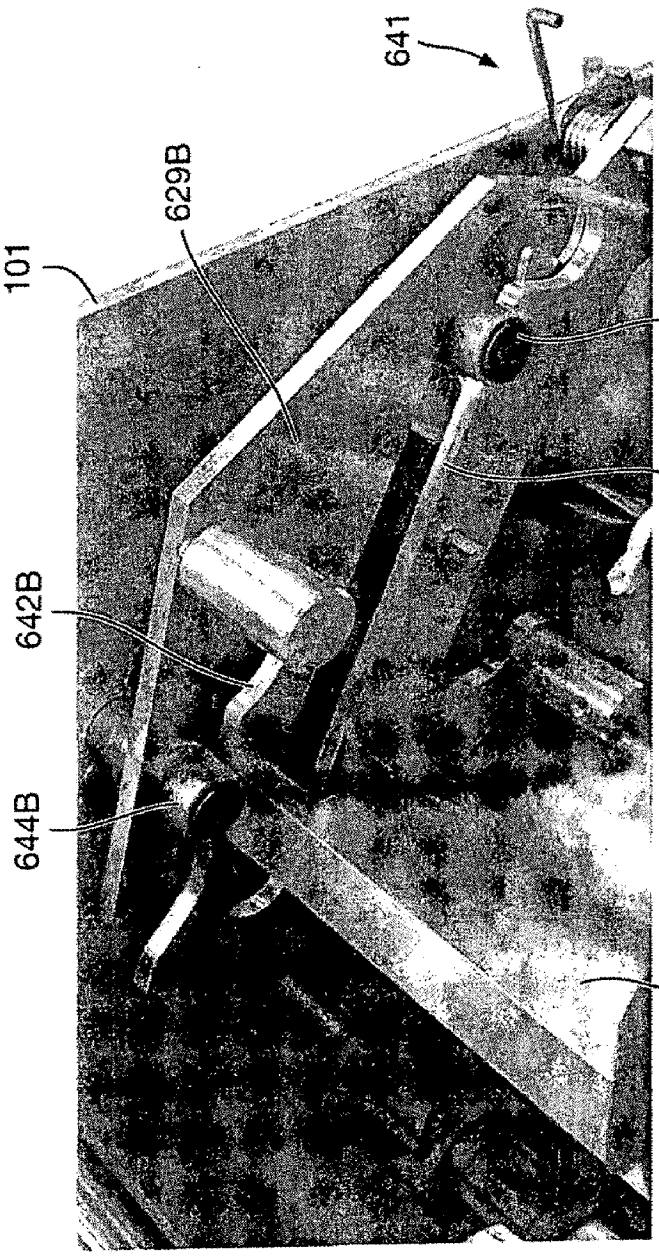


Figure 6L

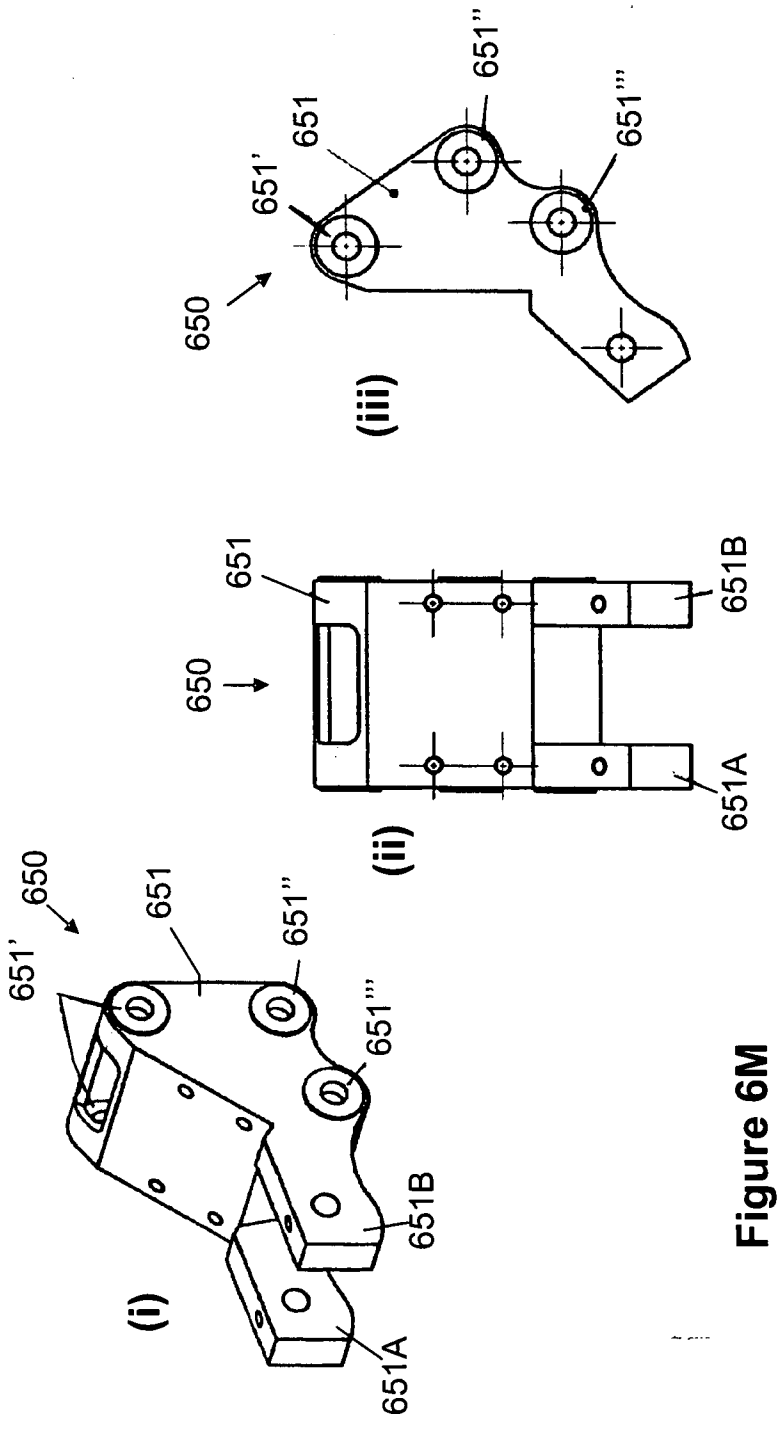

651''
651
651'''
651'
650
(iii)
651
651B
650
651A
(ii)
650
651'
651
651''
651'''
651B
(i)
651A

Figure 6M

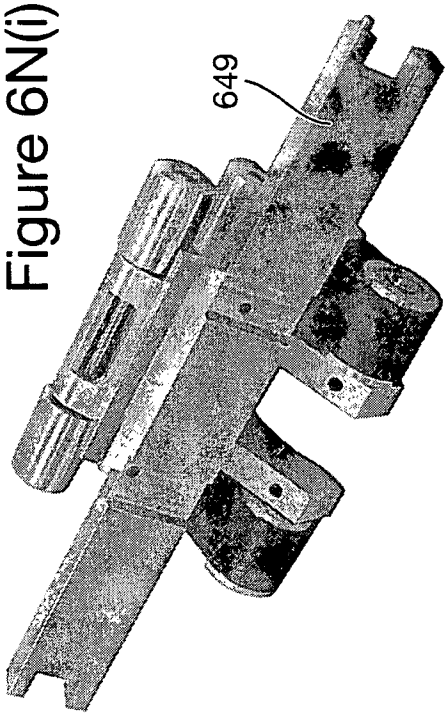


Figure 6N(i)

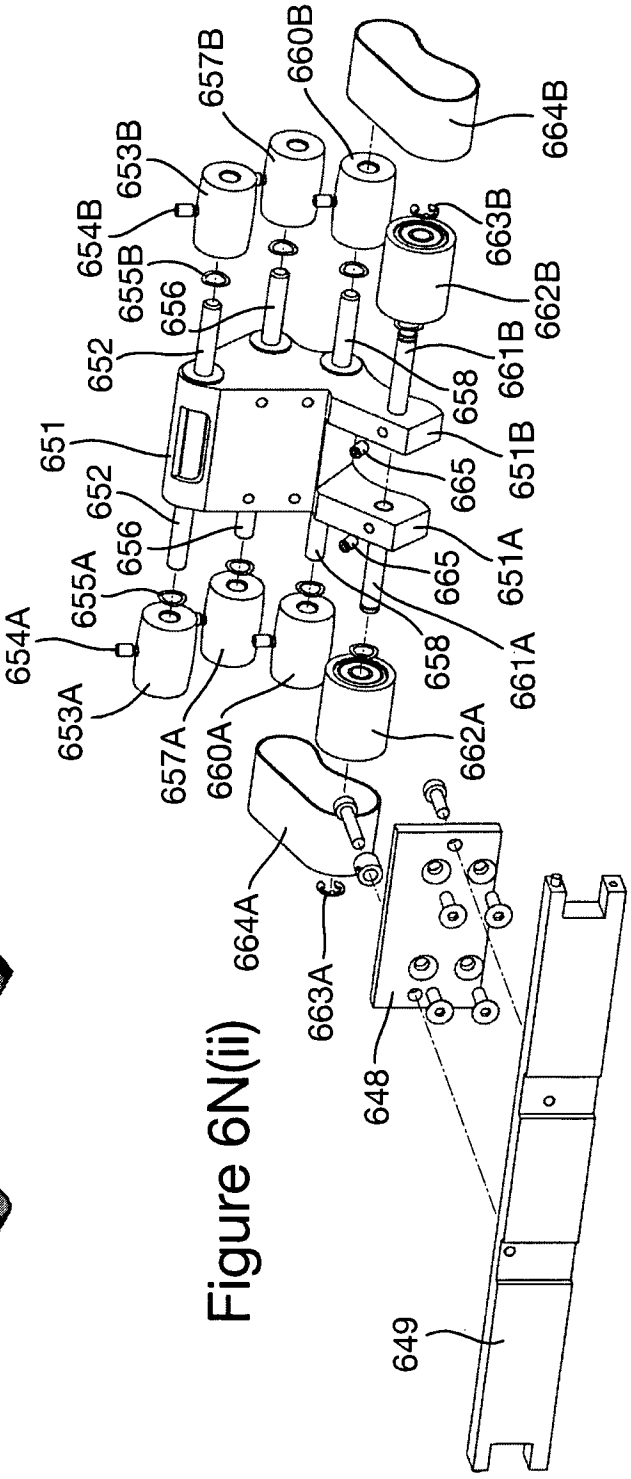


Figure 6N(ii)

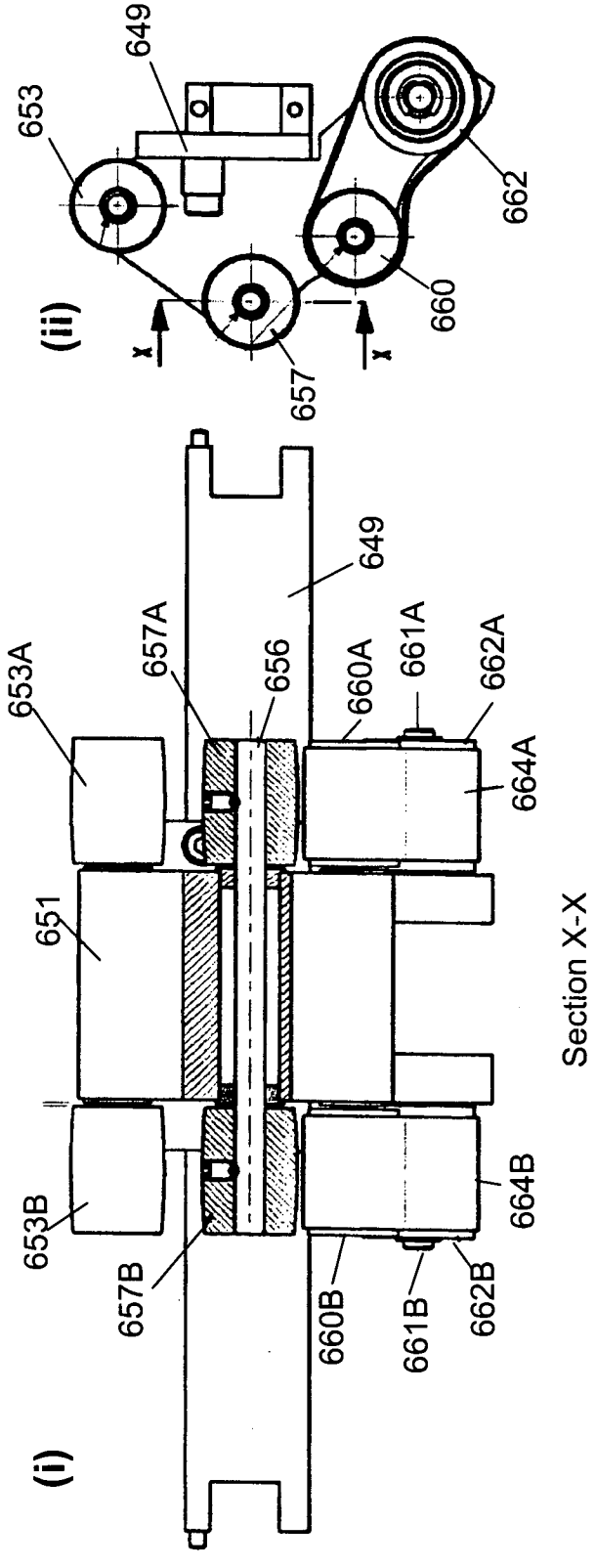

649
653
662
660
(ii)
X
X
657
649
653A
657A
656
660A
661A
662A
664A
651
653B
657B
660B
661B
662B
664B
(i)
Section X-X

Figure 6P

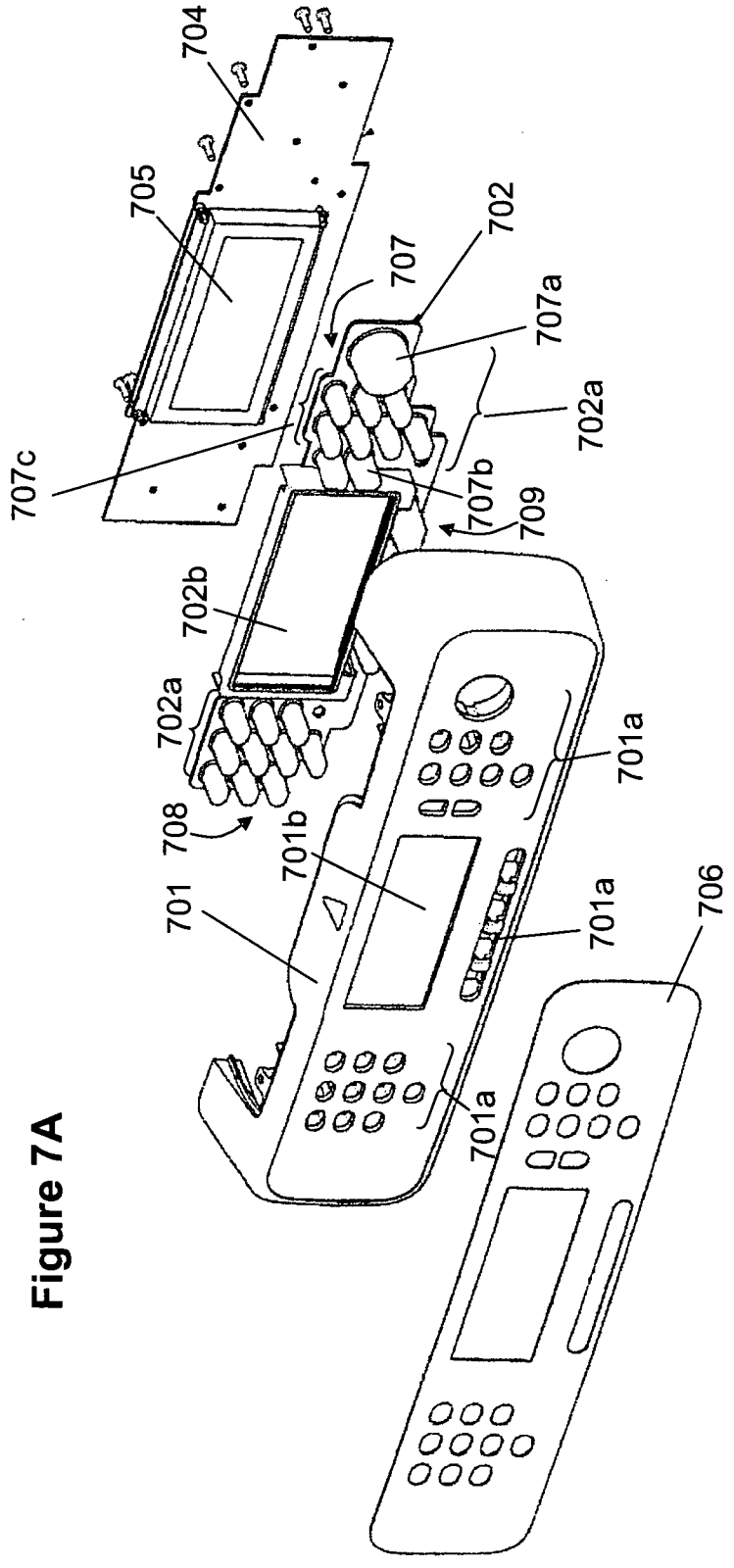

704
705
707
702
707a
702a
707c
707b
709
702b
702a
701a
708
701b
701
701a
706
701a

Figure 7A

Figure 7B

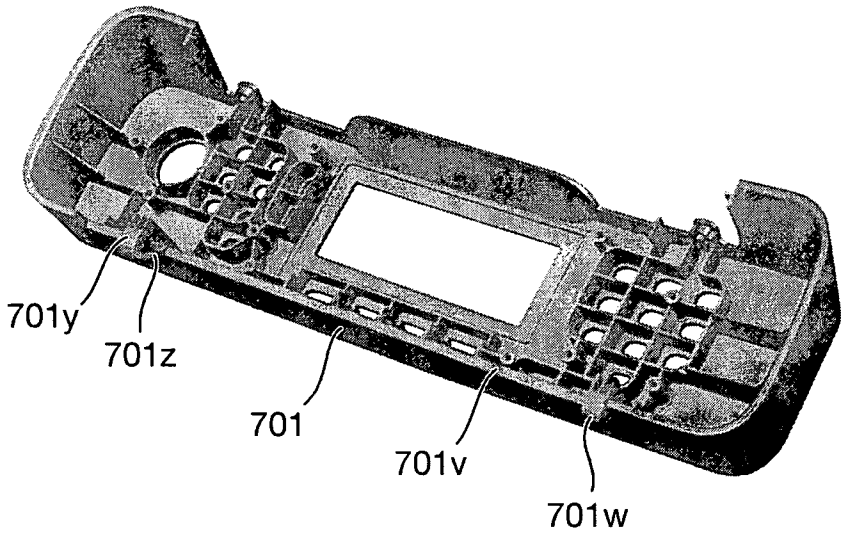


Figure 7C

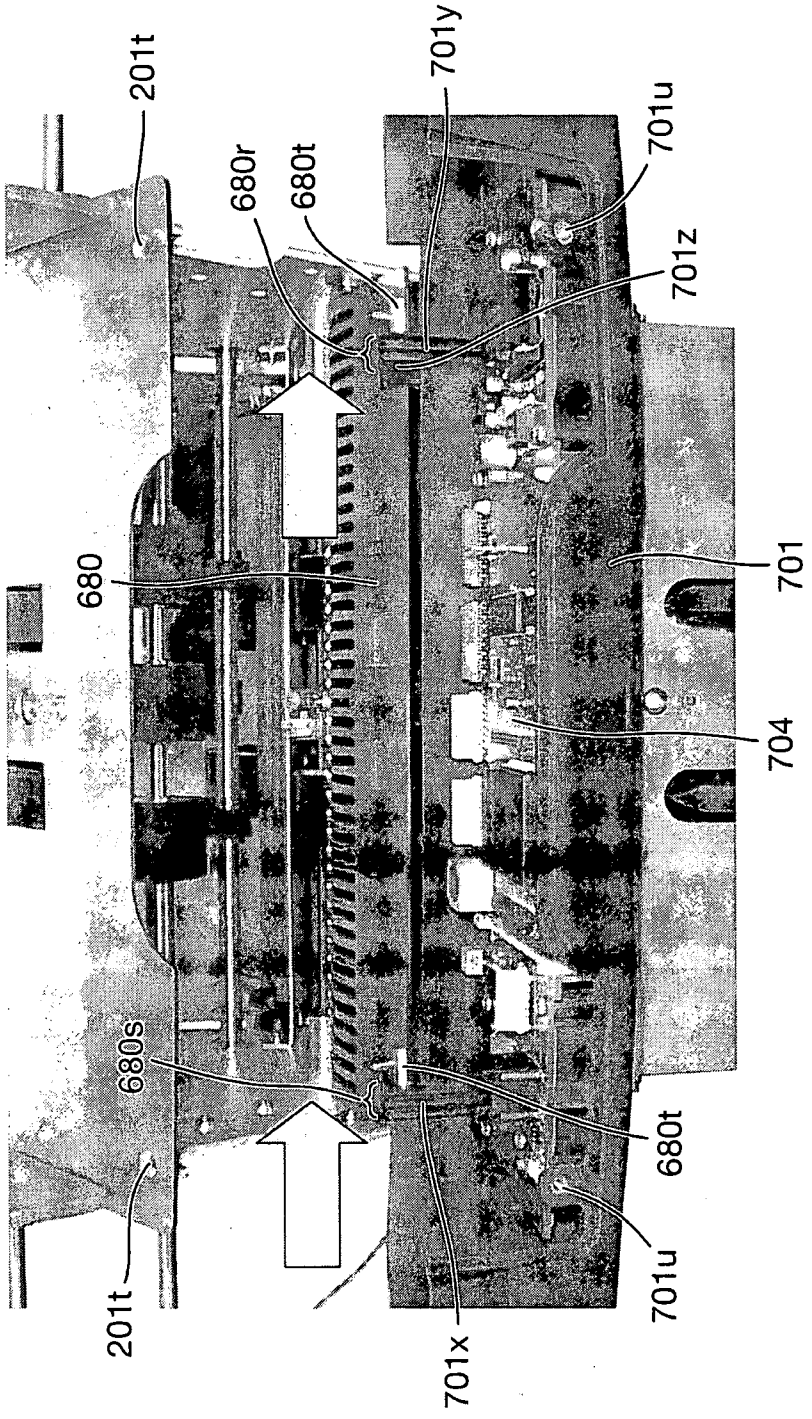
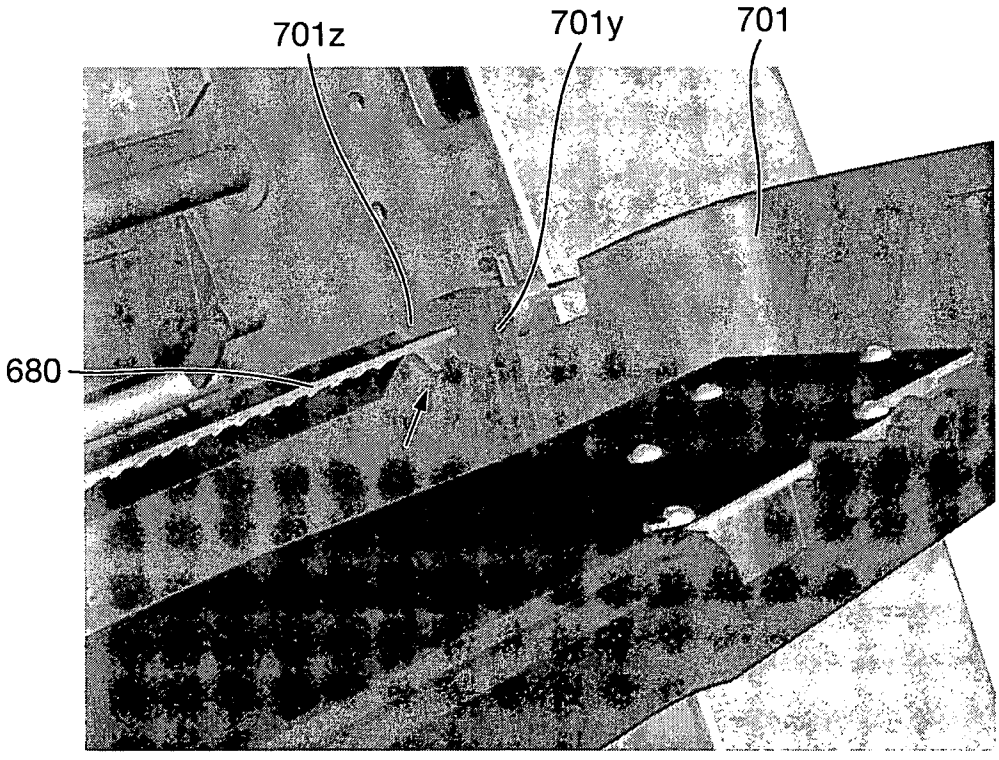

201t
680r
680t
701y
701u
701z
680
701
704
680s
680t
201t
701x
701u

Figure 7D



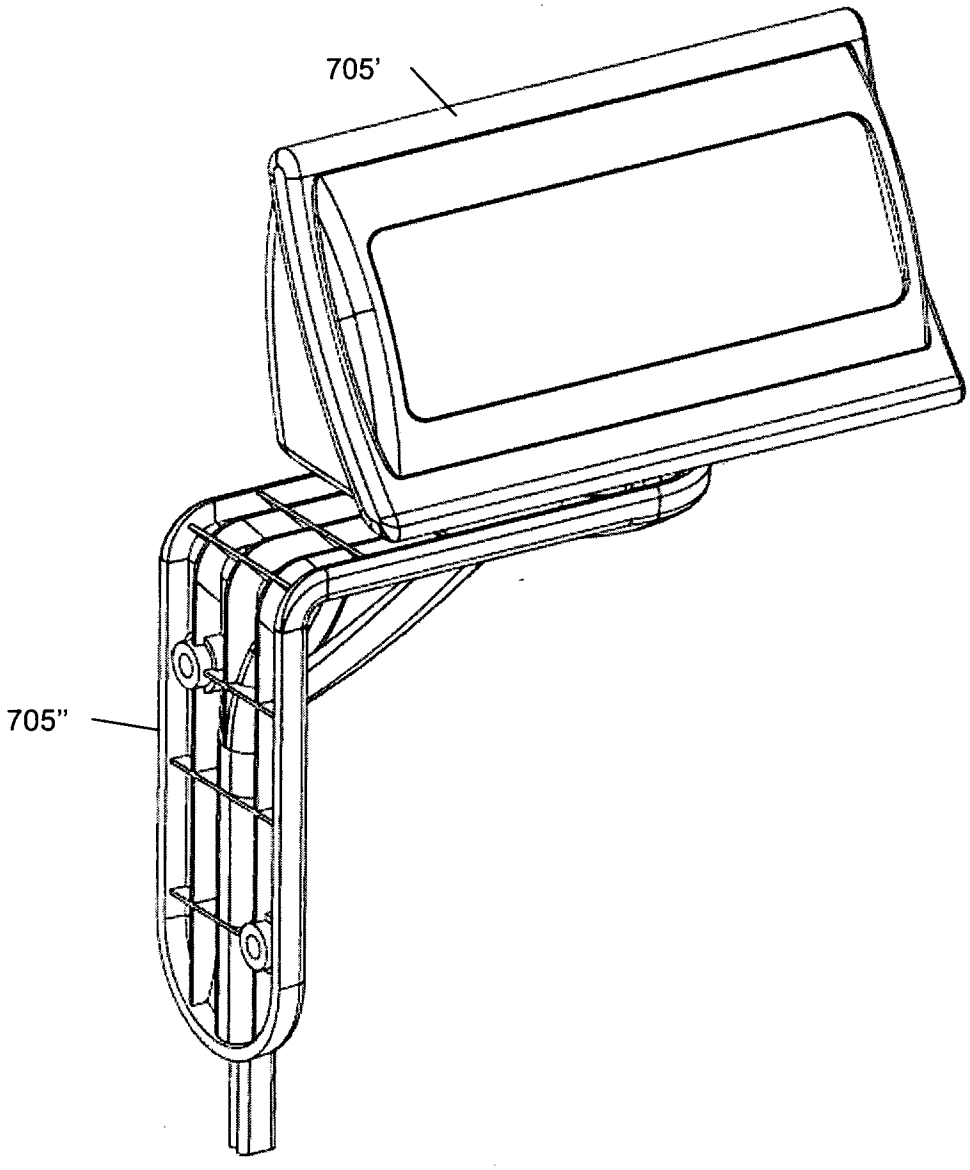
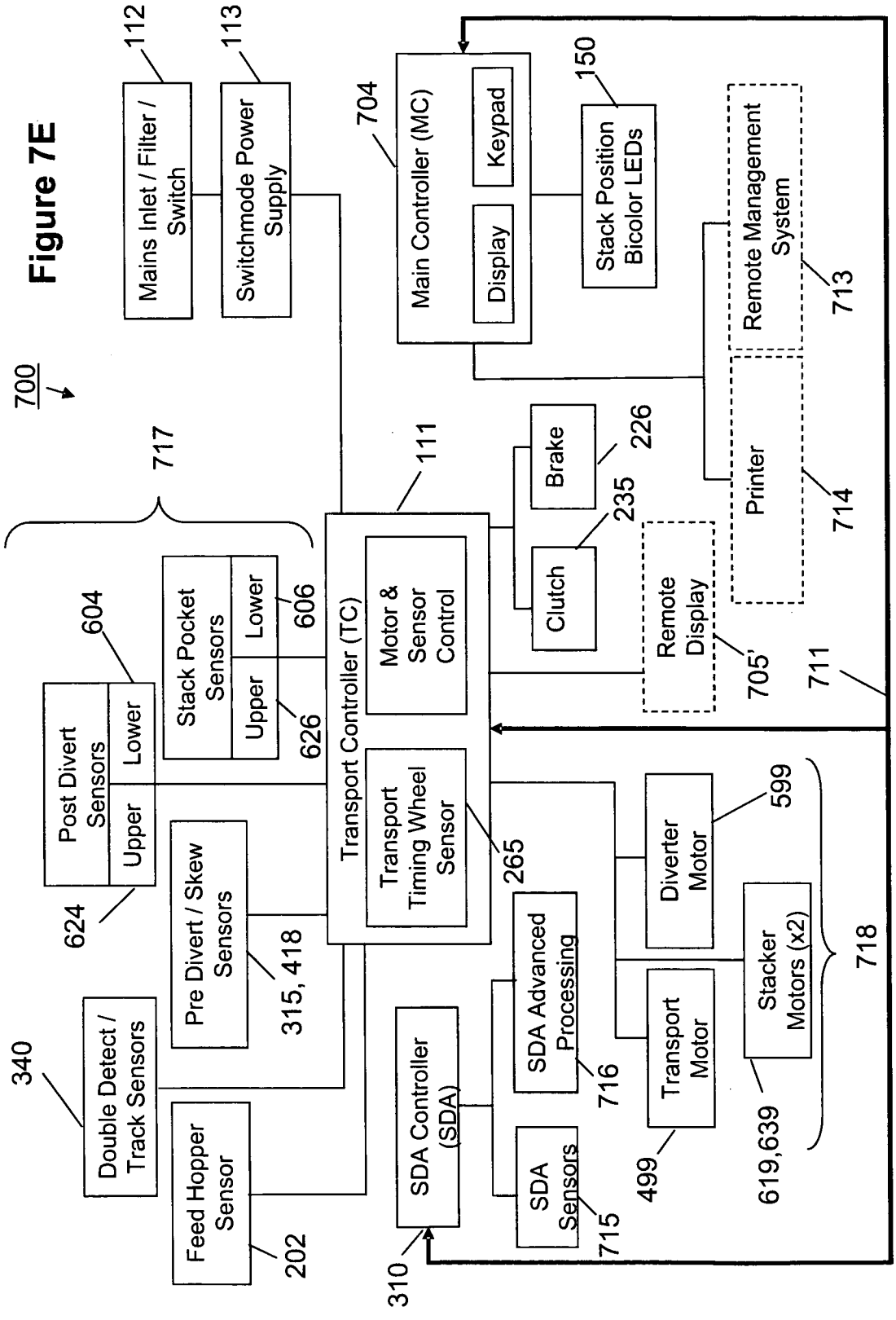


Figure 7D(i)

Figure 7E


700
717
Mains Inlet / Filter / Switch
112
Switchmode Power Supply
113
Main Controller (MC)
704
Keypad
Display
Stack Position Bicolor LEDs
150
Remote Management System
713
Printer
714
Brake
226
Clutch
235
Remote Display
705'
711
Transport Controller (TC)
111
Motor & Sensor Control
Transport Timing Wheel Sensor
265
Stack Pocket Sensors
Lower
Upper
606
626
Post Divert Sensors
Lower
Upper
604
624
Pre Divert / Skew Sensors
315, 418
Double Detect / Track Sensors
340
Feed Hopper Sensor
202
SDA Controller (SDA)
310
SDA Advanced Processing
716
SDA Sensors
715
Diverter Motor
599
Transport Motor
499
Stacker Motors (x2)
619,639
718

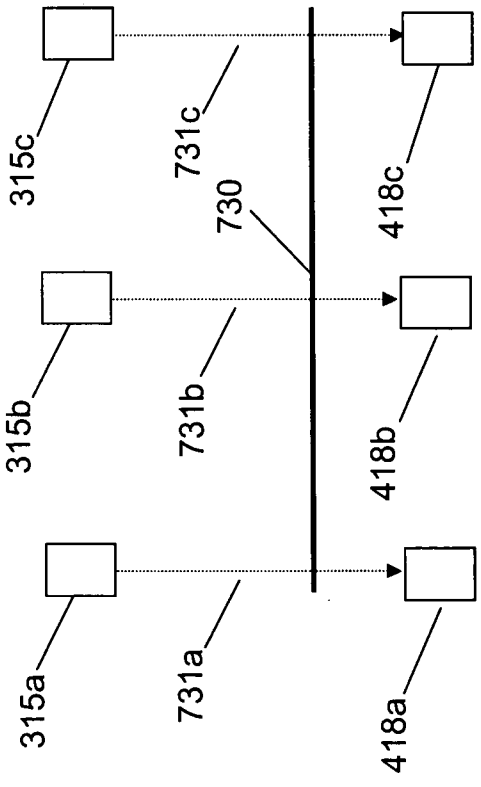


Figure 7F

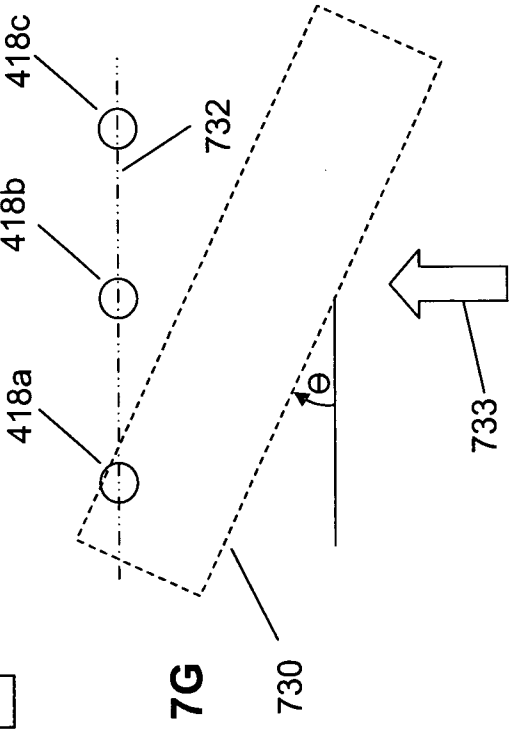


Figure 7G

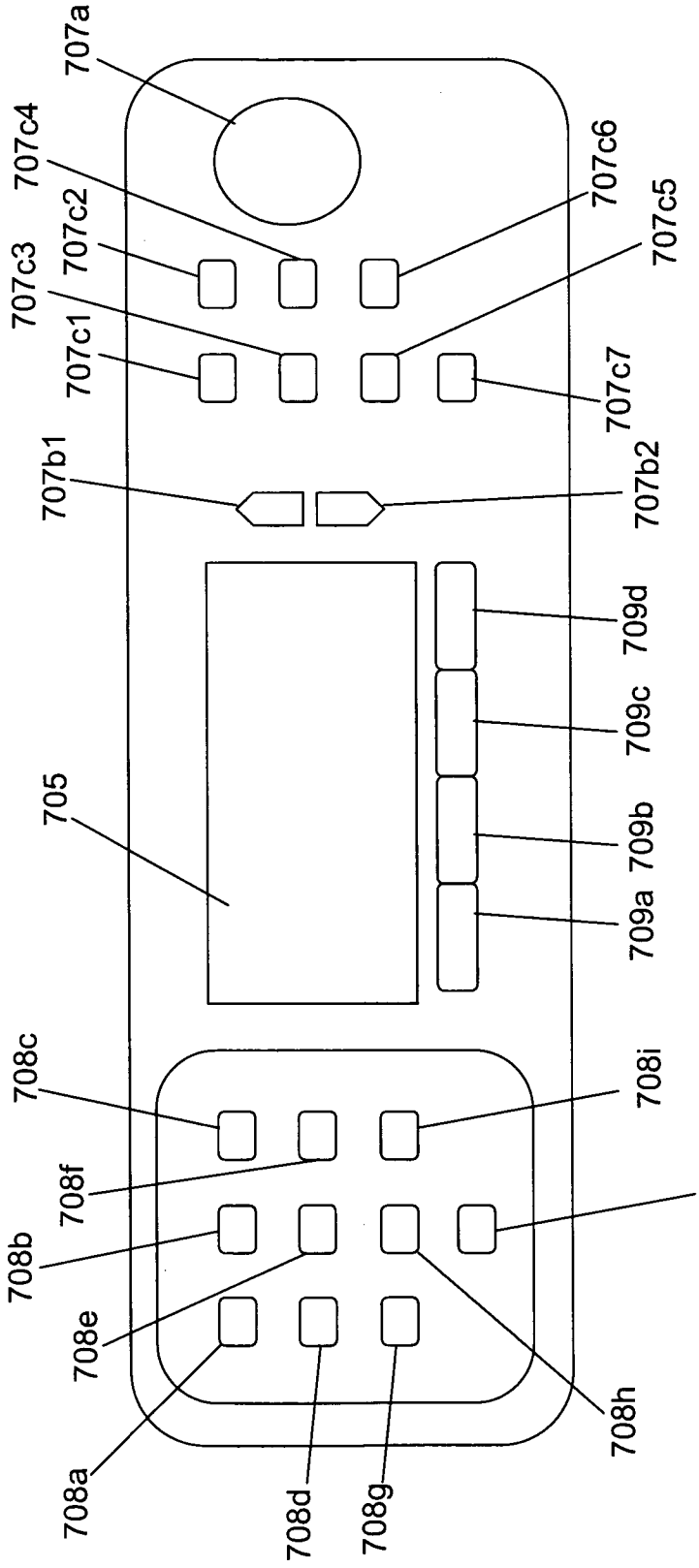

707a
707c4
707c2
707c3
707c1
707c6
707c5
707c7
707b1
707b2
709d
709c
709b
709a
705
708c
708f
708b
708e
708a
708d
708g
708h
708i
708j

Figure 8A

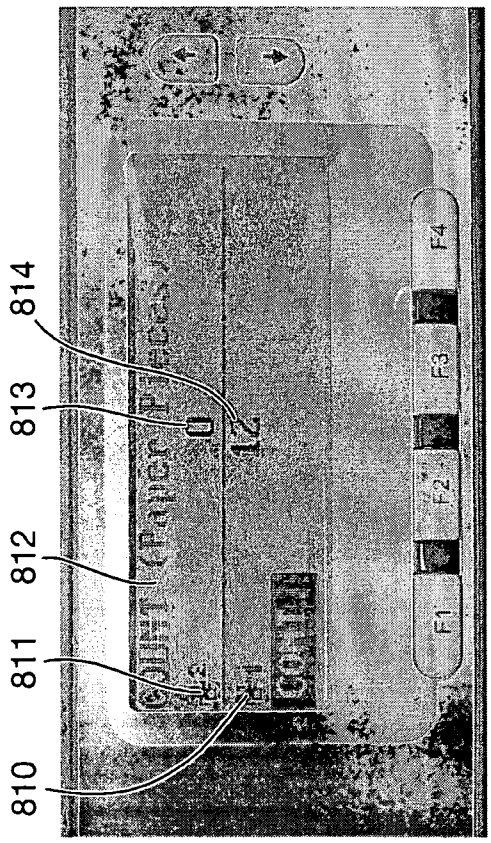


Figure 8B

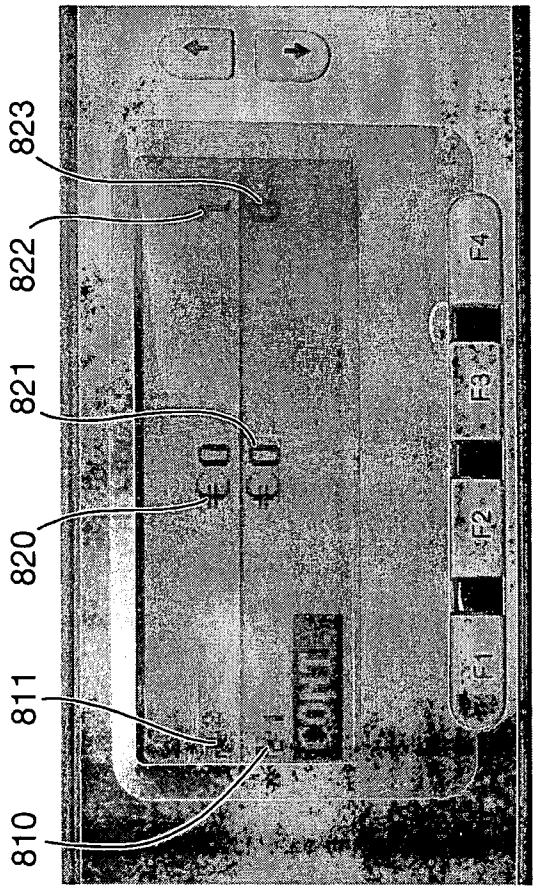


Figure 8C

Figure 8D

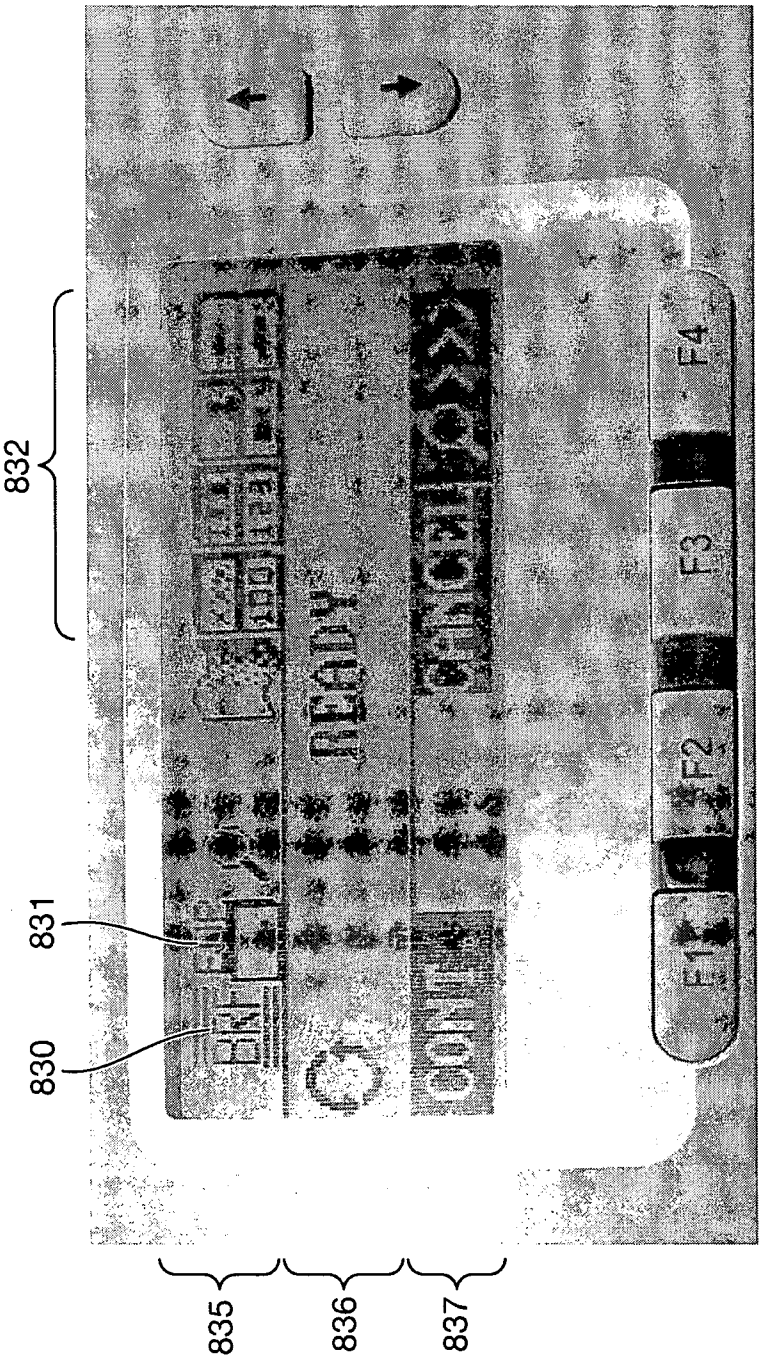


Figure 8E