US011132859B2

(12) **United States Patent**
Gordon et al.

(10) **Patent No.: US 11,132,859 B2**
(45) **Date of Patent: Sep. 28, 2021**

(54) **BANKNOTE PROCESSING DEVICE AND METHODS**

(71) Applicant: **Cummins-Allison Corp.**, Mt. Prospect, IL (US)

(72) Inventors: **Glenn S. Gordon**, Cameron Park, CA (US); **Roy C. Schoon**, Glenview, IL (US); **Ralf H. Jaeger**, Kildeer, IL (US); **Scott Michael Minch**, Wheeling, IL (US)

(73) Assignee: **Cummins-Allison Corp.**, Mt. Prospect, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/844,918**

(22) Filed: **Apr. 9, 2020**

(65) **Prior Publication Data**

US 2020/0327763 A1 Oct. 15, 2020

Related U.S. Application Data

(60) Provisional application No. 62/831,565, filed on Apr. 9, 2019.

(51) **Int. Cl.**

G07D 11/14	(2019.01)
G07D 7/20	(2016.01)
G07D 11/16	(2019.01)
G07D 11/40	(2019.01)
G07D 11/237	(2019.01)
G07D 11/60	(2019.01)

(52) **U.S. Cl.**

CPC ***G07D 11/14*** (2019.01); ***G07D 7/20*** (2013.01); ***G07D 11/16*** (2019.01); ***G07D 11/237*** (2019.01); ***G07D 11/40*** (2019.01); ***G07D 11/60*** (2019.01); *G07D 2207/00* (2013.01); *G07D 2211/00* (2013.01)

(58) **Field of Classification Search**

CPC G07D 11/14; G07D 7/20; G07D 11/16; G07D 11/40; G07D 11/237; G07D 2211/00; G07D 2207/00; G07D 11/26; G07D 11/60

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,790,697 A	8/1998	Munro et al.
5,815,592 A	9/1998	Mennie et al.
8,401,268 B1	3/2013	Yacoubian et al.
8,437,530 B1	5/2013	Mennie et al.
8,781,206 B1	7/2014	Yacoubian et al.

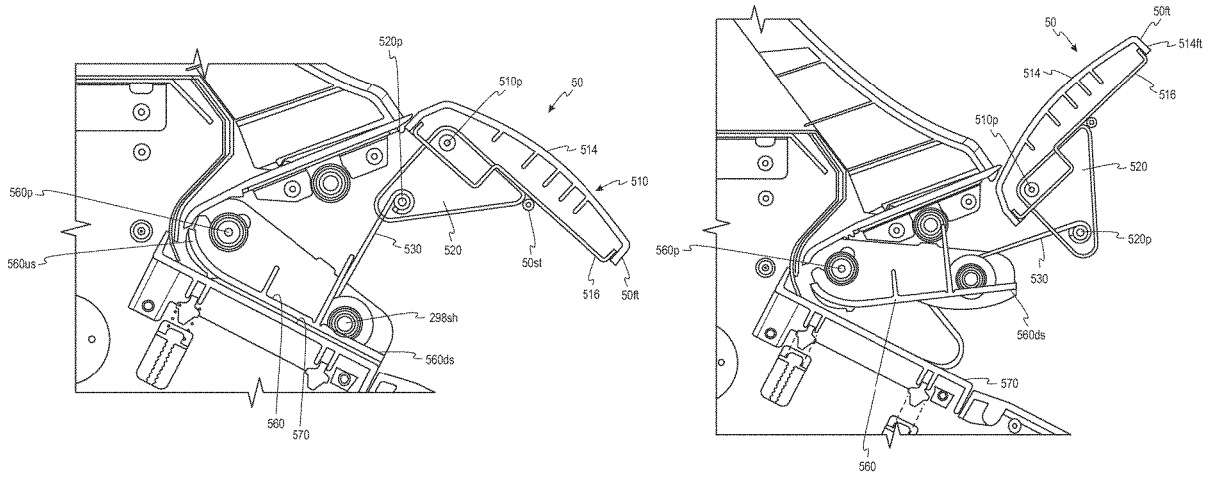
(Continued)

Primary Examiner — Jeffrey A Shapiro

(57) **ABSTRACT**

A banknote processing device comprises a banknote transport path defined at least in part by a transport plate on one side of the banknote transport path, the banknote transport plate being pivotally mounted about a first axis near an upstream end of the transport plate, the transport plate including a working position and an open position, a display assembly being pivotally mounted about a second axis spaced a defined distance apart from the first axis, the display assembly including an operational position and a non-operational position, and a linkage coupled to display assembly and to the transport plate near a downstream end of the transport plate, wherein, when the display assembly is rotated from the operational position to the non-operational position, the linkage causes the transport plate to move from the working position to the open position.

20 Claims, 40 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

9,355,295	B1	5/2016	Jones et al.	
2009/0242624	A1*	10/2009	Matsuura	G07D 11/50 235/379

* cited by examiner

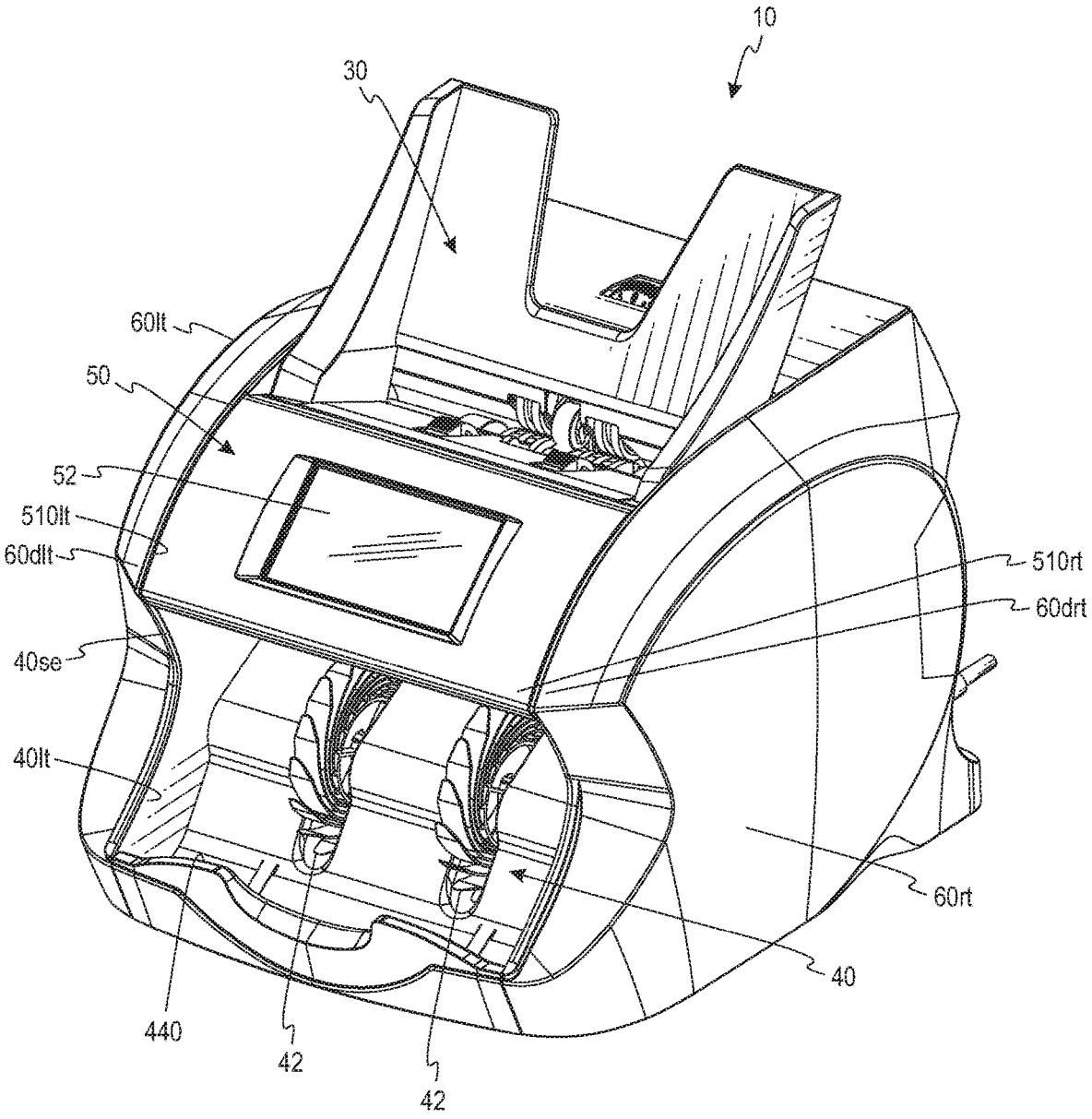

10
30
60lt
50
52
510lt
60dlt
40se
40lt
440
42
42
40
60rt
60drt
510rt

Fig. 1A

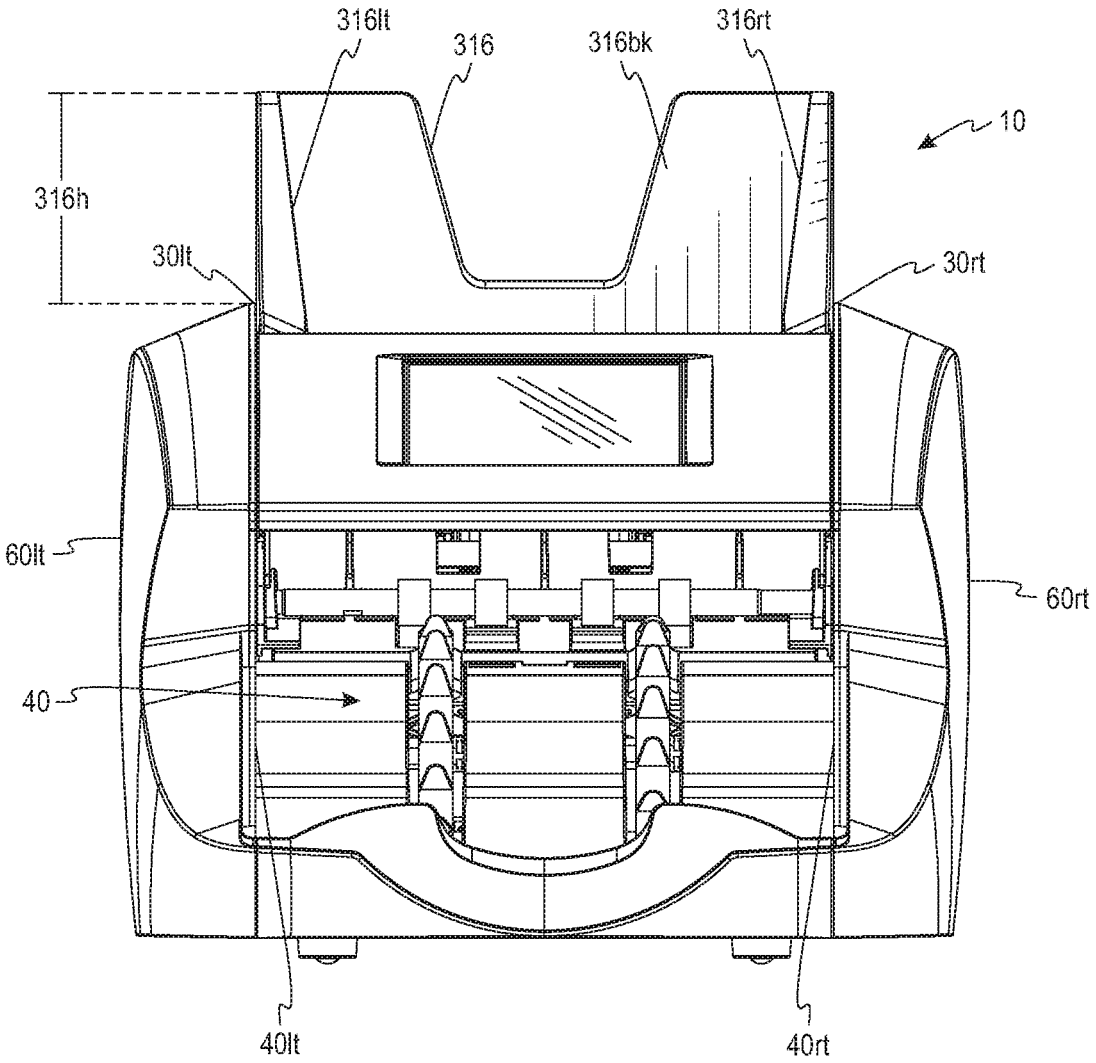

316lt
316
316bk
316rt
10
316h
30lt
30rt
60lt
60rt
40
40lt
40rt

Fig. 1B

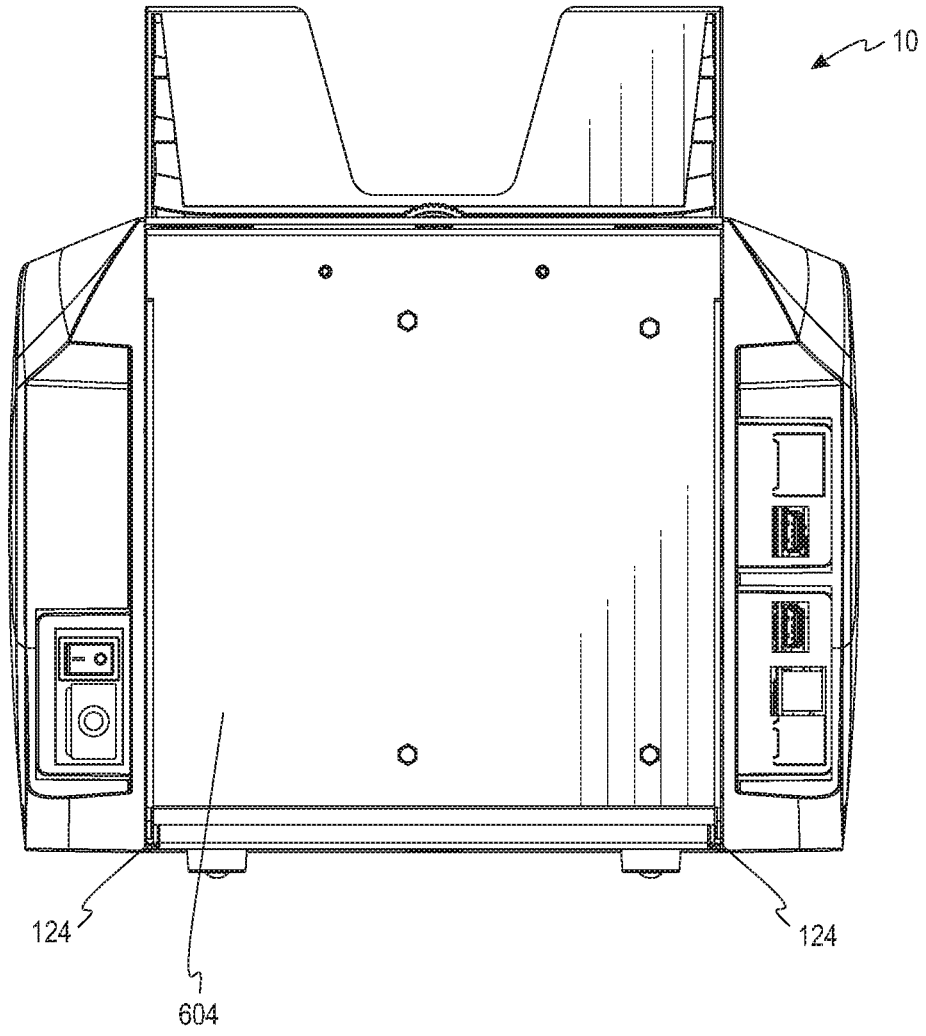


Fig. 1C

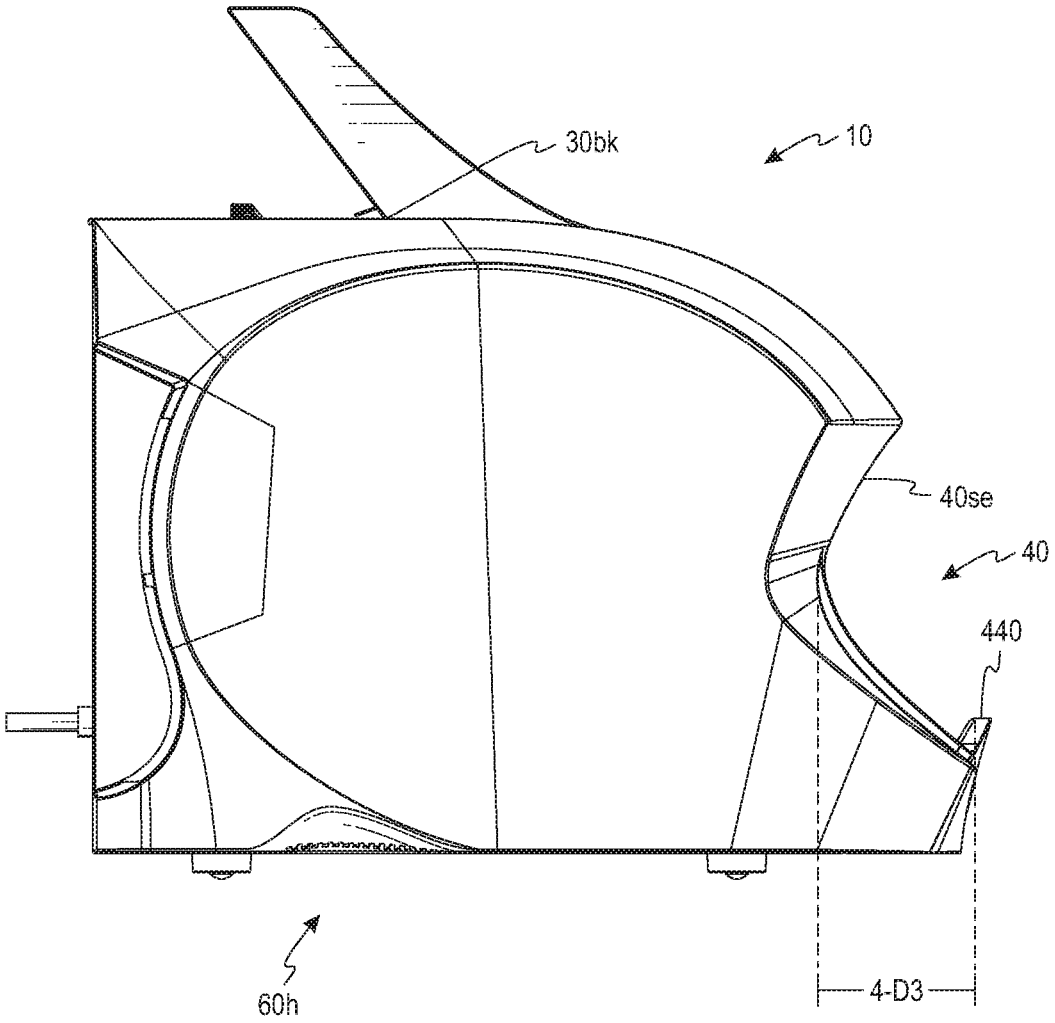


Fig. 1D

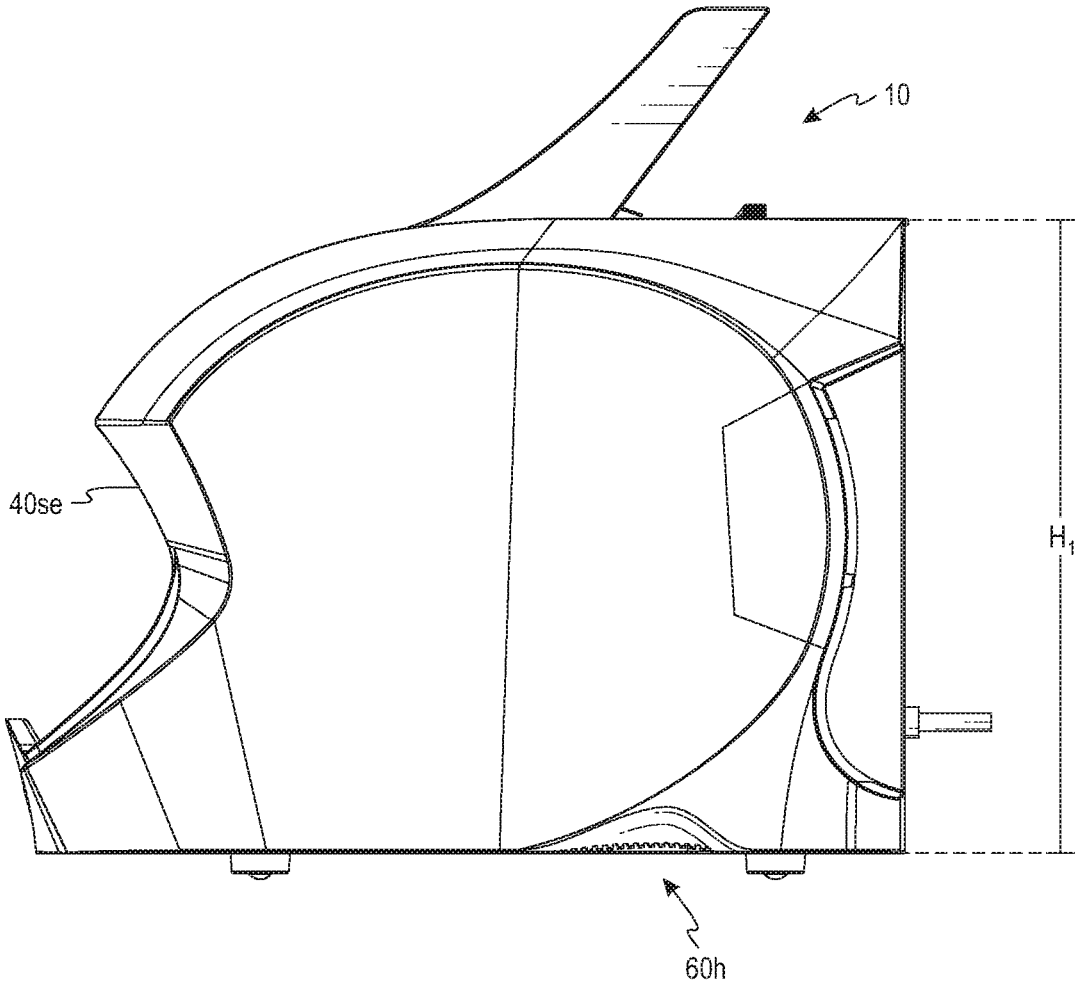


Fig. 1E

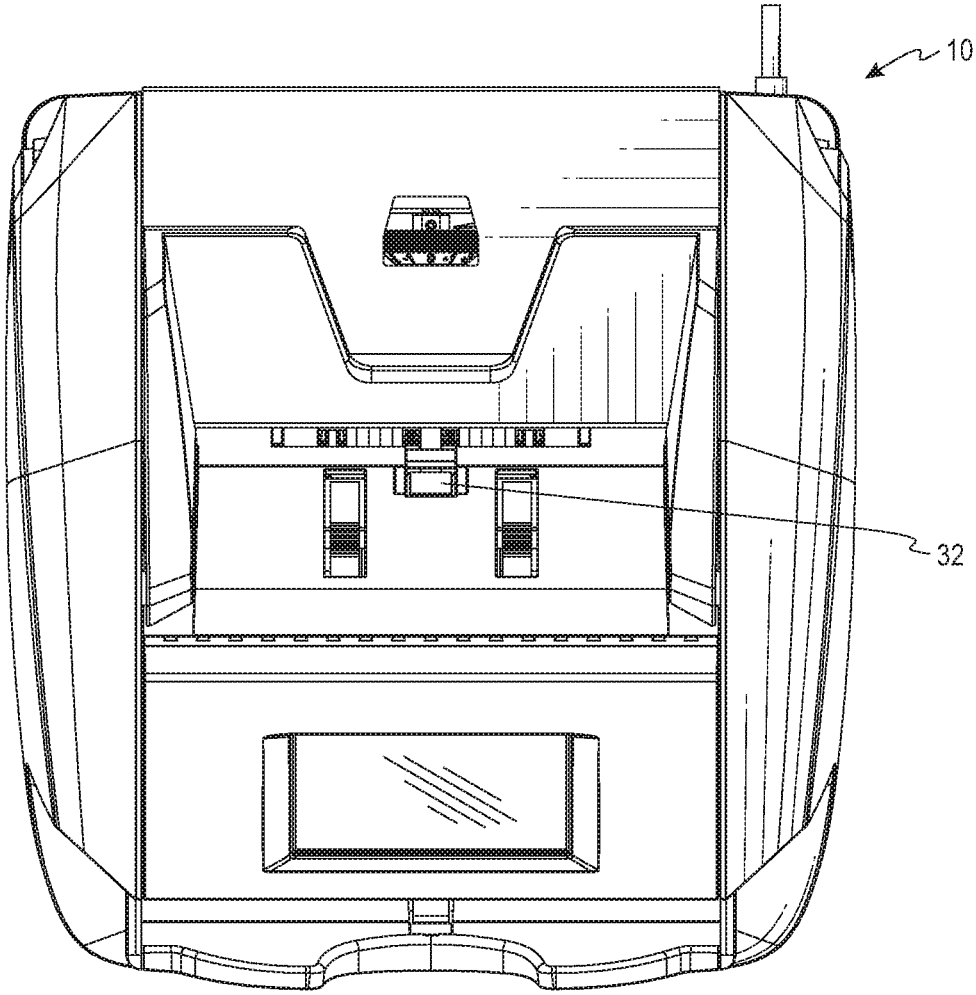


Fig. 1F

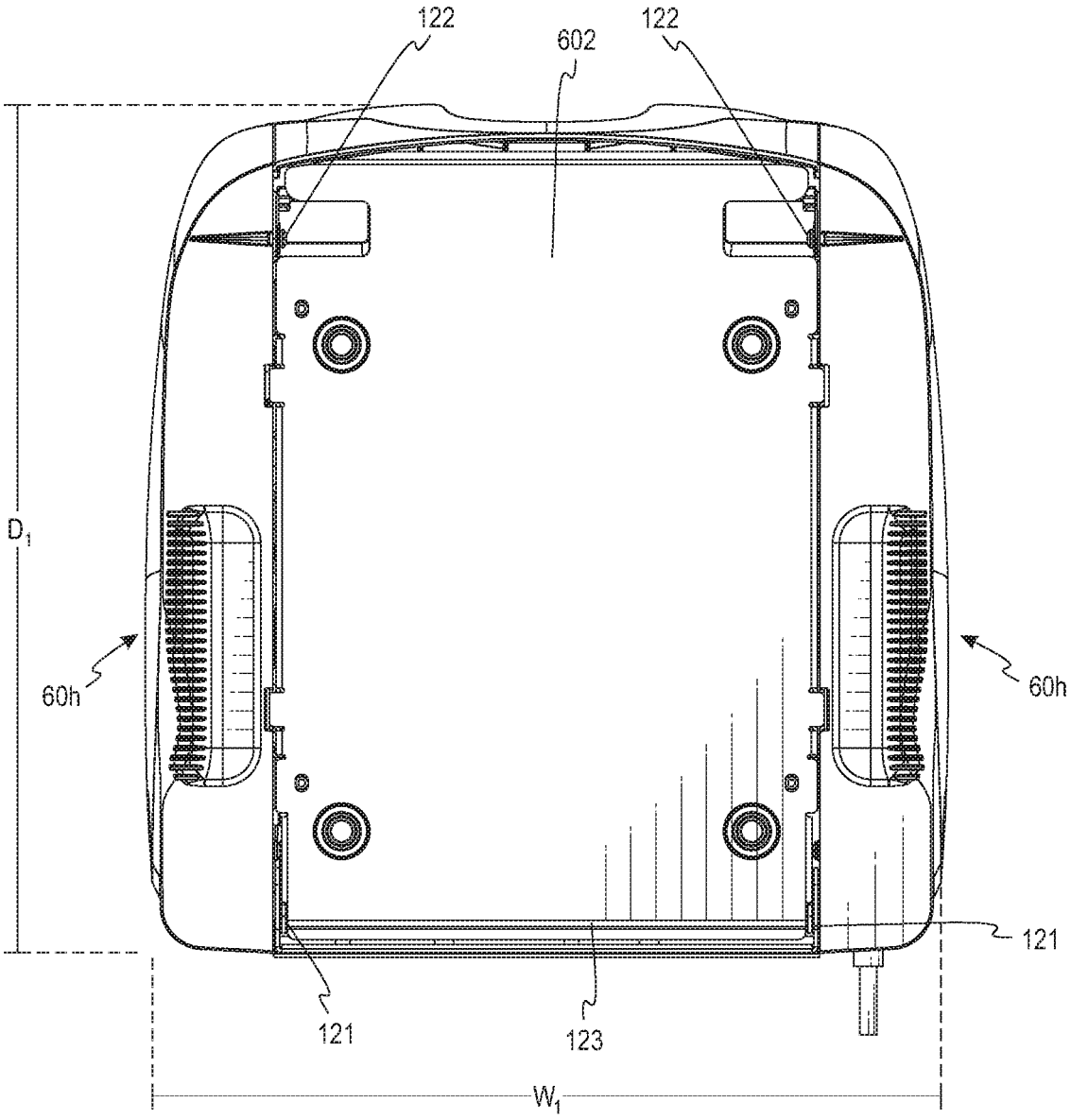


Fig. 1G

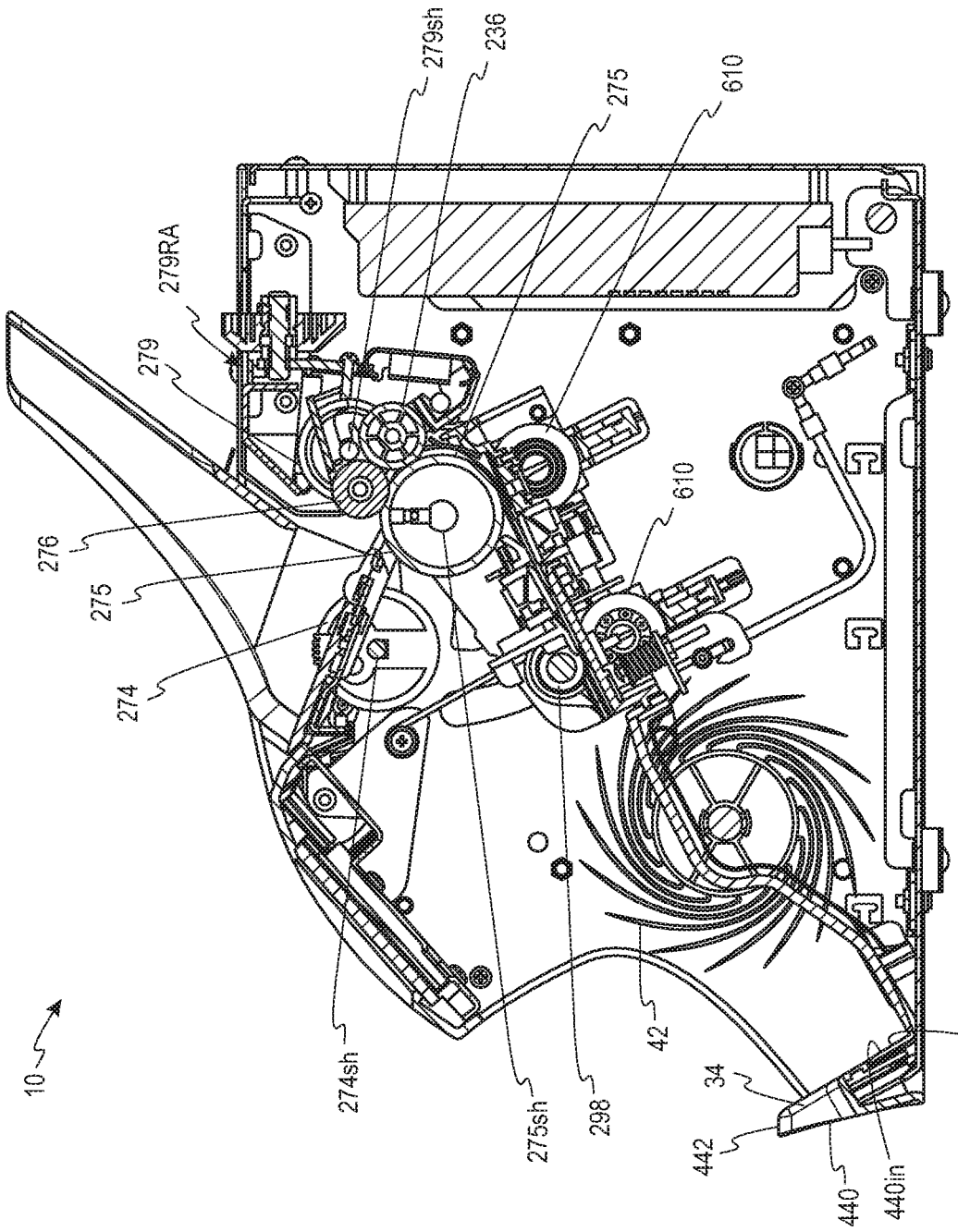

279sh
236
275
610
279RA
279
610
276
275
274
10
274sh
275sh
298
42
34
442
440
440in
440lw

Fig. 2A

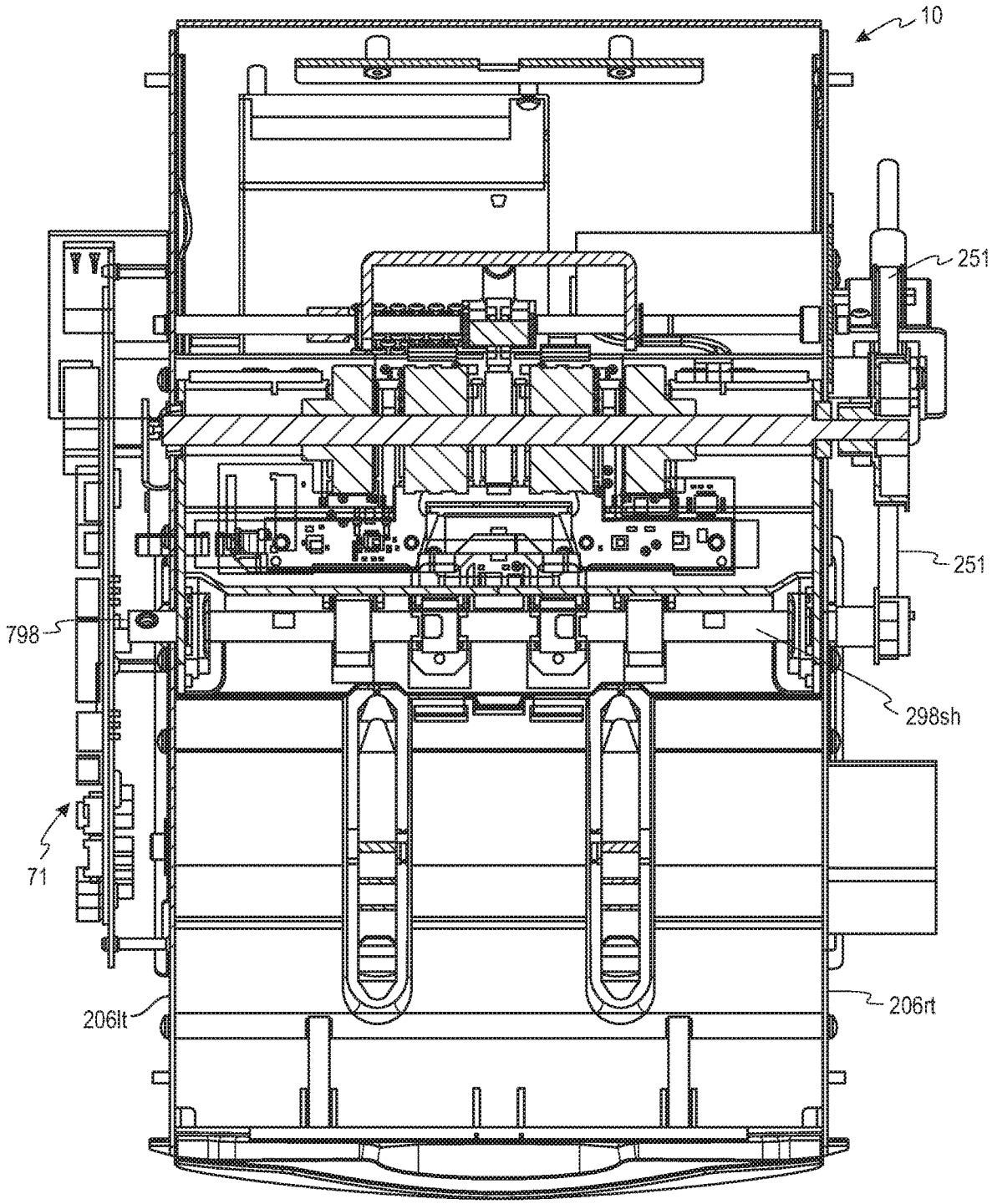


Fig. 2B

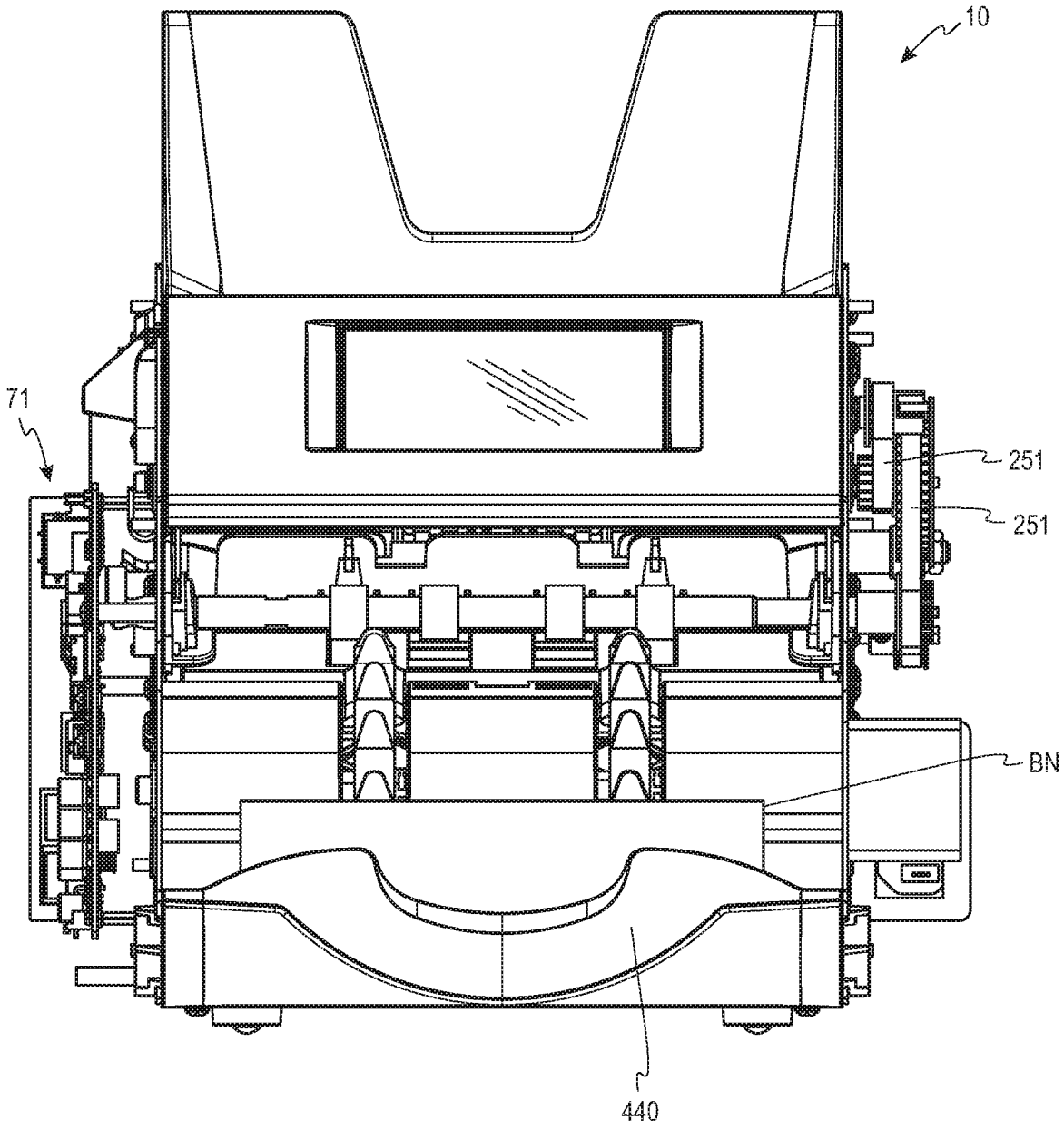


Fig. 2C

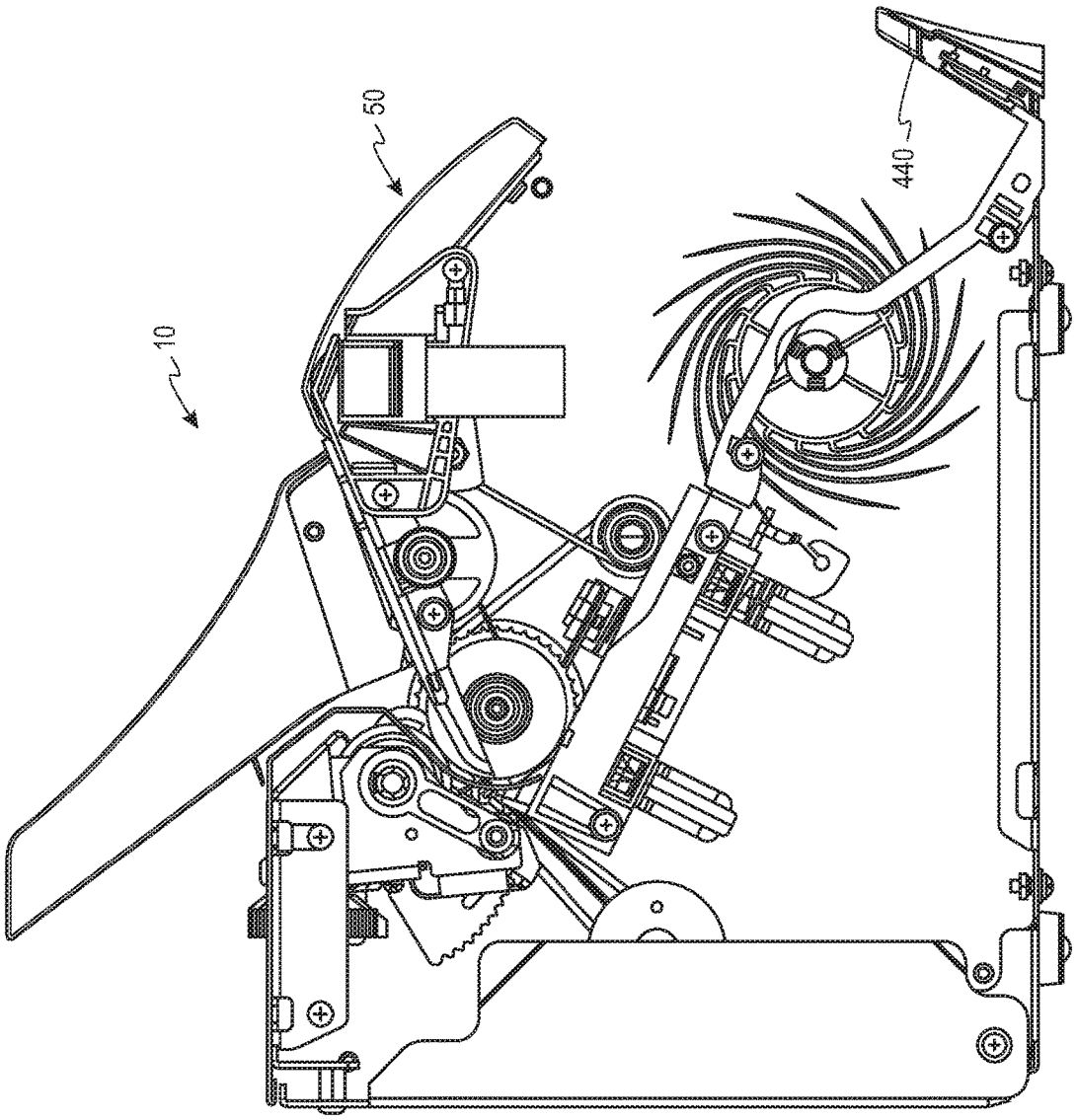


Fig. 2D

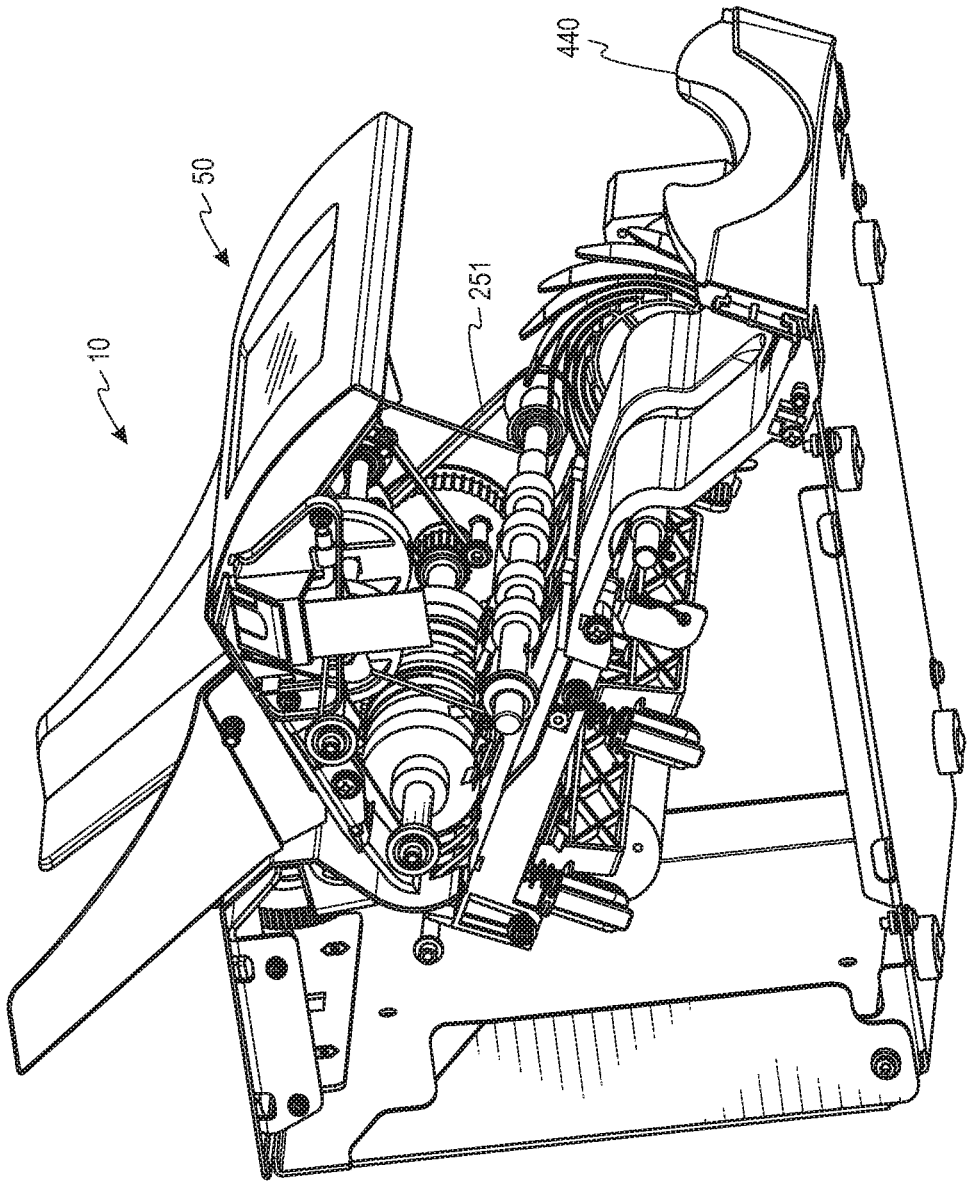


Fig. 2E

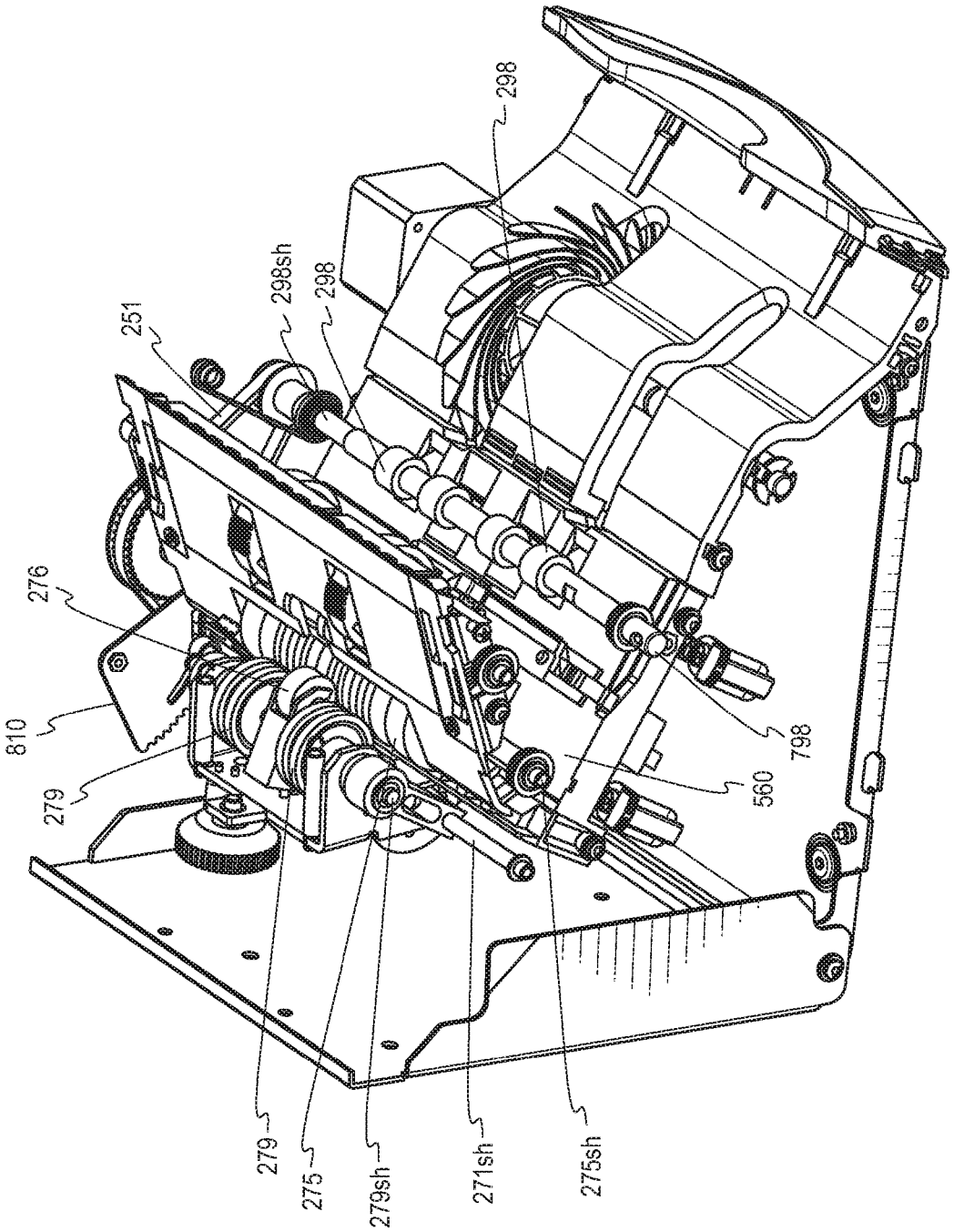

298
298sh
298
251
276
810
279
560
798
279
275
279sh
271sh
275sh

Fig. 2F

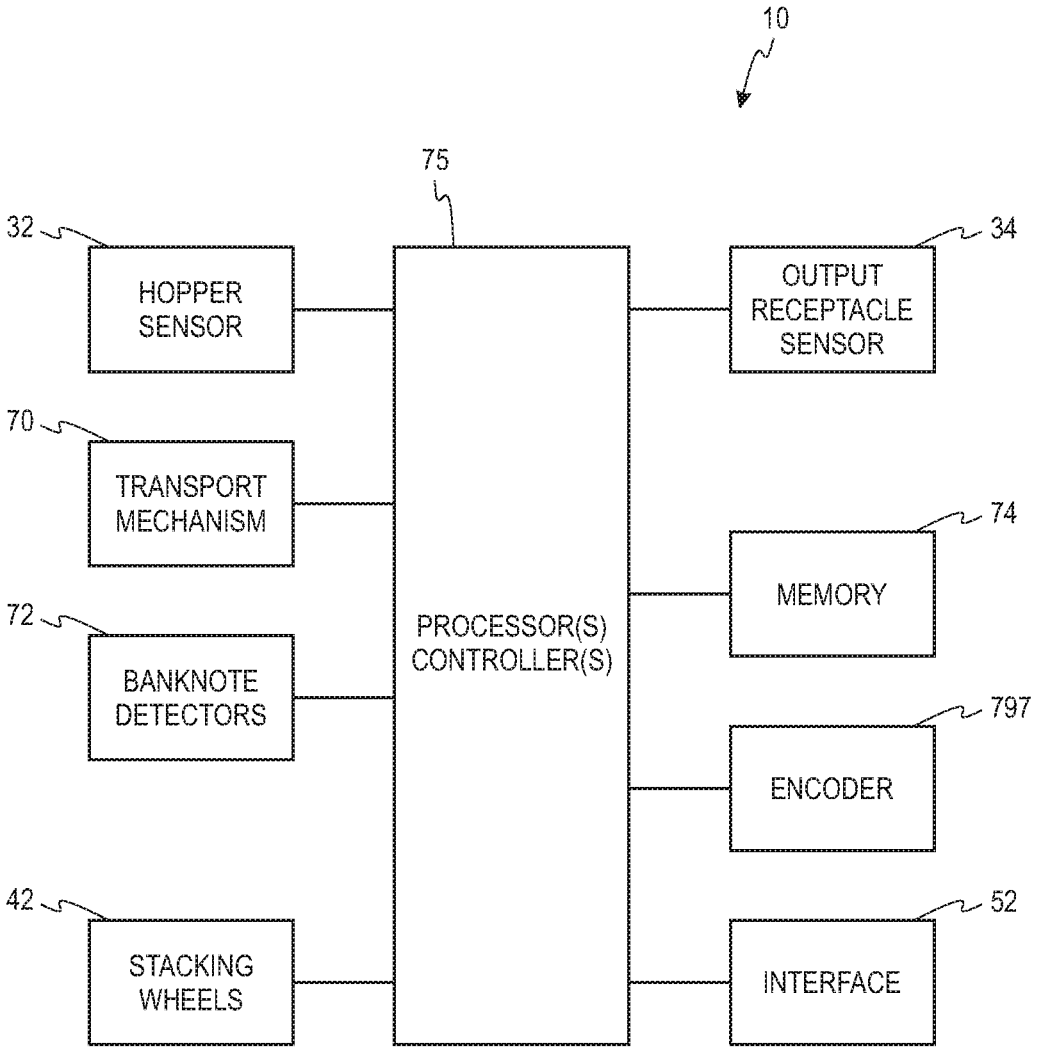

10
75
32
HOPPER SENSOR
70
TRANSPORT MECHANISM
72
BANKNOTE DETECTORS
42
STACKING WHEELS
PROCESSOR(S) CONTROLLER(S)
34
OUTPUT RECEPTACLE SENSOR
74
MEMORY
797
ENCODER
52
INTERFACE

Fig. 2G

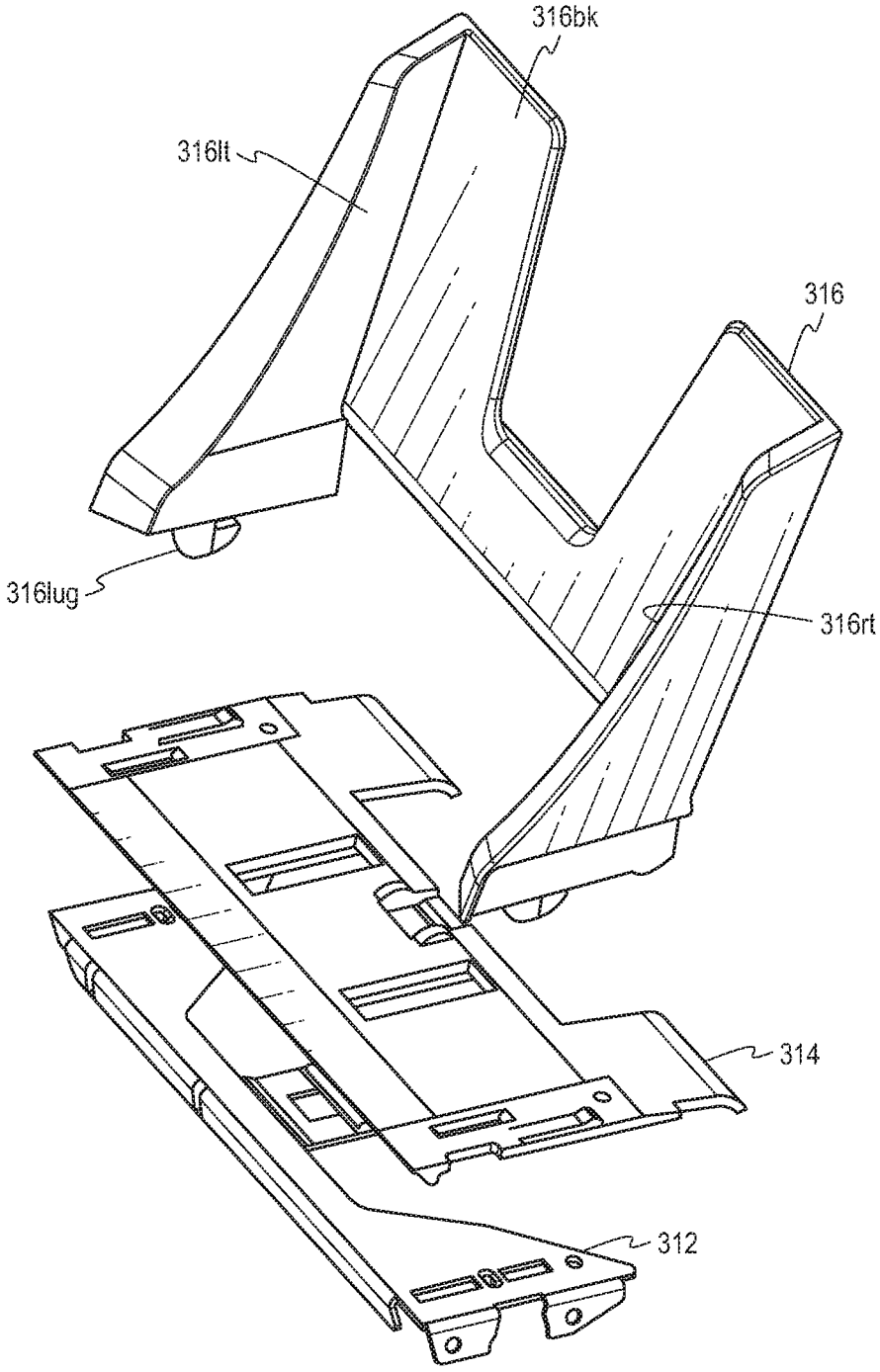


Fig. 3A

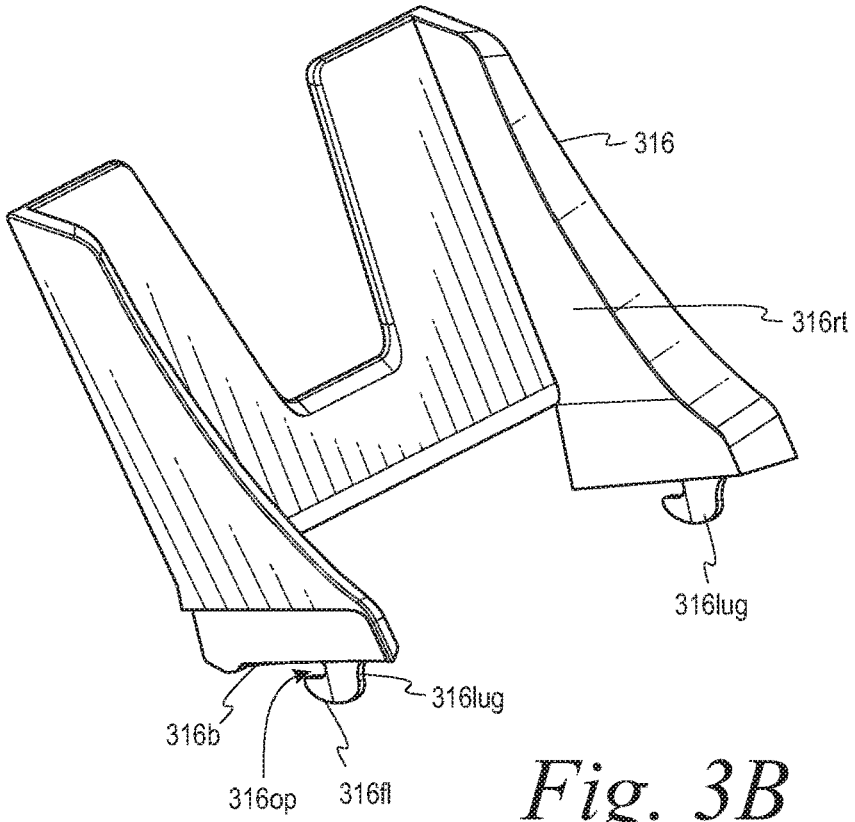


Fig. 3B

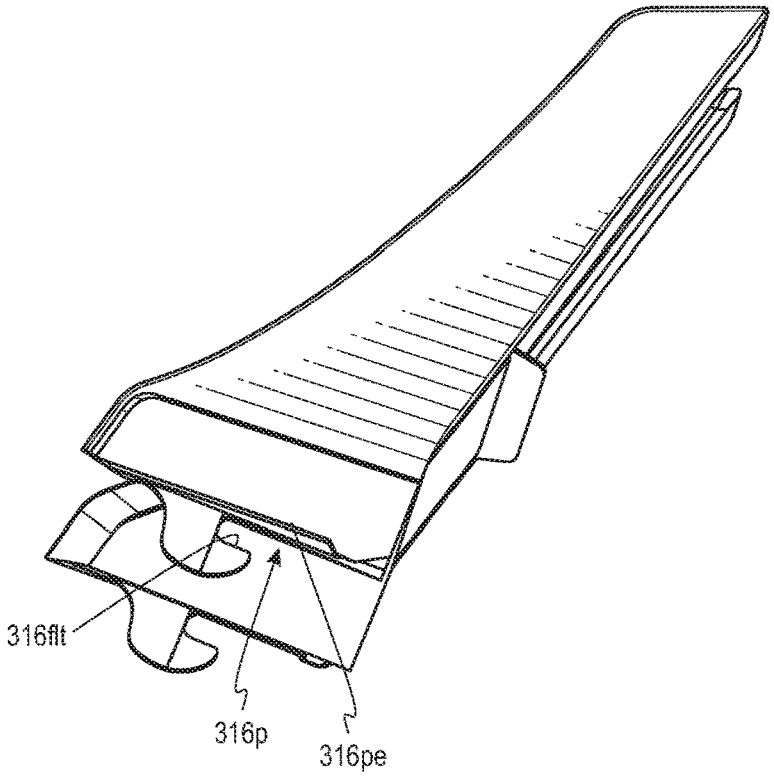


Fig. 3C

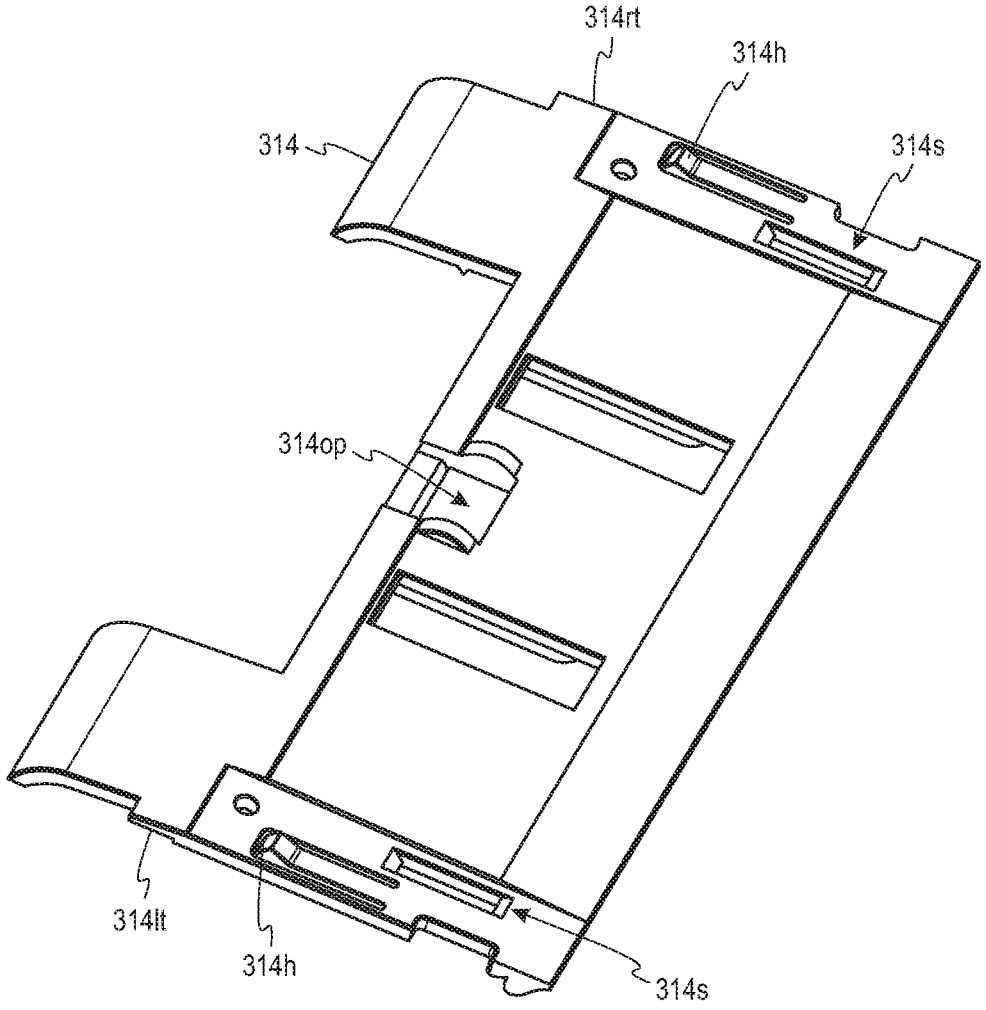


Fig. 3D

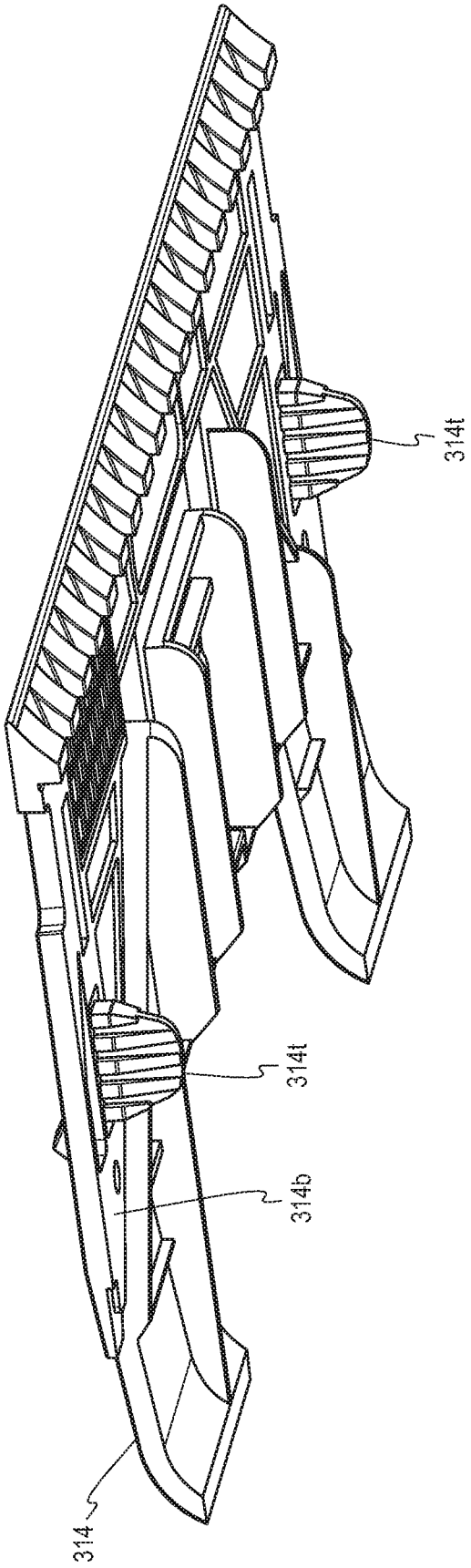


Fig. 3E

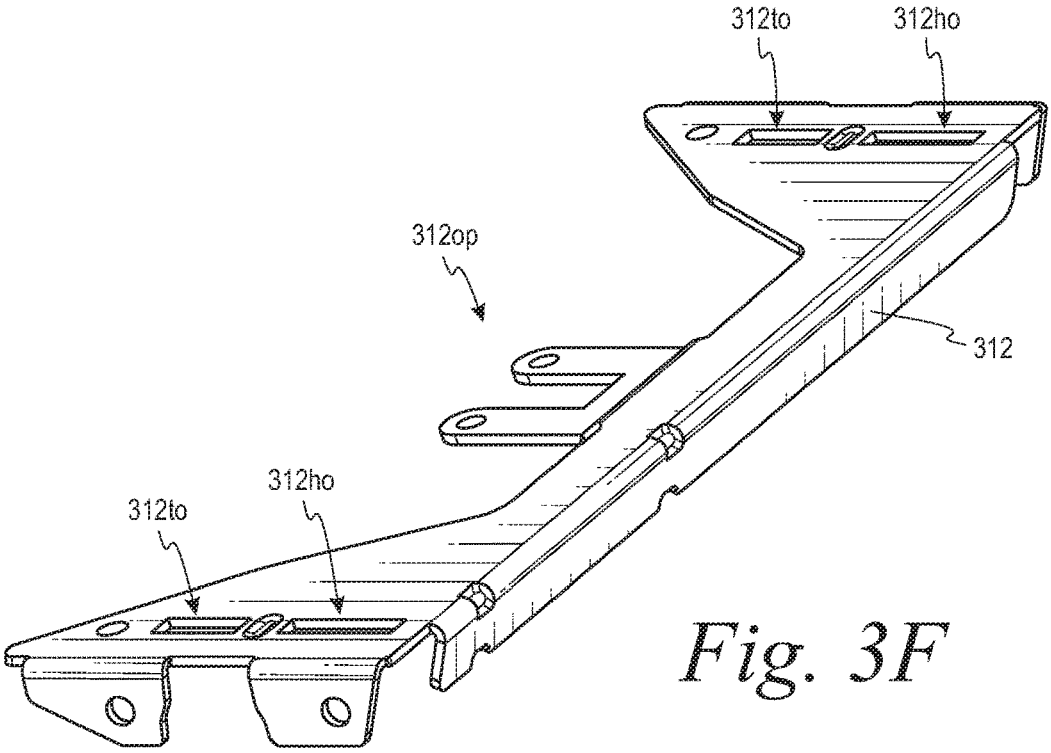


Fig. 3F

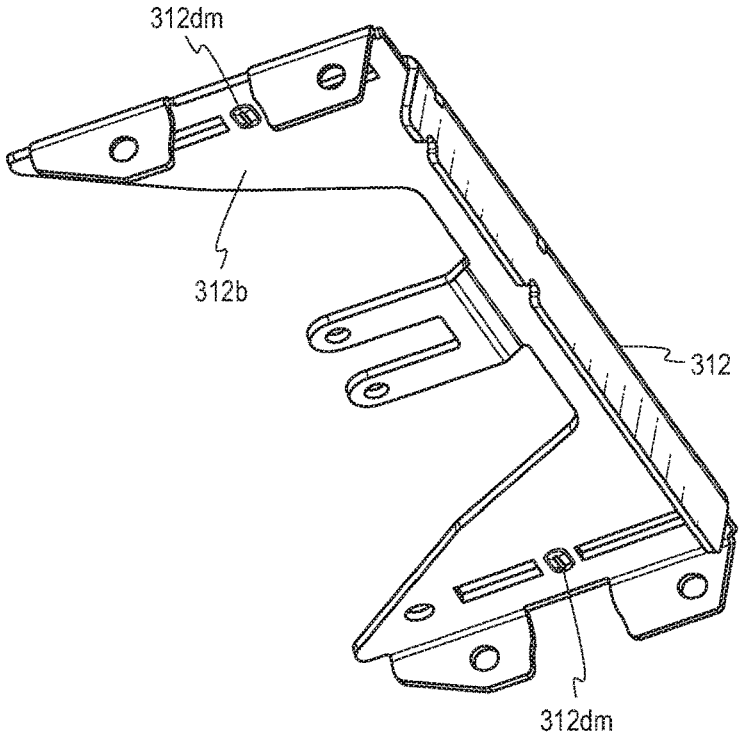


Fig. 3G

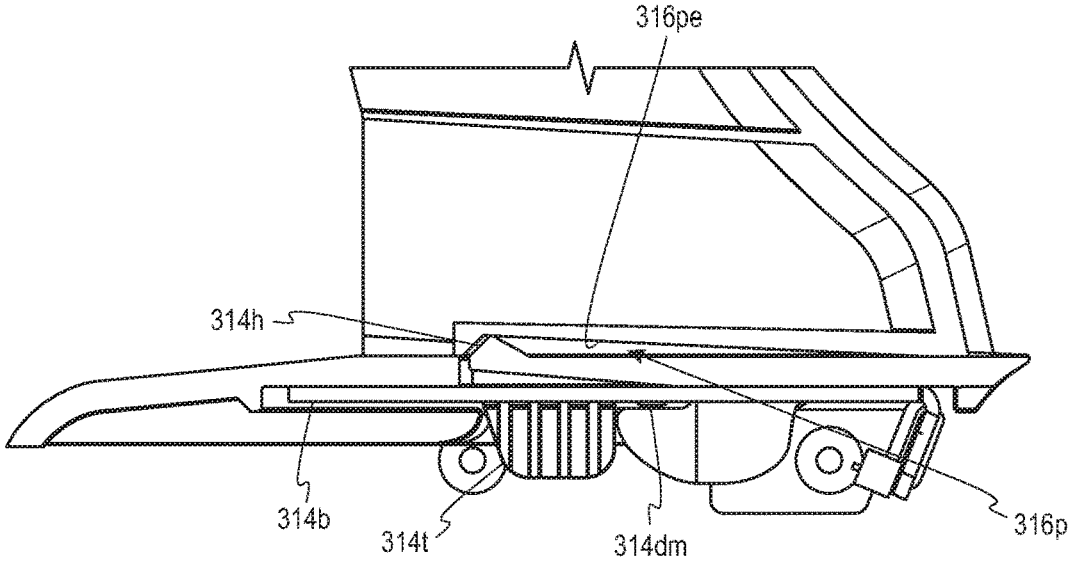


Fig. 3H

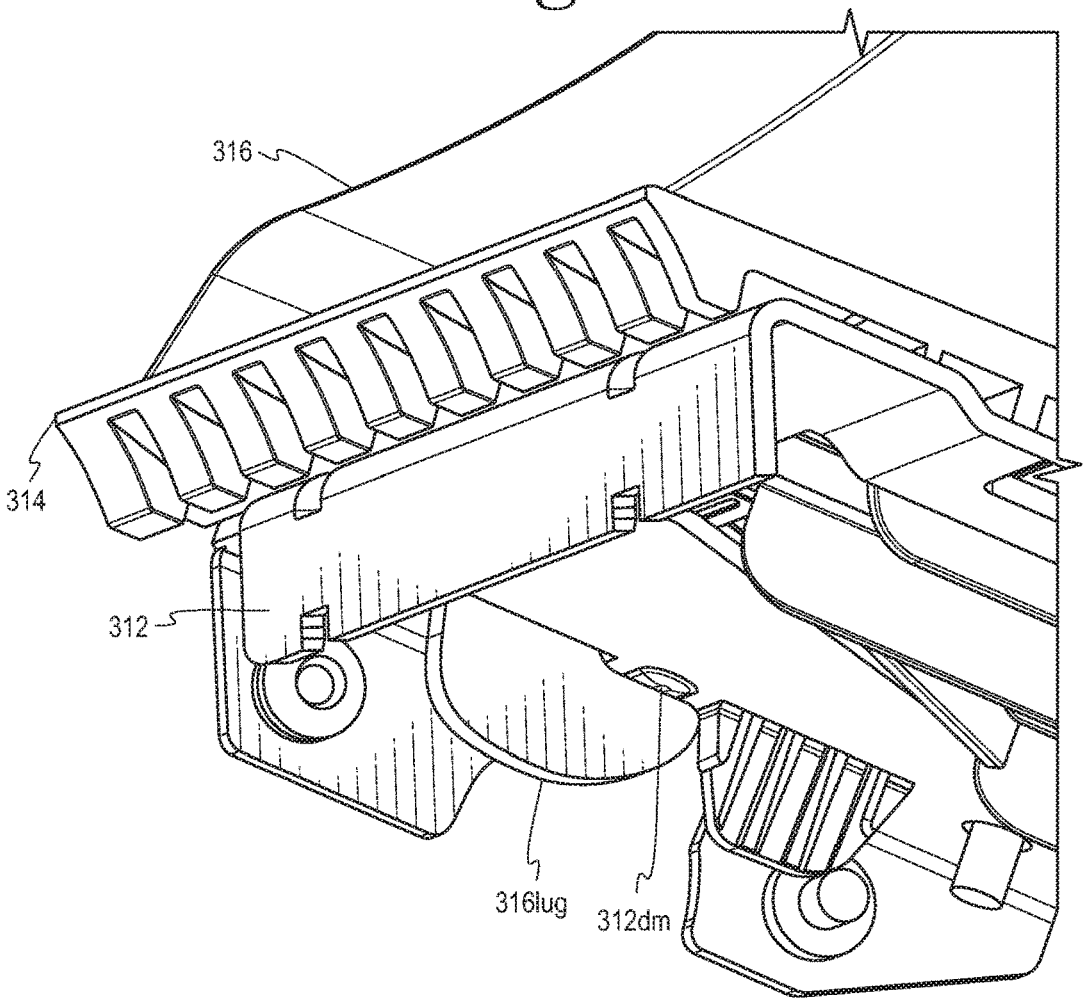


Fig. 3I

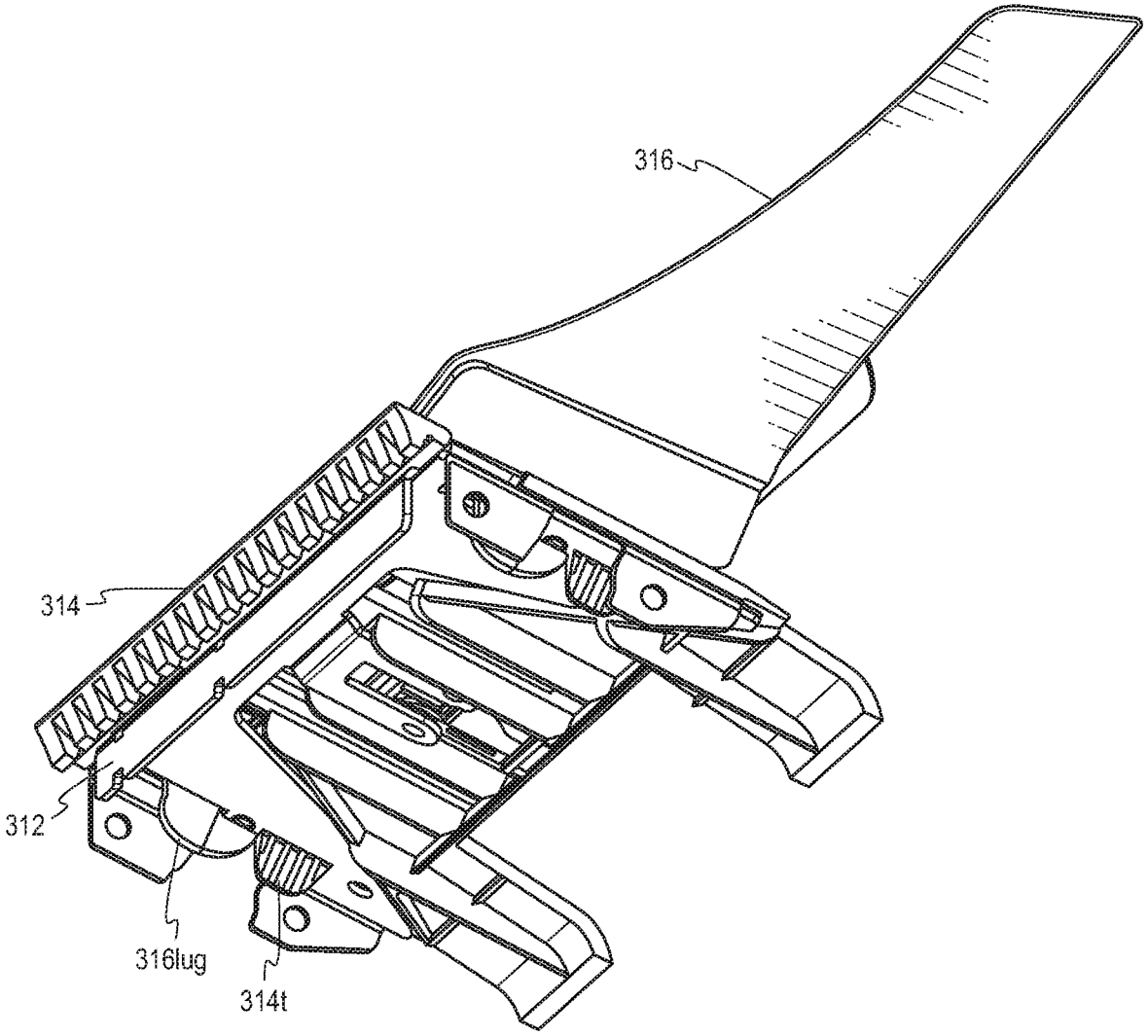


Fig. 3J

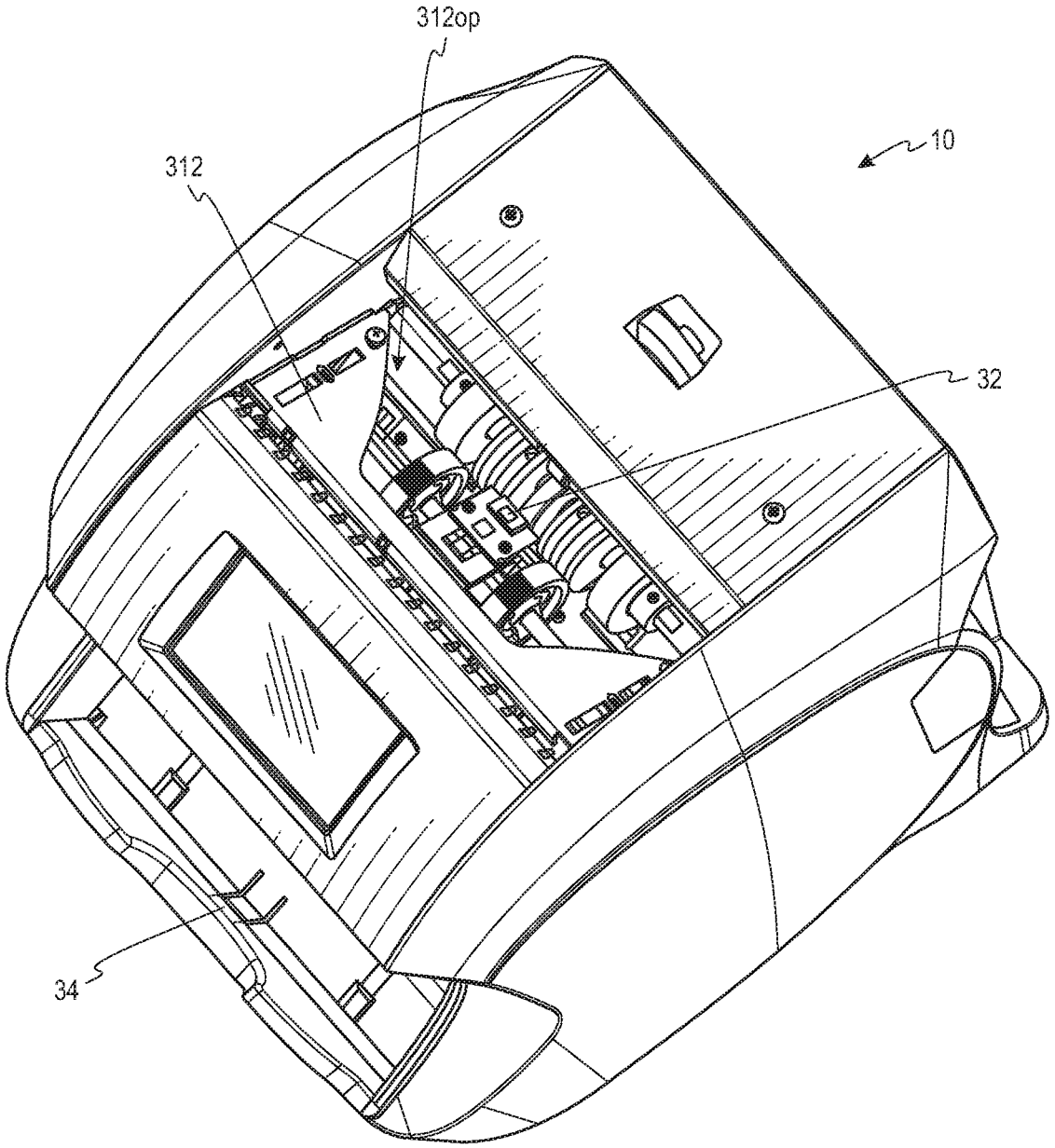


Fig. 3K

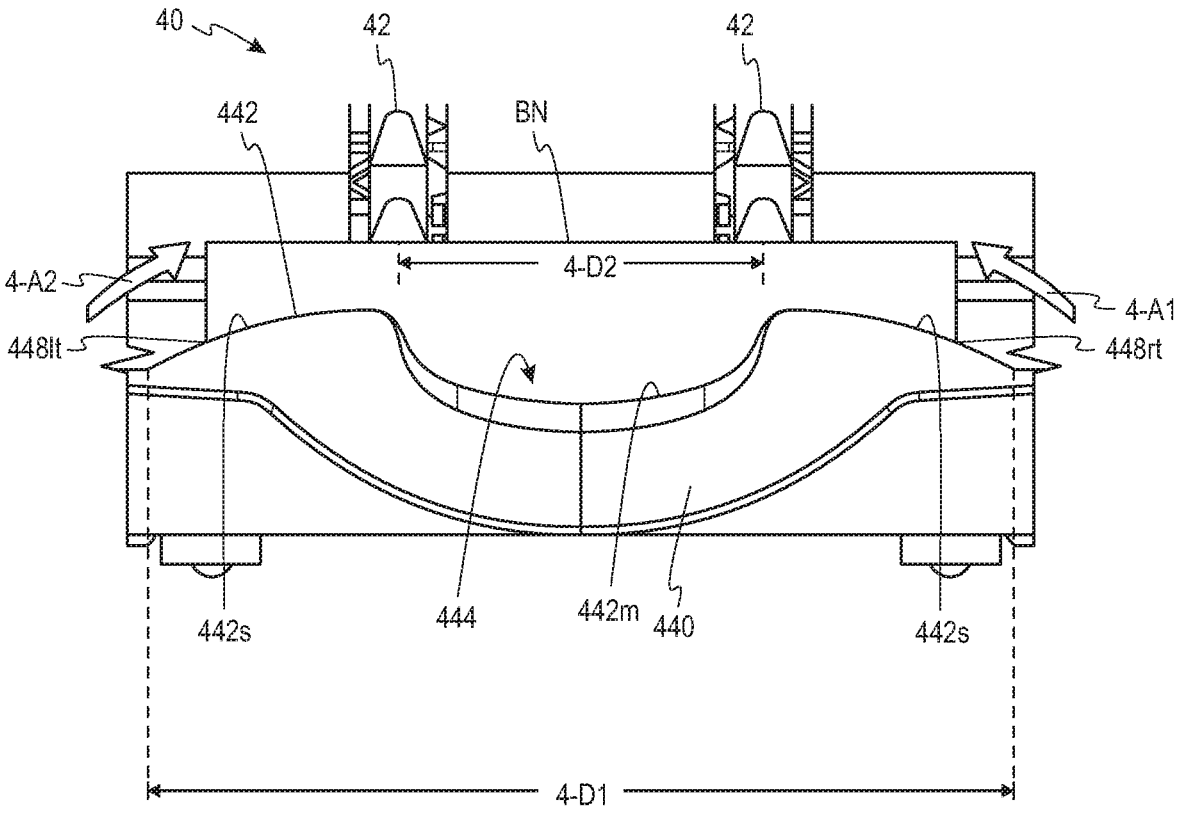

40
42
42
442
BN
4-D2
4-A2
4-A1
448lt
448rt
442s
444
442m
440
442s
4-D1

Fig. 4

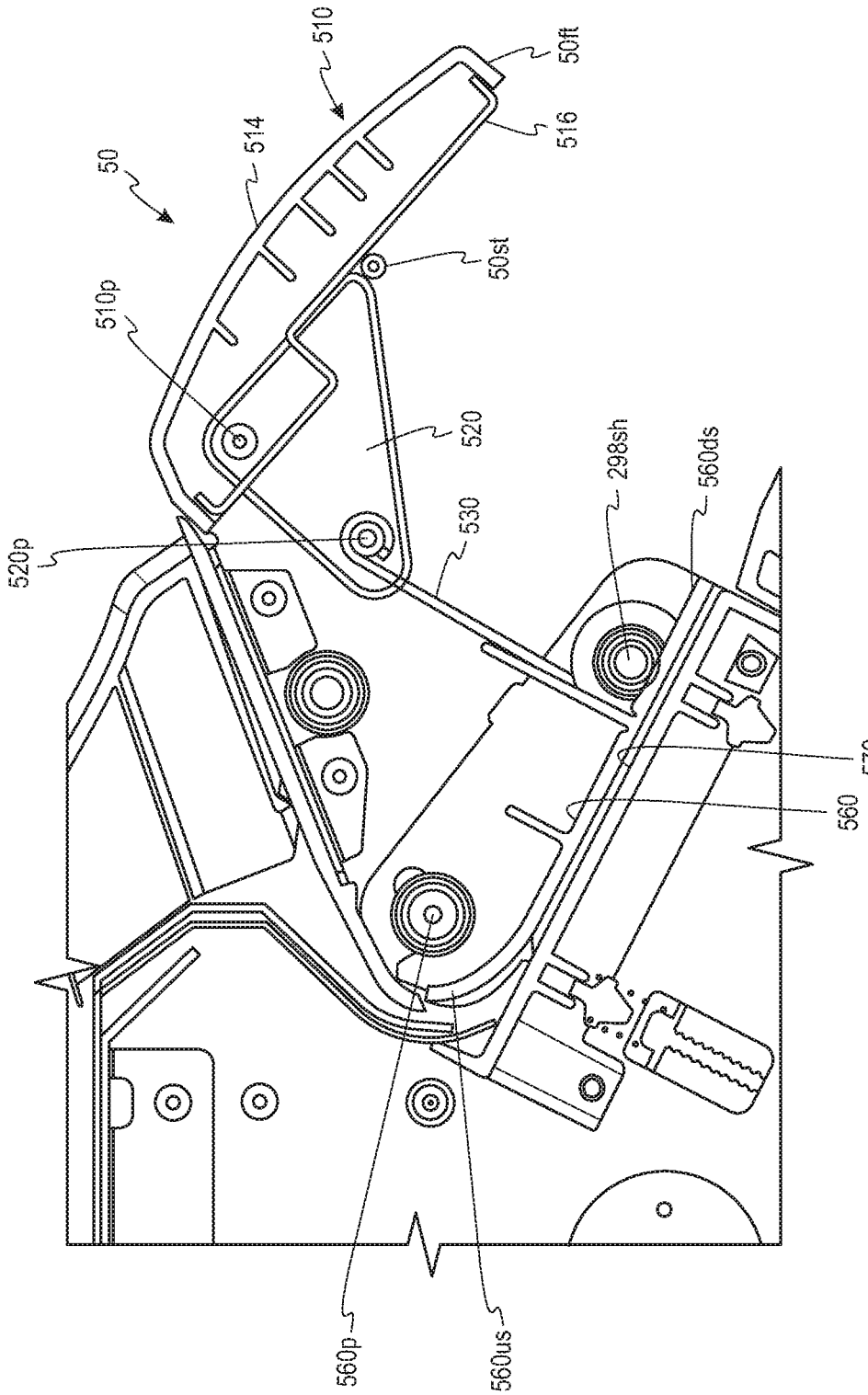

50
510
514
50ft
516
50st
510p
520
520p
530
298sh
560ds
570
560
560p
560us

Fig. 5A

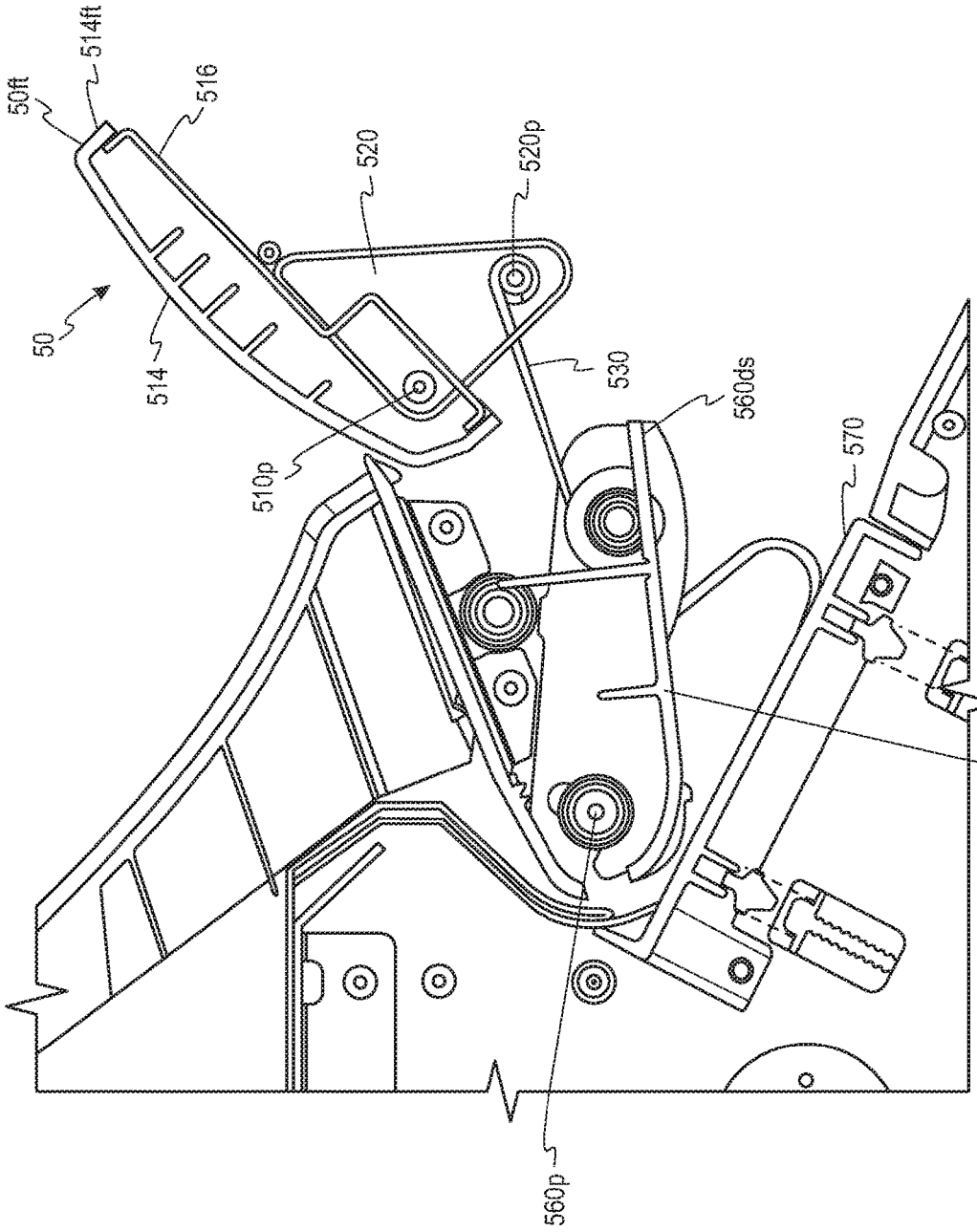


Fig. 5B

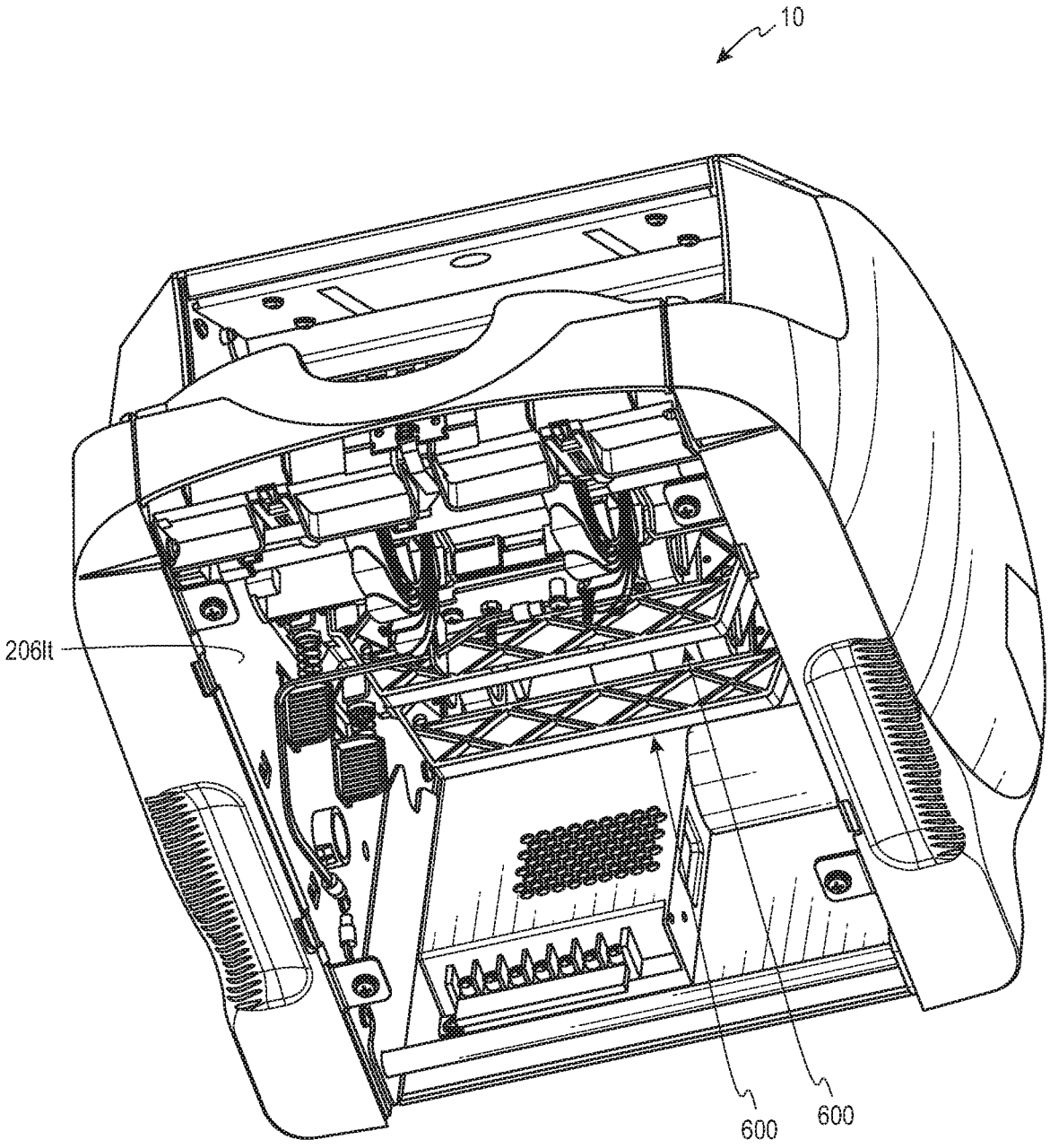


Fig. 6A

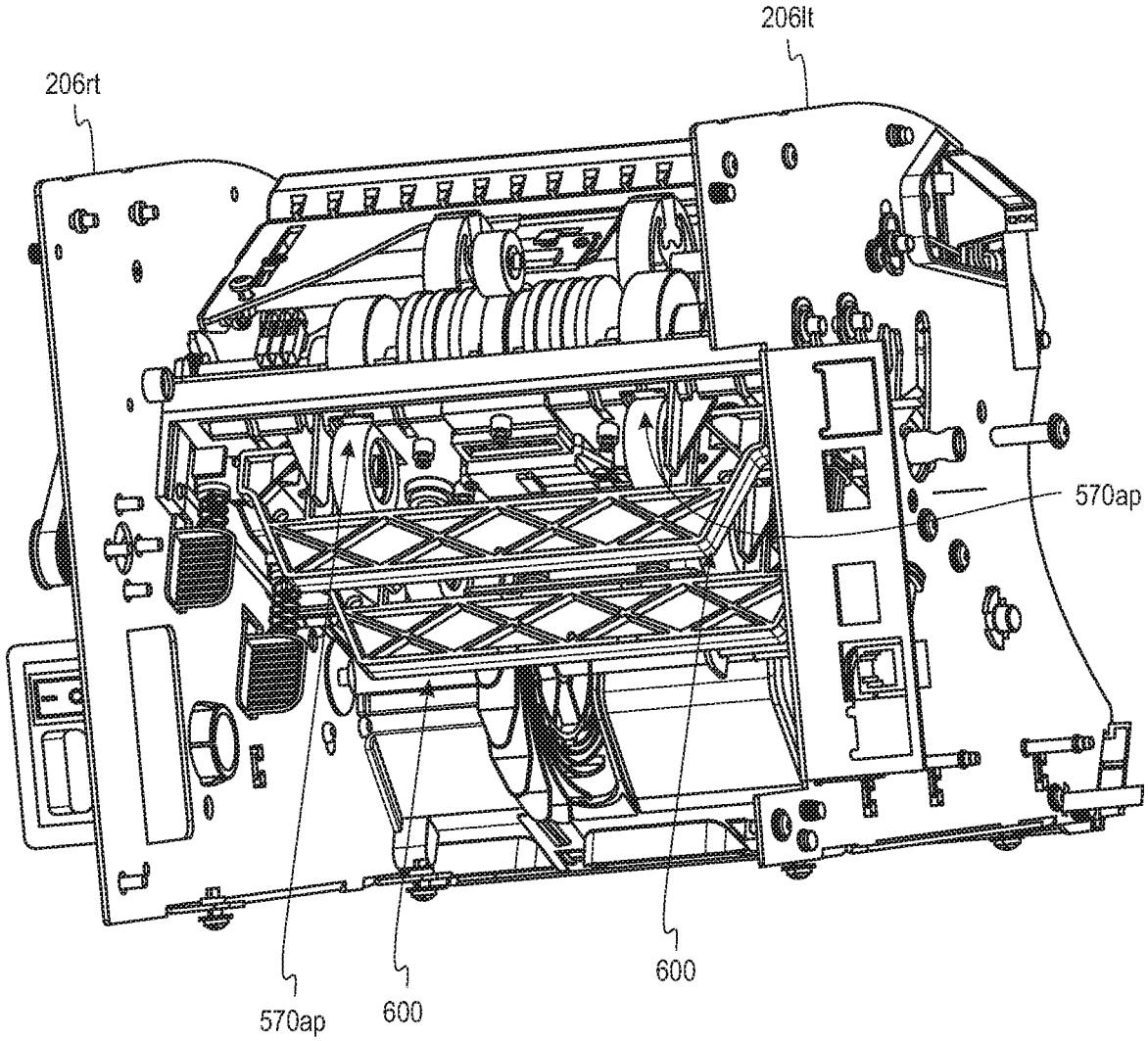


Fig. 6B

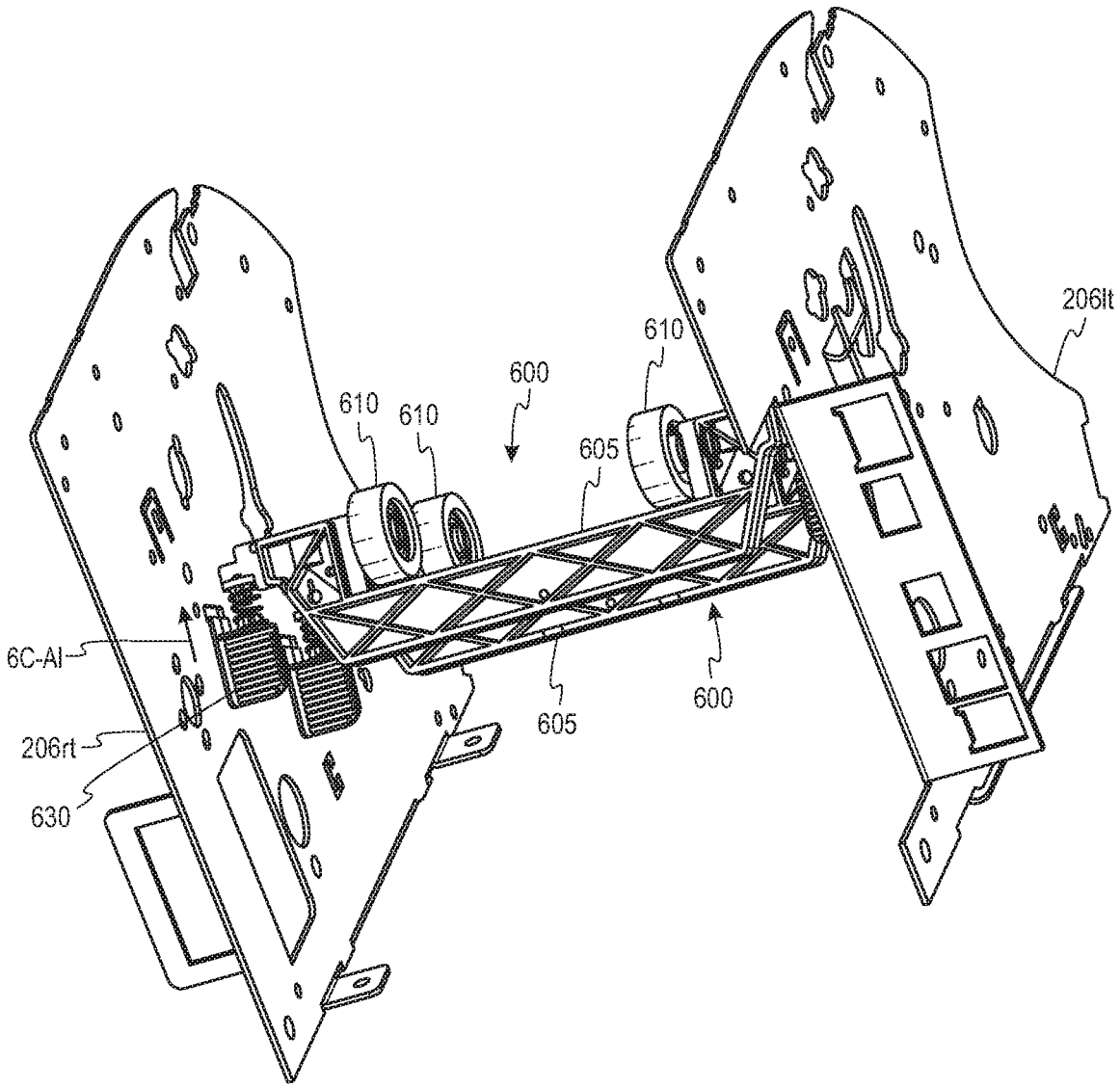


Fig. 6C

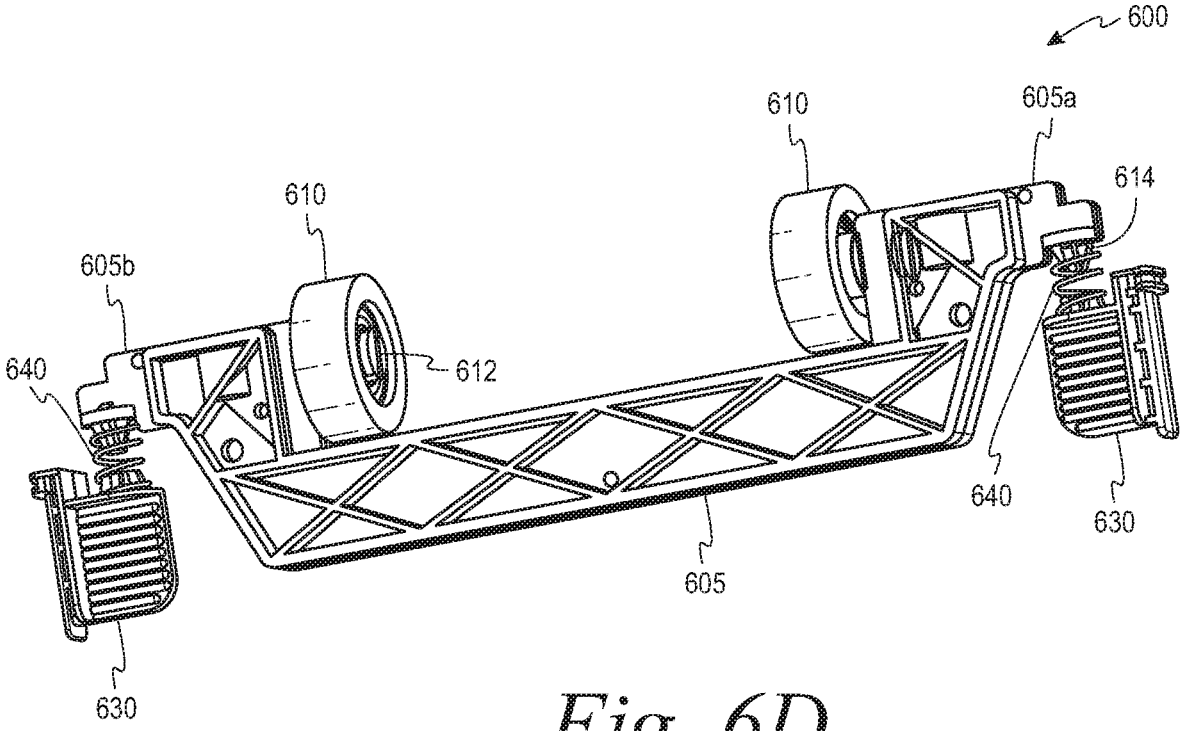

600
610
605a
614
610
605b
612
640
640
630
605
630

Fig. 6D

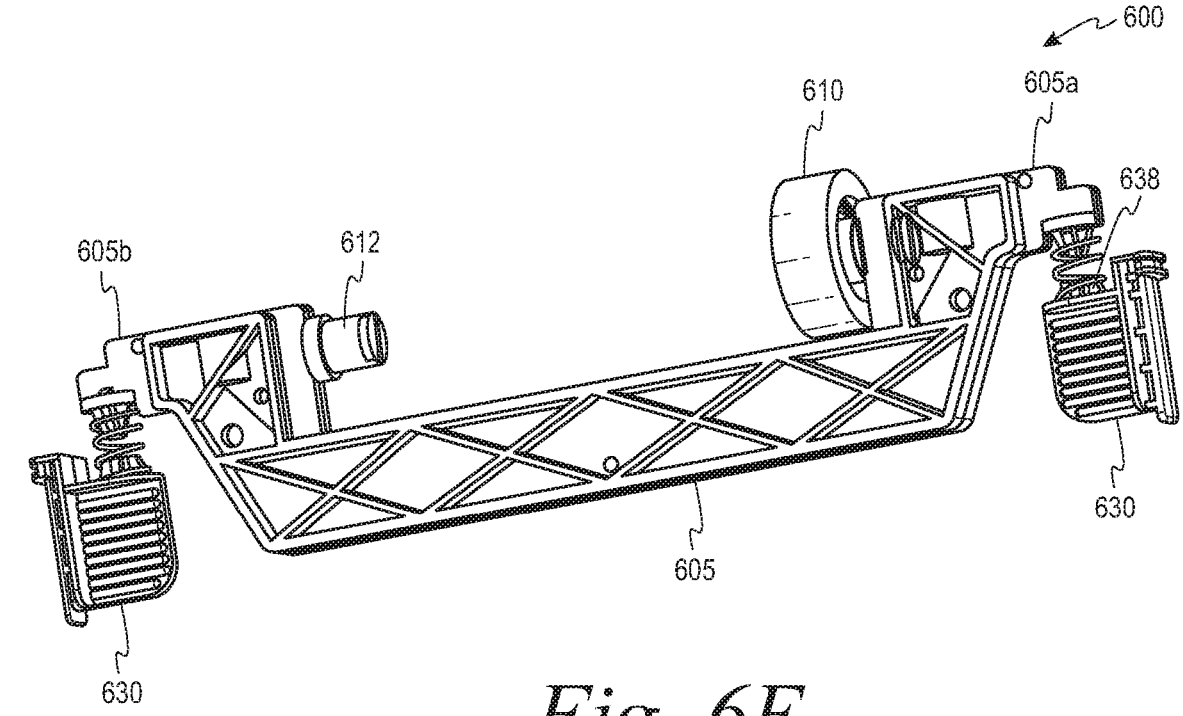

600
610
605a
638
605b
612
630
605
630

Fig. 6E

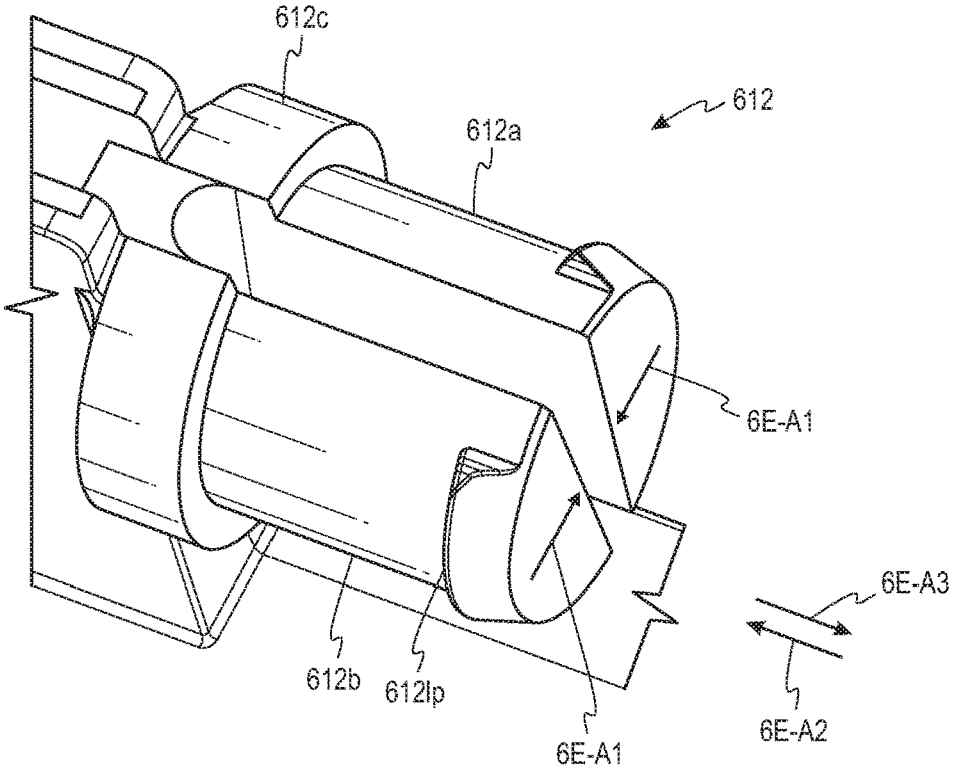


Fig. 6E1

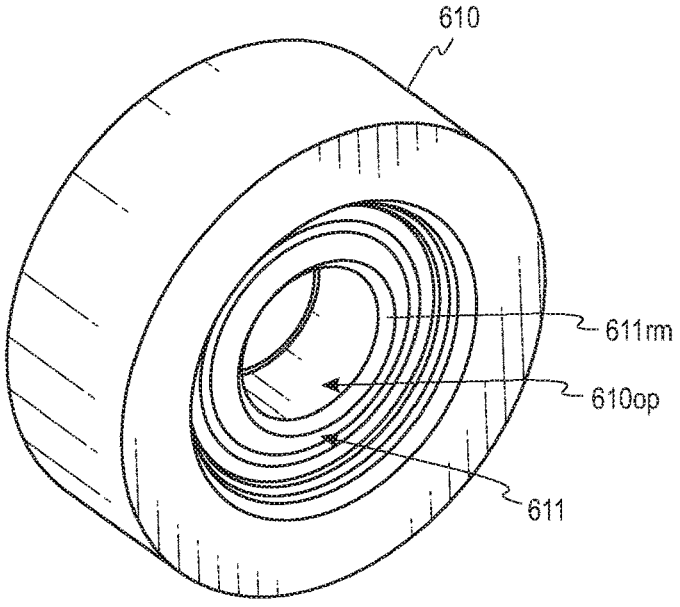


Fig. 6E2

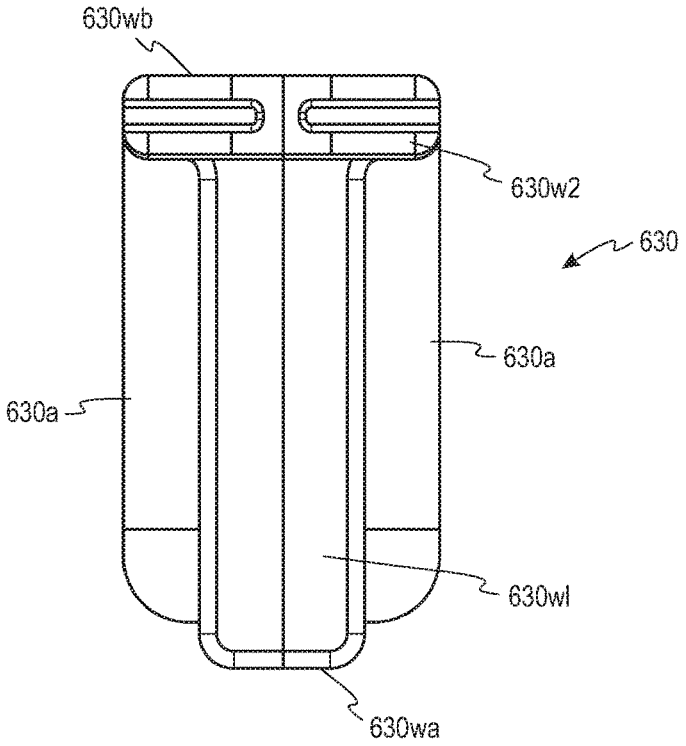

630wb
630w2
630
630a
630a
630wl
630wa

Fig. 6F

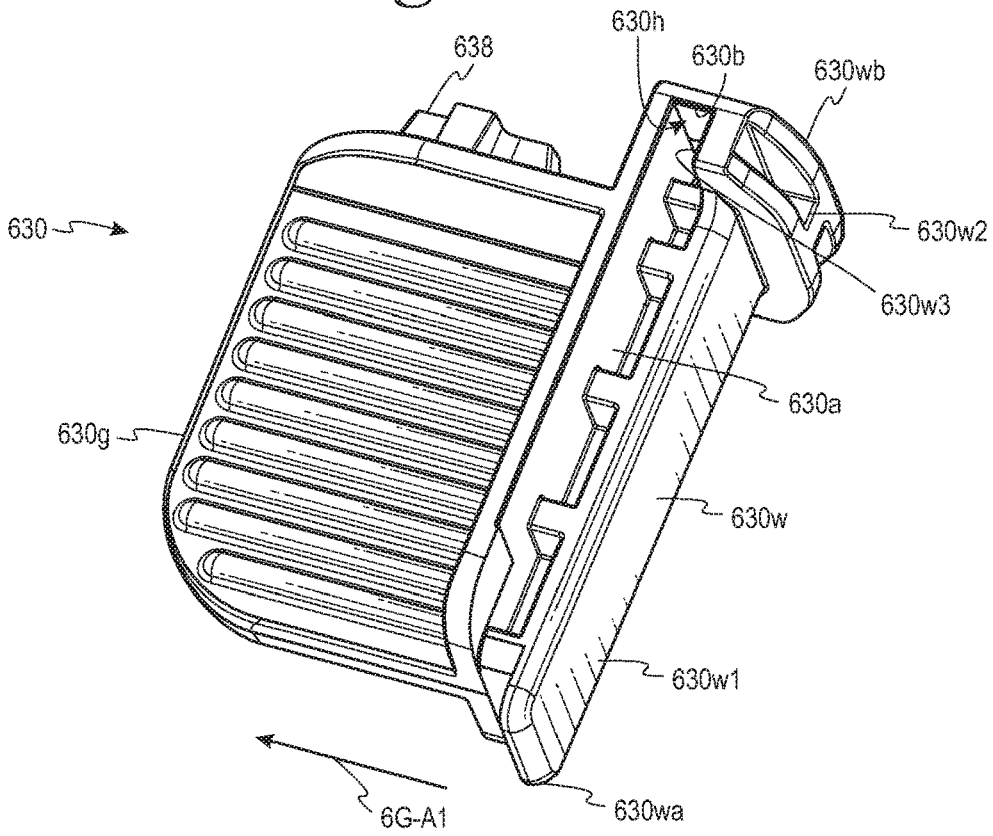

638
630h
630b
630wb
630
630w2
630w3
630a
630g
630w
630w1
6G-A1
630wa

Fig. 6G

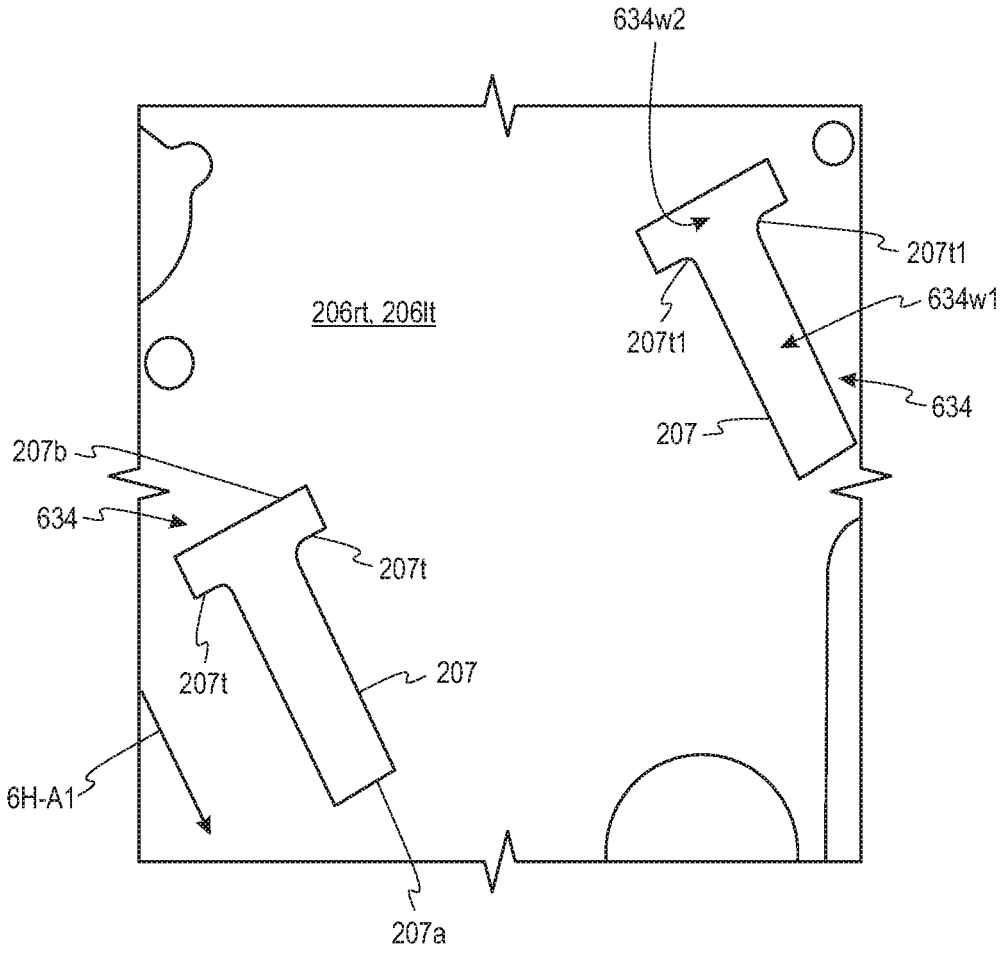

634w2
207t1
634w1
206rt, 206lt
207t1
634
207
207b
634
207t
207t
207
6H-A1
207a

Fig. 6H

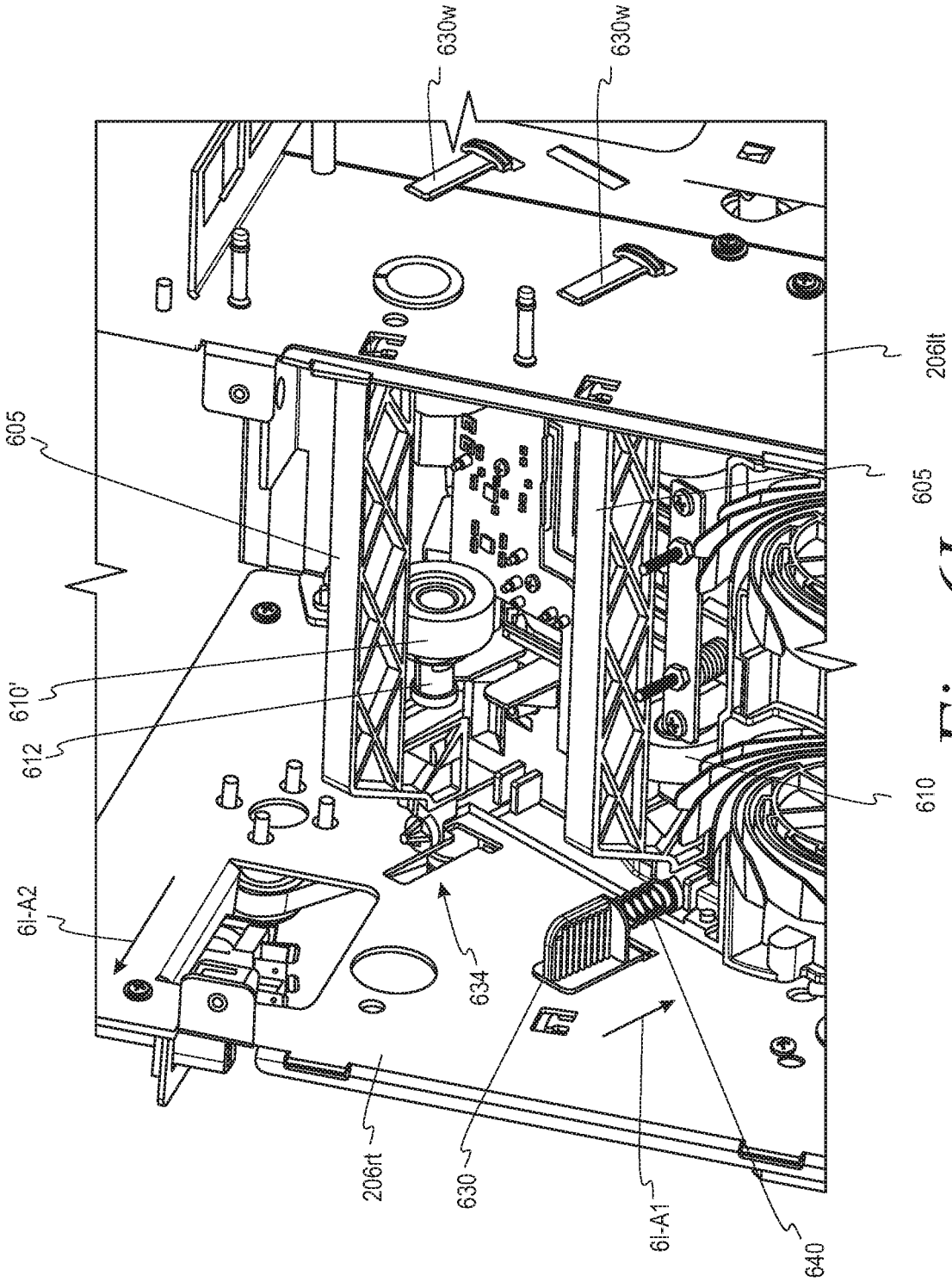

630w
630w
206lt
605
605
610'
612
610
6I-A2
634
206rt
630
6I-A1
640

Fig. 6I

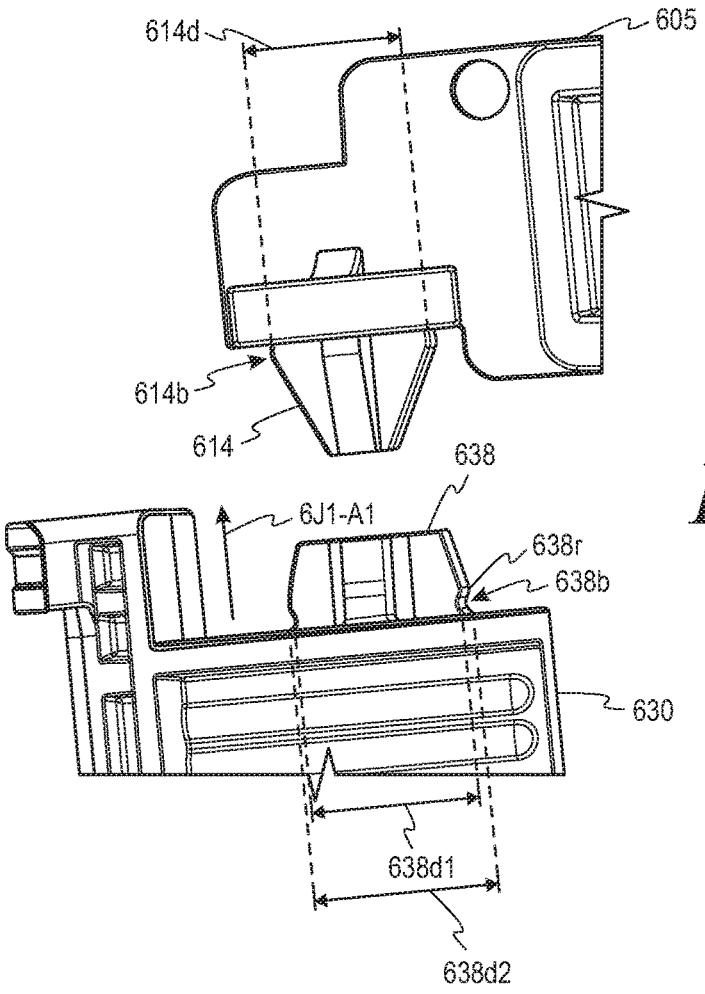


Fig. 6J1

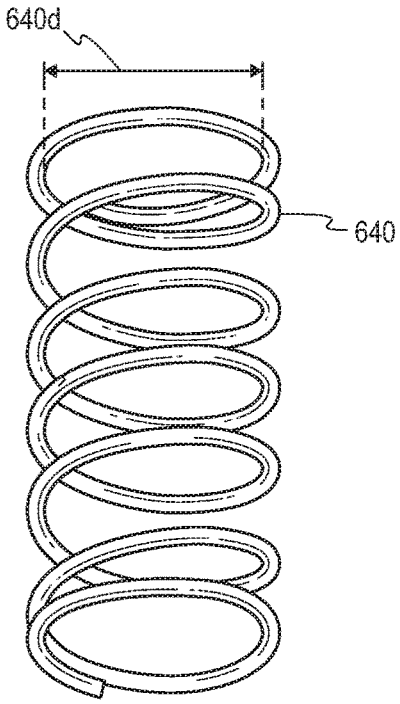


Fig. 6J2

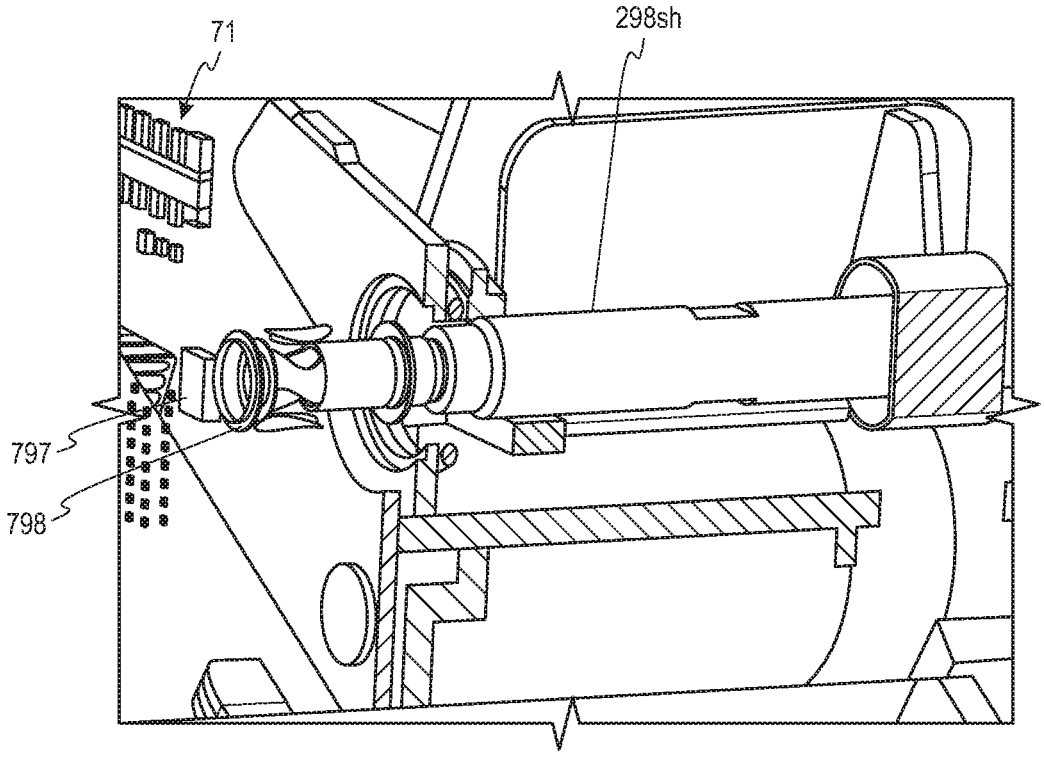


Fig. 7A

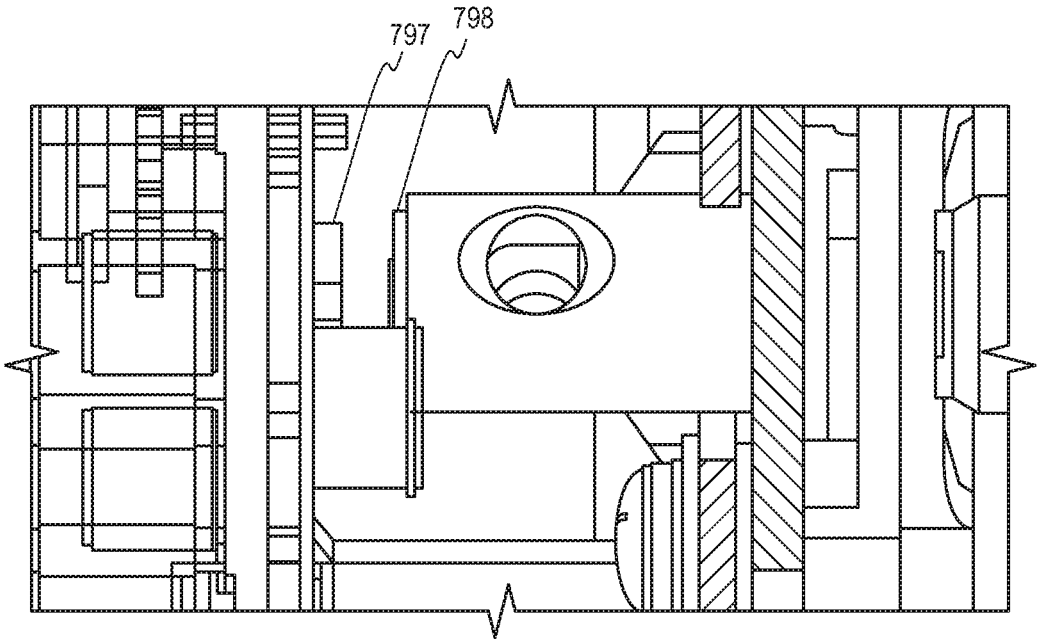


Fig. 7B

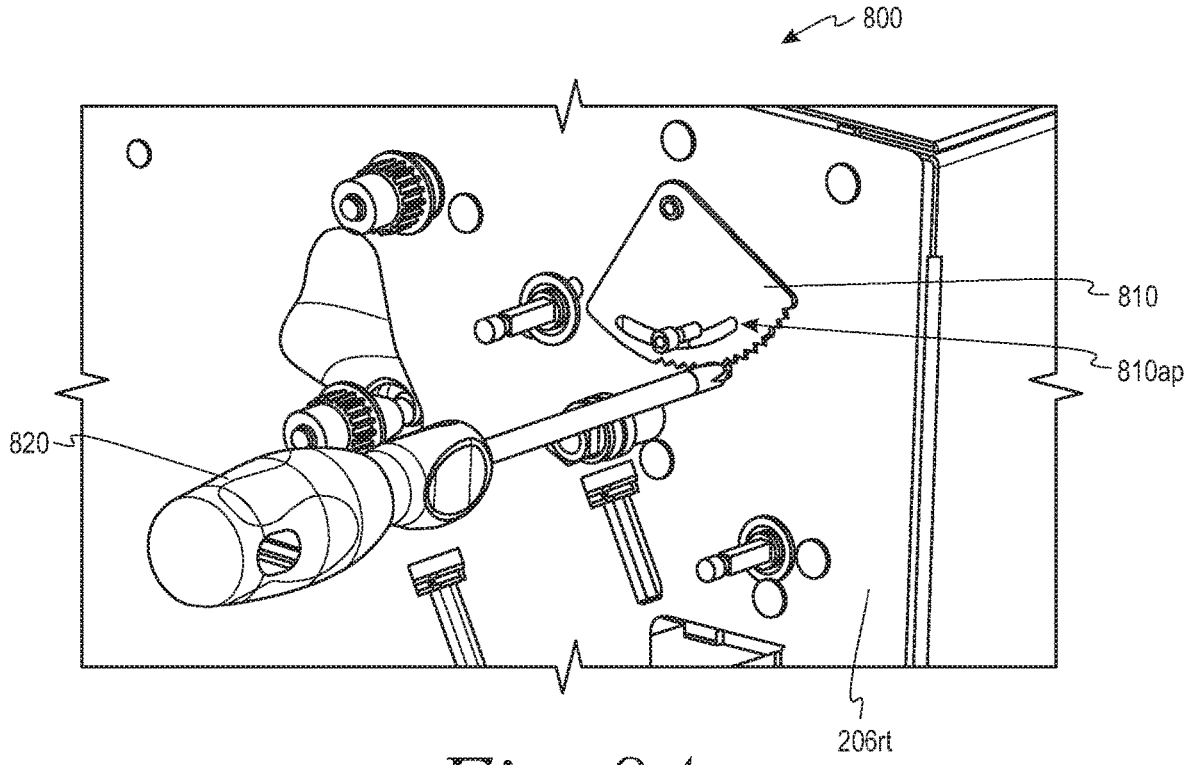

800
810
810ap
820
206rt

Fig. 8A

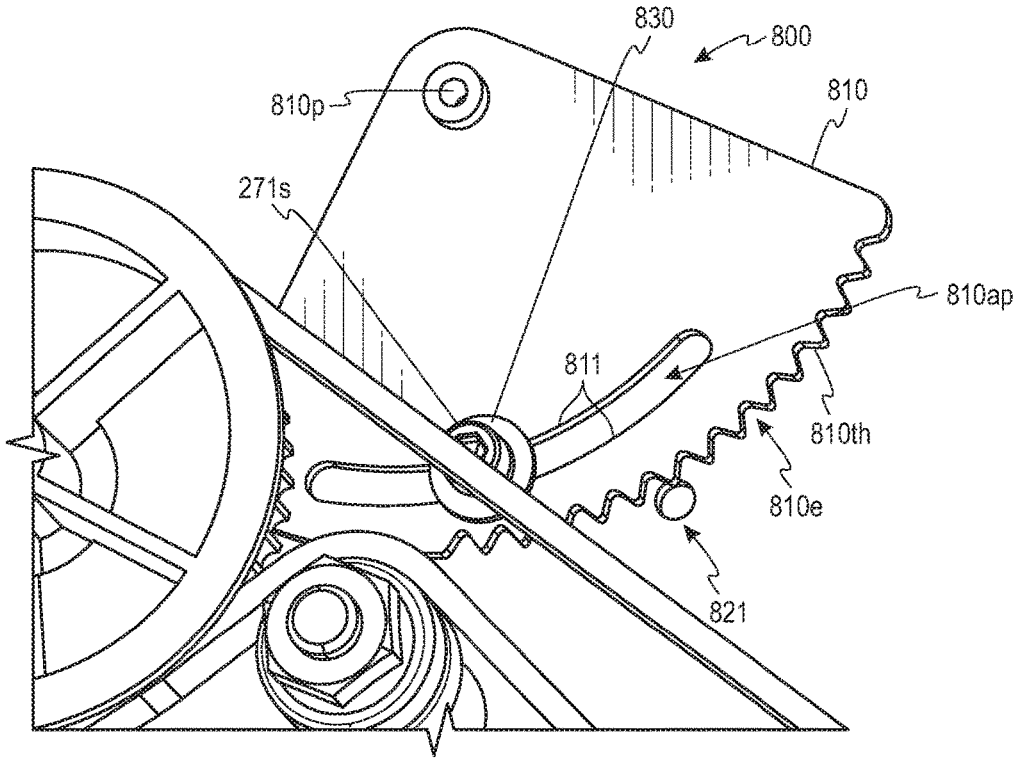

830
800
810p
810
271s
810ap
811
810th
810e
821

Fig. 8B

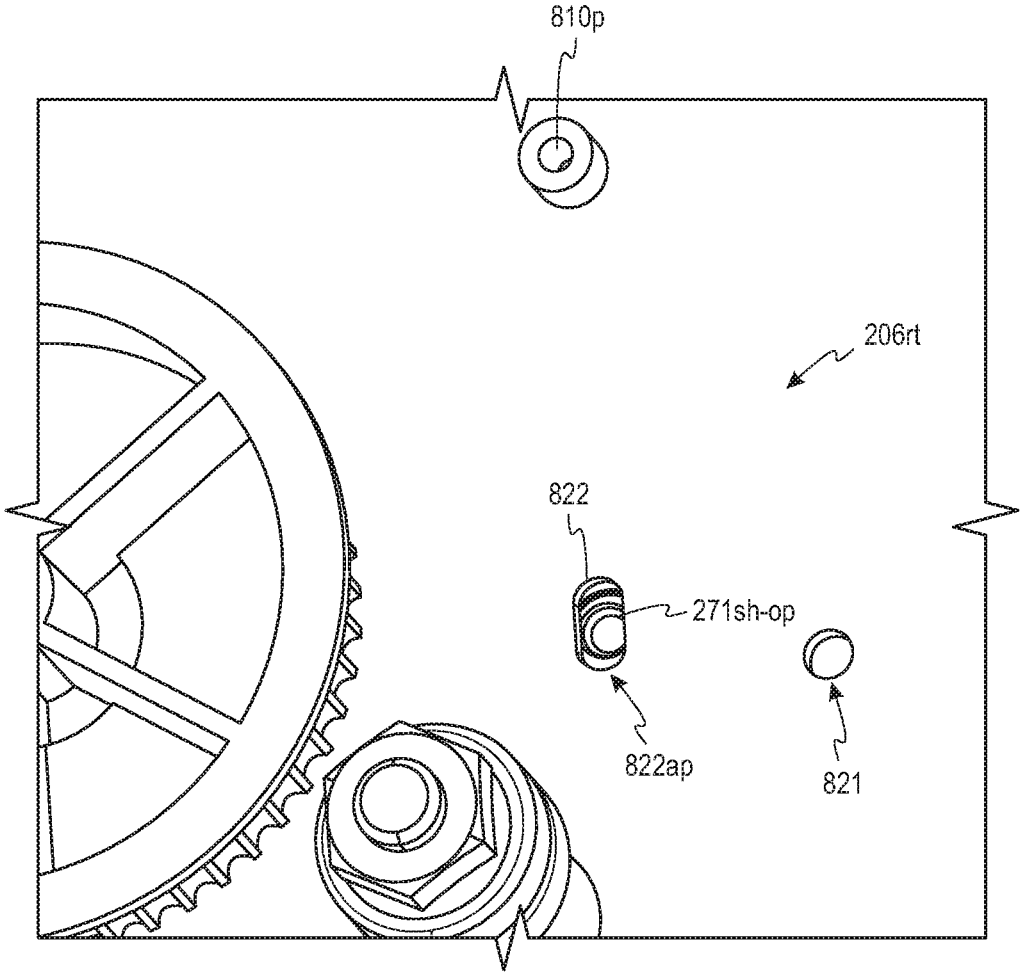


Fig. 8C

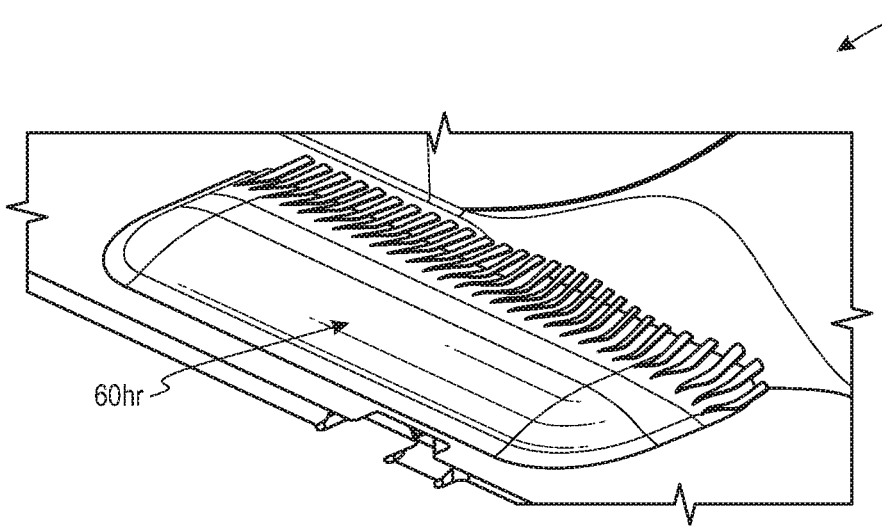


Fig. 9A

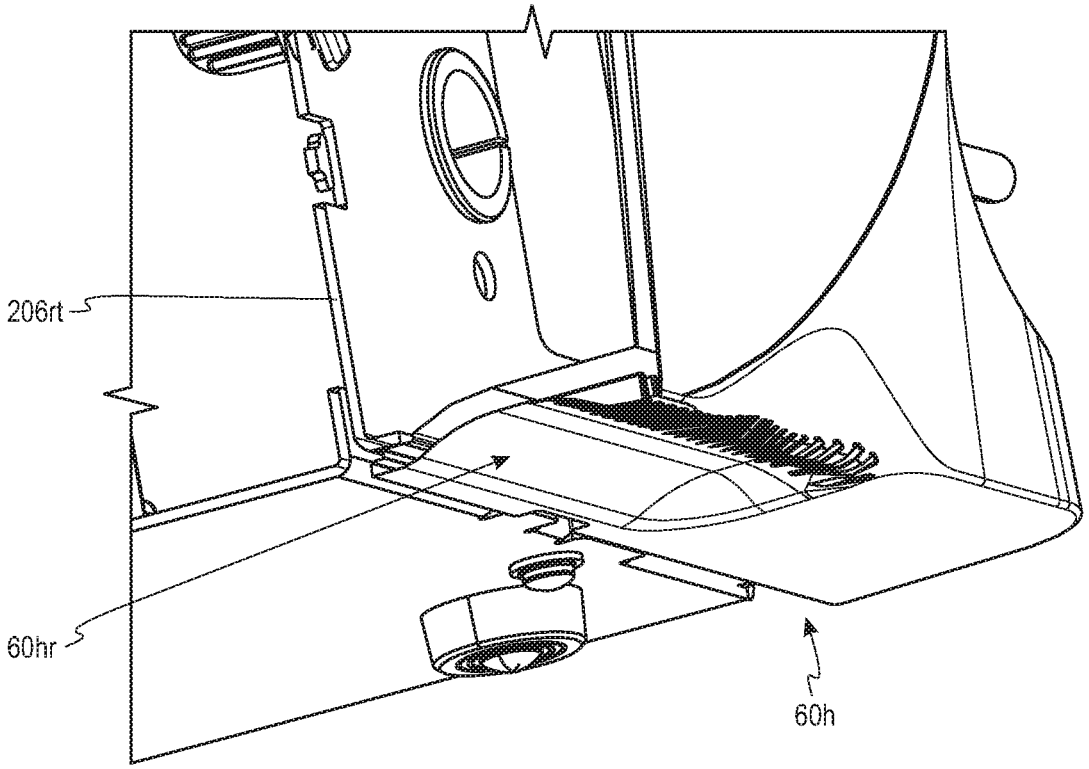


Fig. 9B

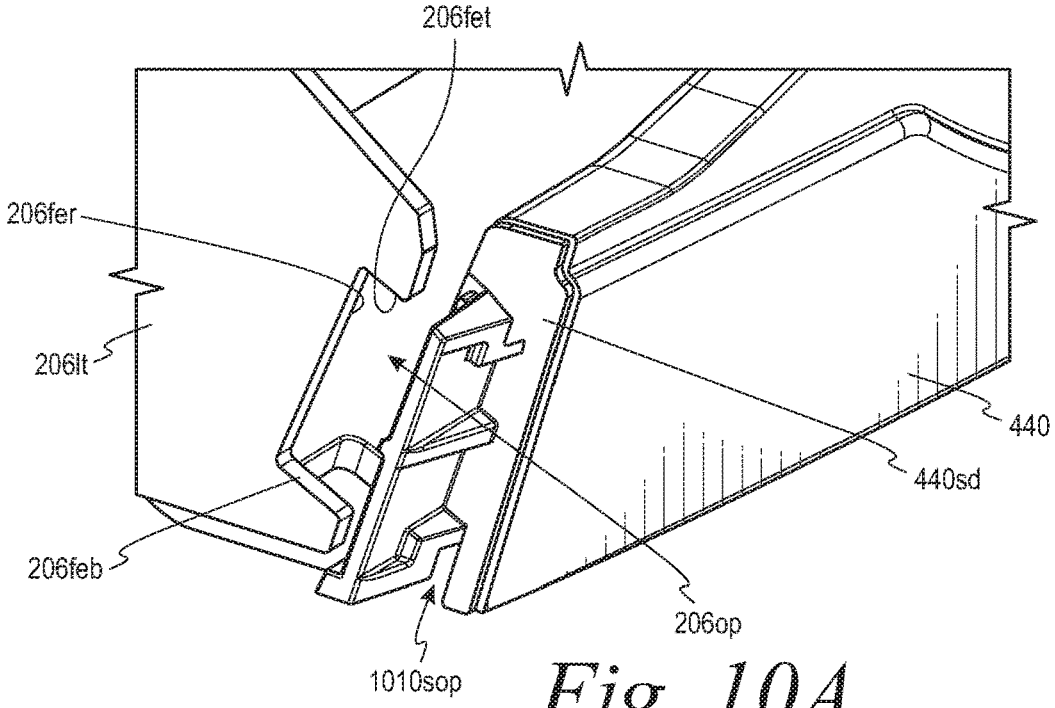


Fig. 10A

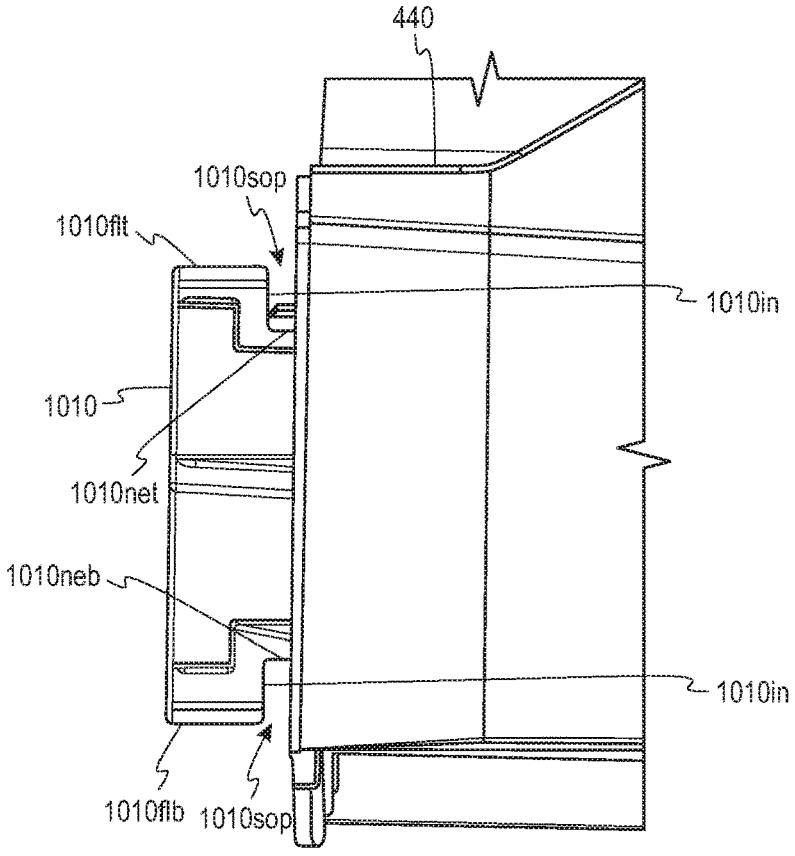


Fig. 10B

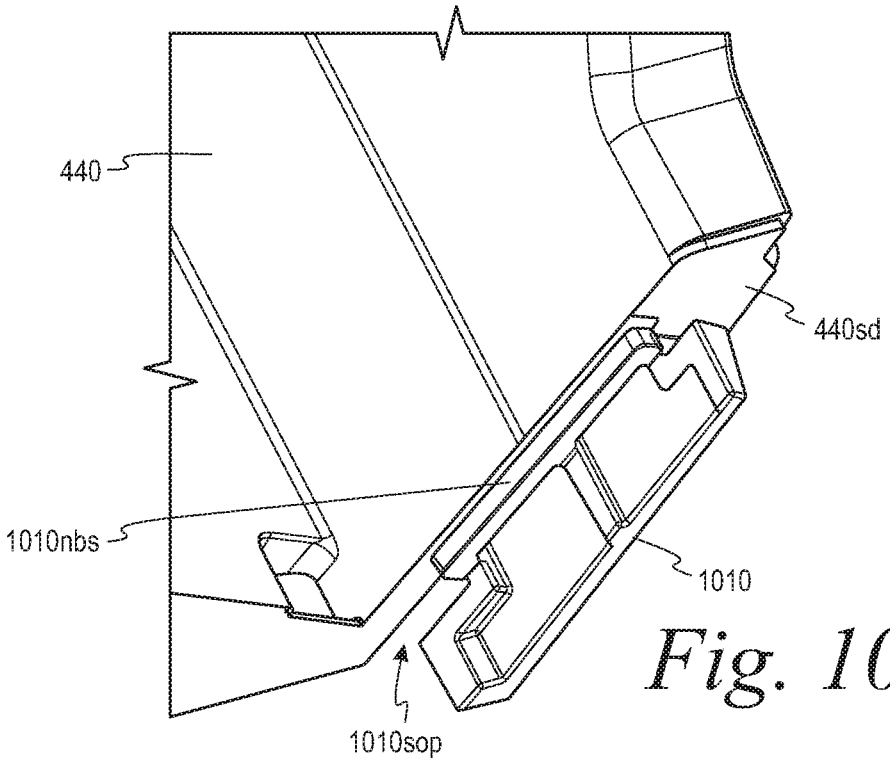


Fig. 10C

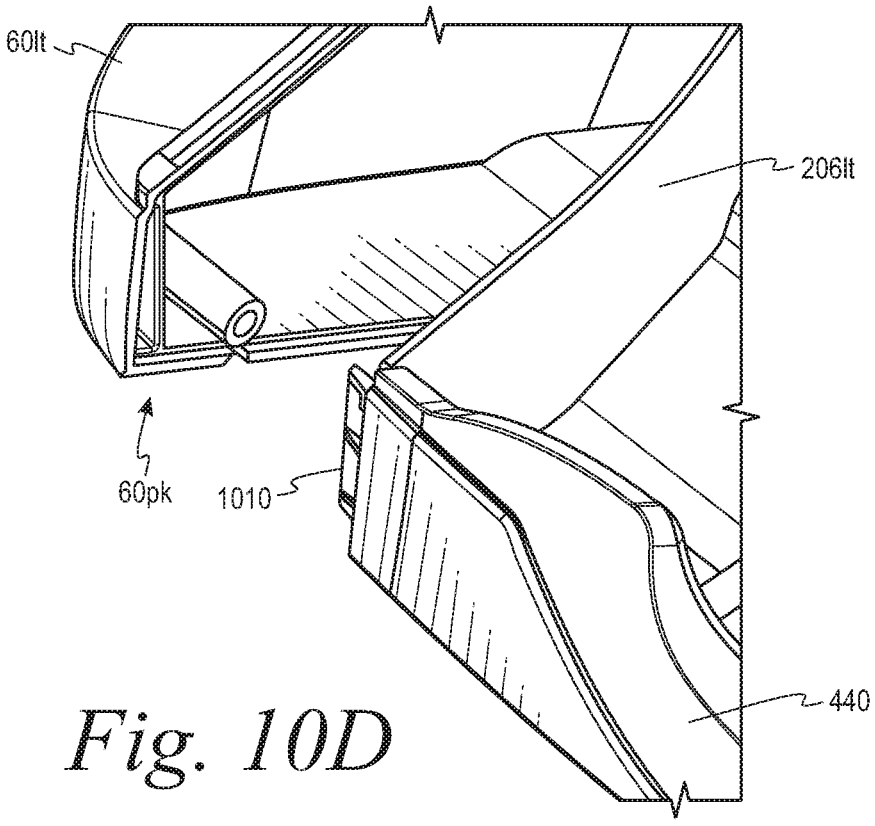


Fig. 10D

BANKNOTE PROCESSING DEVICE AND METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to and the benefit of U.S. Provisional Patent Application No. 62/831,565, filed Apr. 9, 2019, and entitled BANKNOTE PROCESSING DEVICE AND METHODS, which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present disclosure relates generally to banknote or currency bill processing devices and related methods.

SUMMARY

According to some embodiments, a banknote processing device comprises a feeder bracket fixedly coupled to side walls of a banknote processing device, the feeder bracket having longitudinal length and a pair of hopper lug openings positioned near opposite ends of the longitudinal length of the feeder bracket. The banknote processing device further comprising a feeder plate resting upon but not coupled the feeder bracket, the feeder plate having longitudinal length and a pair of slot openings positioned near opposite ends of the longitudinal length of the feeder plate; wherein when the feeder plate is properly positioned relative to the feeder bracket, the slot openings of the feeder plate align with the hopper lug openings of the feeder bracket. The banknote processing device further comprising a hopper bracket having a bottom surface resting on an upper surface of the feeder plate, the hopper bracket having a longitudinal length and a pair of hopper lugs positioned near opposite ends of the longitudinal length of the hopper bracket and extending downward from the bottom surface of the hopper bracket through the slot openings of the feeder plate and the hopper lug openings of the feeder bracket; wherein when the hopper bracket and feeder plate are in an operational position with respect to the feeder bracket, top surfaces of the hopper lugs contact a bottom surface of the feeder bracket establishing an interference fit therebetween so as to maintain the hopper bracket and feeder plate in their operational positions without either the hopper bracket or the feeder plate being fixedly coupled to feeder plate or the rest of the banknote processing device; wherein the hopper bracket is instead removably coupled to the feeder bracket and the feeder plate is sandwiched therebetween.

According to some embodiments, an output receptacle of a banknote processing device comprises a stacker tray having a longitudinal length and having an upper edge that has a central, downward curved portion in a middle portion of the longitudinal length and two curved portions, one on each side of the middle portion, wherein the two curved portions arc upward toward the middle of the stacker tray and a middle of the output receptacle.

According to some embodiments, a banknote processing device comprises a display assembly pivotally mounted about a first axis near a first end of the transport plate, the display assembly having an operational position and an open position; a banknote transport path defined at least in part by a transport plate on one side of the transport path, the transport plate being pivotally mounted about a second axis near a first upstream end of the transport plate, the transport plate having an operational position and an open position;

and a linkage coupled on one end to the display assembly and coupled on a second end to the transport plate near a second downstream end of the transport plate; wherein when the display assembling is rotated from its operational position to an open position, the linkage causes the transport plate to move from its operational position to an open position.

According to some embodiments, a banknote processing device comprises a pair of opposing side plates in spaced relation from each other, each side plate having at least one cleat hooked thereon; a beam having a longitudinal length having two ends which when the beam is positioned in an operational position the longitudinal length extends between the two side plates; and a pair of springs, each of the spring being mounted between a respective end of the beam and a corresponding cleat.

According to some embodiments, a banknote processing device comprises a driven transport shaft having a magnetic coupled to an end thereof; and a magnetic encoder adjacent to but spaced from the magnet.

According to some embodiments, a banknote processing device comprises a transport shaft mounted between two sides plates of the banknote processing device, wherein a first end of the shaft is coupled to a hold-down screw; a shaft adjustment mechanism comprising an adjustment plate pivotally mounted about a first axis to a first one of the side plates, wherein the adjustment plate comprises an arc-shaped aperture defined by an arc-shaped edge, wherein the arc-shaped aperture and edge are slightly non-concentric with respect to the first axis; wherein the adjustment plate comprises an arc-shaped edge which is concentric with respect to the first axis and wherein the arc-shaped edge has a plurality of teeth; wherein the first one of the side plates has a vertical slot opening therein and wherein the hold-down screw passes through both the arc-shaped aperture in the adjustment plate and the vertical slot opening in the first one of the side plates; wherein the first one of the side plates has an adjustment tool receiving aperture therein, wherein when an end of an adjustment tool having a plurality of teeth thereon is inserted in the adjustment tool receiving aperture, a rack and pinion type of mesh is established between the adjustment plate teeth and the teeth on the end of the adjustment tool such that rotating the adjustment tool causes the rotation of the adjustment plate and the associated adjustment plate arc opening and adjustment plate arc opening edge which in turn vertically moves the hold-down screw within the vertical slot opening and vertically moves the end of the shaft to which the hold-down screw is coupled.

According to some embodiments, a banknote processing device comprises a banknote transport path defined at least in part by a transport plate on one side of the banknote transport path, the banknote transport plate being pivotally mounted about a first axis near an upstream end of the transport plate, the transport plate including a working position and an open position, a display assembly being pivotally mounted about a second axis spaced a defined distance apart from the first axis, the display assembly including an operational position and a non-operational position, and a linkage coupled to display assembly and to the transport plate near a downstream end of the transport plate, wherein, when the display assembly is rotated from the operational position to the non-operational position, the linkage causes the transport plate to move from the working position to the open position.

According to some embodiments, a method of a banknote processing device comprises rotating a display assembly

from an operational position to a non-operational position, wherein a linkage is coupled to the display assembly and to a transport plate near a downstream end of the transport plate, wherein the transport plate defines, at least in part, a banknote transport path, wherein the transport plate is pivotally mounted about a first axis near an upstream end of the transport plate, and wherein the display assembly is pivotally mounted about a second axis spaced a defined distance apart from the first axis, and moving the transport plate from a working position to an open position, wherein the movement is caused by the coupling of the linkage to the display assembly and the transport plate and the rotation of the display assembly.

The above summary is not intended to represent every embodiment or every aspect of the present disclosure. Rather, the foregoing summary merely provides an exemplification of some of the novel aspects and features set forth herein. The above features and advantages, and other features and advantages of the present disclosure, which are considered to be inventive singly or in any combination, will be readily apparent from the following detailed description of representative embodiments and modes for carrying out the present inventions when taken in connection with the accompanying drawings and the appended claims.

Other technical features may be readily apparent to one skilled in the art from the following figures, descriptions, and claims.

Definitions for other certain words and phrases are provided throughout this patent document. Those of ordinary skill in the art should understand that in many if not most instances, such definitions apply to prior as well as future uses of such defined words and phrases.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of this disclosure, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

FIG. **1**A is a perspective view of a banknote processing device according to some embodiments of the present disclosure;

FIG. **1**B is a front view of the banknote processing device of FIG. **1**A;

FIG. **1**C is a rear view of the banknote processing device of FIG. **1**A;

FIG. **1**D is a left side view of the banknote processing device of FIG. **1**A;

FIG. **1**E is a right side view of the banknote processing device of FIG. **1**A;

FIG. **1**F is a top view of the banknote processing device of FIG. **1**A;

FIG. **1**G is a bottom side view of the banknote processing device of FIG. **1**A;

FIG. **2**A is a side cross-sectional view of the banknote processing device of FIG. **1**A;

FIG. **2**B is a top view of some components of the banknote processing device of FIG. **1**A;

FIG. **2**C is a front view of some components of the banknote processing device of FIG. **1**A;

FIG. **2**D is a side view of some components of the banknote processing device of FIG. **1**A;

FIG. **2**E is a side perspective view of some components of the banknote processing device of FIG. **1**A;

FIG. **2**F is a downward perspective view of some components of the banknote processing device of FIG. **1**A;

FIG. **2**G is a block diagram of some components of the banknote processing device **10** according to some embodiments;

FIG. **3**A is an exploded perspective view of select components associated with an input hopper according to some embodiments;

FIG. **3**B is a front perspective view and FIG. **3**C is a side perspective view of a hopper extension guide or bracket according to some embodiments;

FIG. **3**D is a top perspective view and FIG. **3**E is a bottom perspective view of a feeder plate according to some embodiments;

FIG. **3**F is a top perspective view and FIG. **3**G is a bottom perspective view of a feeder bracket according to some embodiments;

FIG. **3**H is a side view and FIG. **3**I is a partial bottom perspective of select components associated with an input hopper in an operational assembled state according to some embodiments;

FIG. **3**J is a bottom perspective of select components associated with an input hopper in an operational assembled state according to some embodiments;

FIG. **3**K is a downward perspective view of a banknote processing device according to some embodiments of the present disclosure having a hopper extension guide or bracket and a feeder plate removed;

FIG. **4** is a front view of stacker tray of an output receptacle of a banknote processing device according to some embodiments;

FIG. **5**A is a side sectional view of some components of a banknote processing device according to some embodiments illustrating a display assembly and upper transport plate positioned in an operational position;

FIG. **5**B is a side sectional view of some components of a banknote processing device according to some embodiments illustrating the display assembly and upper transport plate of FIG. **5**A positioned in an open, service position;

FIG. **6**A is a bottom perspective view of a banknote processing device having a bottom panel removed according to some embodiments illustrating idler or passive roller assemblies;

FIG. **6**B is a rear perspective view of some components of a banknote processing device having a rear panel removed according to some embodiments illustrating idler or passive roller assemblies;

FIG. **6**C is a rear perspective view idler or passive roller assemblies mounted between two side walls or plates;

FIG. **6**D is a rear perspective view of an idler or passive roller assembly having two idler rollers mounted thereon and FIG. **6**E is a rear perspective view of an idler or passive roller assembly having one idler roller mounted thereon and a second idler roller removed and illustrating an idler roller mounting post;

FIG. **6**E**1** is an enlarged perspective view of an idler roller mounting post;

FIG. **6**E**2** is a perspective view of an idler roller;

FIG. **6**F is an end plan view of one side of an idler clip or spring cleat and FIG. **6**G is a perspective view of an idler clip or spring cleat;

FIG. **6**H is a plan view of a portion of a side wall or plate illustrating two idler clip or spring cleat apertures;

FIG. **6**I is a bottom perspective view of some components of a banknote processing device according to some embodiments illustrating the removal of an idler roller assembly and an idler roller;

FIG. **6**J**1** is an enlarged perspective view of a spring post of an idler roller beam and a spring post of a spring cleat;

FIG. **6J2** is an enlarged perspective view of a coil spring;

FIG. **7**A is a perspective view of some components of a banknote processing device according to some embodiments illustrating a magnetic encoder;

FIG. **7**B is an enlarged view of a portion of FIG. **2**B illustrating a magnetic encoder adjacent a magnet on the end of a driven roller shaft;

FIG. **8**A is a perspective view of some components of a banknote processing device according to some embodiments illustrating a shaft adjustment mechanism;

FIG. **8**B is a perspective view of a shaft adjustment mechanism according to some embodiments;

FIG. **8**C is a perspective view of that shown in FIG. **8**B with the adjustment plate removed;

FIG. **9**A is an upward bottom perspective view of a handle according to some embodiments;

FIG. **9**B is an upward cross-sectional bottom perspective view of a handle according to some embodiments;

FIG. **10**A is a perspective view illustrating an assembly of a stacker tray and a side plate according to some embodiments;

FIG. **10**B is a front view of a stacker tray according to some embodiments;

FIG. **10**C is a rear perspective view of a positioning tab of a stacker tray; and

FIG. **10**D is a perspective view illustrating an assembly of a stacker tray and a side plate with a side cover according to some embodiments.

The present disclosure is susceptible to various modifications and alternative forms, and some representative embodiments have been shown by way of example in the drawings and will be described in detail herein. It should be understood, however, that the inventive aspects are not limited to the particular forms illustrated in the drawings. Rather, the disclosure is to cover all modifications, equivalents, combinations, and alternatives falling within the spirit and scope of the inventions as defined by the appended claims.

DETAILED DESCRIPTION

Referring to FIGS. **1**A-**2**G a banknote processing device **10** and/or components thereof according to some embodiments of the present disclosure are shown. The banknote processing device **10** comprises in input hopper or receptacle **30** and an output receptacle **40**. According to some embodiments, two stacker wheels **42** stack processed banknotes or other documents in the output receptacle **40**. According to some embodiments, the banknote processing device **10** comprises a display assembly **50** which comprises a user interface **52**. According to some embodiments, the banknote processing device **10** comprises two side covers **60***rt*, **60***lt*.

Banknotes or documents to be processed by the banknote processing device **10** are stacked within input hopper **30**. A transport mechanism **70** then transports the banknotes or documents along a transport path, past one or more sensors or detectors **72**, and to the output receptacle **40**. With reference to FIG. **2**G, according to some embodiments, the banknote processing device **10** comprises one or more processors and/or controllers **75** such as a CPU communicatively coupled to a memory **74**, one or more hopper sensors **32**, one or more output receptacle sensors **34**, components controlling the transport mechanism **70** such as one or motors controlling movement of various driven rollers and the stacking wheels **42**, the one or more banknote or document sensors or detectors **72**, one or more encoders **797**, and/or the user or operator interface **52**. According to some embodiments sensors or detectors **72** include one or more denomination sensors, one or more image scanner(s), one or more authentication sensors, one or more density sensors, one or more fitness sensors, or a combination thereof

According to some embodiments, the operation of banknote processing device **10** and its components are similar to those described in U.S. Pat. No. 5,815,592, incorporated herein by reference in its entirety. According to some embodiments, the operation of banknote processing device **10** and its components are similar to those described in U.S. Pat. Nos. 5,815,592 and 5,790,697, each of which is incorporated here by reference, including the modes of operation described therein (e.g., Mixed Mode, Stranger Mode, etc.).

With reference to FIGS. **2**A-**2**F, the banknote processive device **10** comprises a transport mechanism **70** which may comprise stripping or auxiliary wheels **274**, a driven drive or drum roll **275**, a retard bracket assembly **279**RA comprising an idler roll **276**, retard rollers **279**, pressure roll **236**, retard assembly mounting shaft **279**SH, passive or idler rollers **610**, and/or downstream driven rolls **298** which cooperate to strips banknotes from the bottom of a stack of banknotes residing in input hopper **30** and transport them sequentially in a non-overlapping manner along a transport path from the input hopper **30** to the stacker wheels **42**. The driven drive roll **275**, the downstream driven rolls **298**, and the stacker wheels **42** are driven and controlled by one or more motors controlled by the more or more processors **75**. For example, a drive motor shaft may rotational drive shafts on which drum roll **275** and downstream driven rolls **298** are mounted using one or more drive belts **251**. More details about an exemplary transport mechanism such as a transport mechanism **70** that may be used in banknote processing device **10** are contained in U.S. Pat. No. 5,815,592, incorporated herein by reference in its entirety (see, e.g., FIGS. **19**-**21***a* and the related description thereof).

According to some embodiments, banknotes to be transported by the transport mechanism **70** are generally rectangularly shaped having two generally parallel wide or long edges and two generally orthogonal narrow or short edges and two banknote surfaces or faces. According to some embodiments, the banknote transport mechanism **70** is employed to transport banknotes in a wide-edge leading manner. According to some embodiments, the banknote transport mechanism **70** is configured to transport U.S. banknotes.

According to some embodiments, the transport mechanism **70** is operated at high speeds and can transport banknotes at a rate of at least 1000 banknotes per minute along the transport path such as, for example, at a rate of at least 1000 U.S. banknotes per minute in a wide-edge leading manner.

According to some embodiments, the transport mechanism **70** transports banknotes at a rate of at least 600 banknotes per minute along the transport path such as, for example, at a rate of at least 600 U.S. banknotes per minute in a wide-edge leading manner.

According to some embodiments, the transport mechanism **70** transports banknotes at a rate of at least 800 banknotes per minute along the transport path such as, for example, at a rate of at least 800 U.S. banknotes per minute in a wide-edge leading manner.

According to some embodiments, the transport mechanism **70** transports banknotes at a rate of at least 1200 banknotes per minute along the transport path such as, for

example, at a rate of at least 1200 U.S. banknotes per minute in a wide-edge leading manner.

According to some embodiments, the transport mechanism **70** transports banknotes at a rate of at least 1400 banknotes per minute along the transport path such as, for example, at a rate of at least 1400 U.S. banknotes per minute in a wide-edge leading manner.

According to some embodiments, the transport mechanism **70** transports banknotes at a rate of at least 1500 banknotes per minute along the transport path such as, for example, at a rate of at least 1500 U.S. banknotes per minute in a wide-edge leading manner.

According to some embodiments, the banknote processing device **10** comprises one or more sensors configured to retrieve information from processed banknotes to denominate the banknotes such as, for example, determining the denomination of U.S. banknotes of a plurality of denominations and generating a total of the value of a stack or batch of banknotes processed by the banknote processing device **10**.

According to some embodiments, the banknote processing device **10** comprises one or more scanheads configured to optically detect patterns from passing banknotes and determine the denomination of each passing banknote as described in U.S. Pat. No. 5,815,592, incorporated herein by reference in its entirety (see, e.g., scanheads **18***a* and **18***b* in FIGS. **24-28**, FIGS. **2-5** and **29**, and the related description thereof).

According to some embodiments, in place of or in addition to scanheads **18***a*, **18***b* described in U.S. Pat. No. 5,815,592, banknote processing device employs a first one-inch wide imaging sensor having a resolution of 288 pixels which employs 288 photosensors instead of the single photodetector found in each of the scanheads **18***a*, **18***b*. A second one-inch wide imaging sensor having a resolution of 288 pixels may additionally be employed and be positioned on the opposite side of the transport path in a manner similar to the positioning of scanheads **18***a*, **18***b* to enable imaging of a central strip on both sides of a passing banknote. The one-inch 288-pixel sensor is more robust and accurate than the half-inch wide scanhead **18***a*, **18***b* described in U.S. Pat. No. 5,815,592 that contains only a single photodetector. According to some embodiments, the one-inch 288-pixel sensor provides a low-cost alternative for denominating US currency that is accurate and operates at very high speeds. For example, according to some embodiments, the transport mechanism, the one-inch 288-pixel sensor(s), and the one or more processors **75** transport and denominate U.S. banknotes at rates of at least 600 banknotes per minute, at least 800 banknotes per minute, at least 1000 banknotes per minute, at least 1200 banknotes per minute, and/or at least 1400 banknotes per minute. According to some embodiments, the one-inch 288-pixel sensor improves throughput of the banknote processing device **10** by reducing the number of no-calls and the corresponding number of times the transport mechanism **70** must be stopped.

According to some embodiments, the one-inch 288-pixel sensor improves denominating accuracy and provides more data to the one or more processors **75** of the banknote processing device **10** that enables greater resiliency to accommodate changes in new US banknote designs.

Additional sensors or detectors **72** such as, for example, authentication sensors may also be employed in the banknote processing device **10**.

According to some embodiments, instead of or in addition to scanheads **18***a*, **18***b* described in U.S. Pat. No. 5,815,592 and/or the one-inch 288-pixel imaging sensor(s) described above, the banknote processing device may employ one or more full-width imaging scanheads such as those described in U.S. Pat. Nos. 8,401,268; 8,437,530; 8,781,206; 9,355,295, each incorporated herein by reference in its entirety.

Referring to FIG. **1**C, according to some embodiments the banknote processing device **10** has a rear access panel **604**. Referring to FIG. **1**G, according to some embodiments the banknote processing device **10** has a bottom access panel **602**. According to some embodiments, the rear **604** and/or bottom **602** access panels are configured to be easily opened to permit a person such as a service technician easy access to the interior of the banknote processing machine **10**. For example, rear panel **604** and/or bottom panel **602** may be hingedly coupled to the banknote processing device such as to the side walls or plates **206***lt*, **206***rt* at points **124** in FIG. **1**C and points **121** in FIG. **1**G. For example, referring to FIG. **1**G, bottom panel **602** may be hingedly coupled to side plates **206***rt*, **206***lt* about axis **123** and the bottom plate may be pivotally opened after simply removing two screws **122**.

Referring now to FIGS. **3**A-**3**K, FIG. **3**A is an exploded perspective view of select components associated with an input hopper such as input hopper **30** shown in FIG. **1** according to some embodiments. FIG. **3**B is front perspective view and FIG. **3**C is side perspective view of a hopper extension guide or bracket **316** according to some embodiments. FIG. **3**D is top perspective view and FIG. **3**E is bottom perspective view of a feeder plate **314** according to some embodiments. FIG. **3**F is top perspective view and FIG. **3**G is bottom perspective view of a feeder bracket **312** according to some embodiments. FIG. **3**H is side view and FIG. **3**I is a partial bottom perspective of select components associated with an input hopper in an operational assembled state according to some embodiments. FIG. **3**J is a bottom perspective of select components associated with an input hopper in an operational assembled state according to some embodiments. FIG. **3**K is a downward perspective view of a banknote processing device **10** according to some embodiments of the present disclosure having a hopper extension guide or bracket **316** and a feeder plate **314** removed.

The feeder bracket **312** is fixedly coupled to side walls of the banknote processing device **10** such as via screws according to some embodiments. The feeder plate **314** rests upon to the feeder bracket **312** according to some embodiments. The hopper extension bracket **316** is removably coupled to the feeder bracket **312** according to some embodiments. According to some embodiments, the feeder plate **314** has a longitudinal length and a pair of slot openings **314***s* positioned near opposite left and right ends **314***lt*, **314***rt* of the longitudinal length of the feeder plate. The hopper bracket **316** has a pair of hopper lugs **316***lug* extending from a bottom surface **316***b* of the hopper bracket **316**. The hopper lugs **316***lug* have lower flanges or hooks **316***fl* which along with the bottom surface **316***b* define a feeder plate engagement opening **316***op*. The lower flanges or hooks **316***fl* are sized and configured to fit through the slot openings **314***s*. The lower flanges or hooks **316***fl* are also sized and configured to fit through hopper lug or hook openings **312***ho* in the feeder bracket **312**. When the hopper bracket **316** is moved rearward with respect to the feeder plate **314** and the feeder bracket **312**, top surfaces **316***flt* of the lower flanges or hooks **316***fl* of the hopper lugs **316***lug* contact a bottom surface **312***b* of the feeder bracket **312** so that hopper bracket **316** clips into the feeder bracket **312** via an interference fit. According to some embodiments, the top surfaces **316***flt* of each lower flange or hook **316***fl* of the hopper lugs **316***lug* contact a bump, projection, or dimple **312***dm* on the bottom surface **312***b* of the feeder bracket **312**

so that hopper bracket **316** clips into the feeder bracket **312** via an interference fit with the feeder plate **314** positioned between the hopper bracket **316** and the feeder bracket **312**. Dimple **312***dm* also creates a gap between the inside surface of the hopper lugs **316***lug* relative to the primary underside surface of feeder bracket **312**. Without the gap created by the dimple **312***dm,* when hopper lugs **316***lug* are pushed back to engage the feeder bracket **312**, the hopper lugs **316***lug* would contact the sheet metal edge adjacent to hook openings **312***ho,* which would likely shave or scrape material from the hopper lugs **316***lug*. Dimple **312***dm* prevents the aforementioned scraping or shaving, while simultaneously providing a surface with which to create the interference fit between the feeder bracket **312** and the hopper lugs **316***lug*.

To remove the hopper bracket **316** from the feeder plate **314** and feeder bracket **312**, the hopper bracket **316** is manually slid forward relative to the feeder bracket **312** so that the interference fit between the top surfaces of the lower flanges or hooks **316***fl* of the hopper lugs **316***lug* and the bottom surface **312***b* of the feeder bracket **312** is disengaged and then the hopper lugs **316***lug* are lifted out of hopper lug or hook openings **312***ho* in the feeder bracket **312** and the slot openings **314***s* of the feeder plate **314**. The feeder plate **314** may then be vertically lifted off the feeder bracket **312**.

The interference fit between the hopper bracket **316** and the feeder plate **314** enables the hopper extension bracket **316** to be easily snap coupled to and removed from the feeder plate **314** without the use of tools and fasteners such as screws.

To assemble the feeder plate **314** and hopper extension **316**, the feeder plate **314** is first placed on the feeder bracket **312**. According to some embodiments, the feeder plate **314** has one or more projections or tabs **314***t* on the bottom surface **314***b* thereof and the feeder bracket **312** has a corresponding one or more tab openings **312** to sized and positioned to accommodate the tabs **314***t* fitting therethrough so as to aid in the feeder plate **314** being easily positioned on top of the feeder bracket **312** in the correct location. According to some embodiments, the tabs **314***t* on the bottom surface **314***b* and the corresponding tab openings **312** to constrain the movement of the feeder plate **314** left or right or forward or backward relative to the feeder bracket **312**.

Next, the two lugs **316***lug* on the bottom of the hopper bracket **316** are lined up with openings **314***s* in the feeder plate **314**. Once the lugs **316***lug* on the hopper bracket **316** are inserted into the openings **314***s* in the feeder plate **314**, the lugs **316***lug* pass through corresponding hopper lug or hook openings **312***ho* in the feeder bracket. Then the hopper bracket **316** is manually forced or moved rearward away from the front of banknote processing device **10**, thereby securing the hopper bracket **316** in place by an interference fit between the edge of the opening **316***op* in the lug **316***lug* and a dimple **312***dm* in the feeder bracket **312**. According to some embodiments, the hopper extension bracket **316** and the feeder plate **314** are thus firmly secured in place, eliminating rattling. Yet, the hopper extension bracket **316** and the feeder plate **314** can be easily removed without any tools.

According to some embodiments, a cantilever hook **314***h* in the feeder plate **314** seats in a pocket **316***p* having a pocket edge **316***pe* on the hopper bracket **316** providing a person coupling the hopper bracket **316** to the feeder bracket **312** with a tactile and audible indicator that the hopper extension bracket **316** is properly seated with respect to the feeder bracket **312** and the feeder plate **314**.

In addition to the hopper extension **316**, the feeder plate **314** can also be simply removed without tools once the extension is removed. Once hopper extension bracket **316** has been removed from the feeder plate **314**, the feeder plate **314** can easily be removed by lifting the feeder plate **314** away from the feeder bracket **312** and out of banknote processing device **10**. With reference to FIG. **3**K, once the feeder plate **314** has been removed, easy access to a feeder area is provided to a person such as an operator or service personnel which can facilitate, for example, the removal of any coins or debris that have fallen into the feeder area and/or to facilitate clearing any jams of one or more banknotes or other documents processed by the banknote processing device. As can be seen in FIG. **3**K, after the hopper extension bracket **316** and the feeder plate **314** have been removed, an opening **312***op* in the feeder bracket **312** allows a person access to the area below within the banknote processing device **10** such as to the area near various rollers and transport plates.

According to some embodiments, a hopper sensor **32** (see e.g., FIGS. **1**F and **3**K) communicatively coupled to a processor, e.g., processor **75**, detects the presence or absence of the feeder plate **314** relative to the feeder bracket **312**. When the sensor detects the absence of the feeder plate **314** relative to its proper location with respect to the feeder bracket **312**, the processor prevents one or more motors of the banknote processing device **10** from automatically starting such as when a banknote hopper sensor otherwise would signal a transport motor to start rotating a feed roller.

According to some embodiments, a hopper sensor **32** is mounted in the banknote processing device **10** by being coupled to the feeder bracket **312** and not to the feeder plate **314**, which simplifies the installation and/or removal of the feeder plate **314**. According to some embodiments, the feeder plate **314** has an opening **314***op* to allow the hopper sensor **32** positioned below to detect when banknotes are resting on the feeder plate **314**.

According to some embodiments, the hopper bracket **316** has one or more banknote surfaces to constrain the movement of banknotes stacked in the hopper **30** on the feeder plate **314** such as a left side surface **316***lt,* a right side surface **316***rt,* and/or a rear surface **316***bk.* When a stack of banknotes is placed in the hopper **30** on feeder plate **314**, edges of the banknotes in the stack are constrained from moving left, right, or rearwardly by the left side surface **316***lt,* the right side surface **316***rt,* and the rear surface **316***bk,* respectively. The vertical height of the banknote surfaces of the hopper bracket **316** allow for a higher stack of banknotes to be placed in the input receptacle or hopper **30** without the stack of banknotes falling out of the hopper **30**. For example, with reference to FIGS. **1**B and **1**D, without the hopper extension bracket **316** in place, the top of the hopper **30** would be set by the height of the left side **30***lt,* the right side **30***rt,* and back or rear side **30***bk* of the hopper **30**. If a stack of banknotes rises above any of the sides **30***lt,* **30***rt,* or **30***bk,* banknotes could fall out of the hopper **30**. With the hopper extension bracket **316** in place, an additional height **316***h* is added to the hopper **30** allowing for a higher stack of banknotes to be reliably maintained in the hopper **30**.

FIG. **4** is a front view of stacker tray **440** of an output receptacle **40** of a banknote processing device such as banknote processing device **10** according to some embodiments. According to some embodiments, the stacker tray **440** has an upper edge **442** that has a central, downward curved portion **442***m* in a middle portion and two curved portions **442***s*, one on each side of the middle portion **442***m*. See also FIGS. **1**A, **1**B, **1**D, and **2**A. According to some

embodiments, the stacker tray **440** is tilted forward such that the upper edge **442** of an inside surface **440***in* of the stacker tray **440** is positioned forward of a lower portion **440***lw* of the inside surface **440***in* of the stacker tray. See FIG. **2**A. The forward tilt of the inside surface **440***in* of the stacker tray **440** assists with banknotes BN leaning against the stacker tray **440** after being deposited in the output receptacle **40** by the stacker wheels **42** and the stacking of the banknotes BN in the output receptacle neatly on their edges.

According to some embodiments, the two curved portions **442***s* arc upward toward the middle of the stacker tray **440** and the middle of the output receptacle **40**. According to some embodiments, the curve of the two curved portions **442***s* mirror each other about the middle of the stacker tray **440** and the middle of the output receptacle **40**. Accordingly, the curve of the curved portions **442***s* of the upper edge **442** of the stacker tray facilitates an operator's ability to easily slide one or more fingers along the upper edge **442** to tap or push banknotes BN such as U.S. banknotes either to the left (see arrow **4**-A**1**) to align banknotes against the left side wall **40***lt* of the output receptacle **40** or to the right (see arrow **4**-A**2**) to align banknotes against the right side wall **40***rt* of the output receptacle **40**. Additionally or alternatively, the mirrored curve of the curved portions **442***s* of the upper edge **442** of the stacker tray facilitates an operator's ability to easily slide one or more fingers on each hand along the upper edge **442** to tap or push banknotes BN such as U.S. banknotes toward the middle (see arrows **4**-A**1** and **4**-A**2**) of the output receptacle to align banknotes in the middle of the output receptacle **40** while providing a visual indication to an operator to assist in positioning one or more banknotes in the center of the output receptacle **40** such as the height at which the left edge of a banknote BN touches the stacker tray (see point **448***lt*) and the height at which the right edge of a banknote BN touches the stacker tray (see point **448***rt*) and assessing whether these two heights are equal. According to some embodiments, the above design allows an operator to left justify or right justify a stack of banknotes such as U.S. banknotes using a single finger and/or centrally justify a stack of banknotes such as U.S. banknotes using a single finger on each hand.

As stated above, according to some embodiments, the stacker tray **440** has a central, downward curved portion **442***m*. The central portion **442***m* may comprise two curved portions that each arc from a high point on the outside near portions **442***s* to a low point in the center of the output receptacle and the two curved portions may mirror each other about the center of the output receptacle **40**. The downward curved portion **442***m* provides a central opening **444** which facilitates the ability of an operator to easily reach a hand into the output receptacle **40** and grasped and remove a stack of banknotes BN contained therein.

As best seen in FIGS. **1**A, **1**B, **1**D, **1**E, and **1**F, according to some embodiments, to facilitate the ability of an operator to easily reach a hand and/or one or more fingers into the output receptacle **40** and grasped and remove a stack of banknotes BN contained therein and/or to justify banknotes BN stacked in the output receptacle **40**, the output receptacle **40** has left **40***lt* side wall and/or right **40***rt* side wall curved rearwardly away from the stacker tray **440** thereby providing the output receptacle **40** with large side cutouts in the side walls of the output receptacle **40**. With reference to FIG. **1**D, according to some embodiments, such as embodiments for processing U.S. banknotes, the output receptacle **40** has side walls **40***lt*, **40***rt* having a front edge **40***se* that curve away from the upper edge **442** of the stacker tray **440** by a distance **4**-D**3** as much as between about 1¾ inches and 2¾ inches such as being about 2 inches.

With reference to FIG. **4**, according to some embodiments the width **4**-D**1** of the curved portions **442***s*, **442***m* and/or the width **4**-D**2** of the central, downward curved portion **442***m* are sized to assist the justification and/or removal of U.S. banknotes. According to some embodiments, width **4**-D**1** ranges between about 7¾ inches and 8¼ inches such as being about 8 inches wide. According to some embodiments, width **4**-D**2** ranges between about 3.4 inches and 2.9 inches such as being 3.2 inches wide.

FIG. **5**A is a side sectional view of some components of a banknote processing device such as banknote processing device **10** according to some embodiments illustrating a display assembly **50** and an upper transport plate **560** positioned in an operational position. FIG. **5**B is a side sectional view of some components of a banknote processing device according to some embodiments illustrating the display assembly **50** and the upper transport plate **560** of FIG. **5**A positioned in an open, service position.

According to some embodiments, the display assembly **50** comprises a display bezel **510** and a display assembly bracket **520** coupled thereto. According to some embodiments, the display bezel **510** may comprise a display **52** (see FIG. **1**A), a bezel cover **514** and a bezel backing plate **516**. The display assembly **50** is configured to pivot about display assembly pivot axis **510***p* so a front **50***ft* of the display assembly may be manually moved upward and downward about axis **510***p* by an operator.

According to some embodiments, a linkage such as spring link **530** couples the display assembly **50** to the upper transport plate **560** such as near a downstream end **560***ds* of the upper transport plate **560**. The upper transport plate **560** is configured to pivot about an axis **560***p* located near an upstream end **560***us* of the transport plate **560**. According to some embodiments, the spring link **530** is a wire having a loop at each end. One loop is pivotally connected to the upper transport plate **560** and the other loop is pivotally connected to the display assembly **50**. For example, according to some embodiments, one end of the linkage such as spring link **530** may be pivotally connected to the display assembly bracket **520** about an upper link pivot axis **520***p* and the other end of the linkage such as the spring link **530** may be pivotally connected to the upper transport plate **560** about a lower link pivot axis about a downstream driven roll shaft **298***sh*. According to some embodiments, to provide a desired amount of leverage, axis **520***p* is spaced a desired distance apart from axis **510***p* about which the display assembly pivots. In some embodiments, the linkage can be a rigid component, such as a wire, rod, or other components, connected between the transport plate **560** and the display assembly **50** to maintain the distance between the transport plate **560** and the display assembly **50** during movement, and can be made of various materials, such as metal, plastic, or other materials. In some embodiments, the linkage can be an elastic component, such as a compression spring, an extension spring, a torsion spring, or other elastic components, connected between the transport plate **560** and the display assembly **50** that can compress or otherwise provide an elastic force on the transport plate **560** to hold the transport plate **560** in the working position and provide movement to the transport plate **560** when the display assembly **50** is rotated, and can be made of various materials such as metal, plastic, or other materials.

According to some embodiments, the display assembly **50** comprises a display bezel **510** and a pair of lateral display assembly brackets **520**, one end the left side and one near the

right side of the display bezel **510**, and the display assembly **50** comprises a pair of laterally spaced spring links **530** which couple the display assembly **50** via the lateral display assembly brackets **520** to the upper transport plate **560** such as near a downstream end **560***ds* of the upper transport plate **560** near both the left and right sides of the transport plate **560**.

When the display assembly **50** is opened by rotating it upward, the spring link **530** pulls the front or downstream end **560***ds* of the upper transport plate **560** upward, pivoting about axis **560***p* (FIG. **5**B). According to some embodiments, axis **560***p* coincides with drive or drum roll shaft **275***sh* (see, e.g., FIG. **2**F). With the upper transport plate **560** in its upward, open position, operator access is provided to the paper path, for example, to permit the cleaning of sensors and/or the clearing jams of banknotes.

When the display assembly **50** is rotated downward to its working position (shown in FIG. **5**A), the spring link **530** rotates the upper transport plate **560** to its working position. According to some embodiments, the spring link **530** will slightly over travel, which provides an appropriate amount of pressure to hold the upper transport plate **560** in its operational or working position relative to a lower transport plate **570**.

According to some embodiments, the spring link **530** is an over-center spring link. In addition, when the display bezel **510** is closed, the spring link **530** moves over center to hold the upper transport plate **560** in its working position and locked in place. According to some embodiments, the display assembly **50** comprises one or more display assembly stops **50***st,* e.g., one near each of the left side and the right side of the display assembly **50**. According to some embodiments, when the display assembly **50** is rotated downward to its working position (shown in FIG. **5**A), the rotation downward of the front **514***ft* of the bezel **514** is stopped when the bezel backing plate **516** engages the one or more display assembly stops **50***st.*

According to some embodiments, when the display assembly **50** is rotated downward to its working position (shown in FIG. **5**A) and the display assembly **50** abuts against one or more of the display assembly stops **50***st,* the spring link **530** is in a compressed state and exerts a downward force on the upper transport plate **560**. As shown in FIG. **5**A, the relationship between the display assembly pivot axis **510***p,* the upper link pivot axis **520***p,* and the lower link pivot axis about a downstream driven roll shaft **298***sh* is such that the line of action between the display assembly pivot axis **510***p* and the lower link pivot axis about a downstream driven roll shaft **298***sh* falls slightly to the right side of the upper link pivot axis **520***p.* In this over-center state, the spring link **530** exerts a clockwise moment to the display assembly **50**, holding it against a display assembly stop **50***st.* As the display assembly **50** is opened, the spring link **530** is further compressed as the three pivot points (**510***p,* **520***p,* **298***sh*) are aligned. Further rotation of the display assembly **50** initially unloads the spring link **530**, then utilizes the link **530** as a tension member to open the upper transport plate **560**.

Thus, according to some embodiments, an operator can transition the display assembly **50** and the upper transport plate **560** between their respective operational, working positions and their open, non-operational positions to facilitate access to an area between the upper transport plate **560** and the lower transport plate **570** by simply manually pivoting the display bezel **510** upward and downward. The function of the linkage such as spring link **530** provides a simple mechanism for a person (such as a user or operator or service personnel) to clean sensors and/or clear jams by interacting with one component of the banknote processing machine **10** without having to unlock or remove anything. The pivoting upward of the upper transport plate **560** leaves a wide opening, making it easier for the user to perform one or more desired tasks. The spring link **530** is a low-cost solution that provides a linkage and secures the upper transport plate **560** in its proper working position with an appropriate pressure.

According to some embodiments, the design of the display assembly **50** and the side covers **60***lt,* **60***rt* of the banknote processing device **10** also makes it obvious to the operator when the upper transport plate **560** is not fully closed to its working position. According to some such embodiments, the left **510***lt* and/or right **510***rt* surface of the display assembly **50** is configured to be flush with the adjacent portions **60***dlt,* **60***drt* of the side covers **60***lt,* **60***rt* (see, e.g., FIG. **1**A) when the upper transport plate **560** is in its locked, working position.

According to some embodiments, the banknote processing device **10** is provided with a display assembly **50** that permits the angle of the display/user interface **52** to be adjusted to accommodate varying viewing angles preferred by one or more operators. For example, operators may have varying heights and/or the banknote processing device **10** may be placed on counters or table tops having varying heights. According to some such embodiments, the same spring link **530** may be used to provide some adjustability in the display bezel **510** to allow customers to adjust the display bezel **510** to the best viewing angle. According to some such embodiments, this may be accomplished with the use of a separate spring that assures the transport plate stays locked in position while the display bezel **510** moves slightly. For example, according to some embodiments, a spring-loaded detent may be added to the display assembly **50** to allow independent setting of the display angle relative to the bezel backing plate **516** to allow customers to adjust the display bezel **510** to the best viewing angle.

Referring to FIG. **2**A, opposite a transport path from a drive or drum roll **275**, there are plurality of passive or idler rollers **610** which press banknotes or documents passing therebetween into contact with the drive roll **275**. Likewise, opposite the transport path from downstream driven rolls **298**, there are plurality of passive or idler rollers **610** which press banknotes passing therebetween into contact with the driven rolls **298**. Sometimes the idler rollers **610** need to be replaced as part of maintenance of a banknote processing device such as banknote processing device **10**. Idler rollers assemblies **600** and efficient ways to install, remove, assemble, disassemble, and service the idler rollers **610** and idler rollers assemblies **600** will be discussed in connection with FIGS. **6**A-**6**I.

FIG. **6**A is a bottom perspective view of a banknote processing device such as banknote processing device **10** having a bottom panel **602** (see FIG. **1**G) removed according to some embodiments illustrating idler or passive roller assemblies **600**. FIG. **6**B is a rear perspective view of some components of a banknote processing device such as banknote processing device **10** having a rear panel **604** (see FIG. **1**C) removed according to some embodiments illustrating idler or passive roller assemblies **600**. FIG. **6**C is a rear perspective view idler or passive roller assemblies **600** mounted between two side walls or plates **206***rt,* **206***lt.* FIG. **6**D is a perspective view of an idler or passive roller assembly **600** having two idler rollers **610** mounted thereon and FIG. **6**E is a perspective view of an idler or passive roller assembly **600** having one idler roller **610** mounted thereon

and a second idler roller removed and illustrating an idler roller mounting post or axle **612**. FIG. **6**E**1** is an enlarged perspective view of an idler roller mounting post **612**. FIG. **6**E**2** is a perspective view of an idler roller **610**.

Referring to FIGS. **6**C-**6**D, each idler roller assembly **600** comprises a plurality of idler rollers **610** mounted on an idler roller beam **605**. According to some embodiments, each idler roller **610** is mounted on an idler roller mounting post or axle **612** coupled to or formed integral with the idler roller beam **605**. In FIG. **6**E, one of the idler rollers **610** has been removed illustrating the idler roller mounting post **612** on to which an idler roller **610** may be easily manually mounted and/or removed without the use of tools.

Referring to FIG. **6**E**1**, according to some embodiments, the idler roller post **612** comprises two or more longitudinal projections **612***a*, **612***b* extending from an idler roller post base **612***c*. The distal ends of the two or more longitudinal projections **612***a*, **612***b* are separated from each other by a small gap. The distal ends of the two or more longitudinal projections **612***a*, **612***b* have a lip or flange **612***lp*.

To mount an idler roller **610** onto an idler roller post **612**, a center opening or aperture **610***op* of an idler roller **610** (FIG. **6**E**2**) is aligned with the post **612** and pressed into the distal end of the post **612** along direction **6**E-A**2** causing the distal ends of projections **612***a*, **612***b* to be squeezed toward each other (see arrows **6**E-A**1** in FIG. **6**E**1**). The idler roller **610** is then moved further along the post **612** toward the base **612***c* until the lips **612***lp* of the distal ends of projections **612***a*, **612***b* pass over a rim **611***rm* of a wheel **611** of idler roller **610**. The longitudinal projections **612***a*, **612***b* which are biased outward move away from each other and the lips **612***lp* of the longitudinal projections **612***a*, **612***b* rotatably secure the idler roller **610** on the post **612** by preventing the rim **611***rm* of the wheel **611** from moving off the post in the direction **6**E-A**3**.

To remove an idler roller **610** from an idler roller post **612**, the distal ends of projections **612***a*, **612***b* are manually squeezed toward each other (see arrows **6**E-A**1** in FIG. **6**E**1**) and the idler roller is moved away from the base **612***c* of the post **612** (direction **6**E-A**3** in FIG. **6**E**1**) with the lips **612***lp* of the longitudinal projections **612***a*, **612***b* sliding inside the center opening **610***op* of the idler roller **610**. The idler roller **610** may then be removed from the post **612** by continuing to manually move the idler roller away from the base **612***c*. In FIG. **6**I, idler roller **610'** is shown removed from post **612**.

The idler roller beam **605** has a longitudinal length having two ends **605***a*, **605***b* which when the beam **605** is positioned in an operational position extends between the two side walls or plates **206***rt*, **206***lt* of the banknote processing device **10** (see, e.g., FIG. **6**C). Near each longitudinal end **605***a*, **605***b* the beam **605** has a beam spring post **614** (best seen in FIG. **6**J**1**).

FIG. **6**F is an end plan view of one side of an idler clip or spring cleat **630** and FIG. **6**G is a perspective view of an idler clip or spring cleat **630**. FIG. **6**H is a plan view of a portion of a side wall or plate **206***rt*, **206***lt* illustrating two idler clip or spring cleat retaining apertures or slots **634**. FIG. **6**I is a bottom perspective view of some components of a banknote processing device **10** according to some embodiments illustrating the removal of an idler roller assembly **600** and an idler roller **610'**.

The spring cleat **630** may have a handle portion **630***g* which a person may grasp between a thumb and finger to facilitate the person in holding, moving, and inserting and removing the spring cleat into and out of the aperture **634**. The spring cleat **630** has a cleat spring post **638** about which a first end of a coil spring **640** may abut and be constrained by the spring post **638**. A second end of the coil spring **640** engages about a spring post **614** located near an end **605***a*, **605***b* of an idler roller beam **605**. According to some embodiments, the second end of the coil spring **640** is coupled to the idler roller beam **605** so that it remains attached to the idler roller beam **605** during the installation or removal of the idler roller beam **605** to or from the banknote processing device. According to some such embodiments, the first end of the coil spring **640** is not coupled to the spring post **638** or the spring cleat **630**. Alternatively, according to some embodiments, the first end of the coil spring **640** is coupled to the spring cleat **630** such as by spring post **638** so that it remains attached to the spring cleat **630** during the installation or removal of an idler roller beam **605** to or from the banknote processing device. According to some such alternative embodiments, the second end of the coil spring **640** is not coupled to the spring post **614** or the idler roller beam **605**.

The spring cleat **630** has an exterior portion **630***w* designed to fit through a spring cleat aperture **634** in a side plate **206***rt*, **206***lt* and a larger surface **630***a* that does not fit through the aperture **634** and that abuts an inside surface of the side plate **206***rt*, **206***lt* when the spring cleat **630** is in an operational position. In FIG. **6**I, three cleats **630** are shown in their operational position with exterior portion **630***w* of two of the cleats **630** illustrated on the outside of one of the side plates **206***rt*, **206***lt*. According to some embodiments, the apertures **634** are defined by a T-shaped edge **207** of the side plate **206***rt*, **206***lt*. The edge **207** (and corresponding opening **634** defined thereby) has a longitudinal length extending from a first end **207***a* to a second end **207***b* with the associated T-shape of the aperture **634** having a long, narrower portion **634***w***1** extending from the first end **207***a* associated with the bottom of the T-shape and a transverse, wider portion **634***w***2** associated with the top of the T-shape near end **207***b*. Likewise, the exterior portion **630***w* of the spring cleat **620** may have a corresponding T-shape having a longitudinal length extending from a first end **630***wa* to a second end **630***wb* with the associated T-shape having a long, narrower portion **630***w***1** extending from the first end **630***wa* associated with the bottom of the T-shape and a transverse, wider portion **630***w***2** associated with the top of the T-shape near end **630***wb*.

To install a spring cleat **630** into its operational position, the exterior portion **630***w* is inserted through an aperture **634** in one of the side plates **206***rt*, **206***lt* with the proper orientation (e.g., with narrow portion **630***w***1** positioned near the narrow portion of the aperture **634***w***1** and wider portion **630***w***2** positioned near the wider portion of the aperture **634***w***2**. A spring **640** biases the spring cleat **630** toward the first end **207***a* of edge **207** until one or more inside hook surfaces **630***b* abut portions **207***t* of edge **207** (in direction **6**H-A**1** in FIG. **6**H). The spring **640** then maintains the spring cleat **630** so that inside hook surfaces **630***b* abut portions **207***t*. The exterior portion **630***w* has one or more inside surfaces **630***w***3** which engage with corners **207***t***1** and/or portions **207***t* of edge **207** to prevent the exterior portion **630***w* of the spring cleat **630** from moving back through the aperture **634** in direction **6**G-A**1** in FIG. **6**G. Accordingly, the spring cleat **630** has a hook portion **630***h* formed by surfaces **630***b* and **630***w***3** to engage side wall or side plate **206***rt*, **206***lt* and keep the spring cleat **630** from moving back through the aperture **634** when in an operational position and the spring **640** maintains the spring cleat **630** in its operational position.

The process of removing an idler roller beam **605** will now be described. After opening a bottom panel **602** (see

FIGS. **1**G & **6**A) and/or a rear panel **604** (see FIGS. **1**C & **6**B), a person may gain access to the area below the idler roller beams **605** and the spring cleats **630** associated therewith. With reference to FIG. **6**C, a first spring cleat **630** associated with a beam **605** is released from a side plate **206***rt,* **206***lt* by moving the spring cleat **630** toward the associated idler roller beam **605** (upward as shown by arrow **6**C-A**1** in FIG. **6**C; in the direction opposite of arrow **6**H-A**1** in FIG. **6**H; in the direction of arrow **6**I-A**1** in FIG. **6**I) by manually overcoming the bias of spring **640** and then pulling the exterior portion **630***w* of the cleat **630** through aperture **634**. The first spring cleat **630** may then be set aside. According to some embodiments, wherein the spring **640** is not coupled to either the beam **605** or the cleat **630**, the associated spring **640** is also set aside. This process is repeated for the second spring cleat **630** and/or spring **640** associated with the beam **605**. The beam **605** and the idler rollers **610** thereon may then be moved away from the lower transport plate **570** and removed from the banknote processing device **10** (see, e.g., arrow **6**I-A**2** in FIG. **6**I).

The idler rollers **610** may then be manually pulled off respective idler roller mounting posts or axles **612** of the beam **605**. New idler rollers may then be manually pushed onto the respective idler roller mounting posts or axles **612** of the beam **605**.

The idler roller beam **605** and/or springs **640** may be reinstalled in the banknote processing device **10** and/or a new idler roller beam **605** and/or new springs **640** may be installed in the banknote processing device **10**.

The process of installing an idler roller beam **605** into banknote processing device **10** will now be described. The beam **605** to be installed and the idler rollers **610** thereon are moved toward the lower transport plate **570** and the idler rollers **610** are aligned with idler roller apertures **570***ap* in the lower transport plate **570** (see FIG. **6**B). If one end of a spring **640** is coupled to an end of the beam **605** about one of the spring posts **614**, the other end of the spring is positioned about spring post **638** of a first spring cleat **630** and the first spring cleat is releasably coupled to or hooked on one of the side plates **206***rt,* **206***lt* by inserting the exterior portion **630***w* through a corresponding spring cleat retaining aperture or slot **634** and moving and/or allowing the spring **640** to move the first cleat **630** to its operational position. If one end of a spring **640** is not coupled to an end of the beam **605** about one of the spring posts **614**, one end of the spring is positioned about spring post **638** of the first spring cleat **630** and the other end of the spring is positioned about one of the spring posts **614** of the beam **605** and then the cleat **630** is releasably coupled to one of the side plates **206***rt,* **206***lt* via a retaining aperture **634**. If one end of a spring **640** is coupled to spring post **638** of a first spring cleat **630**, the other end of the spring is positioned about one of the spring posts **614** on the beam **605** and the spring cleat is releasably coupled to one of the side plates **206***rt,* **206***lt* by inserting the exterior portion **630***w* through a corresponding spring cleat retaining aperture or slot **634** and moving and/or allowing the spring **640** to move the first cleat **630** to its operational position. This process is then repeated to releasably couple a second spring cleat **630** to an opposing one of the side plates **206***rt,* **206***lt* to thereby support a second end of the beam **605** with a spring **640** between a second post **614** on the beam **605** and post **638** on the second cleat **630**. Any opened bottom panel **602** (see FIGS. **1**G & **6**A) and/or rear panel **604** (see FIGS. **1**C & **6**B) may then be closed.

The spring-loaded idler rollers **610** are used opposite the driven rollers (drive or drum roll **275**, downstream driven rolls **298**) to provide pressure to press banknotes or documents to be transported against corresponding driven rollers. According to some embodiments, the above spring cleat/beam design makes it easy to install and remove idler rollers **610** from an associated idler roller beam **605** and to install and remove idler or passive roller assemblies **600** from a banknote processing device such as banknote processing device **10**. According to some embodiments, the above design includes spring cleats **630** that individually releasably mount onto the side plates **206***rt,* **206***lt* without the use of any screws, tools, or hardware.

FIG. **6**J**1** is an enlarged perspective view of a spring post **614** of an idler roller beam **605** and a spring post **638** of a spring cleat **630**. FIG. **6**J**2** is an enlarged perspective view of a coil spring **640**. According so some embodiments, the spring posts **638** are dimensioned to hold a spring **640** thereon when the spring cleat **640** is removed from a side plate **206***rt,* **206***lt*. For example, a spring post **638** may be dimensioned to be slightly larger than the interior circumference or diameter of a circular end of a coil spring **640** such that the spring is frictionally coupled to the post **638**. According to some embodiments, the dimension of the post **638** and the interior circumference or diameter of a circular end of a coil spring **640** may be set so that the spring is releasably coupled to the post **638** and may be manually coupled to and removed from the post. According to some such embodiments, the other end of an associated spring **640** is not coupled to a post **614** of a beam **605** but is merely configured to abut and be constrained by the post **614** such as being laterally constrained (laterally being in a direction orthogonal to the axis of spring compression between the two ends of the coil spring).

With reference to FIG. **6**J**1**, according to some embodiments, spring post **614** has a base portion **614***b* which is the widest part of spring post **614**. According to some embodiments, the base portion **614***b* has a width **614***d* slightly less than the inside diameter **640***d* of the spring **640**. According to some embodiments, spring post **638** of a spring cleat **630** has a base portion **638***b* and a rim portion **638***r* located distal of the base portion **638***b*. When in its operational position, the spring **640** has one end nested about the narrower base potion **638***b* and constrained and held in its operational position by the wider rim portion **638***r*. According to some embodiments, the rim portion **638***r* has a width **638***d***2** slightly larger than the inside diameter **640***d* of the spring **640** whereas the base portion **638***b* has a width **638***d***1** which may be slightly less than the inside diameter **640***d* of the spring **640**. The rim portion **638***r* thus holds the spring **640** in its operational position and inhibits the end of the spring **640** positioned about the base portion **638***b* from moving in the direction of arrow **6**J**1**-A**1** in FIG. **6**J**1**. In some embodiments, the width **638***d***2** of rim portion **638***r* is set to constrain an end of the spring **640** from moving out of a position about base portion **638***b* but narrow enough to allow a person to manually pull, push, and/or twist the end of the spring over rim portion **638***r* in order to remove the spring **640** from the cleat **630** and allow a person to manually pull, push, and/or twist the end of the spring over rim portion **638***r* in order to install a spring **640** onto the cleat **630** about base portion **638***b*.

According to some embodiments, the spring cleats **630** support associated springs **640** which apply spring pressure to the axles of associated idler rollers **610**.

Some of the advantages of various embodiments of the above described designs include one or more of the following: (1) providing idler or passive roller assemblies **600** that are very easy to assemble and disassemble without tools during production and/or field service and/or to install into

and/or to remove from a banknote processing device without tools during production and/or field service; (2) providing a very low-cost solution for providing the idler roll spring pressure used to transport documents through a banknote processing device; and/or (3) transferring idler roller spring pressure from a transport plate such as lower transport plate **570** (which in some embodiments may be made of plastic) to side walls or plates **206***rt,* **206***lt* (which in some embodiments may be made of metal such as steel) which can in some embodiments prevent or reduce any undue stress being applied to an associated transport plate **570**. For example, with reference to FIGS. 23 and 24 of U.S. Pat. No. 5,815,592, in a prior banknote processing device, a pair of H-shaped leaf springs **252** and **253** were mounted to a lower transport plate and used to bias passive or idler rolls **250** and **251** into contact with driven rollers on the opposite side of the transport path. With such arrangements wherein the leaf springs are supported by a plastic lower transport plate, the constant pressure applied by the leaf springs that is used to provide a tight grip between the passive rolls and the opposing driven rollers can cause the plastic transport plate to bow and become deformed. According to some embodiments of the present disclosure, by transferring the support/force of the springs **640** from the lower transport plate **570** to the side plates **206***lt,* **206***rt,* spring pressure which might otherwise cause the transport plate **570** to become bowed or deformed is eliminated or reduced. According to some embodiments, by transferring the idler spring pressure to the side walls **206***rt,* **206***lt* rather than the transport plate **570**, both elastic and long-term creep deflection of a plastic transport plate **570** is avoided. According to some embodiments, deflection of the transport plate **570** may affect the performance of the denominating, imaging, and/or other gap-sensitive sensors as well as cause poor feeding or jamming of the banknotes.

According to some embodiments, a banknote processing device such as banknote processing device **10** employs a magnetic encoder to monitor the movement of the transport mechanism. FIG. **7**A is a perspective view of some components of a banknote processing device according to some embodiments illustrating a magnetic encoder **797**. FIG. **7**B is an enlarged view of a portion of FIG. **2**B illustrating a magnetic encoder **797** adjacent a magnet **798** on the end of a driven roller shaft **298***sh.* Referring to FIGS. **2**B, **2**F, **7**A and **7**B, according to some embodiments, a magnet **798** is coupled to the end of one of the driven roller shafts such as downstream driven roll shaft **298***sh* which serves as an encoder shaft and is positioned adjacent to a magnetic encoder **797** which according to some embodiments is located on a printed circuit board **70**. As the encoder shaft **298***sh* with the magnet **798** spins, the encoder **797** reads the rotating magnetic field and determines the angular position of the shaft.

Use of the magnetic encoder has an advantage in that a physical connection is not required between the magnetic encoder **797** and the shaft it is monitoring. According to some embodiments, a magnetic encoder is used to provide the system information about the position of a shaft. According to some embodiments, the implementation of the magnetic encoder does not require a physical connection of the encoder to a spinning shaft driving by a motor. Conversely, an optical encoder requires a physical connection to the spinning shaft to be monitored. Magnetic encoders are more tolerant of dust and lower cost than optical encoders. According to some embodiments, magnetic encoder **797** is an off-the-shelf magnetic encoder and is located on the back side of a printed circuit board **70** that may contain a main processor or CPU. According to some embodiments, the magnetic encoder **797** is an Infineon #TLE5012B magnetic encoder.

FIG. **8**A is a perspective view of some components of a banknote processing device according to some embodiments illustrating a shaft adjustment mechanism **800**. FIG. **8**B is a perspective view of a shaft adjustment mechanism **800**. FIG. **8**C is a perspective view of that shown in FIG. **8**B with the adjustment plate **810** removed. With reference to FIGS. **2**F, **8**A, and **8**B, shaft adjustment mechanism **800** comprises an adjustment plate **810** pivotally mounted about axis **810***p* to one of the side walls or plates **206***rt,* **206***lt.* The adjustment plate **810** also comprises an arc-shaped aperture **810***ap* defined by an arc-shaped edge **811**. The arc-shaped aperture and edge **811** are slightly non-concentric with respect to axis **810***p.* The adjustment plate **810** has an arc-shaped edge **810***e* which is concentric with respect to axis **810***p.* The arc-shaped edge **810***e* has a plurality of teeth **810***th* which collectively comprise a rack. A shaft hold-down screw **271***s* is threadingly screwed into an opening **271***sh-op* in a first end of a shaft to be adjusted by the shaft adjustment mechanism **800** (such as retard roller shaft **271***sh* (see FIG. **2**F)). A washer **830** may be positioned between a head of hold-down screw **271***s* and an outside surface of adjustment plate. A second end of the shaft to be adjusted by the shaft adjustment mechanism **800** (such as retard roller shaft **271***sh* (see FIG. **2**F)) is coupled to a second, opposing one of the side walls or plates **206***rt,* **206***lt.* According to some embodiments, the movement of the shaft hold-down screw **271***s* is constrained to vertical movement within a vertical slot or aperture **822***ap* in the side plate **206***rt* defined by edge **822** and is also constrained by the position of adjustment plate **810** via edges **811** therein.

To adjust the position of the first end of the shaft **271***sh,* the hold-down screw is loosened and an end of an adjustment tool **820** is inserted into an adjustment tool receiving aperture **821** in the side plate **206***rt.* According to some embodiment, the tool **820** has a plurality of teeth thereon and may be a cross-recessed head screwdriver or equivalent (e.g., Torx driver, phillips head screwdriver) that would allow a rack and pinion type of mesh between the adjustment plate teeth **810***th* and the teeth on the end of the tool **820**. While turning the adjustment tool **820**, the rotation of the adjustment plate **810** causes the arc opening **810***p* and edge **811** to move which in turn vertically moves the end of the shaft **271***sh* allowing a service technician to easily and accurately adjust position of the shaft. By rotating the adjustment tool **820**, the eccentric arc of edge **811** vertically moves the hold down screw **271***s* in vertical slot **822***ap.* Once the end of the shaft is in a desired position, the hold-down screw **271***s* is tightened so the end of the shaft **271***sh* no longer moves.

According to some embodiments, to ensure the proper feeding of banknotes or documents along a transport path, it can be important that shafts on which transport rollers are mounted (or which indirectly determined the position of such transport rollers) which are adjacent to each other on opposite sides of a transport path and in between which documents to be transported pass are parallel to each other. Turning to FIG. **2**F, to enhance feeding of banknotes, it may be desirable that retard roller shaft **271***sh* is parallel to drive or drum roll shaft **275***sh.* However, during operation of a banknote processing device such as device **10**, sometimes shafts **271***sh* and **275***sh* move relative to each other such that they are no longer parallel. During a service call, a service technician may need to adjust the positions of the shafts **271***sh* and **275***sh* relative to each other to re-align them so

that they become parallel again. However, with current banknote processing devices, this adjustment may be difficult to do and is done manually using feeler gauges, a slot and a hold down screw. Such a process is an iterative process of adjusting the shaft **271***sh,* locking it in place and checking spacing. According to some embodiments, a service technician determines the end of an adjustable shaft is in a desired position by inserting a piece of paper or a banknote or feeler gauge(s) between two or more pairs of rollers on opposite sides of a transport path and at least some of whose positions are determined by the position of the adjustable shaft controlled by the adjustment plate **810**. The pairs of rollers are spaced laterally respect to each other in a direction generally orthogonal to the direction of transport. The position of one end of the adjustable shaft is then adjusted until matching or similar tension is exerted by the different pairs of opposing rollers on the object (e.g, banknote, feeler gauge) placed therebetween.

According to some embodiments, use of the shaft adjustment mechanism **800** simplifies the precise setting of two independent assemblies, in this case a drum shaft assembly and the retard bracket assembly **279**RA. According to some embodiments, for enhanced accuracy, feeler gauges are used to verify that the gap between the left and right pair of drum rollers **275** and retard rollers **279** are the same.

The shaft adjustment mechanism **800** aids in making the adjustment as to relative parallelism being shafts **271***sh* and **275***sh* much easier. The adjustment plate **810** having a pivot point **810***p* is coupled to the side plate **206***rt* with a corresponding arc (**810***ap,* **811**) that allows the adjustment plate **810** to be easily and accurately pivoted using adjustment tool **820**. The shaft adjustment mechanism **800** thus enables a precise adjustment to the relative positions of shafts **271***s* and **275***sh* such as to set them to be parallel to each other. Furthermore, according to some embodiments, the adjustment mechanism **800** provides a cost-effective means of achieving a precise adjustment between shafts without the shafts moving or slipping relative to each other before the hold-down screw **830** can be tightened.

According to some embodiment, one or more time-of-flight ("ToF") sensors **32**, **34** (see, e.g., FIG. **3**K) are located in the input hopper **30** to detect for the presence of one or more banknotes therein, in the output receptacle **40** to detect for the presence of one or more banknotes therein, or both. Time-of-Flight (ToF) is a method for measuring the distance between a ToF sensor and an object, based on the time difference between the emission of a signal and its return to the sensor, after being reflected by an object. According to some embodiments, a ToF hopper sensor **32** located in the hopper detects for the presence of one or more banknotes or documents or other objects therein. Likewise, according to some embodiments, a ToF stacker sensor **34** located in the output receptacle **40** detects for the presence of one or more banknotes or documents or other objects therein. According to some embodiments, a time-of-flight sensor is employed in both the both the hopper **30** and the output receptacle **40** and each ToF sensor measures the distance between the sensor and the notes. According to some embodiments, hopper time-of-flight sensors **32** and output receptacle time-of-flight sensor **34** are ST Microelectronics #VL6180X sensors.

According to some embodiments, time-of-flight sensors are more tolerant of dust accumulation than the use of a light source such as a visible light source, a reflective mirror, and a photodetector arrangement hopper and/or output receptacle sensor. According to some embodiments, the use of ToF hopper **32** and/or stacker **34** sensors allows for mounting the sensors on one side of the input hopper **30** and/or on side of the output receptacle **40** such as on the bottom of input hopper **30** and/or in the stacker tray **440** (see, e.g., FIG. **1**F, **2**A, and **3**K) without the use of reflected mirrors or receiving sensors, making it simpler and less costly to mount the sensors in the banknote processing device **10**. For example, the use of a hopper and/or output receptacle time-of-flight sensor reduces the number of parts needed such as by eliminating the need for a specialized reflector in each of the hopper **30** and the output receptacle **40** or a separate transmitter and receiver located on opposite sides of hopper **30** and/or output receptacle **40**. According to some embodiments, the time-of-flight sensor(s) operate using light at a wavelength that reduces the chances of ambient light interference and/or the time-of-flight sensor(s) is(are) capable of detecting transparent areas of some banknote designs that may not be detector by traditional optical detectors.

According to some embodiments, a hopper time-of-flight sensor detects the presence/absence of notes in the hopper **30** and likewise the output receptacle time-of-flight sensor detects the presence/absence of notes in the output receptacle **40**. The hopper and output receptacle time-of-flight sensors are communicatively coupled to one or more processors **75** which in turn use the received signals reflecting information about the presence or absence of banknotes in the hopper **30** and/or output receptacle **40** to control the operation of the banknote processing device **10** such as automatically starting or stopping the transport mechanism motor(s) and/or the stacker wheel motor thereby allowing the device **10** to auto start and stop.

According to some embodiments, one or more light sources positioned in or adjacent to the output receptacle **40** may illuminate the output receptacle **40** with a plurality of different colors and/or a plurality of intensities or modulation patterns, e.g., flashing. A processor **75** communicatively coupled to the light source(s) controls which color of light is used to illuminate the output receptacle **40** and/or whether and how the light source(s) should flash or modulate in intensity. The processor **75** may cause the output receptacle **40** to be illuminated with different colors based on the occurrence of different stopping or error conditions and/or control whether the light source(s) flash or modulate in intensity based on the occurrence of different stopping or error conditions. According to some embodiments, the differing colors of light or lighting conditions may be used as a way for the device **10** to communicate to an operator about the occurrence of different stopping or error conditions and/or the action that is required to be taken by the operator. For example, flashing the pocket light and/or illuminating the pocket with alternating colors may be used to draw focused attention to unusual or simultaneous conditions. According to some embodiments, the entire output receptacle or pocket **40** may be flooded with light upon the occurrence of a given condition such as a given error condition. Flooding the pocket **40** with light may be accomplished by illuminating more light sources positioned in or adjacent to the output receptacle **40** and/or increasing the intensity of one or more light sources.

For example, upon the detection of a no call banknote, the pocket light source(s) may illuminate yellow indicating that action needs to be taken by an operator such as making a decision about whether to add the value of the no call banknote to the total being maintained in the memory of the device **10** for a stack of banknotes being processed. As another example, upon the detection of a hard error such as a double detection error, the pocket light source(s) may be red indicating that all notes must be removed from the output

receptacle or pocket **40**. According to some embodiments, the processor **75** controls the user interface **52** such as a display or touch screen to cause a message to be displayed while the special pocket light illumination is occurring explaining the nature of the stopping or error condition and/or indicating what action should be taken by the operator. After a short time period, the operator may learn the nature of stopping or error condition and what action is expected of them simply by relying upon the pocket lighting indications without the continued need to read messages and/or instructions be displayed on the user interface **52** and/or the minimizing the times the operator needs to consult the display of the user interface **52**, thereby leading to improvement in the efficiency in which an operator is able to process banknotes using device **10**.

With reference to FIGS. **1**D, **1**E, and **1**G, according to some embodiments, the banknote processing device **10** comprises a handle **60***h* located at the bottom of each of the left and right sides of the device **10**. The curve of the side cover **60***rt*, **60***lt* in the vicinity of the handles **60***h* guides a person such as an operator to slide the fingers of a hand under the bottom of each side of the device **10** in the area of handles **60***h* and then using two hands easily pick up the device **10** and move it if desired. According to some embodiments, the handles are formed in the side covers **60***rt*, **60***lt*. According to some embodiments, the side covers are made of plastic. As shown, the handles **60***h* positioned at the bottom of each of the side covers **60***rt*, **60***lt* and close to the two side walls or plates **206***rt*, **206***lt*.

FIG. **9**A is an upward bottom perspective view of a handle **60***h*. FIG. **9**B is an upward cross-sectional bottom perspective view of a handle **60***h*. According to some embodiments, the handles **60***h* have an upwardly recessed area **60***hr* configured to accommodate the finger tips of a person holding banknote processing device **10**. In FIG. **9**B, it can be seen that the handle **60***h* and particularly the recessed area **60***hr* are located close to side plate **206***rt*. The bottom location of the handles **60***h* facilitates the carrying of the banknote processing device **10** by a person and also facilitates the transfer of the load imposed by the weight of the device **10** away from the **60** covers **60***rt*, **60***lt* which may be made of plastic to the side plates **206***rt*, **206***lt* which may be made of metal such as steel. As a result of the transfer of the load to the side plates **206***rt*, **206***lt*, the side covers **60***rt*, **60***lt* may be made of a lighter, less rugged type of plastic.

With reference to FIGS. **1**E and **1**G, according to some embodiments, a width W_1 of the banknote processing device **10** is less than between about 11 inches (28 cm) and about 13 inches (33 cm). According to some embodiments, the width W_1 of the banknote processing device **10** is less than or about 11.7 inches (30 cm). According to some embodiments, a depth D_1 of the banknote processing device **10** is less than between about 12 inches (30 cm) and about 14 inches (36 cm). According to some embodiments, the depth D_1 of the banknote processing device **10** is less than or about 12.4 inches (31 cm). According to some embodiments, a height H_1 of the banknote processing device **10** is less than between about 11 inches (28 cm) and about 13 inches (33 cm). According to some embodiments, the height H_1 of the banknote processing device **10** is less than or about 12 inches (30 cm).

According to some embodiments, the banknote processing device **10** has a footprint of less than about 1.3 square feet. According to some embodiments, the banknote processing device **10** has a footprint of less than about 1 square feet. According to some embodiments, the banknote processing device **10** has a footprint of less than 1.1 square feet.

According to some embodiments, the banknote processing device **10** occupies less than about 1.4 cubic feet. According to some embodiments, the banknote processing device **10** occupies less than about 1.2 cubic feet. According to some embodiments, the banknote processing device **10** occupies less than about 1 cubic feet. According to some embodiments, the banknote processing device **10** occupies less than about 1.1 cubic feet.

According to some embodiments, the banknote processing device **10** weighs between about 14 pounds (31 kg) and 18 pounds (40 kg). According to some embodiments, the banknote processing device **10** weighs between about 15 pounds (33 kg) and 20 pounds (44 kg). According to some embodiments, the banknote processing device **10** weighs about or less than about 16.5 pounds (36 kg). According to some embodiments, the banknote processing device **10** weighs about or less than about 17 pounds (38 kg). According to some embodiments, the banknote processing device **10** weighs about or less than about 15 pounds (33 kg).

According to some embodiments, the side walls **206***lt*, **206***rt*, the stacker tray **440**, and the side covers **60***lt*, **60***rt* are designed to aid in the easy and accurate assembly to each other. FIG. **10**A is a perspective view illustrating an assembly of a stacker tray **440** and a side plate **206***lt* according to some embodiments. FIG. **10**B is a front view of a stacker tray **440** according to some embodiments. FIG. **10**C is a rear perspective view of a positioning tab **1010** of a stacker tray **440**. FIG. **10**D is a perspective view illustrating an assembly of a stacker tray **440** and a side plate **206***lt* with a side cover **60***lt* according to some embodiments. Although not shown, the right side plate **206***rt*, the right side of the stacker tray **440**, and the right cover **60***rt* have a mirror design according to some embodiments.

According to some embodiments, a positioning tab **1010** is located on the end of the stacker tray **440**. The positioning tab **1010** has upper and lower side openings **1010***sop* between an inside edge **1010***in* of upper **1010***flt* and lower **1010***flb* flange on the tab **1010** and a side surface **440***sd* of the stacker tray **440**. The upper and a lower side openings **1010***sop* define a neck area of the positioning tab **1010**. The side plate **206***lt* has a cutout or opening **206***op* defined by a generally U-shaped front edge having a bottom edge **206***feb*, a rear edge **206***fer*, and a top edge **206***fet*. The side plate cutout **206***op* is configured to guide a front edge of the side plate **206***lt* to fit accurately about the stacking tray positioning tab **1010** by constraining the vertical position of the side plate **206***lt* through the abutment of the bottom cutout edge **206***feb* adjacent to a bottom neck edge **1010***neb* on the positioning tab **1010** and the abutment of an top cutout edge **206***fet* adjacent to a top neck edge **1010***net* on the positioning tab **1010**. Similarly, the lateral position of the side plate **206***lt* is constrained by the thickness of the side plate and the distance between an inner surface **1010***in* of flanges **1010***flt*, **1010***flb* of positioning tab **1010** and the side surface **440***sd* of the stacking tray **440**. When assembled, a neck back side **1010***nbs* of the positioning tab **1010** abuts the rear edge **206***fer* of the cutout **206***op* of the left side plate **206***lt*.

By controlling and setting the tolerances for the thickness of the side plate **206***lt* near the front edge thereof and the distance between an inner surface **1010***in* and the side surface **440***sd*, the side plate **60***lt* can be accurately laterally positioned snugly against the side surface **440***sd*. Likewise, by controlling and setting the tolerances for the distance between edges **206***fet* and **206***feb* on the side plate **206***lt* and the distance between **1010***net* and **1010***neb* of positioning tab **1010**, the side plate **60***lt* can be accurately vertically positioned relative to the stacking tray **440**. Likewise, by

controlling and setting the tolerances for the position of rear edge **206***fer* of the cutout **206***op* of the left side plate **206***lt* and the neck back side **1010***nbs* of the positioning tab **1010**, the side plate **60***lt* can be accurately positioned depth wise (front/back) relative to the stacking tray **440**. Accordingly, positioning tab **1010** and the side plate dimensions near the side plate cutout **206***op* provide a way to easily and accurately position in three dimensions the side plate **206** relative to the stacker tray **440**.

With respect to FIG. **10**D, according to some embodiments, when assembled, the positioning tab **1010** is dimensioned and configured to fit snugly in a positioning tab pocket **60***pk* in the left side cover **60***lt*. Accordingly, according to some embodiments, the positioning tab **1010** of the stacker tray **440** is used to easily and accurately position in three dimensions the side cover **60***lt* to the stacker tray **440** and side plate **206***lt* by inserting the positioning tab **1010** into the positioning tab pocket **60***pk* in the left side cover **60***lt*. As stated above, although not shown, the right side plate **206***rt*, the right side of the stacker tray **440** having a corresponding positioning tab **1010**, and the right cover **60***rt* have a mirror design according to some embodiments.

The above design utilizing positioning tabs **1010** facilitates the easy and accurate assembly of the stacker tray **440**, the side plates **206***lt*, **206***rt*, and the side covers **60***lt*, **60***rt* to each other while eliminating or reducing issues related to the visual alignment problems between these components in a highly visible area of the banknote processing device **10** by using one multipurpose positioning tab **1010** on the stacker tray **440**.

According to some embodiments, the device **10** communicates information by displaying a QR code on a display screen such on interface **52**. For example, during a service call, a service technician could interact with the interface **52** to cause the processor **75** to display an appropriate QR code in the display **52**. The technician could then scan the QR code using a QR code scanner such as by using a camera on their smartphone or other device (e.g., an Apple iPhone or iPad). After scanning the QR code, the QR code scanner (e.g., iPad, iPhone) then displays appropriate information to the service technician.

For example, the QR code scanner may display a message about an activity that should be performed (e.g., replace left idler roller **610** on downstream idler roller beam **605**) and/or instructions and/or accompanying pictures or graphics explaining on how to perform the indicated activity (e.g., (1) open bottom plate **602**, (2) remove downstream idler roller beam **605**, (3) remove left idler roller **610** and replace with a new idler roller **610**, (4) re-install idler roller bean **605**, (5) closed bottom plate). Furthermore, the QR scanner could provide more detailed instructions and/or accompanying pictures or graphics on how to accomplish each step (e.g., step 1 details—(a) remove two screws **122**, (b) rotate panel **602** open about axis **123** together with photos or graphics similar to that shown in FIG. **1**G and/or with various parts highlighted and/or with arrows pointing to various portions such as screws **122**.

Likewise, for example, a customer operator could interact with the interface **52** to cause the processor **75** to display an appropriate QR code in the display **52**. The operator could then scan the QR code using a QR code scanner such as by using a camera on their smartphone or other device (e.g., an Apple iPhone or iPad). After scanning the QR code, the QR code scanner (e.g., iPad, iPhone) then displays appropriate information to the operator. According to some embodiments, scanning a QR code may cause a portion of a user manual or user guide to be displayed on the QR scanner. According to some embodiments, scanning the QR code will provide information to the customer such as note processing statistics. According to some embodiments, the QR code may used to get diagnostic, machine-specific, or service data, which can be sent by the customer using the QR scanner (e.g., iPhone) to the manufacturer of device **10** and/or service personnel associated with the manufacturer of device **10** and/or third-party service personnel.

According to some embodiments, the QR scanner (e.g., iPhone or iPad) may have an appropriate app downloaded thereon (such as device specific app or a manufacture app) and used to scan the QR code (e.g., a Cummins service app; a Cummins customer app).

According to some embodiments, a device **10** specific app and/or a manufacture specific app (e.g., a Cummins service app; a Cummins customer app) may be downloaded onto a customer or service technician computer device such as a mobile smartphone or tablet (e.g., iPhone or iPad). According to some embodiments, the app provides a link to one or more user manuals and/or one or more service manuals for device **10**. According to some embodiments, such an app provides a customer/operator access to a user guide to help the operator resolve an issue with device **10** on his or her own.

According to some embodiments, a customer may use the app to place a service call for the device **10**. According to some embodiments, the app may use data received by processor **75** and memory **74** about the details of device **10**, its operational state, its past operational statistics, any current or historical error codes generated by device **10**, the model and/or serial number of device **10**, the location of device **10** (e.g., company name of customer and address), etc. According to some embodiments, the app may be used to populate fields in various reports such as service reports or forms requesting a service call.

According to some embodiments, the use of a customer employee's personal computer device such as a mobile smartphone or tablet may be used to avoid potential problems associated using a customer's company network for some remote management functions, for example, due to firewall or other computer network security features. For example, if a banknote processing device such as device **10** stops operating, via the app and/or QR code scanning feature, an employee may be able to easily collect and send information to a service personnel that enables the service personnel to be able to identify the device and any problems associated therewith and potentially provide instructions to the customer employee on how the device **10** may be fixed and/or what replacement parts the service technician needs to bring to the location of the device **10** for a service call.

According to some embodiments, if, for example, a customer wanted to know how many notes were processed by device **10**, the processor **75** may be programmed to provide an appropriate QR code that contains the note processing history in the code. The customer could then open a manufacturer's app (e.g., a Cummins Allison application) on their smartphone or tablet, take a picture of the QR code, and the QR code would be deciphered and the desired statistical information could be displayed on the customer's phone or tablet. This information could also be used in diagnostics so that the customer could send that information to service personnel so diagnostics could be done remotely. This could be a very valuable tool for both the customer and the field service representatives.

According to some embodiments, the QR code may provide information to the customer such as note processing statistics. According to some embodiments, the QR code is

used to get diagnostic, machine-specific, and/or service data, which can be sent by the customer's QR scanner to the device manufacturer and/or service personnel. A camera on a QR scanner (e.g., iPhone or iPad) accessed by the app on a mobile device of a customer or a service technician may be used to retrieve the information via the QR code themselves.

According to some embodiments, the use of a QR code allows an easier way to pull data from a machine such as device **10** other than pairing a wired or wireless device to the machine or connecting a thumb drive to the machine, which requires a PC to view that information. According to some embodiments, the customer scans a QR code displayed on an interface of a machine such as device **10** using a QR code scanner and the QR code scanner sends the information to a remote service technician for troubleshooting the machine.

According to some embodiments, there are number of uses for a banknote processing device being able to generate customized QR codes for use in connection with a QR scanning device having a customized app thereon to scan and decode the QR and/or take further action(s). A first use would be during the production of a banknote processing device such as part of a Quality Control (QC) process. Currently during the manufacture of banknote processing devices, a QC personnel may hand write a report for each machine's serial number, calibration, sensor readings, etc. Prior electronic means for capturing this type info have been found to be too cumbersome to integrate with production and/or QC processes. According to some embodiments, of the present disclosure, a manufacturing and/or QC personnel will be able to press a single button in a menu displayed on a user interface (e.g., interface **52** of device **10**) labeled, for example, 'QC Report' and the banknote processing device will display a customized QR code. According to some embodiments, displayed QR code will contain all or a portion of desired QC report data. Then using a mobile device with a camera such as a tablet with a QR decoding app, the manufacturing or QC personnel may take a picture of the banknote processing screen displaying the customized QR code. The mobile device via app may decode the QR code, extract the data contained therein, and populate corresponding fields in a QC report, e.g., serial number, various calibration settings, sensor readings, etc. The QR decoding app can then be used to send the generated QC report to a central location such as a network shared drive for storage. According to some embodiments, the generated QC report may use the serial number of the device (decoded from the QR code) in its file name.

Another use of QR codes and/or customized apps would be in service contexts such as by service technicians. Service technicians may be asked to capture a device's serial number and piece count statistics when they perform service on a device such as a banknote processing device. They may enter this data into a networked service tracking system/program such as by using an iPad to interface with the service tracking system. According to some embodiments of the present disclosure, at the end of a service call, a technician will instruct the banknote processing device being service through one or service screens displayed on the interface such as interface **52** of the device to display a service QR code on the display screen of the device. Once the device does this, the technician may use an extension of a service app on an iPad to access the iPad's camera and take a picture of the screen of the device being serviced. The service app may then decode the contents or the QR code and use the decoded data to populate corresponding fields for serial number, model, and machine statistics in a service report. The service report may also contain other data entered by the service technician such as, for example, notes about the service call and/or the machine serviced. The iPad may then send the service report for the device via a network to a main service database in which the service report may be saved and stored. A device's service history may also be stored in the main service database along with the new service report. In one embodiment, the scanning of the QR code could be used to create a service record for the machine and populate corresponding data fields therein. According to some embodiments, a service app on the iPad might require a successful QR scan in order to close out the service call, as the device will not render the QR code until its own diagnostics indicate that the device is in a functional state. The QR code might also encode piece counts of perishable parts and/or trend reports so that predictions can be made on subsequent service visits to the same device regarding which replacement parts to bring.

Another use of QR codes and/or customized apps may be by users or operators of banknote or currency processing devices. For example, as parts wear out on a device or as the device itself detects it needs or will require service in the near future, the device can provide the operator a screen (e.g., on interface **52**) where it renders a QR code to generate a service call containing information to aid a service technician in being able to come prepared to resolve the issue. The QR code displayed on the device screen may be scanned by the operator using a mobile device such as a smartphone or tablet with a camera with a custom app (e.g., a Cummins Allison service app) installed thereon. Upon decoding the QR code, mobile device may use a web-based interface to automatically schedule and/or initiate a service call for the device with the operator's local service branch. According to some embodiments, the service app may, alternatively or in addition to placing a service call, recommend a course of action to the operator such as a cleaning of the machine or other simple ways to resolve issues. According to some embodiments, the app may reference an operator manual and select a specific page or pages that addresses the issue that the device is currently experiencing.

The various above QR related embodiments, may require a device with a camera on which a software application (app) runs to decode the QR code and act on its content.

According to some embodiments, the banknote processing device **10** comprises a microphone coupled to the processor **75** and the processor **75** is configured to respond to voice commands from a person such as an operator or service technician. According to such embodiments, an operator may simply give a banknote processing device such as device **10** verbal instructions and the device would comply. For example, an operator may give a verbal instruction to the banknote processing device to end a batch or change modes without actually having to press keys or a touch screen on the banknote processing device much in the same way Alexa and other voice control devices work. According to some embodiments, adding voice control to banknote processing devices such as currency desktop machines improves efficiency by reducing the amount of physical interactions with a user interface **52** such as a touch screen providing the user with more time to dress and strap notes.

According to some embodiments, the banknote processing device **10** comprises a Bluetooth communication receiver coupled to the processor **75**, thus permitting a banknote processing device such as device **10** with the ability to accommodate Bluetooth near field communication. According to some such embodiments, providing Bluetooth

capability which is a wireless form of communications may eliminate the need to physically connect a cable to a banknote processing device such as device **10**.

In one example embodiment, an input hopper for a banknote processing device comprises a feeder bracket fixedly coupled to side walls of a banknote processing device, the feeder bracket having longitudinal length and a pair of hopper lug openings positioned near opposite ends of the longitudinal length of the feeder bracket, a feeder plate resting upon but not coupled the feeder bracket, the feeder plate having longitudinal length and a pair of slot openings positioned near opposite ends of the longitudinal length of the feeder plate; wherein when the feeder plate is properly positioned relative to the feeder bracket, the slot openings of the feeder plate align with the hopper lug openings of the feeder bracket, and a hopper bracket having a bottom surface resting on an upper surface of the feeder plate, the hopper bracket having a longitudinal length and a pair of hopper lugs positioned near opposite ends of the longitudinal length of the hopper bracket and extending downward from the bottom surface of the hopper bracket through the slot openings of the feeder plate and the hopper lug openings of the feeder bracket, wherein when the hopper bracket and feeder plate are in an operational position with respect to the feeder bracket, top surfaces of the hopper lugs contact a bottom surface of the feeder bracket establishing an interference fit therebetween so as to maintain the hopper bracket and feeder plate in their operational positions without either the hopper bracket or the feeder plate being fixedly coupled to feeder plate or the rest of the banknote processing device; wherein the hopper bracket is instead removably coupled to the feeder bracket and the feeder plate is sandwiched therebetween.

In another example embodiment, an output receptacle of a banknote processing device comprises a stacker tray having a longitudinal length and having an upper edge that has a central, downward curved portion in a middle portion of the longitudinal length and two curved portions, one on each side of the middle portion, wherein the two curved portions arc upward toward the middle of the stacker tray and a middle of the output receptacle.

In another example embodiment, a banknote processing device comprises a display assembly being pivotally mounted about a first axis near a first end of the transport plate, the display assembly having an operational position and an open position, a banknote transport path defined at least in part by a transport plate on one side of the transport path, the transport plate being pivotally mounted about a second axis near a first upstream end of the transport plate, the transport plate having an operational position and an open position, and a linkage coupled on one end to the display assembly and coupled on a second end to the transport plate near a second downstream end of the transport plate, wherein when the display assembling is rotated from its operational position to an open position, the linkage causes the transport plate to move from its operational position to an open position.

In one or more of the above examples, the linkage is a spring link.

In one or more of the above examples, the spring link is a generally straight wire coupled on one end to the display assembly and coupled on a second end to the transport plate near a second downstream end of the transport plate.

In another example embodiment, a banknote processing device comprises a pair of opposing side plates in spaced relation from each other, each side plate having at least one spring cleat aperture therein, an idler roller beam having a longitudinal length having two ends which when the beam is positioned in an operational position the longitudinal length extends between the two side plates, the idler roller beam having one or more idler rollers coupled thereto, each end of the beam having a beam spring post, a pair of spring cleats, each cleat having a cleat spring post thereon, each spring cleat having an exterior portion designed to fit through one of the spring cleat apertures in respective ones of the side plates when the cleat is positioned in a non-operational position with respect to the corresponding cleat aperture, each cleat having a larger surface that abuts an inside surface of a respective side plate when the spring cleat is in an operational position, the larger surface not fitting through a corresponding cleat aperture when the cleat is in its operational position, each cleat having one or more inside hook surfaces that abut portions of an edge of a respective cleat aperture when the cleat is in its operational position, wherein the exterior portion of each spring cleat has an inside surface configure to engage of portion of the edge of a respective cleat aperture preventing the exterior portion of the spring cleat from moving through the aperture when the spring cleat is in an operational position, a pair of springs, each of the spring being mounted between a respective one of the beam spring posts and a corresponding cleat spring posts, each spring biasing a corresponding spring cleat into its operational position and biasing a respective end of the idler roller beam into its operational position, wherein a spring cleat may be manually moved into a non-operational position and removed from the banknote processing device without the use of any tools by pulling the cleat through the corresponding cleat aperture, and wherein the idler roller beam may be removed from the banknote processing device without the use of any tools by removing the pair of cleats from the banknote processing device.

In another example embodiment, a banknote processing device comprises a pair of opposing side plates in spaced relation from each other, each side plate having at least one spring cleat aperture therein, an idler roller beam having a longitudinal length having two ends which when the beam is positioned in an operational position the longitudinal length extends between the two side plates, the idler roller beam having one or more idler rollers coupled thereto, each end of the beam having a beam spring post, a pair of spring cleats, each cleat having a cleat spring post thereon, each spring cleat having an operational position and a non-operational position, wherein when the cleat is in its operational position, the spring cleat is coupled to a respective side plate and the spring cleat engages an edge of a respective spring cleat aperture preventing the spring cleat from being decoupled from the respective side plate, wherein when the cleat is in its non-operational position, the spring cleat does not engage an edge of a respective spring cleat aperture and is not prevented from being decoupled from the respective side plate, a pair of springs, each of the spring being mounted between a respective one of the beam spring posts and a corresponding cleat spring posts, each spring biasing a corresponding spring cleat into its operational position, wherein a spring cleat may be manually moved into a non-operational position and removed from the banknote processing device without the use of any tools, and wherein the idler roller beam may be removed from the banknote processing device without the use of any tools by removing the pair of cleats from the banknote processing device.

In another example embodiment, a banknote processing device comprises a pair of opposing side plates in spaced relation from each other, each side plate having at least one cleat hooked thereon, a beam having a longitudinal length

having two ends which when the beam is positioned in an operational position the longitudinal length extends between the two side plates, and a pair of springs, each of the spring being mounted between a respective end of the beam and a corresponding cleat.

In one or more of the above examples, each cleat has an operational position and a non-operational position, wherein when each cleat is in its non-operational position, the cleat may be unhooked and decoupled from a respective side plate, wherein when each cleat is in its operational position, the cleat may not be unhooked and decoupled from a respective side plate, wherein each spring biases a corresponding cleat into its operational position.

In one or more of the above examples, each cleat may be manually moved into its non-operational position and removed from the banknote processing device without the use of any tools.

In one or more of the above examples, the beam may be removed from the banknote processing device without the use of any tools by removing the pair of cleats from the banknote processing device.

In another example embodiment, a banknote processing device comprises a driven transport shaft having a magnetic coupled to an end thereof, and a magnetic encoder adjacent to but spaced from the magnet.

In one or more of the above examples, the driven transport shaft is mounted between two sides plates of the banknote processing device and wherein the end of the driven transport shaft having the magnet coupled thereto extends through an aperture in a first one of the side plates such that the magnet is not positioned between the two side plates, and further comprising a printed circuit board positioned outside of a space between the two side plates and positioned adjacent to the first one of the side plates, wherein the magnetic encoder is coupled to the printed circuit board.

In another example embodiment, a banknote processing device comprises a transport shaft mounted between two sides plates of the banknote processing device, wherein a first end of the shaft is coupled to a hold-down screw, a shaft adjustment mechanism comprising an adjustment plate pivotally mounted about a first axis to a first one of the side plates, wherein the adjustment plate comprises an arc-shaped aperture defined by an arc-shaped edge, wherein the arc-shaped aperture and edge are slightly non-concentric with respect to the first axis; wherein the adjustment plate comprises an arc-shaped edge which is concentric with respect to the first axis and wherein the arc-shaped edge has a plurality of teeth, wherein the first one of the side plates has a vertical slot opening therein and wherein the hold-down screw passes through both the arc-shaped aperture in the adjustment plate and the vertical slot opening in the first one of the side plates, wherein the first one of the side plates has an adjustment tool receiving aperture therein, wherein when an end of an adjustment tool having a plurality of teeth thereon is inserted in the adjustment tool receiving aperture, a rack and pinion type of mesh is established between the adjustment plate teeth and the teeth on the end of the adjustment tool such that rotating the adjustment tool causes the rotation of the adjustment plate and the associated adjustment plate arc opening and adjustment plate arc opening edge which in turn vertically moves the hold-down screw within the vertical slot opening and vertically moves the end of the shaft to which the hold-down screw is coupled.

In one or more of the above examples, the hold-down screw is threadingly screwed into an opening in the first end of the shaft and wherein when the hold-down is tightened into the shaft, adjustment plate is prevented from rotating about the first axis.

In another example embodiment, a banknote processing device comprises a banknote transport path defined at least in part by a transport plate on one side of the banknote transport path, the banknote transport plate being pivotally mounted about a first axis near an upstream end of the transport plate, the transport plate including a working position and an open position, a display assembly being pivotally mounted about a second axis spaced a defined distance apart from the first axis, the display assembly including an operational position and a non-operational position, and a linkage coupled to display assembly and to the transport plate near a downstream end of the transport plate, wherein, when the display assembly is rotated from the operational position to the non-operational position, the linkage causes the transport plate to move from the working position to the open position.

In one or more of the above examples, the linkage is a spring link.

In one or more of the above examples, the spring link is a generally straight wire coupled on one end to the display assembly and coupled on a second end to the transport plate near the downstream end of the transport plate.

In one or more of the above examples, when the display assembly is rotated from the non-operational position to the operational position, the spring link exerts a downward force on the transport plate to hold the transport plate in the working position.

In one or more of the above examples, the display assembly includes a display bezel including a bezel cover, a bezel backing plate coupled to the bezel cover, and a display disposed within the bezel cover.

In one or more of the above examples, the display assembly includes one or more display assembly stops operable to engage the bezel backing plate when the display assembly is rotated from the non-operational position to the operational position.

In one or more of the above examples, when the display assembly is operable to rotate a distance between the operational position and the non-operational position to adjust a viewing angle of the display.

In one or more of the above examples, the movement of the transport plate from the working position to the open position provides an opening to access a paper path of the banknote processing device.

In one or more of the above examples, the banknote processing device further comprises a first side cover portion disposed adjacent a first side surface of the display assembly; and a second side cover portion disposed adjacent a second side surface of the display assembly, wherein, when the display assembly is in the operational position, the first side cover portion is flush with the first side surface of the display assembly and the second side cover portion is flush with the second side surface of the display assembly.

In one or more of the above examples, the transport plate is in a non-working position when the first side cover portion and the second side cover portion are not flush with the first side surface and the second side surface of the display assembly, respectively.

In another example embodiment, a method of a banknote processing device comprises rotating a display assembly from an operational position to a non-operational position, wherein a linkage is coupled to the display assembly and to a transport plate near a downstream end of the transport plate, wherein the transport plate defines, at least in part, a

banknote transport path, wherein the transport plate is pivotally mounted about a first axis near an upstream end of the transport plate, and wherein the display assembly is pivotally mounted about a second axis spaced a defined distance apart from the first axis, and moving the transport plate from a working position to an open position, wherein the movement is caused by the coupling of the linkage to the display assembly and the transport plate and the rotation of the display assembly.

In one or more of the above examples, the linkage is a spring link.

In one or more of the above examples, the spring link is a generally straight wire coupled on one end to the display assembly and coupled on a second end to the transport plate near the downstream end of the transport plate.

In one or more of the above examples, the method further comprises exerting, by the spring link when the display assembly is rotated from the non-operational position to the operational position, a downward force on the transport plate to hold the transport plate in the working position.

In one or more of the above examples, the display assembly includes a display bezel including a bezel cover, a bezel backing plate coupled to the bezel cover, and a display disposed within the bezel cover.

In one or more of the above examples, the method further comprises engaging, by one or more display assembly stops, the bezel backing plate when the display assembly is rotated from the non-operational position to the operational position.

In one or more of the above examples, the method further comprises rotating the display assembly a distance between the operational position and the non-operational position to adjust a viewing angle of the display.

In one or more of the above examples, the method further comprises providing an opening to access a paper path of the banknote processing device due to the movement of the transport plate from the working position to the open position.

In one or more of the above examples, when the display assembly is in the operational position, a first side cover portion is flush with a first side surface of the display assembly and a second side cover portion is flush with a second side surface of the display assembly.

In one or more of the above examples, the transport plate is in a non-working position when the first side cover portion and the second side cover portion are not flush with the first side surface and the second side surface of the display assembly, respectively.

While the concepts disclosed herein are susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and herein described in detail. It should be understood, however, that it is not intended to limit the inventions to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the inventions as defined by the appended claims.

What is claimed is:

1. A banknote processing device comprising:

a banknote transport path defined at least in part by a transport plate on one side of the banknote transport path, the banknote transport plate being pivotally mounted about a first axis near an upstream end of the transport plate, the transport plate including a working position and an open position;

a display assembly being pivotally mounted about a second axis spaced a defined distance apart from the first axis, the display assembly including an operational position and a non-operational position; and

a linkage coupled to the display assembly and to the transport plate near a downstream end of the transport plate,

wherein, when the display assembly is rotated from the operational position to the non-operational position, the linkage causes the transport plate to move from the working position to the open position.

2. The banknote processing device of claim **1**, wherein the linkage is a spring link.

3. The banknote processing device of claim **2**, wherein the spring link is a generally straight wire coupled on one end to the display assembly and coupled on a second end to the transport plate near the downstream end of the transport plate.

4. The banknote processing device of claim **3**, wherein, when the display assembly is rotated from the non-operational position to the operational position, the spring link exerts a downward force on the transport plate to hold the transport plate in the working position.

5. The banknote processing device of claim **1**, wherein the display assembly includes a display bezel including a bezel cover, a bezel backing plate coupled to the bezel cover, and a display disposed within the bezel cover.

6. The banknote processing device of claim **5**, wherein the display assembly includes one or more display assembly stops operable to engage the bezel backing plate when the display assembly is rotated from the non-operational position to the operational position.

7. The banknote processing device of claim **6**, wherein, when the display assembly is operable to rotate a distance between the operational position and the non-operational position to adjust a viewing angle of the display.

8. The banknote processing device of claim **1**, wherein the movement of the transport plate from the working position to the open position provides an opening to access a paper path of the banknote processing device.

9. The banknote processing device of claim **1**, further comprising:

a first side cover portion disposed adjacent a first side surface of the display assembly; and

a second side cover portion disposed adjacent a second side surface of the display assembly,

wherein, when the display assembly is in the operational position, the first side cover portion is flush with the first side surface of the display assembly and the second side cover portion is flush with the second side surface of the display assembly.

10. The banknote processing device of claim **9**, wherein the transport plate is in a non-working position when the first side cover portion and the second side cover portion are not flush with the first side surface and the second side surface of the display assembly, respectively.

11. A method of a banknote processing device, the method comprising:

rotating a display assembly from an operational position to a non-operational position,

wherein a linkage is coupled to the display assembly and to a transport plate near a downstream end of the transport plate,

wherein the transport plate defines, at least in part, a banknote transport path,

wherein the transport plate is pivotally mounted about a first axis near an upstream end of the transport plate, and

wherein the display assembly is pivotally mounted about a second axis spaced a defined distance apart from the first axis; and

moving the transport plate from a working position to an open position, wherein the movement is caused by the coupling of the linkage to the display assembly and the transport plate and the rotation of the display assembly.

12. The method of claim **11**, wherein the linkage is a spring link.

13. The method of claim **12**, wherein the spring link is a generally straight wire coupled on one end to the display assembly and coupled on a second end to the transport plate near the downstream end of the transport plate.

14. The method of claim **13**, further comprising exerting, by the spring link when the display assembly is rotated from the non-operational position to the operational position, a downward force on the transport plate to hold the transport plate in the working position.

15. The method of claim **11**, wherein the display assembly includes a display bezel including a bezel cover, a bezel backing plate coupled to the bezel cover, and a display disposed within the bezel cover.

16. The method of claim **15**, further comprising engaging, by one or more display assembly stops, the bezel backing plate when the display assembly is rotated from the non-operational position to the operational position.

17. The method of claim **16**, further comprising rotating the display assembly a distance between the operational position and the non-operational position to adjust a viewing angle of the display.

18. The method of claim **11**, further comprising providing an opening to access a paper path of the banknote processing device due to the movement of the transport plate from the working position to the open position.

19. The method of claim **11**, wherein, when the display assembly is in the operational position, a first side cover portion is flush with a first side surface of the display assembly and a second side cover portion is flush with a second side surface of the display assembly.

20. The method of claim **19**, wherein the transport plate is in a non-working position when the first side cover portion and the second side cover portion are not flush with the first side surface and the second side surface of the display assembly, respectively.

* * * * *