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(54) **BANKNOTE RECYCLER**

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

(72) Inventors: **Marek Baranowski**, Shamong, NJ (US); **Glenn S. Gordon**, Buffalo Grove, IL (US); **Ralf Jaeger**, Kildeer, IL (US); **James C. Polites**, Lake Zurich, IL (US); **George T. Seelenbinder**, Elk Grove Village, IL (US); **Douglas U. Mennie**, Barrington, IL (US)

(21) Appl. No.: **16/119,768**

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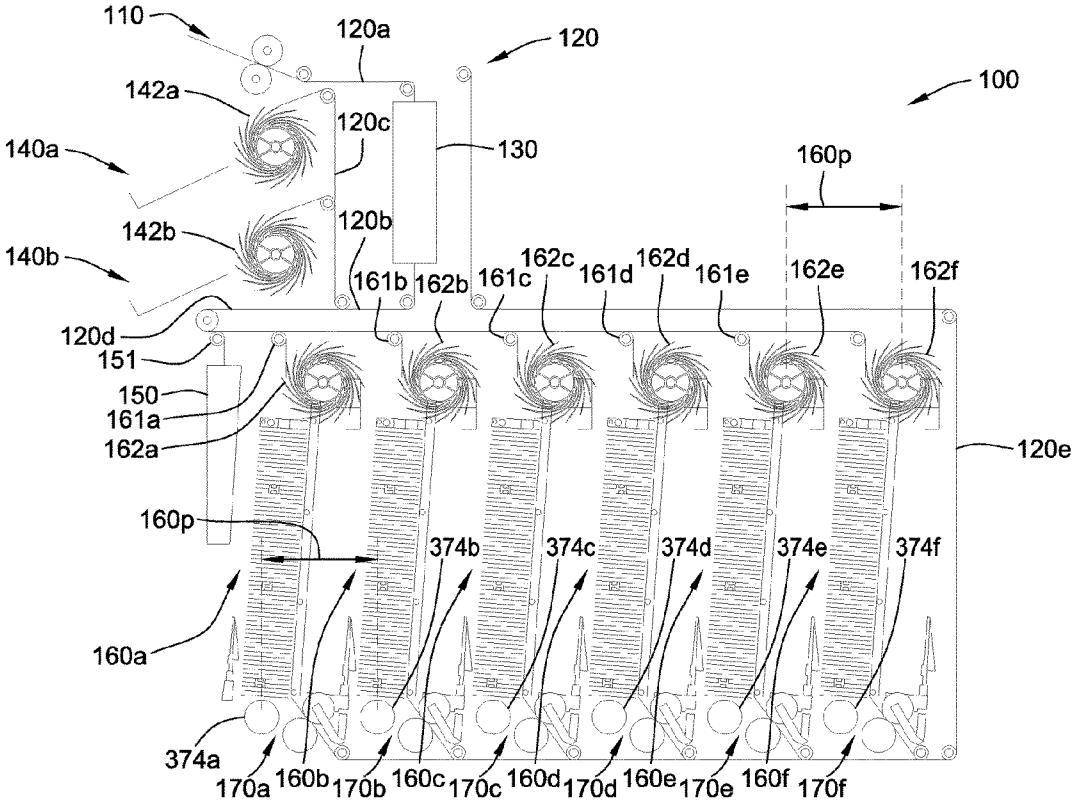
Publication Classification

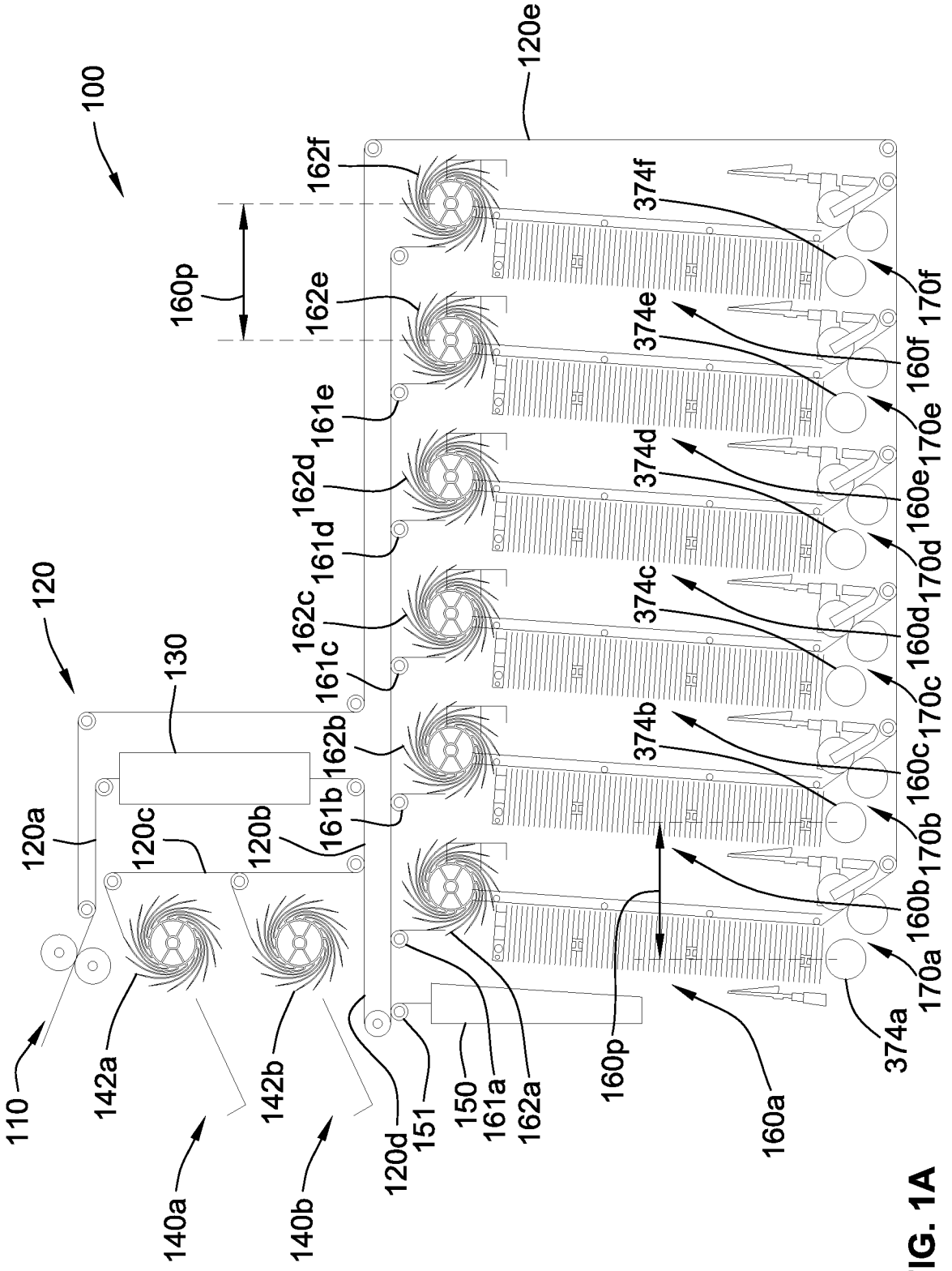
(51) **Int. Cl.**
G07D 11/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G07D 11/0033*** (2013.01); ***G07D 11/0036*** (2013.01); *G07D 11/0012* (2013.01); *G07D 7/181* (2017.05); *G07D 2211/00* (2013.01); *G07D 2207/00* (2013.01); *G07D 11/0018* (2013.01)

(57) **ABSTRACT**

A generally vertical banknote recycling bay arrangement comprising a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end. The arrangement further comprising a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay. The arrangement further comprising a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay. The arrangement further comprising a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft, each stacker wheel being laterally moveable along the driven stacker wheel shaft and a stacker wheel positioning mechanism configured to adjust the lateral positions of the pair of stacker wheels along the stripper wheel shaft. During operation in which banknotes are to be fed into the recycling bay, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an inward position such that banknotes to be fed into the recycling bay are received by the stacker wheels and stacked in the recycling bay. During operation in which banknotes are to be fed out of the recycling bay, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels but instead are engaged by the banknote dispensing assembly which sequentially engages the topmost banknote stacked in the recycling bay and feeds banknotes out of the recycling bay, one bill at a time.

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120e
162f
160p
162e
161e
162d
161d
162c
161c
162b
161b
120
130
120a
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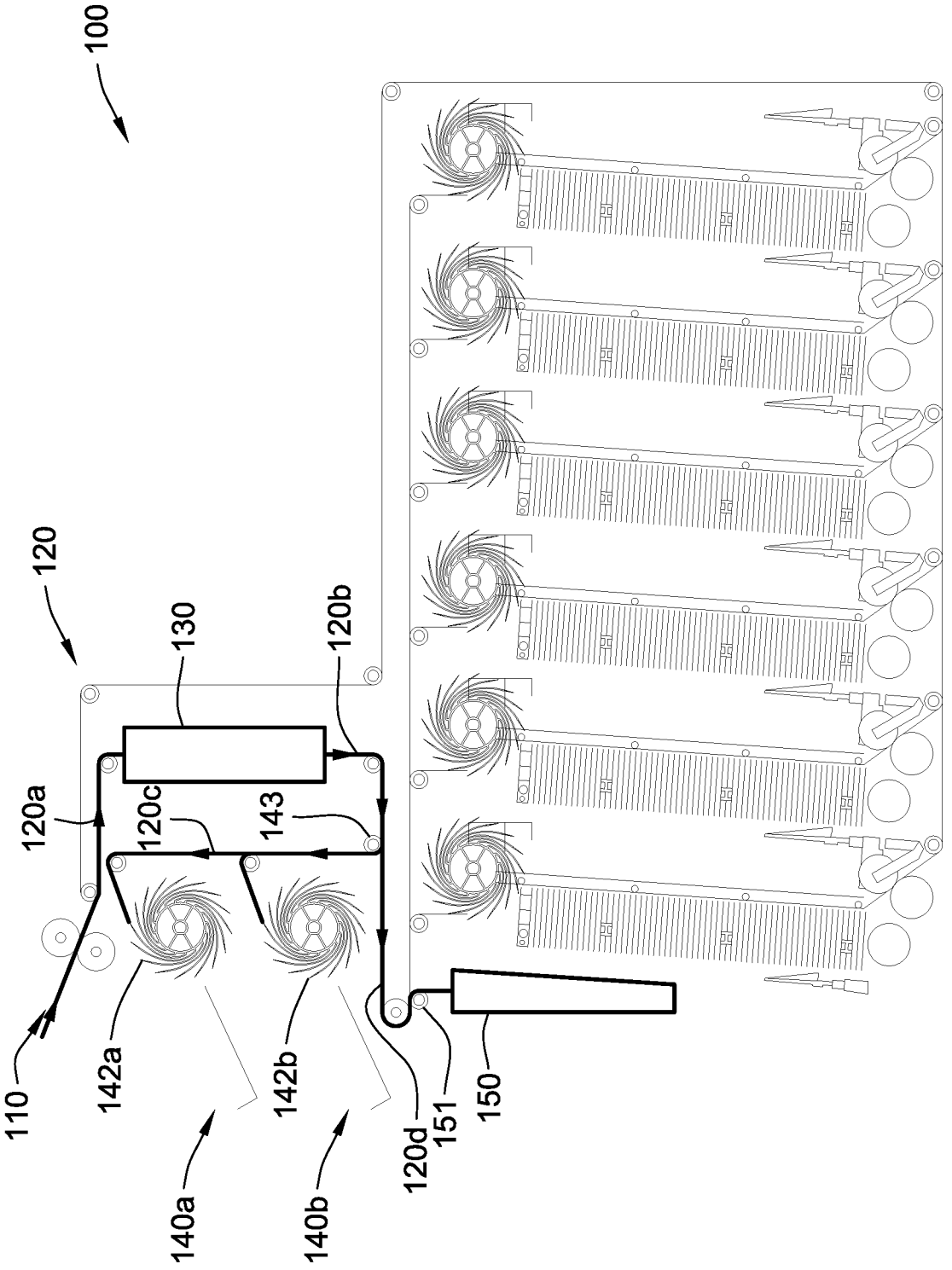
120b
374f
374e
374d
374c
374b
170f
160f
170e
160e
170d
160d
170c
160c
170b
160b
170a
374a
110
142a
142b
140a
140b
120d
151
150
161a
162a
160p
160a

FIG. 1A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120
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120b
120a
120c
143
110
142a
142b
140a
140b
120d
151
150

FIG. 1B

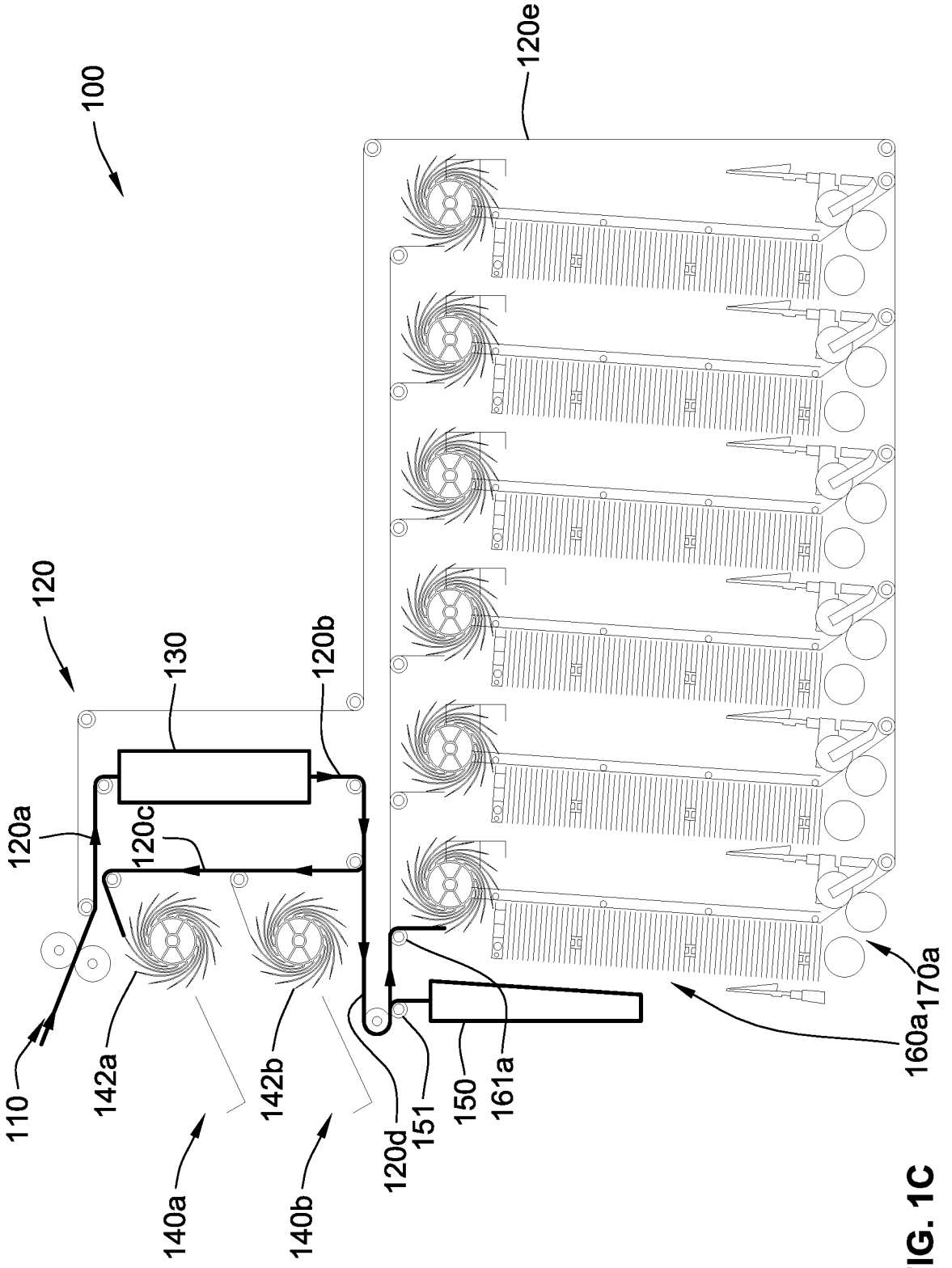

100
120e
120
130
120b
120a
120c
110
142a
142b
140a
140b
120d
151
150
161a
160a
170a

FIG. 1C

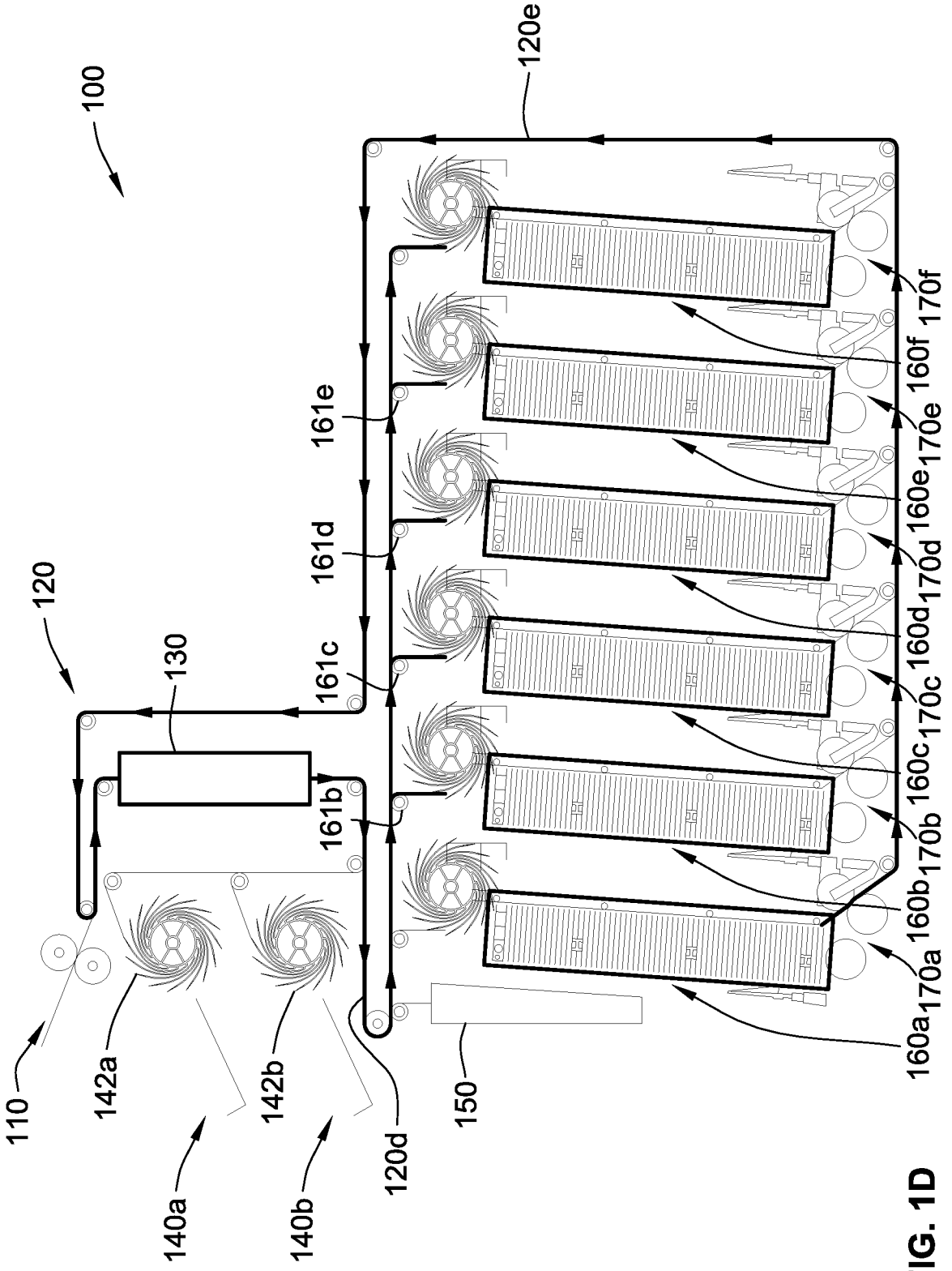

100
120e
120
130
161e
161d
161c
161b
110
142a
142b
140a
140b
120d
150
160a
160b
160c
160d
160e
160f
170a
170b
170c
170d
170e
170f

FIG. 1D

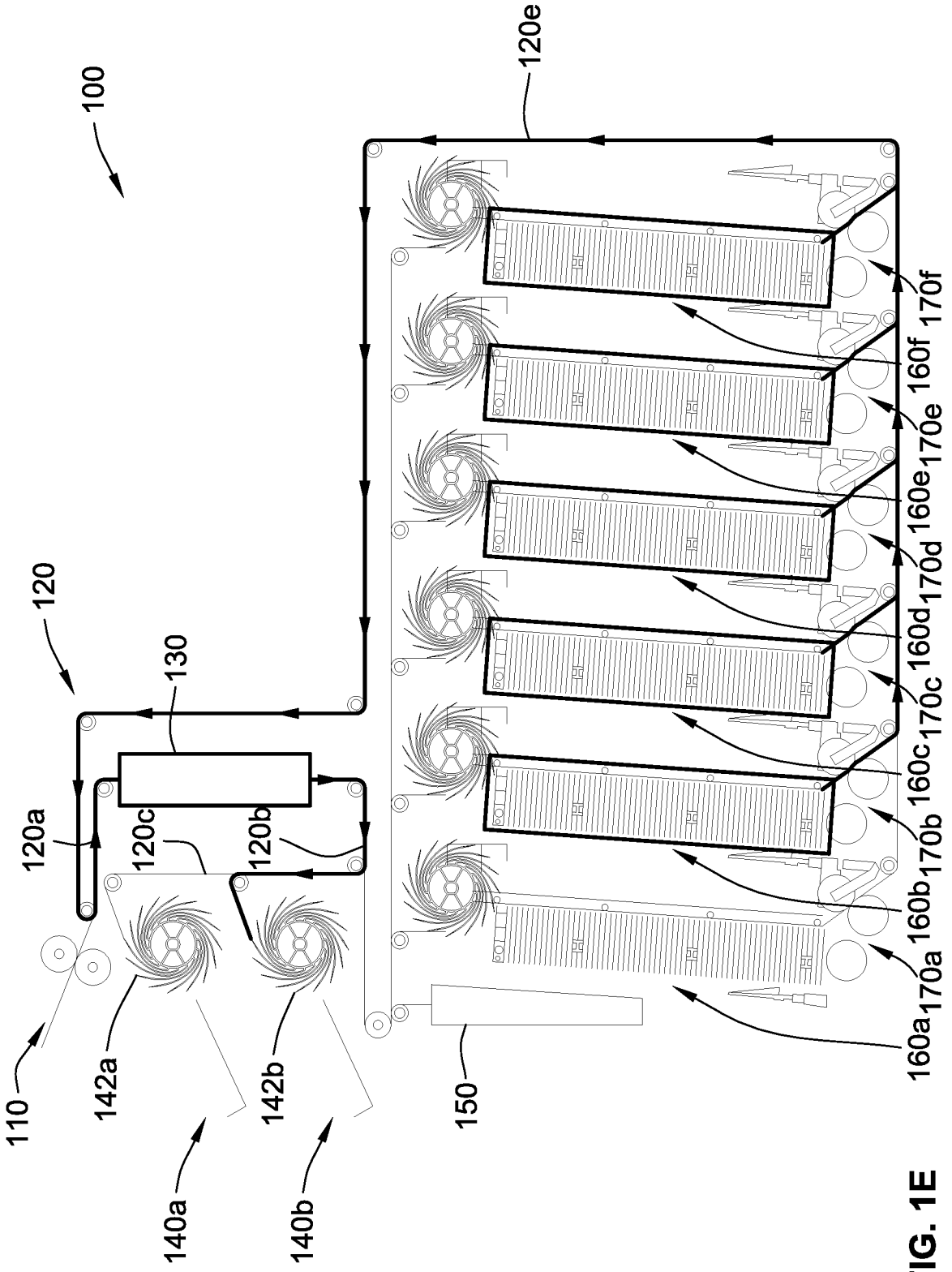

100
120e
120
130
120a
120c
120b
110
142a
142b
150
140a
140b
160a
170a
160b
170b
160c
170c
160d
170d
160e
170e
160f
170f

FIG. 1E

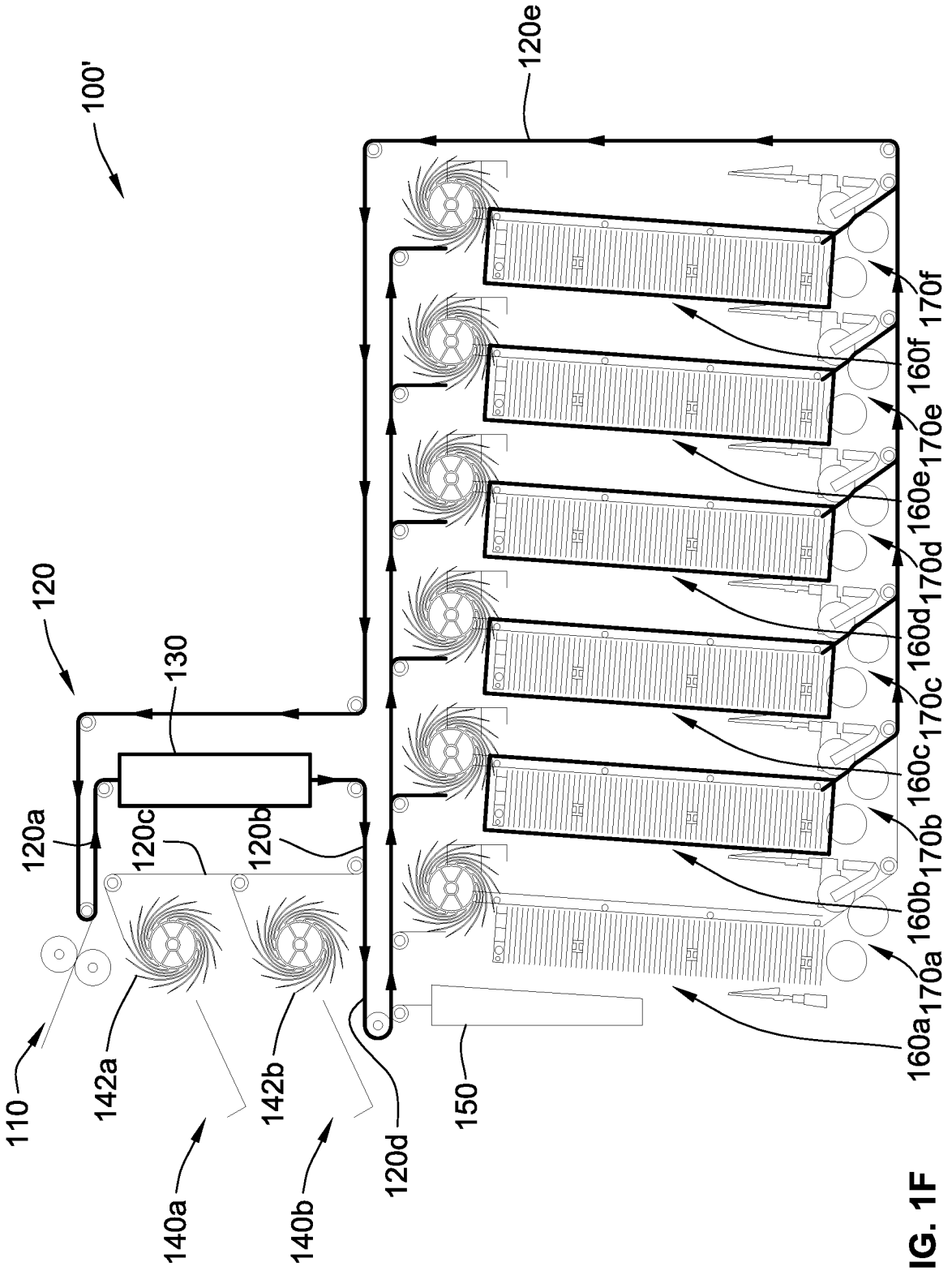

100'
120e
120
130
120a
120c
120b
110
142a
142b
140a
140b
120d
150
160a
170a
160b
170b
160c
170c
160d
170d
160e
170e
160f
170f

FIG. 1F

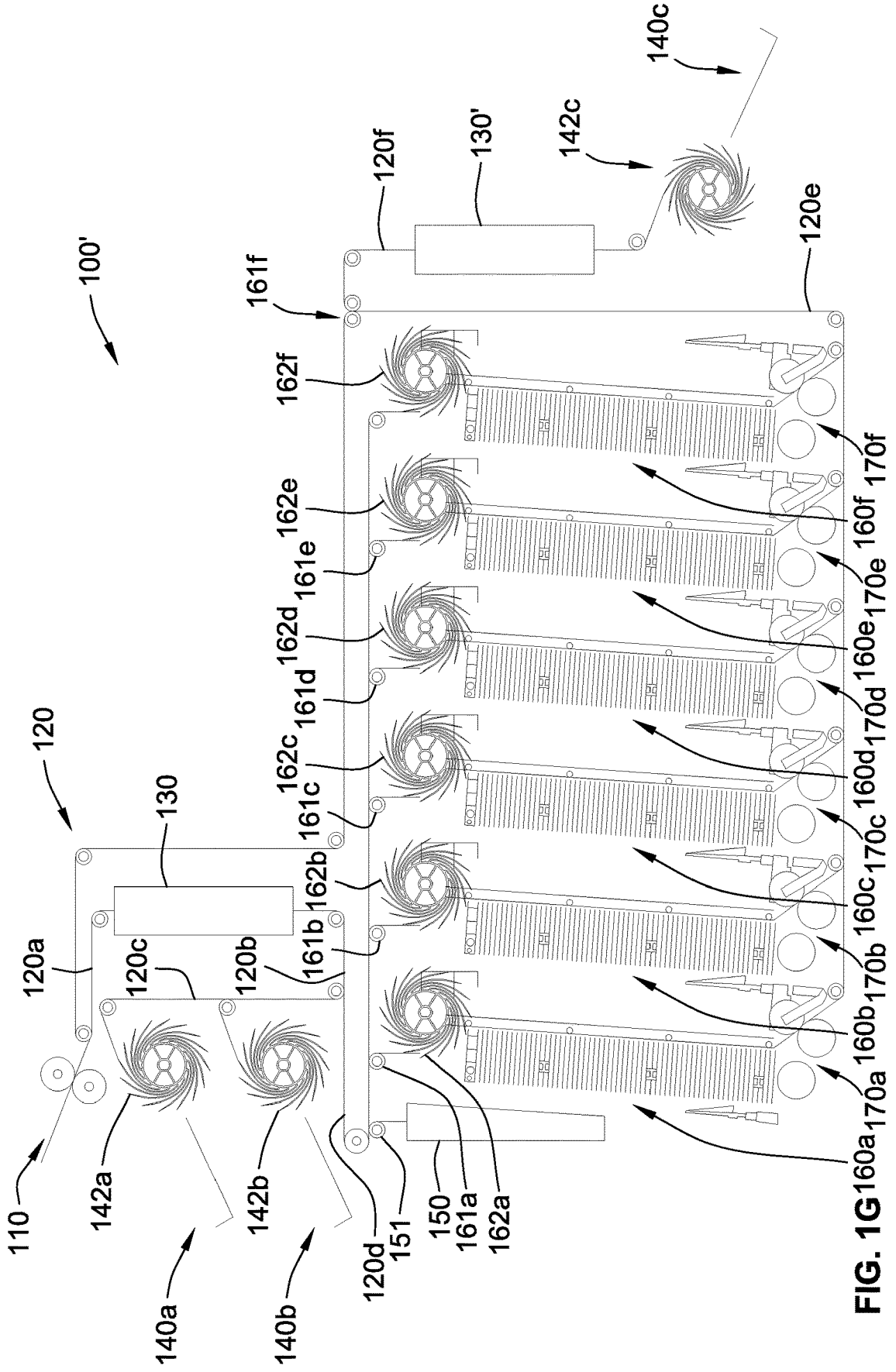

100'
110
120
120a
120b
120c
120d
120e
120f
130
130'
140a
140b
140c
142a
142b
142c
150
151
160a
160b
160c
160d
160e
160f
161a
161b
161c
161d
161e
161f
162a
162b
162c
162d
162e
162f
170a
170b
170c
170d
170e
170f

FIG. 1G

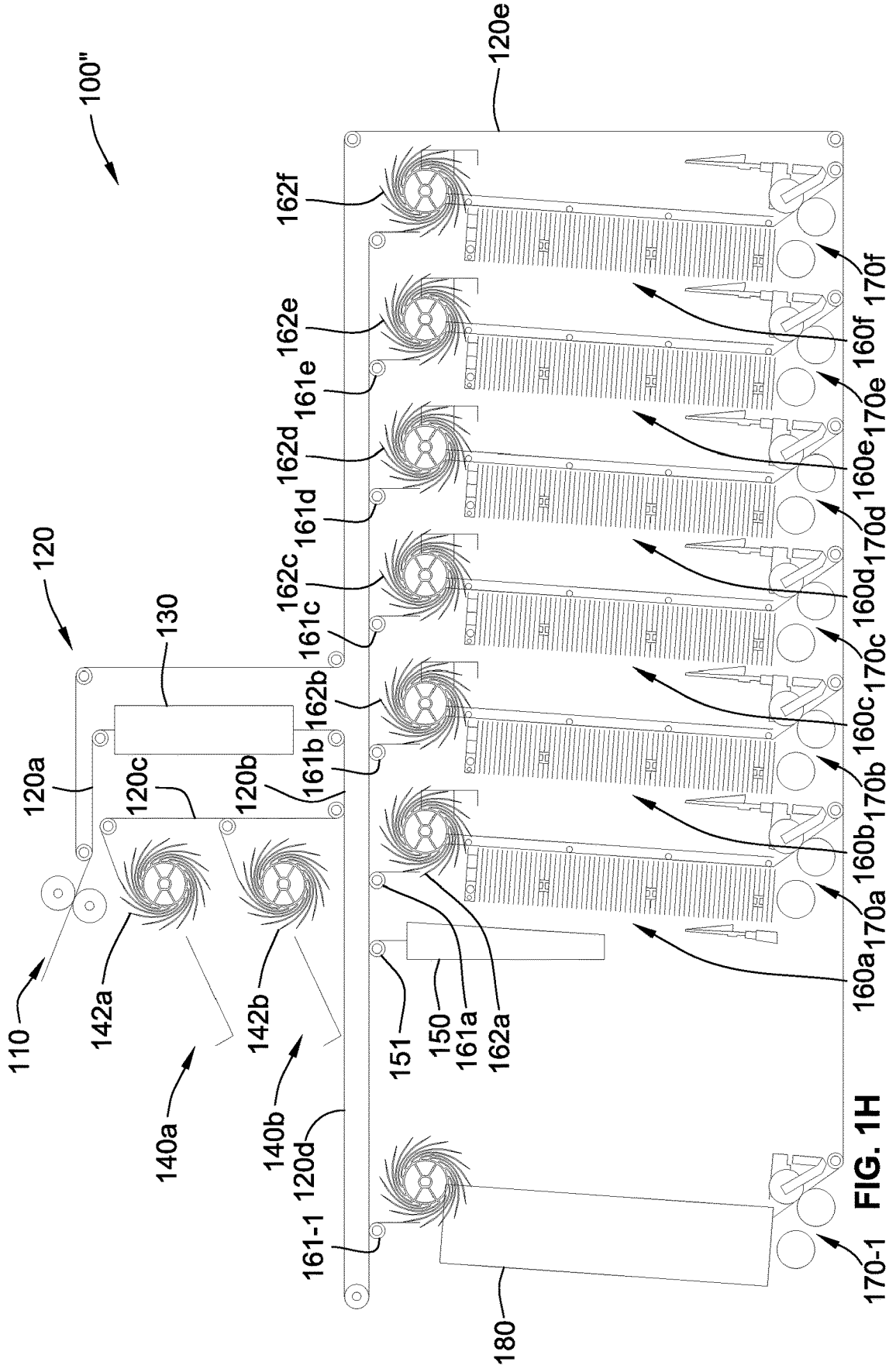

100"
120e
162f
162e
161e
162d
161d
162c
161c
162b
161b
120
130
120a
120c
120b
110
142a
142b
140a
140b
120d
161-1
180
151
150
161a
162a
160a
170a
160b
170b
160c
170c
160d
170d
160e
170e
160f
170f
170-1

FIG. 1H

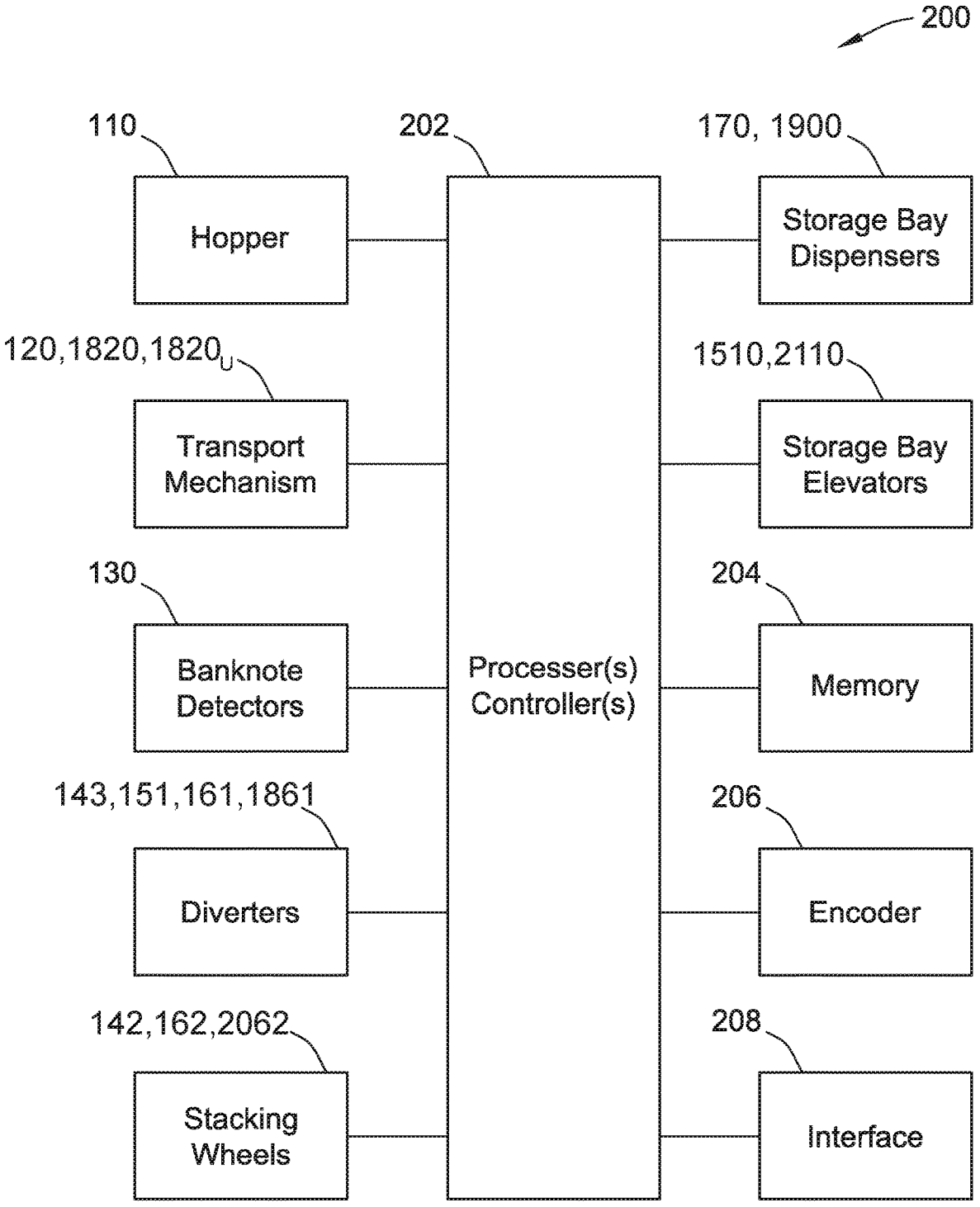
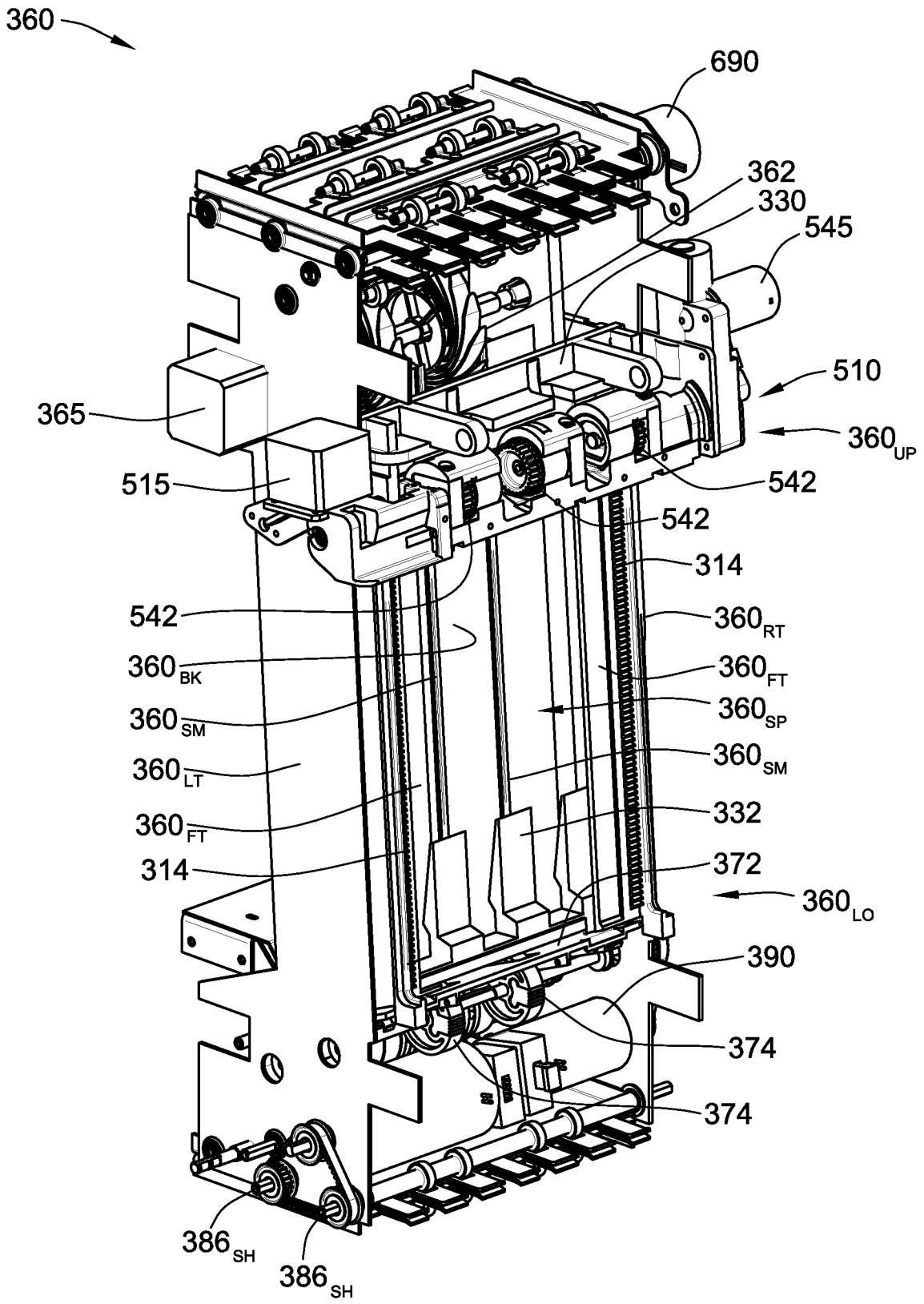

200
110
Hopper
120,1820,1820U
Transport Mechanism
130
Banknote Detectors
143,151,161,1861
Diverters
142,162,2062
Stacking Wheels
202
Processer(s) Controller(s)
170, 1900
Storage Bay Dispensers
1510,2110
Storage Bay Elevators
204
Memory
206
Encoder
208
Interface

FIG. 2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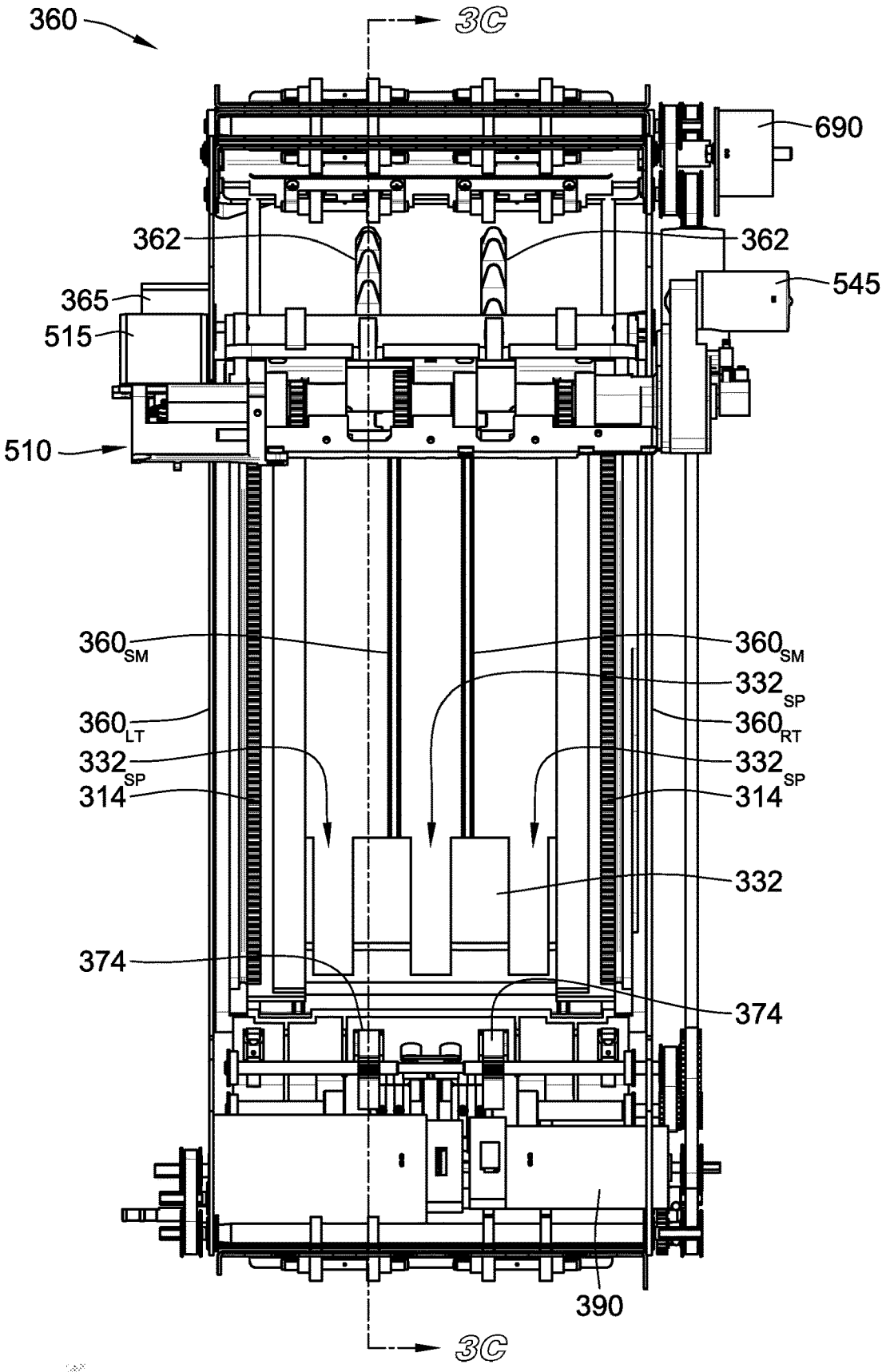
690
362
330
545
510
365
360UP
515
542
542
314
542
360RT
360BK
360FT
360SM
360SP
360LT
360SM
360FT
332
314
372
360LO
390
374
374
386SH
386SH

FIG. 3A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3C
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362
362
545
365
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510
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332
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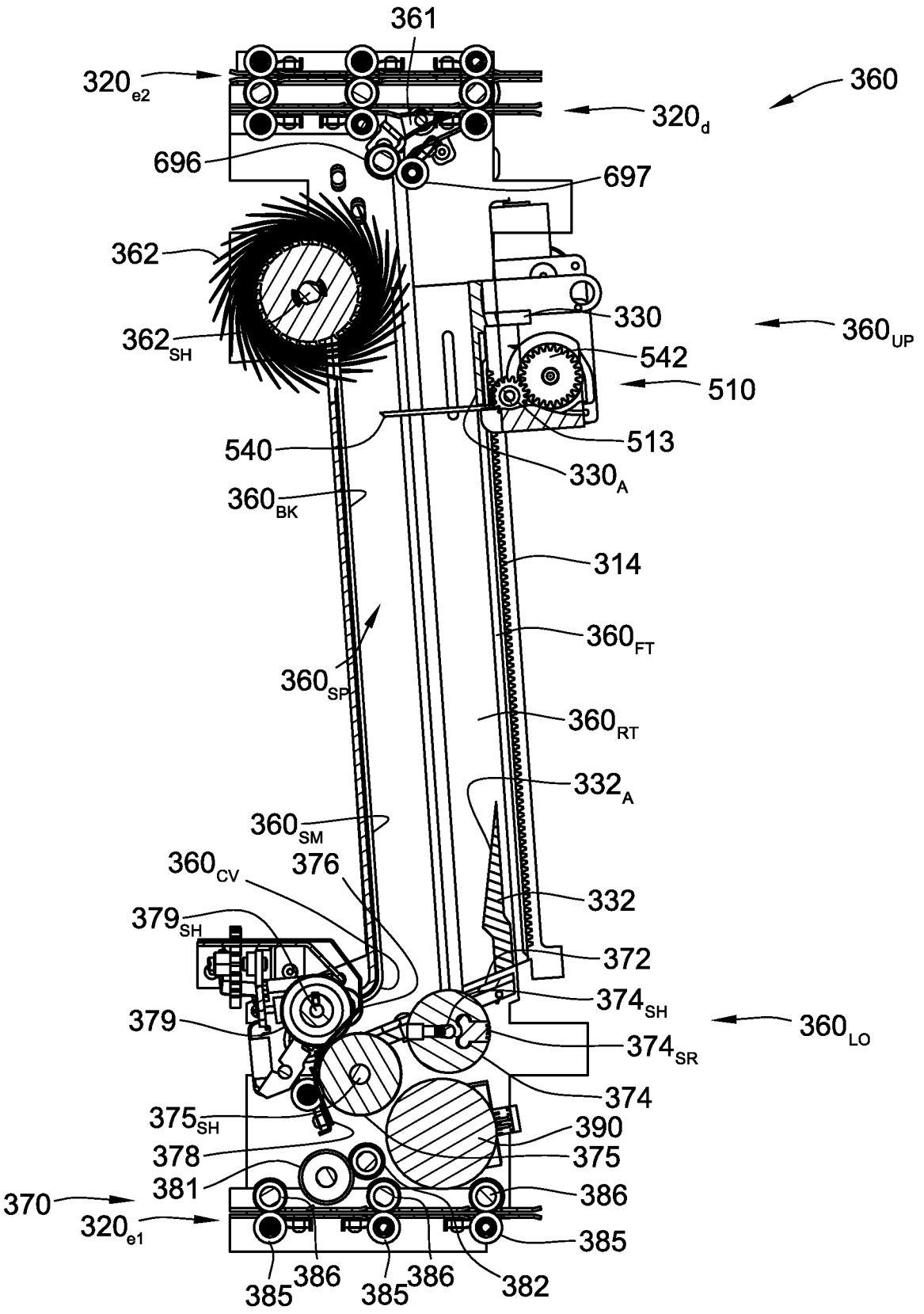
374
390
3C

FIG. 3B


361
320e2
360
320d
696
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362
330
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542
510
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540
330A
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360SP
360RT
332A
360SM
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376
332
379SH
372
374SH
379
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320e1
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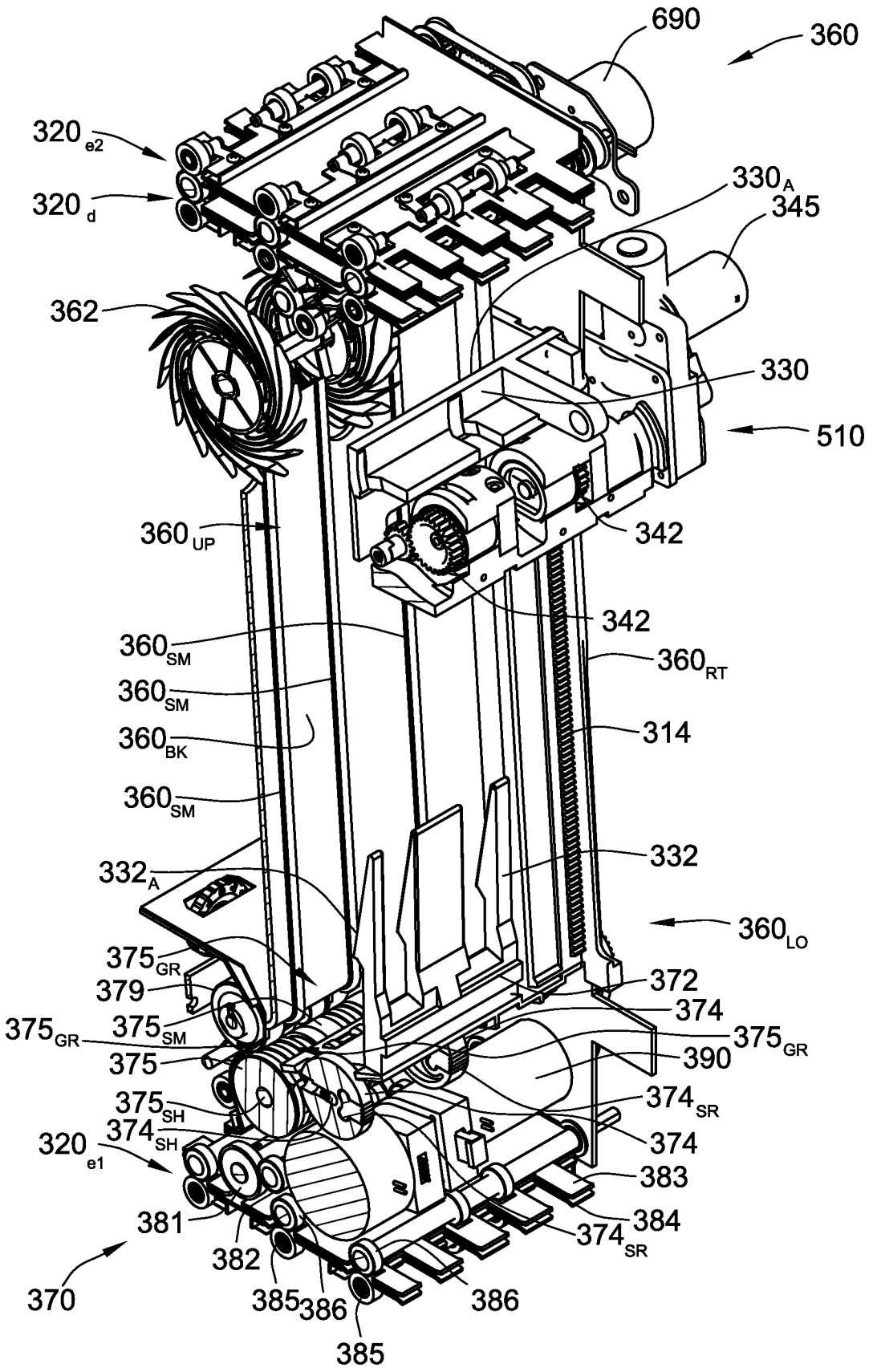
385
386
385
386
382

FIG. 3C


690
360
320 e2
320 d
330 A
345
362
330
510
360 UP
342
342
360 SM
360 RT
360 SM
314
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360 SM
332
332 A
360 LO
375 GR
379
372
374
375 GR
375 SM
375 GR
375
390
375 SH
374 SR
374 SH
374
320 e1
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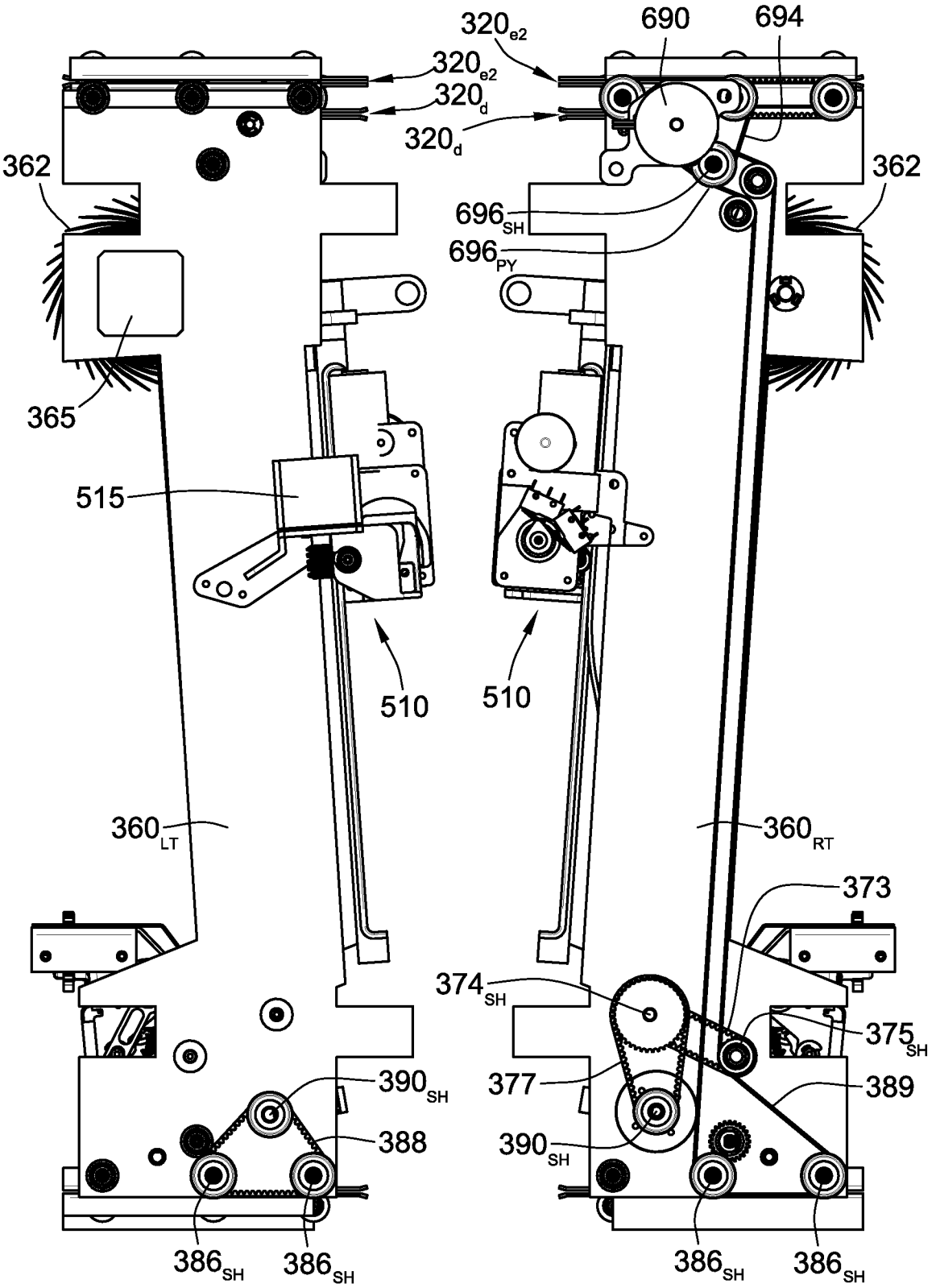
381
384
374 SR
382
370
385
386
386
385

FIG. 3D


320e2
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320d
320d
362
365
515
510
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390SH
388
386SH
386SH
320e2
690
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362
696SH
696PY
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374SH
375SH
377
389
390SH
386SH
386SH

FIG. 3E

FIG. 3F

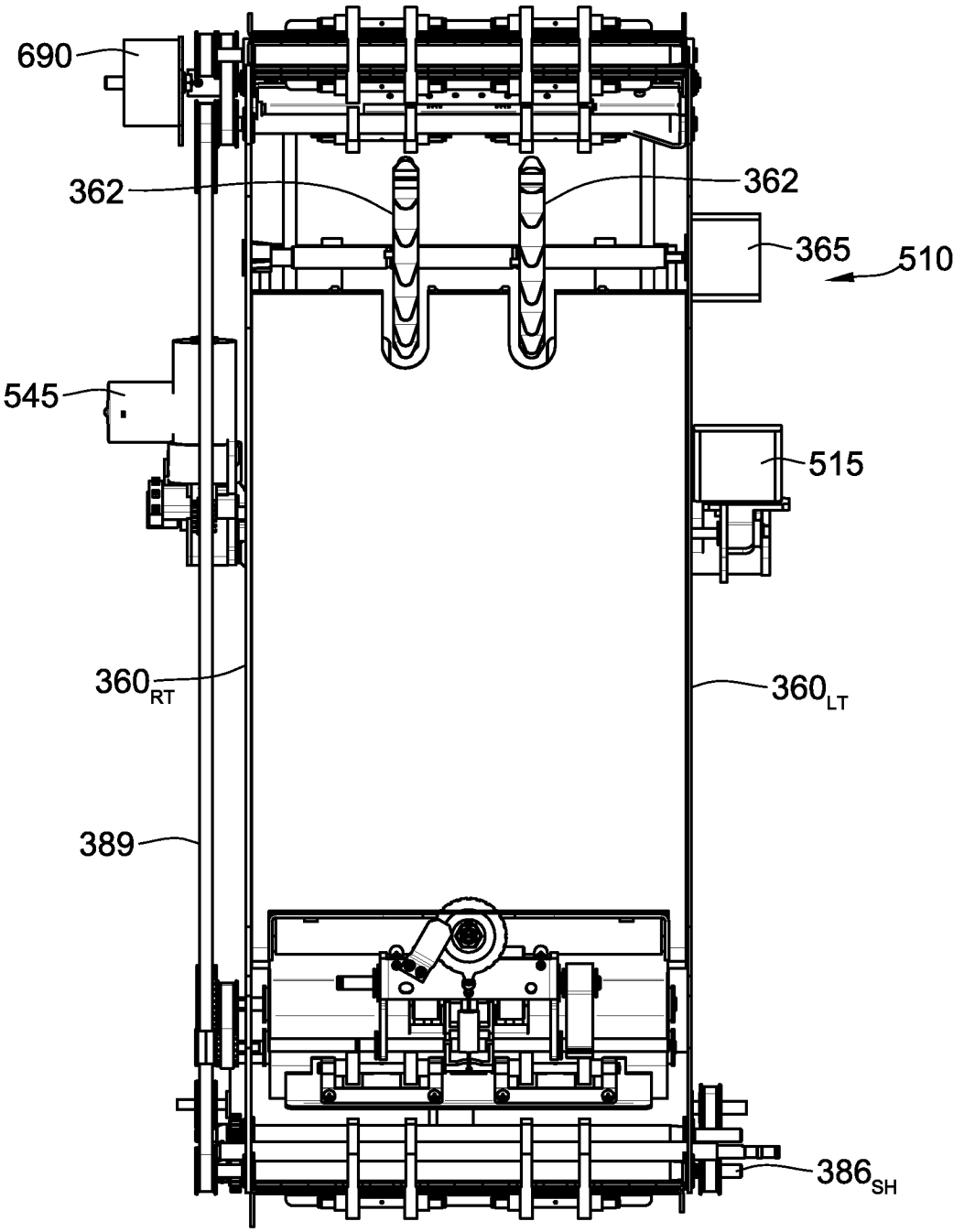
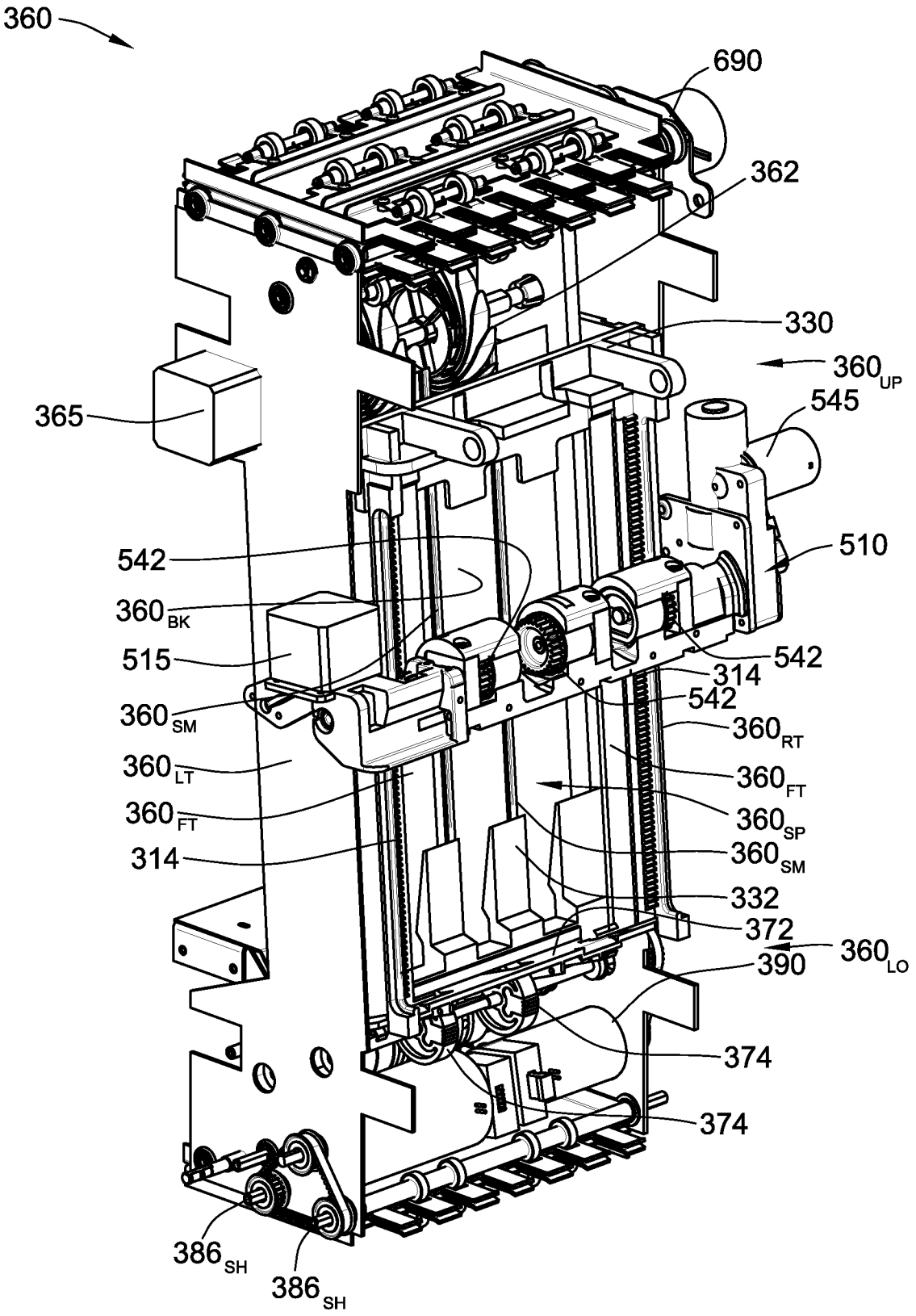


FIG. 3G


360
690
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330
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510
360BK
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542
314
542
360SM
360RT
360LT
360FT
360FT
360SP
314
360SM
332
372
360LO
390
374
374
386SH
386SH

FIG. 4A

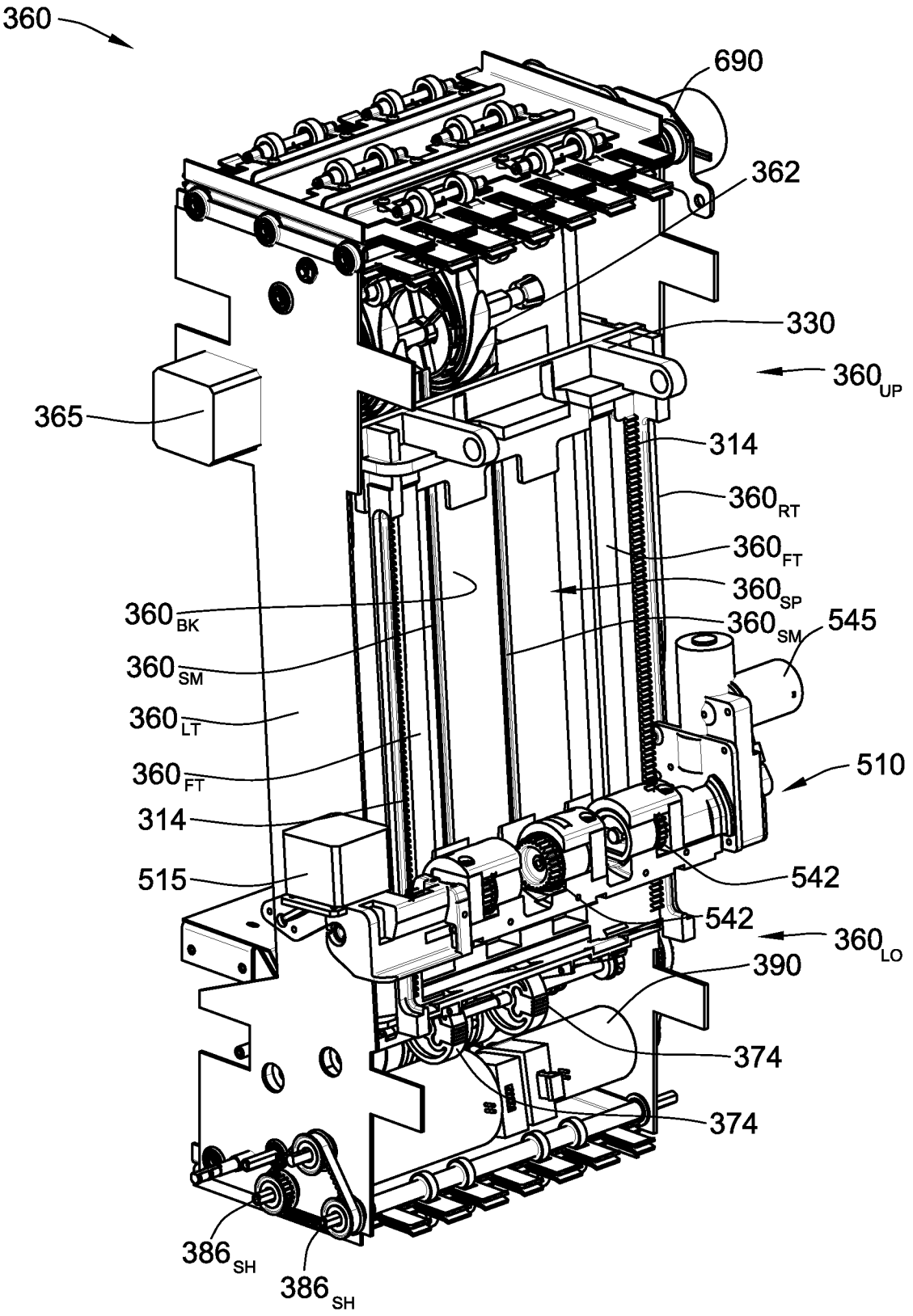
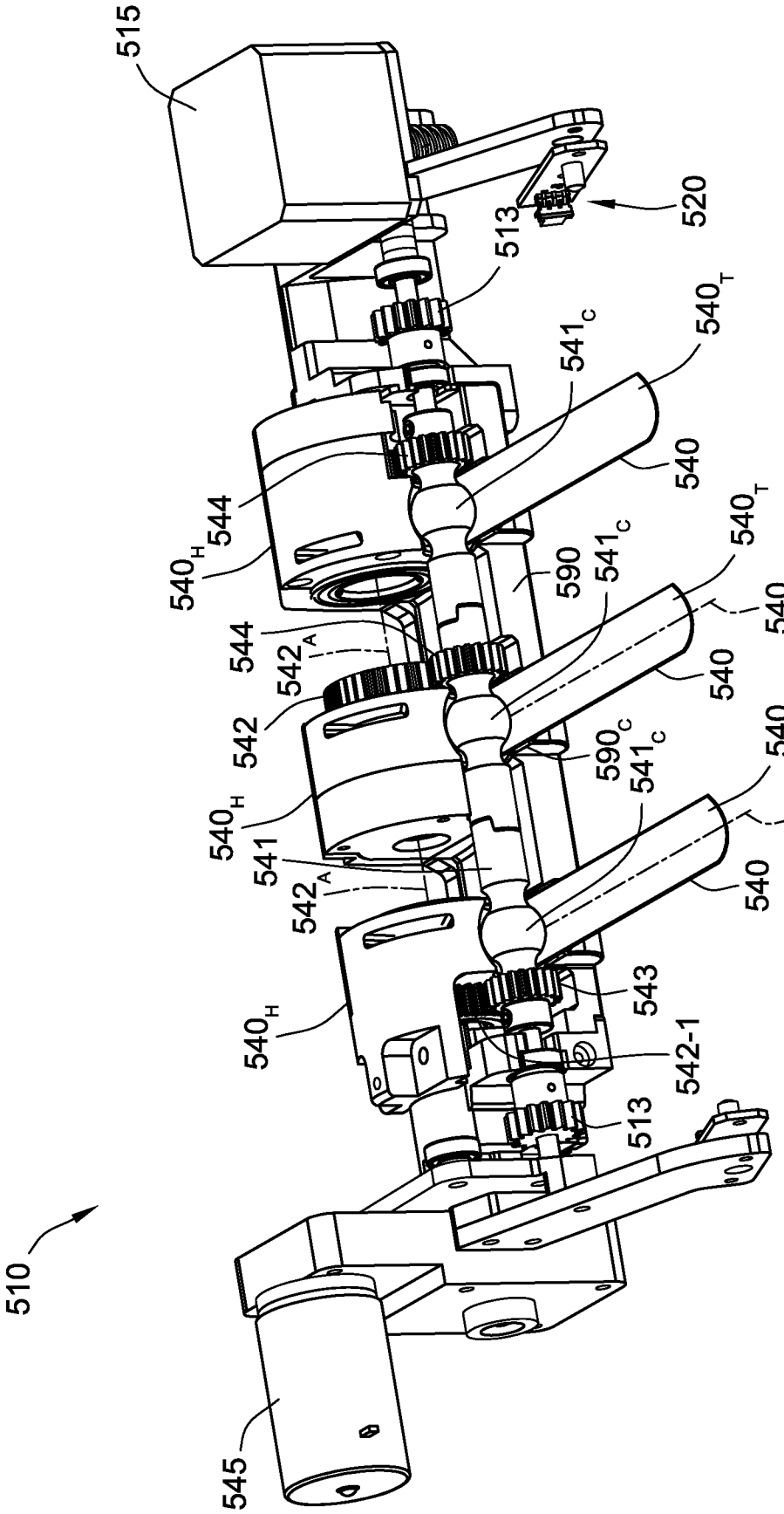

360
690
362
330
360UP
365
314
360RT
360FT
360SP
360BK
360SM
545
360SM
360LT
360FT
510
314
515
542
542
360LO
390
374
374
386SH
386SH

FIG. 4B


515
520
513
540_T
541_C
540
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540_H
590
540_A
542_A
542
590_C
541
543
542-1
510
545

FIG. 5A

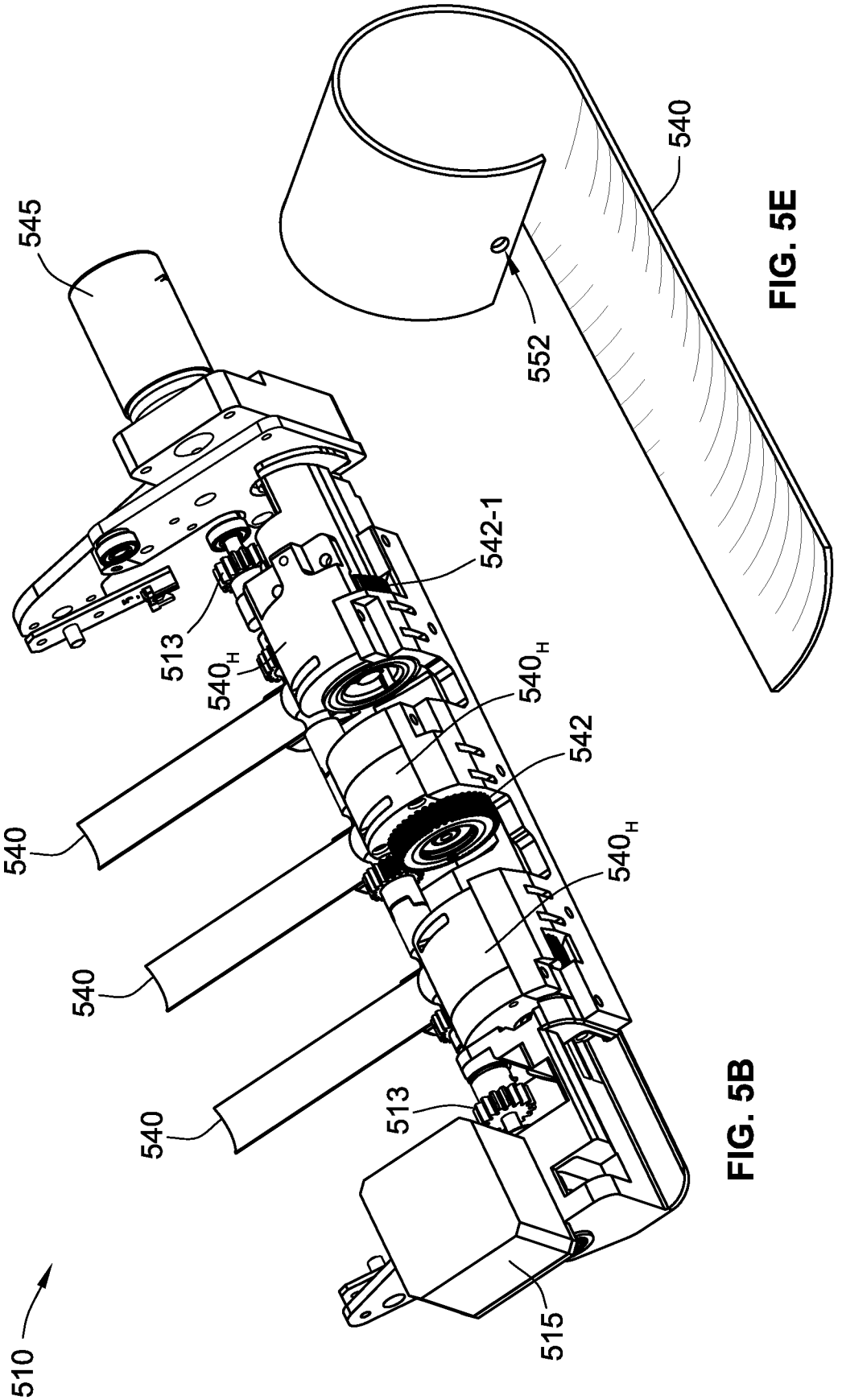


FIG. 5E

FIG. 5B

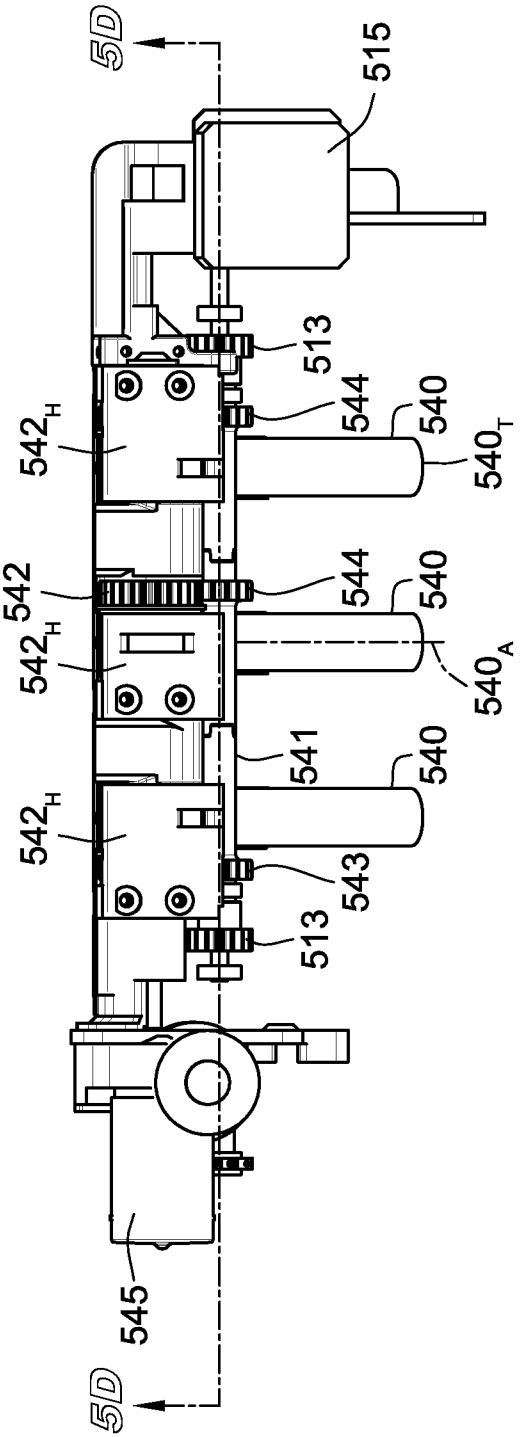

5D
515
513
544
540
540_T
542_H
542
542_H
544
540
540_A
541
540
542_H
543
513
545
5D

FIG. 5C

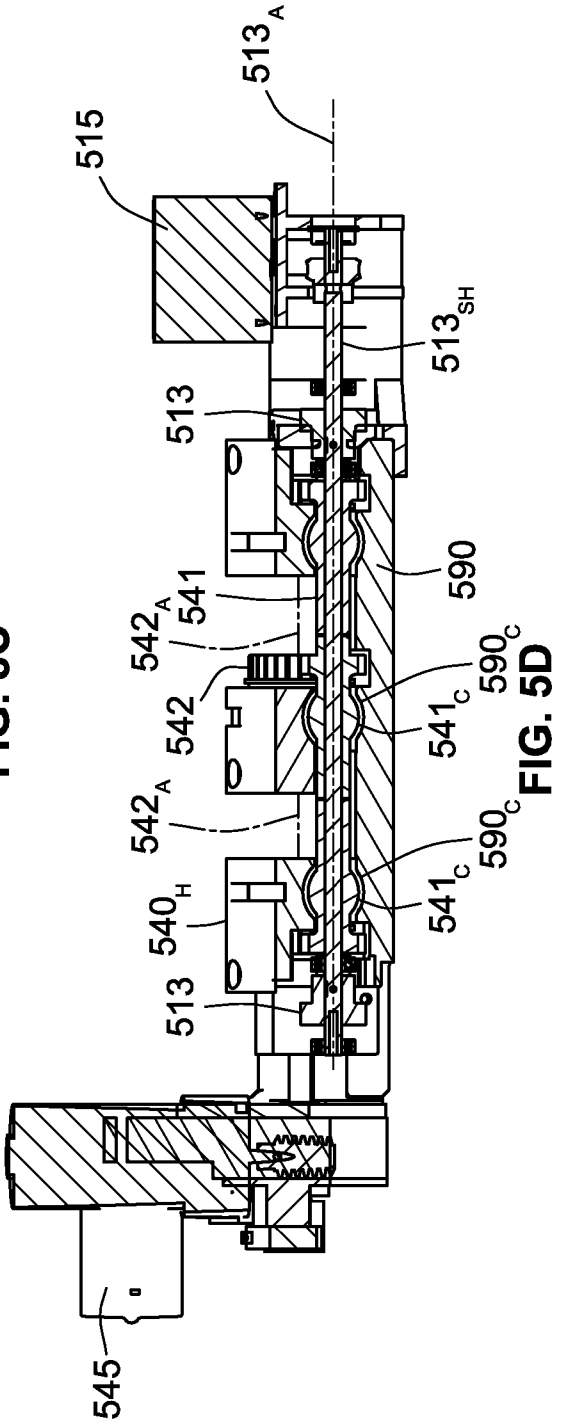

513_A
515
513_{SH}
513
590
542_A
541
542
590_C
541_C
542_A
590_C
540_H
541_C
513
545

FIG. 5D

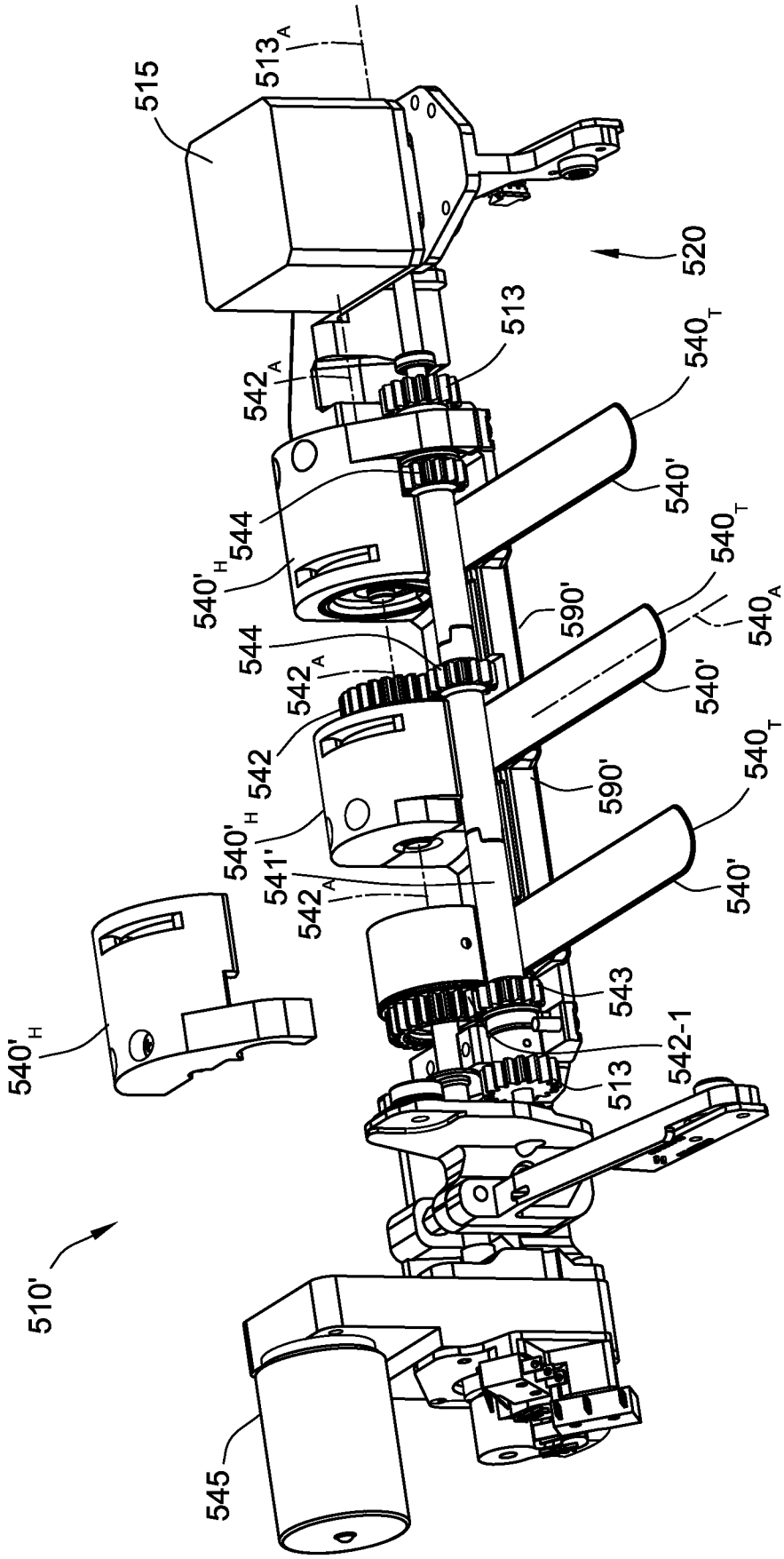

515
513A
520
513
542A
540T
540'
544
540'H
590'
540A
542
541'
543
542-1
510'
545

FIG. 5F

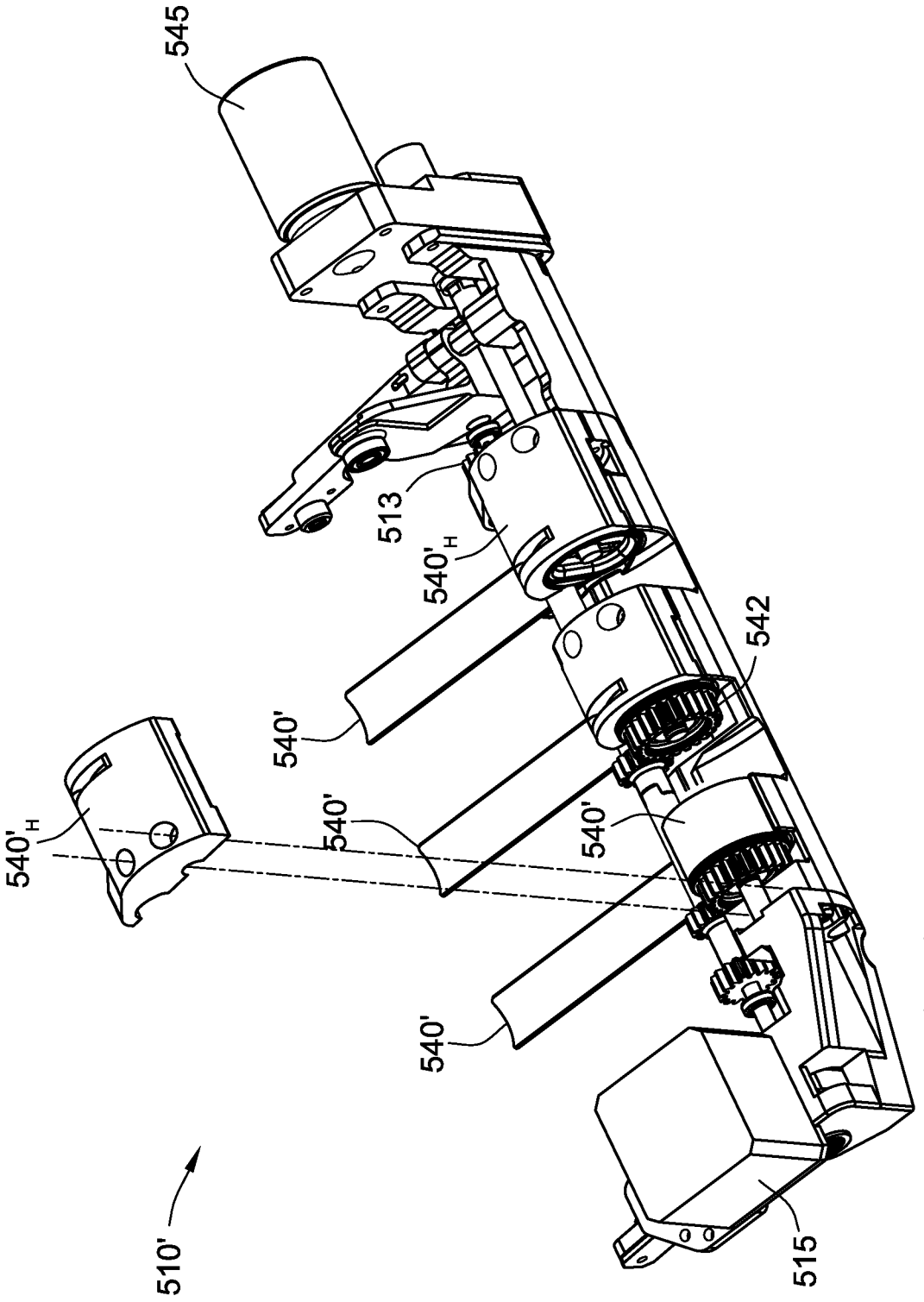


FIG. 5G

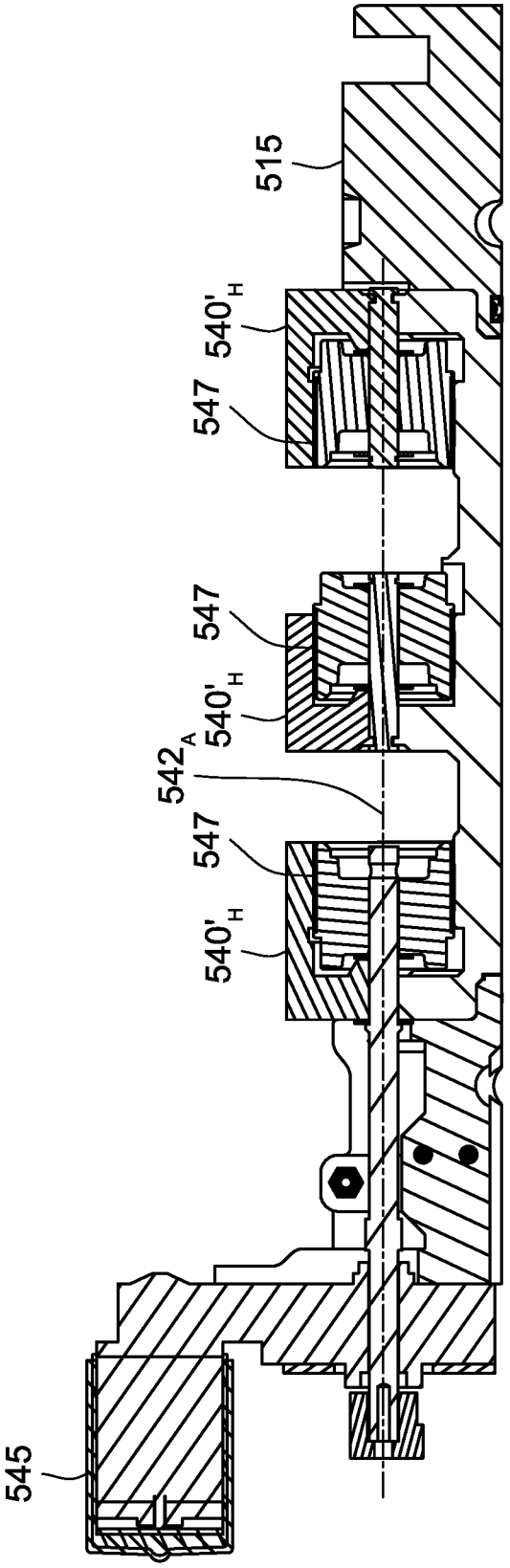


FIG. 5H

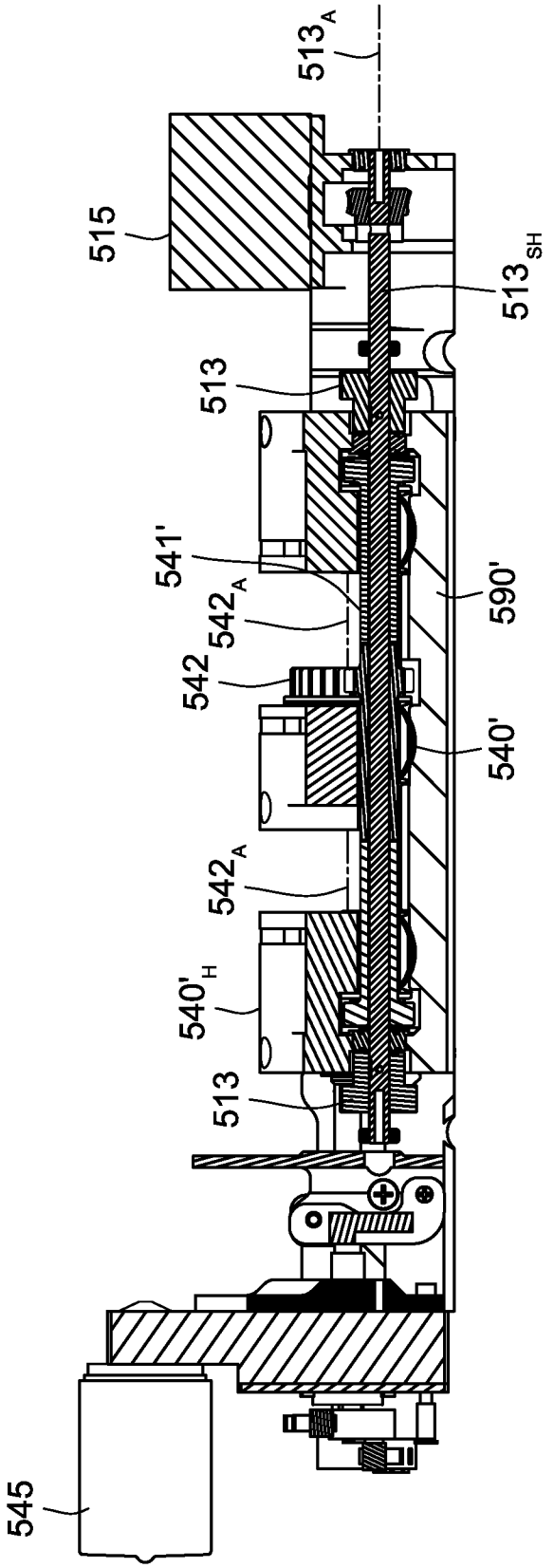


FIG. 5I

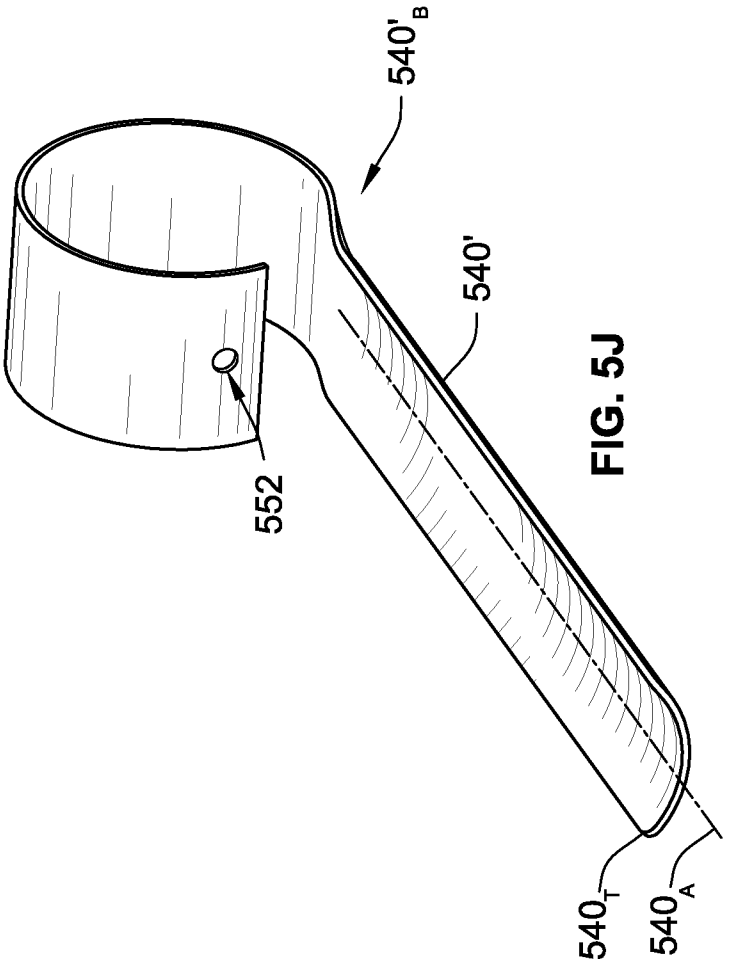


FIG. 5J

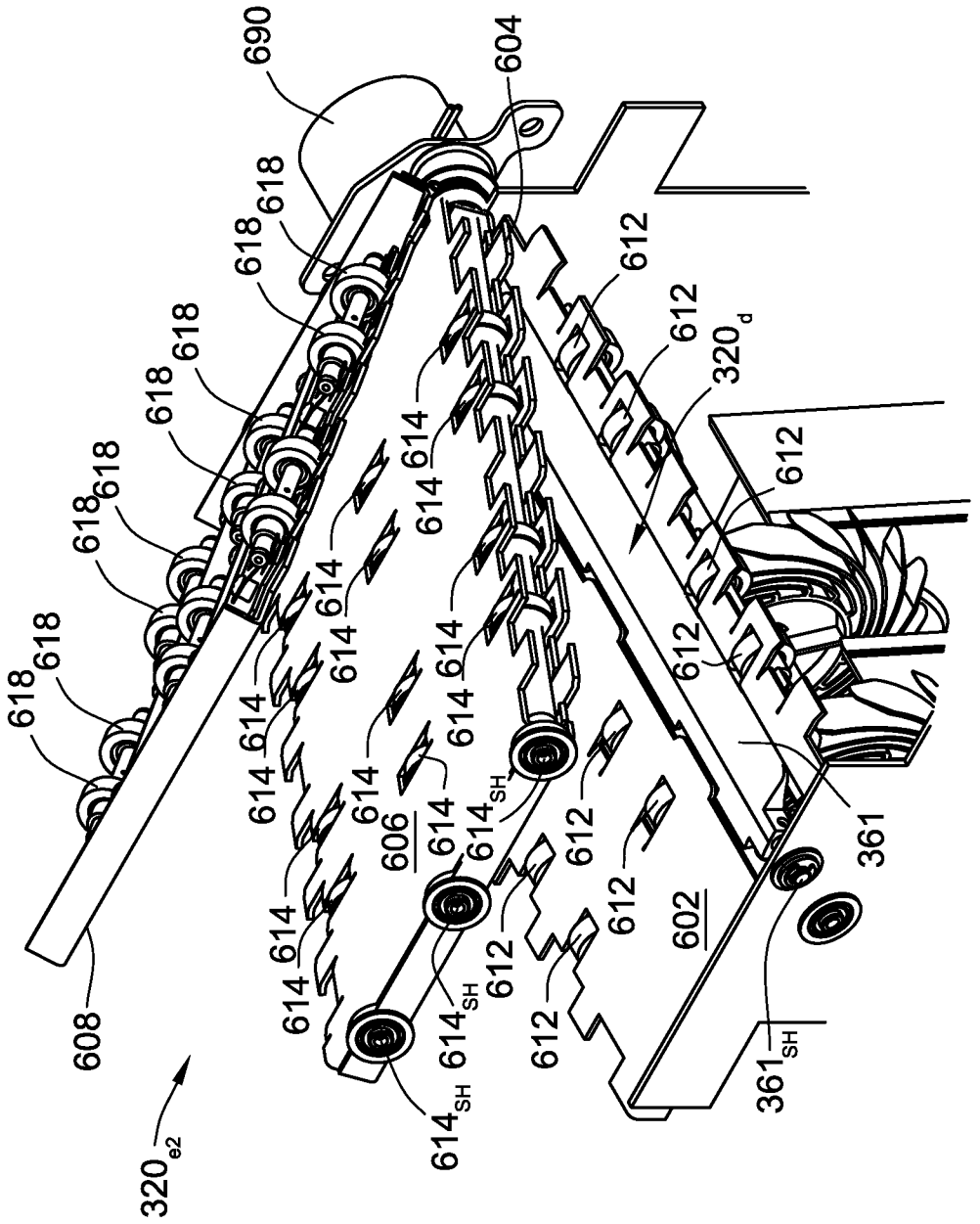
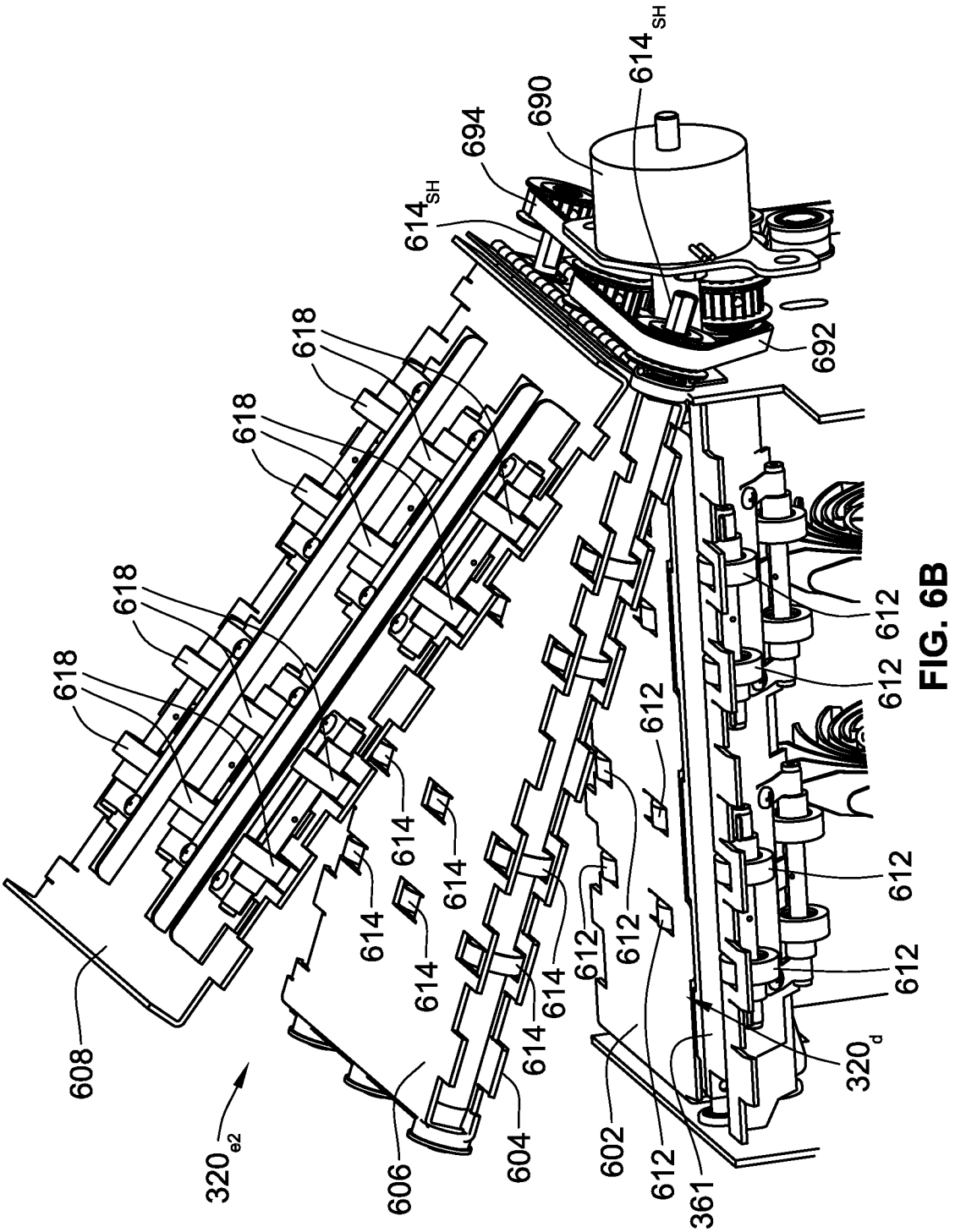


FIG. 6A


614SH
690
694
614SH
618
618
618
618
692
612
612
612
612
612
612
612
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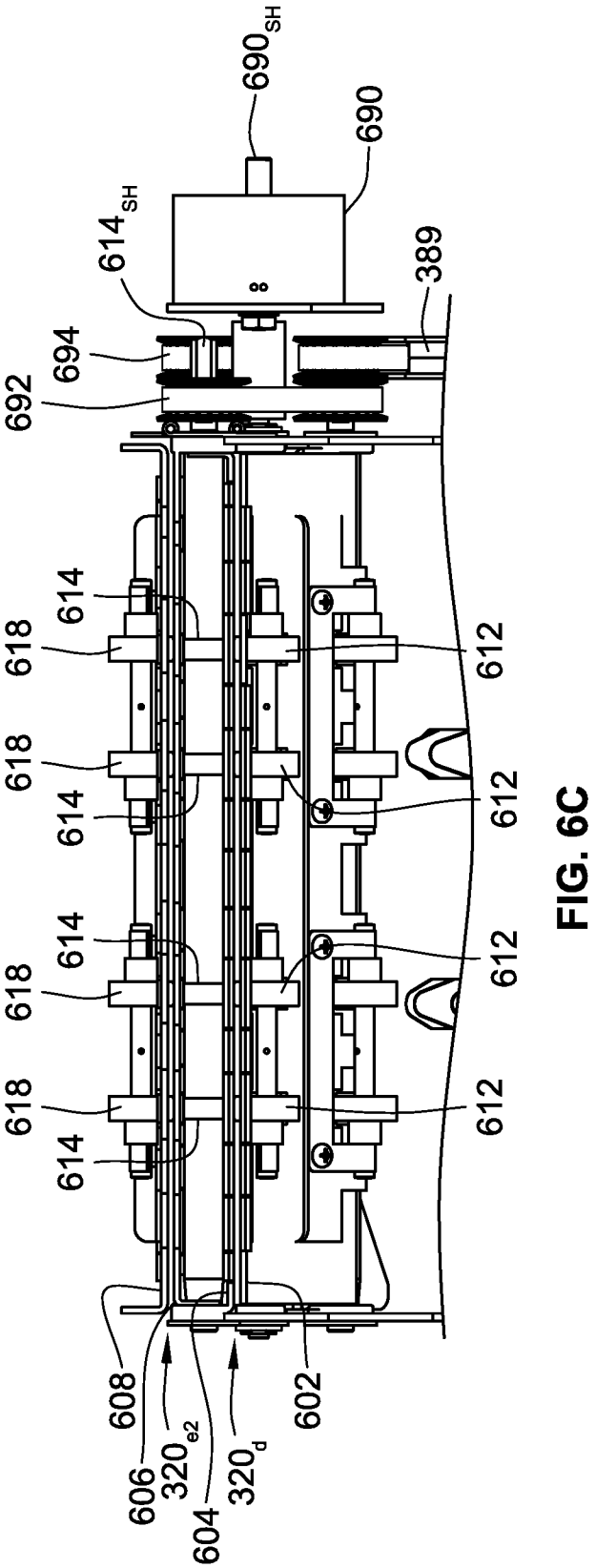
614
614
614
614
614
614
608
606
604
602
612
361
320e2
320d

FIG. 6B


690SH
690
614SH
389
694
692
614
618
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612
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612
608
606
320e2
604
320d
602

FIG. 6C

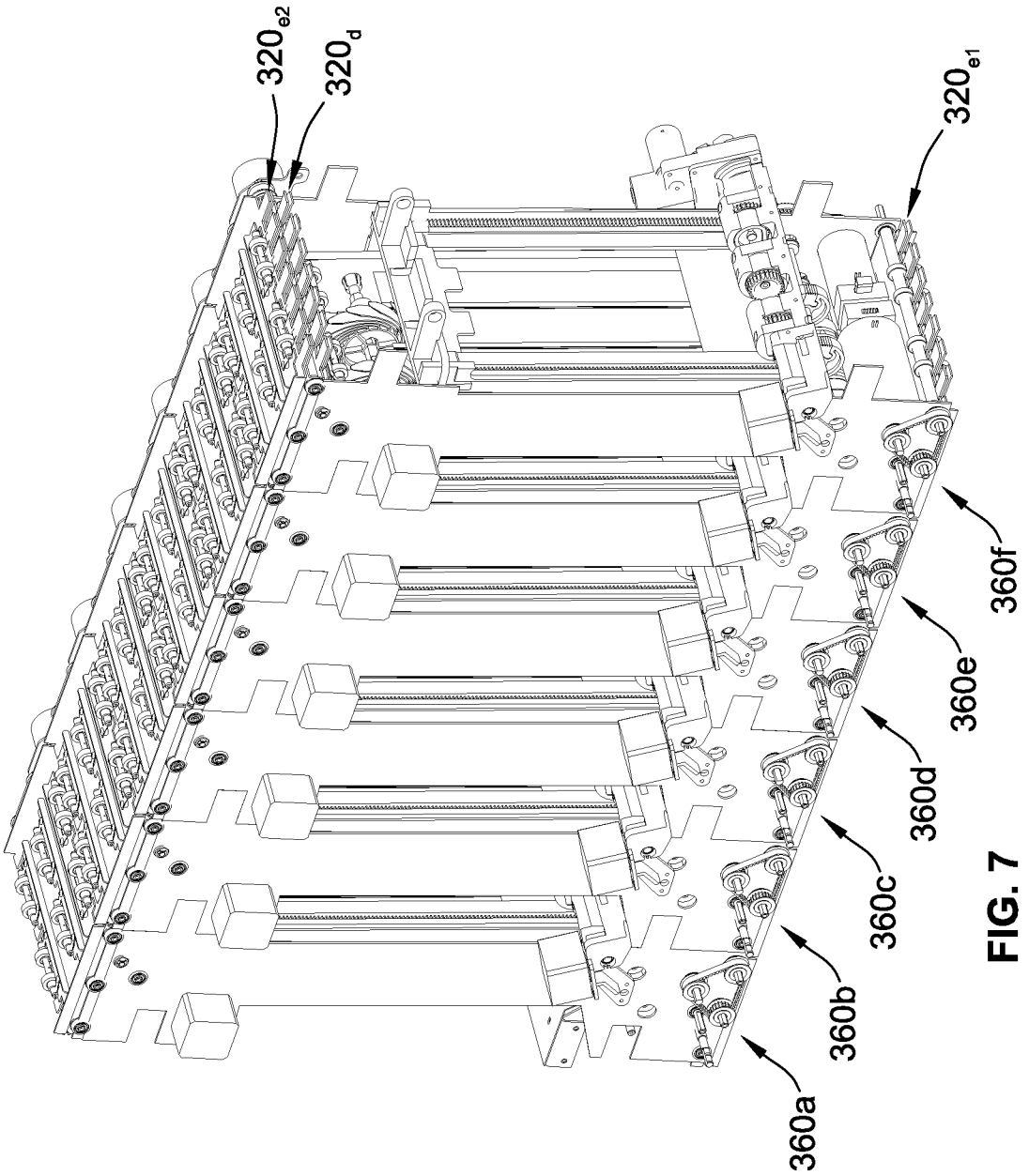


FIG. 7

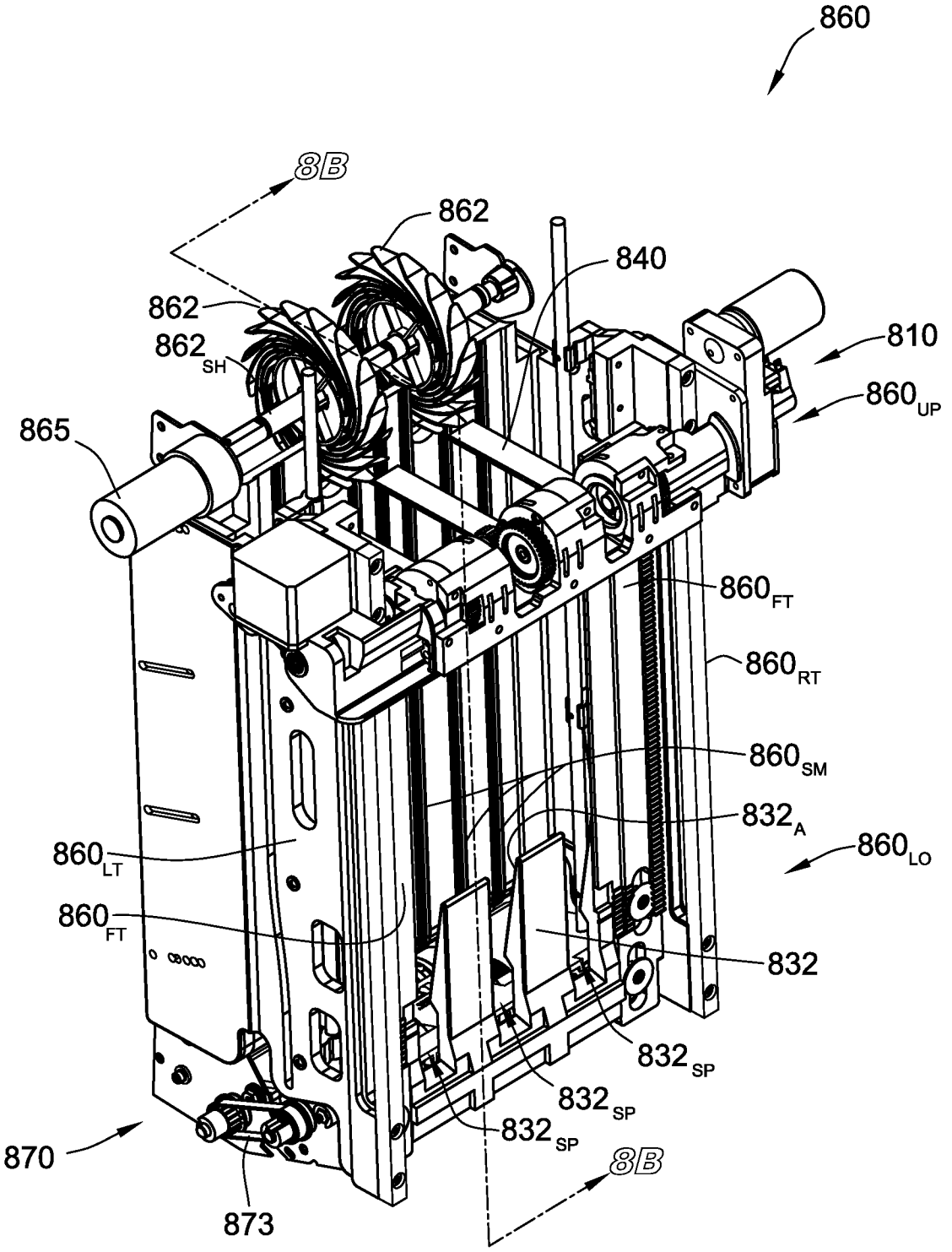

860
8B
862
840
862
862SH
810
860UP
865
860FT
860RT
860SM
832A
860LT
860LO
860FT
832
832SP
832SP
832SP
870
8B
873

FIG. 8A

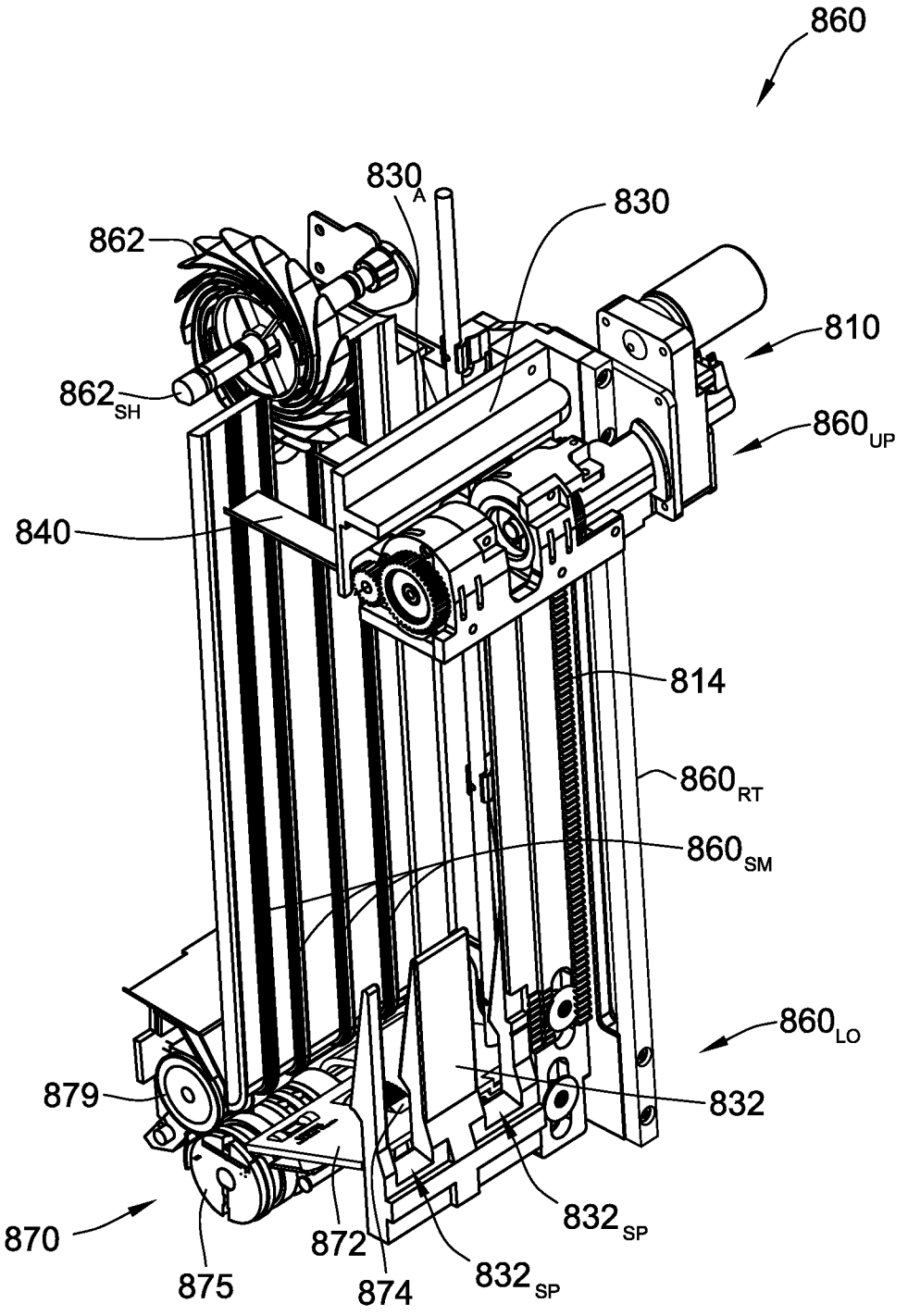
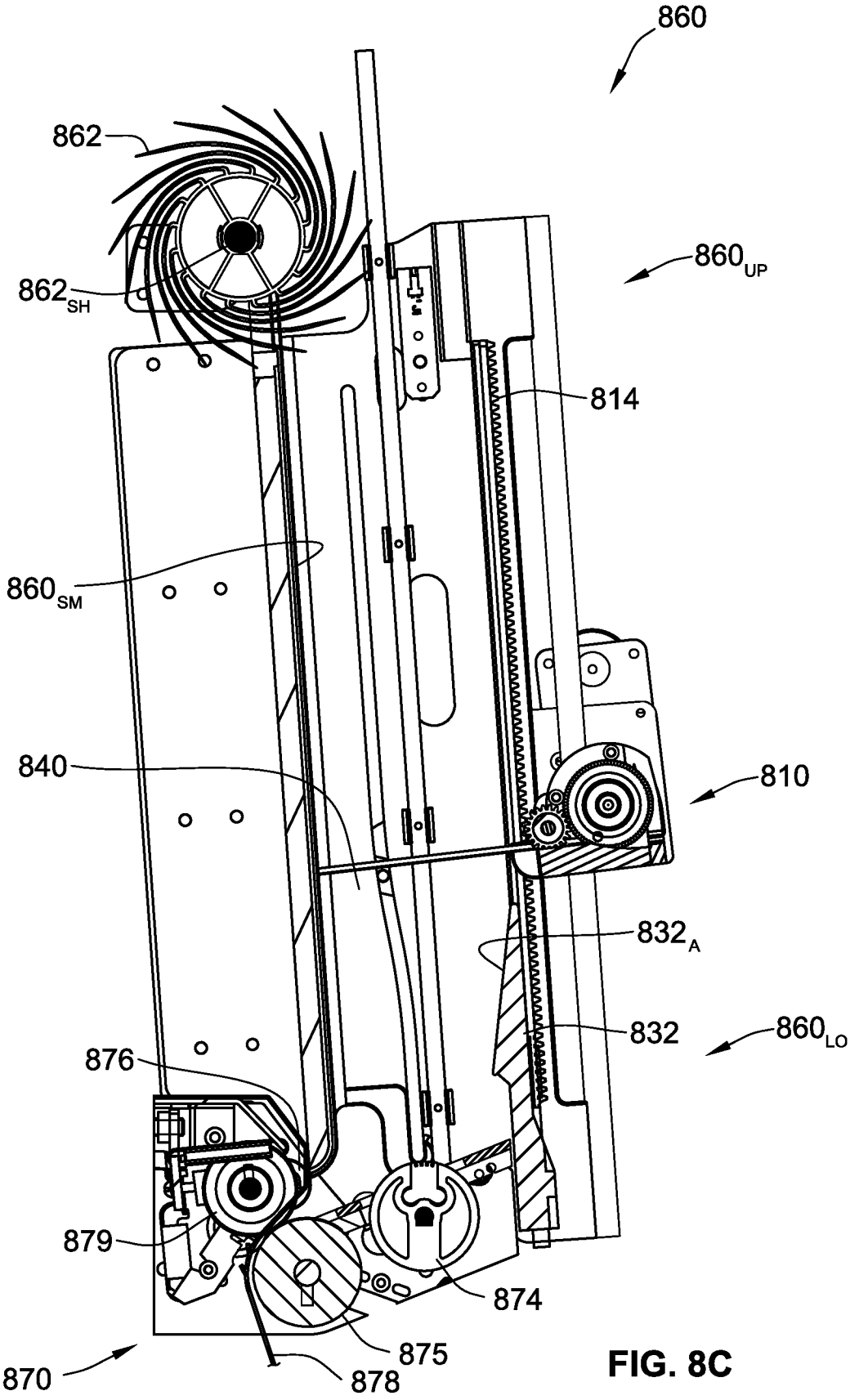

860
830A
830
862
810
862SH
860UP
840
814
860RT
860SM
860LO
879
832
870
832SP
872
875
874
832SP

FIG. 8B


860
862
862SH
860UP
814
860SM
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810
832A
832
860LO
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878
870

FIG. 8C

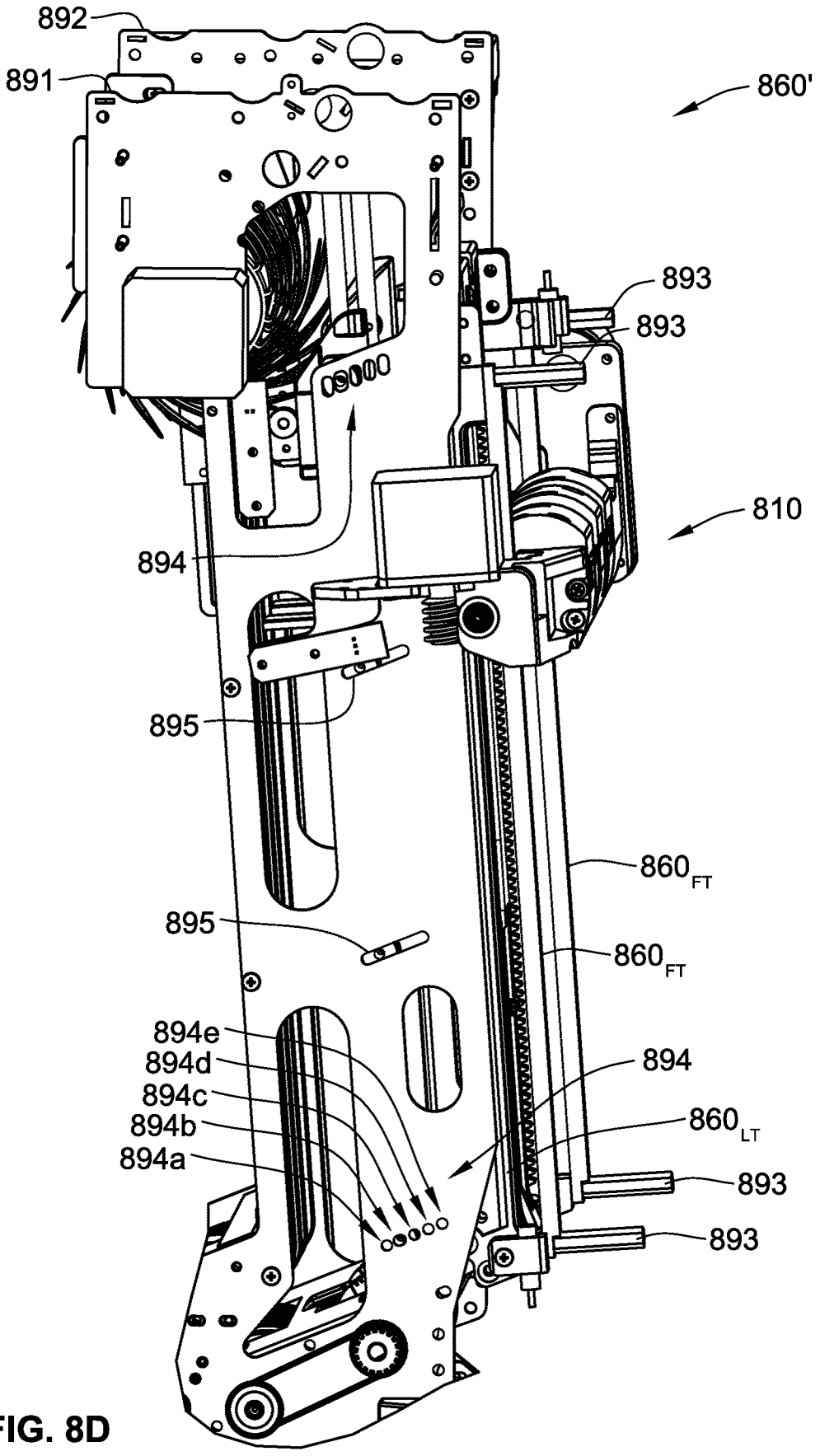
892
891
860'
893
893
810
894
895
860FT
895
860FT
894e
894d
894c
894b
894a
894
860LT
893
893

FIG. 8D

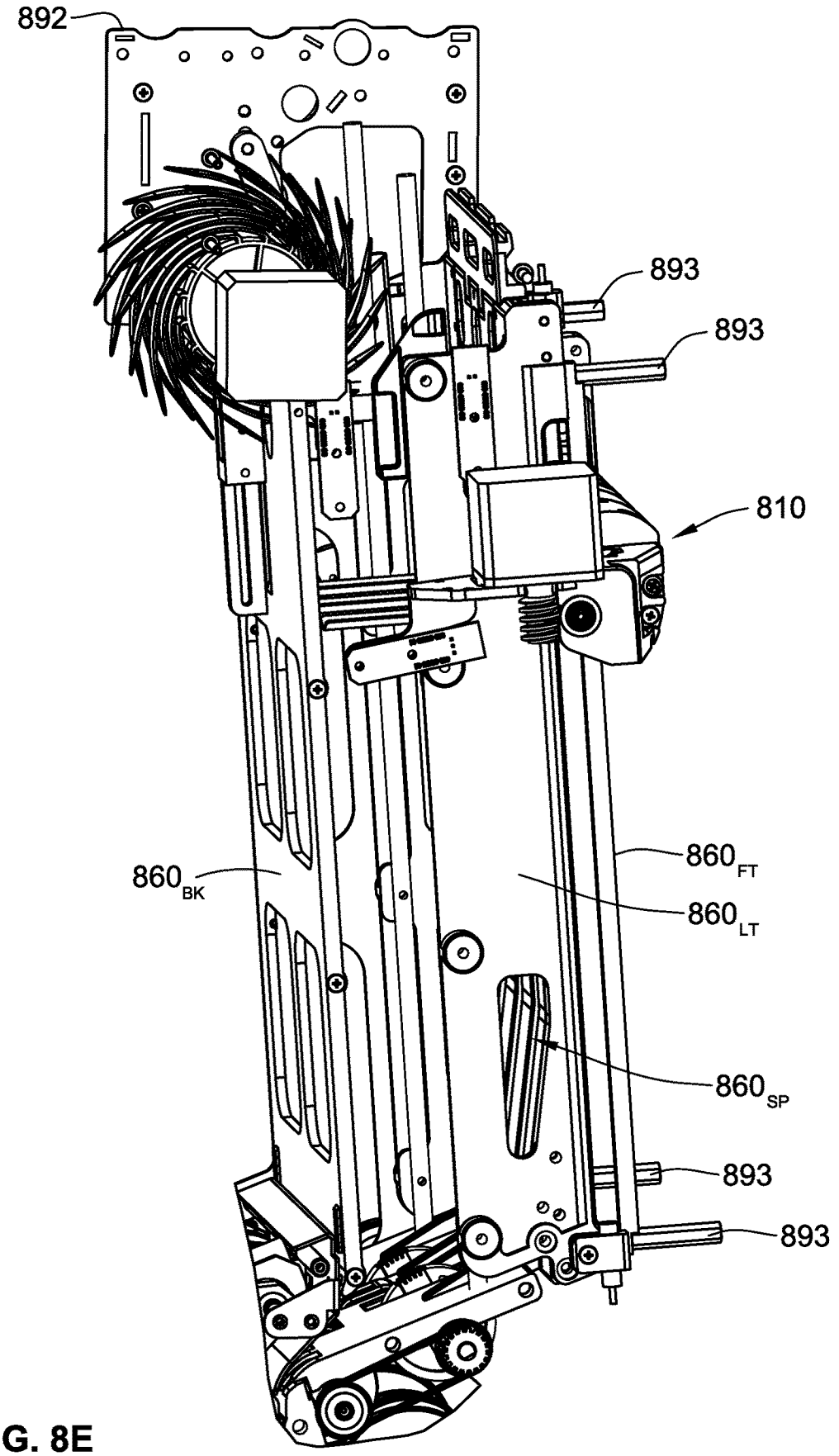

FIG. 8E

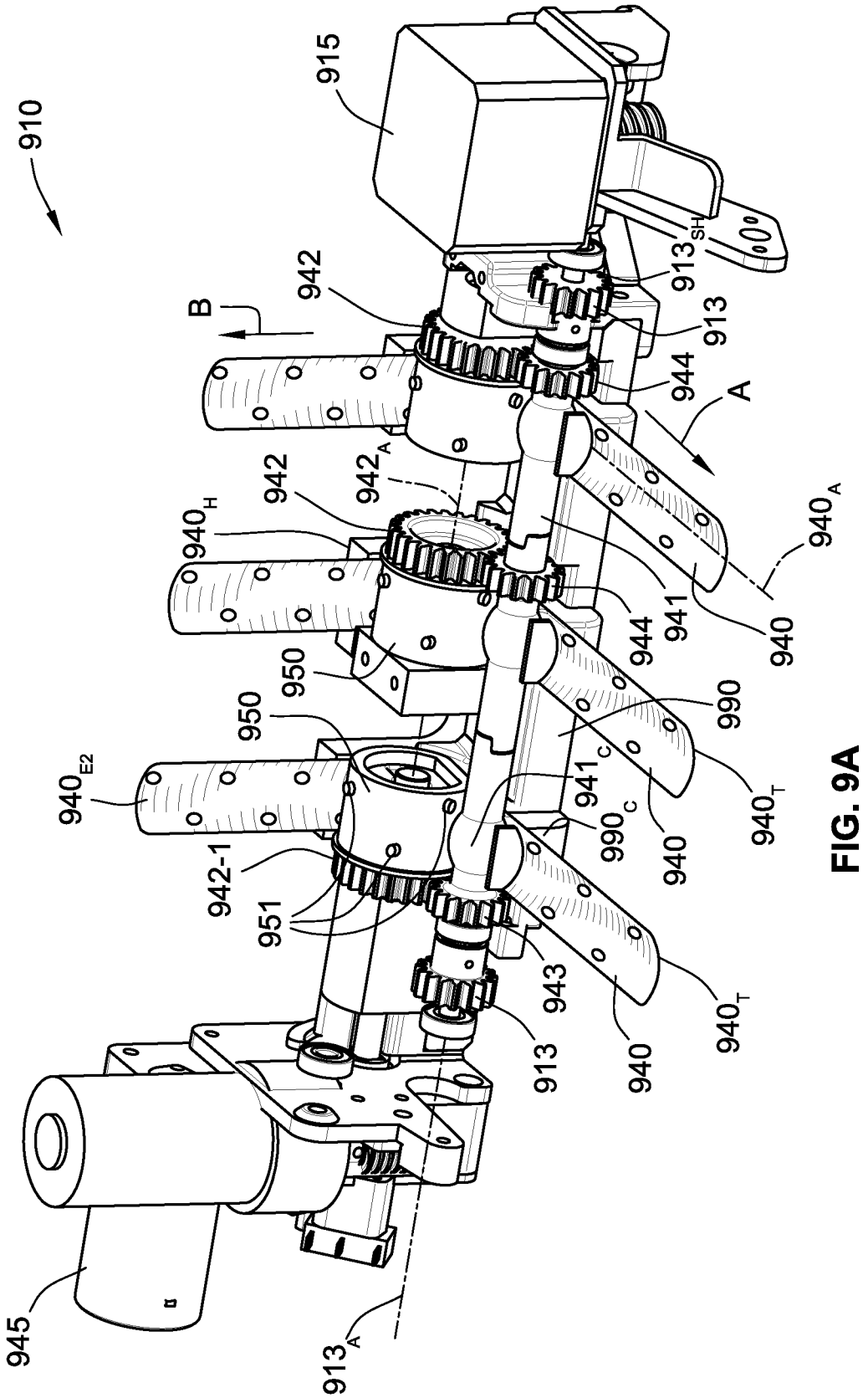
910
915
913SH
913
942
B
944
A
942A
942
940H
940A
941
940
944
950
950
990
940E2
941C
990C
940T
940
942-1
951
943
913
940
940T
945
913A

FIG. 9A

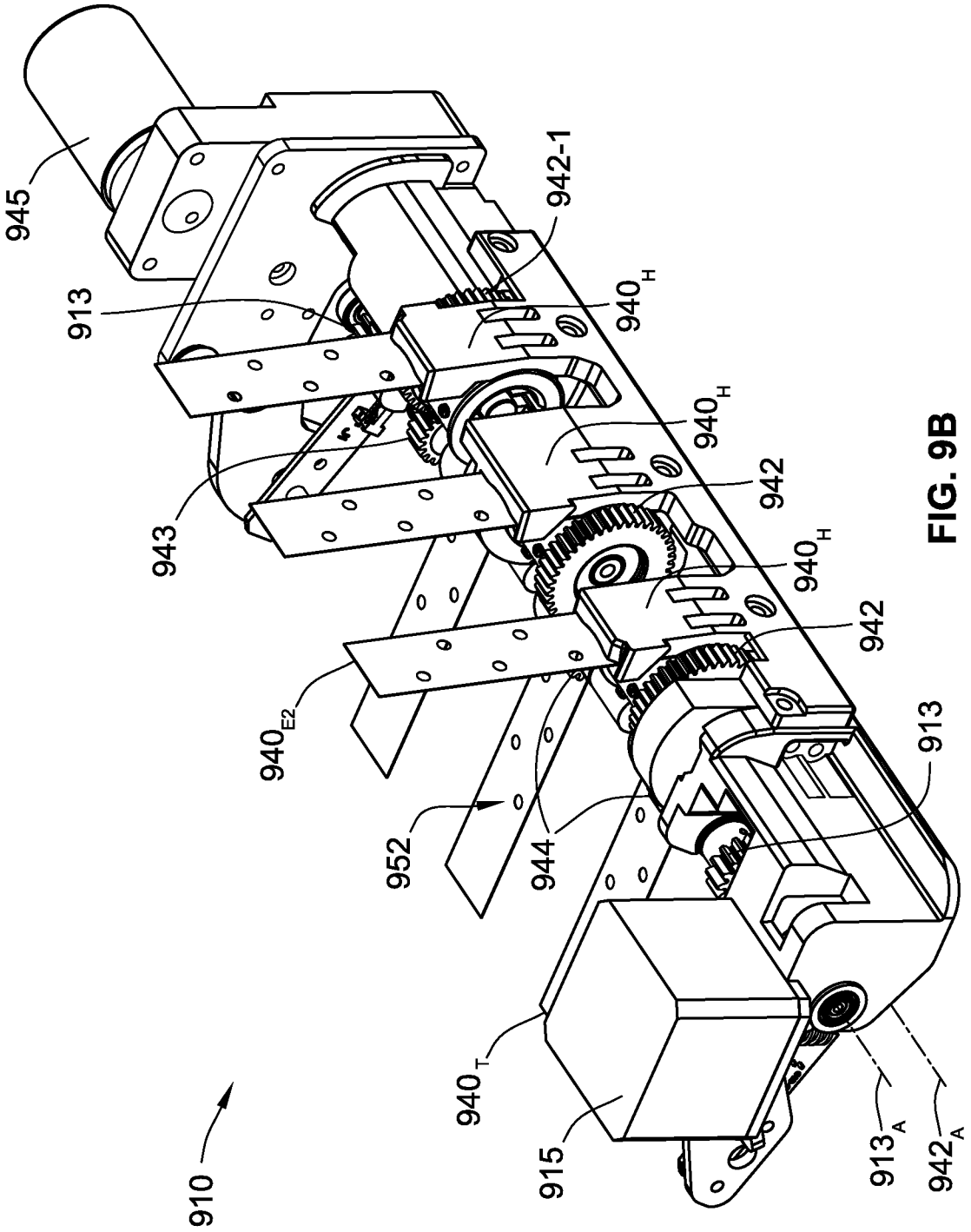
945
913
942-1
940H
940H
942
943
940H
942
940E2
913
952
944
940T
915
913A
942A
910

FIG. 9B

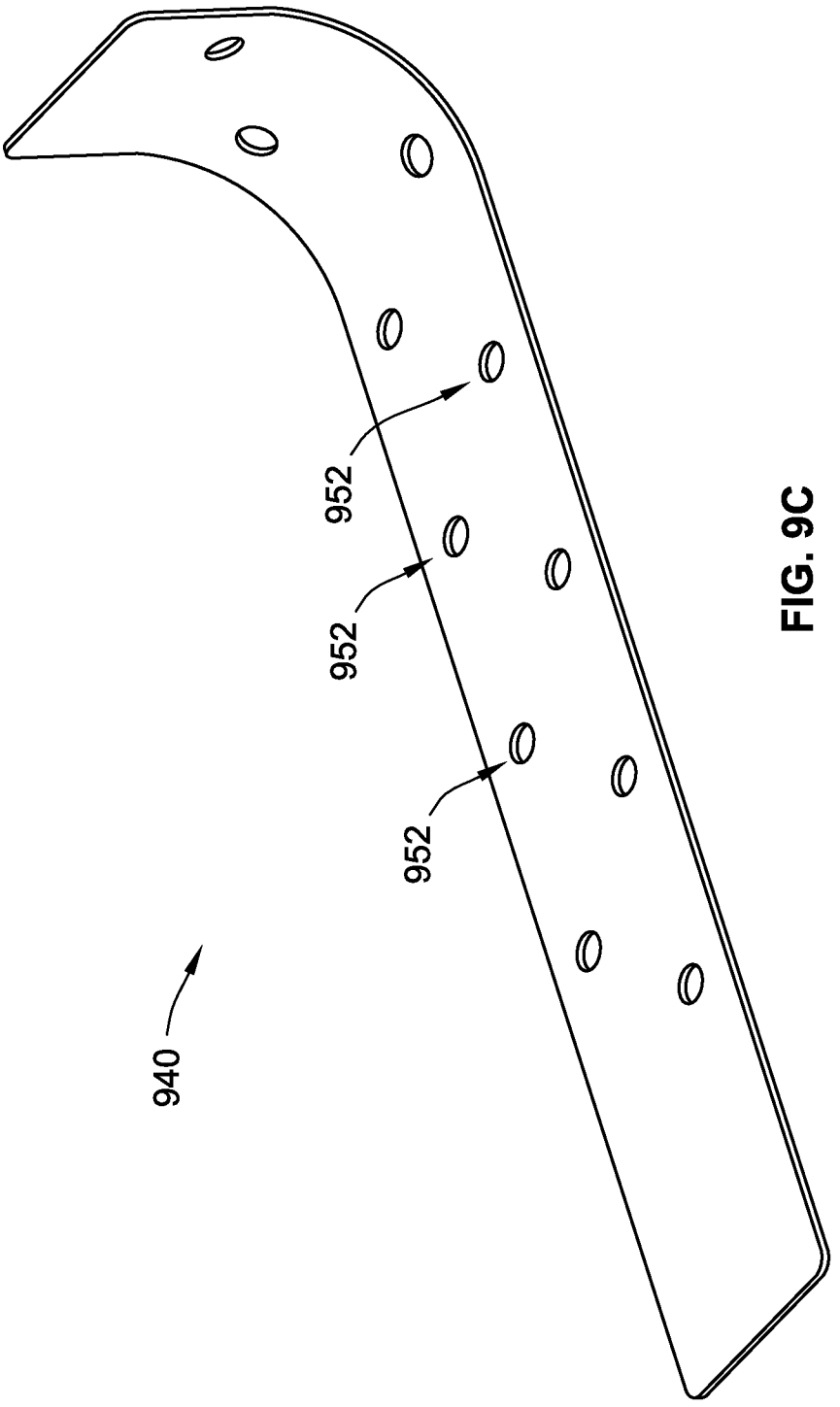

FIG. 9C

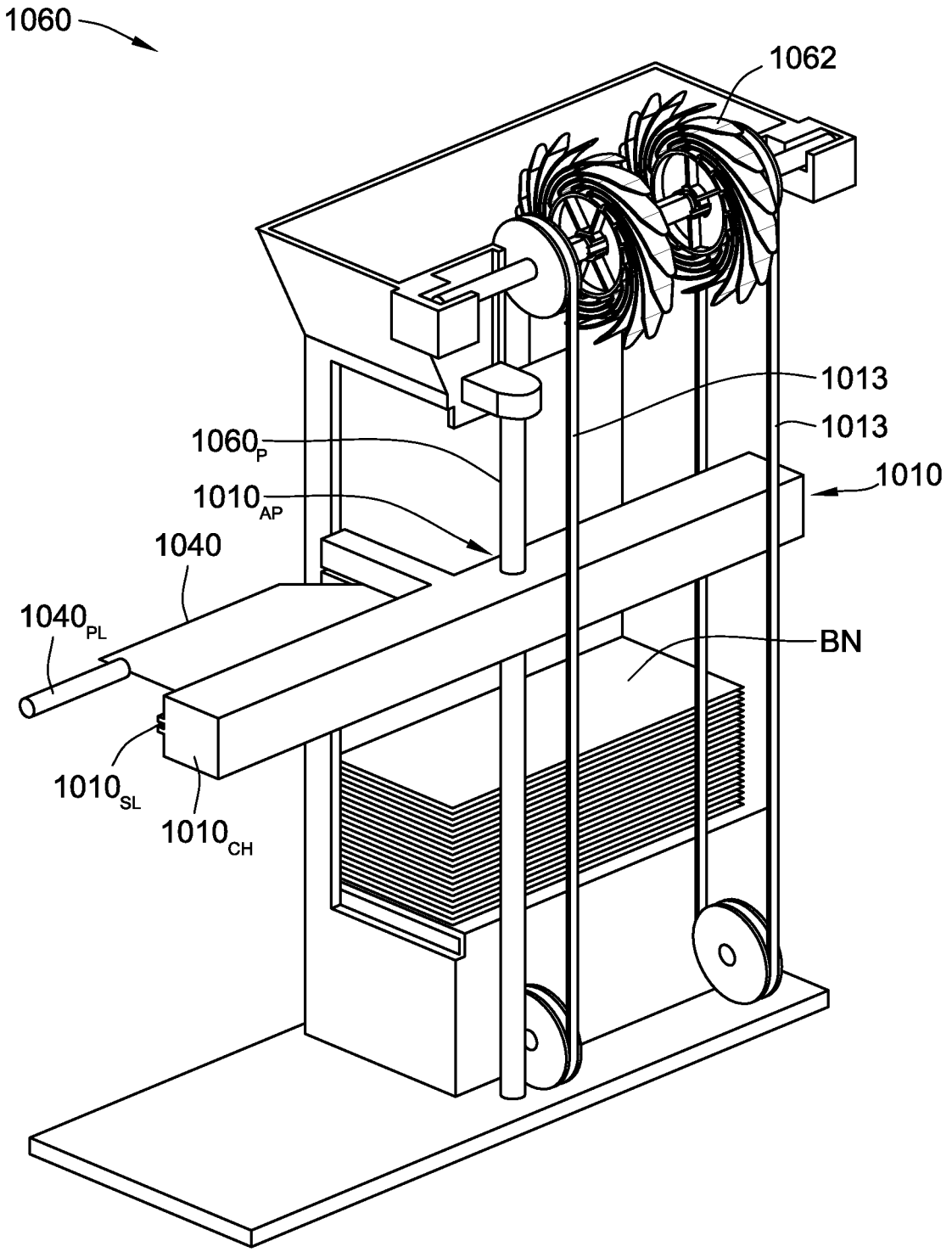
1060
1062
1013
1013
1060P
1010
1010AP
1040
1040PL
BN
1010SL
1010CH

FIG. 10A

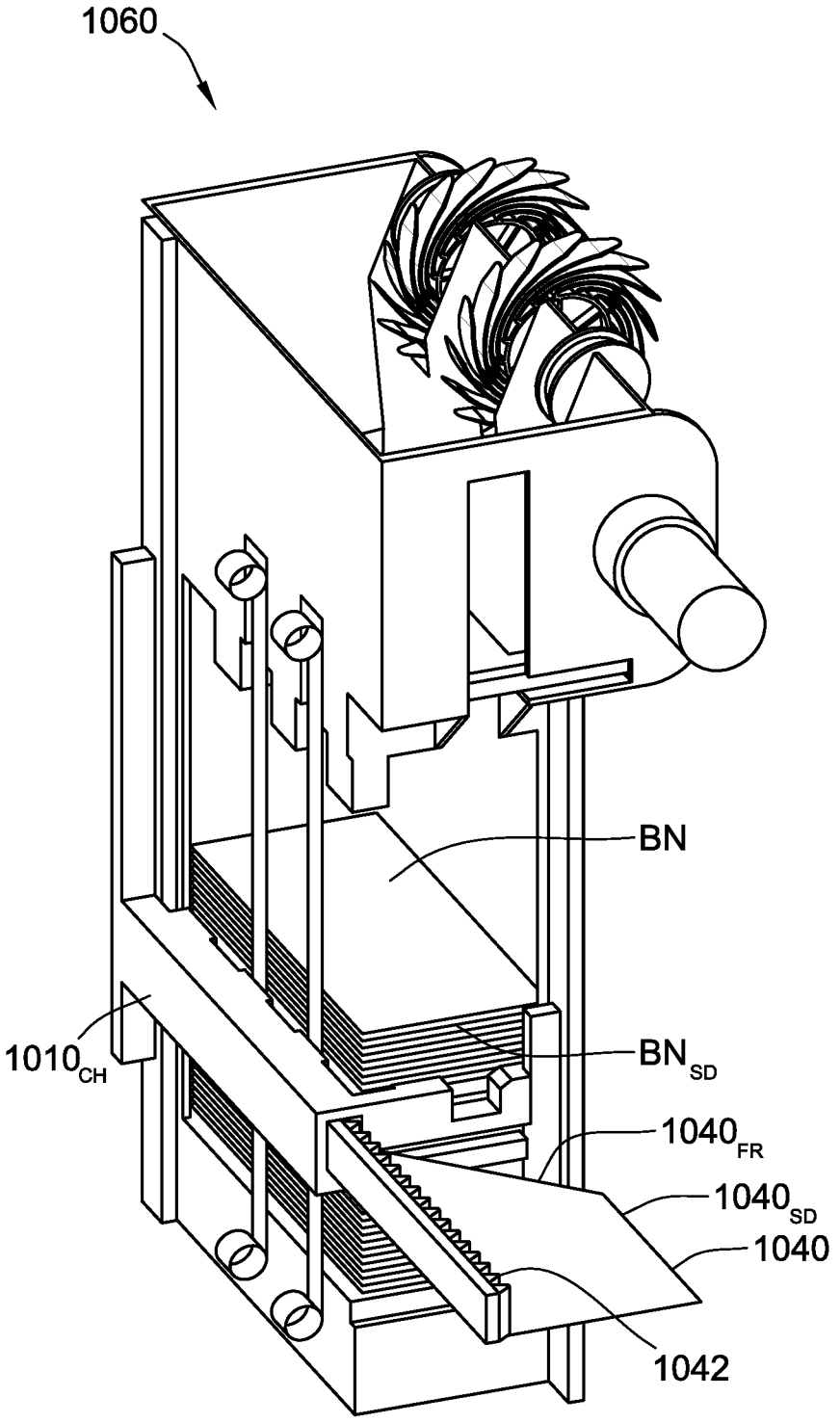

FIG. 10B

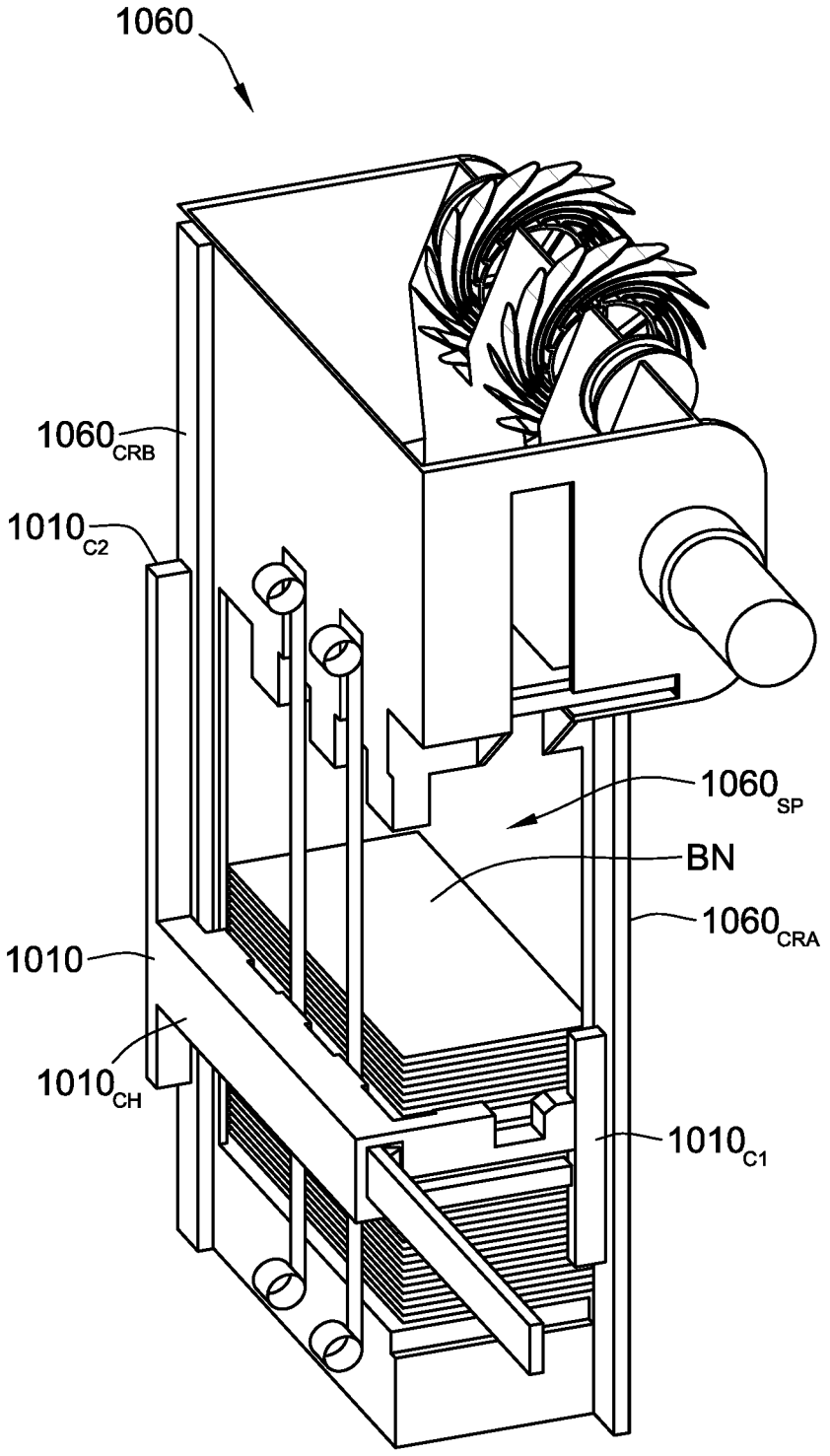

FIG. 10C

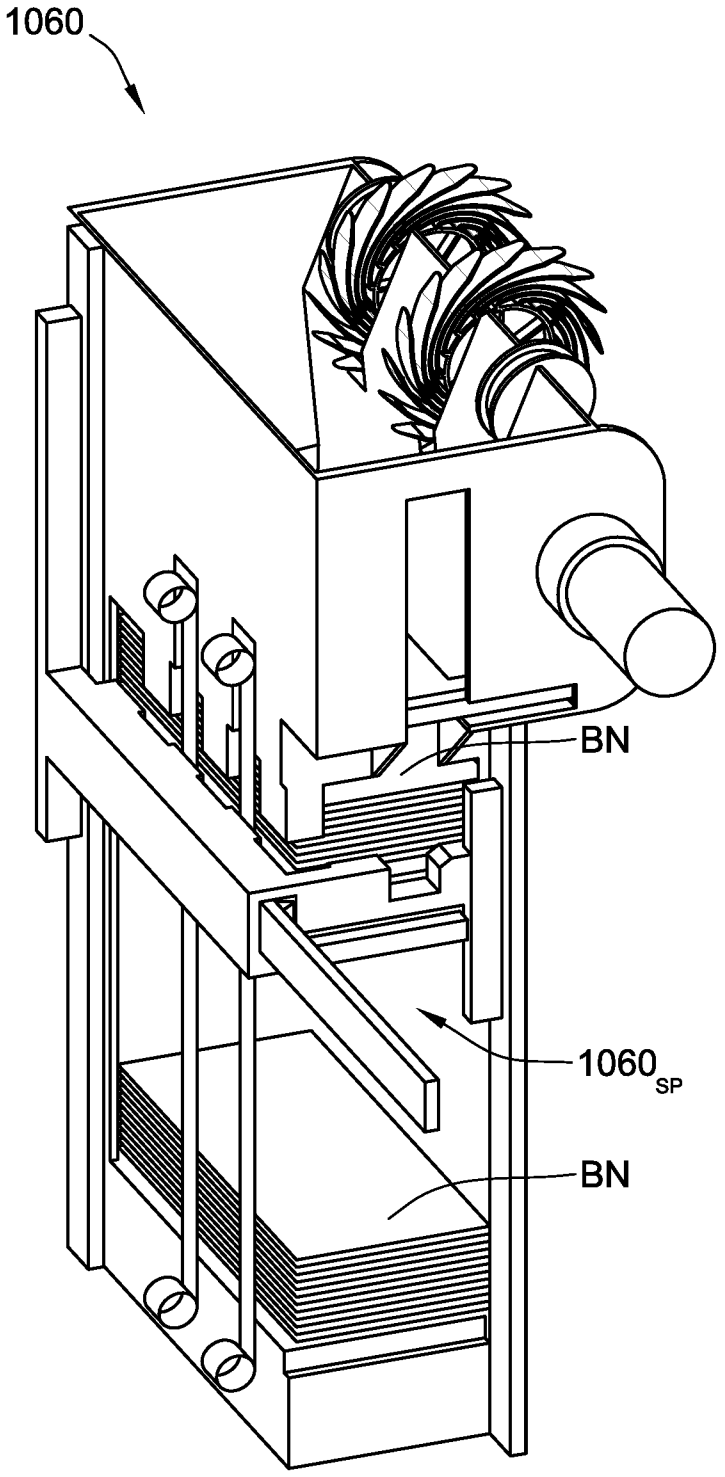

FIG. 10D

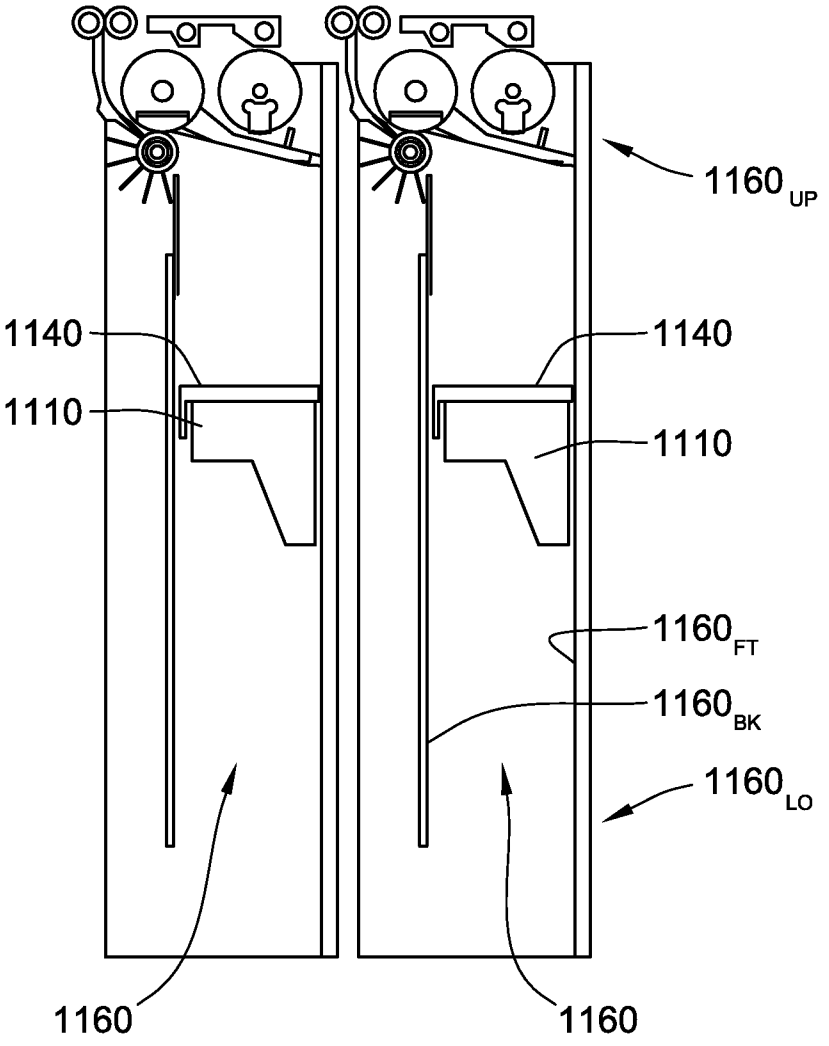

FIG. 11A

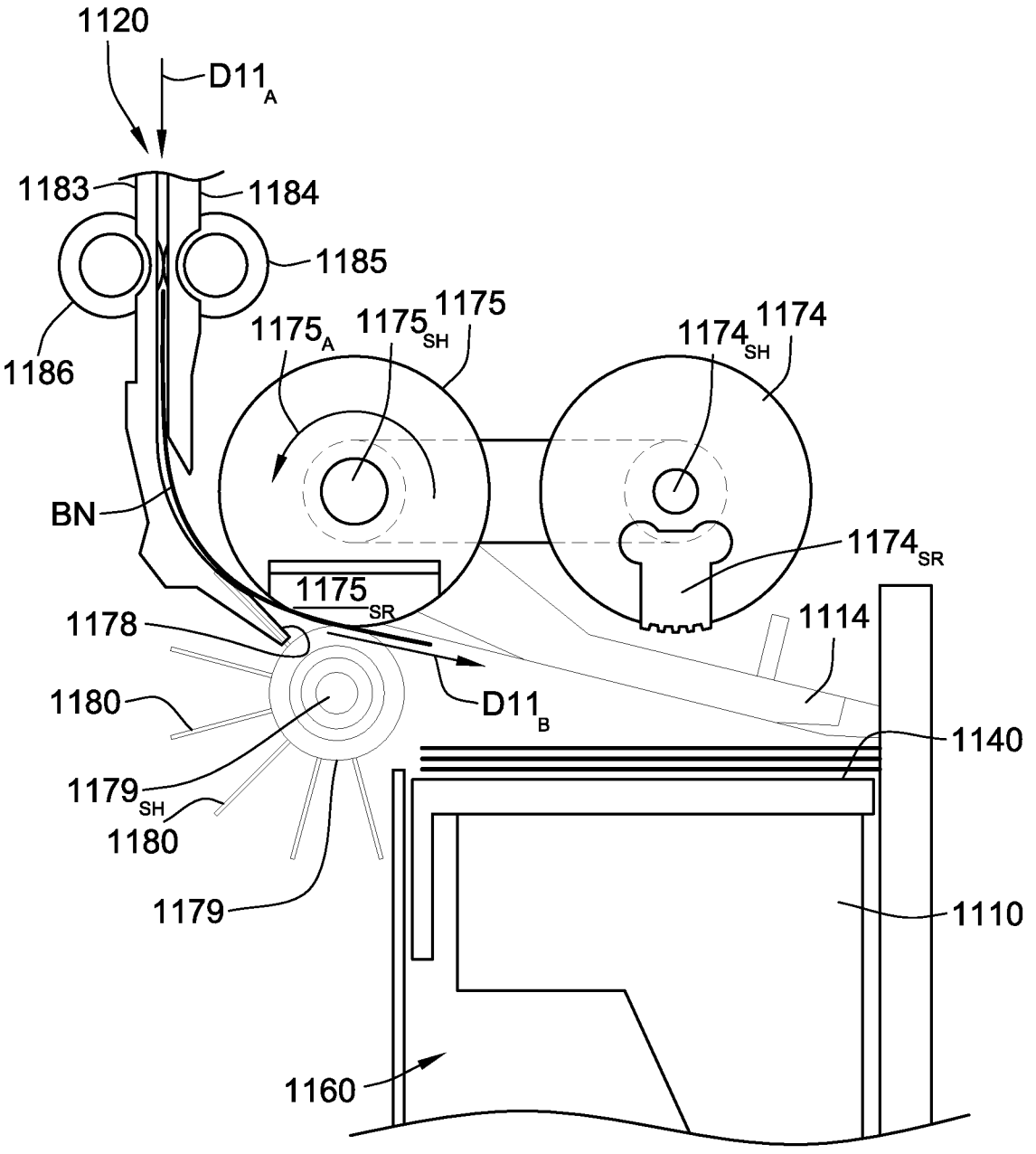
1120
D11A
1183
1184
1185
1186
1175A
1175SH
1175
1174SH
1174
BN
1174SR
1175SR
1178
1114
1180
D11B
1140
1179SH
1180
1179
1110
1160

FIG. 11B

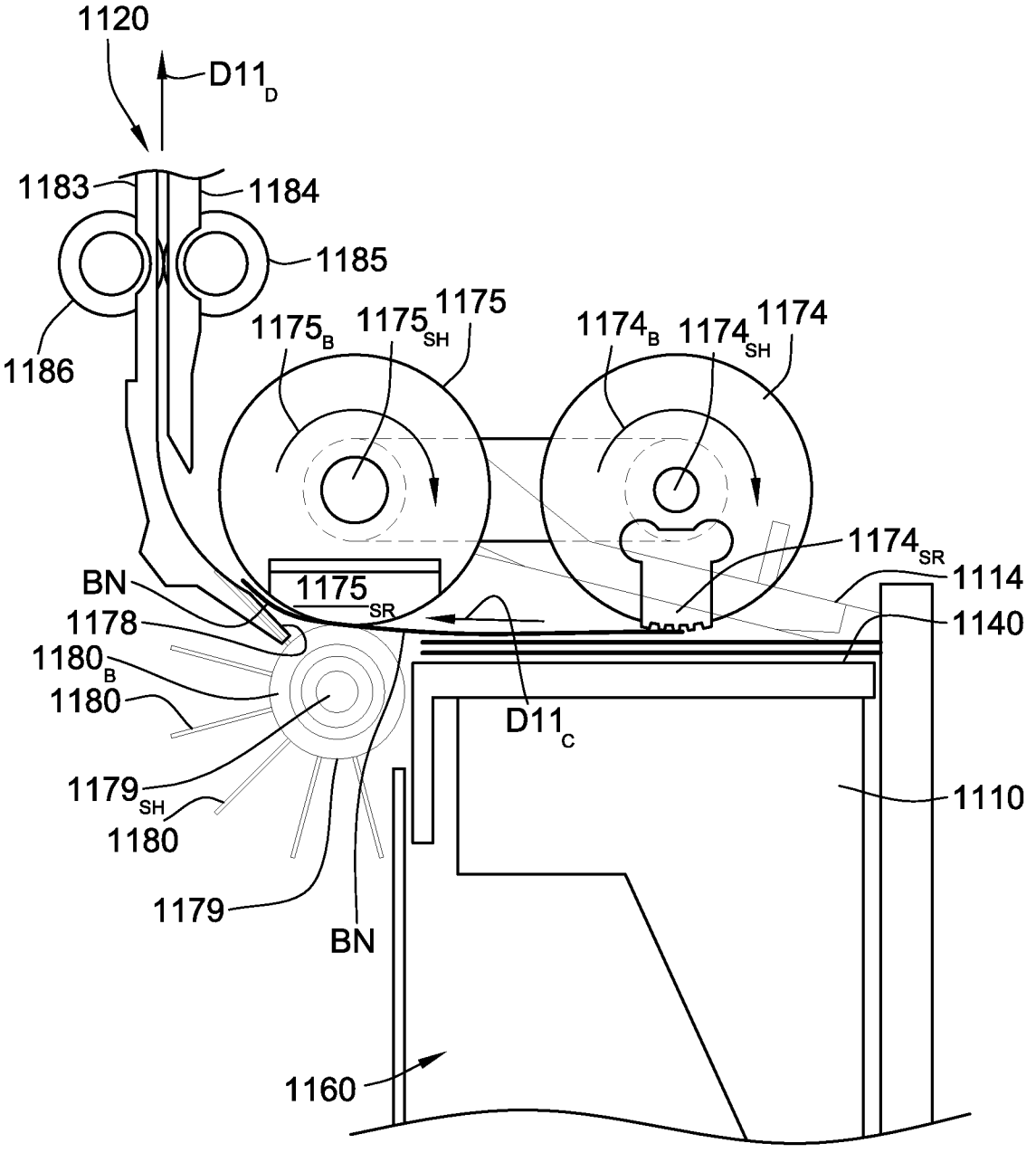
1120
D11D
1183
1184
1185
1186
1175B
1175SH
1175
1174B
1174SH
1174
1174SR
1114
1140
BN
1178
1180B
1180
1175SR
D11C
1179SH
1180
1179
BN
1110
1160

FIG. 11C

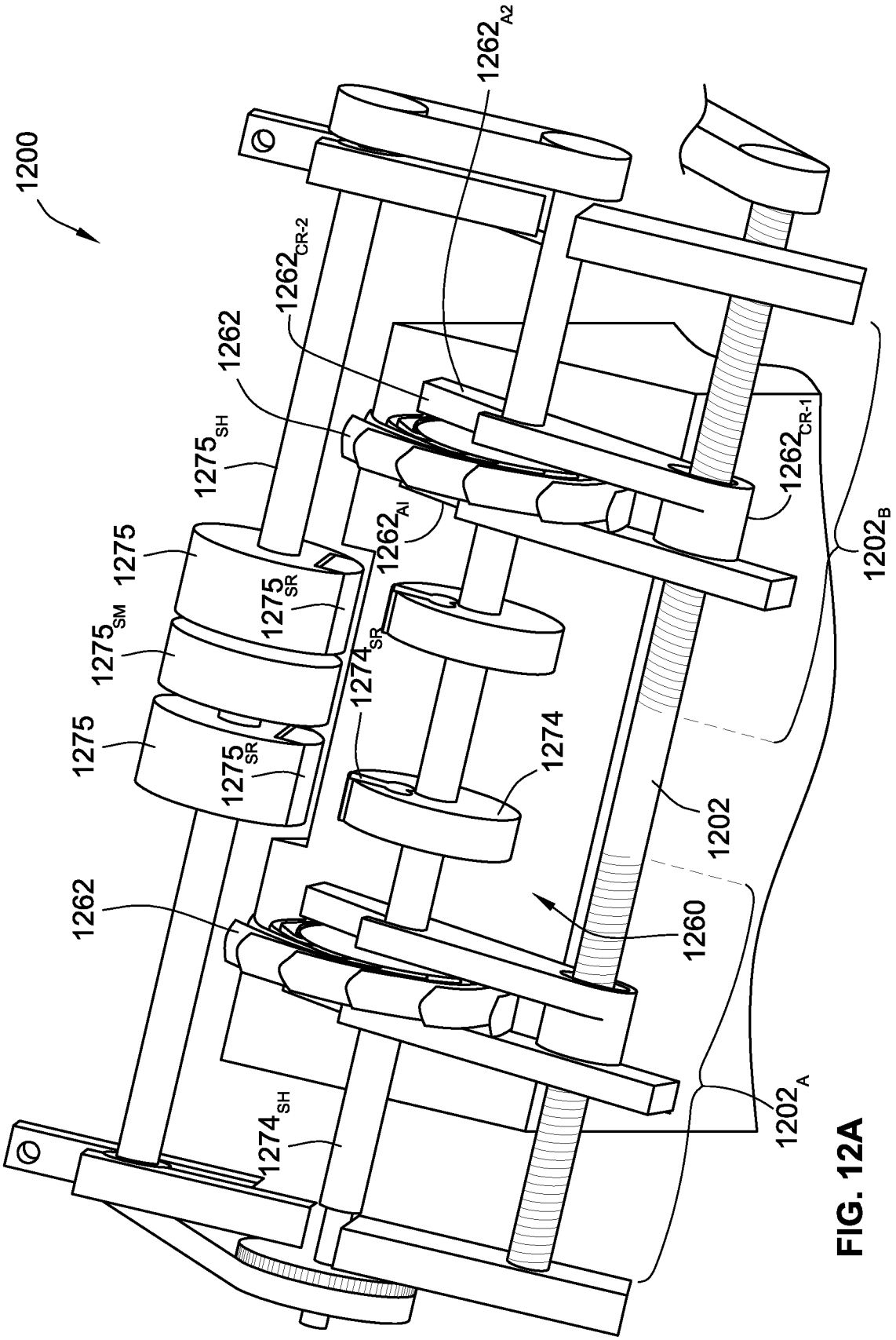
1200
1262A2
1262CR-2
1262
1275SH
1262AI
1262CR-1
1202B
1275
1275SM
1275SR
1274SR
1274
1202
1260
1202A
1274SH

FIG. 12A

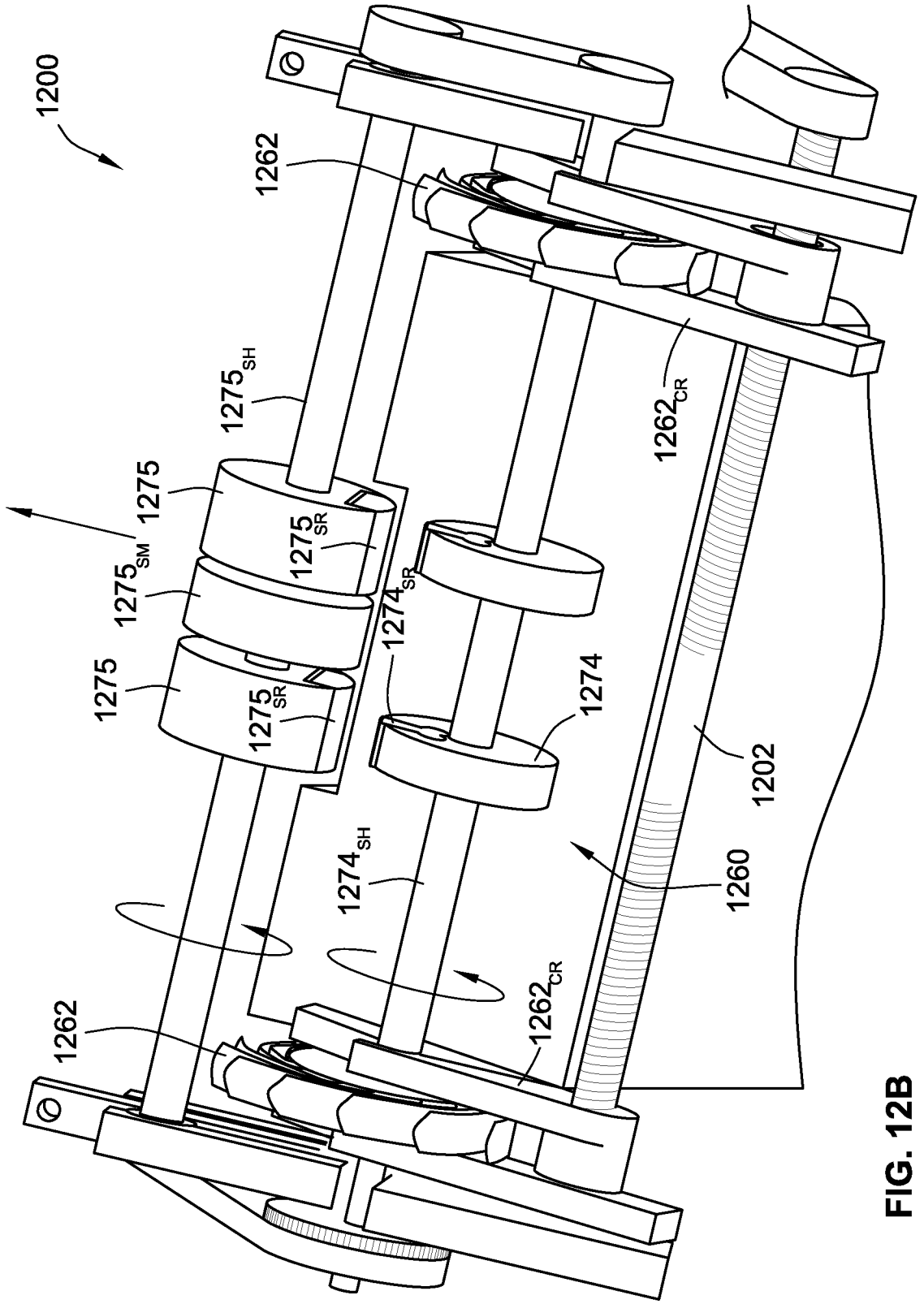
1200
1262
1275SH
1275
1275SM
1275SR
1274SR
1275
1275SR
1274
1274SH
1262CR
1202
1260
1262
1262CR

FIG. 12B

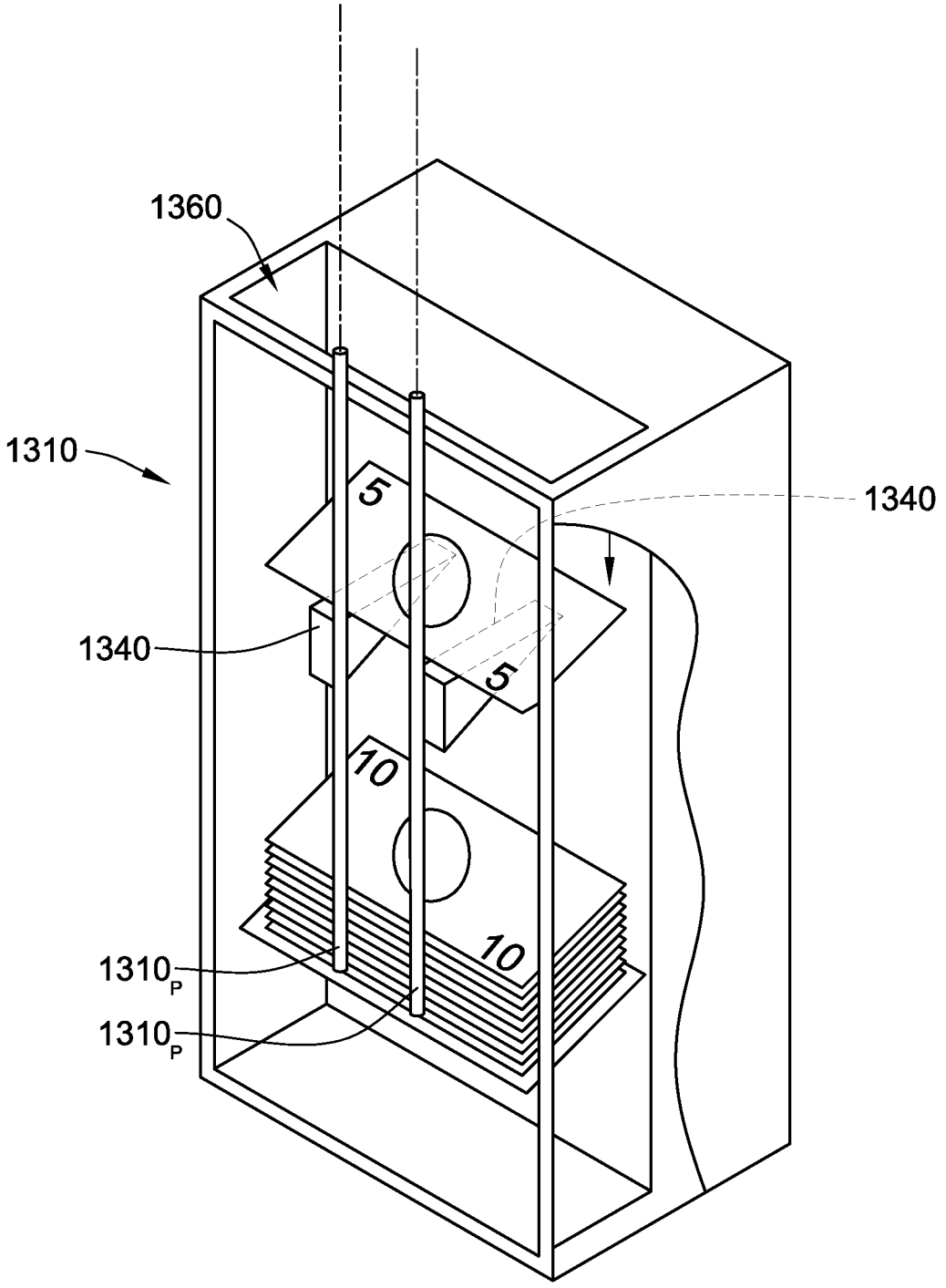

FIG. 13A

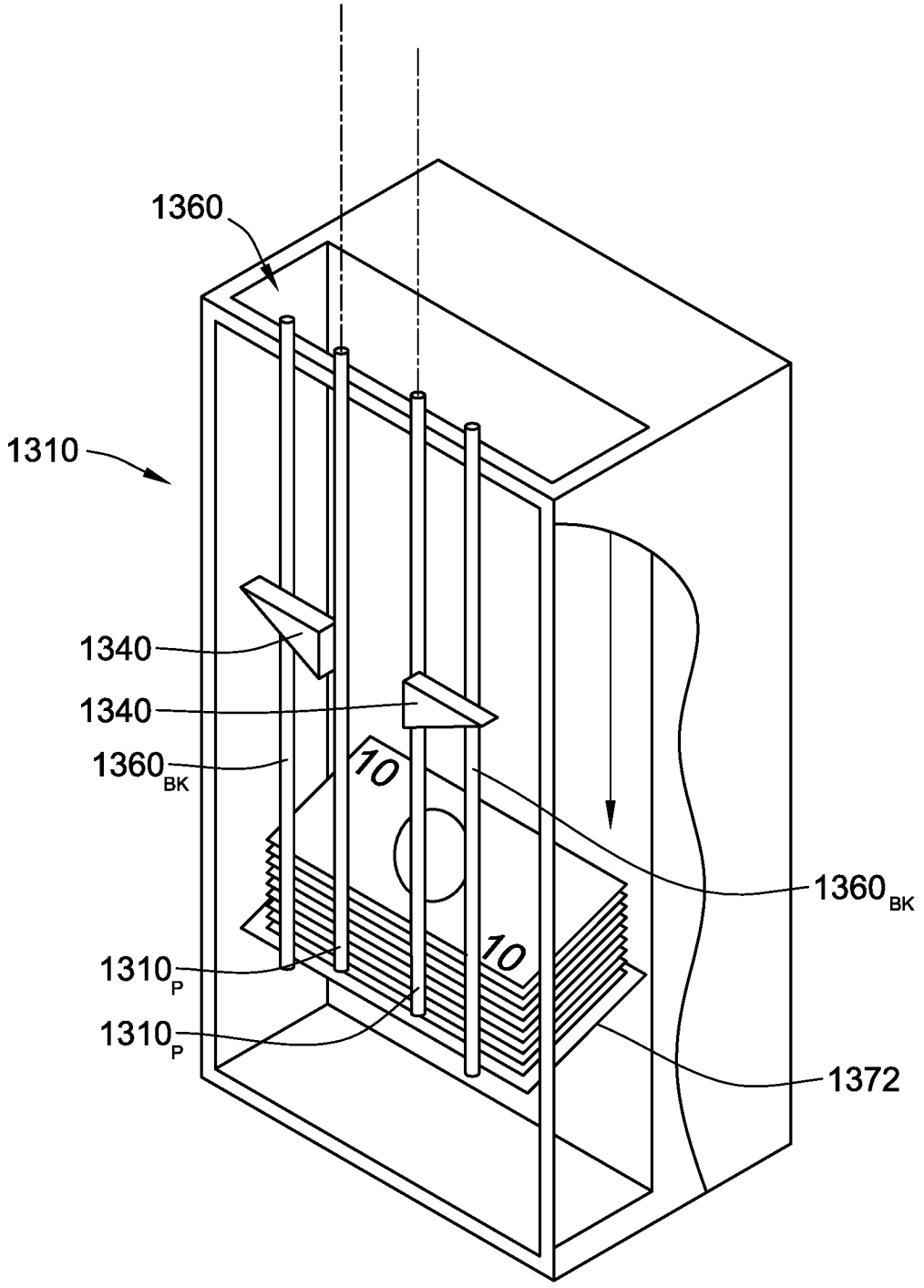

FIG. 13B

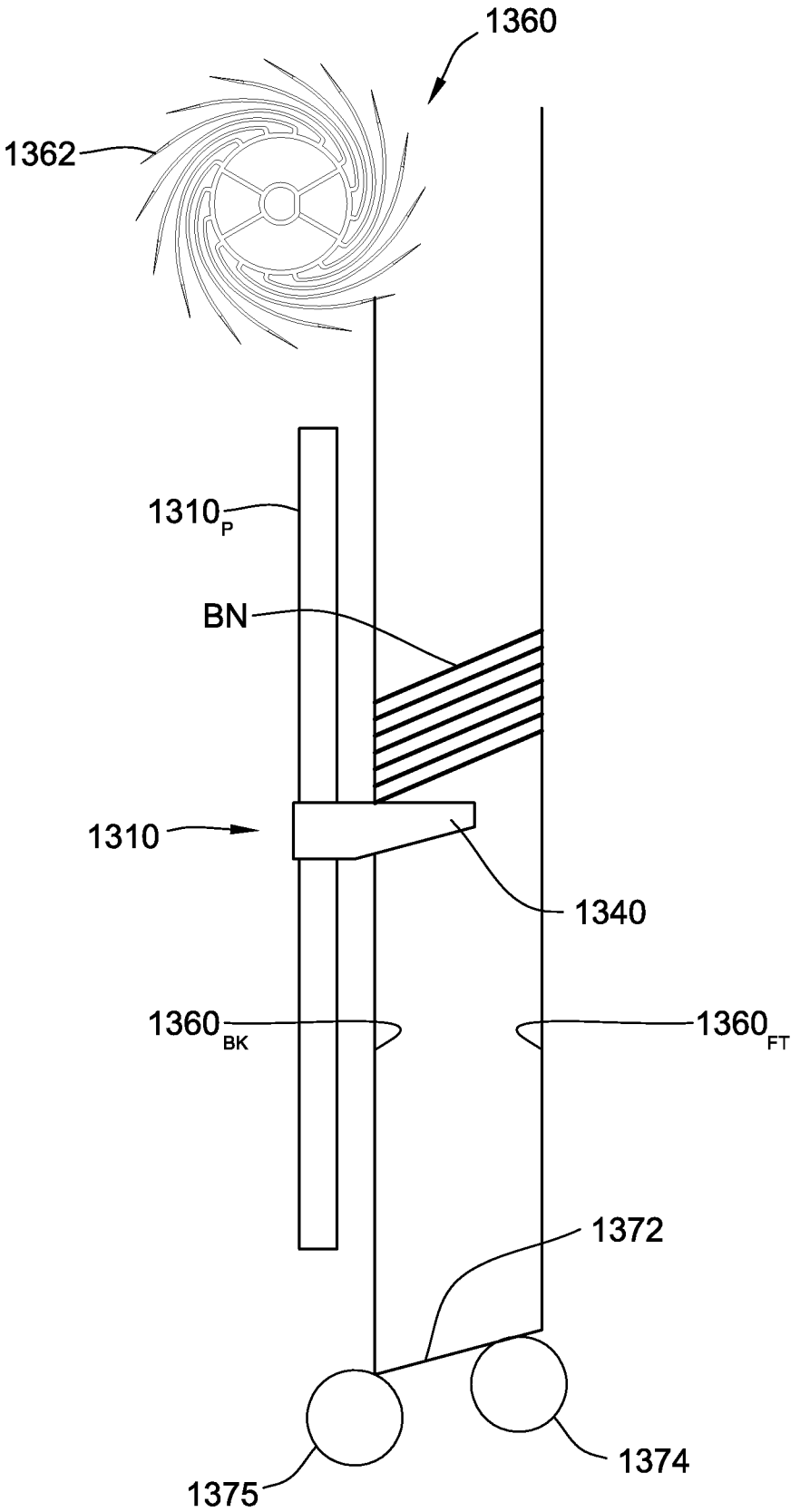

FIG. 13C

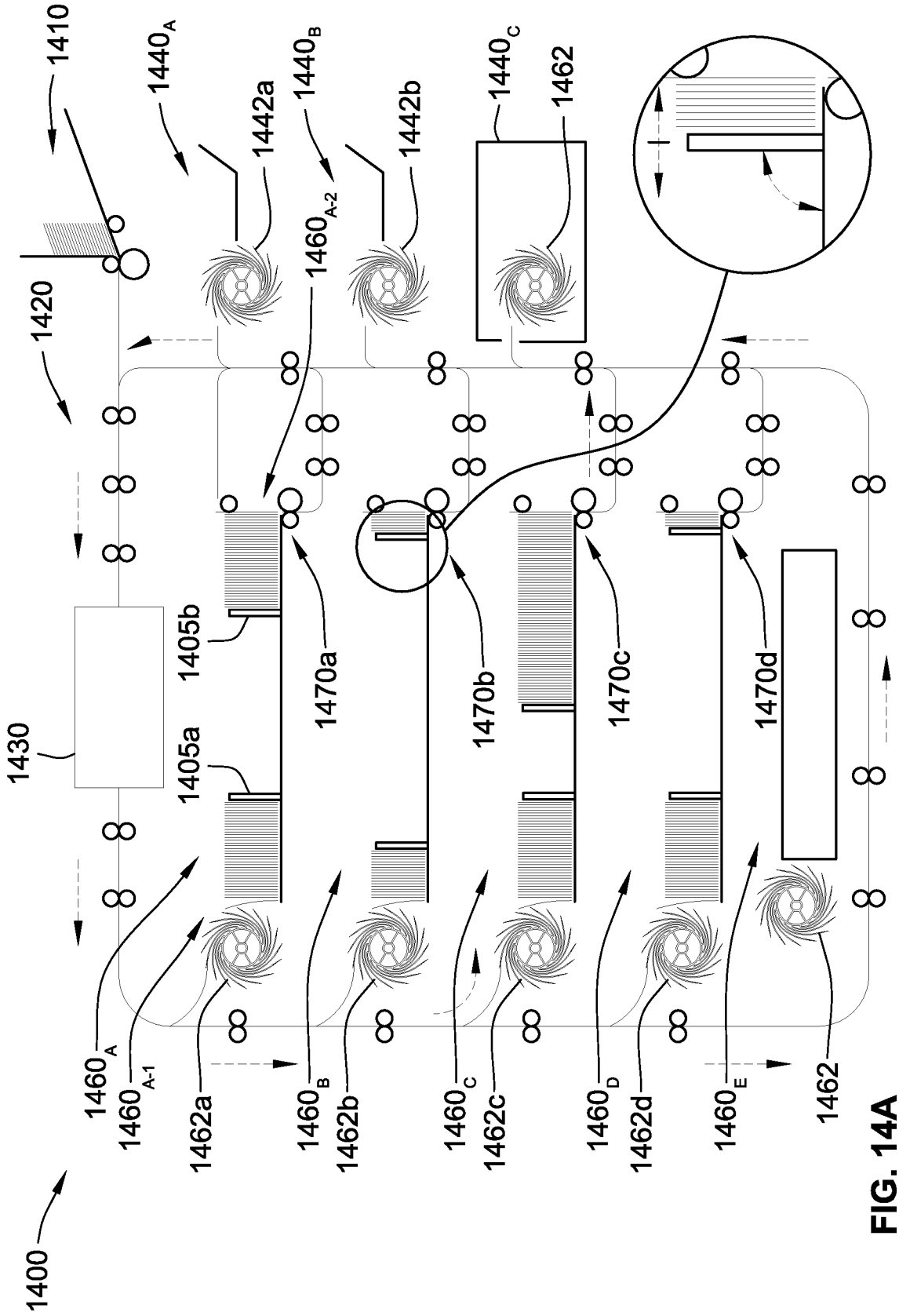
1400
1410
1420
1430
1440A
1440B
1440C
1442a
1442b
1460A-2
1462
1405a
1405b
1470a
1470b
1470c
1470d
1460A
1460A-1
1460B
1460C
1460D
1460E
1462a
1462b
1462c
1462d
1462

FIG. 14A

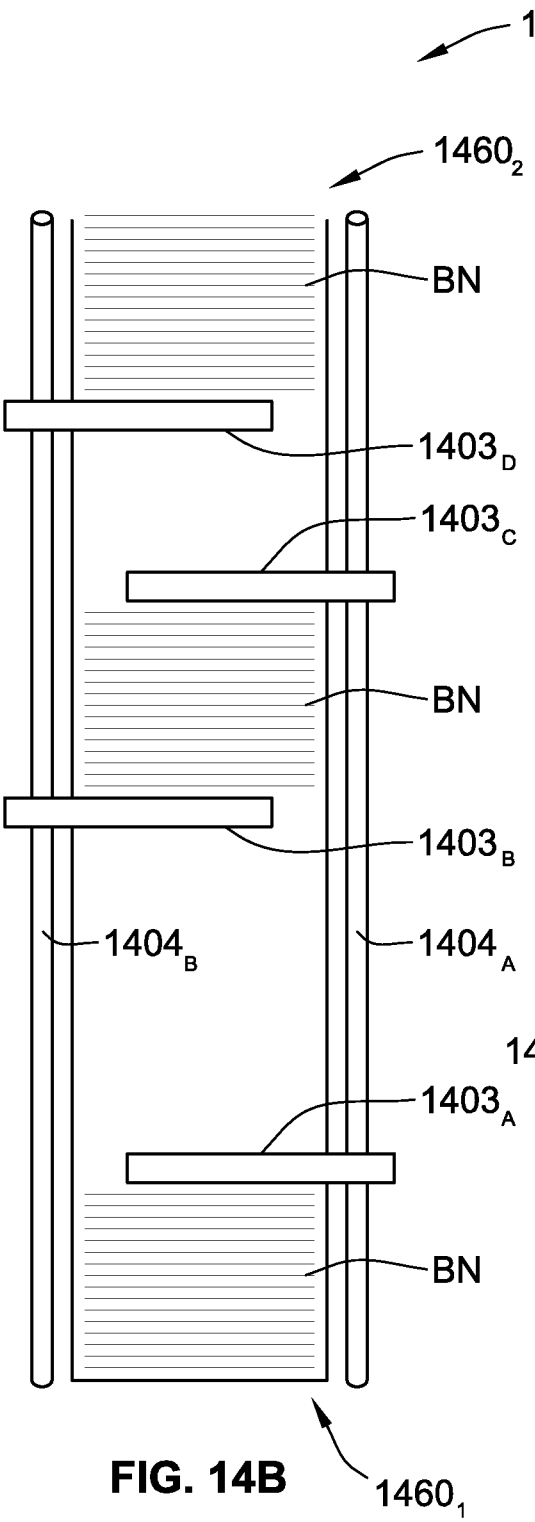

FIG. 14B

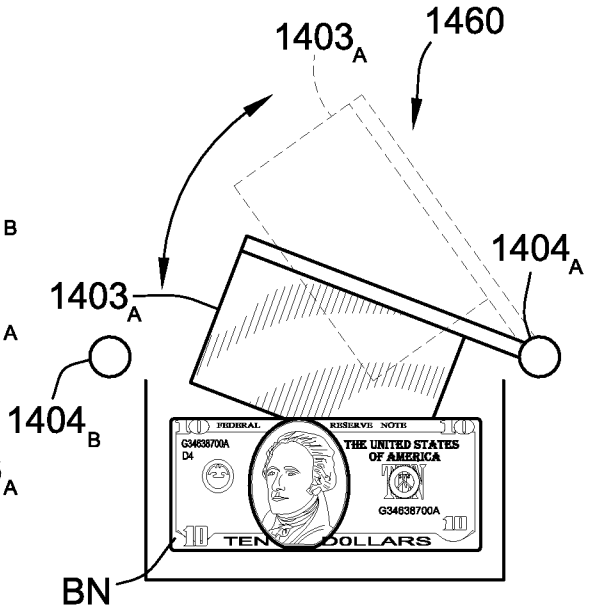

FIG. 14C

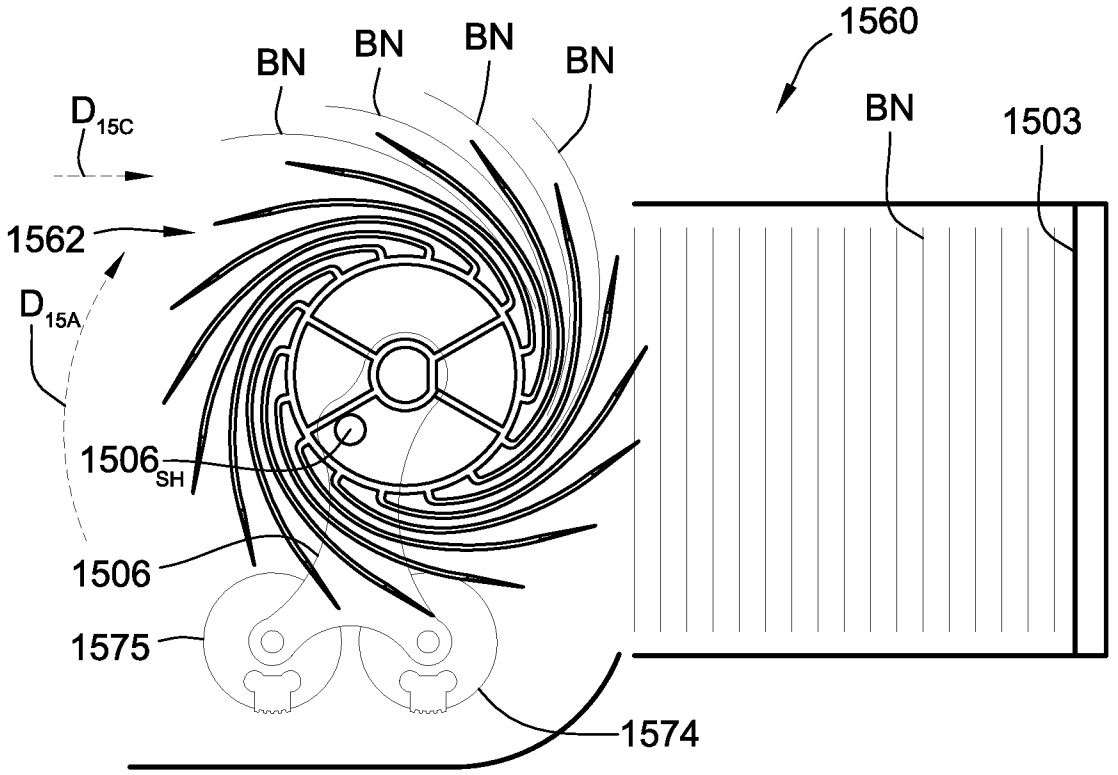

FIG. 15A

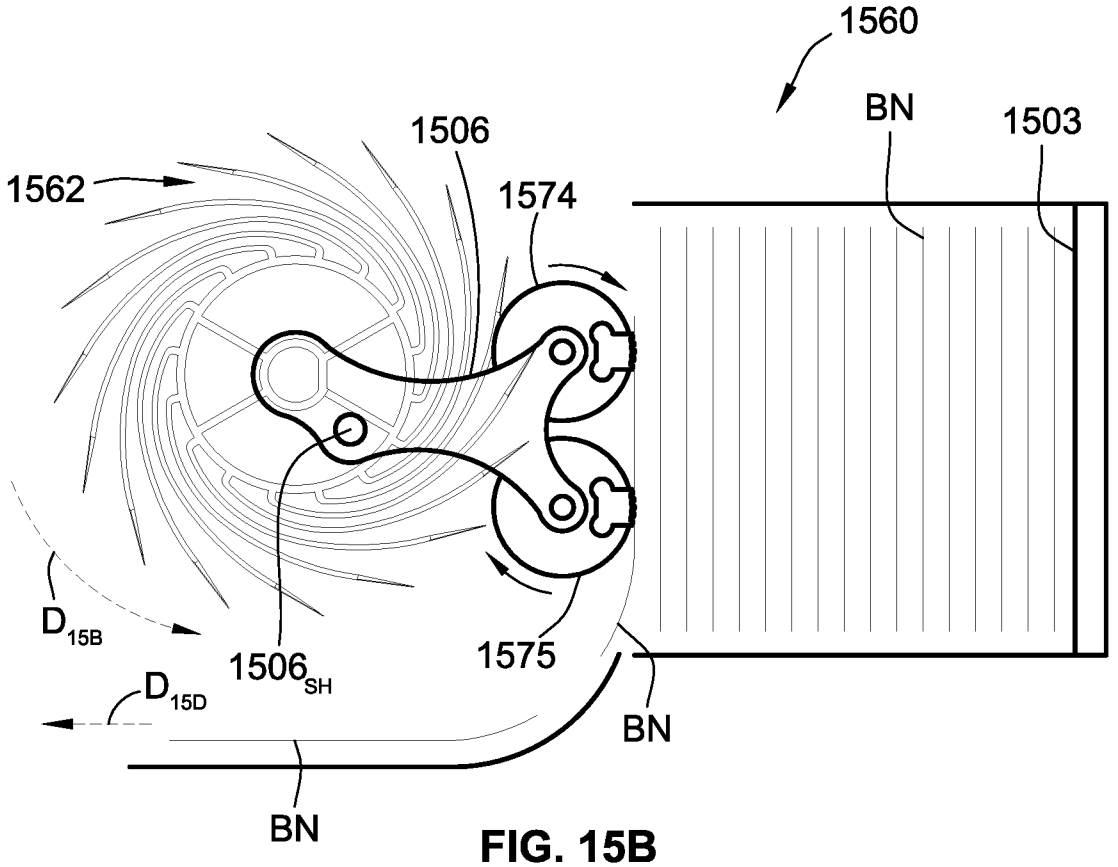

FIG. 15B

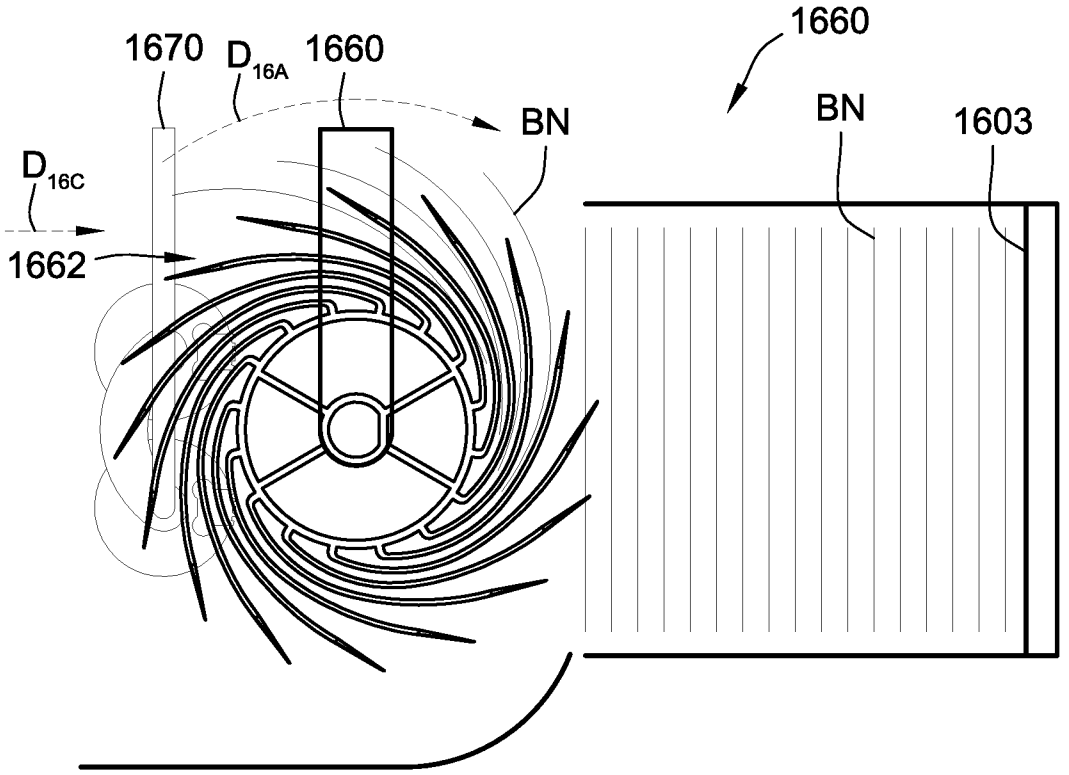

FIG. 16A

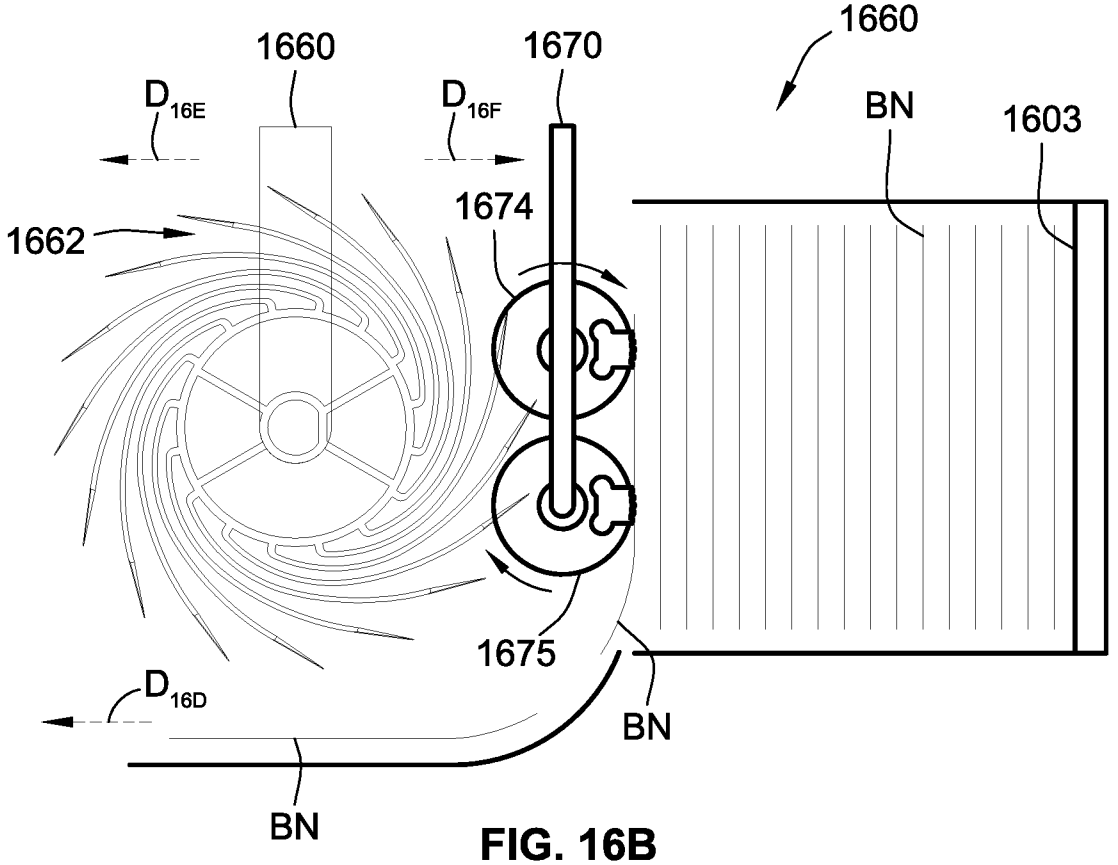

FIG. 16B

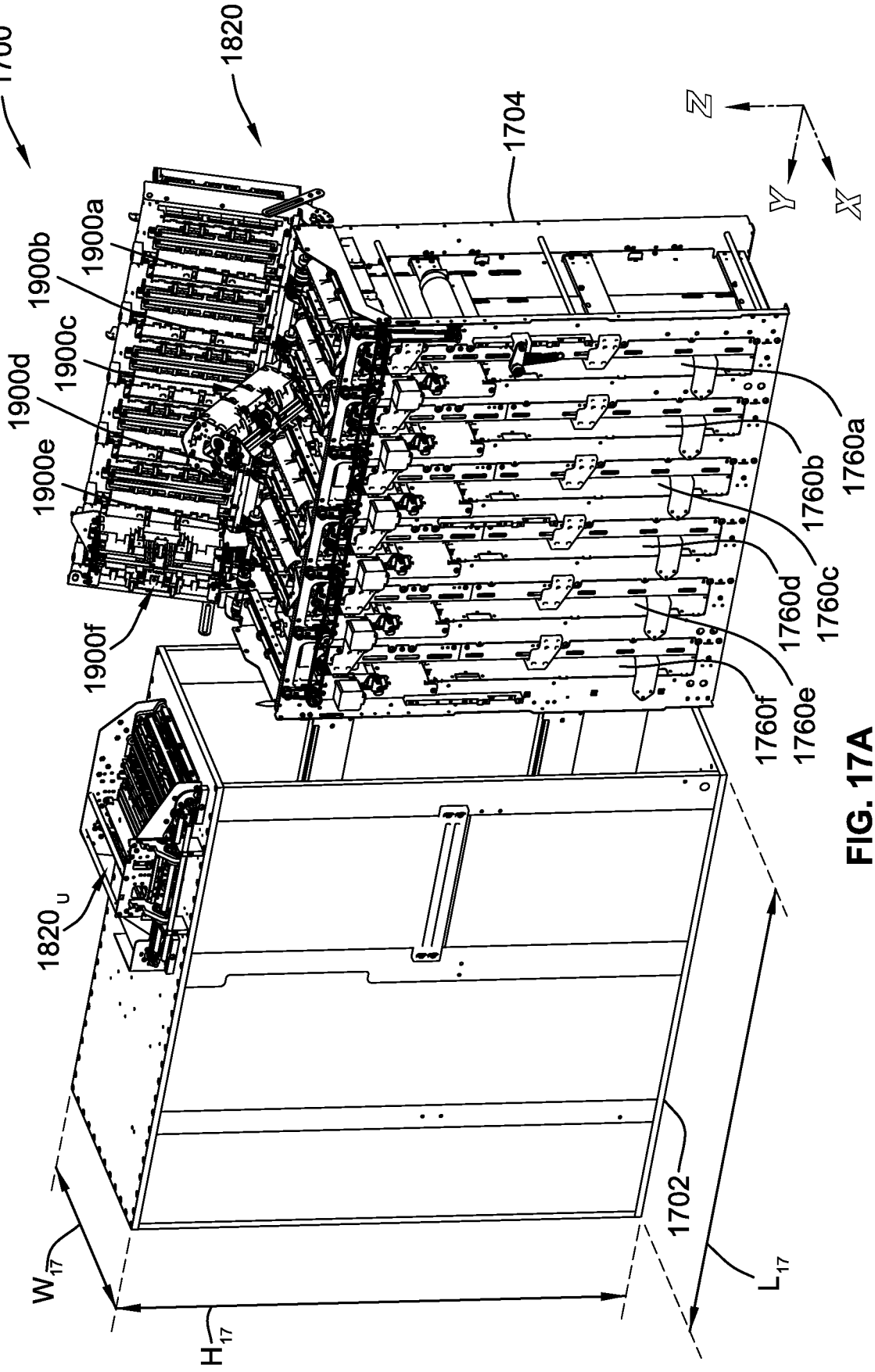
1700
1820
1704
Z
Y
X
1900a
1900b
1900c
1900d
1900e
1900f
1760a
1760b
1760c
1760d
1760e
1760f
1820U
1702
W17
H17
L17

FIG. 17A

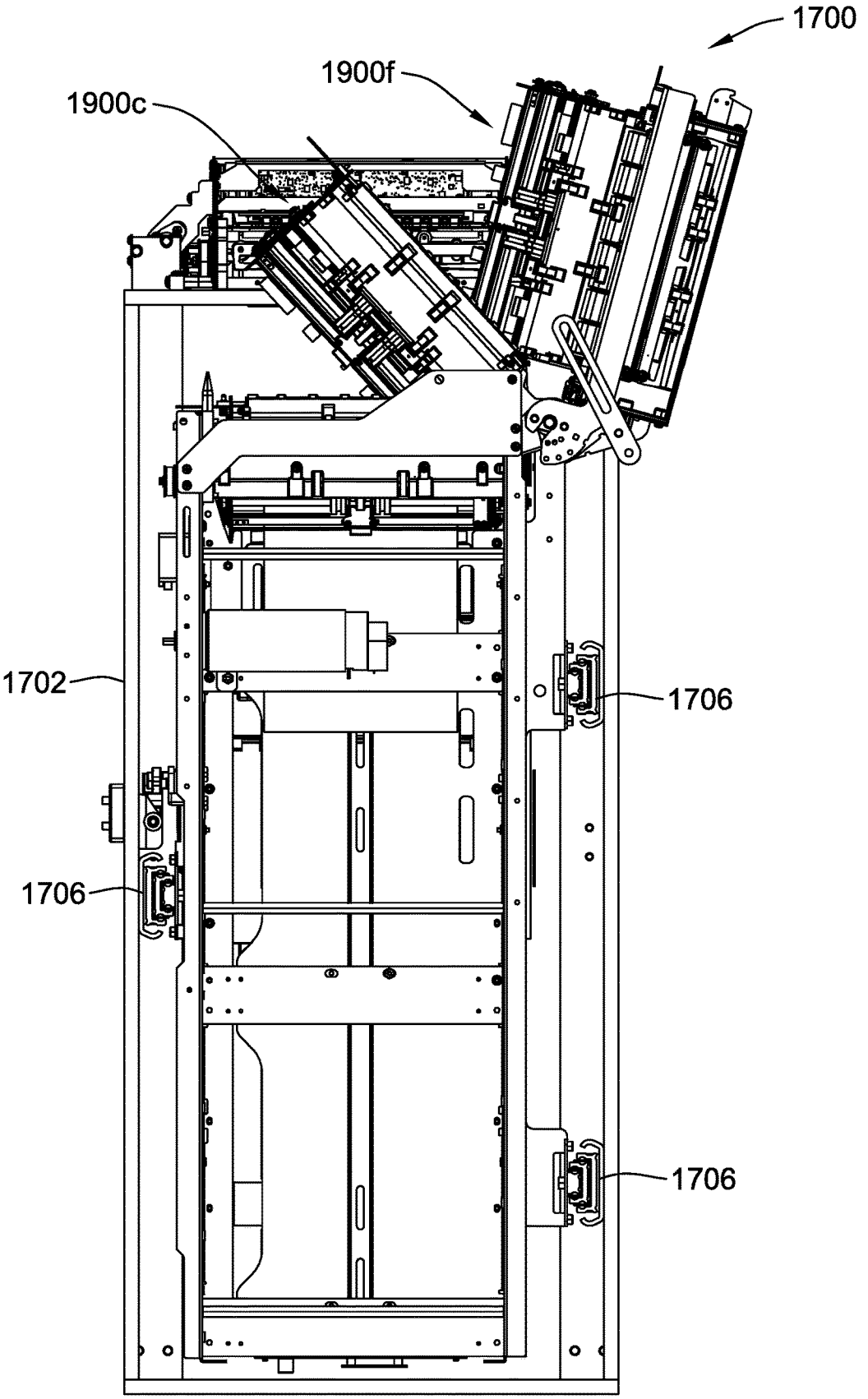

FIG. 17B

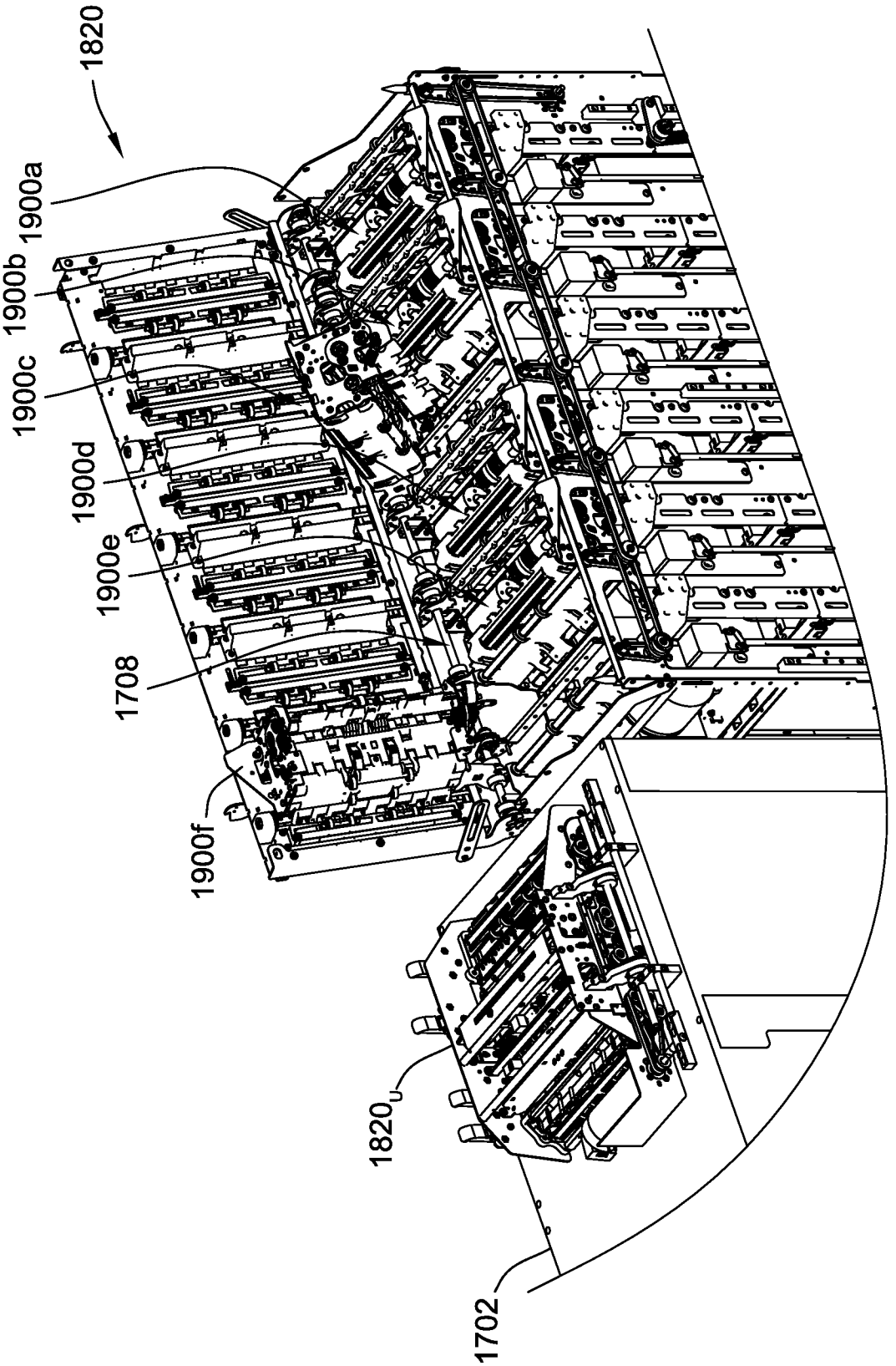

FIG. 17C

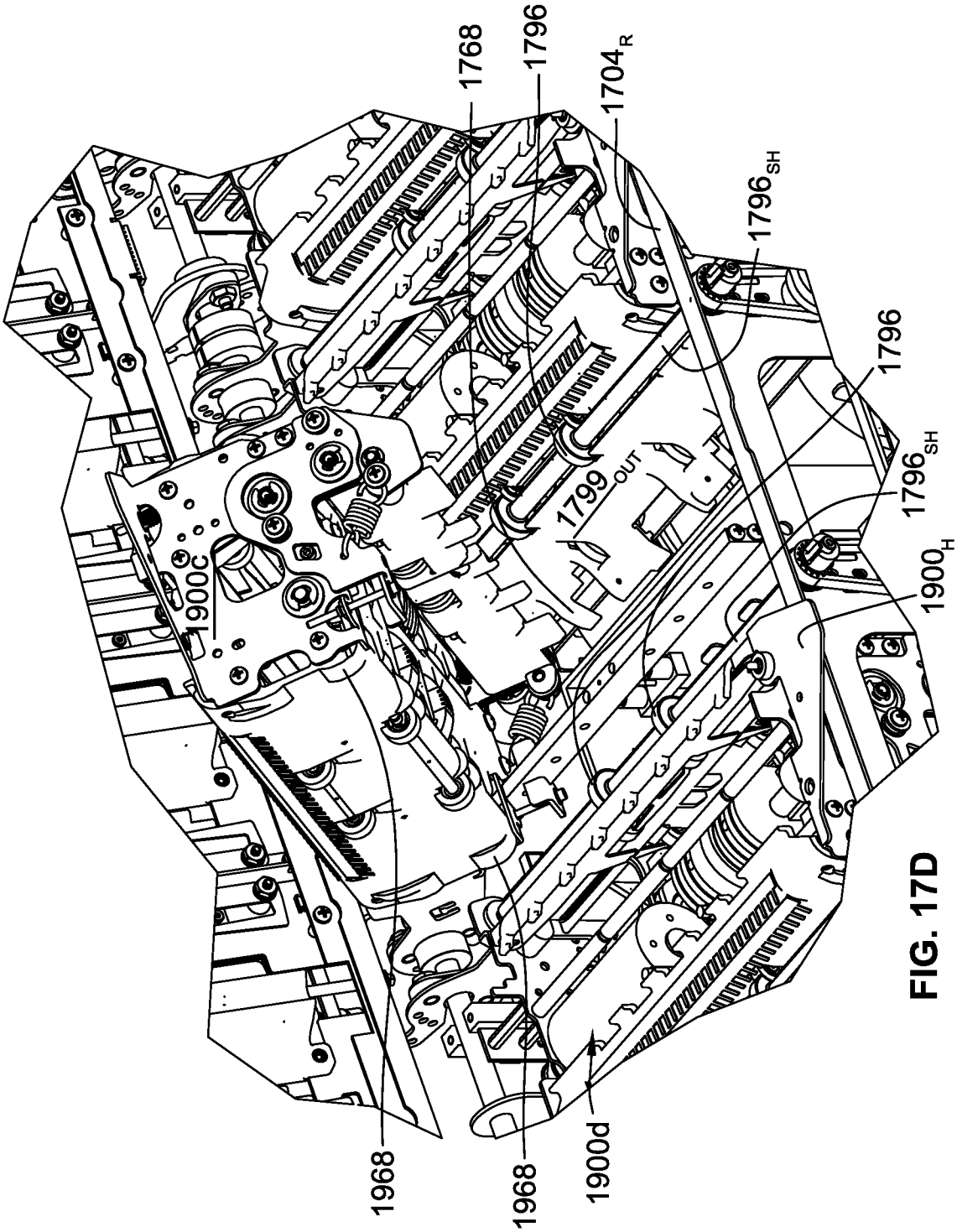
1768
1796
1704R
1796SH
1796
1799OUT
1796SH
1900H
1900c
1968
1968
1900d

FIG. 17D

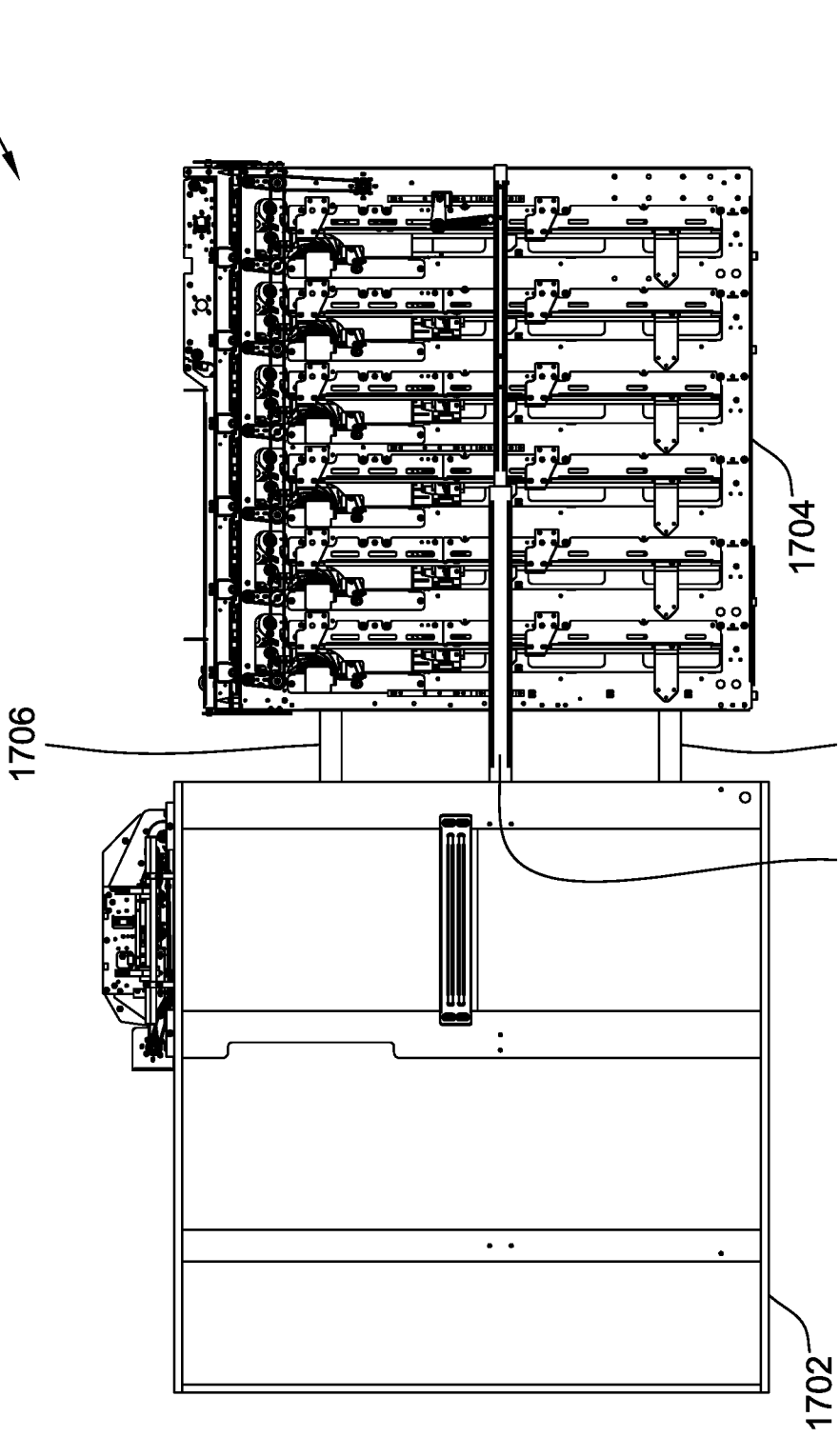

FIG. 17E

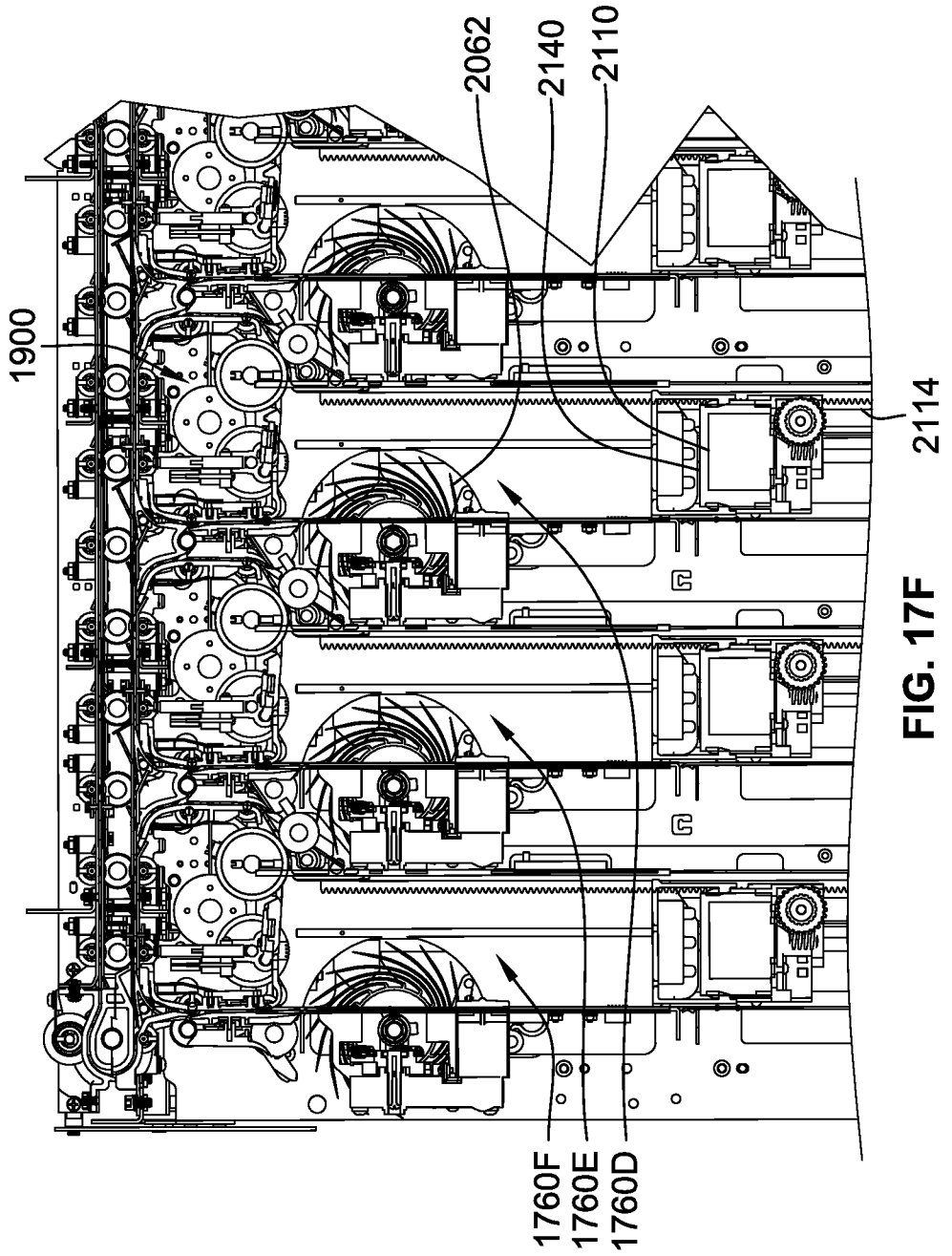

FIG. 17F

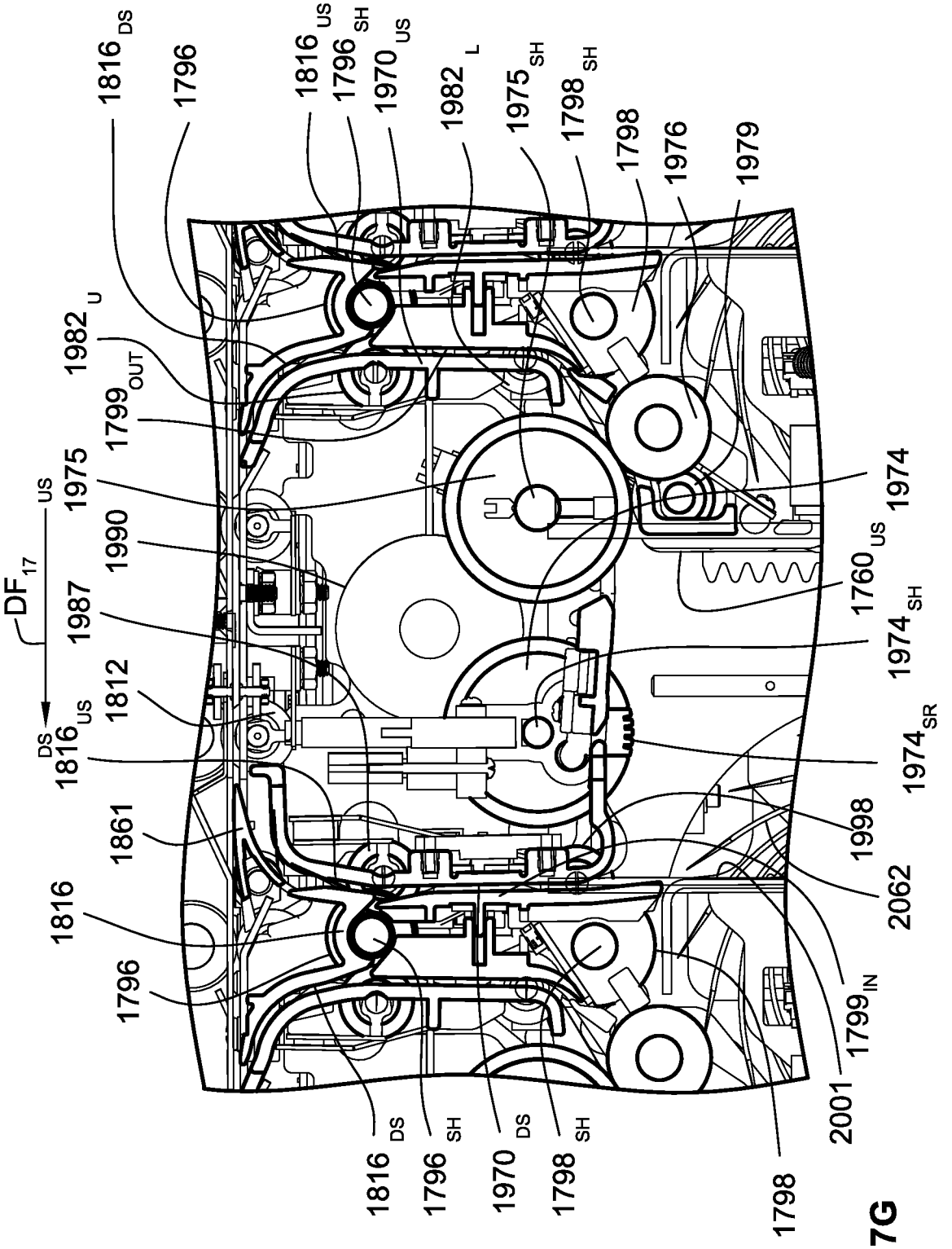
1816 DS
1796
1816 US
1796 SH
1970 US
1982 L
1975 SH
1798 SH
1798
1976
1979
1982 U
1799 OUT
1975
1990
1987
1812
1816 US
1861
1816
1796
DF 17
US
DS
1974
1760 US
1974 SH
1974 SR
1998
2062
1799 IN
2001
1798
1816 DS
1796 SH
1970 DS
1798 SH

FIG. 17G

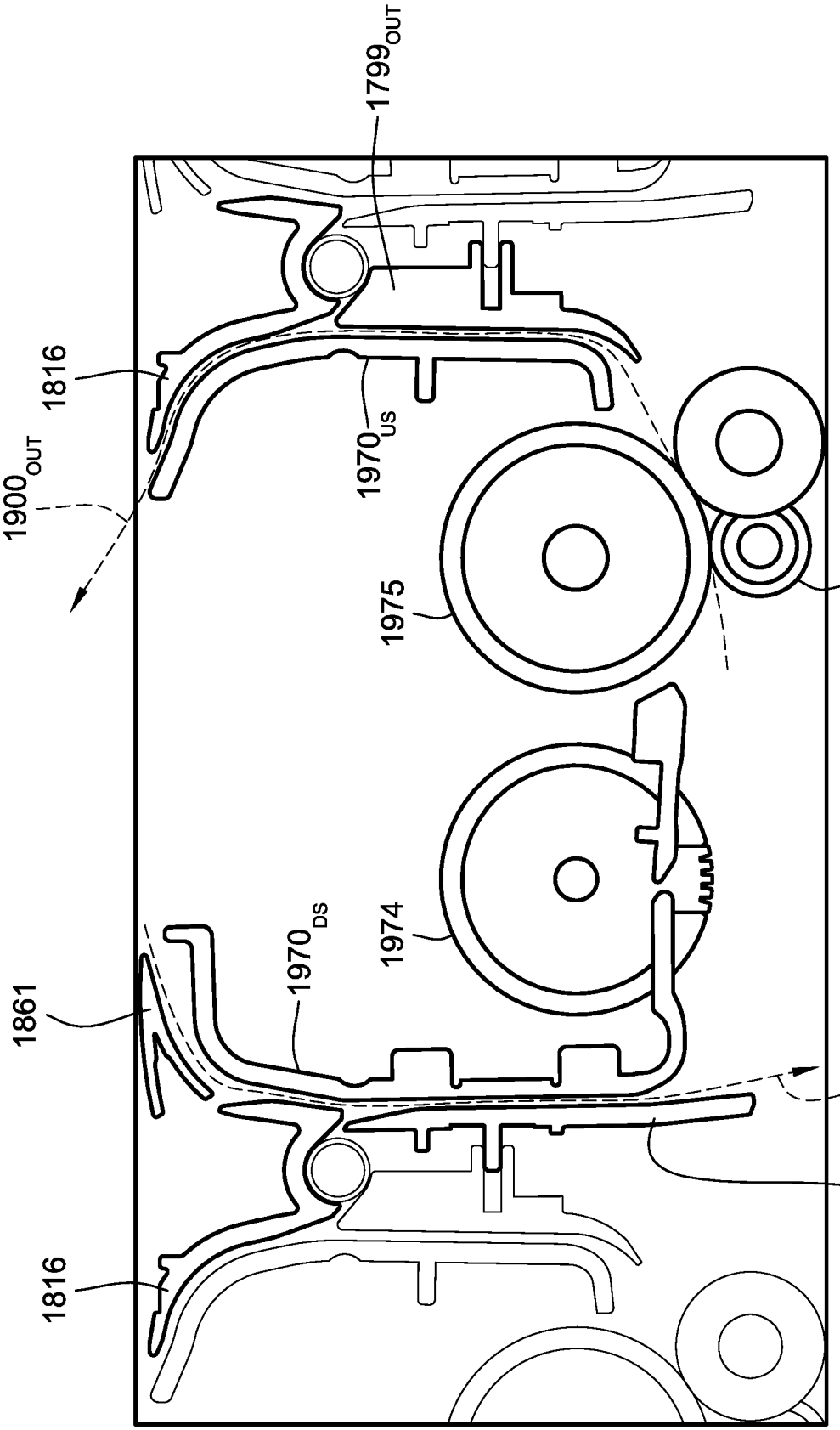
1799OUT
1816
1970US
1900OUT
1975
1979
1974
1970DS
1861
1900IN
1799IN
1816

FIG. 17G-1

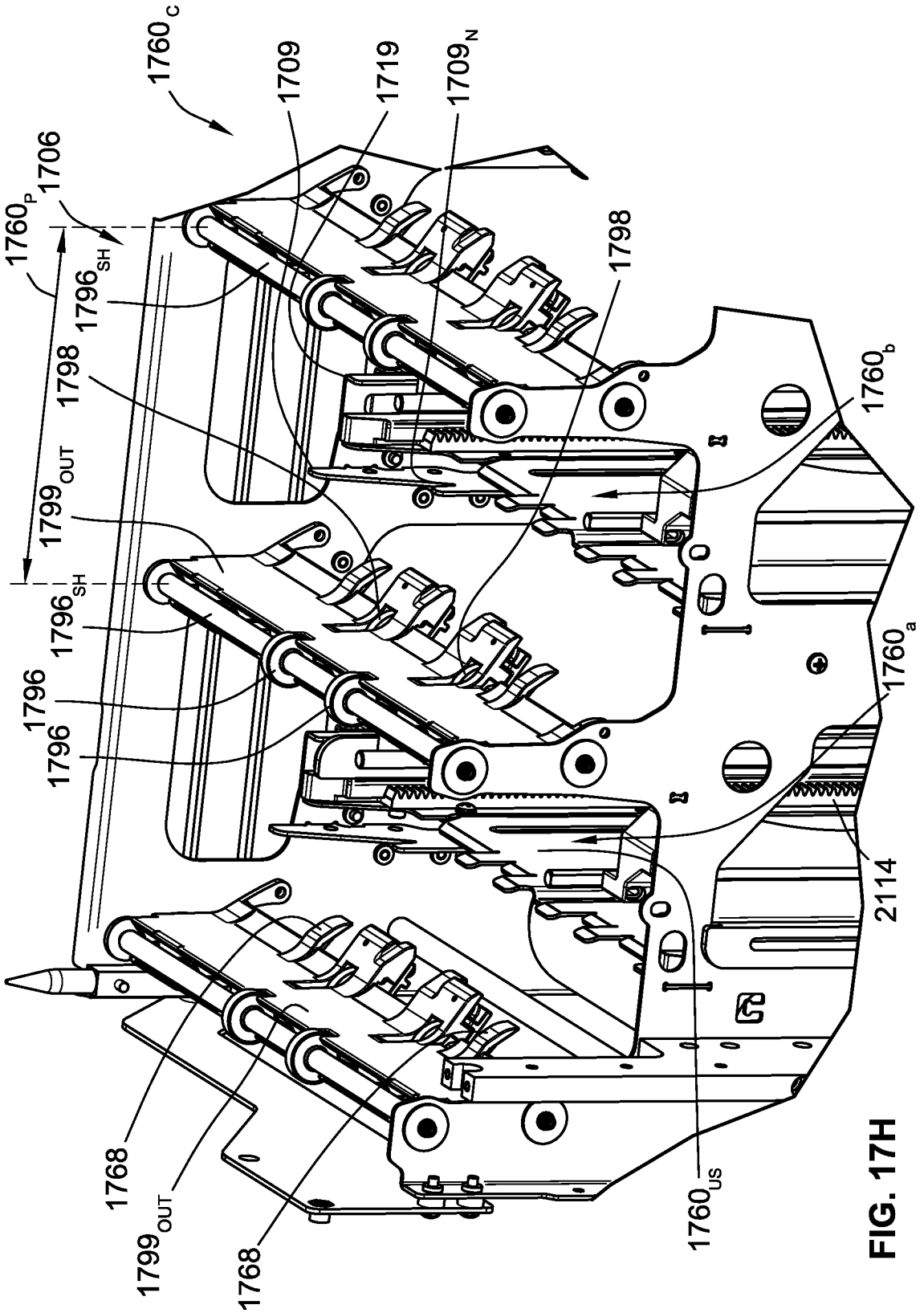
1760C
1709
1719
1709N
1760P
1706
1796SH
1798
1799OUT
1796SH
1796
1796
1798
1760b
1760a
2114
1768
1799OUT
1768
1760US

FIG. 17H

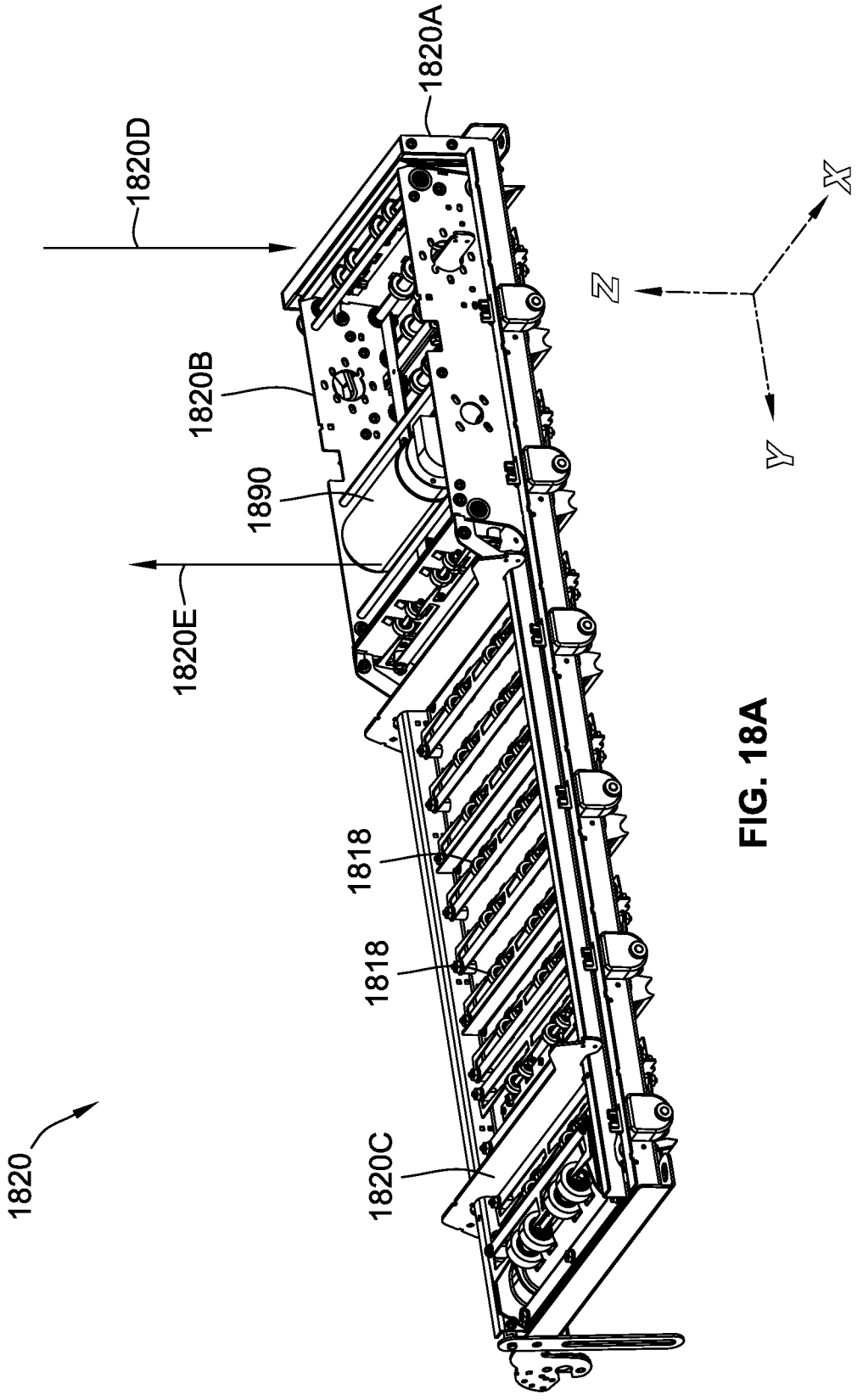

FIG. 18A

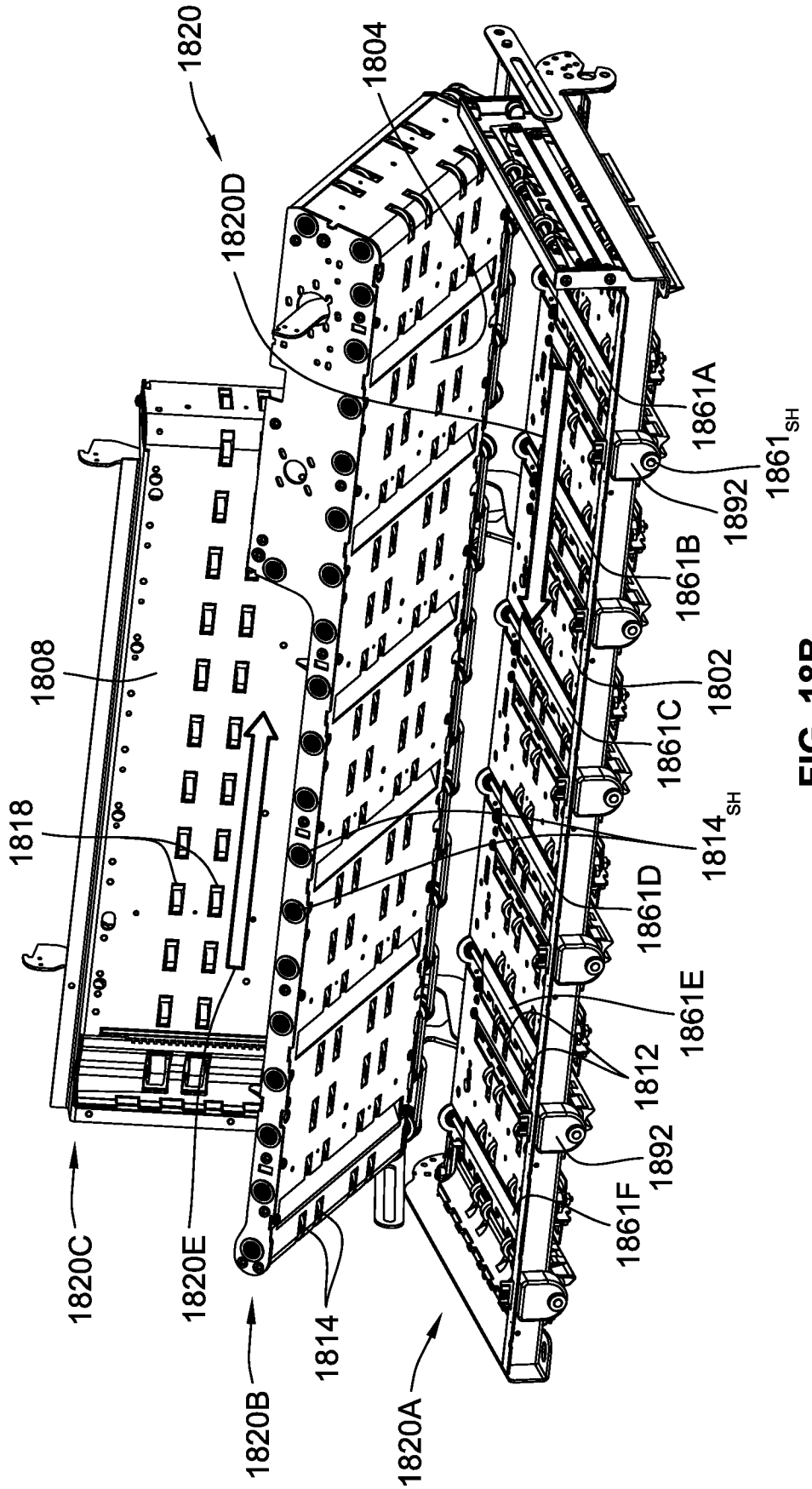
1820
1804
1820D
1861A
1861$_{SH}$
1892
1861B
1808
1802
1861C
1818
1814$_{SH}$
1861D
1861E
1812
1892
1861F
1820C
1820E
1814
1820B
1820A

FIG. 18B

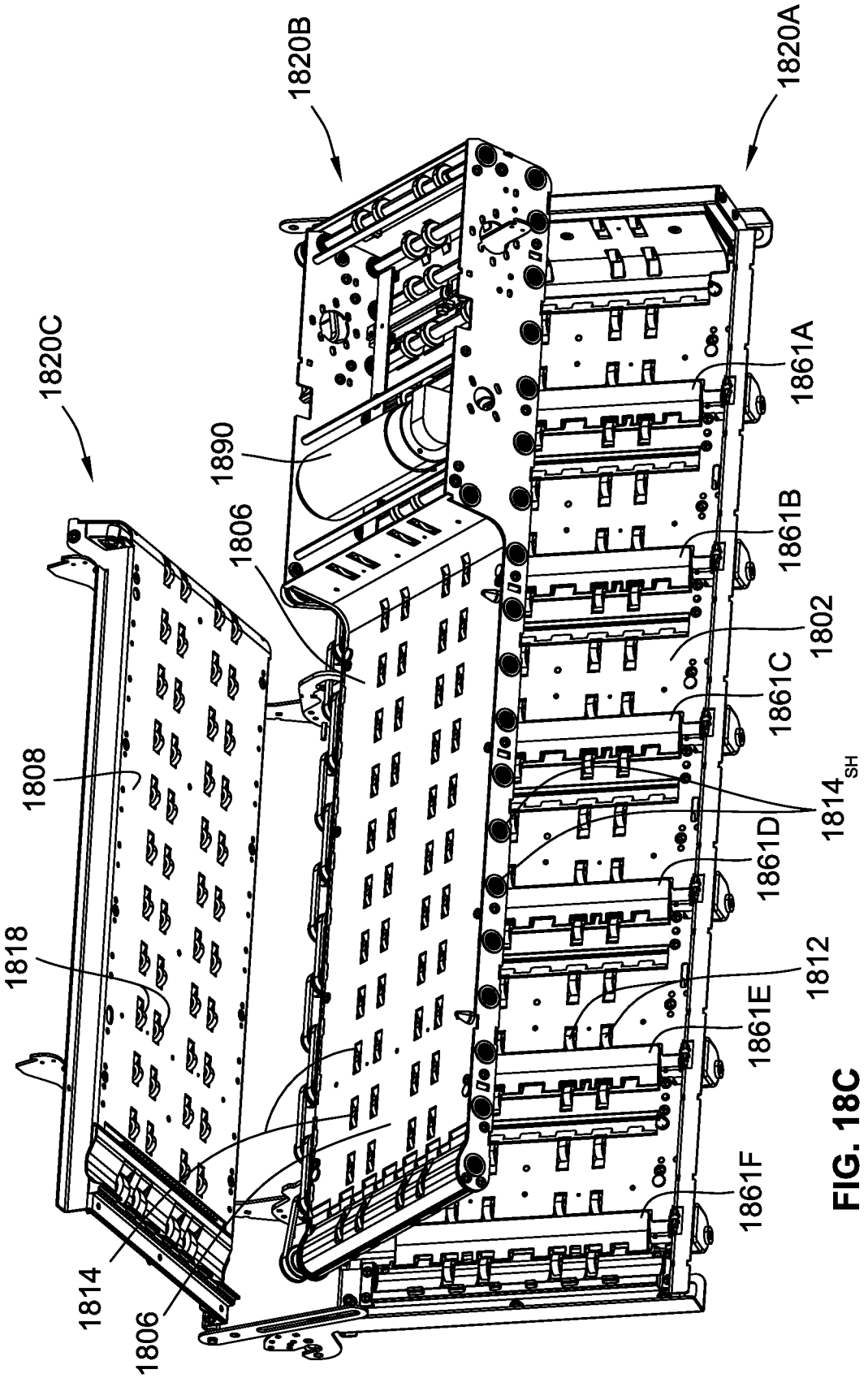
1820B
1820A
1820C
1890
1806
1861A
1861B
1802
1861C
1808
1814SH
1861D
1818
1812
1861E
1861F
1814
1806

FIG. 18C

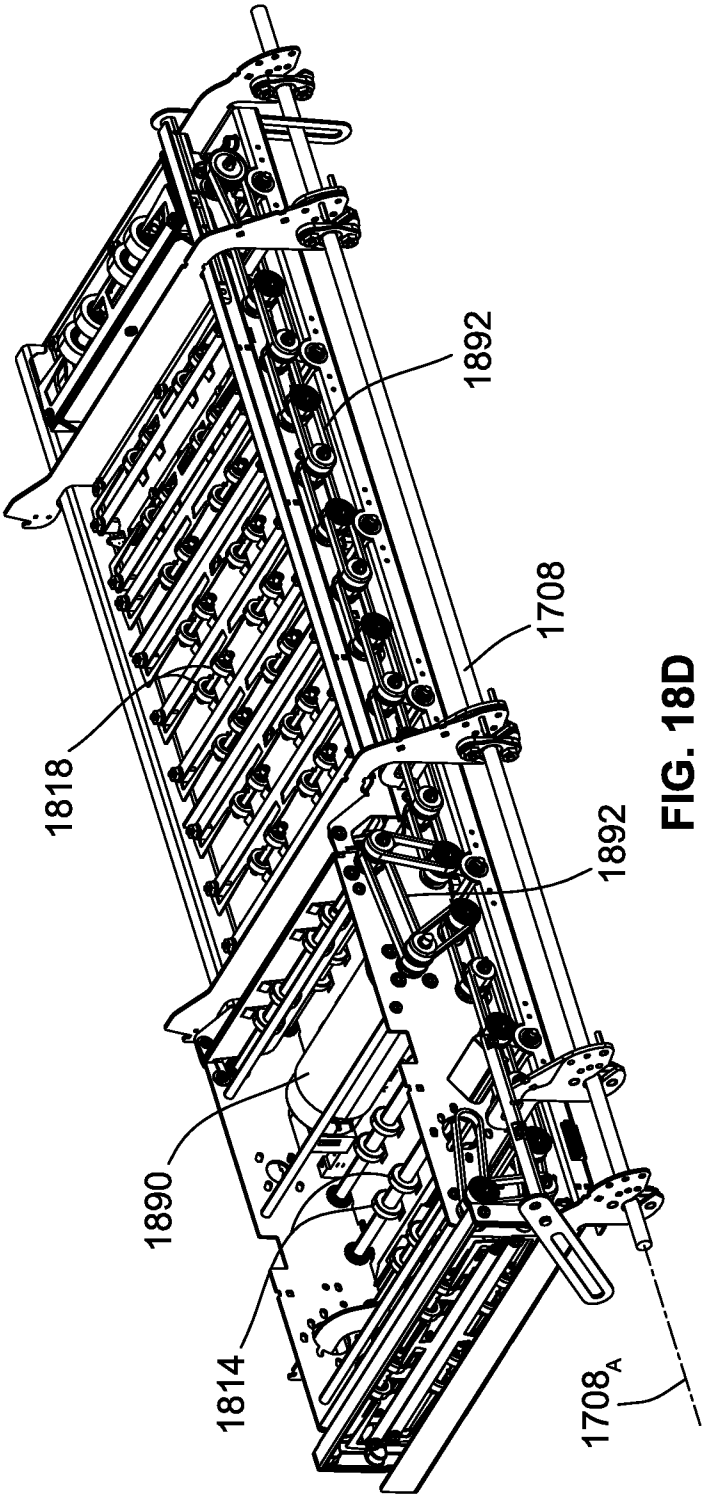

FIG. 18D

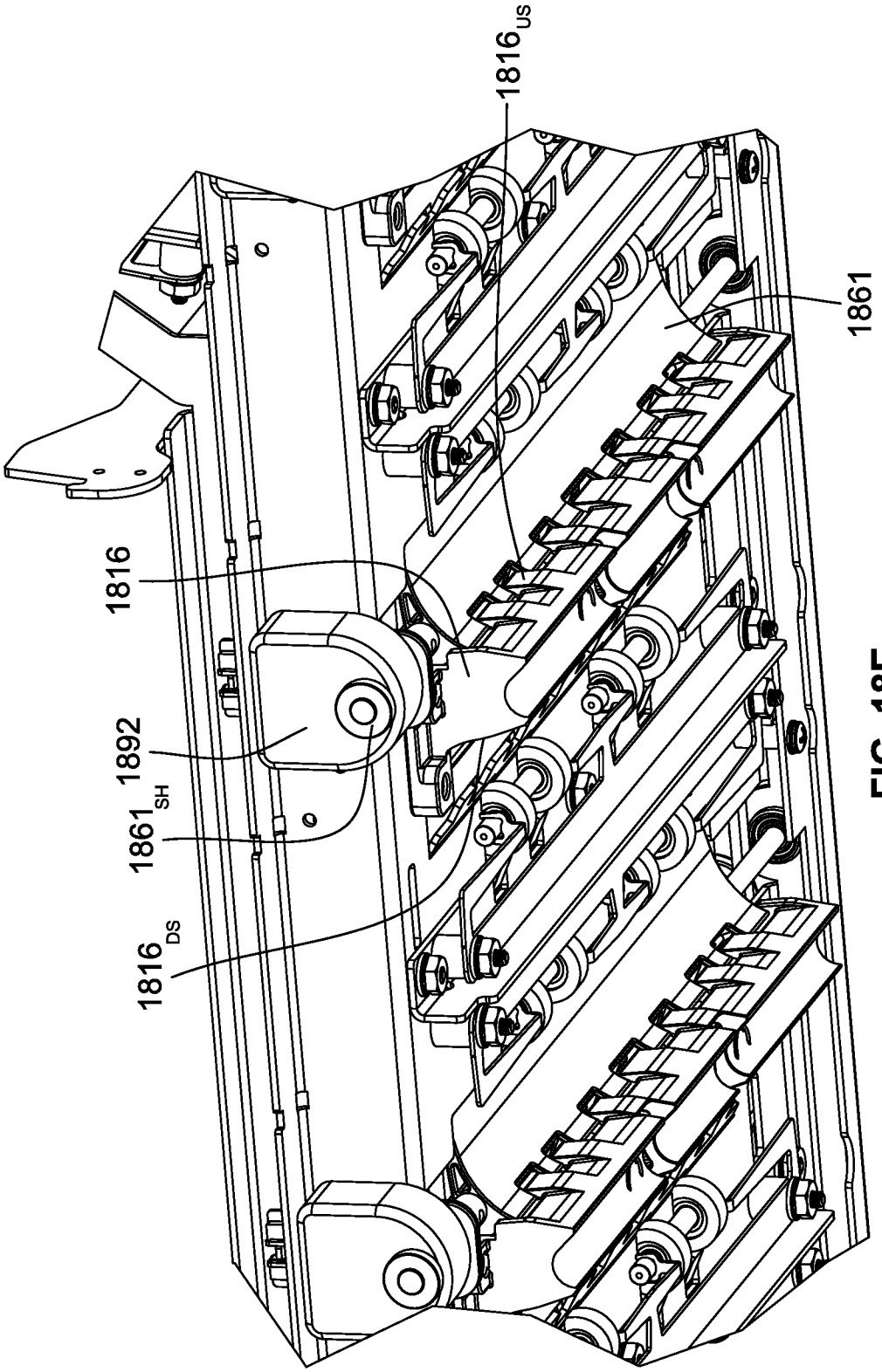

FIG. 18E

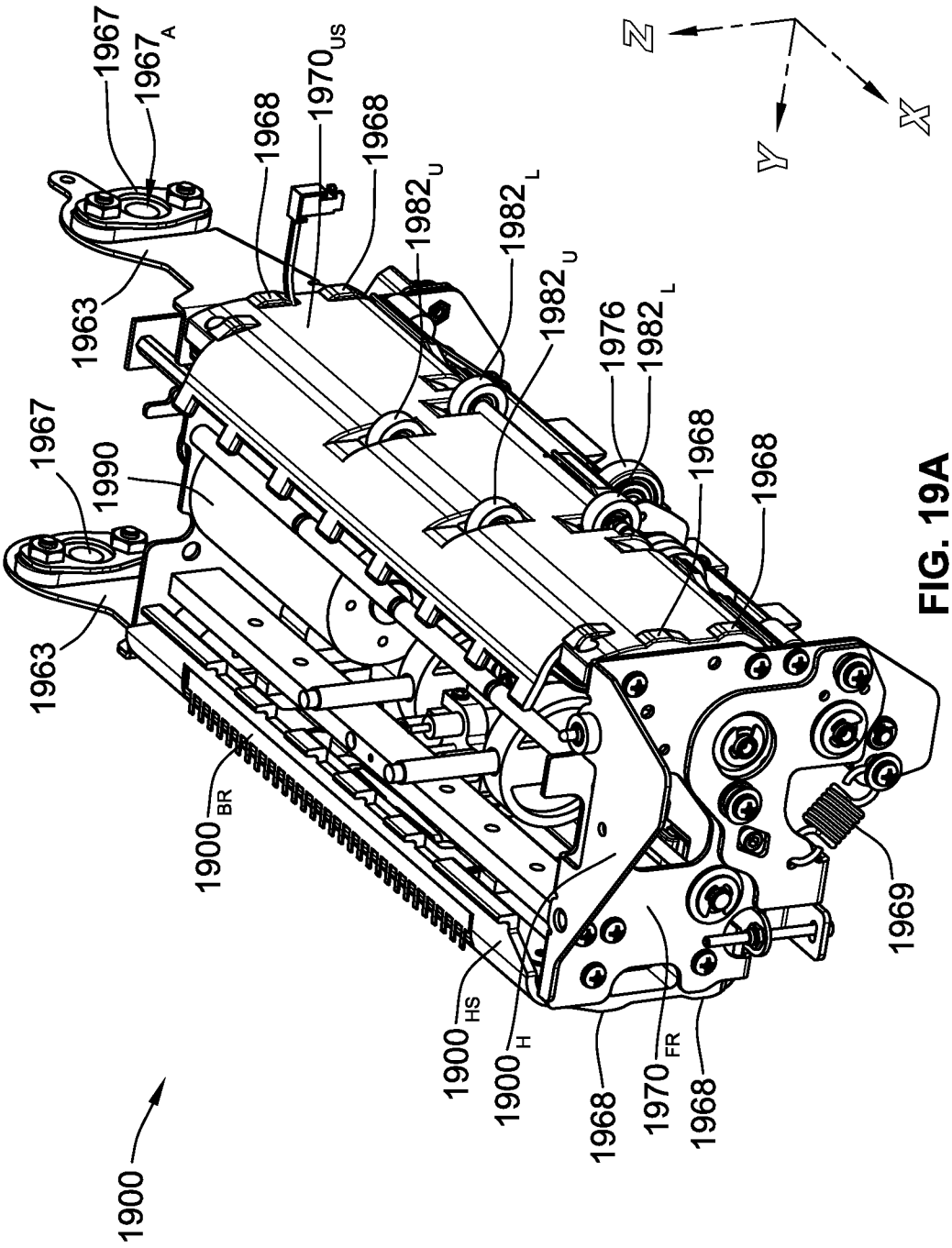
1967
1967A
1968
1970US
1968
1982U
1982L
1982U
1976
1982L
1968
1968
1967
1990
1963
1963
1900BR
1900HS
1900H
1968
1970FR
1968
1969
1900
Z
Y
X

FIG. 19A

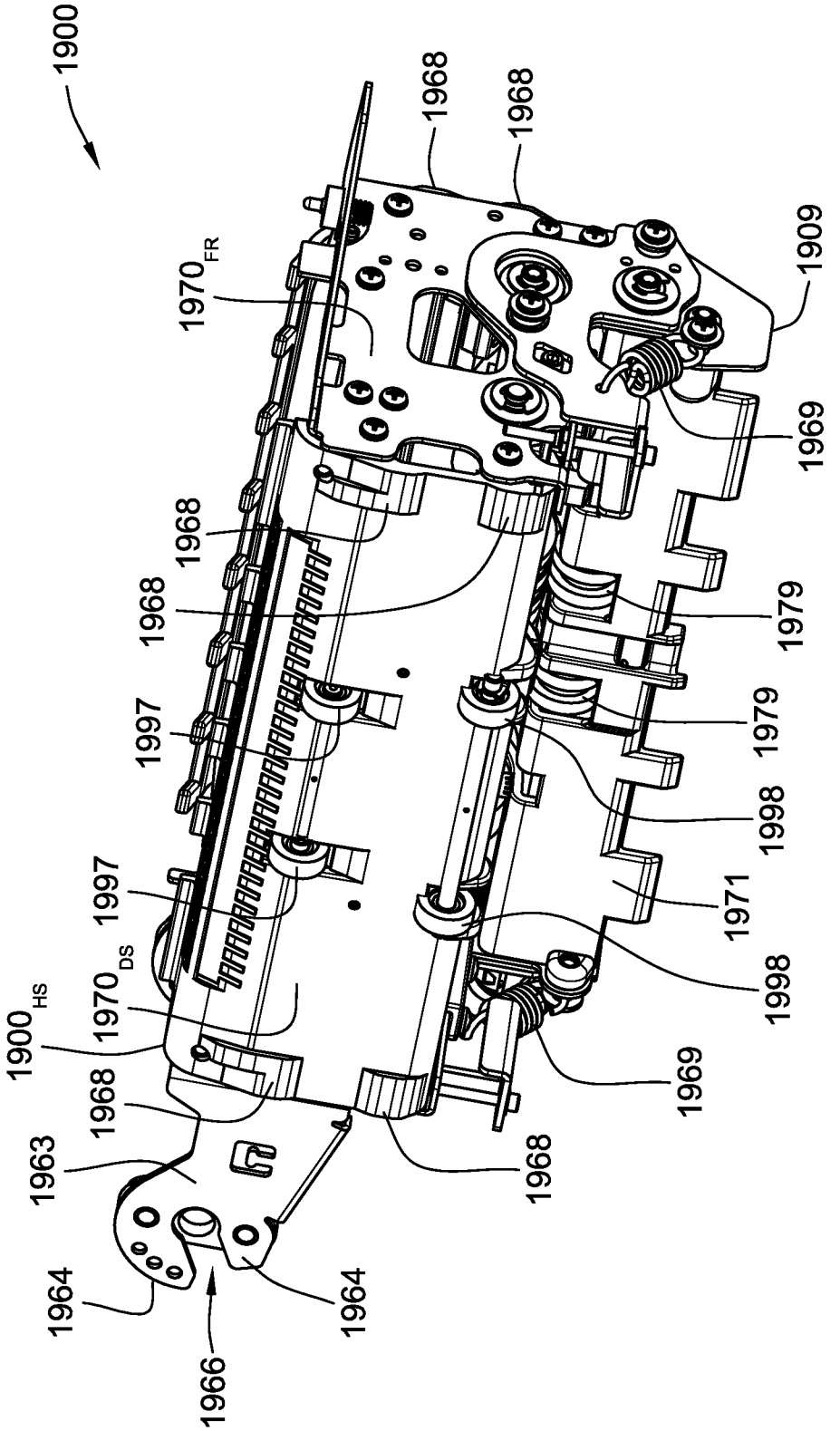
1900
1968
1968
1970FR
1909
1969
1968
1968
1979
1997
1979
1998
1997
1971
1970DS
1998
1900HS
1969
1968
1963
1968
1964
1964
1966

FIG. 19B

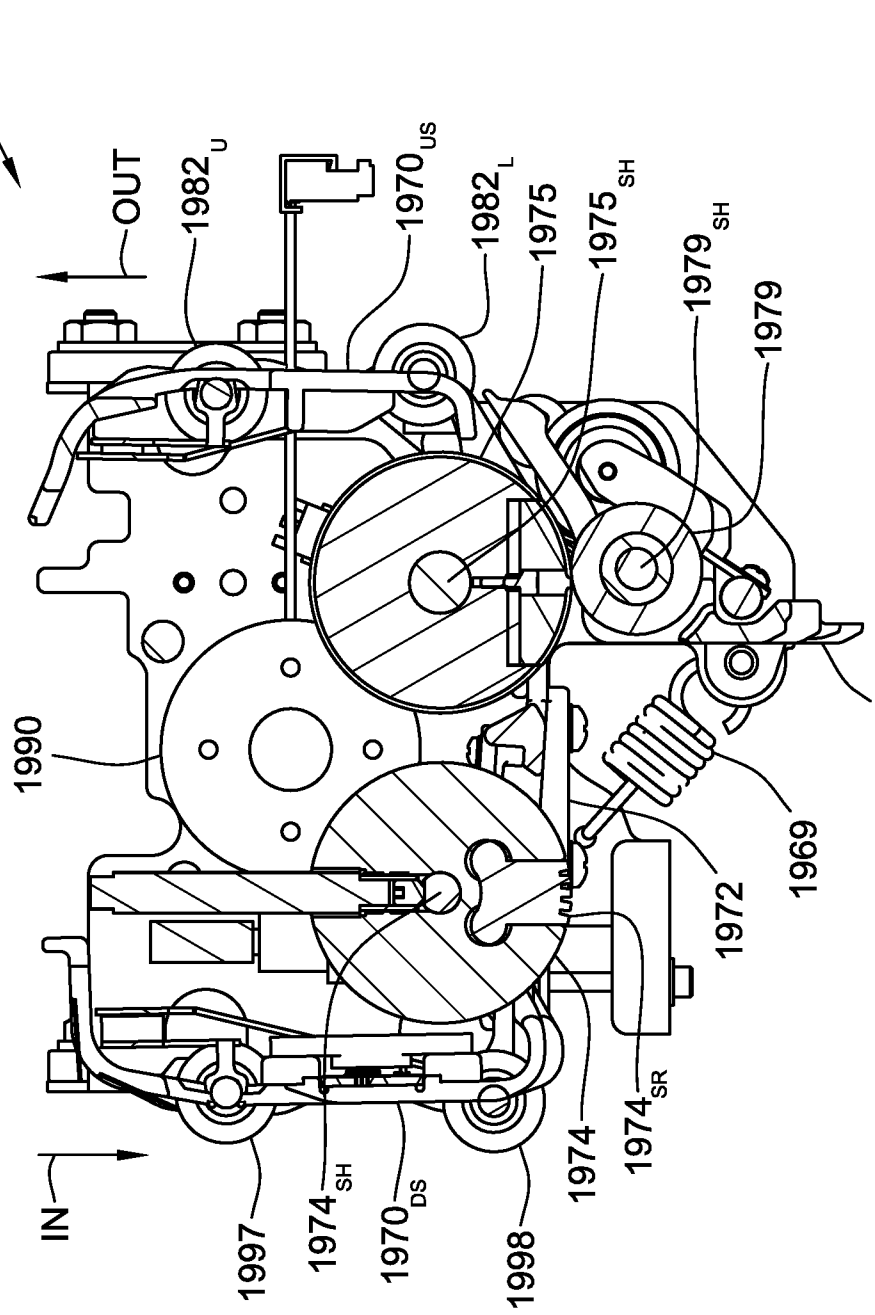
1900
OUT
1982U
1970US
1982L
1975
1975SH
1979SH
1979
1990
1971
1969
1972
1974SR
1974
1974SH
1970DS
1998
1997
IN

FIG. 19C

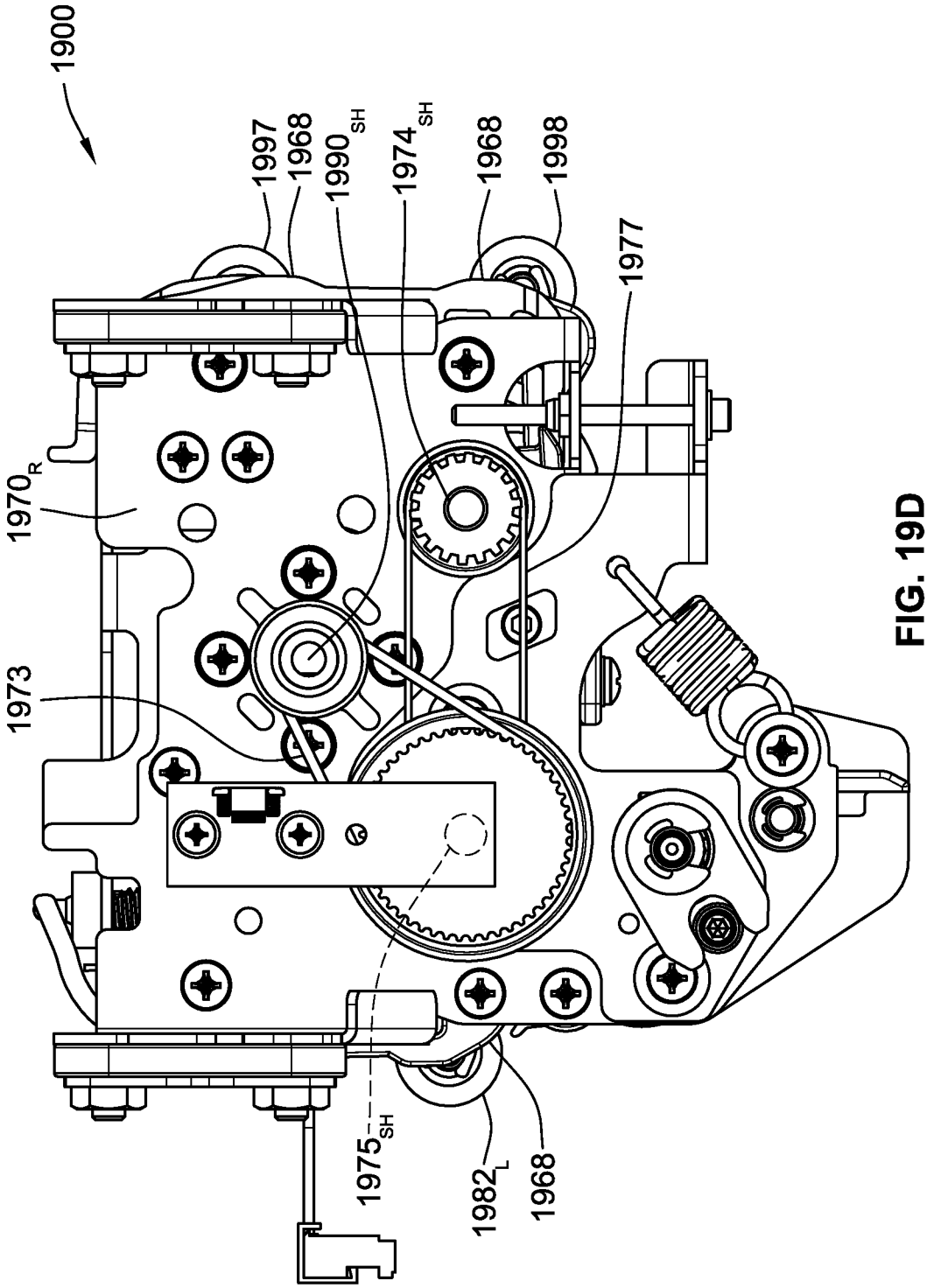
1900
1997
1968
1990SH
1974SH
1968
1998
1977
1970R
1973
1975SH
1982L
1968

FIG. 19D

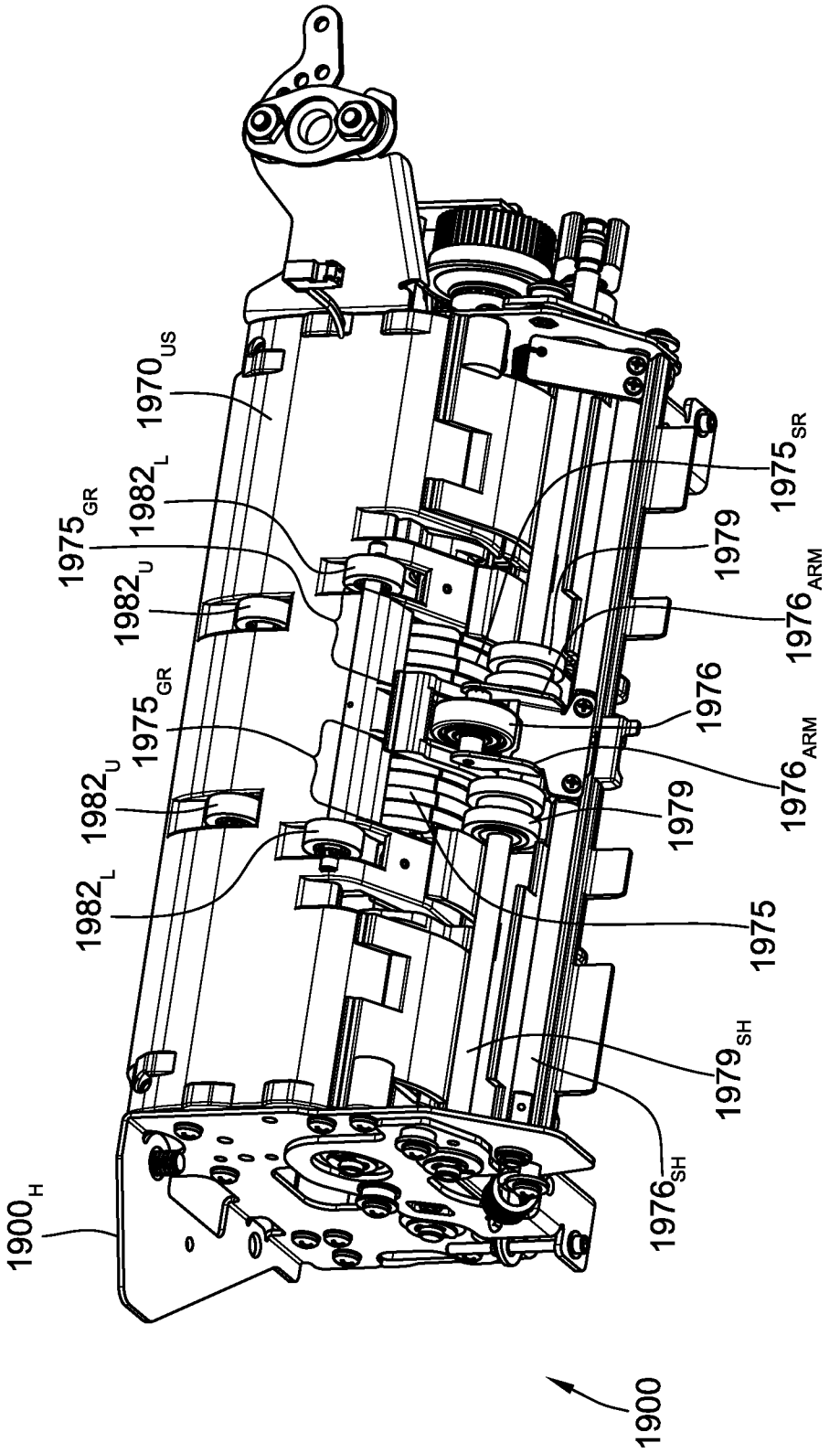
1900
1900H
1970US
1982L
1975GR
1982U
1975GR
1982U
1982L
1975
1979SH
1976SH
1975SR
1979
1976ARM
1976
1976ARM
1979

FIG. 19E

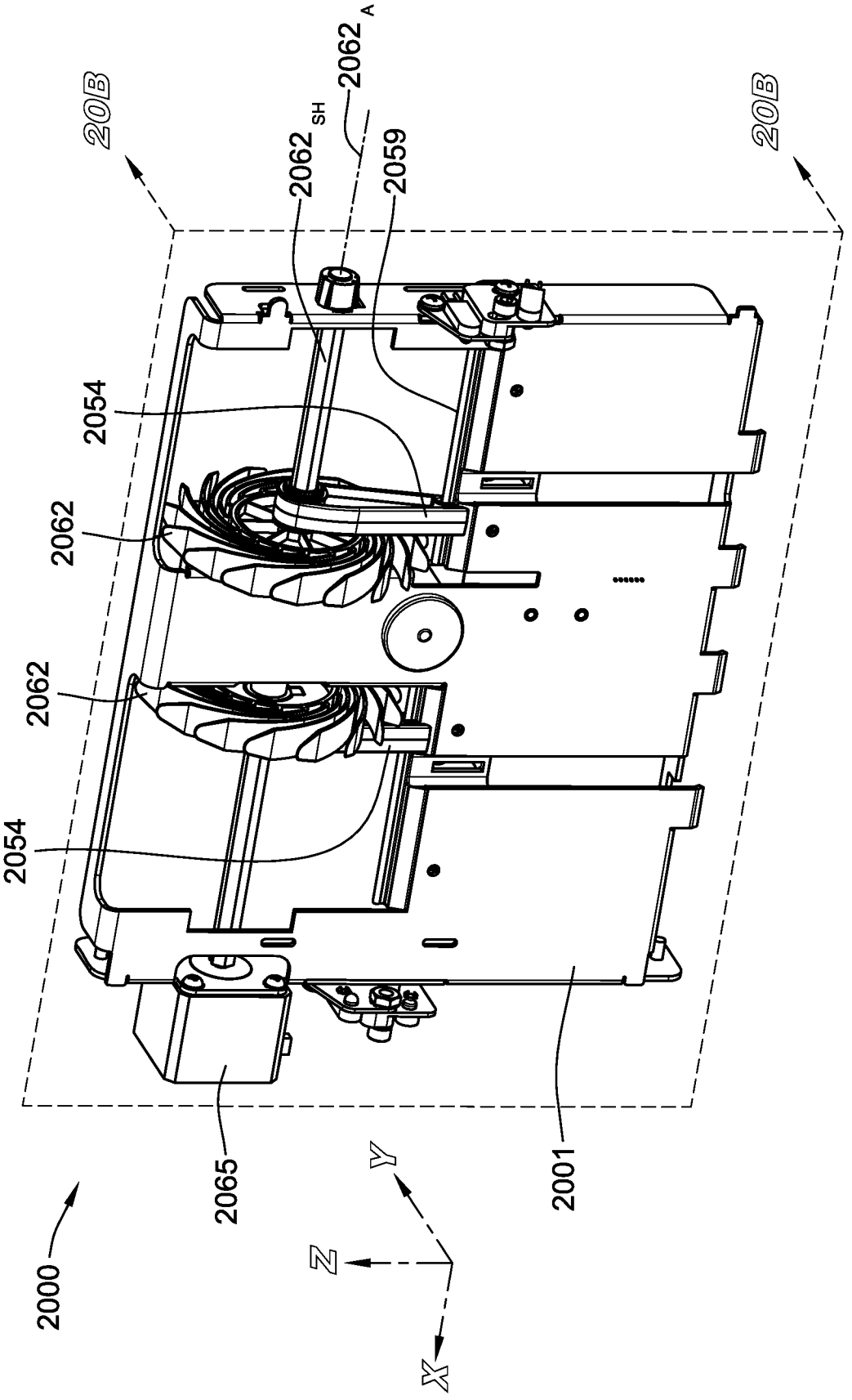
20B
20B
2062 A
2062 SH
2059
2054
2062
2062
2054
2065
2001
2000
Y
Z
X

FIG. 20A

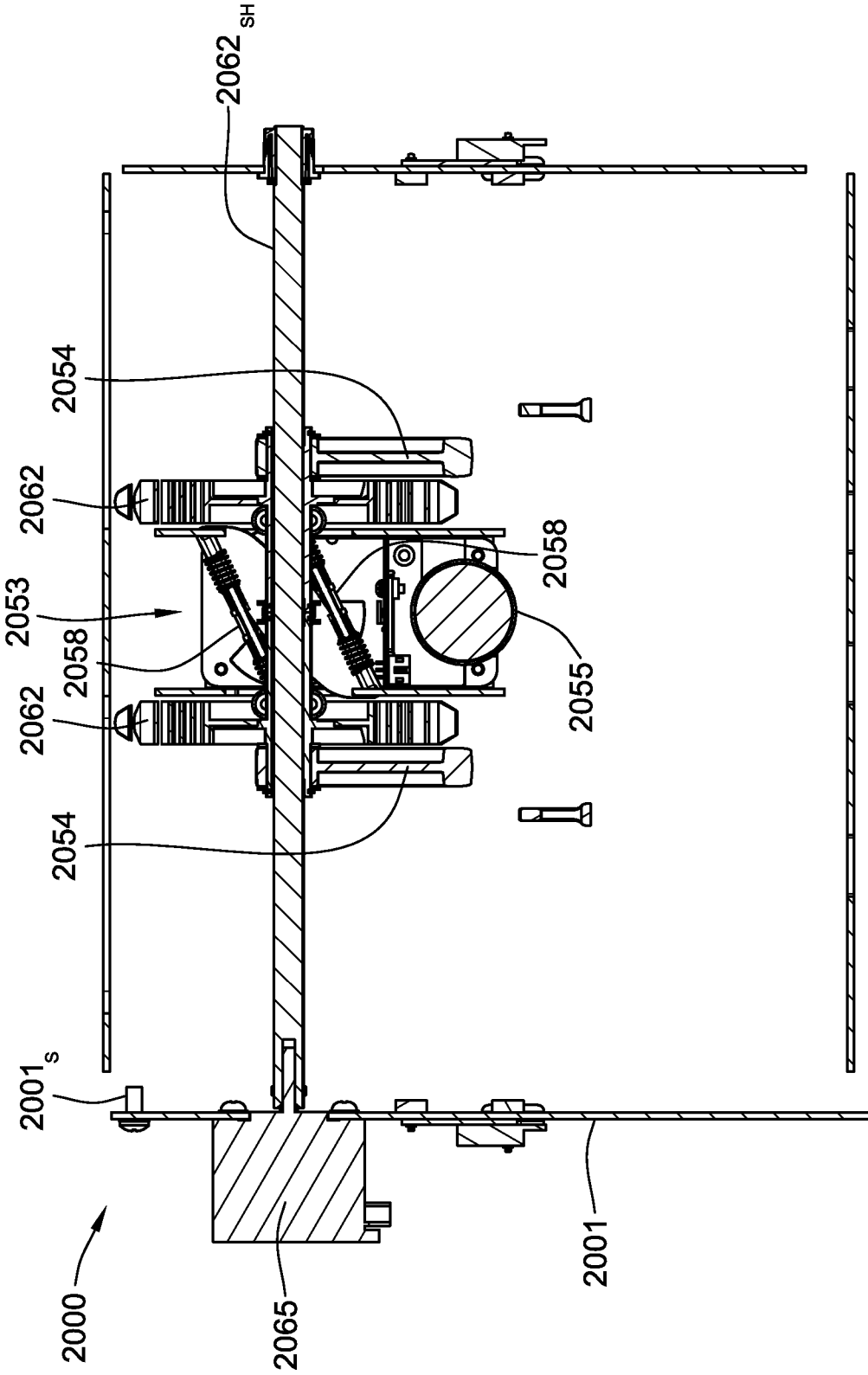
2062 SH
2054
2062
2053
2058
2062
2054
2058
2055
2001 S
2001 S
2000
2065
2001

FIG. 20B

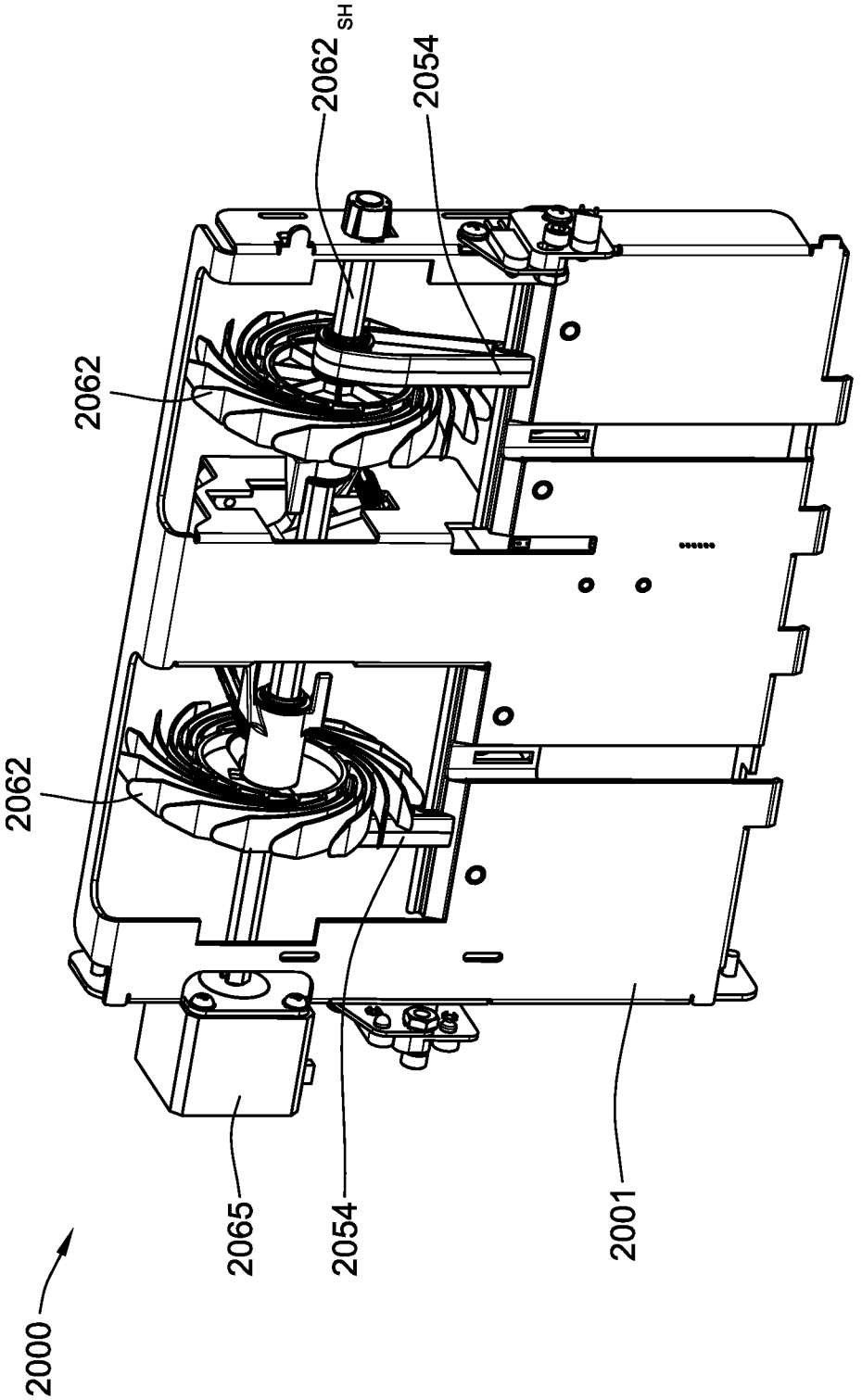

FIG. 20C

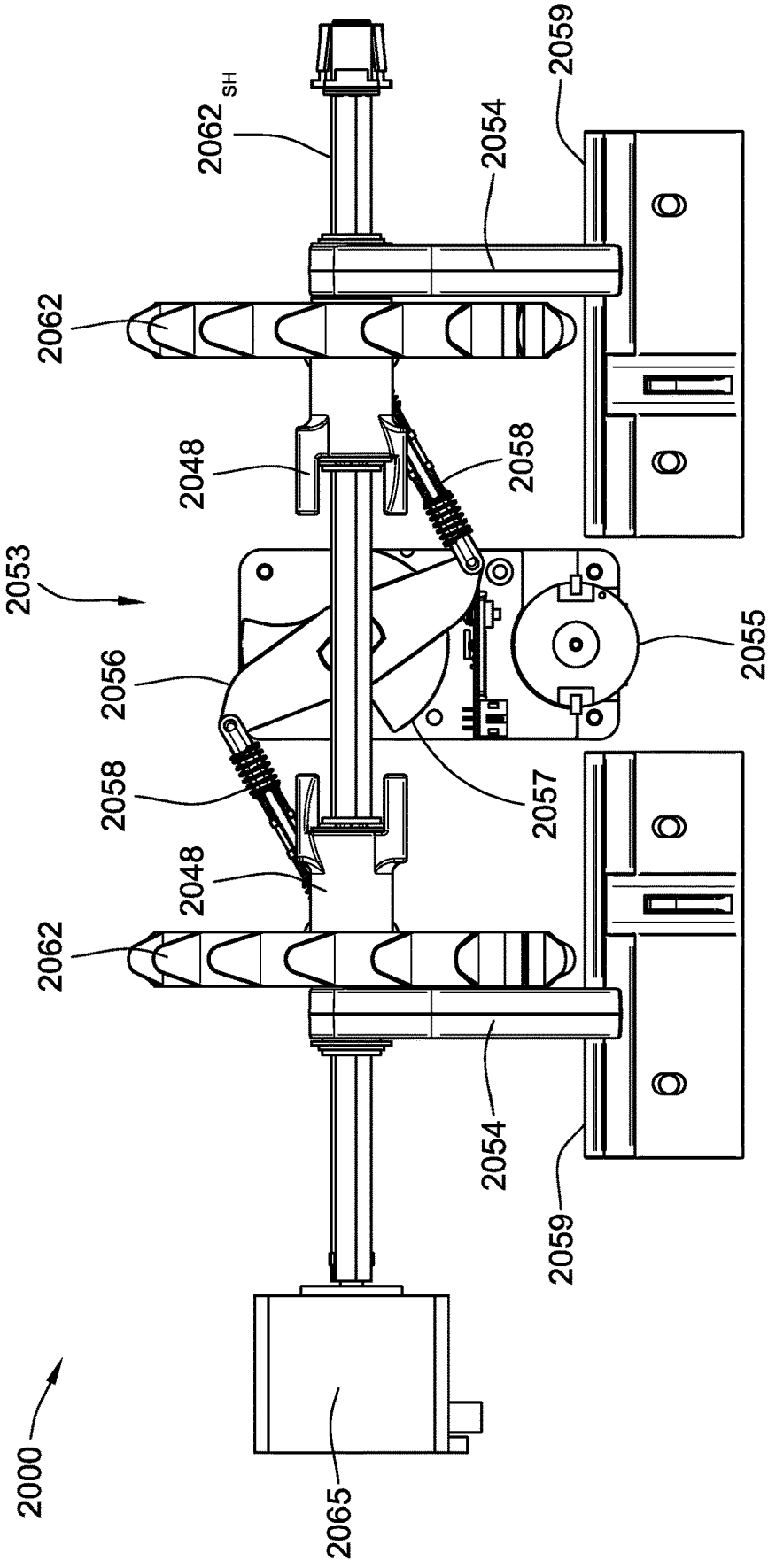
2062 SH
2059
2054
2062
2048
2058
2053
2056
2055
2058
2057
2048
2062
2054
2059
2000
2065

FIG. 20D

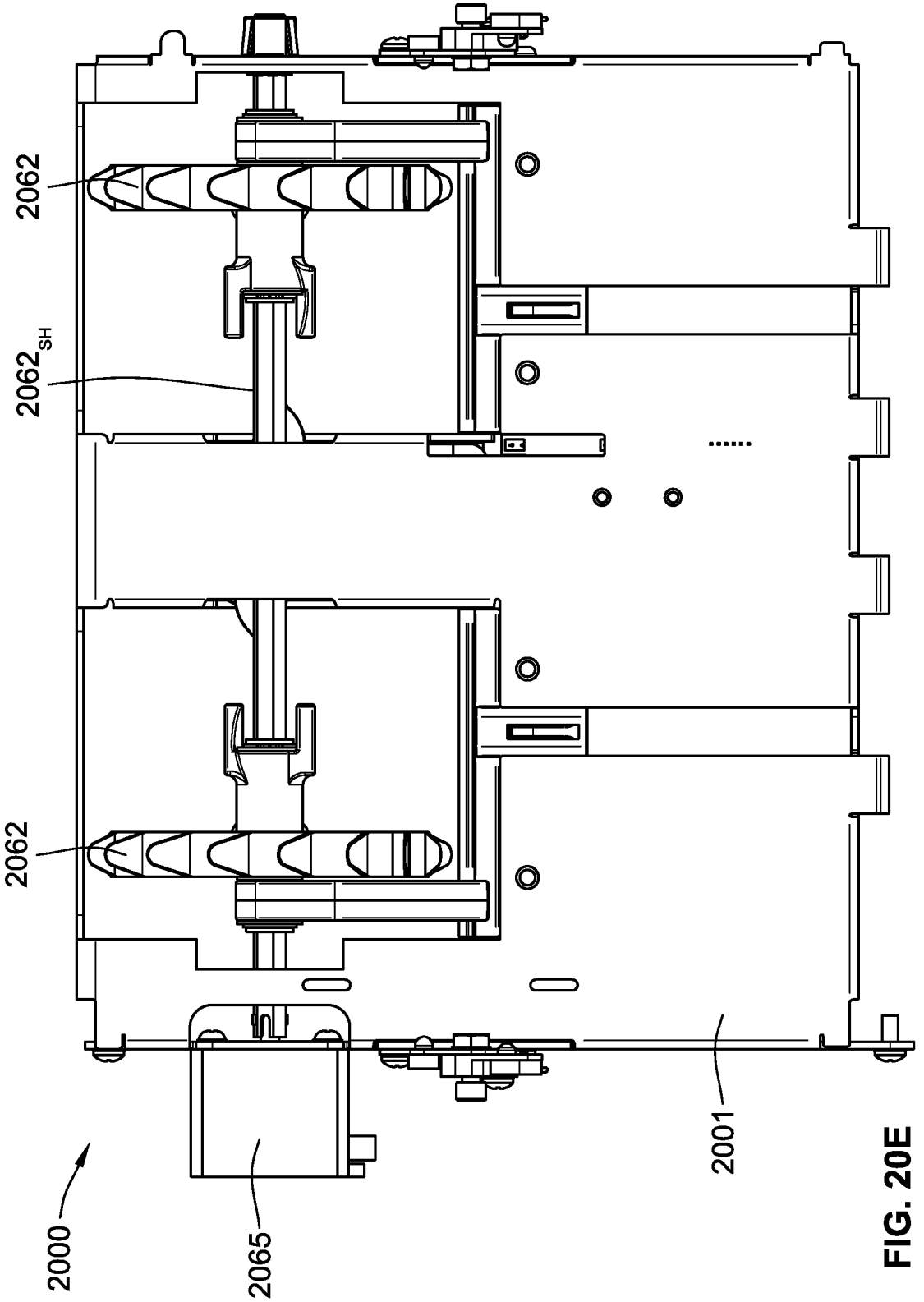

FIG. 20E

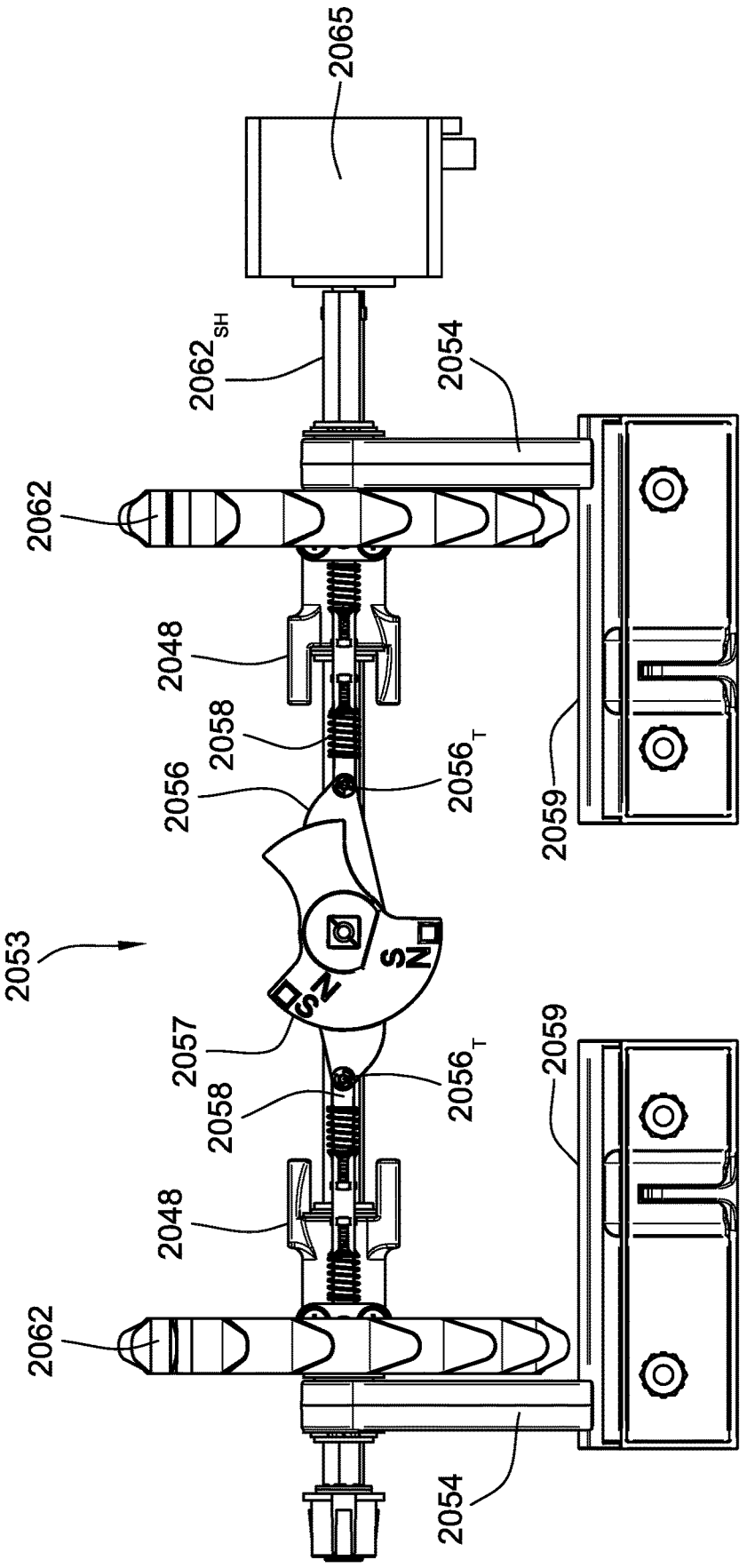
2065
2062SH
2054
2062
2048
2058
2056
2056T
2059
2053
N
S
S
N
2057
2058
2056T
2059
2048
2062
2054

FIG. 20F

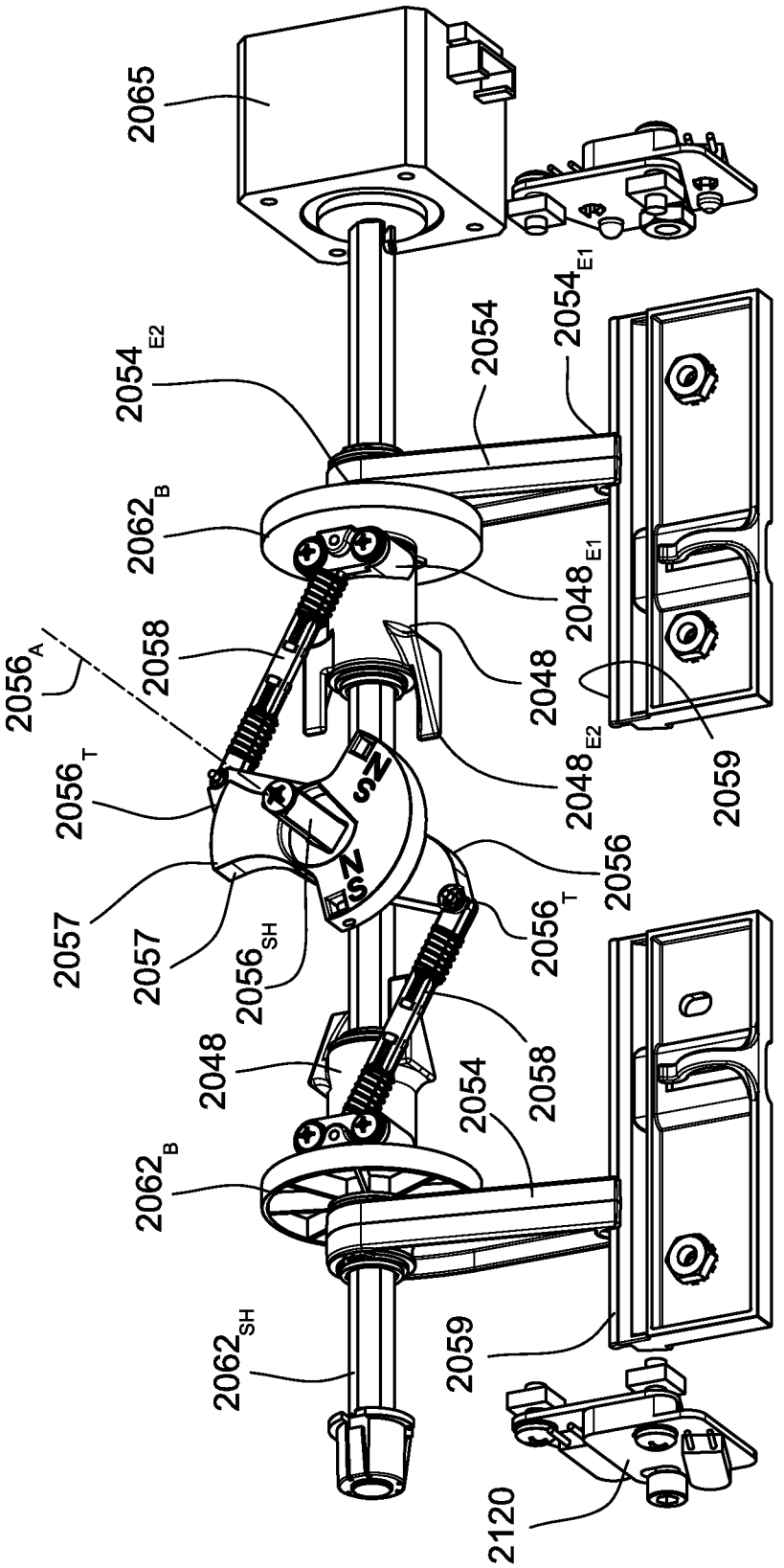
2065
2054E1
2054E2
2054
2062B
2048E1
2058
2056A
2048
2056T
2048E2
2059
2057
2057
2056SH
2056
2056T
2048
2058
2054
2062B
2062SH
2059
2120

FIG. 20G

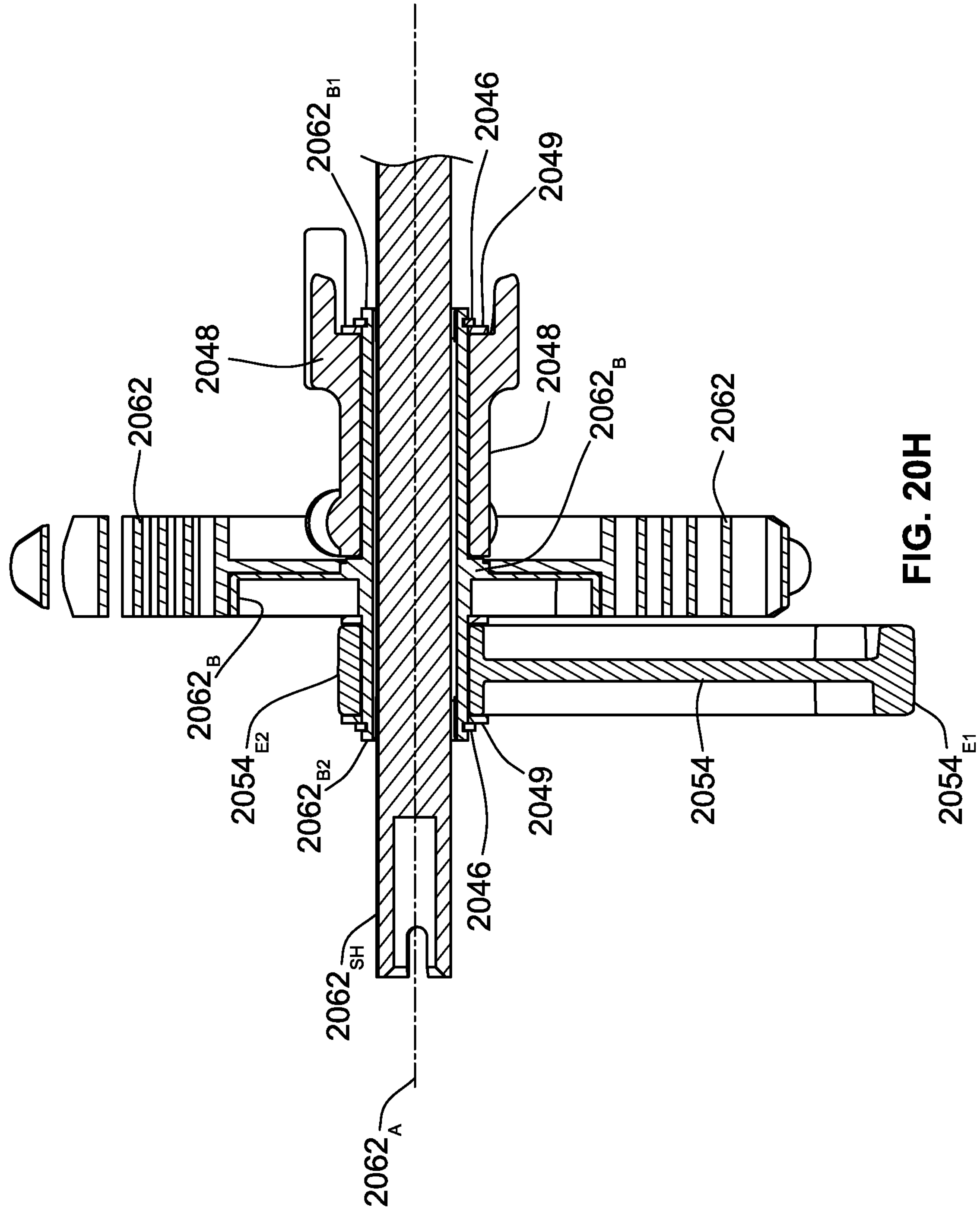
2062_{B1}
2046
2049
2048
2048
2062_{B}
2062
2062
2062_{B}
2054_{E2}
2062_{B2}
2049
2054
2054_{E1}
2046
2062_{SH}
2062_{A}

FIG. 20H

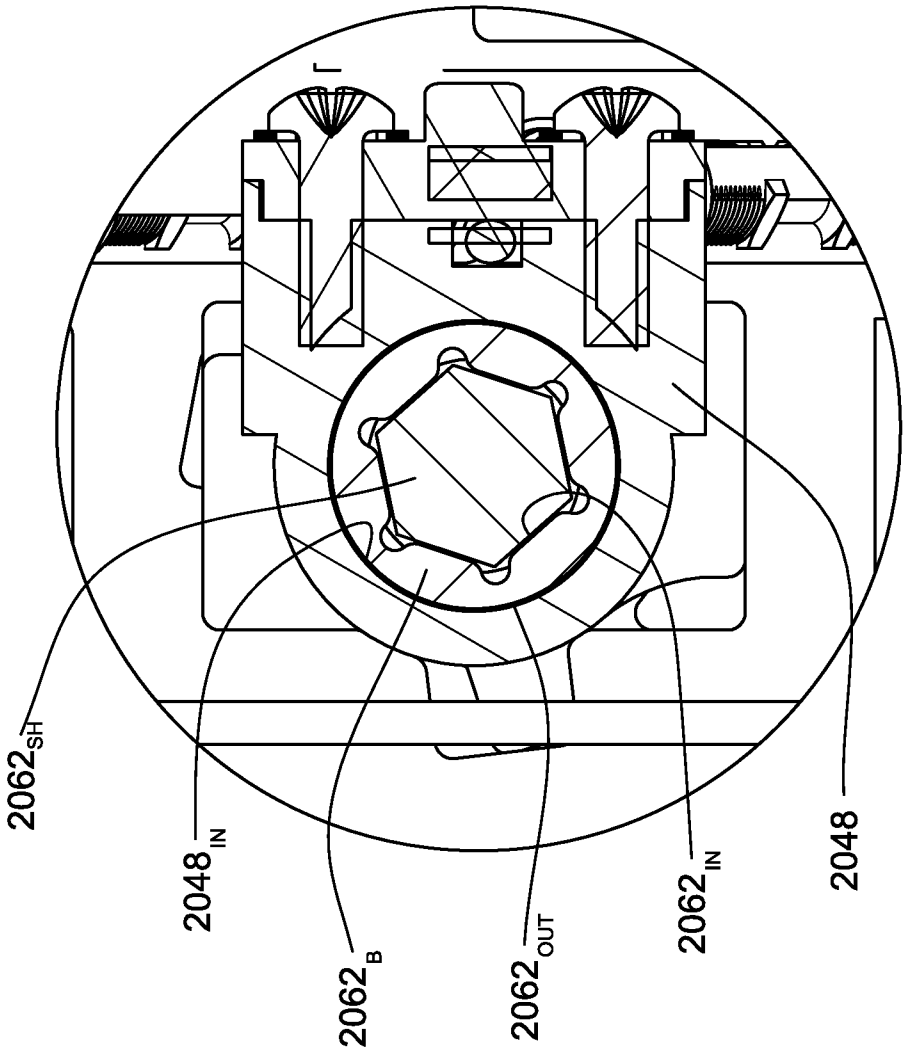

FIG. 20I

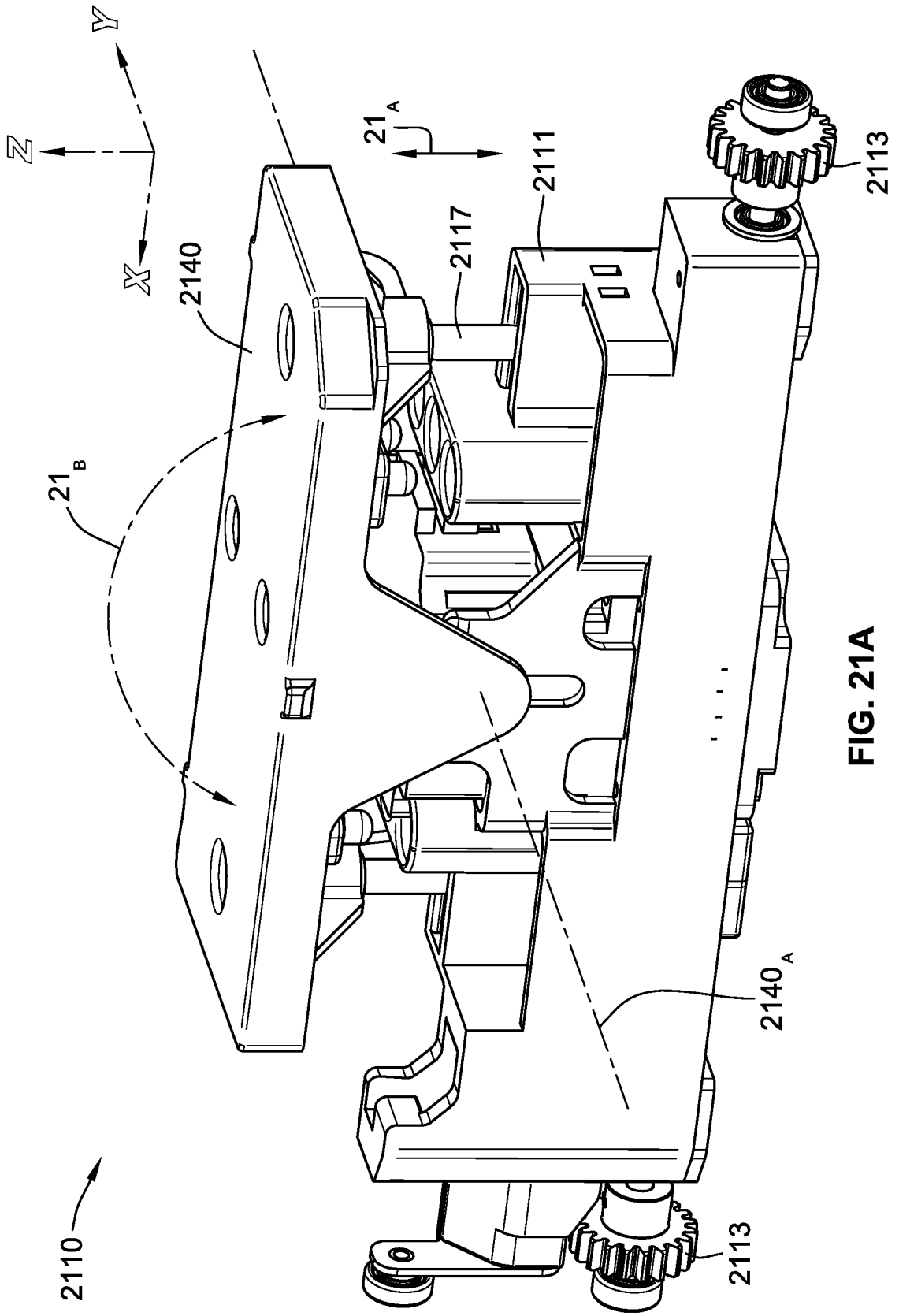

FIG. 21A

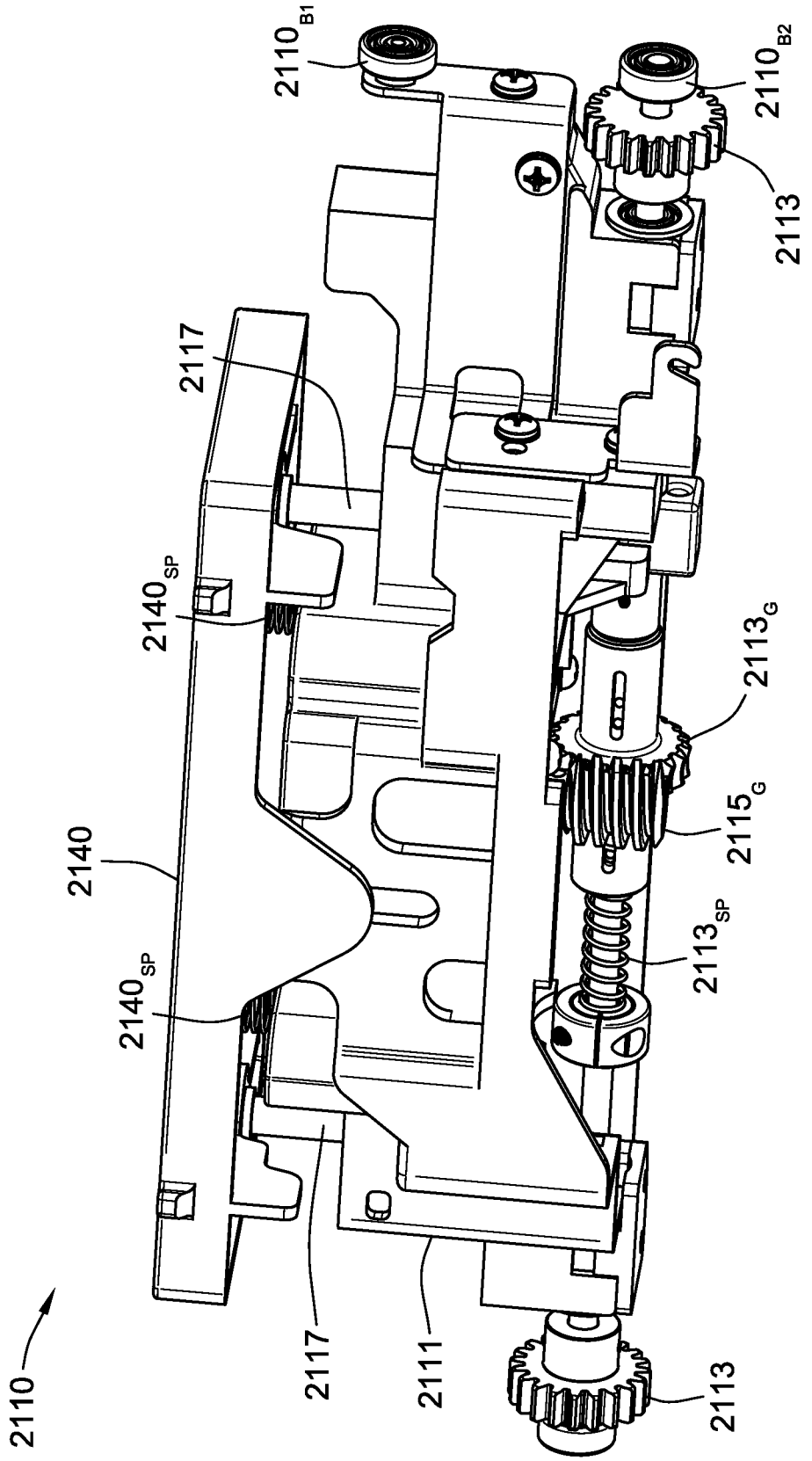
2110
2110B1
2110B2
2113
2117
2140SP
2113G
2140
2115G
2113SP
2140SP
2117
2111
2113

FIG. 21B

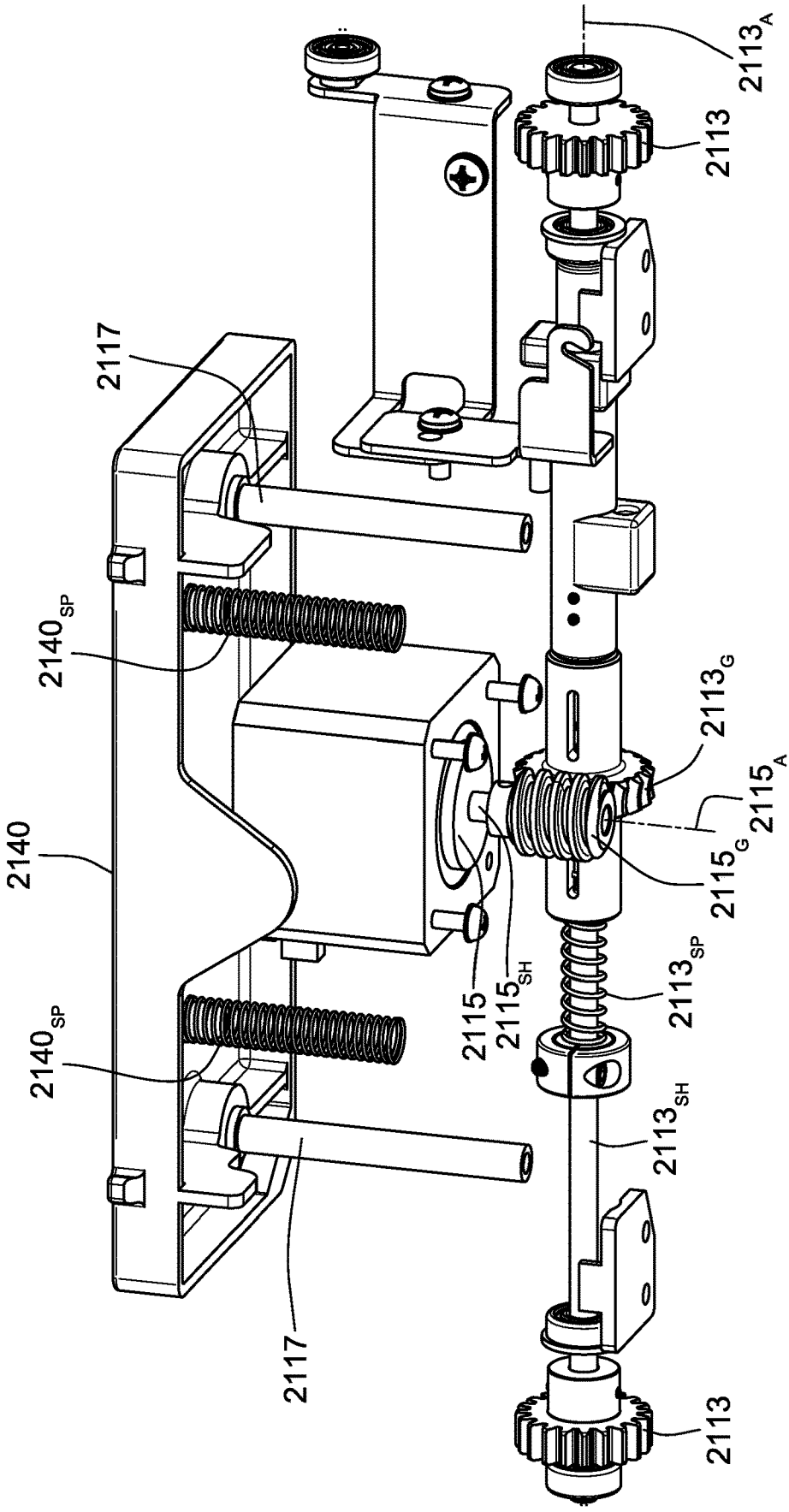
2113A
2113
2117
2140SP
2113G
2115A
2140
2115G
2115SH
2115
2113SP
2140SP
2113SH
2117
2113

FIG. 21C

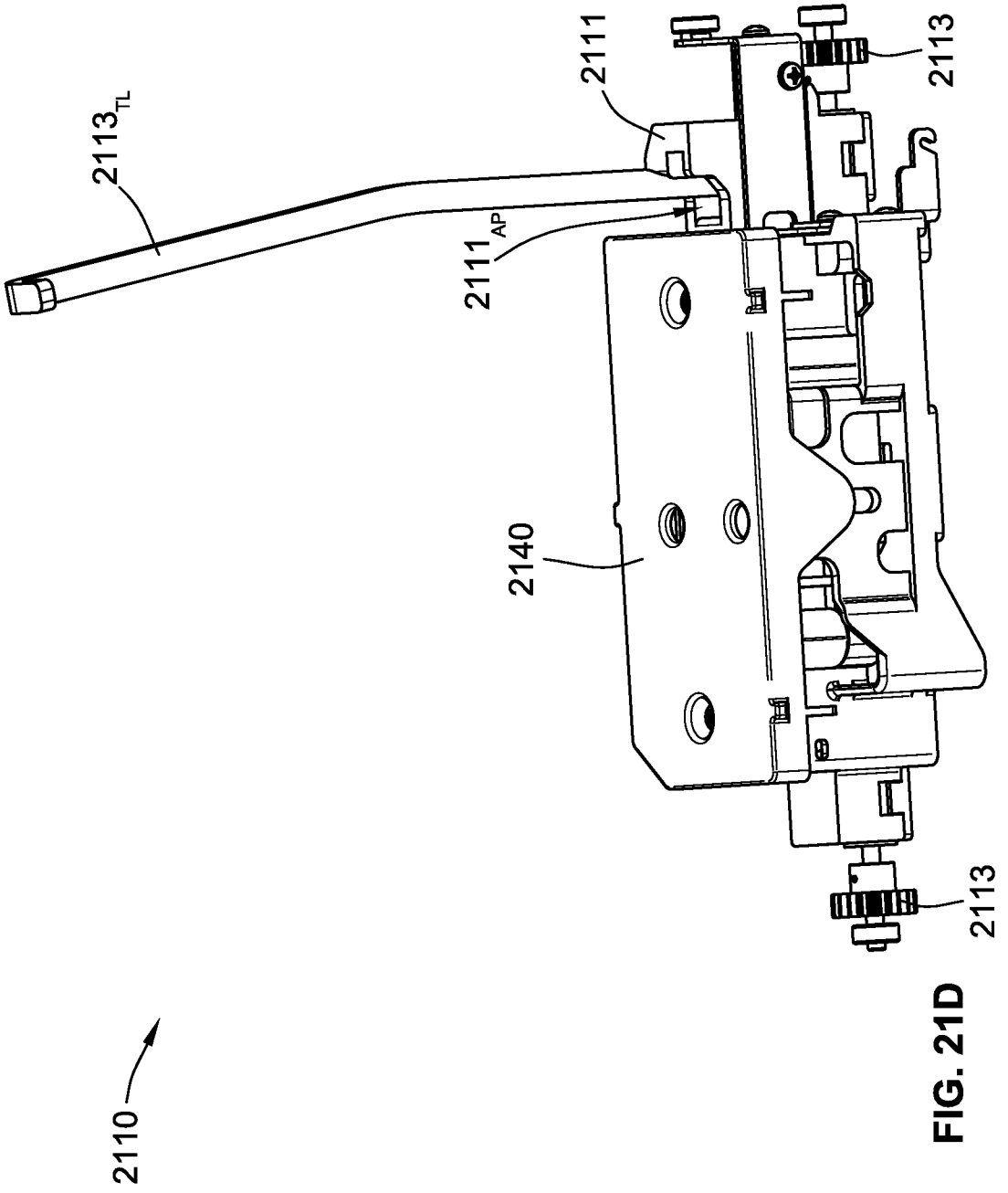

FIG. 21D

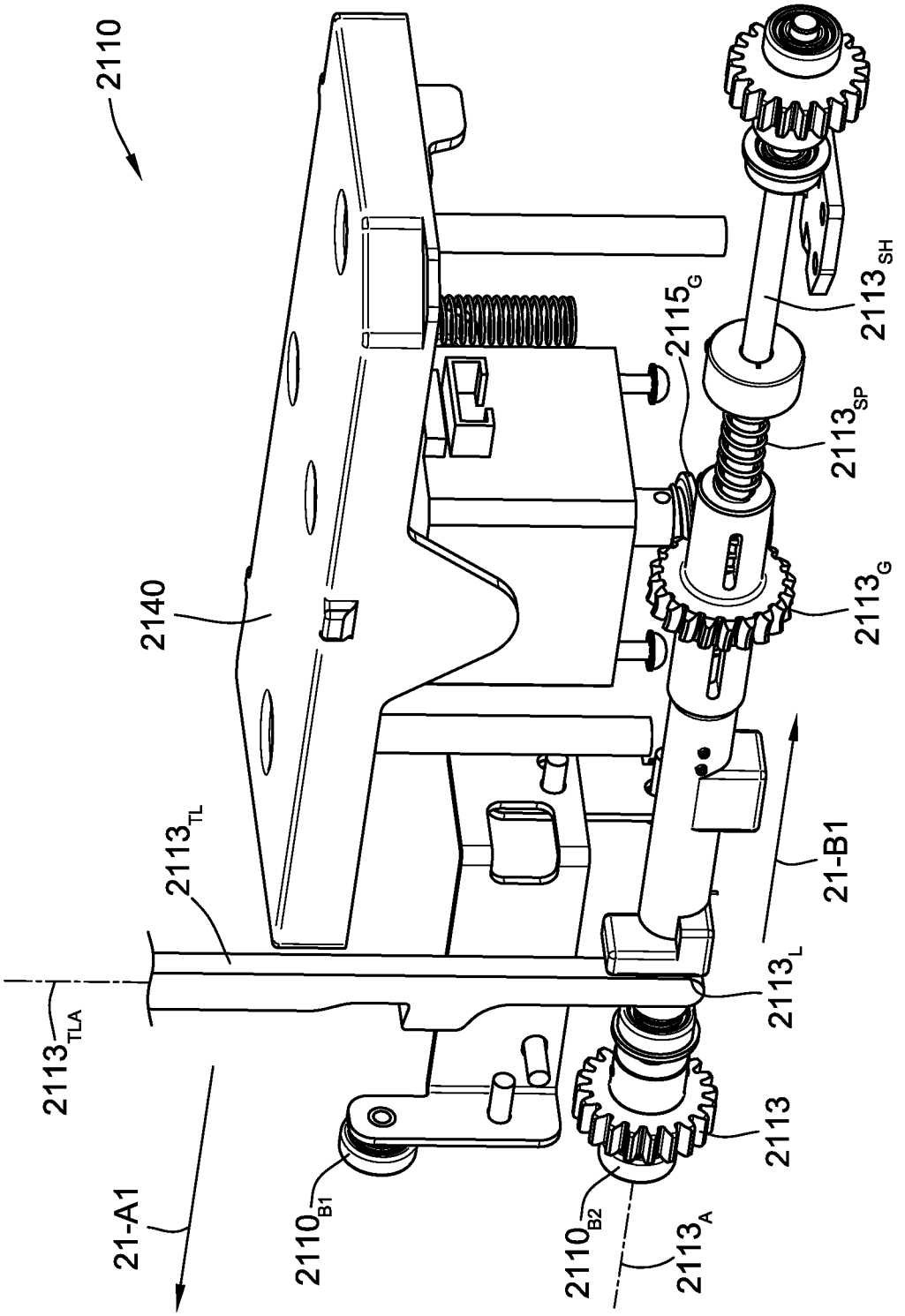
2110
2140
2115G
2113SH
2113SP
2113G
2113TL
21-B1
2113L
2113TLA
2113
21-A1
2110B1
2110B2
2113A

FIG. 21E

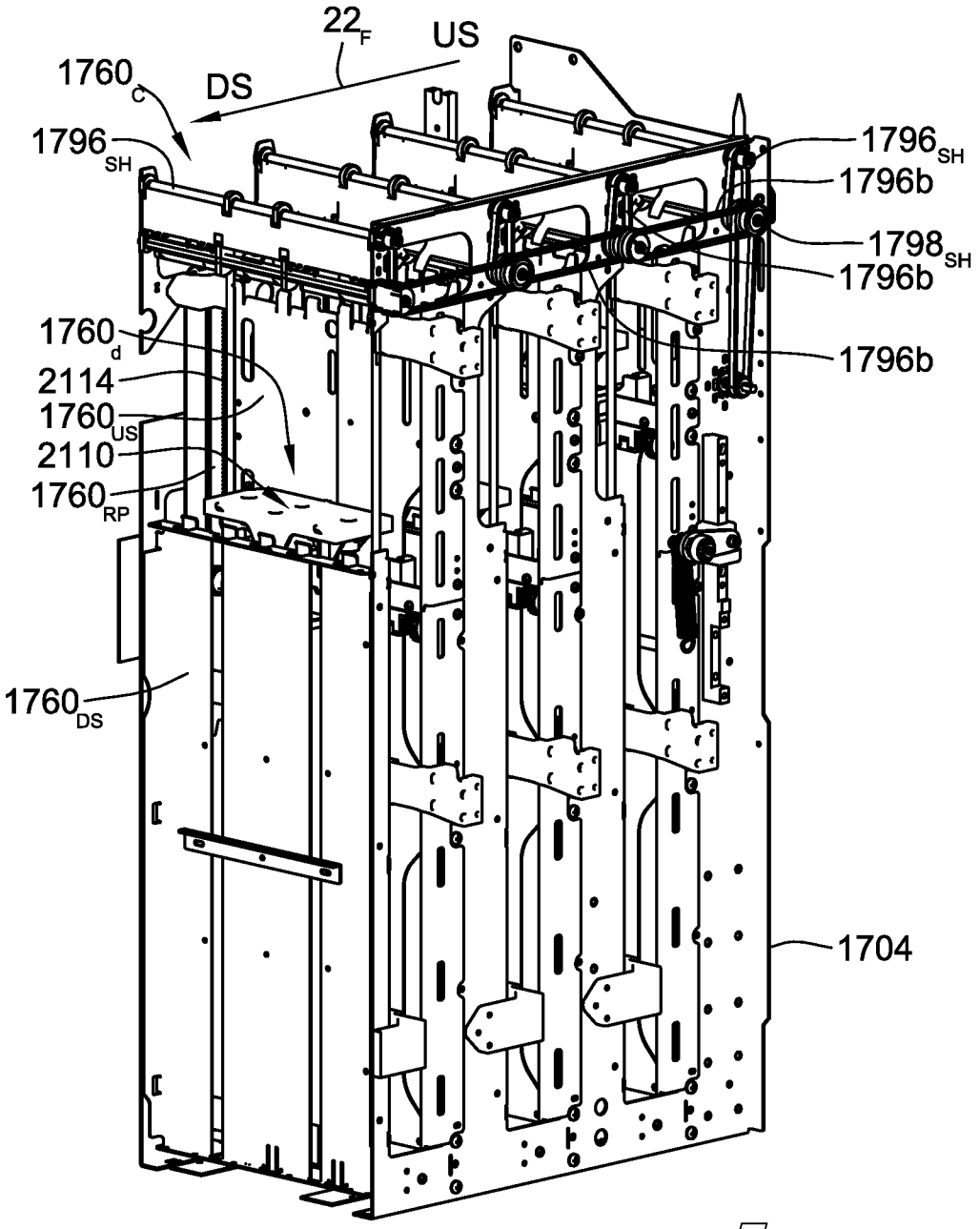
22F
US
1760C
DS
1796SH
1796SH
1796b
1798SH
1796b
1760d
1796b
2114
1760US
2110
1760RP
1760DS
1704
Z
Y
X

FIG. 22A

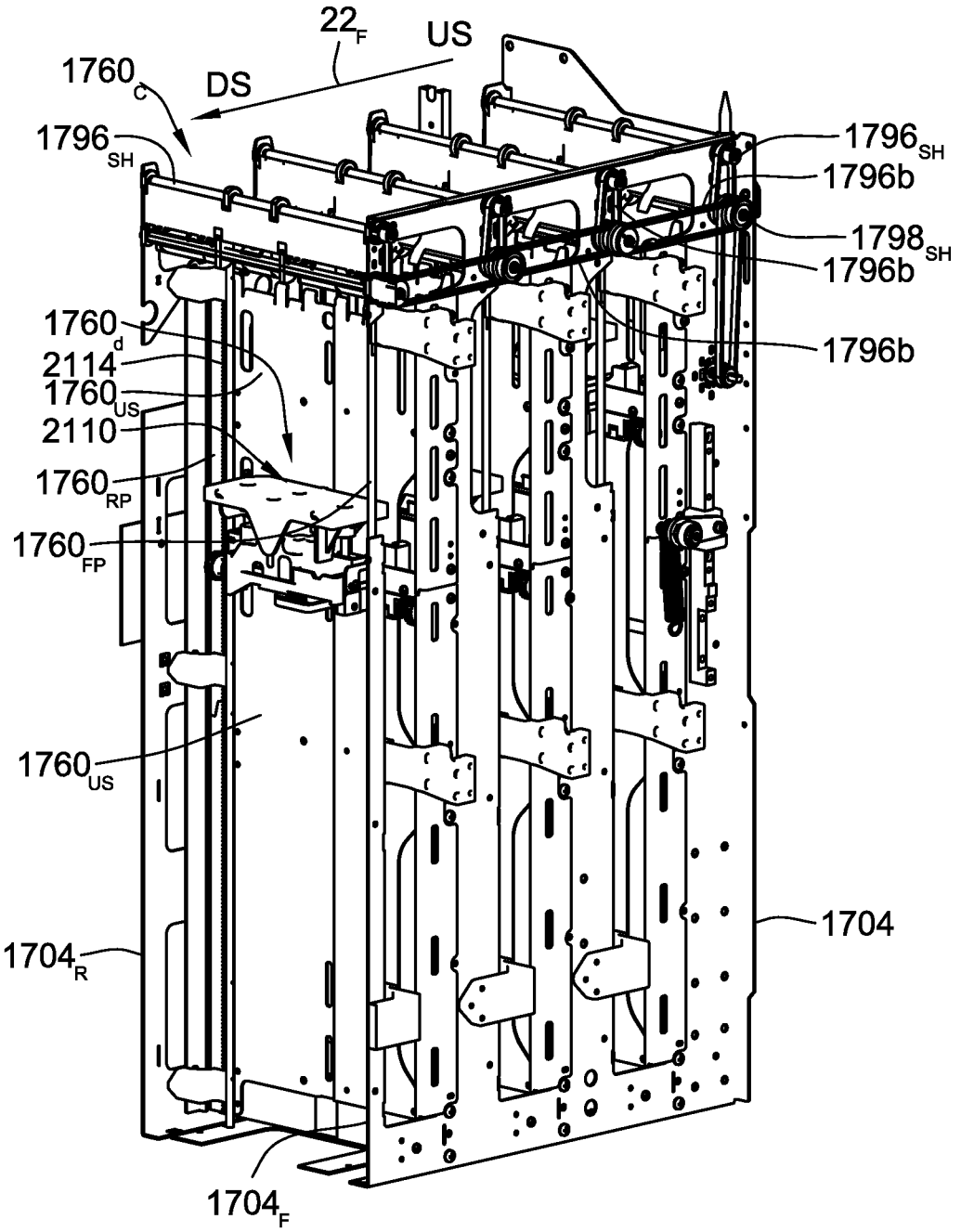
22F
US
1760C
DS
1796SH
1796SH
1796b
1798SH
1796b
1760d
1796b
2114
1760US
2110
1760RP
1760FP
1760US
1704
1704R
1704F

FIG. 22B

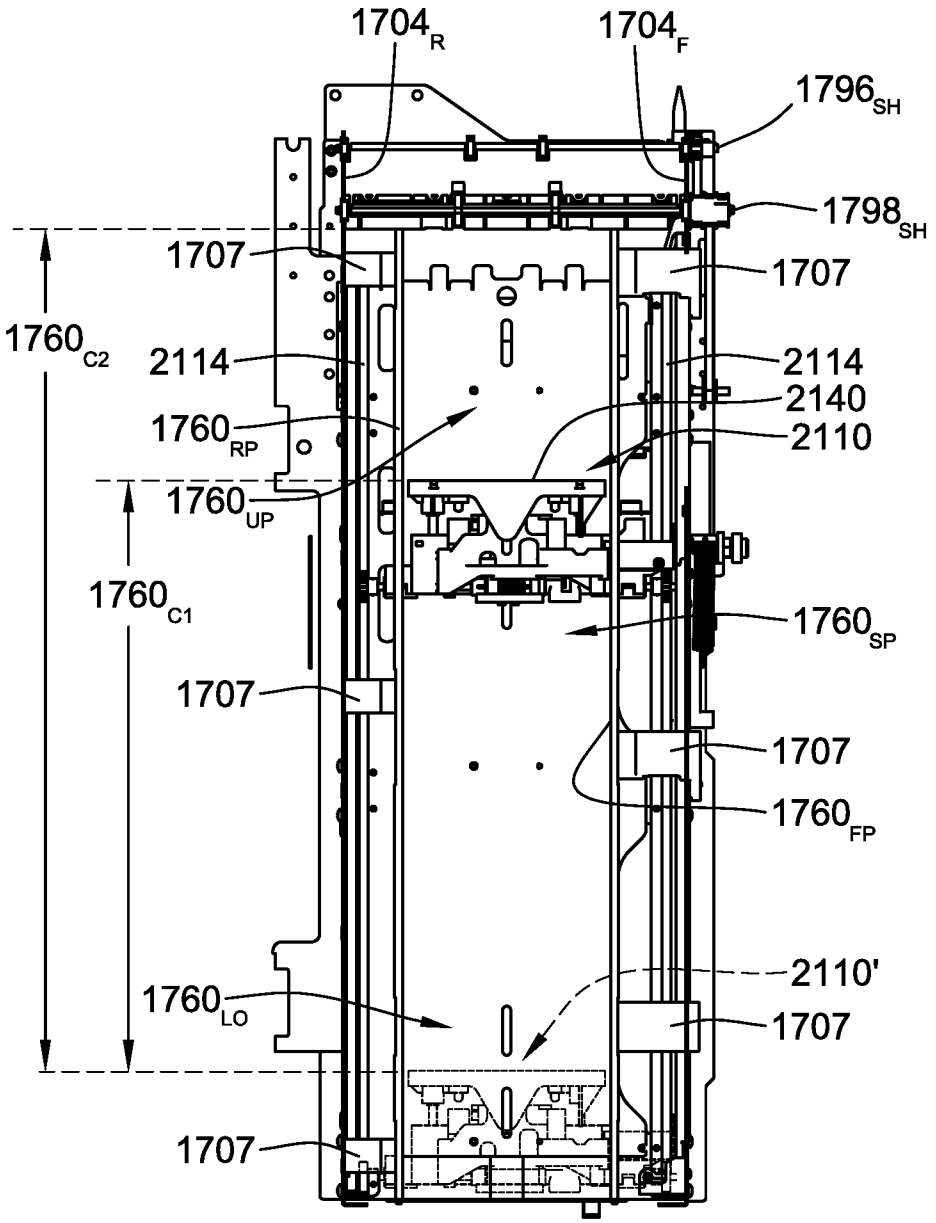
1704R
1704F
1796SH
1798SH
1707
1707
1760C2
2114
2114
2140
1760RP
2110
1760UP
1760C1
1760SP
1707
1707
1760FP
2110'
1760LO
1707
1707

FIG. 22C

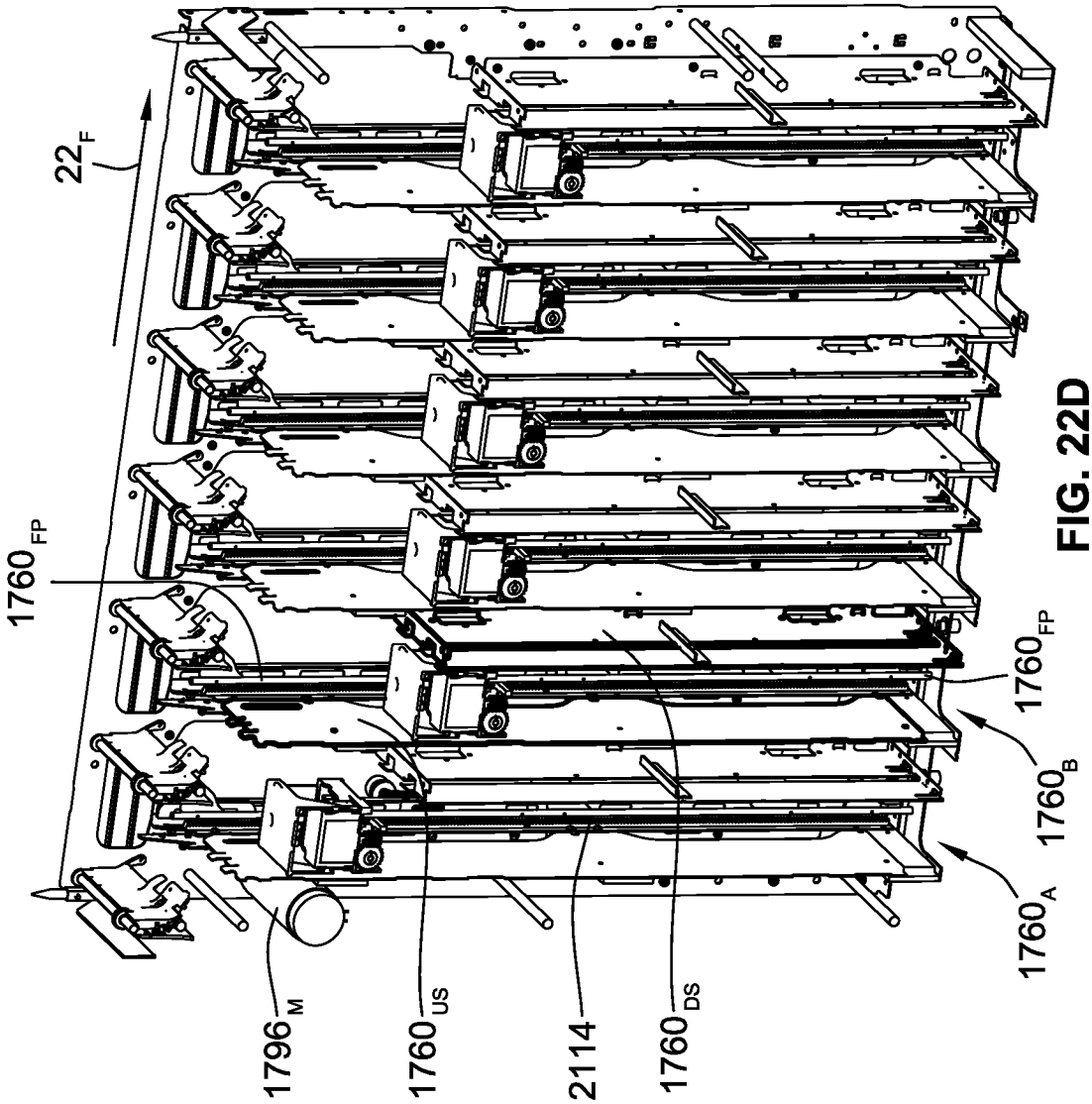

FIG. 22D

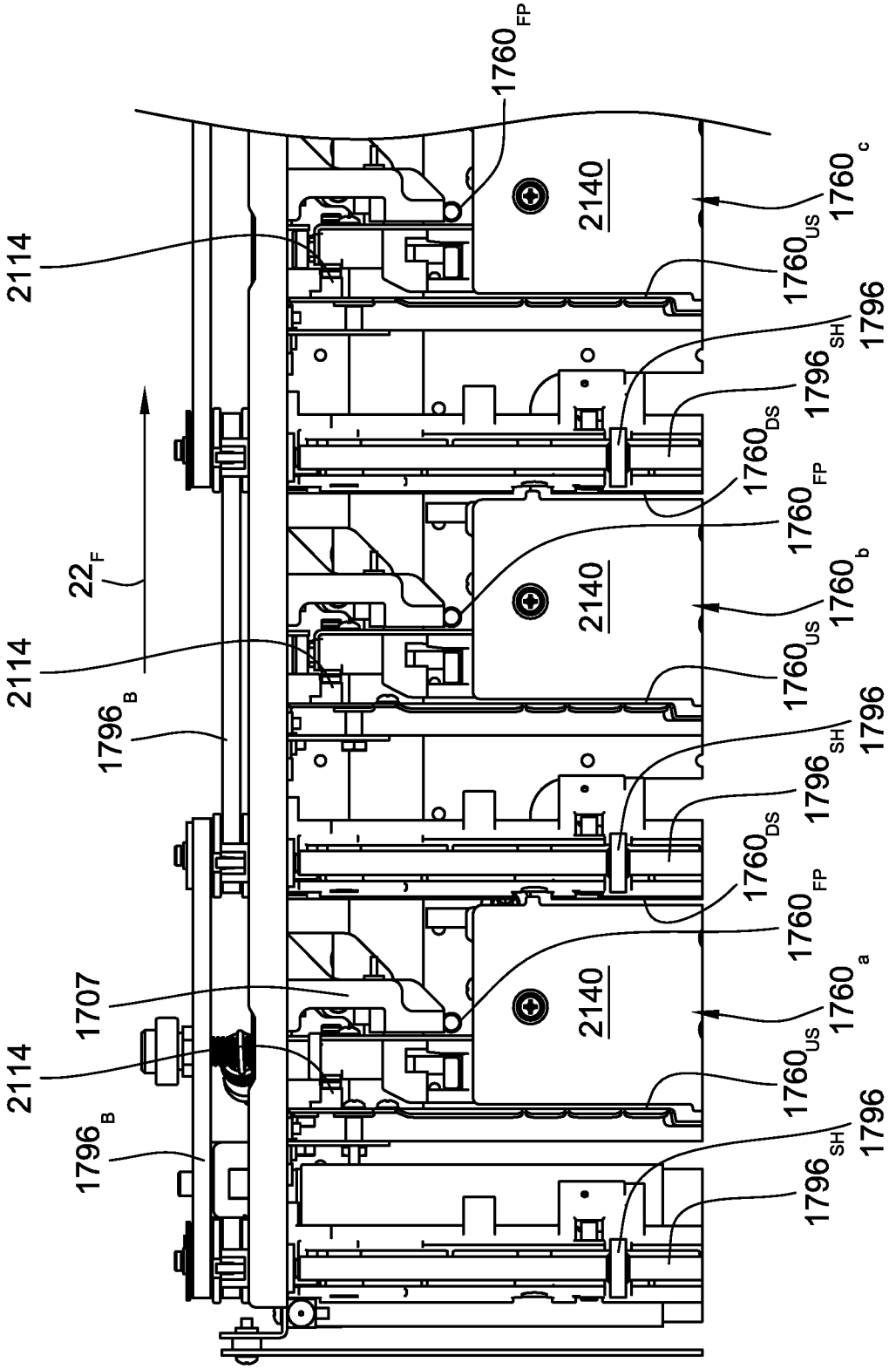
1760FP
2140
1760c
1760US
2114
1796SH
1796
1760DS
1760FP
22F
1760b
1760US
2114
1796B
1796SH
1796
1760DS
1760FP
1707
1760a
1760US
2114
1796B
1796SH
1796

FIG. 22E

BANKNOTE RECYCLER

CLAIM OF PRIORITY AND CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority to U.S. Provisional Patent Application No. 62/553,305 filed on Sep. 1, 2017, incorporated herein by reference in its entirety.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates generally to banknote or currency bill processing, and more particularly to apparatuses and systems for accepting, storing, and dispensing banknotes and related methods.

BACKGROUND OF THE DISCLOSURE

[0003] Previous currency processing devices have various shortcomings.

SUMMARY

[0004] According to some embodiments, a generally vertical banknote recycling bay arrangement comprises a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end. According to some embodiments, the recycling bay arrangement comprises an elevator having at least one retractable banknote support. The elevator is configured to move upward and downward within and/or adjacent the recycler bay and the retractable banknote support is configured to move into and out of the recycling bay. The banknote recycling bay arrangement may further comprise a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay. The banknote recycling bay arrangement may further comprise a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the lower end of the recycling bay.

[0005] According to some embodiments, during operation in which banknotes are to be sequentially fed into the recycling bay, the at least one retractable banknote support is extended into the recycling bay so as to provide a structure on which banknotes may be stacked within the recycling bay and wherein the elevator is raised to a level so as to facilitate the stacking of banknotes being fed into the recycling bay, one on top of the other on the at least one retractable banknote support and wherein the elevator is lowered as banknotes are fed into the recycling bay so that the top of the stack of banknotes residing within the recycling bay and onto which incoming banknotes are stacked remains at about the same level.

[0006] According to some embodiments, prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to the bottom of the recycling bay if no banknotes reside at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon a bottom surface of the recycling bay.

[0007] According to some embodiments, prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to a location adjacent the top of a stack of banknotes resting on the bottom of the recycling bay if there are banknotes already residing at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon the top of the stack of banknotes already residing at the bottom of the recycling bay.

[0008] According to some embodiments, the banknote dispensing assembly comprises a pair of stripping wheels supported for rotational movement about a driven stripping wheel shaft, a pair of drive rolls, and a pair of nip rollers.

[0009] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1**A is a schematic view of a banknote recycler according to some embodiments of the present disclosure;

[0011] FIG. **1**B is a schematic view of the banknote recycler of FIG. **1**A operating in a Currency Denominator/Counter Mode;

[0012] FIG. **1**C is a schematic view of the banknote recycler of FIG. **1**A operating in an Escrow Mode;

[0013] FIG. **1**D is a schematic view of the banknote recycler of FIG. **1**A operating in an Escrow-to-Accept Mode;

[0014] FIG. **1**E is a schematic view of the banknote recycler of FIG. **1**A operating in a Dispense Mode;

[0015] FIG. **1**F is a schematic view of the banknote recycler of FIG. **1**A operating in an Internal Audit Mode;

[0016] FIG. **1**G is a schematic view of a banknote recycler according to some embodiments of the present disclosure;

[0017] FIG. **1**H is a schematic view of a banknote recycler according to some embodiments of the present disclosure having a banknote cassette receiving port or container dock;

[0018] FIG. **2** is a functional block diagram of a banknote recycler according to some embodiments of the present disclosure;

[0019] FIG. **3**A is a front perspective view of a banknote recycler storage bay according to some embodiments of the present disclosure having an elevator positioned near the top of the bay;

[0020] FIG. **3**B is a front view of the banknote recycler storage bay of FIG. **3**A.

[0021] FIG. **3**C is a side sectional of the banknote recycler storage bay of FIG. **3**B taken along line **3**C-**3**C in FIG. **3**B;

[0022] FIG. **3**D is a perspective sectional view of a banknote recycler storage bay of FIG. **3**B taken along line **3**C-**3**C in FIG. **3**B;

[0023] FIG. **3**E is a left side view, FIG. **3**F is a right side view, and FIG. **3**G is a rear view of the banknote recycler storage bay of FIG. **3**A with the elevator **510** positioned at a lower location.

[0024] FIG. **4**A is a front perspective view of the banknote recycler storage bay of FIG. **3**A with the elevator **510** located near the middle of the storage bay;

[0025] FIG. **4**B is a front perspective view of the banknote recycler storage bay of FIG. **3**A with the elevator **510** located near the bottom of the storage bay;

[0026] FIG. **5**A is rear perspective view, FIG. **5**B is a front top perspective view, and FIG. **5**C is a top view of an elevator according to some embodiments;

[0027] FIG. **5**D is a sectional view of the elevator of FIG. **5**C taken along line **5**D-**5**D;

[0028] FIG. **5**E is a perspective view of a banknote support according to some embodiments;

[0029] FIG. **5**F is rear perspective view and FIG. **5**G is a front top perspective view and of an elevator according some embodiments.

[0030] FIG. **5**H is a front sectional view of the elevator of FIG. **5**F taken along axis $\mathbf{542}_A$ shown in FIG. **5**F.

[0031] FIG. **5**I is a front sectional view of the elevator of FIG. **5**F taken along axis $\mathbf{513}_A$ shown in FIG. **5**F.

[0032] FIG. **5**J is a perspective view of a banknote support according to some embodiments.

[0033] FIGS. **6**A and **6**B are front perspective views of a portion of transport paths and their related transport mechanism components in an open, non-operational position located on top of a banknote recycling bay.

[0034] FIG. **6**C is a front view of a portion of transport paths and their related transport mechanism components of FIGS. **6**A-**6**B in a closed, operational position.

[0035] FIG. **7** is a front perspective view of six storage bays of a banknote recycler according to some embodiments of the present disclosure;

[0036] FIG. **8**A is a front perspective view of a banknote recycler storage bay according to some embodiments of the present.

[0037] FIG. **8**B is a perspective sectional view of a banknote recycler storage bay taken along line **8**B-**8**B in FIG. **8**A;

[0038] FIG. **8**C is a side sectional view of a banknote recycler storage bay taken along line **8**B-**8**B in FIG. **8**A;

[0039] FIG. **8**D is a side view of a banknote recycler storage bay mounted in a storage bay frame.

[0040] FIG. **8**E is a side sectional view of the banknote recycler storage bay of FIG. **8**D omitting the left side frame and the left side wall of the storage bay.

[0041] FIG. **9**A is a rear perspective view of an alternate embodiment of an elevator, FIG. **9**B is a front side perspective view of the elevator **910** of FIG. **9**A, and FIG. **9**C is a perspective view of a banknote support for use with the elevator of FIGS. **9**A and **9**B.

[0042] FIGS. **10**A-**10**D are perspective views of a banknote recycler storage bay according to some embodiments of the present disclosure having an alternate embodiment of an elevator;

[0043] FIGS. **11**A-**11**C are sectional views of a generally vertical recycling bay arrangement comprising a banknote recycler storage bay or recycling bay **1160** according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme.

[0044] FIGS. **12**A-**12**B are perspective views of a generally vertical recycling bay arrangement comprising a banknote recycler storage bay or generally vertically oriented banknote recycling bay **1260** according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme.

[0045] FIGS. **13**A and **13**B are a front perspective views and FIG. **13**C is a side sectional view of a banknote recycler storage bay according to some embodiments of the present disclosure.

[0046] FIG. **14**A is a schematic view of a banknote recycler employing generally horizontal storage bays according to some embodiments of the present disclosure.

[0047] FIG. **14**B is a top view and FIG. **14**C is an end view of a generally horizontal storage bay employing banknote supports to support and move banknotes residing in the storage bay according to some embodiments of the present disclosure.

[0048] FIGS. **15**A and **15**B are sectional views of a generally horizontal recycling bay arrangement comprising a banknote recycler storage bay or recycling bay according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme.

[0049] FIGS. **16**A and **16**B are sectional views of a generally horizontal recycling bay arrangement comprising a banknote recycler storage bay or recycling bay according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme.

[0050] FIG. **17**A is a perspective view of components of a banknote recycler having six storage bays illustrating a portion of a main transport mechanism in an open, non-operational position according to some embodiments of the present disclosure.

[0051] FIG. **17**B is an end view of the banknote recycler of FIG. **17**A and FIG. **17**C is an enlarged view of a portion of FIG. **17**A.

[0052] FIG. **17**D is a further enlarged view of a feeder module of FIGS. **17**A-**17**C.

[0053] FIG. **17**E is a front view of a banknote recycler with a main transport mechanism in a closed position according to some embodiments of the present disclosure.

[0054] FIG. **17**F is cross-sectional view of upper ends of banknote recycling bays of the banknote recycler of FIG. **17**E.

[0055] FIG. **17**G is an enlarged view of a feeder module **1900** in an operational position above one of the recycling bays of the banknote recycler of FIG. **17**E.

[0056] FIG. **17**G**1** is an enlarged view similar to FIG. **17**G illustrating an in-feed transport path and an out-feed transport path for one of the recycling bays.

[0057] FIG. **17**H is an enlarged rear perspective view of a couple of recycling bays of the banknote recycler of FIG. **17**E having some components removed.

[0058] FIG. **18**A is a perspective view of a main transport mechanism in its closed, operational state or position, FIG. **18**B is a perspective view of the main transport mechanism **1820** in an open, non-operational state, FIG. **18**C is a downward perspective view of the main transport mechanism in an open, non-operational state, and FIG. **18**D is a rear perspective view of the main transport mechanism in its closed, operational state or position according to some embodiments of the present disclosure.

[0059] FIG. **18**E is an upward perspective view of a lower portion of the main transport mechanism according to some embodiments of the present disclosure.

[0060] FIG. **19**A is a perspective view illustrating an upstream, outfeed side, FIG. **19**B is a perspective view illustrating a downstream, infeed side, FIG. **19**C is a cross-sectional view, FIG. **19**D is a rear view, and FIG. **19**E is an

upward looking bottom perspective view of a feeder module according to some embodiments of the present disclosure.

[0061] FIG. **20**A is a perspective view of a stacker module having a pair of stacker wheels positioned at an inward, operational deposit or feed-in position and FIG. **20**B is cross-sectional view of the stacker module of FIG. **20**A in plane **20**B-**20**B indicated in FIG. **20**A according to some embodiments of the present disclosure.

[0062] FIG. **20**C is a perspective view of the stacker module having the pair of stacker wheels positioned at a transitional, non-operational position and FIG. **20**D is front view of select components of the stacker module of FIG. **20**C according to some embodiments of the present disclosure.

[0063] FIG. **20**E is a front view of the stacker module having the pair of stacker wheels positioned at an outward, non-operational dispense or feed-out position and FIG. **20**F is rear view of select components of the stacker module of FIG. **20**E according to some embodiments of the present disclosure.

[0064] FIG. **20**G is a perspective view of select components of the stacker module of FIG. **20**C.

[0065] FIG. **20**H is a sectional view of a stacker wheel subassembly according to some embodiments of the present disclosure.

[0066] FIG. **20**I is cross-sectional view of a stacker wheels base and linkage arm support mounted about a stacker wheel shaft according to some embodiments of the present disclosure.

[0067] FIG. **21**A is a side perspective view of a storage bay elevator, FIG. **21**B is an upward perspective view of the elevator of FIG. **21**A, and FIG. **21**C is a bottom perspective view of select components of the elevator of FIG. **21**A according to some embodiments of the present disclosure.

[0068] FIG. **21**D is a downward perspective view of the elevator of FIG. **21**A and an elevation shaft worm gear decoupling tool.

[0069] FIG. **21**E is side perspective view of the elevator of FIG. **21**D illustrating a use of the elevation shaft worm gear decoupling tool of FIG. **21**D.

[0070] FIG. **22**A is a cross-sectional perspective view of a banknote recycler chassis according to some embodiments of the present disclosure and FIG. **22**B is a similar view as that of FIG. **22**A but with a downstream wall of a storage bay removed.

[0071] FIG. **22**C is an end view of the storage bay shown in FIG. **22**B.

[0072] FIG. **22**D is a cross-sectional perspective view of a banknote recycler chassis according to some embodiments of the present disclosure taken at 90 degrees from the view of FIG. **22**A.

[0073] FIG. **22**E is a top view of a portion of the chassis shown in FIG. **22**D.

[0074] 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 OF THE ILLUSTRATED EMBODIMENTS

[0075] FIG. **1**A is a schematic view of a currency bill or banknote recycler **100** according to some embodiments and FIG. **2** is a functional block diagram of a banknote recycler **200** such as banknote recycler **100**, **100'**, **100"**, **1700** according to some embodiments. The banknote recycler comprises an input hopper **110** for receiving a banknote or a stack of banknotes or currency bills and a transport mechanism **120** for receiving banknotes from the input hopper **110** and delivering the banknotes to and from a number of locations in the banknote recycler. The banknote recycler further comprises a banknote detector section **130**. According to some embodiments, the banknote detector section **130** comprises one or more detectors for determining various information about banknotes transported past the detectors such as, for example, the denomination and/or authenticity of the banknotes. The output of the one or more detectors of the banknote detector section **130** may be used to count, denominate, authenticate, scan, image, determine the fitness of banknotes and/or other characteristics of banknotes such as described in more detail in U.S. Pat. No. 5,295,196 [Attorney Docket 247171-000072]; U.S. Pat. No. 5,640,463 [Attorney Docket 247171-000115]; U.S. Pat. No. 6,661,910 [Attorney Docket 247171-000186USC2]; U.S. Pat. No. 6,363,164 [Attorney Docket 247171-000187USC1]; U.S. Pat. No. 6,913,260 [Attorney Docket 247171-000368USPT]; U.S. Pat. No. 7,187,795 [Attorney Docket 247171-000298USPT]; U.S. Pat. No. 7,978,899 [Attorney Docket 247171-000440USPT]; and U.S. Pat. No. 8,538,123 [Attorney Docket 247171-000533USP1], each of which is incorporated herein by reference in its entirety. The recycler **100** also comprises one or more externally accessible output receptacles **140***a* and **140***b*. Banknotes delivered to the open, externally accessible output receptacles **140***a*, **140***b* may be removed by a user such as a bank teller reaching into the output receptacles **140***a*, **140***b* and grasping the banknotes with his or her hand. According to some embodiments, the output receptacles **140***a*, **140***b* comprise stacker wheels **142***a*, **142***b* to assist in stacking the banknotes into the output receptacles. In some modes of operation, the output receptacle **140***a* may be used as a reject output receptacle to which rejected banknotes are delivered such as, for example, a banknote or document whose denomination was not determined by the banknote detector section **130**.

[0076] According to some embodiments, the recycler **100** may further comprise a secure banknote storage bin **150**. In some modes of operation, the secure banknote storage bin **150** may be used to store banknotes which are determined to be counterfeit or mutilated using the one or more detectors in the banknote detector section **130**. According to some embodiments, the banknote recycler has a slot or opening in its housing permitting an operator such as a bank teller to insert banknotes (also referred to as bills or currency bills) into (but not withdraw bills from) the secure banknote storage bin **150**. For example, if an operator notices that a banknote to be processed is mutilated and may cause a jam if processed by the banknote recycler, the operator may directly put such notes through the slot in the housing so that such notes may be securely stored in the secure storage bin **150**. According to some embodiments, the operator may use an input/output interface **208** to enter information about the mutilated banknote(s) (such as the denomination and/or the serial number of each note) into the banknote recycler **100**

so that a processor or controller **202** may update information about the related transaction to reflect all bills in a transaction, e.g., so a customer may be given credit for the deposit of all banknotes deposited in a transaction, even those that are too mutilated to be automatically processed by the banknote recycler **100**.

[0077] The recycler **100** further comprises one or more banknote storage or recycle bins or bays **160***a*-**160***f*. According to some embodiments, the first storage bay **160***a* is used as an escrow storage bay to temporarily hold banknotes being deposited into the banknote recycler **100** as will be described in more detail below. According to some embodiments, the remaining storage bays **160***b*-**160***f* are each dedicated to specific denominations of banknotes, e.g., storage bay **160***b* may be assigned to store US $1 bills, storage bay **160***c* may be assigned to store US $5 bills, storage bay **160***d* may be assigned to store US $10 bills, storage bay **160***e* may be assigned to store US $20 bills, storage bay **160***f* may be assigned to store US $100 bills. Note, according to some embodiments, the recycler **100** may comprise fewer or more than six storage bays **160***a*-**160***f*.

[0078] According to some embodiments, the storage bays **160***a*-**160***f* reside within a housing of the recycler **100** having one or more security doors. The housing and security door(s) serve as a safe and may be made of high strength material such as metal and/or hard plastic. The storage bays **160***a*-**160***f* are distinguishable from the output receptacles **140***a*, **140***b* in that the storage bays are secured within a housing of the recycler **100** and are not externally accessible to a typical user or operator such as a bank teller of the recycler **100** during normal operation of the recycler **100** such as during a deposit/escrow or dispense operation. Rather, to gain access to the storage bays **160***a*-**160***f* and the banknotes stored therein, a security door of the recycler must be opened. According to many embodiments, the security door is locked and may only be opened by authorized personnel having a key or access code enabling the security door to be unlocked such as an authorized service technician.

[0079] In the embodiment illustrated in FIG. **1**A, the storage bays **160***a*-**160***f* receive bills or banknotes at their top ends and dispense or feed out bills from their bottom ends. In such embodiments, banknotes are handled in a first-in, first-out (FIFO) manner. According to some embodiments, the storage bays **160***a*-**160***f* comprises dispensers **170***a*-**170***f* to dispense or feed out bills from the respective storage bins **160***a*-**160***f* According to some embodiments, storage bays of the banknote recycler **100** may handle banknotes in a last-in, first-out (LIFO) manner.

[0080] In the embodiment illustrated in FIG. **1**A, stacker wheels **162***a*-**162***f* assist in stacking bills into the respective the storage bays **160***a*-**160***f*.

[0081] FIG. **1**B is a schematic view of the banknote recycler **100** of FIG. **1**A operating in a Currency Denominator/Counter Mode. In this mode, the operation of the banknote recycler **100** may emulate the operation of a Cummins-Allison one or two output receptacle JetScan® currency denominator or counter such as a JetScan® model 4065 or 4095 currency denominator. Examples of the operation of currency denominators are described in more detail in U.S. Pat. No. 5,815,592 [Attorney Docket 247171-000131]; U.S. Pat. No. 6,311,819 [Attorney Docket 247171-000174]; U.S. Pat. No. 7,187,795 [Attorney Docket 247171-000298USPT]; and U.S. Pat. No. 8,538,123 [Attorney Docket 247171-000533USP1], each of which is incorporated herein by reference in its entirety.

[0082] For example, in some embodiments, a stack of currency bills or banknotes is stacked in hopper **110**. Banknotes in hopper **110** are fed, one after the other in a one at a time, seriatim manner, into a first transport path **120***a* of the transport mechanism **120** and then through the banknote detector section **130**. The output of one or more sensors or detectors in the banknote detector section **130** are used to image, count, denominate, and/or authenticate the banknotes and/or to determine other characteristics of the banknotes passing through the banknote detector section **130**. The banknotes are then fed out of the banknote detector section **130** along transport path **120***b* and then are directed to output receptacle transport path **120***c* via diverter **143** and then into one or more of the output receptacles **140***a*, **140***b*. Information about the banknotes received in hopper **110** and/or delivered to one or more of the output receptacles **140***a*, **140***b* such as, for example, the total value of the banknotes, the number or value of each denomination of banknote may be communicated to the operator or user of the banknote recycler **100** such as via a display, touchscreen, speaker, and/or other input/output device **208**. According to some embodiments, output receptacle **140***a* is used as a reject output receptacle and banknotes rejected (e.g., those whose denomination could not be determined, i.e., no call bills or notes) are delivered to output receptacle **140***a*. Banknotes that are acceptable (e.g., those that have been successfully denominated and authenticated) are delivered to output receptacle **140***b*. According to some embodiments, banknotes that are determined to be counterfeit may not be returned to the user or operator via output receptacles **140***a*, **140***b* but instead may be delivered to a secure storage bin **150** accessible only to authorized personnel. Bills or banknotes to be delivered to secure storage bin **150** are not delivered to transport path **120***c* but instead are directed by diverter **143** along storage bay transport path **120***d* and are diverted from storage bay transport path **120***d* by diverter **151** into secure storage bin **150**.

[0083] FIG. **1**C is a schematic view of the banknote recycler **100** of FIG. **1**A operating in an Escrow Mode. Escrow Mode operates similar to the Currency Denominator/Counter Mode described in connection with FIG. **1**B, however, instead of delivering banknotes that are accepted (e.g., those that have been successfully denominated and authenticated) to externally accessible output receptacle **140***b*, such banknotes are delivered to a first internal storage bin or bay **160***a* by being diverted off of storage bay transport path **120***d* via diverter **161***a*. According to some embodiments, the Escrow Mode is used as a preliminary step in depositing banknotes into the banknote recycler **100**. For example, an operator such as a bank teller may receive a stack of banknotes from a bank customer who wishes to deposit the banknotes into his or her bank account. The bank teller places the stack of banknotes into the input hopper **110** of the banknote recycler. Assuming no banknotes are rejected to reject output receptacle **140***a* or sent to secure storage bin **150**, all banknotes in the stack are denominated and delivered into the escrow storage bay **160***a*. Information about the bills or banknotes to be deposited such as the total value of the banknotes is communicated to the bank teller and/or customer via an interface **208**. If the customer and/or bank teller, wishes to continue with the deposit, the bank teller places the machine into the Escrow to Accept Mode

(e.g., by pressing or selecting an ACCEPT key, e.g., via a touching an ACCEPT selection element on a touch screen) as will be described in connection with FIG. **1**D below.

[0084] If the customer and/or bank teller does not wish to continue with the deposit, then the bank teller may cancel the deposit transaction (e.g., by pressing or selecting an CANCEL key, e.g., via a touching a CANCEL selection element on a touch screen) and banknotes in the escrow bay **160***a* are fed out of the escrow bay **160***a* using dispenser **170***a* onto return transport path **120***e* of the transport mechanism **120**. According to some embodiments, the banknotes are then routed along transport path **120***a* through the banknote detector section **130** again and then to output receptacle **140***b*. The user or bank teller may then retrieve the banknotes. Although not shown, the transport mechanism **120** may be provided with a banknote detector section **130** by-pass transport path connecting transport paths **120***a* and **120***b* and/or transport paths **120***e* and **120***b* without going through the banknote detector section **130**.

[0085] FIG. **1**D is a schematic view of the banknote recycler **100** of FIG. **1**A operating in an Escrow-to-Accept Mode. In general, in the Escrow-to-Accept Mode, banknotes are delivered from the escrow storage bay **160***a* and then sorted by denomination into the one or more of the denomination specific storage bays **160***b*-**160***f*. For example, from the Escrow Mode described above, when an ACCEPT key is pressed or selected, banknotes in the escrow bay **160***a* are fed out of the escrow bay **160***a* onto return transport path **120***e* via dispenser **170***a*. According to some embodiments, the banknotes are then routed along transport path **120***a* through the banknote detector section **130** again and then to storage bay transport path **120***d*. According to some embodiments, banknotes are denominated again based on information detected from the banknotes via the detectors in banknote detector section **130**.

[0086] According to some embodiments, information about each banknote (such as the denomination of each banknote) has already been determined before the banknotes were stored in the escrow storage bin **160***a* and this information has been stored in a memory **204** of the banknote recycler **100**. In some such embodiments, the denomination of each bill as determined as a result of the second pass through the banknote detector section **130** is compared to the denomination of each bill as determined as a result of an earlier pass through the banknote detector section **130** where the results of that earlier determination were stored in the memory **204** of the banknote recycler **100**. When the determined denomination of a banknote as determined in a second pass does not agree with the denomination of the banknote as determined in a first or earlier pass, a processor **202** of the banknote recycler may generate an error signal. In contrast, in some such embodiments, the banknotes are not re-scanned when passing through the banknote detector section **130** a second time, but instead, the information about each banknote stored in memory **204** is used to determine to which storage bay **160***b*-**160***f* each banknote is to be sent. Alternatively, in some such embodiments, the banknotes are re-scanned when passing through the banknote detector section **130** a second time, and the information about each banknote as determined during the second pass through the banknote detector section **130** is what is used to determine to which storage bay **160***b*-**160***f* each banknote is to be sent without using any information regarding the banknotes previously collected.

[0087] Although not shown, the transport mechanism **120** may be provided with a banknote detector section **130** by-pass transport path connecting transport paths **120***a* and **120***b* and/or transport paths **120***e* and **120***b* without going through the banknote detector section **130** and banknotes may by-pass the banknote detector section **130** on their way to storage bay transport path **120***d* and the information about each banknote previously stored in memory **204** is used to determine to which storage bay **160***b*-**160***f* each banknote is to be sent.

[0088] Once the banknotes have been delivered to the storage bay transport path **120***d*, diverters **161***b*-**161***e*, under the control of a controller **202**, direct the banknotes into an appropriate one of the storage bays **160***b*-**160***f* based on, for example, the denomination of each banknote. For example, US $1 bills may be delivered into storage bay **160***b*, US $5 bills may be delivered into storage bay **160***c*, US $10 bills may be delivered into storage bay **160***d*, US $20 bills may be delivered into storage bay **160***e*, and US $100 bills may be delivered into storage bay **160***f*.

[0089] FIG. **1**E is a schematic view of the banknote recycler **100** of FIG. **1**A operating in a Dispense Mode. In general, in the Dispense Mode, banknotes are delivered from one or more of the denomination specific storage bays **160***b*-**160***f* and then to one or more of the externally accessible output receptacles **140***a*, **140***b*. In embodiments for which output receptacle **140***a* is used as a reject output receptacle, in the Dispense Mode, banknotes are delivered from one or more of the denomination specific storage bays **160***b*-**160***f* to the externally accessible output receptacle **140***b*.

[0090] In operation, if a user or operator such as bank teller wished to dispense a certain amount of money, e.g., $270, the user places the banknote recycler into the Dispense Mode (e.g., via selecting a Dispense Mode key or selection element via an input/output interface **208** of the banknote recycler **100**). The input/output interface **208** may then prompt the user as to the amount to be dispensed (e.g., $270) and/or the specific breakdown by denomination desired to be dispensed [e.g., a) two $100 banknote, three $20 banknotes, and one $10 banknote or b) thirteen $20 banknotes and one $10 banknote]. A processor or controller **202** of the banknote recycler then causes the appropriate number of banknotes from the appropriate ones of the storage bays **160***b*-**160***f* to be fed out of the storage bays **160***b*-**160***f* onto return transport path **120***e* via dispensers **170***b*-**170***f*.

[0091] For example, where storage bay **160***b* stores US $1 bills, storage bay **160***c* stores US $5 bills, storage bay **160***d* stores US $10 bills, storage bay **160***e* stores US $20 bills, and storage bay **160***f* stores US $100 bills, and a dispense request for $270 is made, two $100 banknotes from storage bay **160***f* may be fed onto return transport path **120***e*, three $20 banknotes from storage bay **160***e* may be fed onto return transport path **120***e*, and one $10 banknote from storage bay **160***d* may be fed onto return transport path **120***e*. A controller or processor **202** of the banknote recycler may control the feeding of bills from the storage bays **160***b*-**160***f* onto the return transport path **120***e* such as by controlling dispensers **170***b*-**170***f* and/or the operation of the transport path **120***e* so that banknotes are arranged on the transport path **120***e* in a non-overlapping manner. Thus, for example, if a banknote has been transported onto return transport path **120***e* from an upstream storage bay, e.g., bay **160***d* relative to bay **160***e*, and the banknote from the upstream bay is passing a

downstream bay, the processor or controller **202** would monitor the movement and location of every banknote on the transport paths and delay, if necessary, the dispensing of a banknote from a downstream bay, e.g., bay **160***e* in the above example, until the banknote(s) from the upstream bay or bays has past the point along the transport path **120***e* at which a banknote from the downstream bay would enter the transport path **120***e*. To aid in this control, the transport mechanisms may have a plurality of transport detectors adjacent of various locations along the various transport paths to monitor the movement and location of banknotes being transported along the transport paths by the transport mechanisms and the output of the transport detectors is coupled to one or more controllers or processors such as controller or processor **202**. According to some embodiments, the banknotes are then routed along transport path **120***a* through the banknote detector section **130** and then to output receptacle **140***b*. The user or bank teller may then retrieve the banknotes. According to some embodiments, banknotes are denominated based on information detected from the banknotes via the detectors in banknote detector section **130**. According to some embodiments, information about each banknote (such as the denomination of each banknote) has already been determined before the banknotes were stored in the escrow storage bin **160***a* and/or storage bays **160***b*-**160***f* and/or the denomination of each banknote is presumed based on the storage bay **160***b*-**160***f* from which it was dispensed and this information has been stored in the memory **204** of the banknote recycler **100**. In some such embodiments, the denomination of each bill as determined as a result of the pass through the banknote detector section **130** in the Dispense Mode is compared to the denomination of each bill as determined as a result of an earlier pass through the banknote detector section **130** where the results of that earlier determination where stored in the memory **204** of the banknote recycler **100** (and/or based on a presumed denomination based on the storage bay **160***b*-**160***f* from which a banknote was dispensed). When the determined denomination of a banknote as determined during the Dispense Mode does not agree with the denomination of the banknote as determined in a first or earlier pass (and/or based on a presumed denomination based on the storage bay **160***b*-**160***f* from which a banknote was dispensed), a processor **202** of the banknote recycler may generate a Denomination Mismatch error signal. According to some embodiments, a banknote triggering a Denomination Mismatch error signal is routed to and stored in secure bin **150** and not dispensed via output receptacle **140***a* or **140***b*. According to some embodiments, when a Denomination Mismatch error signal is generated, a banknote triggering a Denomination Mismatch error signal is routed to and stored in secure bin **150** and a replacement banknote is dispensed from the appropriate storage bay **160***b*-**160***f* onto return transport path **120***e* and to output receptacle **140***a* or **140***b*.

[0092] Although not shown, the transport mechanism **120** may be provided with a banknote detector section **130** by-pass transport path (such as via connecting transport paths **120***a* and **120***b*) without going through the banknote detector section **130**. In such embodiments, the denomination of each banknote is presumed to be the denomination associated with the particular storage bay **160***b*-**160***f* from which it was dispensed and/or based on the denomination previously determined by the banknote recycler and stored in memory **204**.

[0093] FIG. **1**F is a schematic view of the banknote recycler **100** of FIG. **1**A operating in an Internal Audit Mode. In general, in the Internal Audit Mode, banknotes are delivered from one or more of the denomination specific or mixed denomination storage bays **160***b*-**160***f*, through the banknote detector section **130** and then back into the one or more of the denomination specific storage bays **160***b*-**160***f*. The memory **204** of the banknote recycler **100** keeps track of how many bills are stored in each of the denomination specific storage bays **160***b*-**160***f* and/or their denominations. The Internal Audit Mode, is a mode which enables an operator of the banknote recycler **100** to have the banknote recycler double check to verify that the banknotes expected to be stored in one or more or all of the specific storage bays **160***b*-**160***f* are actually stored therein.

[0094] In operation, a user or operator such as bank teller or a bank manager places the banknote recycler into the Internal Audit Mode (e.g., via selecting an Internal Audit Mode key or selection element via an input/output interface **208** of the banknote recycler **100**). A processor or controller **202** of the banknote recycler then causes all the banknotes from the desired one or more or all of the storage bays **160***b*-**160***f* to be fed out of the storage bays **160***b*-**160***f* onto return transport path **120***e* via dispensers **170***b*-**170***f*. According to some embodiments, the processor or controller **202** keeps track of how many banknotes are dispensed from each of the storage bays **160***b*-**160***f* and/or their denominations and updates a total value counter and/or individual denomination counters. For example, where storage bay **160***b* has ten (10) US $1 bills stored therein, storage bay **160***c* has zero (0) US $5 bills stored therein, storage bay **160***d* has zero (0) US $10 bills stored therein, storage bay **160***e* has one hundred (100) US $20 bills stored therein, and storage bay **160***f* has five (5) US $100 bills stored therein, these banknotes are dispensed in an orderly, non-overlapping manner onto the return transport path **120***e*. During the dispensing process, the processor or controller **202** counts that ten (10) US $1 bills have been dispensed from storage bay **160***b*, zero (0) US $5 bills have been dispensed from storage bay **160***c*, zero (0) US $10 bills have been dispensed from storage bay **160***d*, one hundred (100) US $20 bills have been dispensed from storage bay **160***e*, and five (5) US $100 bills have been dispensed from storage bay **160***f* and/or that a total of $2510 and/or a total of 115 banknotes have been dispensed from storage bays **160***b*-**160***f*.

[0095] The banknotes are then routed to transport path **120***a* and through or past the banknote detector section **130**. The banknotes are denominated based on information detected from the banknotes via the detectors in banknote detector section **130**. According to some embodiments, information about each banknote (such as the denomination of each banknote) has already been determined before the banknotes were stored in the escrow storage bin **160***a* and/or storage bay **160***b*-**160***f* and/or the denomination of each banknote is presumed based on the storage bay **160***b*-**160***f* from which it was dispensed and this information has been stored in the memory **204** of the banknote recycler **100**. In some such embodiments, the denomination of each bill as determined as a result of the pass through the banknote detector section **130** in the Internal Audit Mode is compared to the denomination of each bill as determined as a result of an earlier pass through the banknote detector section **130** where the results of that earlier determination where stored in the memory **204** of the banknote recycler **100** (and/or

based on a presumed denomination based on the storage bay **160***b*-**160***f* from which a banknote was dispensed). When the determined denomination of a banknote as determined during the Internal Audit Mode does not agree with the denomination of the banknote as determined in a first or earlier pass (and/or based on a presumed denomination based on the storage bays **160***b*-**160***f* from which a banknote was dispensed), a processor **202** of the banknote recycler may generate a Denomination Mismatch error signal. According to some embodiments, a banknote triggering a Denomination Mismatch error signal is routed to and stored in secure bin **150**.

[0096] The denominated banknotes are then deposited back into the appropriate storage bays **160***b*-**160***f* via transport path **120***b*, storage bay transport path **120***d* and diverters **161***b*-**161***e*. During the depositing process, the processor or controller **202** counts how many banknotes are delivered into each storage bay **160***b*-**160***f*. In the above example, when no error occurs, the processor **202** would count that ten (10) US $1 bills have been deposited into storage bay **160***b*, zero (0) US $5 bills have been deposited into storage bay **160***c*, zero (0) US $10 bills have been deposited into storage bay **160***d*, one hundred (100) US $20 bills have been deposited into storage bay **160***e*, and five (5) US $100 bills have been deposited into storage bay **160***f* and/or that a total of $2510 and/or a total of 115 banknotes have been deposited into storage bays **160***b*-**160***f*.

[0097] When an error condition occurs during the Internal Audit Mode, the processor or controller **202** may generate the appropriate error signal(s) and message(s) and report the details of the error condition(s) to the user or operator of the banknote recycler **100** via the input/output interface **208**. For example, in the above example when ten (10) US $1 bills were expected to reside in storage bay **160***b* but only nine (9) US $1 bills are dispensed from storage bay **160***b*, counted using the sensors of the banknote detector section **130** and re-deposited back into storage bay **160***b* during the operation of the banknote recycler in the Internal Audit Mode, an error condition and/or message may be generated by the processor or controller **202** to communicate to the operator that ten (10) US $1 bills were expected to reside in storage bay **160***b* but only nine (9) US $1 bills were dispensed from and re-deposited into storage bay **160***b*, and one (1) $1 bill is missing from storage bay **160***b*. According to some embodiments, the processor or controller **202** communicates the error condition via the interface **208** which may include a display and/or printer and/or a communication interface to communicate the information to a communication network such as the internet and/or an intranet or a local communication network.

[0098] In a similar fashion, when no error occurs in the Internal Audit Mode, the processor or controller **202** may generate the appropriate confirmation signal(s) and/or message(s) and/or report the details of the number, value, and/or breakdown of banknotes stored in the banknote recycler and/or a signal and/or message to the user or operator of the banknote recycler **100** via the input/output interface **208** that number, value, and/or breakdown of banknotes expected to be stored in the banknote recycler bays **160***b*-**160***f* matches the number, value, and/or breakdown of banknotes determined to be in the banknote recycler bays **160***b*-**160***f* during the Internal Audit Mode. According to some embodiments, the processor or controller **202** to communicates a confirmation (match or no error) condition via the interface **208** which may include a display and/or printer and/or a communication interface to communicate the information to a communication network such as the internet and/or an intranet or a local communication network.

[0099] According to some embodiments, the banknote recycler **100** may be programmed or configured to automatically place itself into and execute the Internal Audit Mode. For example, the banknote recycler processor **202** may be programmed to run at 2:00 a.m. each morning or after each time the safe/vault is accessed (i.e., after the security door(s) of the housing of the recycler **100** have been opened and closed/locked again). Such automatic auditing can be employed to catch a loss or shortage of banknotes.

[0100] According to some embodiments, the banknote recycler **100** is configured to sit on the floor or on a counter between two operators such as between two bank tellers and to be operable by either operator from two different sides of the banknote recycler **100**. According to some embodiments, the banknote recycler is configured to perform only one transaction at a time, such as a deposit transaction or a dispense (or withdrawal) transaction such as at a bank. According to some embodiments, the banknote recycle is made compact. For example, according to some embodiments, the storage bay pitch **160***p* of the storage bays **160***a*-**160***f* (that is the horizontal distance between the same component in adjacent storage bays **160***a*-**160***f*) is less than 7 inches (18 cm). For example, referring to FIG. **1**A the storage bay pitch **160***p* is illustrated as the horizontal distance between the center of the stacker wheel **162***e* and the center of adjacent storage bay stacker wheel **162***f*. As another example, referring to FIG. **1**A the storage bay pitch **160***p* is illustrated as the horizontal distance between the center of a stripping or auxiliary wheel **374***a* of storage bay **160***a* and the center of adjacent stripping auxiliary wheel **374***b* in storage bay **160***b*. Stripping or auxiliary wheels **374** are described more below such as in connection with FIG. **3**C. According to some embodiments, the storage bay pitch **160***p* is less than 6 inches (16 cm). According to some embodiments, the storage bay pitch **160***p* is about 5¼ inches (13.3 cm).

[0101] According to some embodiments, banknotes are scanned by the banknote detector section **130** both when banknotes are being inserted or deposited into the banknote recycler **100** and when banknotes are being dispensed from the banknote recycler **100**. According to some embodiments, banknotes are scanned by the banknote detector section **130** when banknotes are being inserted or deposited into the banknote recycler **100** but not when banknotes are being dispensed from the banknote recycler **100**. According to some embodiments, the banknote recycler has two banknote detector sections **130**. For example, FIG. **1**G is a schematic view of a banknote recycler **100'** according to some embodiments of the present disclosure having a second banknote detector section **130'**. When banknotes are being dispensed from storage bays **160***a*-**160***f*, they may be alternatively routed to transport path **120***f* via a diverter **161***f*, through the second banknote detector section **130'** and to output receptacle **140***c* which may comprise stacker wheels **142***c*. Otherwise, the banknote recycler **100'** may be the same as banknote recycler **100**. According to some such embodiments, banknote recycler **100'** may be configured to process a deposit transaction simultaneously with a withdrawal or dispense transaction. For example, the banknote recycler may be operated in a Feed-to-Escrow mode or Escrow

Accept Mode as discussed above in connection with FIGS. **1**C and **1**D (such as at the request of a first bank teller) and be simultaneously be operated in a Dispense mode (such as at the request of a second bank teller) where banknotes to be dispensed are routed to output receptacle **140***c*.

[0102] According to some embodiments, banknotes of a plurality of denominations may be stored in a single banknote storage bay **160***b*-**160***f*. For example, both $50 banknotes and $100 banknotes may be stored in storage bay **160***f* according to some embodiments. According to some such embodiments, the memory **204** and/or the processor **202** keeps track of the denomination of every banknote in the storage bay **160***f* (e.g., that the bottom ten bills are $100 banknotes, the next five bills are $50 bills, the next bill is a $100 bill, and the top three bills are $50 bills). This information may then be used by the banknote recycler when it is desired to dispense a $50 or $100 bill with the banknote recycler instructing the dispenser **170***f* to dispense the appropriate number of bills to reach the desired denomination of banknote (e.g., if one $50 is requested to be dispensed, the banknote recycler **100**, via processor **202**, instructs the dispenser to dispense eleven (11) banknotes from storage bay **160***f*, route the first ten notes bank into the storage bay **160***f* and route the eleventh bill to output receptacle **140***b*). Alternatively, the banknote recycler (via the processor **202** and/or memory **204**) may keep track that $50 and $100 notes are to be stored in storage bay **160***f* but not the order of the denominations stacked therein. In such embodiments, the processor **202** may instruct the dispenser **170***f* to begin dispensing bills and route the bills through the banknote detector section **130** whereby the denomination of each note is determined. When a banknote of a desired denomination is detected, it is routed to output receptacle **140***b*, otherwise banknotes having undesired denominations are routed back to the storage bay from which they were dispensed. According to some embodiments, banknotes may not be sorted by denominations but instead banknotes of mixed denominations are stored in one or more of the storage bays **160***b*-**160***f* and the memory **204** and/or the processor **202** may keep track of the denomination of every banknote in the storage bays **160***b*-**160***f* and the order they are stored in each storage bay **160***b*-**160***f*. For example, deposited banknotes may be stored in storage bay **160***b* until that storage bay **160***b* reaches its capacity and then deposited banknotes are stored in the next storage bay **160***c* until that storage bay **160***c* reaches its capacity, etc.

[0103] According to some embodiments, the first storage bay **160***a* is used as an escrow storage bay as discussed above. According to some embodiments, in place of or in addition to the first storage bay, the banknote recycler **100** has a banknote cassette receiving port or interface or container dock **180**. FIG. **1**H is a schematic view of a banknote recycler **100"** according to some embodiments of the present disclosure having a banknote cassette receiving port or container dock **180**. According to some such embodiments, a cassette or automated banknote container containing banknotes may be inserted into the cassette port **180** and used to fill the storage bays **160***b*-**160***f* with banknotes or additional banknotes. For example, if the banknote recycler **100"** was running low on $20 bills, a cassette containing $20 bills may be inserted into the port **180** of the banknote recycler **100"** and the banknote recycler **100"** may be placed in an Intake mode via an operator using interface **208**. The port **180** may comprise a dispenser **170-1** similar to dispensers **170***a*-**170***f*. Banknotes would be fed out of the cassette onto banknote return path **120***e*, through the banknote detectors section **130** and into the appropriate storage bay(s) **160***a*-**160***f* such as based on the determined denomination of each banknote.

[0104] According to some such embodiments, the banknote cassette receiving port **180** may be used to remove banknotes in bulk from the banknote recycler **100"**, such as for example, when the banknote recycler **100"** has more than a desired number of banknotes stored therein, e.g., such as more than 1900 notes of a given denomination. An empty banknote cassette may be inserted into the banknote cassette receiving port, and an operator may place the banknote recycler into an appropriate mode, e.g., a Bulk Dispense Mode, and provide instructions to the banknote recycler via the input/output interface **208** as to what notes are to be routed into the cassette, e.g., 1000 $1 bills or all bills in storage bay **160***c*. The appropriate banknotes would then be dispensed from the appropriate storage bays **160***a*-**160***f* and then into the cassette. The banknotes may be first routed through the banknote detector section **130** and the banknote recycler **100"** may determine their denominations and/or other characteristics of the banknotes prior to being routed into the cassette. Any dispensed banknotes not to be routed into the cassette may be routed back into an appropriate one of the storage bays **160***a*-**160***f*.

[0105] Additional details regarding cassettes, banknote containers, secured containers, and smart containers and banknote cassette receiving ports or interfaces or container docks **180** are disclosed in U.S. Pat. No. 9,141,876 [attorney docket 247171-000586USPT], and U.S. Pat. No. 7,600,626 [attorney docket 247171-000345USPT], each incorporated herein by reference in its entirety. According to some embodiments, filling and removing banknotes in bulk via secured cassettes and a banknote cassette receiving port **180** is not only faster but also more secure as it eliminates another point in the operation of the banknote recycler **100"** where a human is handling banknotes and/or banknotes in an unsecured location such as hopper **110** and/or output receptacles **140***a*, **140***b*. The increased security can be particularly advantageous when the banknote recycler is located in a location open to the public such as in a lobby of a bank. According to some embodiments, the banknote cassettes or containers are secured containers and/or smart containers as described in U.S. Pat. No. 9,141,876.

[0106] As mentioned above, FIG. **2** is a functional block diagram of a banknote recycler **200** such as banknote recycler **100**. According to some embodiments, the banknote recycler **200** comprises one or more processors and/or controllers **202** communicatively coupled to electronic components of the hopper **110** such as, for example, hopper sensor(s) and/or motor(s) used to drive stripping wheels and/or other rollers used to feed banknotes to transport path **120***a*. The one or more processors and/or controllers **202** are also communicatively coupled to electronic components of the transport mechanism **120** and related transport path flow detectors, banknote detectors **130**, diverters **143**, **151**, **161**, stacking wheels **142**, **162**, storage bay dispensers **170**, storage bay elevators **510**, a memory **204**, an encoder **206**, and/or interface **208**. Where the banknote recycler **200** comprises a plurality of processors and/or controllers **202**, they may be communicatively coupled to each other. According to some embodiments, the interface **208** comprises a display, keyboard, touchscreen, touchpad, mouse, speaker, microphone, voice recognition module, biometric

input device (e.g., fingerprint scanner, iris scanner, etc.) and/or other input/output devices. Examples of processors and/or controllers being communicatively coupled to and controlling the operation of various components of banknote handling devices such as input hoppers, banknote detectors, and transport mechanisms can be found in U.S. Pat. No. 5,815,592 [Attorney Docket 247171-000131] and U.S. Pat. No. 6,398,000 [Attorney Docket 247171-000246], each of which is incorporated herein by reference in its entirety.

[0107] FIG. **3**A is a front perspective view of a banknote recycler storage bay **360** according to some embodiments of the present disclosure having an elevator **510** positioned near the top of the bay. FIG. **3**B is a front view of the banknote recycler storage bay **360** of FIG. **3**A. FIG. **3**C is a side sectional view (with a retractable banknote support **540** shown in an extended position) and FIG. **3**D is a perspective sectional view of a banknote recycler storage bay **360** taken along line **3**C-**3**C in FIG. **3**B. FIG. **3**E is a left side view, FIG. **3**F is a right side view, and FIG. **3**G is a rear view of the banknote recycler storage bay **360** of FIG. **3**A with the elevator **510** positioned at a lower location. FIG. **4**A is a front perspective view of the banknote recycler storage bay of FIG. **3**A with the elevator **510** located near the middle of the storage bay. FIG. **4**B is a front perspective view of the banknote recycler storage bay of FIG. **3**A with the elevator **510** located near the bottom of the storage bay. FIG. **5**A is rear perspective view, FIG. **5**B is a front top perspective view, FIG. **5**C is a top view of the elevator **510** with banknote supports **540** being in an extended position. FIG. **5**D is a sectional view of elevator **510** taken along line **5**D-**5**D in FIG. **5**C. FIG. **5**E is a perspective view of a banknote support **540** according to some embodiments. The storage bay **360** is an example of a storage bay that may be used as the storage bays **160***a*-**160***f* of banknote recyclers **100**, **100'**, **100"**.

[0108] The banknote recycler storage bay **360** has an upper end $\mathbf{360}_{UP}$ and a lower end $\mathbf{360}_{LO}$ and a right side wall $\mathbf{360}_{RT}$ and a left side wall $\mathbf{360}_{LT}$. The storage bay **360** also has a back wall $\mathbf{360}_{BK}$ and two front walls $\mathbf{360}_{FT}$—one on the right side of the storage bay **360** and one of the left side of the storage bay **360**. The right side wall $\mathbf{360}_{RT}$, the left side wall $\mathbf{360}_{LT}$, the back wall $\mathbf{360}_{BK}$, and the two front walls $\mathbf{360}_{FT}$ help to contain stacked banknotes within the storage bay **360** and serve to define a banknote space $\mathbf{360}_{SP}$ of the storage bay **360**.

[0109] According to some embodiments, the back wall $\mathbf{360}_{BK}$ is separated from the two front walls $\mathbf{360}_{FT}$ by a distance less than the narrow dimension of the banknotes to be stacked therein such that the banknotes stacked therein are angled downwardly toward the back wall $\mathbf{360}_{BK}$ of the storage bay. According to some embodiments, the banknotes are stacked in the storage bay **360** at an angle of between about 10°-20°. For U.S. banknotes, the narrow dimension of the banknotes of all denominations is 2.61 inches (66 mm).

[0110] According to some embodiments, the stacking of the banknotes in the storage bay **360** at an angle relieves some of the weight of the banknotes which would otherwise by borne by a feeding plate **372**. In some such embodiments, the re-allocation of the bearing of the weight of some of the banknotes in the stack from the feeding plate **372** to one or more of the walls of the storage bay **360**, e.g., backwall $\mathbf{360}_{BK}$, increases the number of banknotes that may reside in the storage bay **360** and not have to be lifted up by the elevator **510** and banknote supports **540** prior to dispensing banknotes smoothly and at high speeds (e.g., at least 1000 banknotes per minutes). Such a process will be described in more detail below.

[0111] According to some embodiments, the banknotes are stacked horizontally within the storage bay **360** such as on banknote supports **540** and/or feeding plate **372** and not an angle from horizontal as discussed above.

[0112] According to some embodiments, the back wall $\mathbf{360}_{BK}$ has one or more low friction surfaces to enhance the ability of the edges of banknotes residing in the banknote storage bay **360** and abutting the backwall $\mathbf{360}_{BK}$ to easily slide up or down within the storage bay **360** as the result of the movement of the elevator **510** and/or the feeding out of banknotes from the bottom of the storage bay **360** as will be described in more detail below. According to some embodiments, low friction surfaces take the form of narrow low friction rails $\mathbf{360}_{SM}$ extending the height of the storage bay **360**. According to some embodiments, two to four low friction rails $\mathbf{360}_{SM}$ are positioned on the back wall $\mathbf{360}_{BK}$.

[0113] According to some embodiments, the storage bay **360** is vertical. According to some embodiments, the storage bay is off-set from being vertical by about 4°, e.g., the backwall $\mathbf{360}_{BK}$ and/or the front walls $\mathbf{360}_{FT}$ are tilted at or by at least an angle of about 4° from vertical. According to some embodiments, the storage bay is off-set from being vertical by about 2°-6°. According to some embodiments, the storage bay is off-set from being vertical by about 2°-8°. According to some embodiments, the storage bay is off-set from being vertical by least about 2°. According to some embodiments, the storage bay is off-set from being vertical by least about 6°. According to some embodiments, the storage bay is off-set from being vertical by least about 8°.

[0114] Positioned near the upper end $\mathbf{360}_{UP}$ of the storage bay **360** is an upper front banknote wall **330** having a banknote abutting surface $\mathbf{330}_{A}$ (see FIG. **3**C). According to some embodiments, positioned near the lower end $\mathbf{360}_{LO}$ of the storage bay **360** is a lower front banknote angled wall **332** having an angled banknote abutting surface $\mathbf{332}_{A}$. The upper front banknote wall **330** serves as an additional structure to maintain banknotes within the storage bay **360** while the banknotes are being stacked therein. According to some embodiments, the banknote angled wall **332** takes the form of a series of prongs having a plurality of spaces $\mathbf{332}_{SP}$ (see FIG. **3**B) which permit extended banknote supports **540** to be moved up and/or down near the bottom $\mathbf{360}_{LO}$ of the storage bay **360** as the elevator **510** moves up and/or down without contacting or being blocked by the angled wall **332**.

[0115] According to some embodiments, banknotes are stacked in the storage bay **360** with the aid of a pair of stacker wheels **362** mounted on a stacker wheel shaft $\mathbf{362}_{SH}$ which is rotationally driven by a motor **365**. The motor **365** is controlled by a controller or processor such as controller or processor **202**.

[0116] According to some embodiments, the angled banknote abutting surface $\mathbf{332}_{A}$ of the angled wall **332** serves to increase the angle at which bills are stacked in the storage bay **360** near the lower end $\mathbf{360}_{LO}$ of the storage bay **360** and urge the bills into greater contact with low friction rails $\mathbf{360}_{SM}$ on the back wall $\mathbf{360}_{BK}$ and into engagement with the input of a dispenser **370**. According to some embodiments, the angled banknote abutting surface $\mathbf{332}_{A}$ has a relatively high coefficient of friction, e.g., higher than that of the low friction rails $\mathbf{360}_{SM}$. Note, in FIG. **3**B, the upper front banknote wall **330** has been removed to aid in illustrating the

interior of the storage bay **360**. As can be seen in FIG. **3**C, according to some embodiments, the back wall $\mathbf{360}_{BK}$ is curved at the bottom $\mathbf{360}_{Cv}$. This curve assists in helping banknotes to fan out near the bottom of the storage bay **360** which in turn can facilitate the smooth feeding and separation of banknotes by the dispenser **370** so that they may be fed off the feeding plate **372** sequentially, one bill at a time.

[0117] The elevator **510** has a pair of driven elevation gears **513** (see e.g., FIG. **3**C and FIGS. **5**A-**5**D) that engage a pair of geared elevator tracks **314** (see e.g., FIGS. **3**A-**3**D) positioned on the outside of the two front walls $\mathbf{360}_{FT}$ of the storage bay **360**. The driven elevation gears **513** are driven by an elevation motor **515** coupled to the elevation gears **513**. The elevation motor **515** is communicatively coupled to and controlled by a controller or processor such as controller or processor **202**.

[0118] The elevator **510** has at least one retractable banknote support **540**. In the illustrated embodiment in FIGS. **3**A-**3**G and FIG. **5**A-**5**D, there are three retractable banknote supports **540** (see, e.g., FIGS. **3**C, **5**A and **5**B). Each retractable banknote support is moveable between at least two positions. A first position of each banknote support **540** is an extended position (as shown in FIGS. **3**C, **5**A and **5**B) wherein the banknote support extends into the storage bay **360** and defines a platform on which banknotes may be stacked and which can support a stack of banknotes. A stack of banknotes stacked on the banknote supports **540** can be moved up and down within the storage bay by the elevator **510** being moved up and down. A second position of each banknote support **540** is a retracted position wherein the banknote support **540** does not support a stack of banknotes in the banknote space $\mathbf{360}_{SP}$ of the storage bay.

[0119] In an exemplary embodiment, each banknote support **540** does not project into the banknote space $\mathbf{360}_{SP}$ of the storage bay when in its retracted position but instead is wrapped about a transverse axis and is stored in a compact generally coiled configuration like a window shade. Each banknote support **540** is driven between the extended position and the retracted position via a banknote support positional gear **542**. The banknote support positional gears **542** and/or the support drums (not shown, but see support drum or roller **547** in FIG. **5**H) about which the banknote supports **540** are rolled are in turn driven by a motor or solenoid **545** controlled by a controller or processor such as controller or processor **202**.

[0120] According to some embodiments, each of the banknote supports **540** is made of a relatively narrow strip of material that is designed to achieve an optimal balance between (a) the support strength of a platform defined by one or more banknote supports **540** when in the extended first position and (b) sufficient flexibility of the banknote supports **540** when in the retracted second position.

[0121] It has been found that a banknote support **540** made of metal having a thickness between 0.005" and 0.02" such as a thickness of approximately 0.01" is sufficiently flexible to be wrapped about itself when driven between the extended first position and the retracted second position. According to some embodiments, the banknote support is made of spring steel, but other materials could be used such as, for example, plastic.

[0122] In addition, the cross-section of each banknote support **540** is selected to maximize its bending stiffness in the extended first position. In one embodiment, each banknote support **540** is curled about a longitudinal axis such that in the extended first position it has a concave upward cross-sectional shape and defines an elongated upward opening channel to increase bending stiffness of the banknote support **540** independently of the thickness of the material from which the banknote support **540** is constructed. In this way, the resultant weight bearing capability of the platform that is defined by one or more of the banknote supports **540** when in the extended first position is increased without decreasing the flexibility of the banknote supports **540** when in the second retracted position.

[0123] Turning to FIGS. **5**A-**5**D, an example of an elevator **510** is illustrated in more detail. As discussed above, the elevator **510** comprises driven elevation gears **513** driven by an elevation motor **515** and banknote support positional gears **542** driven by a banknote support motor or solenoid **545**. Turning to FIG. **5**D, the driven elevation gears **513** are fixedly mounted on a rotatable elevation gear shaft $\mathbf{513}_{SH}$ which is rotatable about axis $\mathbf{513}_{A}$.

[0124] Banknote support motor or solenoid **545** is operatively coupled to a first **542-1** one of the banknote support positional gears **542** to cause the first banknote support positional gear **542-1** to rotate about an axis $\mathbf{542}_{A}$. The first banknote support positional gear **542-1** operatively engages a first transmission gear **543** fixedly coupled to a rotatable transmission shaft **541** to cause the first transmission gear **543** and the rotatable transmission shaft **541** to rotate. The rotatable transmission shaft **541** is rotatably mounted about elevation gear shaft $\mathbf{513}_{SH}$ and is configured to rotate independently from the rotation of the elevation gear shaft $\mathbf{513}_{SH}$. Both the rotatable transmission shaft **541** and the elevation gear shaft $\mathbf{513}_{SH}$ are rotatable about axis $\mathbf{513}_{A}$, albeit independently. Additional transmission gears **544** are fixedly mounted to the transmission shaft **541** proximate additional banknote support positional gears **542**. The rotation of the transmission shaft **541** causes the additional transmission gears **544** to cause the additional or remaining banknote support positional gears **542** to rotate about axis $\mathbf{542}_{A}$. As discussed above, the rotation of the banknote support positional gears **542** including the first banknote support positional gear **542-1** causes respective banknote supports **540** to move between a first, extended (wherein a respective banknote support extends into the storage bay **360** and provides a structure on which banknotes may be stacked) and a second position, retracted position (wherein the banknote support **540** does not project into the banknote space $\mathbf{360}_{SP}$ of the storage bay **360**).

[0125] According to some embodiments, when the banknote supports **540** are in their retracted position, they are rolled about themselves and about the transverse axis $\mathbf{542}_{A}$ like a tape measure or window shade when in its retracted position and stored within banknote support housings $\mathbf{540}_{H}$. Each banknote support drum (not shown, but see support drum or roller **547** in FIG. **5**H) and corresponding cover $\mathbf{540}_{H}$ cooperate such that a corresponding banknote support **540** may be extended and retracted with stress to the banknote support material in transition from straight to rolled being minimized. In general, the larger the diameter of the drum, the less stress that is placed on the banknote support material when it is rolled about the drum.

[0126] To aid in maintaining the banknote supports in a curled manner about a longitudinal axis $\mathbf{540}_{A}$ when in the extended position, the transmission shaft **541** comprises curved portions $\mathbf{541}_{C}$. The curved shaped of curved portion $\mathbf{541}_{C}$ is mirrored by a complimentary curved shape $\mathbf{590}_{C}$ of

a bottom elevator housing **590**. Each curved portion $\mathbf{541}_C$ and its complimentary curved shape $\mathbf{590}_C$ of a bottom elevator housing **590** is positioned adjacent a location at which a banknote support **540** emerges from a corresponding banknote housing $\mathbf{540}_H$ so that when the tip **540**T of a banknote support **540** emerges from its banknote housing $\mathbf{540}_H$ it is pressed between the curved portion $\mathbf{541}_C$ and its complimentary curved shape $\mathbf{590}_C$ of a bottom elevator housing **590** which serve to bend the banknote support about the longitudinal axis $\mathbf{540}_A$.

[0127] According to some embodiments, curved portions $\mathbf{541}_C$ and complimentary curved shape $\mathbf{590}_C$ of a bottom elevator housing **590** are omitted. Instead each bottom elevator housing or chassis **590** includes a concave shape which matches and is located below each banknote support **540** to ensure each banknote support **540** attains the correct shape and load-bearing capacity.

[0128] According to some embodiments, the banknote supports **540** may extend into the storage bays **360** in a horizontal manner. According to other embodiments, the banknote supports may extend into the storage bays **360** at an angle from the horizontal such as, for example, from 0°-5° or at an angle from the back wall $\mathbf{360}_{BK}$ such as, for example, from 0°-5°. According to some embodiments, the downward angle of the banknote supports **540** varies based on the vertical location of the elevator **510**. According to some embodiments, the banknote supports **540** are perpendicular to the two front walls $\mathbf{360}_{FT}$ of the storage bay **360** which may serve as a stripping wall when the elevator **510** is positioned at the upper end $\mathbf{360}_{UP}$ of a storage bay **360** for loading of banknotes onto the banknote supports **540**. When the elevator **510** and the banknote supports **540** are moved to the lower end $\mathbf{360}_{LO}$ of a storage bay **360**, the banknote supports **540** are tilted down from 0-5 degrees such as by employing a cam follower. The tilting downward of the banknote supports **540** aids in stacking the banknotes in the area near the angled banknote abutting surface $\mathbf{332}_A$ of the lower front banknote angled wall **332** and also helps avoid the banknotes from bridging across the storage bay **360**, i.e., between angled banknote abutting surface $\mathbf{332}_A$ and the low friction rails $\mathbf{360}_{SM}$ positioned on the back wall $\mathbf{360}_{BK}$. See, e.g., FIG. **3**C.

[0129] According to some embodiments, the elevator **510** also comprises one or more banknote drop-off detectors **520**. In operation, the banknote drop-off detector **520** senses when the elevator **510** and the banknote supports **540** are near or adjacent the top of a stack of banknotes (or the feeding plate **372**) residing below the elevator **510** and/or the banknote supports in the storage bay **360**. According to some embodiments, the drop-off detectors **520** employ a through light beam to detect the presence of banknotes, i.e., a light beam directed through a portion of the storage bay **360** and detected by a detector **520** wherein the presence of a banknote blocks the light beam from reaching the detector **520**. According to some embodiments, one or more other types of detectors **520** may be employed instead of a through light beam detector.

[0130] In FIG. **5**E, an example of a banknote support **540** is illustrated. According to some embodiments, the banknote support **540** has one or more apertures or holes **552** therein that mate with nubs on a support drum or roller (not shown, but see support drum or roller **547** in FIG. **5**H) residing in the housing $\mathbf{540}_H$.

[0131] Turning to FIGS. **5**F-**5**I, an example of an elevator **510'** is illustrated in more detail. The elevator **510'** is the same and its operation is the same as elevator **510** described above in connection with FIGS. **5**A-**5**D except that the transmission shaft **541'** does not comprises curved portions $\mathbf{541}_C$ as with transmission shaft **541**. Accordingly, the same or similar reference numbers are used for FIGS. **5**F-**5**I for the same or similar components. FIG. **5**F is rear perspective view and FIG. **5**G is a front top perspective view and of the elevator **510'** with banknote supports **540'** being in an extended position. FIG. **5**H is a front sectional view of elevator **510** taken along axis $\mathbf{542}_A$ shown in FIG. **5**F. FIG. **5**I is a front sectional view of elevator **510** taken along axis $\mathbf{513}_A$ shown in FIG. **5**F. FIG. **5**J is a perspective view of a banknote support **540'** according to some embodiments. In FIG. **5**J, another example of a banknote support **540'** is illustrated as employed in elevator **510'** of FIGS. **5**F-**5**I According to some embodiments, the banknote support **540'** has one or more apertures or holes **552** therein that mate with nubs on a support drum or roller **547** (see FIG. **5**H) residing in the housing $\mathbf{540}_H$'. Banknote support **540'** comprises a bend $\mathbf{540}_E$ which transitions the banknote support **540'** from being generally flat in a transverse direction to being curved in the transverse direction—being curved upward about longitudinal axis $\mathbf{540}_A$. The bend $\mathbf{540}_E$ assists the banknote support **540'** in curving about longitudinal axis $\mathbf{540}_A$ without the use of the curved portions $\mathbf{541}_C$ of transmission shaft **541**. As with banknote supports **540**, according to some embodiments, when the banknote supports **540'** are in their retracted position, they are rolled about themselves and about the transverse axis $\mathbf{542}_A$ like a tape measure or window shade when in its retracted position and stored within banknote support housings $\mathbf{540}_H$'.

[0132] Turning back to FIGS. **3**A-**3**G and especially FIG. **3**C, at the bottom of the storage bay **360** is a dispenser **370**. The dispenser **370** comprises a feeding plate **372** which forms a bottom surface of the storage bay **360** and serves as a surface on which a stack of banknotes in the storage bay may be placed. During a dispensing operation, banknotes or bills that are stacked on the feeding plate **372** are stripped, one at a time, from the bottom of the stack. The bills are stripped by a pair of stripping wheels **374** mounted on a stripping wheel driven shaft $\mathbf{374}_{SH}$ which, in turn, is supported across the side walls $\mathbf{360}_{LT}$, $\mathbf{360}_{RT}$. The stripping wheels **374** project through a pair of slots formed in the feeding plate **372**. According to some embodiments, part of the periphery of each stripping wheel **374** is provided with a raised high-friction surface $\mathbf{374}_{SR}$ which engages the bottom bill of the stack as the stripping wheels **374** rotate, to initiate feeding movement of the bottom bill from the stack. The high-friction surfaces $\mathbf{374}_{SR}$ may project radially beyond the rest of the wheel peripheries so that the stripping wheels "jog" the bill stack during each revolution so as to agitate and loosen the bottom currency bill within the stack, thereby facilitating the stripping of the bottom bill from the stack.

[0133] The stripping wheels **374** feed each stripped bill into engagement with a drive roll **375** mounted on a driven drive roll shaft $\mathbf{375}_{SH}$ supported across the side walls $\mathbf{360}_{LT}$, $\mathbf{360}_{RT}$. As described and illustrated in more detail in U.S. Pat. No. 5,815,592 [Attorney Docket 247171-000131], incorporated herein by reference in its entirety, the drive roll **375** may include a central smooth friction surface $\mathbf{375}_{SM}$ formed of a material such as rubber or hard plastic. This

smooth friction surface **375**$_{SM}$ is sandwiched between a pair of grooved surfaces **375**$_{GR}$ having high-friction portions formed from a high-friction material.

[0134] The high-friction surfaces engage each bill after it is fed into engagement with the drive roll **375** by the stripping wheels **374**, to frictionally advance the bill into the narrow arcuate passageway formed by a curved guideway **378** adjacent the rear side of the drive roll **375**. The rotational movement of the drive roll **375** and the stripping wheels **374** may be synchronized so that the high-friction surfaces on the drive roll **375** and the stripping wheels **374** maintain a constant relationship to each other. Moreover, according to some embodiments, the drive roll **375** is dimensioned so that the circumference of the outermost portions of the grooved surfaces is greater than the width W of a bill, such as the width of the widest bill to be stacked in a corresponding storage bay **360**, so that the bills advanced by the drive roll **375** are spaced apart from each other. That is, each bill fed to the drive roll **375** is advanced by that roll only when the high-friction surfaces come into engagement with the bill, so that the circumference of the drive roll **375** determines the spacing between the leading edges of successive bills.

[0135] According to some embodiments, the drive roll **375** and the stripping wheels **374** are driven by motor **390** controlled by a controller or processor such as controller or processor **202**. As shown in FIG. **3**F, according to some embodiments, stripping wheel driven shaft **374**$_{SH}$ is rotatably driven via belt **377** coupled to motor shaft **390**$_{SH}$ which is rotatably driven by motor **390** and the driven drive roll shaft **375**$_{SH}$ is rotatably driven via belt **373** coupled to motor shaft **390**$_{SH}$ which is rotatably driven by motor **390**.

[0136] According to some embodiments, to avoid the simultaneous removal of multiple bills from the stack in the storage bay **360**, particularly when small stacks of bills are loaded into the storage bay **360**, the stripping wheels **374** may be always stopped with the raised, high-friction portions **374**$_{SR}$ positioned below the feeding plate **372** of the storage bay **360**. This is accomplished by continuously monitoring the angular position of the high-friction portions of the stripping wheels **374** via an encoder such as encoder **206**, and then controlling the stopping time of the drive motor so that the motor always stops the stripping wheels **374** in a position where the high-friction portions **374**$_{SR}$ are located beneath the feeding plate **372** of the storage bay **360**.

[0137] According to some embodiments, in order to ensure firm engagement between the drive roll **375** and the currency bill or banknote being fed, an idler roll **376** urges each incoming bill against the smooth central surface **375**$_{SM}$ of the drive roll **375**. The idler roll **376** is journalled on a pair of arms which are pivotally mounted on a support shaft **379**$_{SH}$. Also mounted on the shaft **379**$_{SH}$, on opposite sides of the idler roll **376**, are a pair of grooved guide wheels or retard rollers **379**. Grooves in these two wheels **379** are registered with the central ribs in the two grooved surfaces **375**$_{GR}$ of the drive roll **375**. The wheels **379** are locked to the shaft **379**$_{SH}$, which in turn is locked against movement in the direction of the bill movement (clockwise as view in FIG. **3**C) by a one-way clutch (not shown). Each time a bill is fed into the nip between the guide wheels **379** and the drive roll **375**, the clutch is energized to turn the shaft **379**$_{SH}$ just a few degrees in a direction opposite the direction of bill movement. These repeated incremental movements distribute the wear uniformly around the circumferences of the guide wheels **379**. Although the idler roll **376** and the guide wheels **379** are mounted behind the guideway **378**, the guideway is apertured to allow the roll **376** and the wheels **379** to engage the bills on the front side of the guideway.

[0138] At the lower end of the curved guideway **378**, the bill being transported by the drive roll **375** is directed into a nip formed between rolls **381** and **382** and then onto a lower portion **320***e***1** of the return transport path **120***e* of the transport mechanism **120** according to some embodiments. With reference to, for example, FIG. **3**D, the lower portion **320***e***1** of the return transport path **120***e* comprises a pair of space transport plates **383**, **384** and a plurality of driven transport rolls **386** and engaging a plurality of passive transport rolls **385** positioned on the opposite side of the transport path **120***e* and biased into engagement with the driven transport rolls **386**. According to some embodiments, the driven transport rolls **386** are driven by motor **390** controlled by a controller or processor such as controller or processor **202**. According to some embodiments, the driven transport rolls **386** are coupled to rotatable shafts **386**$_{SH}$ which are rotatably driven by a belt **388** coupled to a motor shaft **390**$_{SH}$ which is rotatably driven by motor **390** (see, e.g., FIG. **3**E).

[0139] Above the storage bay **360**, two portions of the transport mechanism **120** are illustrated according to some embodiments. According to some embodiments, a portion of storage bay transport path **120***d* of FIGS. **1**A-**1**H takes the form of storage bay transport path **320***d* and an upper portion of return transport path **120***e* of FIGS. **1**A-**1**H takes the form of upper return transport path **320***e***2**. The transport paths **320***d* and **320***e***2** and their related transport mechanism components will be described primarily with reference to FIGS. **6**A-**6**C.

[0140] FIGS. **6**A and **6**B are front perspective views of a portion of transport paths **320***d* and **320***e***2** and their related transport mechanism components in an open, non-operational position located on top of banknote recycling bay **360**. FIG. **6**C is a front view of a portion of transport paths **320***d* and **320***e***2** and their related transport mechanism components in a closed, operational position. The storage bay transport path **320***d* is formed between two spaced transport plates **602**, **604** and the upper return transport path **320***e***2** is formed between two spaced transport plates **606**, **608**. Each transport plate **602**-**608** has a plurality of transport roll apertures therein through which a corresponding plurality of transport rolls project into the transport paths **320***d* and **320***e***2**. More specifically, the lower transport plate **602** of the storage bay transport path **320***d* has a plurality of transport roll apertures through which a plurality of passive transport rolls **612** project upward into the storage bay transport path **320***d* so as to contact banknotes being transported along the storage bay transport path **320***d*. The upper transport plate **604** of the storage bay transport path **320***d* has a corresponding plurality of transport roll apertures through which a plurality of driven transport rolls **614** project downward into the storage bay transport path **320***d* so as to contact and drive banknotes along the storage bay transport path **320***d*. The transport roll apertures in transport plate **604** are positioned directly above the transport roll apertures in transport plate **602** so that a passive transport roll **612** protecting through each aperture comes in contact with a corresponding driven transport roll **614** when the transport plates **602** and **604** are in an operational position such as shown in FIG. **6**C.

[0141] Similarly, the upper transport plate **608** of the storage bay transport path **320***e***2** has a plurality of transport roll apertures through which a plurality of passive transport rolls **618** project downward into the upper return transport path **320***e***2** so as to contact banknotes being transported along the upper return transport path **320***e***2**. The lower transport plate **606** of the upper return transport path **320***e***2** has a corresponding plurality of transport roll apertures through which the plurality of driven transport rolls **614** project upward into the upper return transport path **320***e***2** so as to contact and drive banknotes along the upper return transport path **320***e***2**. The transport roll apertures in transport plate **608** are positioned directly above the transport roll apertures in transport plate **606** so that a passive transport roll **618** protecting through each aperture comes in contact with a corresponding driven transport roll **614** when the transport plates **606** and **608** are in an operational position such as shown in FIG. **6**C. As illustrated, according to some embodiments, the same driven transport rolls **614** are used to drive bills or banknotes both along transport paths **320***d* and **320***e***2**, but in opposite directions. The driven transport rolls **614** are coupled to and rotate about shafts $\mathbf{614}_{SH}$. According to some embodiments, one side of a driven transport roll **614** projects into transport path **320***d* while an opposing side projects into transport path **320***e***2**.

[0142] According to some embodiments, the driven transport rolls **614** are rotational driven about shafts $\mathbf{614}_{SH}$ by a motor **390** via belts **692** and **694** which rotate shafts $\mathbf{614}_{SH}$ and via belt **389** whose rotation is linked to the rotation of belt **694** via both belts **389** and **694** being coupled to a pulley $\mathbf{696}_{PY}$ mounted to a shaft $\mathbf{696}_{SH}$ (see FIG. **3**F). Belt **389** is coupled to the shafts $\mathbf{386}_{SH}$ driving the driven transport rolls **386** of the lower portion **320***e***1** of the return transport path **120***e* which in turn are driven by the motor **390**. Accordingly, the same motor **390** may be used to drive the driven transport rolls in transport paths $\mathbf{320}_{d}$, $\mathbf{320}_{e1}$, and $\mathbf{320}_{e2}$. In some embodiments, the use of the same motor aids in synchronizing the movement of banknotes along a number of portions of the transport path **120**.

[0143] The motor **390** as discussed above is controlled a processor or controller such as controller **202**.

[0144] As can be seen in FIGS. **6**A and **6**B, according to some embodiments, the transport plates **604**, **606**, and **608** may be moved to an open, non-operational position to aid in clearing jams of banknotes and/or in providing maintenance or service to the transport paths **320***d* and **320***e***2** and their related transport mechanism components. According to some embodiments, transport plate **602** is fixedly coupled to the storage bay **360** and the pair of transport plates **604** and **606** are coupled together in fixed relation to each other. The transport plate **608** and the pair of transport plates **604** and **606** are hingedly coupled (via one or more hinges) to transport plate **602**. According to some embodiments, as illustrated in FIGS. **6**A and **6**B, the transport plates **604**, **606**, and **608** may be moved from a closed, operational position to an open, non-operational position and back to a closed, operational position without having to remove or disconnect with belts **692**, **694** used to drive the driven transport rolls **614**.

[0145] Also illustrated in FIGS. **6**A and **6**B is a diverter **361** which serves as one example of a diverter that may be used as diverters **161** of FIGS. **1**A-**1**H. The diverter **361** is mounted on a diverter shaft $\mathbf{361}_{SH}$ which is coupled to a solenoid **690** which selectively changes the position of the diverter **361** between a non-diverting position (shown in FIGS. **6**A and **6**B) and a diverting position wherein a portion of the diverter projects into the storage bay transport path **320***d* so as to divert a banknote from continuing along storage bay transport path **320***d* and instead directs a bill or banknote into the storage bay **360**. The solenoid **690** is controlled a processor or controller such as controller **202**.

[0146] In operation, banknotes to be stored in one of the storage bays **160***a*-**160***f* are routed along transport path **120***d*. If a banknote is to by-pass a storage bay **360**, the diverter **361** (see FIGS. **3**C, **6**A, and **6**B), is maintained in its non-diverting position and the driven transport rolls **614** advance the banknote along the transport path **320***d* past the diverter **361** and toward the next storage bay **360**. With reference to FIGS. **3**C and **3**F, if a banknote is to be directed into a storage bay **360**, the position of the diverter is moved to its diverting position wherein a portion of the diverter **361** will project into the transport path **320***d* so that the leading edge of the banknote being advanced by the driven transport rolls **614** contacts the diverter and is directed downward between a driven roll **696** and a passive roll **697** and then in between the fingers or vanes of the stacker wheels **362**. The driven roll **696** is mounted on the shaft $\mathbf{696}_{SH}$. The stacker wheels **362** then stack the banknote onto the banknote supports **540** or, if there are already one or more banknotes stacked on the banknote supports **540**, onto the top of the stack of banknotes being supported by banknote supports **540**. The elevator **510** may be slowly lowered as more banknotes are directed into storage bay **360** so that the stacker wheels **362** may stack incoming banknotes onto the top of the stack of banknotes being supported by banknote supports **540** wherein the top of the stack of banknotes is maintained generally at the same height. According to some embodiments, the banknote recycler **100** is operated at high speeds and can deliver notes from the storage bay transport path **120***d*/**320***d* into the storage bay **360** and onto and along the transport path **120***e*/$\mathbf{320}_{e1}$, $\mathbf{320}_{e2}$ at a rate of at least 1000 bills/banknotes per minute.

[0147] After a transaction has been completed, such as an Escrow Accept or Internal Audit transaction and there are no more banknotes to be transported into a storage bay **360** in a given transaction, the elevator **510** may be lowered until the bottom banknote being supported by banknote supports **540** is positioned adjacent either the feeding plate **372** if there are no banknotes positioned below the banknote supports **540** or the top banknote in a stack of banknotes being supported by the feeding plate **372**. According to some embodiments, the banknote drop-off detector(s) **520** aid in determining the appropriate height at which to stop lowering the elevator **510**. At that point, the banknote support positional gears **542** move the banknote supports **540** from their first, extended position to their second, retracted position, thereby causing the bottom banknote previously supported by banknote supports **540** to come to rest on either the feeding plate **372** or the top banknote in a stack of banknotes previously supported by the feeding plate **372**. After the banknote supports **540** have been retracted to their retracted positions, a single stack of banknotes rests on the feeding plate **372**. The elevator **510** is then free to be raised above the top of the combined stack of banknotes such as to a level near the top $\mathbf{360}_{UP}$ of the storage bay **360**. Once the elevator **510** has reached a desired position above the top of the combined stack of banknotes, the banknote supports **540** may be extended again into the banknote storage space

360$_{SP}$ so as to be ready to accommodate additional banknotes to be delivered into the storage bay **360** and stacked on the banknote supports **540** such as during a subsequent transaction.

[0148] To dispense bills or banknotes from the storage bay **360**, the dispenser **370** is activated as discussed above to cause banknotes to be fed from the bottom of the stack of banknotes resting on feeding plate **372**, one a time, onto return transport path **320***e***1**.

[0149] According to some embodiments, the storage bays **360** are dimensioned to accommodate a stack of as many as 2000 banknotes. According to some embodiments, prior to dispensing banknotes from a storage bay **360**, if there are more than a certain number of notes stacked therein, the elevator **510** and the banknote supports **540** are used to pick up the notes in the stack greater than that certain number. In some embodiments, the certain number is 700 banknotes. According to some embodiments, the certain number is adjusted to minimize feed errors and may be different for different qualities of banknotes. For example, for new, "brick" banknotes which tend to stick together, the certain number may be less than 700 banknotes, for example, 400 banknotes. In operation, the elevator **510** is moved generally vertically to the desired position with the banknote supports **540** being in their retracted position. When the elevator **510** is at the desired elevation, then the banknote supports **540** are moved to their extended position wherein a front end or tip **540**T of the banknote supports **540** are pressed between notes in the stack of banknotes resting on the feeding plate **372**. The banknote supports **540** are continued to be extended until the banknote supports are in their extended position. Then the elevator **510** is raised and the banknotes above the banknote supports **540** become supported by the banknote supports **540** and are no longer being supported by the feeding plate **372**. The dispenser **370** is then activated to feed out notes from the storage bay **360**. According to some embodiments, the dispenser **370** is operated at high speeds and can transport banknotes at a rate of at least 5000 inches per minute and/or deliver notes from the storage bay **360** onto the return transport path **120***e***1** at a rate of at least 1000 bills/banknotes per minute. According to some embodiments, the above procedure of using the elevator **510** and banknote supports **540** to remove the weight of some of the banknotes residing in the storage bay **360** off of the feeding plate **372** is employed to facilitate the performance of the dispenser **370** at speeds of at least 1000 banknotes per minute.

[0150] According to some embodiments, a stack of up to about 700 banknotes may be stacked on the feeding plate **372** and dispensed at high-speed (e.g., at least 1000 banknotes per minute or banknotes are transported at a rate of at least 5000 inches per minute) without having to use the elevator **510** to lift off a top portion of the stack of banknotes. According to some such embodiments, when the storage bay **360** has more than a certain number of banknotes (e.g., 700 banknotes) stored therein (e.g., a 1000 or 1800 banknotes), the elevator **510** and the banknote supports **540** may be used to lift up bankotes in the storage bay **360** greater than the certain number of banknotes such as more than 700 banknotes (e.g., to lift up the top **300** or **1100** banknotes in the above examples) so that no more than the certain number of banknotes (e.g., 700 banknotes) are being supported by the feeding plate prior to starting a banknote dispensing operation.

[0151] According to some embodiments, the banknote recycler **100** is operated at high speeds and can deliver notes from the storage bay transport path **120***d*/**320***d* into the storage bay **360** at a rate of at least 1000 bills/banknotes per minute while simultaneously the dispenser **370** is operated at high speeds and can deliver notes from the storage bay **360** onto the return transport path **120***e*/**320***e***1** at a rate of at least 1000 bills/banknotes per minute. According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at a rate of at least 600 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at a rate of at least 800 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at a rate of at least 1000 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at a rate of at least 1200 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at a rate of at least 1400 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at a rate of at least about 1600 banknotes per minutes.

[0152] According to some embodiments, banknotes are stacked into the storage bay **360** and dispensed from the storage bay **360** (either at separate times or simultaneously) at different speeds.

[0153] According to some embodiments, the storage bay **360** described above is modular and interchangeable and can be used as any of storage bays **160***a*-**160***f* of FIGS. **1**A-**1**H. FIG. **7** is a perspective view of six storage bays **360***a*-**360***f* that may be used as storage bays **160***a*-**160***f* of FIGS. **1**A-**1**H wherein each storage bay **360***a*-**360***f* corresponds to the storage bay **360** described above. According to some embodiments, the individual bays **360***a*-**360***f* fit together to form seamless portions of the transport paths **120***d*/**320***d*, **120***e*/**320***e***1**, **320***e***2**. According to various embodiments, the banknote recycler **100** may have more or fewer storage bays than six such as for example, one, two, three, four, five, seven, eight, nine, ten, etc. storage bays.

[0154] FIG. **8**A is a front perspective view of a banknote recycler storage bay **860** according to some embodiments of the present. FIG. **8**B is a perspective sectional view of a banknote recycler storage bay **860** taken along line **8**B-**8**B in FIG. **8**A. FIG. **8**C is a side sectional view of a banknote recycler storage bay **860** taken along line **8**B-**8**B in FIG. **8**A. Storage bay **860** is an alternate embodiment of storage bay **360** and may be used as the storage bays **160***a*-**160***f* of FIGS. **1**A-**1**H.

[0155] The banknote storage bay **860** has an elevator **810**. In FIGS. **8**A-**8**C, the banknote recycler bay **860** is shown with retractable banknote supports **840** shown in their extended positions. In general, the banknote recycler bay **860** operates the same as described above in connection with banknote recycler bay **360** and has the same or similar components. In this regard, the same or similar components

will be identified with the same or similar numbers (e.g., "300" and "500" series numbers are changed to "800" series numbers).

[0156] As with storage bay **360**, the banknote recycler storage bay **860** has an upper end $\mathbf{860}_{UP}$ and a lower end $\mathbf{860}_{LO}$ and a right side wall $\mathbf{860}_{RT}$ and a left side wall $\mathbf{860}_{LT}$. The storage bay **860** also has a back wall $\mathbf{860}_{BK}$ and two front walls $\mathbf{860}_{FT}$—one on the right side of the storage bay **860** and one of the left side of the storage bay **860**. The right side wall $\mathbf{860}_{RT}$, the left side wall $\mathbf{860}_{LT}$, the back wall $\mathbf{860}_{BK}$, and the two front walls $\mathbf{860}_{FT}$ help to contain stacked banknotes within the storage bay **860** and serve to define a banknote space $\mathbf{860}_{SP}$ of the storage bay **860**.

[0157] According to some embodiments, the back wall $\mathbf{860}_{BK}$ is separated from the two front walls $\mathbf{860}_{FT}$ by a distance less than the narrow dimension of the banknotes to be stacked therein such that the banknotes stacked therein are angled downwardly toward the back wall $\mathbf{860}_{BK}$ of the storage bay.

[0158] According to some embodiments, the back wall $\mathbf{860}_{BK}$ has one or more low friction surfaces to enhance the ability of the edges of banknotes residing in the banknote storage bay **860** and abutting the backwall $\mathbf{860}_{BK}$ to easily slide up or down within the storage bay **860** as the result of the movement of an elevator **810** and/or the feeding out of banknotes from the bottom of the storage bay **860** such as described above in connection with storage bay **360**. According to some embodiments, low friction surfaces take the form of narrow low friction rails $\mathbf{860}_{SM}$ extending the height of the storage bay **860**. According to some embodiments, two to four low friction rails $\mathbf{860}_{SM}$ are positioned on the back wall $\mathbf{860}_{BK}$.

[0159] Positioned near the upper end $\mathbf{860}_{UP}$ of the storage bay **860** is an upper front banknote wall **830** having a banknote abutting surface **830**A (see FIG. **8**B; omitted in FIGS. **8**A and **8**C). According to some embodiments, positioned near the lower end $\mathbf{860}_{LO}$ of the storage bay **860** is a lower front banknote angled wall **832** having an angled banknote abutting surface $\mathbf{832}_{A}$. The upper front banknote wall **830** serves as an additional structure to maintain banknotes within the storage bay **860** while the banknotes are being stacked therein. According to some embodiments, the banknote angled wall **832** takes the form of a series of prongs having a plurality of spaces $\mathbf{832}_{SP}$ which permit extended banknote supports **840** to be moved up and/or down near the bottom $\mathbf{860}_{LO}$ of the storage bay **860** as the elevator **810** moves up and/or down without contacting or being blocked by the angled wall **832**.

[0160] According to some embodiments, banknotes are stacked in the storage bay **860** with the aid of a pair of stacker wheels **862** mounted on a stacker wheel shaft $\mathbf{862}_{SH}$ which is rotationally driven by a motor **865**. In FIG. **8**B, only one of the stacker wheels is illustrated for clarity. The motor **865** is controlled by a controller or processor such as controller or processor **202**.

[0161] According to some embodiments, the angled banknote abutting surface $\mathbf{832}_{A}$ of the angled wall **832** serves to increase the angle at which bills are stacked in the storage bay **860** near the lower end $\mathbf{860}_{LO}$ of the storage bay **860** and urge the bills into greater contact with low friction rails $\mathbf{860}_{SM}$ of the back wall $\mathbf{860}_{BK}$ and into engagement with the input of a dispenser **870**.

[0162] According to some embodiments, the elevator **810** is the same as elevator **510** and thus its components and operation will not be repeated here. The pair of driven elevation gears **513** of the elevator engage a pair of geared elevator tracks **814** positioned on the outside of the two front walls $\mathbf{860}_{FT}$ of the storage bay **860**.

[0163] At the bottom of the storage bay **860** is a dispenser **870**. According to some embodiments, the dispenser **870** is the same as dispenser **370** and thus its components and operation will not be repeated here except to point out feeding plate **872** corresponds to feeding plate **372**, stripping wheels **874** corresponds to stripping wheels **374**, drive roll **875** corresponds to drive roll **375**, curved guideway **878** corresponds to curved guideway **378**, and idler roll **876** corresponds to idler roll **376**. According to some embodiments, the belt **873** corresponds to belt **373** but is located on the left side of the dispenser **870** instead of the right side.

[0164] Although not illustrated in FIG. **8**A-**8**C, it should be understood that according to some embodiments, transport paths **320***d* and **320***e***2** are located above the storage bay **860** and transport path **320***e***1** is located below storage bay **860** and the components and operation for feeding banknotes onto and along these transport paths and into the storage bay **860** are the same as described above in connection with storage bay **360** and transport paths **320***d*, **320***e***1**, and **320***e***2** and FIGS. **3**A-**6**C.

[0165] According to some embodiments, the banknote recycler **100** is operated at high speeds and can deliver notes from the storage bay transport path **120***d* into the storage bay **860** and out of the storage bay **860** onto and along the transport path **120***e* at a rate of at least 1000 bills/banknotes per minute.

[0166] As with storage bay **360**, according to some embodiments, the storage bay **860** is dimensioned to accommodate a stack of as many as 2000 banknotes and the elevator **810** and banknote supports **840** may be operated to lift a portion of a stack of banknotes so only a lower portion of a stack of banknotes is supported by the feeding plate **872** prior to activating dispenser **870**.

[0167] According to some embodiments, the banknote recycler **100** is operated at high speeds and can deliver notes from the storage bay transport path **120***d* into the storage bay **860** at a rate of at least 1000 bills/banknotes per minute while simultaneously the dispenser **870** is operated at high speeds and can deliver notes from the storage bay **860** onto the return transport path **120***e* at a rate of at least 1000 bills/banknotes per minute.

[0168] FIG. **8**D is a side view of a banknote recycler storage bay **860'** mounted in a storage bay frame comprising a left side frame **891** and a right side frame **892**. FIG. **8**E is a side sectional view of the banknote recycler storage bay **860'** omitting the left side frame **891** and the left side wall $\mathbf{860}_{LT}$ of storage bay **860'**. Storage bay **860'** is an alternate embodiment of storage bays **860** and **360** and may be used as the storage bays **160***a*-**160***f* of FIGS. **1**A-**1**H. The banknote storage bay **860'** has an elevator **810**. In general, the banknote recycler bay **860'** operates the same as described above in connection with banknote recycler bays **360** and **860** and has the same or similar components. In this regard, the same or similar components will be identified with the same or similar numbers (e.g., "300" and "500" series numbers are changed to "800" series numbers and 800 series numbers are kept the same or designated with a prime).

[0169] According to some embodiments, the internal size (that is, the space in which banknotes are stored) of the storage bays (e.g., **160**, **360**, **860**, **860'**) may be adjusted to

accommodate different sizes of banknotes, e.g., a storage bay sized to accommodate U.S. currency may be adjusted accommodate €10 banknotes or a storage bay sized to accommodate €10 banknotes may be adjusted accommodate €20 banknotes. FIGS. **8**D and **8**E illustrate exemplary mechanisms for facilitating the easy adjustment of the depth of storage bays. According to some embodiments, the size of storage bays may be repeatedly adjusted to accommodate different size banknotes such as by banknote recycler manufacturer service personnel at a customer location at which a banknote recycler resides.

[0170] Turning to FIGS. **8**D and **8**E a storage bay having a left side wall $\mathbf{860}_{LT}$ and a right side wall $\mathbf{860}_{RT}$, a back wall $\mathbf{860}_{BK}$ and a pair of front walls $\mathbf{860}_{FT}$ is mounted between a left side frame **891** and a right side frame **892** of a storage bay frame. According to some embodiments, the back wall $\mathbf{860}_{BK}$ is fixedly mounted between the left side frame **891** and the right side frame **892** such that its position relative to the left side and right side frames **891**, **892** is not adjustable. Conversely, the left side wall $\mathbf{860}_{LT}$, right side wall $\mathbf{860}_{RT}$, and the pair of front walls $\mathbf{860}_{FT}$ are adjustably mounted between the left side and right side frames **891**, **892** of a storage bay frame in a manner in which their position relative to the left side and right side frames **891**, **892** is adjustable thereby permitting the depth of the banknote space $\mathbf{860}_{SP}$ of the storage bay **860'** to be adjusted based on, for example, the narrow dimension of the banknotes to be accommodated therein. According to some such embodiments, the left side wall $\mathbf{860}_{LT}$ and right side wall $\mathbf{860}_{RT}$ are fixedly coupled to the pair of front walls $\mathbf{860}_{FT}$ and the pair of front walls $\mathbf{860}_{FT}$ are slideably mounted on a plurality of storage bay depth adjustment posts **893**. According to some embodiments, the pair of front walls $\mathbf{860}_{FT}$ are releasably, slideably mounted on a plurality of storage bay depth adjustment posts **893** and may be locked into a fixed position relative to the storage bay depth adjustment posts **893** such as via locking screws which releasably engage the storage bay depth adjustment posts **893**. According to some embodiments, the elevator **810** is coupled to the front walls $\mathbf{860}_{FT}$ such that the lateral position of the front walls dictates the lateral position of the elevator **810** (while the elevator is still free to move generally vertically up and down).

[0171] According to some embodiments, the left side and right side frames **891**, **892** have one or more slots **895** therein which cooperate with tabs or posts extending from the exterior sides of the left side wall $\mathbf{860}_{LT}$ and the right side wall $\mathbf{860}_{RT}$ of the storage bay **860'** through the slots **895** to control the movement of the left side wall $\mathbf{860}_{LT}$ and the right side wall $\mathbf{860}_{RT}$ relative to the left side and right side frames **891**, **892**, thereby limiting the direction and extent to which the left side wall $\mathbf{860}_{LT}$ and the right side wall $\mathbf{860}_{RT}$ may be moved relative to the back wall $\mathbf{860}_{BK}$ of the storage bay **860'**. Additionally or alternatively, according to some embodiments, the left side and right side frames **891**, **892** have one or more plurality of preset depth adjustment apertures **894** therein which cooperate with tabs or posts extending from the exterior sides of the left side wall $\mathbf{860}_{LT}$ and the right side wall $\mathbf{860}_{FT}$ of the storage bay **860'** through the apertures **894** to facilitate the distance between the front walls $\mathbf{860}_{FT}$ and the back wall $\mathbf{860}_{BK}$ being adjustably set at a plurality of predefined distances, e.g., distances associated with accommodating U.S banknotes and a plurality of denominations of Euro banknotes. In the embodiment illustrated in FIG. **8**D, a lower set of a plurality of apertures **894** comprises apertures **894***a*-**894***e*.

[0172] Turning to FIGS. **9**A-**9**C, FIG. **9**A is a rear perspective view of an alternate embodiment of an elevator **910**, FIG. **9**B is a front side perspective view of the elevator **910** of FIG. **9**A, and FIG. **9**C is a perspective view of a banknote support **940** for use with the elevator **910** of FIGS. **9**A and **9**B. In general, elevator **910** is the same as elevator **510** discussed above except that instead of rolling up the banknote support **540** like a window shade within housing $\mathbf{540}_{H}$ when in its fully, retracted state, a tip $\mathbf{940}_{T}$ at a first end of the banknote support **940** moves to a position near a banknote support positional gear **942** and a second end $\mathbf{940}_{E2}$ of the banknote support **940** moves in generally vertical direction on the front side of the elevator **910** when in the banknote support **940** is in a fully, retracted position. In this regard, the same or similar components will be identified with the same or similar numbers (e.g., "500" series numbers are changed to "900" series numbers).

[0173] As discussed above with respect to elevator **510**, the elevator **910** comprises driven elevation gears **913** driven by a motor **915** and banknote support positional gears **942** driven by an elevation motor or solenoid **945**. The driven elevation gears **913** are fixedly mounted on a rotatable elevation gear shaft $\mathbf{913}_{SH}$ which is rotatable about axis $\mathbf{913}_{A}$.

[0174] As discussed above with respect to elevator **510**, banknote support motor or solenoid **945** is operatively coupled to a first **942-1** one of the banknote support positional gears **942** to cause the first banknote support positional gear **942-1** to rotate about an axis $\mathbf{942}_{A}$. The first banknote support positional gear **942-1** operatively engages a first transmission gear **943** fixedly coupled to a rotatable transmission shaft **941** to cause the first transmission gear **943** and the rotatable transmission shaft **941** to rotate. The rotatable transmission shaft **941** is rotatably mounted about the elevation gear shaft $\mathbf{913}_{SH}$ and is configured to rotate independently from the rotation of the elevation gear shaft $\mathbf{913}_{SH}$. Both the rotatable transmission shaft **941** and the elevation gear shaft $\mathbf{913}_{SH}$ are rotatable about axis $\mathbf{913}_{A}$, albeit independently. Additional transmission gears **944** are fixedly mounted to the transmission shaft **941** proximate additional banknote support positional gears **942**. The rotation of the transmission shaft **941** causes the additional transmission gears **944** to cause the additional or remaining banknote support positional gears **942** to rotate about axis $\mathbf{942}_{A}$. Similar to as discussed above in connection with elevator **510**, the rotation of the banknote support positional gears **942** including the first banknote support positional gear **942-1** cause respective banknote supports **940** to move between a first, extended (wherein a respective banknote support **940** extends into the storage bay **360**/**860** and provides a structure on which banknotes may be stacked) and a second position, retracted position (wherein the banknote support **940** does not project into the banknote storage space of an associated storage bay such as banknote space $\mathbf{360}_{SP}$ of the storage bay **360** or banknote space $\mathbf{860}_{SP}$ of the storage bay **860**).

[0175] More specifically, each of the banknote support positional gears **942** including the first banknote support positional gear **942-1** are fixedly coupled to banknote support driving drums **950**. Each drum **950** has a series of banknote support engaging nubs **951** configured to project through apertures **952** (see FIG. **9**C) in the banknote sup-

ports **940**. As the banknote support positional gears **942** rotate about an axis $\mathbf{942}_A$, so do the banknote support driving drums **950**. The rotation of the banknote support driving drums **950** drives the banknote supports into and out of the associated storage bay via the nubs **951** engaging the sides of apertures **952**. For example, with reference to FIG. **9**A, when the drums **950** rotate in a clockwise manner, more of the length of each banknote support **940** is driven in direction A into an associated storage bay and when the drums **950** rotate in a counter-clockwise manner, more of the length of each banknote support **940** is driven in direction B out of an associated storage bay.

[0176] As with elevator **510**, to aid in maintaining the banknote supports **940** in a curled manner about a longitudinal axis $\mathbf{940}_A$ when in the extended position, the transmission shaft **941** comprises curved portions $\mathbf{941}_C$. The curved shaped of curved portion $\mathbf{941}_C$ is mirrored by a complimentary curved shape $\mathbf{990}_C$ of a bottom elevator housing **990**. Each curved portion $\mathbf{941}_C$ and its complimentary curved shape $\mathbf{990}_C$ of a bottom elevator housing **990** is positioned adjacent a location at which a banknote support **940** enters an associated storage bay so that when the tip $\mathbf{940}_T$ of a banknote support **940** enters an associated storage bay it is pressed between the curved portion $\mathbf{941}_C$ and its complimentary curved shape $\mathbf{990}_C$ of a bottom elevator housing **990** which serve to bend the banknote support about the longitudinal axis $\mathbf{940}_A$.

[0177] The elevator **910** also comprises a banknote housing $\mathbf{940}_H$ for each banknote support **940** to guide the second end $\mathbf{940}_{E2}$ of each banknote support **940** in a generally vertical direction on the front side of the elevator **910**.

[0178] FIGS. **10**A-**10**D are perspective views of a generally vertical banknote recycler storage bay **1060** according to some embodiments of the present disclosure having an alternate embodiment of an elevator **1010**. More specifically, FIG. **10**A is a rear perspective view of the banknote recycler storage bay **1060** with the elevator **1010** positioned near the middle of the bay **1060** wherein a banknote support **1040** is positioned in a retracted position; FIG. **10**B is a side perspective view of the banknote recycler storage bay **1060** with the banknote support **1040** positioned in a retracted position ready to be inserted into a stack of banknotes BN residing within the storage bay **1060**; FIG. **10**C is a side perspective view of the banknote recycler storage bay **1060** similar to that shown in FIG. **10**B but with the banknote support **1040** positioned in an extended position after being inserted between two banknotes BN in a stack of banknotes residing within the storage bay **1060**; and FIG. **10**D is a side perspective view of the banknote recycler storage bay **1060** similar to that shown in FIG. **10**C but with the banknote support **1040** positioned in an extended position after being raised above and thereby raising some of the banknotes BN residing above the banknote support **1040** upward and away from remaining banknotes BN that remain supported by the bottom of the storage bay **1060**.

[0179] Although illustrated differently, the banknote recycler storage bay **1060** may be the same as or similar to storage bays **160** and/or **360** described above and may be employed in the banknote recyclers **100**, **100'**, **100"** described above. The storage bay **1060** is an example of a storage bay that may be used as the storage bays **160***a*-**160***f* of banknote recyclers **100**, **100'**, **100"**. In general, except as illustrated in FIGS. **10**A-**10**D and described herein, the banknote recycler bay **1060** may operate the same as described above in connection with banknote recycler bay **360** and may have the same or similar components. In this regard, the same or similar components will be identified with the same or similar numbers (e.g., "300" and "500" series numbers are changed to "1000" series numbers).

[0180] The elevator **1010** comprises an elevator chassis $\mathbf{1010}_{CH}$ to which the banknote support **1040** is coupled. The banknote chassis $\mathbf{1010}_{CH}$ is slidably coupled to sides of the banknote storage bay **1060** such as via elevator couplers $\mathbf{1010}_{C1}$ and $\mathbf{1010}_{C2}$ which couple portions of the elevator **1010** to portions of the storage bay **1060** such as at corner supports $\mathbf{1060}_{CRA}$ and $\mathbf{1060}_{CRB}$. Alternatively or additionally, the banknote chassis $\mathbf{1010}_{CH}$ may be slidably coupled to the banknote storage bay **1060** via a post $\mathbf{1060}_P$ coupled to storage bay **1060** positioned within an aperture $\mathbf{1010}_{AP}$ in the elevator chassis $\mathbf{1010}_{CH}$. According to some embodiments, the elevator may be raised and lowered via the post $\mathbf{1060}_P$ being rotatable and threaded and cooperating with threads on chassis $\mathbf{1010}_{CH}$ within aperture $\mathbf{1010}_{AP}$. Alternatively or additionally, the elevator may be raised and lowered via a drive mechanism such as one or more driven belts **1013** coupled to the chassis $\mathbf{1010}_{CH}$. As with elevator **510**, the elevation position of the elevator **1010** may be driven by a motor (not shown) such as elevation motor **515** which in turn may be controlled by a controller or processor such as controller or processor **202**.

[0181] As with the banknote supports **540**, the banknote support **1040** may be used to lift up some and/or all of banknotes in the storage bay **1060**. A first position of the banknote support **1040** is an extended or operative position (as shown in FIGS. **10**C and **10**D) wherein the banknote support **1040** extends into the storage bay **1060** and defines a platform on which banknotes may be stacked and which can support a stack of banknotes. A stack of banknotes stacked on the banknote supports **540** can be moved up and down within the storage bay by the elevator **1010** being moved up and down. A second position of the banknote support **1040** is a retracted position wherein the banknote support **540** does not support a stack of banknotes BN in the banknote space $\mathbf{1060}_{SP}$ of the storage bay **1060** as illustrated in FIG. **10**B.

[0182] In an exemplary embodiment, the banknote support **1040** does not project into the banknote space $\mathbf{1060}_{SP}$ of the storage bay **1060** when in its retracted position but instead is positioned outside the banknote space $\mathbf{1060}_{SP}$. According to some embodiments, the banknote support **1040** is moved between the extended position and the retracted position via a plunger arm $\mathbf{1040}_{PL}$ (FIG. **10**A) coupled to a banknote support positional motor such as a motor or solenoid similar to a motor or solenoid **545** controlled by a controller or processor such as controller or processor **202**. In some such embodiments, an edge of the support **1040** slides in a slot $\mathbf{1010}_{SL}$ in chassis $\mathbf{1010}_{CH}$.

[0183] According to some embodiments, the banknote support **1040** is coupled to banknote a support positional gear **1042** (FIG. **10**B) which is cooperatively and operatively coupled to gears (not shown) within chassis $\mathbf{1010}_{CH}$ coupled to a banknote support positional motor or solenoid (not shown) similar to a motor or solenoid **545** controlled by a controller or processor such as controller or processor **202**. By operation of the banknote support positional motor, a portion of the gears **1042** (and the banknote support **1040**) may be moved out of the chassis $\mathbf{1010}_{CH}$ to a retracted

position (FIG. **10**B) or moved into the chassis $\mathbf{1010}_{CH}$ to an operative position (FIGS. **10**C and **10**D).

[0184] According to some embodiments, such as shown in, for example, FIG. **10**B, the banknote support **1040** has an angled leading or front edge $\mathbf{1040}_{FR}$. The front edge $\mathbf{1040}_{FR}$ is the edge of the banknote support **1040** which enters the banknote storage space $\mathbf{1060}_{SP}$ first when the banknote support **1040** is moved from a retracted position to an operative position. According to some embodiments, the front edge $\mathbf{1040}_{FR}$ is angled by about 45° relative to one or both of the side edges $\mathbf{1040}_{SD}$ of the banknote support **1040** and/or the side edges BN_{SD} of banknotes BN stacked within the banknote storage space $\mathbf{1060}_{SP}$. The angled leading or front edge $\mathbf{1040}_{FR}$ assists with allowing the banknote support **1040** to be slipped within two adjacent banknotes BN stacked within the banknote storage space $\mathbf{1060}_{SP}$ when the banknote support **1040** is moved from a retracted position to an operative position.

[0185] According to some embodiments, the banknote support **1040** is made of a relatively thin strip of material such as metal or plastic.

[0186] The operation of the elevator **1010** may otherwise be same or similar to that described above in connection with elevator **510**.

[0187] FIGS. **11**A-**11**C are sectional views of a generally vertical recycling bay arrangement comprising a banknote recycler storage bay or generally vertically oriented banknote recycling bay **1160** according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme. More specifically, FIG. **11**A is a side sectional view of two banknote recycler storage bays **1160**. FIG. **11**B is a side sectional view of a top portion of the banknote recycler storage bay **1160** illustrating a banknote BN being fed into the storage bay **1160**. FIG. **11**C is a side sectional view of a top portion of the banknote recycler storage bay **1160** illustrating a banknote BN being fed out and dispensed from the storage bay **1160**.

[0188] Although illustrated differently, the banknote recycler storage bay **1160** may be the same as or similar to storage bays **160** and/or **360** described above and may be employed in the banknote recyclers **100**, **100'**, **100"** described above. The storage bay **1160** is an example of a storage bay that may be used as the storage bays **160***a*-**160***f* of banknote recyclers **100**, **100'**, **100"**. In general, except as illustrated in FIGS. **11**A-**11**C and described therewith, the banknote recycler bay **1160** may operate the same as described above in connection with banknote recycler bay **360** and may have the same or similar components. In this regard, the same or similar components will be identified with the same or similar numbers (e.g., "300" and "500" series numbers are changed to "1100" series numbers).

[0189] Each bay **1160** has an elevator **1110** therein having a top surface which serves as a banknote support **1140**. According to some embodiments, the banknote support **1140** is a banknote stacker plate. The elevator **1110** is moved up and down to accommodate banknotes being fed into or dispensed from the corresponding storage bay **1160**. Each storage bay **1160** has an upper end $\mathbf{1160}_{UP}$, a lower end $\mathbf{1160}_{LO}$, a banknote leading edge side or back side $\mathbf{1160}_{BK}$, and a banknote trailing edge side or front side $\mathbf{1160}_{FT}$.

[0190] Turning to FIG. **11**B, the depositing or feeding in operation will be described. A banknote BN to be deposited into a given storage bay **1160** is routed in direction $\mathrm{D}\mathbf{11}_{A}$ along an transport path **1120** between a pair of space transport plates **1183**, **1184**. The banknote engages and is driven along the transport path **1120** by a driven transport roll **1186** and a passive transport roll **1185** positioned on the opposite side of the transport path **1120** and biased into engagement with the driven transport roll **1186**. According to some embodiments, the driven transport roll **1186** is driven by a motor (such as motor **390**) controlled by a controller or processor such as controller or processor **202**. A lower portion of transport plate **1183** is curved so as to direct incoming banknotes BN between a drive roll **1175** and a guide wheel **1179**. The guide wheel **1179** is mounted to guide wheel shaft $\mathbf{1179}_{SH}$. The drive roll **1175** is mounted to drive wheel shaft $\mathbf{1175}_{SH}$ which is driven in a counterclockwise direction $\mathbf{1175}_{A}$ in FIG. **11**B during a banknote depositing operation. An incoming banknote BN is then driven in direction $\mathrm{D}\mathbf{11}_{B}$ into the storage bay **1160**. The incoming banknote BN then engages a pair of ceiling guides **1114** which guide the leading edge of an incoming banknote BN toward the banknote support **1140** of the elevator **1110** or the top of a stack of banknotes already residing on the banknote support **1140**. According to some embodiments, the drive roll **1175** is mounted to a drive roll shaft $\mathbf{1175}_{SH}$ and may take the form of drive roll **375** described above. According to some embodiments, one end of each of the ceiling guides is pivotally coupled to the drive roll shaft $\mathbf{1175}_{SH}$ and a second end of each of the ceiling guides **1114** are biased downward such as via a spring. As a banknote BN enters the storage bay **1160**, the leading edge of the banknote BN may contact the ceiling guides **1114** and then a front wall $\mathbf{1160}_{FT}$ of the storage bay **1160**. In some embodiments, the ceiling guides **1114** may pivot upward slightly when a banknote BN contacts them. According to some embodiments, a damper may be positioned near the front wall $\mathbf{1160}_{FT}$ of the storage bay **1160**. The damper may be biased (such as via a spring) into the storage bay **1160** and move in a direction toward the front wall $\mathbf{1160}_{FT}$ when a banknote BN contacts it so as to slow or control the deceleration of a banknote BN as it is deposited on top of the banknote support **1140** or banknotes already supported by banknote support **1140**.

[0191] According to some embodiments, a plurality of flexible tap-down fingers **1180** are rotationally mounted to and positioned along part of the circumference of guide wheel shaft $\mathbf{1179}_{SH}$. The rotation of the tap-down fingers **1180** is controlled so that as the leading edge of a banknote BN passes the guide wheel **1179** and enters the storage bay **1160** the fingers **1180** do not intersect the transport path and the banknote BN does not contact the fingers **1180**. As a banknote BN passes the position at which the guide wheel **1179** and drive roll **1175** are biased into each other, the fingers **1180** are rotated (clockwise in FIG. **11**B) so as to engage the trailing edge of a banknote BN and move the trailing edge downward toward the banknote support **1140**. According to some embodiments, the operation of the tap-down fingers **1180** facilitates moving the trailing edge of a banknote BN out of the way so that the leading edge of a subsequent banknote BN does not slip under the trailing edge of a previously deposited banknote BN when entering the storage bay **1160**.

[0192] As discussed above such as in connection with elevator **510**, the height of the banknote support **1140** and elevator **1110** can be adjusted to accommodate additional banknotes BN being deposited into the storage bay **1160**.

[0193] According to some embodiments, the drive roll **1175**, the guide wheel **1179**, and the fingers **1180** comprise

part of a banknote feeding assembly. According to some such embodiments, the banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay **1160** is positioned near the upper end $\mathbf{1160}_{UP}$ and banknote trailing edge side $\mathbf{1160}_{BK}$ of the recycling or storage bay **1160**. The drive roll **1175** may comprise a pair of drive rolls supported for rotational movement about the driven drive roll shaft $\mathbf{1175}_{SH}$. The guide wheel **1179** may take the form of a pair of nip rollers supported for rotational movement about a guide wheel or nip roller shaft $\mathbf{1179}_{SH}$, each of the nip rollers being positioned below a corresponding one of the drive rolls such that banknotes may pass between each corresponding drive roll and nip roller pair.

[0194] According to some embodiments the plurality of flexible tap-down fingers **1180** comprise part of a plurality of tap-down assemblies supported for rotational movement about the nip roller shaft $\mathbf{1179}_{SH}$, each tap-down assembly having the base $\mathbf{1180}_{B}$ and a plurality of the flexible tap-down fingers or projections **1180** extending from the base $\mathbf{1180}_{B}$. The base $\mathbf{1180}_{B}$ has a circumference extending around the nip roller shaft $\mathbf{1179}_{SH}$ and the plurality of tap-down projections or fingers are positioned about the circumference of a corresponding base $\mathbf{1180}_{B}$ such that collectively the plurality of tap-down projections or fingers **1180** extend from a corresponding base $\mathbf{1180}_{B}$ over less than about 180° of the circumference of the base $\mathbf{1180}_{B}$.

[0195] According to some embodiments, the banknote feeding assembly further comprises a pair of ceiling guides **1114** positioned so as to guide the leading edge of banknotes BN emerging from between each drive roll **1175** and nip roller **1179** pair downward into the recycling bay **1160** and toward the banknote leading edge side $\mathbf{1160}_{FT}$ of the recycling bay and on top of any preceding banknotes resting on the banknote support **1140**.

[0196] According to some embodiments, during operation in which banknotes are to be sequentially fed into the storage or recycling bay **1160**, the plurality of tap-down assemblies are rotated such that the plurality of tap-down projections or fingers **1180** push the trailing edges of banknotes BN that have been fed into the recycling bay **1160** downward so as to facilitate a subsequent banknote entering the recycling bay to be positioned on the upper side of a prior fed banknote.

[0197] Turning to FIG. **11**C, the dispensing or feeding out operation will be described. When one or more banknotes BN are to be dispensed from the storage bay **1160**, the elevator **1110** is raised (under control of a processor such as processor **202**) to press a topmost banknote BN into engagement with a pair of stripping wheels **1174**. During a dispensing operation, banknotes or bills that are stacked on the banknote support **1140** are stripped, one at a time, from the top of the stack. The banknotes are stripped by the pair of stripping wheels **1174** mounted on a driven stripping wheel shaft $\mathbf{1174}_{SH}$. According to some embodiments, part of the periphery of each stripping wheel **1174** is provided with a raised high-friction surface $\mathbf{1174}_{SR}$ which engages the top bill of the stack as the stripping wheels **1174** rotate (in direction $\mathbf{1174}_{B}$, clockwise in FIG. **11**C), to initiate feeding movement of the top bill from the stack. The high-friction surfaces $\mathbf{1174}_{SR}$ may project radially beyond the rest of the wheel peripheries so that the high-friction surfaces $\mathbf{1174}_{SR}$ intermittently contact the stack of banknotes so as to agitate and loosen the top banknote within the stack, thereby facilitating the stripping of the top banknote from the stack.

[0198] The top banknote BN is moved in direction $\mathbf{D11}_{C}$ into engagement with drive roll **1175** and guide wheel **1179**. According to some embodiments, high-friction surfaces $\mathbf{1175}_{SR}$ of drive roll **1175** engage each banknote after it is fed into the drive roll **1175** by the stripping wheels **1174**, to frictionally advance the banknote into the narrow arcuate passageway **1120** formed by a curved guideway **1183** adjacent the rear side of the drive roll **1175**. The rotational movement of the drive roll **1175** and the stripping wheels **1174** may be synchronized so that the high-friction surfaces on the drive roll **1175** and the stripping wheels **1174** maintain a constant relationship to each other. Moreover, according to some embodiments, the drive roll **1175** is dimensioned so that the circumference of the outermost portions of grooved surfaces of the drive roll **1175** is greater than the width W of a banknote to be dispensed from a given storage bay **1160**, so that the banknotes advanced by the drive roll **1175** are spaced apart from each other. That is, each banknote fed to the drive roll **1175** is advanced by that roll only when the high-friction surfaces come into engagement with the banknote, so that the circumference of the drive roll **1175** determines the spacing between the leading edges of successive banknotes. The drive roll **1175** is mounted to drive wheel shaft $\mathbf{1175}_{SH}$ which is driven in a clockwise direction $\mathbf{1175}_{B}$ in FIG. **11**C during a banknote dispensing operation.

[0199] According to some embodiments, the drive roll **1175** and the stripping wheels **1174** are driven by a motor (such as motor **390**) controlled by a controller or processor such as controller or processor **202**.

[0200] A banknote BN to be dispensed from a given storage bay **1160** is then routed in direction $\mathbf{D11}_{D}$ along the transport path **1120** between the pair of space transport plates **1183**, **1184**. The banknote engages and is driven along the transport path **1120** by a driven transport roll **1186** and a passive transport roll **1185** positioned on the opposite side of the transport path **1120** and biased into engagement with the driven transport roll **1186**. According to some embodiments, the driven transport roll **1186** is driven by a motor (such as motor **390**) controlled by a controller or processor such as controller or processor **202**.

[0201] During a dispensing operation, according to some embodiments, the top banknote or the banknote support **1140** engages the ceiling guides **1114** and pivots them upward. During a dispensing operation, the position of the tap-down fingers **1180** is controlled (such as via controller **202**) so that the fingers **1180** do not intersect the transport path **1120** and exiting banknotes BN do not contact the fingers **1180**.

[0202] According to some embodiments, banknote support **1140** comprises a spring biased plate mounted to the top of elevator **1110**. According to some embodiments, a pressure sensor monitors pressure on the stripping wheel driven shaft $\mathbf{1174}_{SH}$. The pressure sensor and a motor controlling the movement of elevator **1110** may be coupled to a controller or processor such as controller or processor **202**. The controller monitors the pressure sensor signals and controls the elevation and/or movement of the elevator **1110** based on the information derived from the pressure sensor such as by instructing the motor controlling the elevator **1110** movement to slow down or stop.

[0203] According to some embodiments, a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling or storage bay **1160** comprises stripping wheels **1174**, drive roll **1175**, and guide wheel or nip roller

1179. The dispensing assembly is positioned near the upper end $\mathbf{1160}_{UP}$ of the recycling or storage bay **1160**. According to some embodiments, the stripping wheel **1174** comprise a pair of stripping wheels supported for rotational movement about the driven stripping wheel shaft $\mathbf{1174}_{SH}$, the drive roll **1175** comprises a pair of drive rolls, and the guide wheel **1179** comprises a pair of nip rollers.

[0204] According to some embodiments, during a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator banknote support **1140** is elevated such that the stripping wheels **1174** sequentially engage the topmost banknote stacked in the recycling or storage bay **1160** and urge the topmost banknote into contact with the pair of drive rolls **1175** which act to feed banknotes out of the recycling bay **1160**, one bill at a time; and wherein during a dispensing operation the tap-down assemblies are rotationally positioned such that the plurality of tap-down projections or fingers **1180** do not extend into the recycling bay nor above the top of the nip rollers **1179**.

[0205] According to some embodiments, banknotes BN may be deposited into and dispensed from storage bay **1160** at a rate of at least 1000 banknotes per minute. According to some embodiments, the distance between a front wall $\mathbf{1160}_{FT}$ and a back wall $\mathbf{1160}_{BK}$ is between about 2.5 and 5.0 inches for storage bays **1160** configured to accept and dispense U.S. banknotes.

[0206] FIGS. **12**A-**12**B are perspective views of a generally vertical recycling bay arrangement comprising a banknote recycler storage bay or generally vertically oriented banknote recycling bay **1260** according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme. More specifically, FIG. **12**A is a top perspective view of a banknote recycler storage bay **1260** configured to accept banknotes to be deposited into the storage bay **1260** with stacker wheels **1262** positioned in a deposit or feed-in location. FIG. **12**B is a top perspective view of a banknote recycler storage bay **1260** configured to dispense banknotes from the storage bay **1260** with stacker wheels **1262** positioned in a non-operational, dispense or feed-out location. In general, the banknote recycling bay arrangement of FIGS. **12**A and **12**B and its operation may be the same as or similar to the banknote recycling bay arrangement of FIGS. **11**A-**11**C except that a pair of stacker wheels **1262** are employed for depositing banknotes into the storage bay **1260** as opposed to the drive roll **1175** and the guide wheel or nip roller **1179** and the fingers **1180**. The dispensing operation may operate in the same manner as described above with respect to FIGS. **11**A-**11**C.

[0207] According to some embodiments, a generally vertical banknote recycling bay arrangement **1200** comprises a generally vertically oriented banknote recycling or storage bay **1260** for receiving banknotes therein. As with storage bay **1160**, the recycling bay **1260** has an upper end and a lower end. The arrangement **1200** further comprises a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay and comprising a pair of stacker wheels **1262** supported for rotational movement about a driven stripper wheel shaft $\mathbf{1274}_{SH}$. Each stacker wheel **1262** is laterally moveable along the driven stripper wheel shaft $\mathbf{1274}_{SH}$. The feeding assembly further comprises a stacker wheel positioning mechanism such as driven positioning screw **1202** and a pair of stacker wheel carriages $\mathbf{1262}_{CR}$, each carriage $\mathbf{1262}_{CR}$ having a screw end $\mathbf{1262}_{CR\text{-}1}$ and a stacker wheel end $\mathbf{1262}_{CR\text{-}2}$, the screw end $\mathbf{1262}_{CR\text{-}1}$ of each carriage $\mathbf{1262}_{CR}$ having a threaded aperture therein through which a portion of the positioning screw **1202** is threaded, each carriage $\mathbf{1262}_{CR}$ having a pair of arms $\mathbf{1262}_{A1}$, $\mathbf{1262}_{A2}$, each arm $\mathbf{1262}_{A1}$, $\mathbf{1262}_{A2}$ extending from the screw end $\mathbf{1262}_{CR\text{-}1}$ toward the stacker wheel end $\mathbf{1262}_{CR\text{-}2}$ and at least partially conforming about the stripper wheel shaft $\mathbf{1274}_{SH}$. The pair of arms $\mathbf{1262}_{A1}$, $\mathbf{1262}_{A2}$ of each carriage $\mathbf{1262}_{CR}$ extend toward the stripper wheel shaft $\mathbf{1274}_{SH}$ such that a corresponding stacker wheel **1262** is positioned about the stripper wheel shaft $\mathbf{1274}_{SH}$ between the arms $\mathbf{1262}_{A1}$, $\mathbf{1262}_{A2}$ of a corresponding carriage $\mathbf{1262}_{CR}$.

[0208] The arrangement **1200** further comprises a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay **1260**, the dispensing assembly being positioned near the upper end of the recycling bay and comprising a pair of stripping wheels **1274** supported for rotational movement about the driven stripper wheel shaft $\mathbf{1274}_{SH}$. The pair of stripping wheels **1274** are laterally positioned about the stripper wheel shaft $\mathbf{1274}_{SH}$ between the pair of stacker wheels **1262**. The dispensing assembly further comprises a pair of drive rolls **1275** supported for rotational movement about a drive roll shaft $\mathbf{1275}_{SH}$.

[0209] As shown in FIG. **12**A, during operation in which banknotes are to be fed or deposited into the recycling bay **1260**, the lateral position of the stacker wheels **1262** is adjusted to an inward, operational position such that banknotes to be fed into the recycling bay **1260** are received by the stacker wheels **1262** and stacked in the recycling bay **1260**. As shown in FIG. **12**B, during operation in which banknotes are to be fed out of or dispensed from the recycling bay **1260**, the lateral position of the stacker wheels **1262** is adjusted to an outward, non-operational position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels **1262** but instead are engaged by the stripping wheels **1274** which sequentially engage the topmost banknote stacked in the recycling bay **1260** and urge the topmost banknote into contact with the pair of drive rolls **1275** which act to feed banknotes out of the recycling bay arrangement, one bill at a time.

[0210] According to some embodiments, the lateral positions of the stacker wheels **1262** are adjusted by rotational movement of the stacker wheel positioning screw **1202** which serves to laterally move the pair of stacker wheel carriages $\mathbf{1262}_{CR}$ laterally toward each other when driven in a first rotational direction and to laterally move the pair of stacker wheel carriages $\mathbf{1262}_{CR}$ laterally away each other when driven in a second rotational direction, the lateral movement of the stacker wheel carriages $\mathbf{1262}_{CR}$ imparting a corresponding lateral movement on the stacker wheels **1262**.

[0211] According to some embodiments, the stacker wheel positioning screw **1202** comprises threads oriented in a first direction on a first portion $\mathbf{1202}_{A}$ and threads oriented in a second opposite direction on a second portion $\mathbf{1202}_{B}$, and wherein a first one of the stacker wheel carriages $\mathbf{1262}_{CR}$ threadingly engages the first portion $\mathbf{1202}_{A}$ of the positioning screw and a second one of the stacker wheel carriages $\mathbf{1262}_{CR}$ threadingly engages the second portion $\mathbf{1202}_{B}$ of the positioning screw **1202**.

[0212] As described and illustrated in more detail in U.S. Pat. No. 5,815,592 [Attorney Docket 247171-000131], incorporated herein by reference in its entirety, the drive roll

1275 may include a central smooth friction surface $\mathbf{1275}_{SM}$ formed of a material such as rubber or hard plastic. This smooth friction surface $\mathbf{1275}_{SM}$ is sandwiched between a pair of grooved surfaces having high-friction portions $\mathbf{1275}_{SR}$ formed from a high-friction material. According to some embodiments, part of the periphery of each stripping wheel **1274** is provided with a raised high-friction surface $\mathbf{1274}_{SR}$ which engages the top bill of the stack as the stripping wheels **1274** rotate, to initiate feeding movement of the top bill from the stack toward the drive roll **1275**. The drive roll **1275** and stripping wheels **1274** may be the same or similar to the drive rolls **375**, **1175** and stripping wheels **374**, **1174** described above.

[0213] Although not illustrated, each bay **1260** has an elevator with a banknote support similar or identical to those discussed above such as elevators **510**, **1110** and banknote supports **540**, **1140**. The elevator is moved up and down to accommodate banknotes being fed into or dispensed from the corresponding storage bay **1260** as discussed above such as with respect to elevator **510** and/or **1110**.

[0214] According to some embodiments, the drive roll **1275**, the stripping wheels **1274**, the stacker wheels **1262**, and the positional screw **1202** are driven by one or more motors (such as motor **390**) controlled by a controller or processor such as controller or processor **202**.

[0215] FIGS. **13**A and **13**B are a front perspective views and FIG. **13**C is a side view of a banknote recycler storage bay **1360** according to some embodiments of the present disclosure. In general, the storage bay **1360** and its operation may be similar as or identical to that described above in connection with storage bay **360** except for the storage bay **1360** employing a different elevator **1310** and elevator system in place of elevator **510**.

[0216] Although illustrated differently, the banknote recycler storage bay **1360** may be the same as or similar to storage bays **160** and/or **360** described above and may be employed in the banknote recyclers **100**, **100'**, **100"** described above. The storage bay **1360** is an example of a storage bay that may be used as the storage bays **160***a*-**160***f* of banknote recyclers **100**, **100'**, **100"**. In general, except as illustrated in FIGS. **13**A-**13**C and described therewith, the banknote recycler bay **1360** may operate the same as described above in connection with banknote recycler bay **360** and may have the same or similar components. In this regard, the same or similar components will be identified with the same or similar numbers (e.g., "300" and "500" series numbers are changed to "1300" series numbers).

[0217] The storage bay **1360** comprises a front wall $\mathbf{1360}_{FT}$ and a back wall $\mathbf{1360}_{BK}$ spaced apart by a distance less than the narrow dimension of banknotes BN to be received therein so that banknotes stacked therein are positioned at an angle as shown in FIG. **13**C. An elevator system comprises a pair of banknote supports **1340** which are threadingly coupled to a pair of elevator positioning posts $\mathbf{1310}_{P}$. According to some embodiments, the elevator positioning posts $\mathbf{1310}_{P}$ are threaded shafts with one having a left-hand thread and the other having a right-hand thread. The elevator positioning posts $\mathbf{1310}_{P}$ are rotationally driven by one or more motors communicatively coupled to and controlled by a controller or processor such as controller or processor **202**. According to some embodiments, the elevator positioning posts $\mathbf{1310}_{P}$ are geared together. The vertical position of banknote supports **1340** may be raised or lowered by rotating the elevator positioning posts $\mathbf{1310}_{P}$ in one direction or the other. The banknote supports **1340** may be positioned in an operational position wherein the supports **1340** project into the storage bay **1360** as shown in FIGS. **13**A and **13**C thereby enabling the banknote supports **1340** to support one or more banknotes BN thereon and also to raise or lower the banknotes supported thereon as the banknote supports **1340** are raised or lowered. The banknote supports **1340** may also be positioned in a non-operational position wherein the supports **1340** do not project into the storage bay **1360** as shown in FIG. **13**B thereby enabling the banknote supports **1340** to be raised or lowered without adjusting the level of banknotes residing in the storage bay **1360**.

[0218] As with storage bay **360**, according to some embodiments, the stacking of the banknotes in the storage bay **1360** at an angle relieves some of the weight of the banknotes which would otherwise by borne by a feeding plate **1372** which is positioned at the bottom of storage bay **1360**. In some such embodiments, the re-allocation of the bearing of the weight of some of the banknotes in the stack from the feeding plate **1372** to one or more of the walls of the storage bay **1360**, e.g., backwall $\mathbf{1360}_{BK}$, increases the number of banknotes that may reside in the storage bay **1360** and not have to be lifted up by the elevator **1310** and banknote supports **1340** prior to dispensing banknotes smoothly and at high speeds (e.g., at least 1000 banknotes per minutes). As with storage bay **360**, stripping wheels **1374** and drive roll **1375** form part of a dispensing mechanism at the bottom of storage bay **1360** which may be similar or identical in construction and operation as stripping wheels **374** and drive roll **375** of storage bay **360**.

[0219] During a depositing or feed-in operation, banknote supports **1340** are positioned in an operational position and are raised near the top of storage bay **1360** so that banknotes from stacker wheels **1362** may be deposited onto and supported by the banknote supports **1340**. As with storage bay **360**, the banknote supports **1340** may be lowered as more banknotes are stacked thereon so as to maintain the top of the stack of banknotes supported by the banknote supports **1340** at generally the same elevation.

[0220] During a dispensing or feed-out operation, the banknote supports **1340** may be lowered so that any banknotes being supported thereon may be lowered so as that they may come to rest upon feeding plate **1372** or the top of a stack banknotes already being supported by feeding plate **1372**. The banknote supports may be moved (rotated) to a non-operational position thereby transferring the banknotes previously supported thereon to the feeding plate **1372** or the top of a stack banknotes already being supported by feeding plate **1372**. Banknotes on the feeding plate **1372** may be dispensed as discussed above in connection with storage bay **360**.

[0221] While maintaining the banknote supports **1340** in a non-operational position, the banknote supports may be raised above the stack of banknotes supported by feeding plate **1372**. Once above the stack of banknotes, the banknote supports **1340** may be moved (rotated) back to an operational position and raised to be in position to receive additional banknotes from stacker wheels **1362**.

[0222] According to some embodiments, to move or rotate the banknote supports **1340** between the operational and non-operational positions, the banknote supports **1340** are coupled to one or more banknote support positional motors communicatively coupled to and controlled by a controller

or processor such as controller or processor **202**. According to some embodiments, the banknote supports **1340** are maintained or locked in operational positions while being raised or lowered in the middle of the storage bay **1360** and can only be moved out of the operational positions when the banknotes supports **1340** are near the bottom of the storage bay **1360** and can only be move into operational positions when near the top of the storage bay **1360**.

[0223] According to some embodiments, while in the operational positions and being lowered within the storage bay **1360**, the banknote supports **1340** are laterally constrained by a slot in the back wall $\mathbf{1360}_{BK}$ so as to prevent the banknote supports **1340** from rotating about the axes of the elevator positioning posts $\mathbf{1310}_{P}$. The lateral constraint ends prior to the banknote supports **1340** reaching the bottom of their travel along elevator positioning posts $\mathbf{1310}_{P}$ so that when the banknote supports **1340** reach the bottom of their travel, the rotation of elevator positioning posts $\mathbf{1310}_{P}$ causes the banknote supports **1340** to pivot about the axes of the elevator positioning posts $\mathbf{1310}_{P}$ repositioning the banknote supports **1340** into their non-operational positions wherein the supports **1340** do not project into the storage bay **1360** as shown in FIG. **13**B. According to some embodiments, as the banknote supports **1340** rotate out of their operational position, they snap into rotational detents which hold the banknote supports **1340** in their non-operational position. Upon reversal of the rotation direction of the elevator positioning posts $\mathbf{1310}_{P}$, the banknote supports **1340** may be driven in their non-operational positions to the top of the storage bay **1360**. The detents prevent the banknote supports **1340** from rotating into their operational positions while being raised. As the banknote supports **1340** reach the top of the storage bay **1360**, the constraint of the detents is removed and the rotation of elevator positioning posts $\mathbf{1310}_{P}$ causes the banknote supports **1340** to pivot about the axes of the elevator positioning posts $\mathbf{1310}_{P}$ repositioning the banknote supports **1340** into their operational positions wherein the supports **1340** do project into the storage bay **1360** as shown in FIGS. **13**A and **13**C. FIG. **14**A is a schematic view of a banknote recycler **1400** employing generally horizontal storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{D}$ according to some embodiments. In general, the banknote recycler **1400** and its operation may be similar to or identical to the banknote recycler **100** except that the banknote recycler **1400** employs generally horizontal storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{D}$ whereas banknote recycler **100** employs generally vertical storage bays **160***a*-**160***f*.

[0224] The banknote recycler **1400** comprises an input hopper **1410** for receiving a banknote or a stack of banknotes and a transport mechanism **1420** for receiving banknotes from the input hopper **110** and delivering the banknotes to and from a number of locations in the banknote recycler **1400**. The banknote recycler **1400** further comprises a banknote detector section **1430** which may be the same or similar to banknote detector section **130** discussed above. The recycler **1400** also comprises one or more externally accessible output receptacles $\mathbf{1440}_{A}$ and $\mathbf{1440}_{B}$. Banknotes delivered to the output receptacles $\mathbf{1440}_{A}$, $\mathbf{1440}_{B}$ may be removed by a user reaching into the output receptacles $\mathbf{1440}_{A}$, $\mathbf{1440}_{B}$ and grasping the banknotes with his or her hand. According to some embodiments, the output receptacles $\mathbf{1440}_{A}$, $\mathbf{1440}_{B}$ comprise stacker wheels **1442***a*, **1442***b* to assist in stacking the banknotes into the output receptacles $\mathbf{1440}_{A}$, $\mathbf{1440}_{B}$. In some modes of operation, the output receptacle $\mathbf{1440}_{A}$ may be used as a reject output receptacle to which rejected banknotes are delivered such as, for example, a banknote or document whose denomination was not determined by the banknote detector section **1430**.

[0225] According to some embodiments, the recycler **1400** further comprises a secure banknote storage bin $\mathbf{1440}_{C}$. In some modes of operation, the secure banknote storage bin $\mathbf{1440}_{C}$ may be used store banknotes which are determined to be counterfeit or mutilated using the one or more detectors in the banknote detector section **1430**. According to some embodiments, the banknote recycler has a slot or opening in its housing permitting an operator to insert banknotes into (but not withdraw bills from) the secure banknote storage bin $\mathbf{1440}_{C}$. For example, if an operator notices that a banknote to be processed is mutilated and may cause a jam if processed by the banknote recycler **1400**, the operator may directly put such notes through the slot in the housing so that such notes may be securely stored in the secure storage bin $\mathbf{1440}_{C}$. According to some embodiments, the operator may use an input/output interface (such as interface **208**) to enter information about the mutilated banknote(s) (such as the denomination and/or the serial number of each note) into the banknote recycler **1400** so that a processor or controller **202** may update information about the related transaction to reflect all bills in a transaction, e.g., so a customer may be given credit for the deposit of all banknotes deposited in a transaction, even those that are too mutilated to be automatically processed by the banknote recycler **1400**.

[0226] The recycler **1400** further comprises one or more generally horizontal banknote storage bins or bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{D}$. According to some embodiments, the first storage bay $\mathbf{1460}_{A}$ is used as an escrow storage bay to temporarily hold banknotes being deposited into the banknote recycler **1400** as described above in connection with storage bay **160***a*. According to some embodiments, the remaining storage bays $\mathbf{1460}_{B}$-$\mathbf{1460}_{D}$ are each dedicated to specific denominations of banknotes, e.g., storage bay $\mathbf{1460}_{B}$ may be assigned to store US $1 bills, storage bay $\mathbf{1460}_{C}$ may be assigned to store US $5 bills, storage bay $\mathbf{1460}_{D}$ may be assigned to store US $10 bills. Although not illustrated, the recycler may comprise additional storage bays such as a storage bay assigned to store US $20 bills and a storage bay to store US $100 bills. According to some embodiments, the recycler may also comprise one or more overflow storage bays such as storage bay $\mathbf{1460}_{E}$. Note, according to some embodiments, the recycler **1400** may comprise fewer or more than four to seven storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{E}$. The storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{E}$ are distinguishable from the output receptacles $\mathbf{1440}_{A}$, $\mathbf{1440}_{B}$ in that the storage bays **1460** are secured within a housing of the recycler **1400** and are not externally accessible to a typical user or operator of the recycler **1400**. Rather, to gain access to the storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{E}$ and the banknotes stored therein, a security door of the recycler must be opened. According to many embodiments, the security door is locked and may only be opened by authorized personnel having a key or access code enabling the security door to be unlocked.

[0227] In the embodiment illustrated in FIG. **14**A, each of the storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{D}$ receive bills or banknotes at a receiving end (e.g., $\mathbf{1460}_{A\text{-}1}$) and dispense or feed out bills from their other end (e.g., $\mathbf{1460}_{A\text{-}2}$). In such embodiments, banknotes are handled in a first-in, first out (FIFO) manner. According to some embodiments, the storage bays $\mathbf{1460}_{A}$-$\mathbf{1460}_{D}$ comprises dispensers **1470***a*-**1470***d* to dispense or

feed out bills from the respective storage bins **1460**$_A$-**1460**$_D$. According to some embodiments, the overflow storage bay **1460**$_E$ does not include a dispenser. According to other embodiments, the overflow storage bay **1460**$_E$ does include a dispenser. According to some embodiments, storage bays of the banknote recycler **1400** may handle banknotes in a last-in, first out (LIFO) manner.

[0228] In the embodiment illustrated in FIG. **14**A, stacker wheels **1462***a*-**1462***d*, **1462** assist in stacking bills into the respective the storage bays **1460**$_A$-**1460**$_E$. According to some embodiments, the stacker wheels **1462***a*-**1462***d*, **1462** stack bills on their edges within the storage bays **1460**$_A$-**1460**$_E$.

[0229] According to some embodiments, the storage bays **1460**$_A$-**1460**$_E$ comprises one or more moveable partitions or banknote supports **1405***a*, **1405***b*. The moveable partitions or banknote supports **1405***a*, **1405***b* may be horizontally moveable (such as in a manner similar to the one or more vertical elevators and banknote supports described above are moveable. For example, a first moveable partition **1405***a* may be positioned near a receiving end **1460**$_{A\text{-}1}$ of a storage bay **1460**$_A$. During a depositing or feed-in operation, the banknote support may be positioned near stacker wheel **1462***a* and move horizontally away from the stacker wheel (to the right in FIG. **14**A) as more and more banknotes are stacked within the storage bay **1460**$_A$. Likewise, a banknote support **1405***b* may be positioned closer to the dispensing end **1460**$_{A\text{-}2}$ of storage bay **1460**. The horizontal position of the banknote support may be adjusted to aid in the dispensing of banknotes by the dispenser **1470***a* such as by pressing banknotes into engagement with the dispenser **1470***a* and moving toward the dispensing end **1460**$_{A\text{-}2}$ as banknotes are fed out of the storage bay **1460**$_A$. Similar banknote supports may be positioned in the other generally horizontal storage bays **1460**$_B$-**1460**$_E$.

[0230] According to some embodiments, the generally horizontal storage bays **1460**$_A$-**1460**$_D$ may also comprises a means for moving stacks of banknotes from the receiving ends (e.g., **1460**$_{A\text{-}1}$) of the storage bays toward the dispensing ends (e.g., **1460**$_{A\text{-}2}$). For example, as will be described in more detail with respect to FIGS. **14**B and **14**C, the storage bays **1460**$_A$-**1460**$_D$ may comprise banknote supports **1405** that may be raised out of (or into) and lowered into (or out of) storage bays **1460**$_A$-**1460**$_D$. For example, the banknote supports **1405** may have operational positions in which they extend into the storage bays **1460**$_A$-**1460**$_D$ and support banknotes within the storage bays **1460**$_A$-**1460**$_D$ and non-operational positions in which they do not extend into the storage bays **1460**$_A$-**1460**$_D$ and support banknotes within the storage bays **1460**$_A$-**1460**$_D$. To move a stack of banknotes, two banknote supports **1405** may be positioned on either side of a stack of banknotes to be moved and then moved to their operational positions. Then such two banknote supports **1405** may then be moved horizontally in tandem so as to keep the banknotes therebetween standing on their edges until the stack of banknotes abuts the dispensing end (e.g., **1460**$_{A\text{-}2}$) or a banknote support supporting a stack of banknotes against the dispensing end (e.g., **1460**$_{A\text{-}2}$). Then the banknote support or supports near the dispensing end (e.g., **1460**$_{A\text{-}2}$) may be moved to its or their non-operational position(s) so that one end of the moved stack of banknotes abuts the dispenser or an end of a stack of banknotes already positioned at the dispensing end (e.g., **1460**$_{A\text{-}2}$).

[0231] Alternatively, banknotes may be continued to be deposited into a storage bay until a first banknote support (e.g., **1405***a*) is sufficiently close to a second banknote support (e.g., **1405***b*) that the first (and/or second) banknote support may be moved to a non-operational position (such as by moving or folding down into or through a floor of the storage bay) and the banknotes may be merged into a single stack of banknotes resting on their edges.

[0232] FIG. **14**B is a top view and FIG. **14**C is an end view of a generally horizontal storage bay **1460** employing banknote supports **1403**$_A$-**1403**$_D$ to support and move banknotes BN residing in storage bay **1460**. According to some embodiments, the banknote supports **1403**$_A$-**1403**$_D$ may be similar to the paddles described in U.S. Pat. No. 6,398,000, incorporated herein by reference in its entirety (see e.g., FIG. **3***a* of U.S. Pat. No. 6,398,000). According to some embodiments, the means for moving stacks of banknotes from the receiving ends (e.g., **1460**$_{A\text{-}1}$) of the storage bays toward the dispensing ends (e.g., **1460**$_{A\text{-}2}$) of the generally horizontal storage bays **1460**$_A$-**1460**$_D$ employ the banknote supports **1403**$_A$-**1403**$_D$ illustrated in FIGS. **14**B and **14**C. For example, the storage bays **1460**$_A$-**1460**$_D$ may comprise banknote supports **1403**$_A$-**1403**$_D$ that may be raised or pivoted out of and lowered or pivoted into storage bays **1460**$_A$-**1460**$_D$. For example, the banknote supports **1403**$_A$-**1403**$_D$ have operational positions in which they extend into the storage bays **1460**$_A$-**1460**$_D$ and support banknotes within the storage bays **1460**$_A$-**1460**$_D$ and non-operational positions in which they do not extend into the storage bays **1460**$_A$-**1460**$_D$ and support banknotes within the storage bays **1460**$_A$-**1460**$_D$. To move a stack of banknotes, two banknote supports such as **1403**$_B$ and **1403**$_C$ may be positioned on either side of a stack of banknotes to be moved and then moved to their operational positions. Then the two banknote supports **1403**$_B$, **1403**$_C$ may be moved horizontally in tandem so as to keep the banknotes therebetween standing on their edges until the stack of banknotes abuts the dispensing end **1460**$_2$ or a banknote support supporting a stack of banknotes against the dispensing end (e.g., banknote support **1403**$_D$). Then the banknote support or supports **1403**$_C$, **1403**$_D$ near the dispensing end **1460**$_2$ may be moved to its or their non-operational position(s) so that one end of the moved stack of banknotes abuts the dispenser **1460**$_2$ or an end of a stack of banknotes already positioned at the dispensing end.

[0233] According to some embodiments, the banknote supports **1403**$_A$-**1403**$_D$ are pivotally mounted to respective guide posts **1404**$_A$, **1404**$_B$ positioned near and generally parallel the top of storage bay **1460**. The posts **1404**$_A$, **1404**$_B$ may extend from a receiving end **1460**$_1$ to a dispensing end **1460**$_2$ of the storage bay **1460** and be positioned on opposite sides of the storage bay **1460**. The banknote supports **1403**$_A$-**1403**$_D$ may be pivoted into and out of the storage bay **1460**. One or more motors communicatively coupled to and controlled by a controller or processor such as controller or processor **202** may move the banknote supports **1403**$_A$-**1403**$_D$ into and out of the storage bays (into and out of operational positions) and along the guide posts **1404**$_A$, **1404**$_B$.

[0234] FIGS. **15**A and **15**B are sectional views of a generally horizontal recycling bay arrangement comprising a banknote recycler storage bay or recycling bay **1560** according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme. During a depositing or feed-in operation illustrated in FIG. **15**A, banknotes BN are received in a pair of stacker wheels **1562** and stacked on their edges in the storage bay **1560**. The

stacking wheels **1562** are coupled to a rotatable stacking wheel/dispenser carriage **1506** configured to rotate about carriage axis $\mathbf{1506}_{SH}$. To switch from a depositing operation to a dispensing operation as shown in FIG. **15**B, the carriage is rotated (via a motor communicatively coupled to and controlled by a controller or processor such as controller or processor **202**) so as to rotate the stacker wheels **1562** away from an open end of the storage bay **1560** and rotate a dispenser mechanism into position near the open end of the storage bay **1560**. As illustrated in FIG. **15**B, the rotation is in a counter-clockwise direction D_{15B}. The dispenser mechanism may comprise stripping wheels **1574** and drive rolls **1575** that may be the same as or similar to in both construction and operation as the stripping wheels (e.g., **374**, **874**, **1174**, **1274**) and drive rolls (e.g., **375**, **875**, **1175**, **1275**) described above. Banknotes BN may be fed out of storage bay **1560** via the dispenser mechanism such as in direction D_{15D}. A generally horizontally moveable banknote support **1503** assists with maintaining banknotes stacked on their edges within banknote storage bay **1560** and into engagement with the stripping wheels **1574** during a dispensing operation. To switch from a dispensing operation to a depositing operation as shown in FIG. **15**A, the carriage is rotated (via a motor communicatively coupled to and controlled by a controller or processor such as controller or processor **202**) so as to rotate the stacker wheels **1562** into position near an open end of the storage bay **1560** and rotate a dispenser mechanism away from the open end of the storage bay **1560**. As illustrated in FIG. **15**A, the rotation is in a clockwise direction D_{15A}. Banknotes may be fed into the stacker wheels **1562** such as in direction D_{15C}.

[0235] FIGS. **16**A and **16**B are sectional views of a generally horizontal recycling bay arrangement comprising a banknote recycler storage bay or recycling bay **1660** according to some embodiments of the present disclosure employing a Last-In, First-Out (LIFO) feeding scheme. In general, the arrangement of FIGS. **16**A and **16**B is similar or identical in construction and operation as described above in connection with FIGS. **15**A and **15**B except that in FIGS. **16**A and **16**B the stacker wheels **1662** are on a separate carriage **1660** than the dispensing mechanism carriage **1670** while in FIGS. **15**A and **15**B, the stacker wheels **1562** and the dispensing mechanism are on the same carriage **1506**. During a depositing or feed-in operation illustrated in FIG. **16**A, banknotes BN are received in a pair of stacker wheels **1662** and stacked on their edges in the storage bay **1660**. The stacking wheels **1662** are coupled to a moveable stacking wheel carriage **1660** configured to move in front of an open end of storage bay **1660** and away from the open end of storage bay **1660** (e.g., in directions D_{16E} and D_{16F} shown in FIG. **16**B). Likewise, a dispensing mechanism comprising stripping wheels **1674** and drive rolls **1675** are coupled to a moveable dispenser carriage **1670** configured to move in front of an open end of storage bay **1660** and away from the open end of storage bay **1660** (e.g., in directions D_{16E} and D_{16F} shown in FIG. **16**B). The stripping wheels **1674** and drive rolls **1675** that may be the same as or similar to in both construction and operation as the stripping wheels (e.g., **374**, **874**, **1174**, **1274**) and drive rolls (e.g., **375**, **875**, **1175**, **1275**) described above. To switch from a depositing operation to a dispensing operation as shown in FIG. **16**B, the stacker wheel carriage **1660** is moved (via a motor communicatively coupled to and controlled by a controller or processor such as controller or processor **202**) so that the stacker wheels **1662** are moved away from an open end of the storage bay **1660** (e.g., in direction D_{16E}) and the dispenser mechanism carriage **1670** is moved so that the dispenser mechanism is positioned near the open end of the storage bay **1660** (e.g., in direction D_{16F}). Banknotes BN may be fed out of storage bay **1660** via the dispenser mechanism such as in direction D_{16D}. A generally horizontally moveable banknote support **1603** assists with maintaining banknotes stacked on their edges within banknote storage bay **1660** and into engagement with the stripping wheels **1674** during a dispensing operation. To switch from a dispensing operation to a depositing operation as shown in FIG. **16**A, the stacker wheel carriage **1660** is moved (via a motor communicatively coupled to and controlled by a controller or processor such as controller or processor **202**) so that the stacker wheels **1662** are moved near an open end of the storage bay **1660** (e.g., in direction D_{16F}) and the dispenser mechanism carriage **1670** is moved so that the dispenser mechanism is positioned away from the open end of the storage bay **1660** (e.g., in direction D_{16E}). Banknotes may be fed into the stacker wheels **1662** such as in direction D_{16C}.

[0236] FIG. **17**A is a perspective view of components of a banknote recycler **1700** having six recycler storage bays or generally vertically oriented banknote recycling bays **1760***a*-**1760***f* according to some embodiments of the present disclosure. FIG. **17**B is an end view of the banknote recycler **1700** of FIG. **17**A and FIG. **17**C is an enlarged view of a portion of FIG. **17**A. In FIGS. **17**A-**17**C a portion of a main transport mechanism **1820** is shown in an open, non-operational position and depicting a plurality of banknote feeding modules **1900***a*-**1900***f* residing at the top of respective storage bays **1760***a*-**1760***f*. FIG. **17**D is a further enlarged view of a feeder module **1900***c* of FIGS. **17**A-**17**C. FIG. **17**E is a front view of banknote recycler **1700** with a main transport mechanism **1820** in a closed position. FIG. **17**F is cross-sectional view of upper ends of banknote recycling bays **1760***d*-**1760***f*. FIG. **17**G is an enlarged view of a feeder module **1900** in an operational position above one of the recycling bays **1760***a*-**1760***f*. FIG. **17**G**1** is an enlarged view similar to FIG. **17**G illustrating an in-feed transport path $\mathbf{1900}_{IN}$ and an out-feed transport path $\mathbf{1900}_{OUT}$ for one of the recycling bays **1760***a*-**1760***f*. FIG. **17**H is an enlarged rear perspective view of a couple of recycling bays **1760***a*-**1760***b* having some components such as the main transport mechanism **1820** and feeder modules **1900** removed. In FIG. **17**G, a direction of banknote transport DF_{17} along transport path **1820**D (see FIG. **18**B) is illustrated with indication of the upstream US end and the downstream DS end.

[0237] The banknote recycler **1700** comprises a multiple storage bay chassis **1704** and a housing **1702**. According to some embodiments, the housing has an exterior width W_{17} less than or equal to about 18 inches (46 cm), an exterior height H_{17} less than or equal to about 38 inches (97 cm), and an exterior length L_{17} less than or equal to about 39 inches (99 cm). In FIGS. **17**A-**17**C multiple storage bay chassis **1704** is illustrated in an extended, non-operational position outside of housing **1702**. In an operational position, transport mechanism **1820** is placed in a closed, operational position (see, e.g., FIGS. **17**E, **17**F, **18**A, **18**D) and the multiple storage bay chassis **1704** is nested inside of housing **1702** (not shown). According to some embodiments, the multiple storage bay chassis **1704** is supported on retractable bearing arms **1706** (see FIGS. **17**B and **17**E) which permit the multiple storage bay chassis **1704** to be moved out of and

back into the housing **1702**. According to some embodiments, the multiple storage bay chassis **1704** is alternatively or additionally supported on wheels to facilitate the multiple storage bay chassis **1704** being moved out of and into the housing **1702**.

[0238] The banknote recycler **1700** comprises a banknote transport mechanism comprising a main transport mechanism **1820** and an upper transport mechanism $\mathbf{1820}_U$. Although not illustrated in FIGS. **17**A-**17**C, the upper transport mechanism $\mathbf{1820}_U$ is communicatively coupled to an input receptacle to permit banknotes to be received or deposited into the banknote recycler such as input receptacle or hopper **110** shown in, for example, FIG. **1**A and open, externally accessible output receptacles to permit banknotes to be dispensed from the banknote recycler such as open, externally accessible output receptacles **140***a*, **140***b*. Likewise, the upper transport mechanism $\mathbf{1820}_U$ may include or be communicatively coupled a banknote detector section **130** as described above.

[0239] According to some embodiments, the banknote recycler **1700** operates similar as described above in connection with banknote recyclers **100**, **100'**, and/or **100"** described in connection with FIGS. **1**A-**1**H and **2** above with the exception that banknotes are fed into and out of individual storage bays **1760***a*-**1760***f* at the top of each storage bay **1760** as opposed to being fed in at the top and fed out at the bottom of each bay **160**. As a result, banknote recycler **1700** employs a Last-In, First-Out (LIFO) feeding scheme as opposed to the first-in, first-out (FIFO) feeding scheme of FIGS. **1**A-**1**H. Accordingly, according to some embodiments, banknote recycler may comprise secure storage bin **150**, a banknote detector section **130'**, and/or a banknote cassette receiving port or interface or container dock **180**. Accordingly, banknote recycler **1700** is similar to banknote recycler **1200** described above in connection with FIGS. **12**A-**12**B. Additionally, whereas in some embodiments or modes of operations banknotes may be deposited into and dispensed from a given storage bay **160**/**360** simultaneously, banknotes may be either deposited into or dispensed from a given storage bay **1760** at a given time but both operations may not be performed simultaneously for a given storage bay **1760**. For example, in an Internal Audit Mode, instead of feeding banknotes out of a particular bay, e.g., bay **1760***b* and immediately back into the same bay, e.g., bay **1760***b*, the banknotes may be first routed to and stored in an empty bay such as an escrow bay, e.g., bay **1760***a*. Likewise, in an Internal Audit Mode, the contents of each storage bay, e.g., bays **1760***b*-**1760***f*, may be audited in a sequential manner in conjunction with an empty bay such as an escrow bay, e.g., first banknotes from storage **1760***b* are fed out and past banknote detector **130** and into storage bay **1760***a* and once all the banknotes have been verified and transferred into storage bay **1760***a*, they are then transferred from storage bay **1760***a* back into storage bay **1760***b*. Then banknotes from storage **1760***c* are fed out and past banknote detector **130** and into storage bay **1760***a* and once all the banknotes have been verified and transferred into storage bay **1760***a*, they are then transferred from storage bay **1760***a* back into storage bay **1760***c*. This process may then be continued until the contents of all remaining storage bays, e.g., **1760***d*-**1760***f*, have been audited. As another example, for embodiments wherein banknotes of a plurality of denominations are stored in a single storage bay, an empty bay such as an escrow bay (e.g., storage bay **1760***a*) may be used to hold banknotes that are dispensed from given one of such storage bays (e.g., storage bay **1760***b*) but not to be dispensed to an output receptacle **140***a*, **140***b* until dispensing from the given one of such storage bays (e.g., storage bay **1760***b*) is ended, e.g., when it is determined that a desired number of banknotes of a particular denomination have been dispensed to one of the output receptacles **140***a*, **140***b* and/or have been detected by banknote detector **130**. After a processer such as processor **202** determines that no more banknotes need to be dispensed from the given storage bay (e.g., storage bay **1760***b*), the storage bay (e.g., storage bay **1760***b*) may be placed into a deposit configuration and the banknotes stored in the escrow bay (e.g., storage bay **1760***a*) may to transferred back into the given storage bay (e.g., storage bay **1760***b*). Otherwise, the operation of the banknote recycler **1700** may be the same as that described above in connection with FIGS. **1**A-**1**H, **2** and FIGS. **12**A-**12**B including having the various modes of operation as described above in connection with FIGS. **1**A-**1**H.

[0240] The banknote recycler **1700** comprises a main transport mechanism **1820**, a plurality of storage bays **1760**, with each storage bay **1760** having associated therewith a feeding module **1900**, a stacker module **2000**, and an elevator **2110**.

[0241] In general, except as illustrated in FIGS. **17**A-**22**E and described therewith, the banknote recycler bay **1760** may operate the same as described above in connection with banknote recycler bay **160**, **360** and **1260** and may have the same or similar components. In this regard, the same or similar components will be identified with the same or similar numbers (e.g., "300" series numbers are changed to "1700" series numbers, "500" series numbers are changed "2100" series numbers, "100" series numbers are changed to one or more of "1700" series, "1800" series, "1900" series, "2000" series numbers) For example, in FIGS. **1**A-**1**H, diverters **161***a*-**161***f* divert banknotes into storage bays **160***a*-**160***f* whereas for recycler **1700** the corresponding diverters are designated diverters **1861**A-**1861**F. Similarly, for recycler **1700** the storage bay stacker wheels are designated storage bay stacker wheels **2062***a*-**2062***f* corresponding to the designations of storage bay stacker wheels **162***a*-**162***f* in FIGS. **1**A-**1**H. Likewise, except as illustrated in FIGS. **12**A-**12**B and described therewith, a banknote recycler such as recylcers **100**, **100'**, and **100"** having an arrangement **1200** may operate the same or similar as described below in connection with banknote recycler bay **1760**.

[0242] According to some embodiments, the first storage bay **1760***a* is used as an escrow storage bay to temporarily hold banknotes being deposited into the banknote recycler **1700** as will be described in more detail below. According to some embodiments, the remaining storage bays **1760***b*-**1760***f* are each dedicated to specific denominations of banknotes, e.g., storage bay **1760***b* may be assigned to store US $1 bills, storage bay **1760***c* may be assigned to store US $5 bills, storage bay **1760***d* may be assigned to store US $10 bills, storage bay **1760***e* may be assigned to store US $20 bills, storage bay **1760***f* may be assigned to store US $100 bills. Note, according to some embodiments, the recycler **100** may comprise fewer or more than six storage bays **1760***a*-**1760***f* such as for example, one, two, three, four, five, seven, eight, nine, ten, etc. storage bays **1760**.

[0243] According to some embodiments, the storage bays **1760***a*-**1760***f* reside within a housing such as housing **1702** of the recycler **1700** having one or more security doors. The

housing and security door(s) serve as a safe and may be made of high strength material such as metal and/or hard plastic. The storage bays **1760***a*-**1760***f* are distinguishable from the open output receptacles **140***a*, **140***b* in that the storage bays are secured within a housing of the recycler **1700** and are not externally accessible to a typical user or operator of the recycler **1700** and are not externally accessible while the banknote recycler **1700** is operating under normal operating conditions such as when an operator is using the banknote recycler to deposit notes into the banknote recycler **1700** via an input receptacle such as input receptacle **110** and/or when an operator is using the banknote recycler **1700** to dispense banknotes to one or more externally accessible, open output receptacles such as open output receptacles **140***a*, **140***b* shown in FIG. **1**A. Rather, to gain access to the storage bays **1760***a*-**1760***f* and the banknotes stored therein, a security door of the recycler must be opened. According to many embodiments, the security door is locked and may only be opened by authorized personnel having a key or access code enabling the security door to be unlocked. According to some embodiments, the housing **1702** having one or more security doors constitutes a safe complying with UL 291 standard.

[0244] The main transport mechanism **1820** is described in more detail in connection with FIGS. **18**A-**18**E. FIG. **18**A is a perspective view of the main transport mechanism **1820** in its closed, operational state or position, FIG. **18**B is a perspective view of the main transport mechanism **1820** in an open, non-operational state, FIG. **18**C is a downward perspective view of the main transport mechanism **1820** in an open, non-operational state, and FIG. **18**D is a rear perspective view of the main transport mechanism **1820** in its closed, operational state or position. FIG. **18**E is an upward perspective view of a lower portion of the main transport mechanism **1820**. The main transport mechanism **1820** comprises a lower transport section **1820**A, a middle transport section **1820**B, and an upper transport section **1820**C.

[0245] A lower storage bay transport path **1820**D is formed between the middle transport section **1820**B and the lower transport section **1820**A and an upper transport path **1820**E is formed between the middle transport section **1820**B and the upper transport section **1820**C. The lower transport section comprises an upper transport plate **1802**, the middle transport section **1820**B comprises a lower transport plate **1804** and an upper transport plate **1806**, and the upper transport section **1820**C comprises a lower transport plate **1808**. When in their closed operational position, the transport plates **1802** and **1804** are slightly spaced apart from each other and define the lower transport path **1820**D therebetween and the transport plates **1806** and **1808** are slightly spaced apart for each other and define the upper transport path **1820**E therebetween. Each transport plate **1802**-**1808** has a plurality of transport roll apertures therein through which a corresponding plurality of transport rolls project into the transport paths **1820**D and **1820**E. More specifically, the transport plate **1802** has a plurality of transport roll apertures through which a plurality of passive transport rolls **1812** project upward into the lower transport path **1820**D so as to contact banknotes being transported along the lower transport path **1820**D. The transport plate **1804** has a corresponding plurality of transport roll apertures through which a plurality of driven transport rolls **1814** project downward into the lower transport path **1820**D so as to contact and drive banknotes along the lower transport path **1820**D. The transport roll apertures in transport plate **1804** are positioned directly above the transport roll apertures in transport plate **1802** so that a passive transport roll **1812** protecting through each aperture comes in contact with a corresponding driven transport roll **1814** when the transport plates **1802** and **1804** are in an operational position such as shown in FIG. **18**A.

[0246] Similarly, the transport plate **1808** has a plurality of transport roll apertures through which a plurality of passive transport rolls **1818** project downward into the upper return transport path **1820**E so as to contact banknotes being transported along the upper return transport path **1820**E. The transport plate **1806** has a corresponding plurality of transport roll apertures through which the plurality of driven transport rolls **1814** project upward into the upper return transport path **1820**E so as to contact and drive banknotes along the upper return transport path **1820**E. The transport roll apertures in transport plate **1808** are positioned directly above the transport roll apertures in transport plate **1806** so that a passive transport roll **1818** protecting through each aperture comes in contact with a corresponding driven transport roll **1814** when the transport plates **1806** and **1808** are in an operational position such as shown in FIG. **18**A. As illustrated, according to some embodiments, the same driven transport rolls **1814** are used to drive bills or banknotes both along portions of transport paths **1820**D and **1820**E, but in opposite directions. The driven transport rolls **1814** are coupled to and rotate about shafts $\mathbf{1814}_{SH}$. According to some embodiments, one side of a driven transport roll **1814** projects into transport path **1820**D while an opposing side projects into transport path **1820**E.

[0247] As best seen if FIG. **18**D, according to some embodiments, the driven transport rolls **1814** are rotational driven about shafts $\mathbf{1814}_{SH}$ by a motor **1890** via belts **1892**. In some embodiments, the use of the same motor aids in synchronizing the movement of banknotes along a number of portions of the transport path **120**/**1820**. The motor **1890** may be similar to motor **390** discussed above and is controlled a processor or controller such as controller **202**.

[0248] As can be seen in FIGS. **18**B and **18**C, according to some embodiments, the transport plates **1804**, **1806**, and **1808** may be moved to an open, non-operational position to aid in clearing jams of banknotes and/or in providing maintenance or service to the transport paths **1820**D and **1820**E and their related transport mechanism components as well as to gain access to feeding modules **1900***a*-**1900***f* and/or into storage bays **1760***a*-**1760***f*. According to some embodiments, the pair of transport plates **1804** and **1806** are coupled together in fixed relation to each other. The transport sections **1820**A-**1820**C and their associated transport plates **1802**, **1804**, **1806**, and **1808** are pivotally coupled to a pivot bar **1708** (see FIGS. **18**D and **17**C) having a longitudinal axis $\mathbf{1708}_{A}$. According to some embodiments, as illustrated in FIGS. **18**A and **18**B, the transport plates **1804**, **1806**, and **1808** may be moved from a closed, operational position to an open, non-operational position and back to a closed, operational position without having to remove or disconnect with belts **1892** used to drive the driven transport rolls **1814**. According to some embodiments, when a transport section **1820**A-**1820**C is moved to an open position, it is configured to remain in the open position. As can be seen if FIGS. **18**B-**18**C, according to some embodiments, transport sections **1820**B-**1820**C may be opened relative to each

other and/or transport section **1820**A to provide access to the entire transport paths **1820**D and **1820**E; thus, facilitating the clearing of jams of banknotes and/or in providing maintenance or service to the transport paths **1820**D and **1820**E and their related transport mechanism components.

[0249] Also illustrated in FIGS. **18**B and **18**C are diverters **1861**A-**1861**F which serves as one example of a diverter that may be used as diverters **161** of FIGS. **1**A-**1**H. The diverters **1861** are mounted on respective diverter shafts $\mathbf{18616}_{SH}$ which are each coupled to a respective solenoid **1892** which selectively changes the position of a respective diverter **1861** between a non-diverting position (shown in FIGS. **18**B and **18**C) and a diverting position wherein a portion of the diverter projects into the lower transport path **1820**D so as to divert a banknote from continuing along lower transport path **1820**D and instead directs a bill or banknote into a respective storage bay **1760**. The solenoid **1892** is controlled a processor or controller such as controller **202**.

[0250] Referring to FIGS. **17**A and **18**A, when the banknote recycler is in a normal operating condition, the chassis **1704** is positioned within and secured in housing/safe **1702**. In such a normal operable position, the right side of the main transport mechanism **1820** is positioned below the upper transport mechanism $\mathbf{1820}_{U}$ so that banknotes placed in hopper **110** (not shown in FIG. **17**A; see, e.g., FIG. **1**A) are fed into the upper transport mechanism $\mathbf{1820}_{U}$ and then into the main transport mechanism **1820**, being received in the main transport mechanism **1820** in the direction as indicated in FIG. **18**A by arrow **1820**D. Likewise, in such an normal operable position, the right side of the main transport mechanism **1820** is positioned below the upper transport mechanism $\mathbf{1820}_{U}$ so that banknotes may be transported from the main transport mechanism **1820** to the upper transport mechanism $\mathbf{1820}_{U}$ in the direction as indicated in FIG. **18**A by arrow **1820**E and from the upper transport mechanism $\mathbf{1820}_{U}$ to one or more open output receptacles such as output receptacles **140***a*, **140***b* (see, e.g., FIG. **1**A). While being transported within the upper transport mechanism $\mathbf{1820}_{U}$ banknotes may be routed through and analyzed (e.g., denominated, authenticated, etc.) by a banknote detector section **130** as described above in connection with FIGS. **1**A-**1**H.

[0251] One of the feeder modules **1900** is described in more detail in connection with FIGS. **19**A-**19**E. FIG. **19**A is a perspective view illustrating an upstream, outfeed side $\mathbf{1970}_{US}$, FIG. **19**B is a perspective view illustrating a downstream, infeed side $\mathbf{1970}_{DS}$, FIG. **19**C is a cross-sectional view, FIG. **19**D is a rear view, and FIG. **19**E is an upward looking bottom perspective view of a feeder module **1900**.

[0252] The feeder module **1900** may comprise a housing $\mathbf{1900}_{HS}$ comprising an upstream side $\mathbf{1970}_{US}$, a downstream side $\mathbf{1970}_{DS}$, a front side $\mathbf{1970}_{FR}$, and a rear side $\mathbf{1970}_{R}$. The feeder module **1900** may also comprise one or more of a guide feeder entry wall **1971**, a feeding plate **1972**, positioning tabs **1968**, upper in-feed passive rolls **1997**, lower in-feed passive rolls **1998**, feeder springs **1969**, upper out-feed passive rolls $\mathbf{1982}_{U}$, lower out-feed passive rolls $\mathbf{1982}_{L}$, a feeder module motor **1990**, stripping or auxiliary wheels **1974**, a drive roll **1975**, retard rollers **1979**, and an idler roll **1976**.

[0253] According to some embodiments, the feeder module **1900** assists with both the feeding of banknotes into a corresponding storage bay **1760** but also feeding of banknotes out of the storage bay. According to some embodiments, the feeder module **1900** comprises a banknote dispensing assembly that may comprises one or more stripping or auxiliary wheels **1974** and one or more drive rolls **1975**. According to some embodiments, the dispensing assembly may also comprise one or more retard rollers **1979**, one or more idler rolls **1976**, and/or the feeder module motor **1990**.

[0254] According to some embodiments, each feeder module **1900** have one or more electrostatic brushes $\mathbf{1900}_{BR}$ (see, e.g., FIG. **19**A). As banknotes enter the in-feed path $\mathbf{1900}_{IN}$ (see, e.g., FIG. **17**G-**1**), the banknotes engage the electrostatic brush $\mathbf{1900}_{BR}$ will serves to remove or reduce the amount of electrostatic electricity existing on the banknotes. According to some embodiments, the electrostatic brushes $\mathbf{1900}_{BR}$ are made of an electrically conductive material such as a metal such as copper and are electrically grounded.

[0255] According to some embodiments, the feeder modules **1900** have one or more arms **1963** extending from a rear side of the feeder module housing $\mathbf{1900}_{HS}$. Each arm **1963** has a pair of flanges **1964** with a slot **1966** therebetween. The feeder module **1900** may be pivotally coupled to the pivot bar **1708** (see FIGS. **18**D and **17**C) of the multiple storage bay chassis **1704** by fitting the flanges **1964** about the bar **1708** so that the bar **1708** is positioned within the slot **1966**. According to some embodiment, the flanges **1964** may be secured to mounting brackets **1967** positioned about the bar **1708** passing through an aperture $\mathbf{1967}_{A}$ of the mounting brackets **1967**. According to some embodiments, the flanges **1964** are coupled to the mounting bracket **1967** using screws, nuts and bolts, or the like. To remove a feeder module **1900** from the banknote recycler **1700**, the main transport mechanism **1820** is pivoted about bar **1708** and placed in an open, non-operational state such as shown in FIG. **17**A, the feeder module **1900** is pivoted up so the front of the feeder module clears the multiple storage bay chassis **1704** (such as the position of feeder module **1900***c* shown in FIG. **17**A) and the flanges **1964** of the feeder module **1900** are slid off of the bar **1708**. If coupled to mounting brackets **1967**, the flanges **1964** are decoupled from the mounting brackets **1967** (such as by unscrewing screws or removing bolts) prior to sliding the flanges **1964** off of the bar **1708**. To install a feeder module **1900** into the banknote recycler, the flanges **1964** are slid about bar **1708** and the feeder module **1900** is pivoted downward into an operational position such as the position of feeder module **1900***a* shown in FIG. **17**A. The flanges **1964** may then be coupled to mounting brackets **1967**, if present. When removing a first feeder module **1900** from the banknote recycler **1700**, for example, when the feeder module **1900** is not operating properly or otherwise needs service, a service personnel or technician may quickly disconnect any associated electrical connections (e.g., power, communications lines to one or more processors such as processor **202**), remove the first feeder module **1900** as described above, insert another second feeder module **1900** as described above and reconnect the associated electrical connections.

[0256] Additionally, according to some embodiments, the feeder modules **1900** and the storage bay chassis **1704** are configured to allow a feeder module **1900** to self-center itself when lowered into its operating position (e.g., when lowered from the positions of feeder module **1900***d* shown in FIG. **17**D to the position of feeder module **1900***d* shown in FIG. **17**D) and/or when a replacement feeder module **1900** is installed during service of the banknote recycler

1700 by a service personnel or technician. Referring to, for example, FIGS. **17**D and **17**H, the storage bay chassis **1704** has a plurality of feeder module positioning flanges **1768** located on the upstream side and/or the downstream side near the top of each storage bay **1760**. Similarly, referring to, for example, FIGS. **17**D and **19**A-**19**B, each feeder module has a plurality of feeder module positioning flanges **1968** located on the upstream side $\mathbf{1970}_{US}$ and/or the downstream side $\mathbf{1970}_{US}$ of the housing $\mathbf{1900}_{HS}$ of the feeding module **1900**.

[0257] According to some embodiments, when the feeder module **1900** is moved into its operational position, the positioning flanges **1968** of the feeding module contact the infeed upper wall $\mathbf{1799}_{IN}$ and the outfeed upper wall $\mathbf{1799}_{OUT}$ (see FIGS. **17**G, **17**G-**1**, **17**D and **17**H) and operate to accurately self-position the feeder module **1900** into its correct upstream-downstream position and vertical orientation above a given storage bay **1760**.

[0258] According to some embodiments, the feeder module **1900** and chassis **1704** also comprise one or more components to ensure a feeder module **1900** when lower into its operational position is also accurately vertically positioned at a desired height. According to some embodiments, the feeder module **1900** comprises a front lower positioning flange **1909** (FIG. **19**B) and the chassis **1704** has coupled thereto a feeder module positioning flange **1709** which according to some embodiments has a positioning receiving notch $\mathbf{1709}_N$. According to some embodiments, when the feeder module **1900** is moved into its operational position, the feeder module positioning flange **1709** nests into the bottom of the positioning receiving notch $\mathbf{1709}_N$. Accordingly, the height of the bottom of the positioning receiving notch $\mathbf{1709}_N$ can be set to ensure the front of the feeder module self-positions itself at a desired height. Furthermore, according to some embodiments, the location of the positioning receiving notch $\mathbf{1709}_N$ in a direction transverse to the upstream-downstream direction (in a front-back direction) can be set so that when the feeder module **1900** is moved into its operational position and the feeder module positioning flange **1709** nests into the bottom of the positioning receiving notch $\mathbf{1709}_N$, the front-back position of the feeder module is accurately set at a desired location. According to some embodiments, the vertical position of the rear of the feeder module **1900** may be accurately controlled by vertical position of the pivot bar **1708** and the configuration of the arms **1963** of the feeder module coupled to or engaging the pivot bar. As a result, according to some embodiments, a service personnel or technician does not need to spend time adjusting the position of a feeder module **1900** after it has been lowered into its operational position and the feeder module **1900** and mating components ensure the feeder module **1900** becomes automatically and accurately positioned in a proper upstream-downstream, front-back, vertical, and/or orientation.

[0259] According to some embodiments, other feeder module **1900** positioning components may be alternatively or additionally employed. For example, according to some embodiments, when the feeder module **1900** is moved into its operational position, pairs of the positioning flanges **1768**, **1968** contact each other and self-position the feeder module **1900** into its correct position above a given storage bay **1760**. For example, one positioning flange **1768** near the top of a given storage bay **1760** is located so as to contact a corresponding positioning flange **1968** located on a feeder module **1900** when the feeder module is lowered into and/or is in its operational position. According to some embodiments, there is at least one set of positioning flanges **1768**, **1968** on both the upstream side and the downstream side above each storage bay **1760**. According to some embodiments, each pair of positioning flanges **1768**, **1968** has a complimentary shape so that the chassis positioning flanges **1786** support the feeder modules **1900** via the feeder module positioning flanges **1968** and limit the depth to which a feeder module **1900** moves when lowered into an operational position. In this way, according to some embodiments, the positioning flanges **1768**, **1968** position both vertically and horizontally (upstream-downstream) a feeder module above a given storage bay **1760** in a desired operational position. According to some embodiments, however, the positioning flanges **1768**, **1968** position horizontally (upstream-downstream) a feeder module above a given storage bay **1760** in a desired operational position whereas the vertical position of the front of the feeder module **1900** is controlled by a bottom surface of a handle $\mathbf{1900}_H$ of the feeder module **1900** resting upon a front chassis rail $\mathbf{1704}_R$ (see FIG. **17**D) while the vertical position of the rear of the feeder module **1900** is controlled by coupling of the arms **1963** of the feeder module to the pivot bar **1708**. As a result, according to some embodiments, a service personnel or technician does not need to spend time adjusting the position of a feeder module **1900** after it has been lowered into engagement with the chassis positioning flanges **1768**.

[0260] According to some embodiments, each of the feeder modules **1900***a*-**1900***f* are identical and interchangeable modules that may be quickly inserted into and/or removed from a storage bay **1760**. Thus, when servicing banknote recycler **1700**, if one or more of the feeder modules is not working properly, a service technician may quickly and easily remove a malfunctioning feeder module **1900** and replace it with another modular feeder module **1900**. According to such embodiments, the banknote recycler may then be quickly serviced and placed back into normal operational use. According to some such embodiments, a malfunctioning feeder module may then be serviced at a different location such as at a service technician's or manufacturer's facility so as to minimize time during which a service technician would need to interfere with the normal operation and use of the banknote recycler such as by bank tellers.

[0261] Depositing/in-Feeding

[0262] With particular reference to FIGS. **17**G, **17**H and **19**A-**19**E, in operation, banknotes to be stored in one of the storage bays **1760***a*-**1760***f* are routed along transport path **1820**D. If a banknote is to by-pass a storage bay **1760**, the corresponding diverter **1861** is maintained in its non-diverting position and the driven transport rolls **1814** advance the banknote along the lower transport path **1820**D past the diverter **1861** and toward the next storage bay **1760**. If a banknote is to be directed into a storage bay **1760**, the position of the corresponding diverter **1861** is moved to its diverting position wherein a portion of the diverter **1861** will project into the transport path **1820**D so that the leading edge of the banknote being advanced by the driven transport rolls **1814** contacts the diverter **1861** and is directed downward along a lower surface of the diverter **1861**, along an in-feed path defined between a downstream side $\mathbf{1970}_{DS}$ of a feeding module **1900** on one side of the in-feed path and an upstream surface $\mathbf{1816}_{US}$ of a banknote guide **1816** on the downstream

side of the storage bay **1760** and an infeed upper wall $\mathbf{1799}_{IN}$ above the storage bay **1760** on the other side of the in-feed path. While proceeding along the in-feed path, a banknote proceeds past one or more driven feeder rolls **1796** located on a downstream side of an upper end of a corresponding storage bay **1760** and one or more upper in-feed passive rolls **1997** and between one or more second driven feeder rolls **1798** located on an downstream side of the upper end of a corresponding storage bay **1760** and one or more lower in-feed passive rolls **1998** and then in between the fingers of the stacker wheels **2062**. The driven feeder rolls **1796** are mounted on a feeder roll shaft $\mathbf{1796}_{SH}$ and the driven feeder rolls **1798** are mounted on a feeder roll shaft $\mathbf{1798}_{SH}$.

[0263] The stacker wheels **2062** then stack the banknote onto a banknote support **2140** or, if there are already one or more banknotes stacked on the banknote support **2140**, onto the top of the stack of banknotes being supported by banknote support **2140**. The elevator **2110** may be slowly lowered as more banknotes are directed into storage bay **1760** so that the stacker wheels **2062** may stack incoming banknotes onto the top of the stack of banknotes being supported by banknote support **2140** wherein the top of the stack of banknotes is maintained generally at the same height. As the banknotes are not perfectly flat and may, in fact, have wrinkles and creases therein, as a stack of banknotes grows on the banknote support **2140**, the stack of banknotes becomes to have a degree of vertical sponginess. According to some embodiments, the banknote recycler **1700** is operated at high speeds and can deliver notes from the storage bay transport path **1820**D into a storage bay **1760** and onto and along the transport path **1820**D and **1820**E at a rate of at least 1000 bills/banknotes per minute.

[0264] Dispensing/Out-Feeding

[0265] Also with particular reference to FIGS. **17**G, **17**H and **19**A-**19**E, at the top of the storage bay **1760** is a dispenser **1970**. The dispenser **1970** comprises a feeding plate **1972** which forms a top surface of the storage bay **1760** and serves as a surface against which a stack of banknotes in the storage bay may be pressed during a dispensing or feeding out operation. During a dispensing operation, banknotes or bills that are stacked on an elevator banknote support **2140** of an elevator **2110** are stripped, one at a time, from the top of the stack. The bills are stripped by a pair of stripping wheels **1974** mounted on a stripping wheel driven shaft $\mathbf{1974}_{SH}$ which, in turn, is supported across the front and rear walls $\mathbf{1970}_{FR}$ and $\mathbf{1970}_{R}$ of the feeder module **1900**. The stripping wheels **1974** project through a pair of slots formed in the feeding plate **1972**. According to some embodiments, part of the periphery of each stripping wheel **1974** is provided with a raised high-friction surface $\mathbf{1974}_{SR}$ which engages the top bill of the stack as the stripping wheels **1974** rotate (counter-clockwise in FIG. **17**G), to initiate feeding movement of the top bill from the stack. The high-friction surfaces $\mathbf{1974}_{SR}$ may project radially beyond the rest of the wheel peripheries so that the stripping wheels intermittently contact the bill stack during each revolution so as to agitate and loosen the top currency bill within the stack, thereby facilitating the stripping of the top bill from the stack.

[0266] The stripping wheels **1974** feed each stripped bill into engagement with a drive roll **1975** mounted on a driven drive roll shaft $\mathbf{1975}_{SH}$ supported across the front and rear walls $\mathbf{1970}_{FR}$ and $\mathbf{1970}_{R}$ of the feeder module **1900**. As described and illustrated in more detail in U.S. Pat. No. 5,815,592 [Attorney Docket 247171-000131], incorporated herein by reference in its entirety, the drive roll **1975** may include a central smooth friction surface formed of a material such as rubber or hard plastic. This smooth friction surface is sandwiched between a pair of grooved surfaces $\mathbf{1975}_{GR}$ having high-friction portions formed from a high-friction material. The drive roll **1975** is mounted to drive wheel shaft $\mathbf{1975}_{SH}$ which is driven in a counter-clockwise in FIG. **17**G during a banknote dispensing operation.

[0267] The high-friction surfaces engage each bill after it is fed into engagement with the drive roll **1975** by the stripping wheels **1974**, to frictionally advance the bill along a narrow passageway. The rotational movement of the drive roll **1975** and the stripping wheels **1974** may be synchronized so that the high-friction surfaces on the drive roll **1975** and the stripping wheels **1974** maintain a constant relationship to each other. Moreover, according to some embodiments, the drive roll **1975** is dimensioned so that the circumference of the outermost portions of the grooved surfaces is greater than the width W of a bill, such as the width of the widest bill to be stacked in a corresponding storage bay **1760**, so that the bills advanced by the drive roll **1975** are spaced apart from each other. That is, each bill fed to the drive roll **1975** is advanced by that roll only when the high-friction surfaces come into engagement with the bill, so that the circumference of the drive roll **1975** determines the spacing between the leading edges of successive bills.

[0268] According to some embodiments, the drive roll **1975** and the stripping wheels **1974** are driven by motor **1990** controlled by a controller or processor such as controller or processor **202**. As shown in FIG. **19**D, according to some embodiments, stripping wheel driven shaft $\mathbf{1974}_{SH}$ is rotatably driven via belt **1977** coupled to driven drive roll shaft $\mathbf{1975}_{SH}$ which is turn is coupled to motor shaft $\mathbf{1990}_{SH}$ via belt **1973** which is rotatably driven by motor **1990**.

[0269] According to some embodiments, to assist with stopping of feeding of banknotes from the stack in the storage bay **1760** on an exact note, independent of the size of the stack, the stripping wheels **1974** may be always stopped with the raised, high-friction portions $\mathbf{1974}_{SR}$ positioned above the feeding plate **1972** of the storage bay **1760**. This is accomplished by continuously monitoring the angular position of the high-friction portions of the stripping wheels **1974** via an encoder such as encoder **206**, and then controlling the stopping time of the feeder module motor **1990** so that the motor **1990** always stops the stripping wheels **1974** in a position where the high-friction portions $\mathbf{1974}_{SR}$ are located above the feeding plate **1972** of the storage bay **1760**.

[0270] According to some embodiments, in order to ensure firm engagement between the drive roll **1975** and a currency bill or banknote being fed, an idler roll **1976** urges each incoming bill against the smooth central surface of the drive roll **1975**. The idler roll **1976** is journalled on a pair of arms $\mathbf{1976}_{ARM}$ (see FIG. **19**E) which are pivotally mounted on a support shaft $\mathbf{1976}_{SH}$. Mounted on the shaft $\mathbf{1979}_{SH}$, on opposite sides of the idler roll **1976**, are a pair of grooved guide wheels or retard rollers **1979**. Grooves in these two retard rollers **1979** are registered with the central ribs in the two grooved surfaces $\mathbf{1975}_{GR}$ of the drive roll **1975**. The retard rollers **1979** are locked to the shaft $\mathbf{1979}_{SH}$, which in turn is locked against movement in the direction of the bill movement (clockwise as view in FIG. **17**G) by a one-way clutch (not shown). Each time a bill is fed into the nip between the retard rollers **1979** and the drive roll **1975**, the

clutch is energized to turn the shaft **1979**$_{SH}$ just a few degrees in a direction opposite the direction of bill movement. These repeated incremental movements distribute the wear uniformly around the circumferences of the retard rollers **1979**. Although the idler roll **1976** and the retard rollers **1979** are mounted behind a guideway, the guideway is apertured to allow the roll **1976** and the retard rollers **1979** to engage the bills being fed along the banknote passageway.

[0271] Turning back to FIGS. **17**G and **19**E, as mentioned above, when one or more banknotes are to be dispensed from the storage bay **1760**, the elevator **2110** is raised (under control of a processor such as processor **202**) to press a topmost banknote into engagement with a pair of stripping wheels **1974**. The top banknote is moved into engagement with drive roll **1975** and retard rollers **1979**. According to some embodiments, high-friction surfaces **1975**$_{SR}$ of drive roll **1975** engage each banknote after it is fed into the drive roll **1975** by the stripping wheels **1974**, to frictionally advance the banknote into an out-feed path or passageway defined between an upstream side **1970**$_{US}$ of a feeding module **1900** on one side of the out-feed path and an outfeed upper wall **1799**$_{OUT}$ above the storage bay **1760** and a downstream upstream surface **1816**$_{DS}$ of a banknote guide **1816** on the upstream side of the storage bay **1760** on the other side of the out-feed path. While preceding along the out-feed path, a banknote proceeds between one or more second driven feeder rolls **1798** located on an upstream side of the upper end of a corresponding storage bay **1760** and one or more lower out-feed passive rolls **1982**$_{L}$ and one or more driven feeder rolls **1796** located on an upstream side of the upper end of a corresponding storage bay **1760** and one or more upper out-feed passive rolls **1982**$_{U}$ and then onto the transport path **1820**D.

[0272] A banknote to be dispensed from a given storage bay **1760** is then routed along the transport path **1920***d* between the pair of spaced transport plates **1802**, **1804**. The banknote engages and is driven along the transport path **1820**D by the driven transport rolls **1814** and a passive transport rolls **1812** positioned on the opposite side of the transport path **1820**D and biased into engagement with the driven transport rolls **1814**.

[0273] As can be seen in FIGS. **17**D, **17**G and **17**H driven feeder rolls **1796** and **1798** are located above and between two storage bays **1760**. According to some embodiments, one set of feeder rolls **1796** and **1798** positioned above and between two adjacent storage bays (e.g., **1760***d* and **1760***e*) is employed both to advance banknotes along an in-feed path at the downstream side of a first storage bay **1760**, e.g., storage bay **1760***d*, and to advance banknotes along an out-feed path at the upstream side of an adjacent second storage bay **1760**, e.g., storage bay **1760***e*. As illustrated, according to some embodiments, the driven feeder rolls **1796**, **1798** are used to drive bills or banknotes both along in-feed and outfeed transport paths **1900**$_{IN}$ and **1900**$_{OUT}$, but in opposite directions. The driven feeder rolls **1796** are coupled to and rotate about shafts **1796**$_{SH}$ and the driven feeder rolls **1798** are coupled to and rotate about shafts **1798**$_{SH}$. According to some embodiments, one side of a driven feeder roll **1796**, **1798** projects into the in-feed transport path **1900**$_{IN}$ of first storage bay **1760**, e.g., storage bay **1760***d*, while an opposing side of the driven feeder roll **1796**, **1798** projects into the out-feed transport path **1900**$_{OUT}$ of an adjacent second storage bay **1760**, e.g., storage bay **1760***e*. The dual use of such driven feeder rolls **1796**, **1798** contributes to a reduction in the number of components of the banknote recycler **1700** and also contributes to allowing adjacent storage bays **1760** to be positioned closer together. For example, according to some embodiments, the storage bay pitch **1760***p* of the storage bays **1760***a*-**1760***f* (that is the horizontal distance between the same component in adjacent storage bays **1760***a*-**1760***f*) is less than 7 inches (18 cm). For example, referring to FIG. **17**H the storage bay pitch **1760***p* is illustrated as the horizontal distance between the center of the driven roll **1796** positioned between a first storage bay and second storage bay, e.g., storage bays **1760***a* and **1760***b*) and the center of a horizontally adjacent driven roll **1796** positioned between the second storage bay and a third storage bay, e.g., storage bays **1760***b* and **1760***c*). According to some embodiments, the storage bay pitch **1760***p* is less than 6 inches (15¼ cm). According to some embodiments, the storage bay pitch **1760***p* is about 5.3 inches (13.5 cm).

[0274] According to some embodiments, the use of the springs **1969** aids in biasing the retard rollers **1979** into contact with banknotes traveling along the out-feed transport path **1900**$_{OUT}$ while allowing the use of smaller retard rollers **1979** which in turn aids in making the feeder module **1900** and the overall recycler **1700** more compact.

[0275] According to some embodiments, as will be described more in connection with FIGS. **21**A-**21**C, elevator **2110** comprises a spring biased banknote support or platform **2140** mounted to the top of elevator **2110**. According to some embodiments, a pressure sensor monitors pressure on the stripping wheel driven shaft **1974**$_{SH}$. The pressure sensor and a motor controlling the movement of elevator **2110** may be coupled to a controller or processor such as controller or processor **202**. The controller monitors the pressure sensor signals and controls the elevation and/or movement of the elevator **2110** based on the information derived from the pressure sensor such as by instructing the motor controlling the elevator **2110** movement to slow down or stop.

[0276] According to some embodiments, a banknote dispensing assembly **1970** for feeding banknotes, one at a time, out of the recycling or storage bay **1760** comprises stripping wheel **1974**, drive roll **1975**, and retard roller or nip roller **1979**. The dispensing assembly **1970** is positioned near the upper end **1760**$_{UP}$ of the recycling or storage bay **1760**. According to some embodiments, the stripping wheel **1974** comprises a pair of stripping wheels supported for rotational movement about the driven stripping wheel shaft **1974**$_{SH}$, the drive roll **1975** comprises a pair of drive rolls, and the retard roller **1979** comprises a pair of nip rollers.

[0277] According to some embodiments, banknotes may be deposited into and dispensed from storage bay **1760** at a rate of at least 1000 banknotes per minute.

[0278] According to some embodiments, the distance between an upstream wall **1760**$_{US}$ and a downstream wall **1760**$_{PS}$ is between about 2.5 and 5.0 inches for storage bays **1760** configured to accept and dispense U.S. banknotes. According to some embodiments, the distance between an upstream wall **1760**$_{US}$ and a downstream wall **1760**$_{PS}$ is about 2¾ inches for storage bays **1760** configured to accept and dispense U.S. banknotes.

[0279] Stacker Modules

[0280] FIG. **20**A is a perspective view of a stacker module **2000** having a pair of stacker wheels **2062** positioned at an inward, operational deposit or feed-in position and FIG. **20**B is cross-sectional view of the stacker module of FIG. **20**A in

plane **20**B-**20**B indicated in FIG. **20**A. FIG. **20**C is a perspective view of the stacker module **2000** having the pair of stacker wheels **2062** positioned at a transitional, non-operational position and FIG. **20**D is front view of select components of the stacker module of FIG. **20**C. FIG. **20**E is a front view of the stacker module **2000** having the pair of stacker wheels **2062** positioned at an outward, non-operational dispense or feed-out position and FIG. **20**F is rear view of select components of the stacker module of FIG. **20**E. FIG. **20**G is a perspective view of select components of the stacker module of FIG. **20**C. FIG. **20**H is a sectional view of a stacker wheel subassembly. FIG. **20**I is cross-sectional view of a stacker wheels base $\mathbf{2062}_B$ and linkage arm support **2048** mounted about a stacker wheel shaft $\mathbf{2062}_{SH}$.

[0281] According to some embodiments, banknotes are stacked in a respective one of the storage bays **1760***a*-**1760***f* with the aid of a pair of stacker wheels **2062** mounted on a stacker wheel shaft $\mathbf{2062}_{SH}$ which is rotationally driven by a stacker wheel motor **2065**. The motor **2065** is controlled by a controller or processor such as controller or processor **202**.

[0282] The pair of stacker wheels **2062** are supported for rotational movement about a driven stripper wheel shaft $\mathbf{2062}_{SH}$. The stripper wheel shaft $\mathbf{2062}_{SH}$ is rotationally driven about a longitudinal axis $\mathbf{2062}_A$ by the motor **2065**. Each stacker wheel **2062** is laterally moveable along the stripper wheel shaft $\mathbf{2062}_{SH}$. The stacker module **2000** further comprises a stacker wheel positioning mechanism **2053** that adjusts the lateral positions of the pair of stacker wheels **2062** along the stripper wheel shaft $\mathbf{2062}_{SH}$.

[0283] According to some embodiments, the stacker module **2000** further comprises a pair of banknote stripping walls **2054**. Referring to FIG. **20**G, each banknote stripping wall **2054** has a first stripping wall end $\mathbf{2054}_{E1}$ which may slide laterally along a recovery rail **2059** and a second stripping wall end $\mathbf{2054}_{E2}$. The first end $\mathbf{2054}_{E1}$ of each banknote stripping wall **2054** has a notch therein configured accept therein the recovery rail **2059**. The banknote stripping walls **2054** serve to strip banknotes residing in the fingers or vanes of the stripping wheels **2062** and cause them to be deposited onto the top of the elevator platform **2140** or the top of a stack of banknotes supported by the elevator platform **2140** residing in a storage bay **1760***a*-**1760***f*.

[0284] During a banknote in-feed or deposit operation in which one or more banknotes are to be fed into a respective storage bay **1760***a*-**1760***f*, the stacker wheels **2062** are moved into an inward, operational deposit or feed-in position as shown in FIGS. **20**A-**20**B. During a banknote out-feed or dispense operation in which one or more banknotes are to be fed from a respective storage bay **1760***a*-**1760***f*, the stacker wheels **2062** are moved to an outward, non-operational dispense or feed-out position as shown in FIGS. **20**E-**20**F. FIGS. **20**C-**20**D illustrate the stacker wheels **2062** in transition between the operational deposit and the non-operational dispense positions. The stacker wheel positioning mechanism **2053** is configured to adjust the lateral positions of the pair of stacker wheels **2062** along the stripper wheel shaft $\mathbf{2062}_{SH}$ to the operational deposit and the non-operational dispense positions and the transitional positions therebetween. According to some embodiments, the stacker wheel positioning mechanism **2053** comprises a stacker wheel positioning motor or solenoid **2055**, an elongated rotatable cam crank **2056**, a pair of linkage arms **2058**, a pair of stacker wheel bases $\mathbf{2062}_B$ and a pair of linkage arm supports **2048**. The motor or solenoid **2055** is configured to rotate the elongated rotatable cam crank **2056** about a cam axis $\mathbf{2056}_A$. According to some embodiments, the motor **2055** rotates a cam shaft $\mathbf{2056}_{SH}$ about the cam axis $\mathbf{2056}_A$ and the cam shaft $\mathbf{2056}_{SH}$ rotates the cam crank **2056**. The motor **2055** is controlled by a controller or processor such as controller or processor **202**. A first end of each linkage arm **2058** is coupled to a respective outer end $\mathbf{2056}_T$ of the elongated cam crank **2056** and a second end of each linkage arm **2058** is coupled to respective linkage arm supports **2048**. Each linkage arm support **2048** comprises an outer end $\mathbf{2048}_{E1}$ positioned away from the cam axis $\mathbf{2056}_A$ and an inner end $\mathbf{2048}_{E2}$ positioned closer to the cam axis $\mathbf{2056}_A$ than the respective outer end $\mathbf{2048}_{E1}$. While the linkage arms **2058** are illustrated having an adjustable length, they may have a fixed length such as each being a bar or rod.

[0285] Referring to FIGS. **20**H and **20**I, according to some embodiments, each stacker wheel **2062** is fixedly coupled to an elongated stacker wheel base $\mathbf{2062}_B$ having a central aperture in which a portion the stacker wheel shaft $\mathbf{2062}_{SH}$ is positioned. The elongated stacker wheel base $\mathbf{2062}_B$ has a first longitudinal end $\mathbf{2062}_{B1}$ and a second longitudinal end $\mathbf{2062}_{B2}$ wherein the first longitudinal end $\mathbf{2062}_{B1}$ is positioned closer to the cam axis $\mathbf{2056}_A$ than the respective second longitudinal end $\mathbf{2062}_{B2}$. According to some embodiments, the exterior cross-section of the stacker wheel shaft $\mathbf{2062}_{SH}$ is non-circular (such as being hexagonal) and interior walls $\mathbf{2062}_{IN}$ of the stacker wheel base $\mathbf{2062}_B$ defining the aperture of stacker wheel base $\mathbf{2062}_B$ have a conforming non-circular shape (such as hexagonal). Accordingly, when the stacker wheel shaft $\mathbf{2062}_{SH}$ is rotated about its longitudinal axis $\mathbf{2062}_A$, the stacker wheel base $\mathbf{2062}_B$ and the stacker wheel **2062** coupled thereto also rotate about the longitudinal axis $\mathbf{2062}_A$. Conversely, the outer wall $\mathbf{2062}_{OUT}$ of the stacker wheel base $\mathbf{2062}_B$ has a circular cross-section.

[0286] Each linkage arm support **2048** has a central longitudinal aperture therein having a interior wall $\mathbf{2048}_{IN}$ having a circular cross-section. Each linkage arm support **2048** is positioned about the outer wall of the first longitudinal end $\mathbf{2062}_{B1}$ of the stacker wheel base $\mathbf{2062}_B$ such that that the first longitudinal end $\mathbf{2060}_{B1}$ of the stacker wheel base $\mathbf{2062}_B$ resides inside the central longitudinal aperture of the linkage arm support **2048**. In similar fashion, the second stripping wall end $\mathbf{2054}_{E2}$ of each stripping wall **2054** has a central longitudinal aperture therein having a circular cross-section and each second stripping wall end $\mathbf{2054}_{E2}$ of each stripping wall **2054** is positioned about the outer wall of the second longitudinal end $\mathbf{2062}_{B2}$ of the stacker wheel base $\mathbf{2062}_B$ such that that the second longitudinal end $\mathbf{2062}_{B2}$ of the stacker wheel base $\mathbf{2062}_B$ resides inside the central longitudinal aperture of the second stripping wall end $\mathbf{2054}_{E2}$ of each stripping wall **2054**. According to some embodiments, a pair of retaining rings **2046** fixedly coupled to the ends of the stacker wheel base $\mathbf{2062}_B$ keep the linkage arm support **2048** and the second stripping wall end $\mathbf{2054}_{E2}$ of each stripping wall **2054** from sliding off of the first and second longitudinal ends $\mathbf{2062}_{B1}$, $\mathbf{2062}_{B2}$ of the stacker wheel base $\mathbf{2062}_B$ as the linkage arm support **2048**, the stacker wheel base $\mathbf{2062}_B$, and the second stripping wall end $\mathbf{2054}_{E2}$ of each stripping wall **2054** move longitudinally along the stacker wheel shaft $\mathbf{2062}_{SH}$ (left and right in FIG. **20**H). According to some embodiments, a pair of low friction washers **2049** are positioned between the ends of the stacker wheel base $\mathbf{2062}_B$ and the retainer rings **2046**.

[0287] While the stacker wheel base **2062**$_B$ and the stacker wheel **2062** coupled thereto also rotate about the longitudinal axis **2062**$_A$ when the stacker wheel shaft **2062**$_{SH}$ is rotated about its longitudinal axis **2062**$_A$, due to the circular cross-sections of the outer wall of the stacker wheel base **2062**$_B$, the central longitudinal aperture of the linkage arm support **2048**, and the central longitudinal aperture of the second stripping wall end **2054**$_{E2}$ of each stripping wall **2054**, the stacker wheel base **2062**$_B$ is free to rotate about the longitudinal axis **2062**$_A$ while the linkage arm support **2048** and stripping wall **2054** do not rotate about the longitudinal axis **2062**$_A$. The connection of each linkage arm support **2048** to a linkage arm **2048** inhibits the linkage arm support **2048** from rotating about the longitudinal axis **2062**$_A$. Likewise, the recovery rail **2059** residing in the notch in each first end **2054**$_{E1}$ of each banknote stripping wall **2054** inhibits each banknote stripping wall **2054** from rotating about the longitudinal axis **2062**$_A$.

[0288] In FIG. **20**G, the stacker wheels **2062** have been omitted in this figure to more clearly show the stacker wheel bases **2062**$_B$, it being understood stacker wheels **2062** are coupled to the stacker wheel bases **2062**$_B$ such as shown in FIGS. **20**A-**20**F and **20**H. Referring to FIG. **20**G which illustrates the stacker wheel bases **2062**$_B$ in transitional positions, to move the stacker wheels **2062** into the operational deposit position, the cam crank **2056** is rotated in a counter-clockwise direction (as viewed in FIG. **20**G). Conversely, to move the stacker wheels **2062** into the non-operational dispense position, the cam crank **2056** is rotated in a clockwise direction (as viewed in FIG. **20**G). According to some embodiments, the lateral position of the stacker wheels **2062** and/or components having a related laterally position such as, for example, the stripping walls **2054**, the linkage arm support **2048**, etc. are monitored and/or the rotational position and/or movement of the cam shaft **2056**$_{SH}$ is monitored and/or the timing of operation of the motor **2055** and electronic feedback is provided to a processor controlling the operation of the motor **2055** to assist with the movement of the stacker wheels **2062** from their operational, deposit position to their non-operational, dispense position and vice versa. Referring to FIG. **20**G, according to some embodiments, a multi-position rotational indicator **2057** is coupled the cam shaft **2056**$_{SH}$. In the embodiment shown in FIG. **20**G, the indicator has two magnet positions with one having its north pole positioned radially outward and one having its south pole positioned radially outward and a third position having no magnet. An associated detector detects and monitors the rotational movement of the cam shaft **2056**$_{SH}$ by monitoring the movement of each of these positions past the detector which may be, for example, a Hall effect sensor. Other arrangements and/or sensors may alternatively or additionally be employed to monitor the movement of the stacker wheels **2062** such as switches, using a stepper motor with an encoder, placing physically stops to the movement of the stripper wheels when they reach either their operational, deposit position or their non-operational, dispense position and monitoring the resistance to the movement of the cam shaft **2056**$_{SH}$, etc.

[0289] While the stacker wheels **2062** and stacker wheel bases **2062**$_B$ have been illustrated as two separate components, in some embodiments, each stacker wheel and stacker wheel base may be combined into a single integral part and/or comprise more than two parts.

[0290] The various components of the stacker module **2000** are coupled directly or indirectly to a removable stacker module mounting plate **2001**. The stacker module mounting plate **2001** is mounted to near the upper end of a storage bay **1760***a*-**1760***f* (see, e.g., FIG. **17**F). According to some embodiments, the stacking module mounting plate **2001** is coupled to the storage bay chassis **1704** or walls of a storage bay **1760** using a few couplers such as nuts and bolts and/or screws **2001***s* so that an individual stacker module mounting plate **2001** may be quickly and easily installed and/or removed from a respective storage bay **1760***a*-**1760***f*. According to some embodiments, the stacking module mounting plate **2001** is coupled to the storage bay chassis **1704** or walls of a storage bay **1760** using two nuts and bolts and/or screws **2001***s*. For example, if a first one of the stacker modules **2000** in a particular storage bay **1760***a*-**1760***f* is not operating properly or otherwise needs service, a service personnel or technician may quickly disconnect the corresponding first stacker module mounting plate **2001** and associated electrical connections (e.g., power, communications lines to one or more processors such as processor **202**), remove the corresponding first stacker module mounting plate **2001** from the top of the storage bay **1760***a*-**1760***f*, insert another second stacker module **2000** coupled to another second stacker module mounting plate **2001**, couple the second stacker module mounting plate **2001** to the frame or walls of the corresponding storage bay **1760***a*-**1760***f*, and reconnect the associated electrical connections. According to some embodiments, the replacement of a second stacker module mounting plate **2001** may be accomplished by a service technician by first placing a portion of the transport mechanism **1820** in an open, non-operational position such as shown in FIG. **17**A, moving a corresponding one of the feeder modules **1900***a*-**1900***f* to an upper, non-operational position such as the position of feeder module **1900***f* in FIG. **17**A and/or removing the corresponding feeder module **1900** from the chassis **1704**, and then reaching into the top of the corresponding storage bay **1760***a*-**1760***f* and removing the first stacker module mounting plate **2001** such as by uncoupling it from the chassis **1704** such as by removing screws or bolts **2001***s*.

[0291] According to some embodiments to replace a first stacker module **2000**, a service personnel or technician may quickly disconnect the corresponding first stacker module mounting plate **2001** and associated electrical connections associated with a stacker module **2000** to be removed, remove the corresponding first stacker module mounting plate **2001** from a side of the storage bay **1760***a*-**1760***f* such as via a front side of chassis **1704**$_F$, insert another second stacker module **2000** coupled to another second stacker module mounting plate **2001** through the side of the storage bay **1760***a*-**1760***f* such as via a front side of chassis **1704**$_F$, couple the second stacker module mounting plate **2001** to the frame or walls of the corresponding storage bay **1760***a*-**1760***f*, and reconnect the associated electrical connections. According to some such embodiments, a feeder module **1900** above the storage bay **1760** in which a stacker module **2000** is to be replaced does not have to be raised for removal of the stacker module **2000** or the insertion of a replacement stacker module **2000**. According to some embodiments, each of the stacker modules **2000***a*-**2000***f* are identical and interchangeable modules that may be quickly inserted into and/or removed from a storage bay **1760**. Thus, when servicing banknote recycler **1700**, if one or more of the stacker

modules is not working properly, a service technician may quickly and easily remove a malfunctioning stacker module **2000** and replace it with another modular stacker module **2000**. According to such embodiments, the banknote recycler may then be quickly serviced and placed back into normal operational use. According to some such embodiments, a malfunctioning stacker module may then be serviced at a different location such as at a service technician's or manufacturer's facility so as to minimize time during which a service technician would need to interfere with the normal operation and use of the banknote recycler such as by bank tellers.

[0292] As shown in FIG. **20**A, during operation in which banknotes are to be fed or deposited into a recycling bay **1760**, the lateral position of the stacker wheels **2062** is adjusted to the inward, operational position such that banknotes to be fed into the recycling bay **1760** are received by the stacker wheels **2062** and stacked onto top of an elevator platform **2140** or on top of a stack of banknotes being supported on the elevator platform **2140** of an elevator **2110** in the associated storage or recycling bay **1760**. As shown in FIG. **20**E, during operation in which banknotes are to be fed out of or dispensed from the recycling bay **2060**, the lateral position of the stacker wheels **2062** is adjusted to an outward, non-operational position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels **2062** but instead are engaged by the stripping wheels **1974** which sequentially engage the topmost banknote stacked in the recycling bay **1760** and urge the topmost banknote into contact with the pair of drive rolls **1975** which act to feed banknotes out of the recycling bay, one bill at a time.

[0293] According to some embodiments, the stacking module **2000** also comprises one or more banknote drop-off detectors **2120**. In operation, the banknote drop-off detector **2120** senses when the elevator **2110** and the banknote platform **2140** or top of the stack of banknotes are near or adjacent the stacking wheels **2062**. According to some embodiments, the drop-off detectors **2120** employ a through light beam to detect the presence of banknotes, i.e., a light beam directed through a portion of the storage bay **1760** and detected by a detector **2120** wherein the presence of a banknote or the banknote platform **2140** blocks the light beam from reaching the detector **2120**. According to some embodiments, one or more other types of detectors **2120** may be employed instead of a through light beam detector. The signal or signals from the detectors may be coupled to a processor such as processor **202** so that the elevator **2110** may be positioned at a desirable height to facilitate smooth stacking of banknotes onto the elevator platform **2140** or on to the top of a stack of banknotes residing thereon.

[0294] According to some embodiments, during operation in which banknotes are to be fed or deposited into a recycling bay **1760**, a coordinated set of tamping devices will make repeated hits against the edges of the banknotes as the banknotes are engaged in the stacker wheels **2062** and against the edges of the top-most portion of the stack of banknotes being supported on the elevator platform **2140** of an elevator **2110**. In operation, the coordinated set of tamping devices will urge the edges of the banknotes to be in alignment, so as to reduce or eliminate the chance a banknote will be in a position which will cause an error when that banknote is to be fed out of the recycling bay **1760**. According to some embodiments, the coordinated set of tamping devices act only on the short or narrow sides of the banknotes, moving them to be centered about the stripping wheels **1974**. According to some embodiments, the coordinated set of tamping devices act only on the wide or long side of the banknotes which are against downstream wall $\mathbf{1760}_{PS}$. According to some embodiments, the coordinated set of tamping devices act only on the wide or long side of the banknotes which are against upstream wall $\mathbf{1760}_{US}$. According to some embodiments, the coordinated set of tamping devices act on the wide or long side of the banknotes which are against downstream wall $\mathbf{1760}_{DS}$ and the narrow or short sides of the banknotes. According to some embodiments, the coordinated set of tamping devices act on the wide or long side of the banknotes which are against upstream wall $\mathbf{1760}_{US}$ and the narrow or short sides of the banknotes. According to some embodiments, the coordinated set of tamping devices act on the wide, long sides of the banknotes which are against downstream wall $\mathbf{1760}_{DS}$ and on the wide, long side of the banknotes which are against the upstream wall $\mathbf{1760}_{US}$ and the narrow, short sides of the banknotes. According to some embodiments, the coordinated set of tamping devices are actuated to make repeated hits against the edges of the banknotes by direct or indirect contact with cam devices located on the stacker wheel shaft $\mathbf{2062}_{SH}$. According to some embodiments, some of the coordinated set of tamping devices are actuated to make repeated hits against the edges of the banknotes by a motor or solenoid controlled by one or more processors or controllers such as processor **202**.

[0295] Elevator

[0296] FIG. **21**A is a side perspective view of a storage bay elevator **2110**, FIG. **21**B is an upward perspective view of the elevator **2110**, and FIG. **21**C is a bottom perspective view of select components of the elevator **2110**.

[0297] The elevator **2110** has a lower housing **2111** and a banknote support or platform **2140**. According to some embodiments, the platform **2140** is flexibly coupled to the lower housing **2110** such that the platform **2140** may move up and down (see arrow $\mathbf{21}_A$) relative to the lower housing **2110**. According to some embodiments, the platform **2140** is also pivotally coupled to the lower housing **2111** such that it may rotate about a pivot axis $\mathbf{2140}_A$ (see arrow $\mathbf{21}_B$) with the pivot axis $\mathbf{2140}_A$ also being moveable up and down (see arrow $\mathbf{21}_A$). According to some embodiments, the banknote support or platform **2140** is biased such as by one or more platform springs $\mathbf{2140}_{SP}$ upward away from the lower housing **2111** in each storage bay **1760***a*-**1760***f* in a generally horizontal manner. According to some embodiments, the platform springs $\mathbf{2140}_{SP}$ permit a range of pivot or tilt of the platform **2140** about the pivot axis $\mathbf{2140}_A$ and a range of downward movement of the platform **2140** relative to the lower housing **2111** while the spacers **2117** limit that range of tilt and/or downward movement. According to some embodiments, the spacers **2117** allow the banknote support or platform **2140** to pivot about axis $\mathbf{2140}_A$ as previously described without allowing the banknote support or platform **2140** to pivot in any other direction. According to some embodiments, the spacers **2117** may be molded as an integral part of the platform **2140** or may be form as separate parts from the platform **2140**

[0298] The elevator **2110** also comprises a pair of driven elevation gears **2113** that engage a pair of geared elevator tracks **2114** (see e.g., FIGS. **17**F-**17**H) positioned on and coupled to an upstream wall $\mathbf{1760}_{US}$ of each storage bay **1760***a*-**1760***f*. The driven elevation gears **2113** are fixedly

mounted on a rotatable elevation gear shaft **2113**$_{SH}$ which is rotatable about axis **2113**$_{A}$. The driven elevation gears **2113** are driven by an elevation motor **2115** coupled to the elevation gears **2113**. The elevation motor **2115** is communicatively coupled to and controlled by a controller or processor such as controller or processor **202**.

[0299] According to some embodiments, the elevation motor **2115** drives an elevation motor shaft **2115**$_{SH}$ to rotate about an elevation motor shaft axis **2115**$_{A}$. An elevation motor worm gear **2115**$_{G}$ is fixedly coupled to the elevation motor shaft **2115**$_{SH}$ and drives one or more elevation shaft worm gears **2113**$_{G}$ fixedly coupled to the elevation gear shaft **2113**$_{SH}$. As illustrated in FIGS. **21**B-**21**E, a single elevation shaft worm gear **2113**$_{G}$ is employed. According to some embodiments, the elevation gear shaft **2113**$_{SH}$ is arranged at a right angle to the elevation motor shaft **2115**$_{SH}$.

[0300] A banknote or a stack of banknotes stacked on the banknote support or platform **2140** can be moved up and down within a storage bay **1760***a*-**1760***f* by the elevator **2110** being moved up and down.

[0301] Depositing/in-Feeding

[0302] As explained above, during a depositing, in-feed operation, the stacker wheels **2062** stack an in-coming banknote onto the banknote support **2140** or, if there are already one or more banknotes stacked on the banknote support **2140**, onto the top of the stack of banknotes being supported by banknote support **2140**. The elevator **2110** (under control of a processor or controller such as controller **202**) may be slowly lowered as more banknotes are directed into storage bay **1760** so that the stacker wheels **2062** may stack incoming banknotes onto the top of the stack of banknotes being supported by banknote support **2140** wherein the top of the stack of banknotes is maintained generally at the same height. As the banknotes are not perfectly flat and may, in fact, have wrinkles and creases therein, as a stack of banknotes grows on the banknote support **2140**, the stack of banknotes becomes to have a degree of vertical sponginess.

[0303] According to some embodiments, when a number of banknotes below a certain threshold are stacked on the banknote platform **2140**, the platform springs **2140**$_{SP}$ bias the banknote platform **2140** upward away from the lower housing **2111** and when more than the threshold number of banknotes are stacked on the banknote platform **2140**, the weight of the stack of banknotes overcomes the bias of the platform springs **2140**$_{SP}$ such that the banknote platform **2140** moves to its lowest point relative to the lower housing **2111** as may be dictated by spacers **2117**. According to some embodiments, the platform springs **2140**$_{SP}$ are selected so that threshold number of banknotes is relatively low, e.g., about 30 banknotes. According to some embodiments, the platform springs **2140**$_{SP}$ are selected so that threshold number of banknotes is, e.g., about 300 banknotes. According to some embodiments, the platform springs **2140**$_{SP}$ are selected so that threshold number of banknotes is, e.g., about 250 banknotes. According to some embodiments, the platform springs **2140**$_{SP}$ are selected so that threshold number of banknotes is between about 240-360 banknotes. According to some embodiments, the platform springs **2140**$_{SP}$ are selected so that threshold number of banknotes is higher such that the banknote platform **2140** remains biased away from the lower housing **2111** even when a relatively large number of banknotes are stacked on the platform.

[0304] Dispensing/Out-Feeding/Contact Force Measurement

[0305] During a feed-out or dispense operation, as discussed above in connection with FIG. **17**G, when one or more banknotes are to be dispensed from the storage bay **1760**, the elevator **2110** is raised (under control of a processor such as processor **202**) to press a topmost banknote into engagement with the pair of stripping wheels **1974**. According to some embodiments, the pressure or contact force the top of the stack of banknotes applies to the stripping wheels **1974** and/or the feeding plate **1972** is monitored and the feedback from monitoring this pressure is used to control the elevation of the elevator **2110** and/or banknote platform **2140** so that the applied pressure or contact force is maintained within an acceptable range. According to some embodiments, one or more pressure sensors are employed to monitor the pressure or contact force exerted on the stripping wheels **1974** and/or the feeding plate **1972**. The one or more pressure sensors generate a pressure signal indicative of the amount of pressure measured by a corresponding pressure sensor.

[0306] The output of the one or more sensors may be communicatively coupled to a controller or processor such as controller or processor **202** that controls the operation of elevation motor **2115** that controls the movement of the elevator **2110** (and/or the other elevators described herein) such as by communicating a pressure sensor to the processor. The controller or processor monitors the pressure sensor signal(s) and controls the elevation and/or movement of the elevator **2110** based on the information derived from the pressure sensor(s) such as by instructing the elevation motor **2115** controlling the elevator **2110** movement to slow down or stop or reverse direction so that the applied pressure or contact force by the top of the stack of banknotes on the stripping wheels **1974** and/or the feeding plate **1972** is maintained within an acceptable range. If the measured pressure is within the acceptable range, the feeding out operation is continued, e.g., stripping wheels **1974** and drive roll **1975** continue to rotate, and the elevator **2110** is maintained at its current position. When the measured pressure falls below a lower threshold value for the acceptable range, the elevator **2110** is raised (by signaling the elevator motor **2115** to rotate so as to raise the elevator) until the measured pressure again until the measured pressure is within the acceptable range, at which point the elevator **2110** is held at its current position (by signaling the elevator motor **2115** to stop) The feeding out operation is then continued, e.g., stripping wheels **1974** and drive roll **1975** rotate. This automated, self-regulating process continues until banknotes are no longer to be feed out of a corresponding storage bay **1760** and the feed-out or dispense operation is discontinued.

[0307] According to some embodiments, upon the initiation of a dispensing operation, the elevator **2110** is slowly raised and the controller monitors the pressure sensor signal. When the pressure sensor signal exceeds a first target threshold indicative that the amount of pressure is at a desired or optimal level, the controller instructs the elevator motor **2115** to stop causing the elevator **2110** to stop being raised. The controller then instructs a banknote dispensing assembly to start so that banknotes begin to be fed out of the banknotes storage bay. According to embodiments employing the feeder module **1900**, the controller is communicatively coupled to feeder motor **1990** and instructs it to begin rotating which in turn causes stripping wheels **1974** and

drive roll **1975** to being rotating. As banknotes are fed out of the storage bay, the level of the pressure sensor signal will begin to fall. When the pressure sensor signal falls below a first lower threshold, the controller instructs the elevator motor **2115** to begin rotating to cause the elevator **2110** to begin being raised. When the pressure sensor signal again exceeds the first target threshold indicative that the amount of pressure is at a desired or optimal level, the controller instructs the elevator motor to stop causing the elevator **2110** to stop being raised. According to some embodiments, between the time when the pressure sensor signal falls below the first lower threshold and the time it again exceeds the first target threshold, the controller signals the feeder motor **1990** to stop rotating. According to some alternative embodiments, between the time when the pressure sensor signal falls below the first lower threshold and the time it again exceeds the first target threshold, the feeder motor **1990** continues to rotate. According to some such alternative embodiments, the controller may signal the feeder motor **1990** to stop rotating if the pressure sensor signal falls below a second lower threshold which is lower than the first lower threshold.

[0308] The applied pressure or contact force by the top of the stack of banknotes on the stripping wheels **1974** and/or the feeding plate **1972** can be sensed either directly or indirectly. An embodiment for measuring the contact force indirectly can be understood with reference to FIG. **19**F. FIG. **19**F is a schematic view of a pressure or contact force sensor $\mathbf{1974}_{SN}$ used to measure a displacement of the stripping wheel driven shaft $\mathbf{1974}_{SH}$. Referring to FIG. **19**F, according to some embodiments, the pressure exerted by banknotes on the stripping wheels is monitored indirectly by a sensor $\mathbf{1974}_{SN}$ which monitors the vertical displacement of the stripping wheel driven shaft $\mathbf{1974}_{SH}$ such as by repeatedly measuring the gap, G, between the sensor $\mathbf{1974}_{SN}$ and the stripping wheel driven shaft $\mathbf{1974}_{SH}$. According to some embodiments, the controller **202** and sensor $\mathbf{1974}_{SN}$ operate in a self-calibrating manner by using measurements from sensor $\mathbf{1974}_{SN}$ when the elevator **2110** has been lowered so that the top banknote does not contact the stripping wheels **1974** and/or the feeding plate **1972** (such as when the elevator **2110** and the banknotes stacked thereon are in an in-feed, receiving position) and using such measurements to establish a no-load baseline for the sensor $\mathbf{1974}_{SN}$. Generally speaking, in such a position, at any given stripping wheel **1974** rotary position, for embodiments in which the contact force is measured directly, the controller **202** sets the measured force to correspond to "zero" contact force between stripping wheels and the top of the stack. For embodiments in which the contact force is measured indirectly by measuring displacement of some portion or portions of the stripping wheel(s) **1974** or stripping wheel shaft $\mathbf{1974}_{SH}$, the controller **202** sets the measured displacement/position as corresponding to a "zero" contact force between stripping wheels **1974** and the top of the stack of banknotes. According to some embodiments employing indirect measurement by measuring the amount of deflection of the stripping wheel shaft $\mathbf{1974}_{SH}$ (such as shown in FIG. **19**F) the controller factors into consideration a known spring constant for the stripping wheel shaft $\mathbf{1974}_{SH}$.

[0309] According to some embodiments, upon the initiation of a feed-out or dispense operation, the stripping wheels **1974** and drive roll **1975** are not rotated while the stack of banknotes supported by banknote platform **2140** is raised. As the top of the stack of banknotes starts to contact the stripping wheels **1974** a contact force begins to build up as the elevator **2114** continues to rise and the stack of banknotes begins to compress. Once the measured contact force reaches a target threshold value within the acceptable range, the controller **202** stops raising the elevator (by instructing the elevator motor **2115** to stop). At this point, the controller **2002** may initiate feeding out banknotes by instructing the feeder module motor **1990** to rotate the stripping wheel shaft $\mathbf{1974}_{SH}$ and the drive roll shaft $\mathbf{1975}_{SH}$.

[0310] The controller **202** continues to monitor the contact as the stripping wheel shaft $\mathbf{1974}_{SH}$ rotates and as banknotes are being fed out. According to some embodiments, since realistic parts will have tolerances and run-outs associated with them, the controller **202** may average measurements over a single or a plurality of revolution cycles. According to some embodiments, the controller **202** could monitor the contract force mapped based on encoder position(s) and compare to an encoder-position based calibration. In conjunction with the sponginess of the note stack (or on shorter stacks with the help of the paddle springs) this will guarantee a fairly consistent contact pressure.

[0311] As explained above, the pressure or contact force between the top of a stack of banknotes and stripping wheels **1974** and/or the feeding plate **1972** can be sensed either directly or indirectly. According to some embodiments and with reference to FIG. **19**F, the stripping wheel shaft $\mathbf{1974}_{SH}$ is employed as a spring whereby the middle part of the stripping wheel shaft $\mathbf{1974}_{SH}$ is allowed it to flex up in the center as a stack of banknotes is pressed into the stripping wheels **1974**. One or more sensors $\mathbf{1974}_{SN}$ is positioned vertically above stripping wheel shaft $\mathbf{1974}_{SH}$ and measures the distance G between the sensor $\mathbf{1974}_{SN}$ and the top of the stripping wheel shaft $\mathbf{1974}_{SH}$. The measurements are used to determine the amount of deflection (as a displacement measurement) of the stripping wheel shaft $\mathbf{1974}_{SH}$ as an indirect measure for the contact load by the top of the banknotes onto the stripping wheels **1974**. The spring constant of the shaft $\mathbf{1974}_{SH}$ (as a in bending deflecting spring is either known by design or determined by experiment) may be employed in determining the contact force. According to some such embodiments, the shaft deflection is measured/sensed in or near the center of the shaft $\mathbf{1974}_{SH}$ (as shown in FIG. **19**F), but alternatively could be measured in other locations along the shaft $\mathbf{1974}_{SH}$. According to some such embodiments, sensor $\mathbf{1974}_{SN}$ is a proximity sensor such as a coil is oriented vertically above the shaft $\mathbf{1974}_{SH}$, sensing directly the change in the vertical gap, G.

[0312] According to some embodiments, the contact force is determined by measuring the $\mathbf{1974}_{SH}$ bending strain.

[0313] According to some embodiments, a stiffer stripping wheel shaft $\mathbf{1974}_{SH}$ is employed and has bearings at each end thereof guided in such a way that the ends of the shaft $\mathbf{1974}_{SH}$ can move up and down. According to some such embodiments, the ends of the shaft $\mathbf{1974}_{SH}$ are spring loaded with known spring constants downward. According to such embodiments, the shaft $\mathbf{1974}_{SH}$ can move up and down as a whole and the position of the shaft is measured as an indication of the contact force of the top of the stack of banknotes on the stripping wheels **1974**.

[0314] According to some embodiments and with reference to FIG. **19**F, the stripping wheel shaft $\mathbf{1974}_{SH}$ is employed as a spring whereby the middle part of the stripping wheel shaft $\mathbf{1974}_{SH}$ is allowed it to flex up in the

center as a stack of banknotes is pressed into the stripping wheels **1974** and one or more sensors $\mathbf{1974}_{SN}$ are positioned horizontally to the side of the stripping wheel shaft $\mathbf{1974}_{SH}$, near the middle of the stripping wheel shaft $\mathbf{1974}_{SH}$. The horizontally offset sensor(s) $\mathbf{1974}_{SN}$ measure the shaft displacement. According to some such embodiments, a sensor arrangement $\mathbf{1974}_{SN}$ comprises two integral hall effect sensors, slightly vertically offset with respect to each other, positioned within a common housing. The two integral hall effect sensors look at the shaft $\mathbf{1974}_{SH}$ horizontally. The sensor arrangement $\mathbf{1974}_{SN}$ measures the signal differential between the two hall effect sensors only. For example, when the shaft $\mathbf{1974}_{SH}$ moves (deflects) up, the upper sensor reads more signal and the lower sensor less and when the shaft $\mathbf{1974}_{SH}$ moves (deflects) down, the upper sensor reads less signal and the lower sensor more. According to some embodiments, if the shaft $\mathbf{1974}_{SH}$ moves (within limits) horizontally to and from sensor arrangement $\mathbf{1974}_{SN}$, there is no change to the signal differential and hence no vertical deflection is (correctly) detected.

[0315] According to some embodiments, shaft displacement stripping wheel shaft $\mathbf{1974}_{SH}$ may measured by two sensors by measuring the vertical displacement of each of two spring loaded bearing/bearing blocks at the ends of the stripping wheel shaft $\mathbf{1974}_{SH}$.

[0316] According to some embodiments, force sensors are placed over vertically guided bearing blocks at each end of the stripping wheel shaft $\mathbf{1974}_{SH}$. As the shaft gets pushed up, force sensors generate a direct force read-out (signal).

[0317] According to some embodiments including those described in the preceding paragraphs, measuring the displacement of the rotating shaft $\mathbf{1974}_{SH}$ is performed by one or more non-contact sensors such as hall effect sensors, proximity sensors (coils) or optical sensors. Alternatively or additionally, according to some embodiments including those described in the preceding paragraphs, measuring the displacement of the rotating shaft $\mathbf{1974}_{SH}$ is performed by one or more sensors that require contact with the rotating shaft $\mathbf{1974}_{SH}$ (e.g. by an LVDT or a contact lever leading to a sensor or even by a micro switch set to a certain trigger point) and may employ a bearing added to make the area of contact non-rotating if need be.

[0318] According to some embodiments, a bearing is added to the center of the shaft $\mathbf{1974}_{SH}$, creating a non-rotating area onto which a lever can contact may be employed to allow for a direct force measurement in or near the center of the shaft.

[0319] According to some embodiments, a combination of compression or extension springs and limit switches are employed to provide feedback to the elevator motor **2115** and may be employed to maintain near constant contact pressure of the top of the stack of banknotes against stripping rollers **1974**. According to some such embodiments, the use of the combination of compression or extension springs and limit switches does not require constant monitoring the pressure or contact force on the shaft $\mathbf{1974}_{SH}$, and thus, may be employed to reduce the duty cycle of the motor **2115**.

[0320] As discussed above, the platform **2140** is initially maintained in a generally horizontal manner or plane as banknotes are deposited on top of the platform **2140**. However, because banknotes may be crinkled and/or creased as banknotes are stacked on top of each other, the top banknote may become to lie in a non-horizontal plane. During a feed-out or dispense operation, as discussed above in connection with FIG. **17**G, when one or more banknotes are to be dispensed from a storage bay **1760**, the elevator **2110** is raised (under control of a processor such as processor **202**) to press a topmost banknote into engagement with the pair of stripping wheels **1974**. To accommodate for the fact that the top banknote may come to lie in a tilted, non-horizontal manner, as described above the platform **2140** is flexibly coupled to the lower housing **2110** such that the platform **2140** may move up and down (see arrow $\mathbf{21}_A$) relative to the lower housing **2110** and to also rotate about a pivot axis $\mathbf{2140}_A$ (see arrow $\mathbf{21}_B$) with the pivot axis $\mathbf{2140}_A$ also being moveable up and down (see arrow $\mathbf{21}_A$). The ability of the platform **2140** to pivot helps compensate for the height of one side of a stack of banknotes differing from the height of another side of the stack of banknotes. For example, when a stack of banknotes has an uneven height, e.g, the height left side of the stack is greater than the height of the right side of the stack, when the top banknote is pressed into engagement with a pair of stripping wheels **1974** the elevator platform **2140** can pivot so that a more even amount of pressure may be applied over the face of the top banknote as it is pressed against the stripping wheels **1974** and/or the feeding plate **1972**, such as by the left side of elevator platform pivoting or being compressed downward due to the greater height of the left side of the stack of banknotes, provided the weight of the stack of banknotes has not overcome the upward bias forces of the platform springs $\mathbf{2140}_{SP}$. Additionally, the sponginess of the stack of banknotes may also help to even amount of pressure may be applied over the face of the top banknote as it is pressed against the stripping wheels **1974** and/or the feeding plate **1972** as the stack of banknote initially compresses as it is pressed against the stripping wheels **1974** and/or the feeding plate **1972**.

[0321] Additionally, the initial sponginess of a stack of banknotes and/or the ability of the platform **2140** which is spring-biased upward to tilt and/or move downward also assist in maintaining the amount of pressure or contact force by which the top banknote is pressed against the stripping wheels **1974** and/or the feeding plate **1972** within an acceptable range such as by providing some forgiveness without necessarily having to make fine adjustments to the level of the elevator **2110**. For example, as banknotes are fed out of the storage bay **1760**, one by one, and the weight of the remaining banknotes is not sufficient to overcome the upward bias of the platform springs $\mathbf{2140}_{SP}$, the platform springs $\mathbf{2140}_{SP}$ will cause the platform **2140** to slowly rise, assisting with maintaining the contact force within the acceptable range without having to raise the elevator **2110**. For larger stacks of banknotes even where the weight of the remaining banknotes is sufficient to overcome the upward bias of the platform springs $\mathbf{2140}_{SP}$, as banknotes are fed out of the storage bay **1760**, one by one, the sponginess of a stack of banknotes assists with maintaining the contact force within the acceptable range without having to raise the elevator **2110**, that is, as notes are feed out of the storage bay, the sponginess of the remaining notes forces the topmost banknote upward against the stripping wheels **1974** without requiring the elevator **2110** to be moved upward.

[0322] However, as described above, in some embodiments, the weight of a sufficiently large number of banknotes overcomes the upward bias forces of the platform springs $\mathbf{2140}_{SP}$ such that the banknote platform **2140** moves to its lowest point relative to the lower housing **2111** and no

longer provides a mechanism for assisting maintaining the contact force within an acceptable range as the top banknote is pressed against the stripping wheels **1974** and/or the feeding plate **1972**. Accordingly, at such point, the position of the elevator **2110** must be adjusted as described above when the contact pressure falls outside the acceptable range.

[0323] According to some embodiments, the elevator lower housing **2111** is held generally horizontal in the storage bay **1760***a-f* in the long direction by the alignment of the left and right gears **2113** on the gear tracks **2114**. The elevator lower housing **2111** (and therefore the banknote support or platform **2140**) is held generally horizontal in the storage bay **1760***a-f* in the narrow or short direction by one or more bearings such as bearing $\mathbf{2110}_{B1}$ which is separated by some distance from the elevation gear shaft $\mathbf{2113}_{SH}$, and made to run vertically in a bearing track **1719** (see FIG. **17**H) coupled to the inside of one of the chassis housing walls $\mathbf{1704}_{F}$, $\mathbf{1704}_{R}$ to be described below in conjunctions with FIGS. **22**A-**22**E. According to some embodiments, a bearing $\mathbf{2110}_{B2}$ is coupled at each end of the elevation gear shaft $\mathbf{2113}_{SH}$ and run vertically in bearing tracks (such as bearing track **1719** for the bearing $\mathbf{2110}_{B2}$ positioned at the same end of the elevator **2110** and below bearing $\mathbf{2110}_{B1}$) coupled to the inside the chassis housing walls $\mathbf{1704}_{F}$, $\mathbf{1704}_{R}$. The bearings $\mathbf{2110}_{B2}$ and the bearing tracks operate to ensure the elevation gears **2113** remain operably engaged with the gear tracks **2114**.

[0324] According to some embodiments, each of the elevators **2110** are identical and interchangeable that may be quickly inserted into and/or removed from a storage bay **1760**. Thus, when servicing banknote recycler **1700**, if one or more of the elevators **2110** is not working properly, a service technician may quickly and easily remove a malfunctioning elevator **2110** and replace it with another modular elevator **2110**. According to such embodiments, the banknote recycler may then be quickly serviced and placed back into normal operational use. According to some such embodiments, a malfunctioning elevator **2110** may then be serviced at a different location such as at a service technician's or manufacturer's facility so as to minimize time during which a service technician would need to interfere with the normal operation and use of the banknote recycler such as by bank tellers.

[0325] FIG. **21**D is a downward perspective view of elevator **2110** and elevation shaft worm gear decoupling tool $\mathbf{2113}_{TL}$. FIG. **21**E is side perspective view of elevator **2110** illustrating a use of the elevation shaft worm gear decoupling tool $\mathbf{2113}_{TL}$. Referring to FIGS. **21**D-**21**E, according to some embodiments, the elevator **2110** is inserted into and/or removed from a storage bay **1760** from the top end of the storage bay **1760** with the assistance of an elevation shaft worm gear decoupling tool $\mathbf{2113}_{TL}$ which disengages the elevation gear shaft worm gear $\mathbf{2113}_{G}$ from the elevation motor worm gear $\mathbf{2115}_{G}$. According to some embodiments, the elevation gear shaft worm gear $\mathbf{2113}_{G}$ is mounted about the elevation gear shaft $\mathbf{2113}_{SH}$ so as to permit it to slide longitudinally along the axis $\mathbf{2113}_{A}$ of the elevation gear shaft $\mathbf{2113}_{SH}$. An elevation gear shaft spring $\mathbf{2113}_{SP}$ biases the elevation gear shaft worm gear $\mathbf{2113}_{G}$ into an operable position whereat it will be engaged by the elevation motor worm gear $\mathbf{2115}_{G}$. At least when it the operable position, the elevation gear shaft worm gear $\mathbf{2113}_{G}$ is rotationally, fixedly coupled to the elevation gear shaft $\mathbf{2113}_{SH}$ so that when the elevation motor worm gear $\mathbf{2115}_{G}$ causes the elevation gear shaft worm gear $\mathbf{2113}_{G}$ to rotate, the elevation gear shaft worm gear $\mathbf{2113}_{G}$ causes the elevation gear shaft $\mathbf{2113}_{SH}$ to rotate about its longitudinal axis $\mathbf{2113}_{A}$. According to some embodiments, to remove the elevator **2110** from a storage bay **1760**, the elevation shaft worm gear decoupling tool $\mathbf{2113}_{TL}$ may inserted by a service technician into a vertical aperture $\mathbf{2111}_{AP}$ in the housing **2111** and a lower end of the tool $\mathbf{2113}_{TL}$ is positioned adjacent a decoupling flange $\mathbf{2113}_{L}$ mounted about elevation gear shaft $\mathbf{2113}_{SH}$ and coupled to elevation gear shaft worm gear $\mathbf{2113}_{G}$. As seen in FIG. **21**E, the upper end of the tool $\mathbf{2113}_{TL}$ may be moved in a direction **21**-A1 away from elevation gear shaft worm gear $\mathbf{2113}_{G}$ so that it pivots about a portion of lower housing **2111**, or the tool may be twisted about its longitudinal axis $\mathbf{2113}_{TLA}$, causing the lower end of the tool $\mathbf{2113}_{TL}$ to press the decoupling flange $\mathbf{2113}_{L}$ and the elevation gear shaft worm gear $\mathbf{2113}_{G}$ in direction **21**-B1 until the elevation gear shaft worm gear $\mathbf{2113}_{G}$ becomes decoupled from the elevation motor worm gear $\mathbf{2115}_{G}$. Once decoupled, the elevation gear shaft worm gear $\mathbf{2113}_{G}$ and the elevation gear shaft $\mathbf{2113}_{SH}$ are free to rotate independently of the elevation motor worm gear $\mathbf{2115}_{G}$ and the elevator **2110** may be manually raised with the elevation gears **2113** running along the geared elevator tracks **2114** until the elevation gears **2113** run off the top of the elevator tracks **2114**. The elevator **2010** may then be move out of the top of the storage bay **1760**.

[0326] According to some embodiments, to install an elevator **2110** into a bay **1760**, the elevation gear shaft worm gear $\mathbf{2113}_{G}$ is decoupled from the elevation motor worm gear $\mathbf{2115}_{G}$, the elevation gears **2113** are coupled to the elevator tracks **2114** and the elevator **2110** is manually lowered down the tracks **2114**. Then the lower end of tool $\mathbf{2113}_{TL}$ may be positioned on the opposite side of decoupling flange $\mathbf{2113}_{L}$ and the top of the tool $\mathbf{2113}_{TL}$ may move moved in the direction opposite to direction **21**-A1 toward from elevation gear shaft worm gear $\mathbf{2113}_{G}$ so that it pivots about a portion of lower housing **2111** causing the lower end of the tool $\mathbf{2113}_{TL}$ to pull the decoupling flange $\mathbf{2113}_{L}$ and the elevation gear shaft worm gear $\mathbf{2113}_{G}$ in direction opposite of direction **21**-B1 until the elevation gear shaft worm gear $\mathbf{2113}_{G}$ becomes coupled from the elevation motor worm gear $\mathbf{2115}_{G}$.

[0327] According to some embodiments, absent the presence of the tool $\mathbf{2113}_{TL}$, the elevation gear shaft spring $\mathbf{2113}_{SP}$ biases the elevation gear shaft worm gear $\mathbf{2113}_{G}$ into the operable position into engagement with the elevation motor worm gear $\mathbf{2115}_{G}$. According to such embodiments, the bottom of the tool $\mathbf{2113}_{TL}$ must remain pushing flange decoupling flange $\mathbf{2113}_{L}$ in direction **21**-B1 while the elevator is manually raised or lowered along the tracks **2114**.

[0328] According to some embodiments, a service technician may instruct the processor or controller controlling the elevation motor **2115** such as controller **202** (such via an interface such as interface **208**) to raise the elevator **2110** to the top of tracks **2114** where it may be manually removed and/or to lower the elevator **2110** down the tracks **2114** after the elevator **2110** has be coupled to the tracks **2114**.

[0329] When removing a first elevator **2110** from the banknote recycler **1700**, for example, when the elevator **2110** is not operating properly or otherwise needs service, a service personnel or technician may quickly disconnect any associated electrical connections (e.g., power, communications lines to one or more processors such as processor **202**), remove the first elevator **2110** as described above, insert

another elevator **2110** as described above and reconnect the associated electrical connections.

[0330] FIG. **22**A is a cross-sectional perspective view of chassis **1704**. FIG. **22**B is a similar view as that of FIG. **22**A but with a downstream wall $\mathbf{1760}_{DS}$ of storage bay **1760***d* removed. FIG. **22**C is an end view of the storage bay **1760***d* shown in FIG. **22**B. FIG. **22**D is a cross-sectional perspective view of the chassis **1704** taken at 90 degrees from the view of FIG. **22**A. FIG. **22**E is a top view of a portion of the chassis **1704** shown in FIG. **22**D.

[0331] Referring to FIGS. **22**A-**22**E, the direction of flow in which banknotes are transported along transport path **1820**D (see, e.g., FIG. **18**B) is represented by arrow $\mathbf{22}_F$ and orients the upstream (US) side of various components from the downstream (DS) side. According to some embodiments, banknotes are transported by the transport mechanisms **1820** and $\mathbf{1820}_U$ in a wide-edge leading manner along the various transport paths including **1820**D and **1820**E.

[0332] According to some embodiments, each storage bay **1760** comprises an upstream wall or plate $\mathbf{1760}_{US}$ and a downstream wall or plate $\mathbf{1760}_{DS}$. According to some embodiments, each storage bay **1760** comprises a means for maintaining the position of banknotes stack in a storage bay in transverse direction such as a front wall and a rear wall. In some embodiments, the front walls and rear walls are replaced with front retaining post $\mathbf{1760}_{FP}$ and a rear retaining post $\mathbf{1760}_{RP}$. According to some embodiments, the upstream walls $\mathbf{1760}_{US}$ and the downstream walls $\mathbf{1760}_{DS}$ may be replaced with one or more posts. Each banknote recycler storage bay **1760** has an upper end $\mathbf{1760}_{UP}$ and a lower end $\mathbf{1760}_{LO}$. The upstream wall $\mathbf{1760}_{US}$, the downstream wall $\mathbf{1760}_{DS}$, the front retaining post $\mathbf{1760}_{FP}$, and the rear retaining post $\mathbf{1760}_{RP}$ help to contain stacked banknotes within the storage bay **1760** and serve to define a banknote space $\mathbf{1760}_{SP}$ of the storage bay **1760**. According to some embodiments, banknotes are transported in a wide-edge leading manner and stacked each the storage bay **1760** with their wide edges being adjacent the upstream wall $\mathbf{1760}_{US}$ and the downstream wall $\mathbf{1760}_{DS}$ and their narrow edges being adjacent the front retaining post $\mathbf{1760}_{FP}$, and the rear retaining post $\mathbf{1760}_{RP}$.

[0333] According to some embodiments, the feeder shafts $\mathbf{1796}_{SH}$ and $\mathbf{1798}_{SH}$ on which driven feeder rolls **1796** and **1798**, respectively, are mounted, are rotationally driven by one or more motors such as motor $\mathbf{1796}_M$. According to some embodiments, the feeder shafts $\mathbf{1796}_{SH}$ and $\mathbf{1798}_{SH}$ are rotationally driven by one or more belts $\mathbf{1796}_B$ operatively coupled to the one or motors $\mathbf{1796}_M$. According to some embodiments, a single motor $\mathbf{1796}_M$ drives a plurality of feeder shafts $\mathbf{1796}_{SH}$ and a plurality of shafts $\mathbf{1798}_{SH}$. According to some embodiments, a single motor $\mathbf{1796}_M$ drives a plurality of feeder shafts $\mathbf{1796}_{SH}$ and a plurality of shafts $\mathbf{1798}_{SH}$ associated with in-feed transport paths $\mathbf{1900}_{IN}$ and out-feed transport paths $\mathbf{1900}_{OUT}$ associated with a plurality of storage bays **1760**. According to some embodiments, a single motor $\mathbf{1796}_M$ drives all the feeder shafts $\mathbf{1796}_{SH}$ and all the shafts $\mathbf{1798}_{SH}$ of the banknote recycler **1700**. According to some embodiments, the chassis **1704** has a front wall $\mathbf{1704}_F$ and a rear wall $\mathbf{1704}_R$. According to some embodiments, the feeder shafts $\mathbf{1796}_{SH}$ and $\mathbf{1798}_{SH}$ are rotationally coupled to a front wall $\mathbf{1704}_F$ and a rear wall $\mathbf{1704}_R$.

[0334] According to some embodiments, the internal size (that is, the space in which banknotes are stored) of the storage bays **1760***a*-**1760***f* may be adjusted to accommodate different sizes of banknotes, e.g., a storage bay sized to accommodate U.S. currency may be adjusted accommodate €10 banknotes or a storage bay sized to accommodate €10 banknotes may be adjusted accommodate €20 banknotes as described above in connection with FIGS. **8**D and **8**E and the chassis **1704** and/or storage bays **1760** may contain one or more of the exemplary mechanisms for facilitating the easy adjustment of the depth of storage bays described above in connection with FIGS. FIGS. **8**D and **8**E. For example, the upstream wall $\mathbf{1760}_{US}$ and/or the downstream wall $\mathbf{1760}_{DS}$ may be slideably mounted on a plurality of storage bay depth adjustment posts (see storage bay depth adjustment posts **893** in FIGS. **8**D and **8**E) and one or both of the walls $\mathbf{1760}_{US}$, $\mathbf{1760}_{DS}$ are releasably, slideably mounted on the plurality of storage bay depth adjustment posts and may be locked into a fixed position relative to the storage bay depth adjustment posts such as via locking screws which releasably engage the storage bay depth adjustment posts. Likewise, according to some embodiments, the left side and right side frames of chassis **1704** may have one or more slots (see slots **895** in FIG. **8**D) therein which cooperate with tabs or posts extending from the exterior sides of one or both of the walls $\mathbf{1760}_{US}$, $\mathbf{1760}_{DS}$ of the storage bay **1760** through the slots **895** to control the movement of the wall $\mathbf{1760}_{US}$, and/or wall $\mathbf{1760}_{DS}$ relative to the front side and rear side frames of the chassis **1704**, thereby limiting the direction and extent to which the wall $\mathbf{1760}_{US}$, and/or wall $\mathbf{1760}_{DS}$ may be moved relative to each other. Additionally or alternatively, according to some embodiments, the left side and right side frames of the chassis **1704** may have one or more plurality of preset depth adjustment apertures (see apertures **894** in FIG. **8**D) therein which cooperate with tabs or posts extending from the exterior sides of the wall $\mathbf{1760}_{US}$, and/or wall $\mathbf{1760}_{DS}$ of the storage bay **1760** through the apertures **894** to facilitate the distance between the wall $\mathbf{1760}_{US}$, and wall $\mathbf{1760}_{DS}$ being adjustably set at a plurality of predefined distances, e.g., distances associated with accommodating U.S banknotes and a plurality of denominations of Euro banknotes. In the embodiment illustrated in FIG. **8**D, a lower set of a plurality of apertures **894** comprises apertures **894***a*-**894***e* and such apertures may be included in the frame of chassis **1704** near one or more of the storage bays **1760***a*-**1760***f*.

[0335] According to some embodiments, the front retaining post $\mathbf{1760}_{FP}$ and the rear retaining post $\mathbf{1760}_{RP}$ are coupled to the chassis **1704** via storage bay wall retainers **1707**. According to some embodiments, the wide or long horizontal dimension of the banknote space $\mathbf{1760}_{SP}$ of a storage bay **1760** may be adjusted by uses storage bay wall retainers **1707** of different lengths so as to adjust the distance between a front retaining post $\mathbf{1760}_{FP}$ or rear retaining post $\mathbf{1760}_{RP}$ and a corresponding front wall $\mathbf{1704}_F$ and a rear wall $\mathbf{1704}_R$ of the chassis. According to some embodiments, the storage bay wall retainers **1707** may have a slidably, adjustable length in the front-back direction (parallel to a wide-dimension of a storage bay **1760**) of the storage bay such that one or both of the front-back positions of the front retaining post $\mathbf{1760}_{FP}$ and/or rear retaining post $\mathbf{1760}_{RP}$ may be adjusted. According to some such embodiments, the storage bay wall retainers **1707** may have preset engagement positions corresponding to wide-dimensions associated with banknotes having different wide dimensions, e.g., a first present engagement position for U.S. banknotes, a second

preset engagement position for €10 banknotes, a third preset engagement position for €20 banknotes, etc. According to some embodiments, the storage bay wall retainers **1707** snap into the various preset engagement positions as the front retaining post $\mathbf{1760}_{FP}$ and/or rear retaining post $\mathbf{1760}_{RP}$ are pulled or push in a front-back (parallel to a wide-dimension of a storage bay **1760**) direction.

[0336] According to some embodiments, the storage bays **1760***a*-**1760***f* are dimensioned to accommodate a stack of as many as 5000 banknotes. For recyclers **1700** having six storage bays with one being used as an escrow bay, the five remaining storage bays, e.g., bays **1760***b*-**1760***f* may accommodate and store as many as 25,000 banknotes. According to some embodiments, each storage bay **1760***a*-**1760***f* is dimensioned to accommodate a stack of at least 4,5000 banknotes. According to some embodiments, each storage bay **1760***a*-**1760***f* is dimensioned to accommodate a stack of at least 4000 banknotes. According to some embodiments, each storage bay **1760***a*-**1760***f* is dimensioned to accommodate a stack of at least 3000 banknotes. According to some embodiments, each storage bay **1760***a*-**1760***f* is dimensioned to accommodate a stack of at least 1000 banknotes. According to some embodiments, each storage bay **1760***a*-**1760***f* is dimensioned to accommodate a stack of at least 2000 banknotes. According to some embodiments, each storage bay **1760***a*-**1760***f* is dimensioned to accommodate a stack of at least 2500 banknotes.

[0337] According to some embodiments, referring to FIG. **22**C, the distance $\mathbf{1760}_{C1}$ between the height of the top of the banknote platform **2140** when the elevator **2110** is lowered to its lowest position and the height of the top of the banknote platform **2140** with no banknotes stacked therein when the elevator **2110** is raised to receive an initial banknote from the stacking wheels **2062** is about 22 inches (56 cm). According to some embodiments, the distance $\mathbf{1760}_{C2}$ between the height of the top of the banknote platform **2140** when the elevator **2110** is lowered to its lowest position and the bottom of the feeding plate **1972** is about 26 inches (66 cm). According to some embodiments, the storage bay **1760** capacities described in the preceding paragraph are achieved for storage bays having the $\mathbf{1760}_{C1}$ and $\mathbf{1760}_{C2}$ vertical dimensions above including being able to accommodate a stack of as many as 5000 banknotes in a storage bay having a $\mathbf{1760}_{C1}$ dimension of less than or about 22 inches and a $\mathbf{1760}_{C2}$ dimension of less than or about 26 inches within a housing **1702** having an exterior width W_{17} less than or equal to about 18 inches (46 cm), an exterior height H_{17} less than or equal to about 38 inches (97 cm), and an exterior length L_{17} less than or equal to about 39 inches (99 cm).

[0338] According to some embodiments, banknotes may be deposited into and dispensed from storage bay **1760** at a rate of at least 1000 banknotes per minute.

[0339] According to some embodiments, the transport mechanism **1820** is operated at high speeds and can transport banknotes at a rate of at least 5000 inches per minute and/or deliver notes from the transport path **1820**D into a storage bay **1760** at a rate of at least 1000 bills/banknotes per minute and/or deliver notes from a storage bay **1760** onto the transport path **1820**D at a rate of at least 1000 bills/banknotes per minute.

[0340] According to some embodiments, a stack of up to about 5000 banknotes may be stacked on the elevator platform **2140** and dispensed at high-speed (e.g., at least 1000 banknotes per minute or banknotes are transported at a rate of at least 5000 inches per minute). According to some embodiments, a stack of at least about 4500 banknotes may be stacked on the elevator platform **2140** and dispensed at high-speed (e.g., at least 1000 banknotes per minute or banknotes are transported at a rate of at least 5000 inches per minute). According to some embodiments, a stack of at least about 3000 banknotes may be stacked on the elevator platform **2140** and dispensed at high-speed (e.g., at least 1000 banknotes per minute or banknotes are transported at a rate of at least 5000 inches per minute). According to some embodiments, a stack of at least about 2000 banknotes may be stacked on the elevator platform **2140** and dispensed at high-speed (e.g., at least 1000 banknotes per minute or banknotes are transported at a rate of at least 5000 inches per minute). According to some embodiments, a stack of at least about 1000 banknotes may be stacked on the elevator platform **2140** and dispensed at high-speed (e.g., at least 1000 banknotes per minute or banknotes are transported at a rate of at least 5000 inches per minute).

[0341] According to some embodiments, the banknote recycler **1700** is operated at high speeds and can deliver notes from the storage bay transport path **1820**D into a storage bay **1760** at a rate of at least 1000 bills/banknotes per minute. According to some embodiments, banknotes are stacked into a storage bay **1760** and dispensed from the storage bay **1760** at a rate of at least 600 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **1760** and dispensed from the storage bay **1760** at a rate of at least 800 banknotes per minutes. According to some embodiments, banknotes are stacked into the storage bay **1760** and dispensed from the storage bay **1760** at a rate of at least 1000 banknotes per minutes.

[0342] According to some embodiments, banknotes are stacked into the storage bay **1760** and dispensed from the storage bay **1760** at different speeds.

[0343] According to some embodiments, the storage bays **1760** described above are modular and interchangeable with each other.

Further Embodiments

[0344] Embodiment 1. A generally vertical banknote recycling bay arrangement comprising:

[0345] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end and at least one generally vertically side;

[0346] an elevator having at least one retractable banknote support, the elevator configured to move upward and downward with respect to the at least one generally vertically side of the recycler bay, the retractable banknote support configured to move into and out of the recycling bay;

[0347] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay;

[0348] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the lower end of the recycling bay and comprising:

[0349] a pair of stripping wheels supported for rotational movement about a driven stripping wheel shaft,

[0350] a pair of drive rolls, and

[0351] a pair of nip rollers;

[0352] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the at least one retractable banknote support is extended into the recycling bay so as to provide a structure on which banknotes may be stacked within the recycling bay and wherein the elevator is raised to a level so as to facilitate the stacking of banknotes being fed into the recycling bay, one on top of the other on the at least one retractable banknote support and wherein the elevator is lowered as banknotes are fed into the recycling bay so that the top of the stack of banknotes residing within the recycling bay and onto which incoming banknotes are stacked remains at about the same level;

[0353] wherein prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to a bottom of the recycling bay if no banknotes reside at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon a bottom surface of the recycling bay;

[0354] wherein prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to a location adjacent the top of a stack of banknotes resting on the bottom of the recycling bay if there are banknotes already residing at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon the top of the stack of banknotes already residing at the bottom of the recycling bay.

[0355] Embodiment 2. A generally vertical banknote recycling bay arrangement comprising:

[0356] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end and at least one generally vertically side;

[0357] an elevator having at least one retractable banknote support, the elevator configured to move upward and downward with respect to the at least one generally vertically side of the recycler bay, the retractable banknote support configured to move into and out of the recycling bay;

[0358] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay;

[0359] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the lower end of the recycling bay;

[0360] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the at least one retractable banknote support is extended into the recycling bay so as to provide a structure on which banknotes may be stacked within the recycling bay and wherein the elevator is raised to a level so as to facilitate the stacking of banknotes being fed into the recycling bay, one on top of the other on the at least one retractable banknote support and wherein the elevator is lowered as banknotes are fed into the recycling bay so that the top of the stack of banknotes residing within the recycling bay and onto which incoming banknotes are stacked remains at about the same level;

[0361] wherein prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to the bottom of the recycling bay if no banknotes reside at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon a bottom surface of the recycling bay;

[0362] wherein prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to a location adjacent the top of a stack of banknotes resting on the bottom of the recycling bay if there are banknotes already residing at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon the top of the stack of banknotes already residing at the bottom of the recycling bay.

[0363] Embodiment 3. A generally vertical banknote recycling bay arrangement comprising:

[0364] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end, the recycling bay having a banknote leading edge side and a banknote trailing edge side;

[0365] an elevator banknote stacker plate configured to move upward and downward within the recycler bay;

[0366] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end and banknote trailing edge side of the recycling bay and comprising:

[0367] a pair of drive rolls supported for rotational movement about a driven drive roll shaft,

[0368] a pair of nip rollers supported for rotational movement about a nip roller shaft, each of the nip rollers being positioned below a corresponding one of the drive rolls such that banknotes may pass between each corresponding drive roll and nip roller pair,

[0369] a plurality of tap down assemblies supported for rotational movement about the nip roller shaft, each tap down assembly having a base and a plurality of flexible tap down projections extending from the base, the base having a circumference extending around the nip roller shaft, the plurality of tap down projections being positioned about the circumference of a corresponding base such that collectively the plurality of tap down projections extend from a corresponding base over less than about 180° of the circumference of the base, and

[0370] a pair of ceiling guides positioned so as to guide the leading edge of banknotes emerging from between each drive roll and nip roller pair downward into the recycling bay and toward the banknote leading edge side of the recycling bay and on top of any preceding banknotes resting on the elevator banknote stacker plate;

[0371] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay and comprising:

[0372] a pair of stripping wheels supported for rotational movement about a driven stripping wheel shaft,

[0373] the pair of drive rolls, and

[0374] the pair of nip rollers;

[0375] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the plurality of tap down assemblies are rotated such that the plurality of tap

down projections push the trailing edges of banknotes that have been fed into the recycling bay downward so as to facilitate a succeeding banknote entering the recycling bay to be positioned on the upper side of a prior fed banknote;

[0376] wherein during a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator banknote stacker plate is elevated such that the stripping wheels sequentially engage the topmost banknote stacked in the recycling bay and urge the topmost banknote into contact with the pair of drive rolls which act to feed banknotes out of the recycling bay arrangement, one bill at a time; and wherein during a dispensing operation the tap down assemblies are rotationally positioned such that the plurality of tap down projections do not extend into the recycling bay nor above the top of the nip rollers.

[0377] Embodiment 4. A generally vertical banknote recycling bay arrangement comprising:

[0378] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end, the recycling bay having a banknote leading edge side and a banknote trailing edge side;

[0379] an elevator banknote stacker plate configured to move upward and downward within the recycler bay;

[0380] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end and banknote trailing edge side of the recycling bay and comprising:

[0381] one or more tap down assemblies supported for rotational movement about a shaft, each tap down assembly having a base and a plurality of flexible tap down projections extending from the base, the base having a circumference extending around the shaft, the plurality of tap down projections being positioned about the circumference of a corresponding base such that collectively the plurality of tap down projections extend from a corresponding base over less than about 180° of the circumference of the base, and

[0382] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay;

[0383] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the plurality of tap down assemblies are rotated such that the plurality of tap down projections push the trailing edges of banknotes that have been fed into the recycling bay downward so as to facilitate a succeeding banknote entering the recycling bay to be positioned on an upper side of a prior fed banknote;

[0384] wherein during a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator banknote stacker plate is elevated such that the banknote feeding assembly sequentially engages the topmost banknote stacked in the recycling bay and feeds banknotes out of the recycling bay arrangement, one bill at a time; and wherein during a dispensing operation the tap down assemblies are rotationally positioned such that the plurality of tap down projections do not extend into the recycling bay.

[0385] Embodiment 5. The banknote recycling bay arrangement of embodiment 4 wherein the banknote feeding assembly further comprises one or more of drive rolls supported for rotational movement about a driven drive roll shaft, one or more pair of nip rollers supported for rotational movement about a nip roller shaft, each of the nip rollers being positioned below a corresponding one of the drive rolls such that banknotes may pass between each corresponding drive roll and nip roller pair.

[0386] Embodiment 6. The banknote recycling bay arrangement of embodiments 4 or 5 further comprising one or more of ceiling guides positioned so as to guide the leading edge of banknotes emerging from between each drive roll and nip roller pair downward into the recycling bay and toward the banknote leading edge side of the recycling bay and on top of any preceding banknotes resting on the elevator banknote stacker plate.

[0387] Embodiment 7. The banknote recycling bay arrangement of any of embodiments 4-6 wherein the dispensing assembly comprises: one or more of stripping wheels supported for rotational movement about a driven stripping wheel shaft, one or more pair of drive rolls, and one or more pair of nip rollers.

[0388] Embodiment 8. The banknote recycling bay arrangement of either embodiment 6 or embodiment 7 wherein during a dispensing operation the tap down assemblies are rotationally positioned such that the plurality of tap down projections do not extend into the recycling bay nor above the top of the one or more nip rollers.

[0389] Embodiment 9. A generally vertical banknote recycling bay arrangement comprising:

[0390] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end;

[0391] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay and comprising:

[0392] a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft;

[0393] each stacker wheel being laterally moveable along the driven stacker wheel shaft;

[0394] a stacker wheel positioning screw,

[0395] a pair of stacker wheel carriages, each carriage having a screw end and a stacker wheel end, the screw end of each carriage having a threaded aperture therein through which a portion of the positioning screw is threaded, each carriage having a pair of arms, each arm extending from the screw end toward the stacker wheel end and at least partially conforming about the stacker wheel shaft, the pair of arms of each carriage extending toward the stacker wheel shaft such that a corresponding stacker wheel is positioned about the stacker wheel shaft between the arms of a corresponding carriage; and

[0396] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay and comprising:

[0397] a pair of stripping wheels supported for rotational movement about the driven stacker wheel shaft, the pair of stripping wheels being laterally positioned about the stacker wheel shaft between the pair of stacker wheels, and

[0398] a pair of drive rolls supported for rotational movement about the drive roll shaft;

[0399] wherein during operation in which banknotes are to be fed into the recycling bay, the lateral position of the stacker wheels is adjusted to an inward position such that banknotes to be fed into the recycling bay are received by the stacker wheels and stacked in the recycling bay;

[0400] wherein during operation in which banknotes are to be fed out of the recycling bay, the lateral position of the

stacker wheels is adjusted to an outward position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels but instead are engaged by the stripping wheels which sequentially engage the topmost banknote stacked in the recycling bay and urge the topmost banknote into contact with the pair of drive rolls which act to feed banknotes out of the recycling bay arrangement, one bill at a time;

[0401] wherein the lateral positions of the stacker wheels are adjusted by rotational movement of the stacker wheel positioning screw which serves to laterally move the pair of stacker wheel carriages laterally toward each other when driven in a first rotational direction and to laterally move the pair of stacker wheel carriages laterally away each other when driven in a second rotational direction, the lateral movement of the stacker wheel carriages imparting a corresponding lateral movement on the stacker wheels.

[0402] Embodiment 10. The generally vertical banknote recycling bay arrangement of embodiment 9 wherein the stacker wheel positioning screw comprises threads oriented in a first direction on a first portion and threads oriented in a second opposite direction on a second portion, and wherein a first one of the stacker wheel carriages threadingly engages the first portion of the positioning screw and a second one of the stacker wheel carriages threadingly engages the second portion of the positioning screw.

[0403] Embodiment 11. A method of operating a generally vertical banknote recycling bay arrangement comprising a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end and at least one generally vertical side, the recycling bay comprising an elevator configured to move upward and downward with respect to the at least one generally vertical side of the recycler bay, a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay, and a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the lower end of the recycling bay, the method comprising the acts of: feeding banknotes into the recycling bay; and simultaneously feeding banknotes out of the recycling bay.

[0404] Embodiment 12. The method of embodiment 11 wherein the elevator has at least one retractable banknote support and the retractable banknote support configured to move into and out of the recycling bay.

[0405] Embodiment 13. A method of operating a generally vertical banknote recycling bay arrangement comprising a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end, a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay, and a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the lower end of the recycling bay, the method comprising the acts of: feeding banknotes into the recycling bay; and simultaneously feeding banknotes out of the recycling bay.

[0406] Embodiment 14. The method according to any of embodiments 11-13 wherein the act of feeding banknotes into the recycling bay is performed at a rate of at least 600 banknotes per minutes and wherein the act of simultaneously feeding banknotes out of the recycling bay is performed at a rate of at least 600 banknotes per minutes.

[0407] Embodiment 15. The method according to any of embodiments 11-13 wherein the act of feeding banknotes into the recycling bay is performed at a rate of at least 800 banknotes per minutes and wherein the act of simultaneously feeding banknotes out of the recycling bay is performed at a rate of at least 800 banknotes per minutes.

[0408] Embodiment 16. The method according to any of embodiments 11-13 wherein the act of feeding banknotes into the recycling bay is performed at a rate of at least 1000 banknotes per minutes and wherein the act of simultaneously feeding banknotes out of the recycling bay is performed at a rate of at least 1000 banknotes per minutes.

[0409] Embodiment 17. The method according to any of embodiments 11-13 wherein the act of feeding banknotes into the recycling bay is performed at a rate of at least 1200 banknotes per minutes and wherein the act of simultaneously feeding banknotes out of the recycling bay is performed at a rate of at least 1200 banknotes per minutes.

[0410] Embodiment 18. A generally vertical banknote recycling bay arrangement comprising:

[0411] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end and at least one generally vertically side;

[0412] an elevator having at least one retractable banknote support, the elevator configured to move upward and downward with respect to the at least one generally vertically side of the recycler bay, the retractable banknote support configured to move into and out of the recycling bay;

[0413] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the at least one retractable banknote support is extended into the recycling bay so as to provide a structure on which banknotes may be stacked within the recycling bay and wherein the elevator is raised to a level so as to facilitate the stacking of banknotes being fed into the recycling bay, one on top of the other on the at least one retractable banknote support and wherein the elevator is lowered as banknotes are fed into the recycling bay so that the top of the stack of banknotes residing within the recycling bay and onto which incoming banknotes are stacked remains at about the same level;

[0414] wherein prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to the bottom of the recycling bay if no banknotes reside at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon a bottom surface of the recycling bay;

[0415] wherein prior to a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator is lowered to a location adjacent the top of a stack of banknotes resting on the bottom of the recycling bay if there are banknotes already residing at the bottom of the recycling bay and wherein the at least one retractable banknote support is moved out of the recycling bay so that the stack of banknotes that had been supported by the at least one retractable support come to rest upon the top of the stack of banknotes already residing at the bottom of the recycling bay.

[0416] Embodiment 19. A generally vertical banknote recycling bay arrangement comprising:

[0417] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end and at least one generally vertically side;

[0418] an elevator having at least one retractable banknote support, the elevator configured to move upward and downward with respect to the at least one generally vertically side of the recycler bay, the retractable banknote support configured to move into and out of the recycling bay;

[0419] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the at least one retractable banknote support is extended into the recycling bay so as to provide a structure on which banknotes may be stacked within the recycling bay.

[0420] Embodiment 20. A generally vertical banknote recycling bay arrangement comprising:

[0421] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end, the recycling bay having a banknote leading edge side and a banknote trailing edge side;

[0422] an elevator banknote stacker plate or support configured to move upward and downward within the recycler bay;

[0423] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end and banknote trailing edge side of the recycling bay and comprising:

[0424] a pair of drive rolls supported for rotational movement about a driven drive roll shaft,

[0425] a pair of nip rollers supported for rotational movement about a nip roller shaft, each of the nip rollers being positioned below a corresponding one of the drive rolls such that banknotes may pass between each corresponding drive roll and nip roller pair,

[0426] a plurality of tap down assemblies supported for rotational movement about the nip roller shaft, each tap down assembly having the base and a plurality of flexible tap down projections extending from the base, the base having a circumference extending around the nip roller shaft, the plurality of tap down projections being positioned about the circumference of a corresponding base such that collectively the plurality of tap down projections extending from a corresponding base over less than about 180° of the circumference of the base, and

[0427] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay;

[0428] wherein during operation in which banknotes are to be sequentially fed into the recycling bay, the plurality of tap down assemblies are rotated such that the plurality of tap down projections push the trailing edges of banknotes that have been fed into the recycling bay downward so as to facilitate a succeeding banknote entering the recycling bay to be positioned on the upper side of a prior fed banknote;

[0429] wherein during a dispensing operation in which banknotes are to be fed out of the recycling bay, the elevator banknote stacker plate or support is elevated to urge a topmost banknote against the banknote dispensing assembly; and wherein during a dispensing operation the tap down assemblies are rotationally positioned such that the plurality of tap down projections do not extend into the recycling bay nor above the top of the nip rollers.

[0430] Embodiment 21. A generally vertical banknote recycling bay arrangement comprising:

[0431] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end;

[0432] a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the feeding assembly being positioned near the upper end of the recycling bay;

[0433] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay;

[0434] a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft, each stacker wheel being laterally moveable along the driven stacker wheel shaft;

[0435] a stacker wheel positioning mechanism configured to adjust the lateral positions of the pair of stacker wheels along the stripper wheel shaft;

[0436] wherein during operation in which banknotes are to be fed into the recycling bay, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an inward position such that banknotes to be fed into the recycling bay are received by the stacker wheels and stacked in the recycling bay;

[0437] wherein during operation in which banknotes are to be fed out of the recycling bay, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels but instead are engaged by the banknote dispensing assembly which sequentially engages the topmost banknote stacked in the recycling bay and feeds banknotes out of the recycling bay, one bill at a time.

[0438] Embodiment 22. The generally vertical banknote recycling bay arrangement of embodiment 21 wherein a stacker wheel positioning mechanism comprises:

[0439] a stacker wheel positioning screw; and

[0440] a pair of stacker wheel carriages, each carriage having a screw end and a stacker wheel end, the screw end of each carriage having a threaded aperture therein through which a portion of the positioning screw is threaded, each carriage having a pair of arms, each arm extending from the screw end toward the stacker wheel end and at least partially conforming about the stacker wheel shaft, the pair of arms of each carriage extending toward the stacker wheel shaft such that a corresponding stacker wheel is positioned about the stacker wheel shaft between the arms of a corresponding carriage;

[0441] wherein the lateral positions of the stacker wheels are adjusted by rotational movement of the stacker wheel positioning screw which serves to laterally move the pair of stacker wheel carriages laterally toward each other when driven in a first rotational direction and to laterally move the pair of stacker wheel carriages laterally away each other when driven in a second rotational direction, the lateral movement of the stacker wheel carriages imparting a corresponding lateral movement on the stacker wheels.

[0442] Embodiment 23. The generally vertical banknote recycling bay arrangement of embodiment 22 wherein the stacker wheel positioning screw comprises threads oriented

in a first direction on a first portion and threads oriented in a second opposite direction on a second portion, and wherein a first one of the stacker wheel carriages threadingly engages the first portion of the positioning screw and a second one of the stacker wheel carriages threadingly engages the second portion of the positioning screw.

[0443] Embodiment 24. The generally vertical banknote recycling bay arrangement of any of embodiments 21-23 further comprising:

[0444] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned near the upper end of the recycling bay and comprising:

[0445] one or more stripping wheels supported for rotational movement about the driven stacker wheel shaft, the pair of stripping wheels being laterally positioned about the stacker wheel shaft between the pair of stacker wheels, and

[0446] one or more drive rolls supported for rotational movement about the drive roll shaft; and

[0447] wherein during operation in which banknotes are to be fed out of the recycling bay, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels but instead are engaged by the one or more stripping wheels which sequentially engages the topmost banknote stacked in the recycling bay and urges the topmost banknote into contact with the one or more drive rolls which act to feed banknotes out of the recycling bay arrangement, one bill at a time.

[0448] Embodiment 25. The generally vertical banknote recycling bay arrangement of embodiment 21 wherein a stacker wheel positioning mechanism comprises:

[0449] a stacker wheel positioning motor or solenoid, an elongated rotatable cam crank comprising two ends, a pair of linkage arms comprising two ends, and a pair of linkage arm supports.

[0450] Embodiment 26. The generally vertical banknote recycling bay arrangement of embodiment 25

[0451] wherein one end of a first one of the linkage arms is coupled to a first one of the ends of the cam crank and a second end of the first one of the linkage arms is couple to a first one of the linkage arm supports,

[0452] wherein one end of a second one of the linkage arms is coupled to a second one of the ends of the cam crank and a second end of the second one of the linkage arms is couple to a second one of the linkage arm supports,

[0453] wherein each stacker wheel is rotatably coupled to a respective one of the linkage arm supports.

[0454] Embodiment 27. The generally vertical banknote recycling bay arrangement of embodiment 26 wherein the motor or solenoid is configured to rotate the elongated rotatable cam crank about a cam axis causing the ends of the cam crank to rotate about the cam axis thereby causing the linkage arm supports and the stacker wheels coupled thereto to move either laterally closer to each other or laterally away from each other.

[0455] Embodiment 28. The generally vertical banknote recycling bay arrangement of any of embodiments 25-27 further comprising a controller or processor communicatively coupled to and controlling the motor or solenoid.

[0456] Embodiment 29. The generally vertical banknote recycling bay arrangement of any of embodiments 25-28 further comprising a pair of stacker wheel bases and wherein each stacker wheel is fixedly coupled to a respective one of the stacker wheel bases and wherein each stacker wheel base is rotatably coupled to a respective one of the linkage arm supports.

[0457] Embodiment 30. A banknote stacker wheel assembly for stacking banknotes in a banknote receptacle comprising:

[0458] a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft, each stacker wheel being laterally moveable along the driven stacker wheel shaft;

[0459] a stacker wheel positioning mechanism configured to adjust the lateral positions of the pair of stacker wheels along the stripper wheel shaft.

[0460] Embodiment 31. The banknote stacker wheel assembly of embodiment 30 wherein a stacker wheel positioning mechanism comprises a stacker wheel positioning motor or solenoid, an elongated rotatable cam crank comprising two ends, a pair of linkage arms comprising two ends, and a pair of linkage arm supports.

[0461] Embodiment 32. The banknote stacker wheel assembly of embodiment 31

[0462] wherein one end of a first one of the linkage arms is coupled to a first one of the ends of the cam crank and a second end of the first one of the linkage arms is couple to a first one of the linkage arm supports,

[0463] wherein one end of a second one of the linkage arms is coupled to a second one of the ends of the cam crank and a second end of the second one of the linkage arms is couple to a second one of the linkage arm supports,

[0464] wherein each stacker wheel is rotatably coupled to a respective one of the linkage arm supports.

[0465] Embodiment 33. The banknote stacker wheel assembly of embodiment 32 wherein the motor or solenoid is configured to rotate the elongated rotatable cam crank about a cam axis causing the ends of the cam crank to rotate about the cam axis thereby causing the linkage arm supports and the stacker wheels coupled thereto to move either laterally closer to each other or laterally away from each other.

[0466] Embodiment 34. The banknote stacker wheel assembly of any of embodiments 31-33 further comprising a controller or processor communicatively coupled to and controlling the motor or solenoid.

[0467] Embodiment 35. The banknote stacker wheel assembly of any of embodiments 31-34 further comprising a pair of stacker wheel bases and wherein each stacker wheel is fixedly coupled to a respective one of the stacker wheel bases and wherein each stacker wheel base is rotatably coupled to a respective one of the linkage arm supports.

[0468] Embodiment 36. The banknote stacker wheel assembly of embodiment 30 wherein a stacker wheel positioning mechanism comprises:

[0469] a stacker wheel positioning screw; and

[0470] a pair of stacker wheel carriages, each carriage having a screw end and a stacker wheel end, the screw end of each carriage having a threaded aperture therein through which a portion of the positioning screw is threaded, each carriage having a pair of arms, each arm extending from the screw end toward the stacker wheel end and at least partially conforming about the stacker wheel shaft, the pair of arms of each carriage extending toward the stacker wheel shaft

such that a corresponding stacker wheel is positioned about the stacker wheel shaft between the arms of a corresponding carriage;

[0471] wherein the lateral positions of the stacker wheels are adjusted by rotational movement of the stacker wheel positioning screw which serves to laterally move the pair of stacker wheel carriages laterally toward each other when driven in a first rotational direction and to laterally move the pair of stacker wheel carriages laterally away each other when driven in a second rotational direction, the lateral movement of the stacker wheel carriages imparting a corresponding lateral movement on the stacker wheels.

[0472] Embodiment 37. The banknote stacker wheel assembly of embodiment 36 wherein the stacker wheel positioning screw comprises threads oriented in a first direction on a first portion and threads oriented in a second opposite direction on a second portion, and wherein a first one of the stacker wheel carriages threadingly engages the first portion of the positioning screw and a second one of the stacker wheel carriages threadingly engages the second portion of the positioning screw.

[0473] Embodiment 38. The banknote stacker wheel assembly of any of embodiments 30-37

[0474] wherein during operation in which banknotes are to be fed into the banknote receptacle, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an inward position such that banknotes to be fed into the banknote receptacle are received by the stacker wheels and stacked in the banknote receptacle;

[0475] wherein during operation in which banknotes are to be fed out of the banknote receptacle, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels but instead are engaged by a banknote dispensing assembly which sequentially engages a topmost banknote stacked in the banknote receptacle and feeds banknotes out of the banknote receptacle, one bill at a time.

[0476] Embodiment 39. A banknote stacker wheel module for stacking banknotes in a banknote receptacle comprising a removable stacker module mounting plate having coupled thereto: a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft, each stacker wheel being laterally moveable along the driven stacker wheel shaft; and a stacker wheel positioning mechanism configured to adjust the lateral positions of the pair of stacker wheels along the stripper wheel shaft.

[0477] Embodiment 40. The banknote stacker wheel module of embodiment 39 wherein a stacker wheel positioning mechanism comprises: a stacker wheel positioning motor or solenoid, an elongated rotatable cam crank comprising two ends, a pair of linkage arms comprising two ends, and a pair of linkage arm supports.

[0478] Embodiment 41. The banknote stacker wheel module of embodiment 40

[0479] wherein one end of a first one of the linkage arms is coupled to a first one of the ends of the cam crank and a second end of the first one of the linkage arms is couple to a first one of the linkage arm supports,

[0480] wherein one end of a second one of the linkage arms is coupled to a second one of the ends of the cam crank and a second end of the second one of the linkage arms is couple to a second one of the linkage arm supports,

[0481] wherein each stacker wheel is rotatably coupled to a respective one of the linkage arm supports.

[0482] Embodiment 42. The banknote stacker wheel module of embodiment 41 wherein the motor or solenoid is configured to rotate the elongated rotatable cam crank about a cam axis causing the ends of the cam crank to rotate about the cam axis thereby causing the linkage arm supports and the stacker wheels coupled thereto to move either laterally closer to each other or laterally away from each other.

[0483] Embodiment 43. The banknote stacker wheel module of any of embodiments 40-42 further comprising an electrical connections interface configured to be coupled to an external mating electrical connections interface not residing in the stacker wheel module such that when the two electrical connections interfaces are connected an external processor is communicatively coupled to the motor or solenoid.

[0484] Embodiment 44. The banknote stacker wheel module of any of embodiments 40-43 further comprising a pair of stacker wheel bases and wherein each stacker wheel is fixedly coupled to a respective one of the stacker wheel bases and wherein each stacker wheel base is rotatably coupled to a respective one of the linkage arm supports.

[0485] Embodiment 45. The banknote stacker wheel module of any of embodiments 39-44 wherein during operation in which banknotes are to be fed into the banknote receptacle, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an inward position such that banknotes to be fed into the banknote receptacle are received by the stacker wheels and stacked in the banknote receptacle; wherein during operation in which banknotes are to be fed out of the banknote receptacle, the lateral position of the stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out the recycling bay are not engaged by the stacker wheels but instead are engaged by a banknote dispensing assembly which sequentially engages a topmost banknote stacked in the banknote receptacle and feeds banknotes out of the banknote receptacle, one bill at a time.

[0486] Embodiment 46. The banknote stacker wheel module of any of embodiments 39-45 wherein the removable stacker module mounting plate is removeably coupled to a portion of the banknote receptacle by one or more coupling devices.

[0487] Embodiment 47. The banknote stacker wheel module of embodiment 46 wherein the coupling devices comprise one or more screws.

[0488] Embodiment 48. The banknote stacker wheel module of embodiment 46 wherein the coupling devices comprise one or more bolts.

[0489] Embodiment 49. A feeder module for feeding banknotes into a banknote receptacle and feeding banknotes out of the banknote receptacle comprising:

[0490] a housing, the housing comprising a first side and an opposing a second side, wherein banknotes to be fed into the banknote receptacle are received adjacent the first side of the housing and are transported into the banknote receptacle along an in-feed transport path adjacent the first side, and wherein banknotes to be fed out of the banknote receptacle are received adjacent the second side of the housing and are transported out of the banknote receptacle along an out-feed transport path adjacent the second side;

[0491] a banknote dispensing assembly for feeding banknotes, one at a time, out of the banknote receptacle, the dispensing assembly being positioned near the upper end of the banknote receptacle and comprising:

[0492] one or more stripping wheels supported for rotational movement about the driven stacker wheel shaft, the pair of stripping wheels being laterally positioned about the stacker wheel shaft between the pair of stacker wheels, and

[0493] one or more drive rolls supported for rotational movement about the drive roll shaft;

[0494] wherein the banknote dispensing assembly feeds banknotes urged against the one or more stripping wheels into and along the out-feed transport path.

[0495] Embodiment 50. A banknote recycler comprising:

[0496] a chassis comprising a banknote storage bay; and

[0497] a feeder module positioned above the storage bay;

[0498] wherein the feeder module comprises:

[0499] a feeder module housing, the feeder module housing comprising a first side and an opposing a second side; and

[0500] a banknote dispensing assembly for feeding banknotes, one at a time, out of the banknote receptacle;

[0501] wherein the chassis comprises an infeed upper wall, an outfeed upper wall, and a plurality of driven feeder rolls, the infeed upper wall being positioned adjacent to the first side of the feeder module housing and defining an in-feed path therebetween, the outfeed upper wall being positioned adjacent to the second side of the feeder module housing and defining an out-feed path therebetween, at least a first one of the driven feeder rolls protects into the in-feed path and isoperable to transport banknotes along the in-feed path, and at least a second one of the driven feeder rolls protects into the out-feed path and is operable to transport banknotes along the out-feed path;

[0502] wherein banknotes to be fed into the banknote receptacle are received adjacent the first side of the housing and are transported along the in-feed transport path adjacent the first side and into the banknote receptacle, and wherein banknotes to be fed out of the banknote receptacle are received adjacent the second side of the housing and are transported out of the banknote receptacle along an out-feed transport path adjacent the second side; and

[0503] wherein the banknote dispensing assembly feeds banknotes in the storage bay, one at a time, into the out-feed transport path.

[0504] Embodiment 51. A banknote recycler comprising:

[0505] a chassis comprising a plurality of banknote storage bays positioned adjacent each other in an upstream/downstream direction; and

[0506] a feeder module positioned above each storage bay;

[0507] wherein each feeder module comprises:

[0508] a feeder module housing, the feeder module housing comprising a first side and an opposing a second side; and

[0509] a banknote dispensing assembly for feeding banknotes, one at a time, out of the banknote receptacle;

[0510] wherein the chassis comprises a plurality of infeed upper walls, a plurality of outfeed upper walls, and a plurality of driven feeder rolls, the chassis comprising:

[0511] a first infeed upper wall being positioned adjacent to the first side of a first feeder module housing of a first feeder module and defining a first in-feed path therebetween, a first outfeed upper wall being positioned adjacent to the second side of the first feeder module housing of the first feeder module and defining a first out-feed path therebetween,

[0512] a second infeed upper wall being positioned adjacent to the first side of a second feeder module housing of a second feeder module and defining a second in-feed path therebetween, a second outfeed upper wall being positioned adjacent to the second side of the second feeder module housing of the second feeder module and defining a second out-feed path therebetween, wherein the second feeder module is located downstream of the first feeder module,

[0513] a third infeed upper wall being positioned adjacent to the first side of a third feeder module housing of a third feeder module and defining a third in-feed path therebetween, a third outfeed upper wall being positioned adjacent to the second side of the third feeder module housing of the third feeder module and defining a third out-feed path therebetween, wherein the third feeder module is located upstream of the first feeder module,

[0514] wherein at least a first one of the driven feeder rolls protects through the first infeed upper wall into the first in-feed path and is operable to transport banknotes along the first in-feed path,

[0515] wherein the first one of the driven feeder rolls also protects through the second outfeed upper wall into the second out-feed path and is operable to transport banknotes along the second out-feed path;

[0516] wherein at least a second one of the driven feeder rolls protects through the first outfeed upper wall into the first out-feed path and is operable to transport banknotes along the first out-feed path;

[0517] wherein the second one of the driven feeder rolls also protects through the third outfeed upper wall into the third in-feed path and is operable to transport banknotes along the third in-feed path,

[0518] Embodiment 52. The banknote recyclers of embodiment 50 or embodiment 51 wherein each feeder module comprises one or more first positioning tabs located on a respective first side of the feeder module housing of the associated feeder module, and/or one or more second positioning tabs located on a respective second side of the feeder module housing of the associated feeder module, wherein each first positioning tab is configured to engage the infeed upper wall adjacent the associated first side of the feeder module housing, wherein each second positioning tab is configured to engage the outfeed upper wall adjacent the associated second side of the feeder module housing, and wherein the first positioning tabs and/or the second positioning tabs are configured to accurately position each feeder module between the associated infeed and outfeed upper walls of the chassis.

[0519] Embodiment 53. A banknote storage bay elevator comprising a lower housing; and a banknote platform positioned above the lower housing, wherein the platform is flexibly coupled to the lower housing such that the platform may move up and down relative to the lower housing.

[0520] Embodiment 54. The banknote storage bay elevator of embodiment 53 further comprising one or more platform springs biasing the banknote platform upward away from the lower housing.

[0521] Embodiment 56. The banknote storage bay elevator of embodiment 53 further wherein the one or more platform springs biasing the banknote platform upward

away from the lower housing such that an upper surface of the platform lies in a generally horizontal plane.

[0522] Embodiment 57. The banknote storage bay elevator of any of embodiments 53-56 wherein the platform has a long dimension and a narrow dimension and wherein the platform is pivotally coupled to the lower housing such that the platform may rotate about a pivot axis transverse to the long dimension of the platform.

[0523] Embodiment 58. The banknote storage bay elevator of embodiment 57 further comprising one or more spacers coupled to either the platform or the lower housing and wherein a range of downward movement of the platform relative to the lower housing is limited by the spacers.

[0524] Embodiment 59. The banknote storage bay elevator of embodiment 57 wherein the spacers allow the banknote support or platform to pivot about the pivot axis without allowing the banknote support or platform to pivot in any other direction.

[0525] Embodiment 60. The banknote storage bay elevator of any of embodiments 53-57 further comprising one or more spacers coupled to either the platform or the lower housing and wherein a range of downward movement of the platform relative to the lower housing is limited by the spacers.

[0526] Embodiment 61. The banknote storage bay elevator of any of embodiments 53-60 further comprising one or more driven elevation gears fixedly mounted on a rotatable elevation gear shaft and a motor operable couple to and configured to rotate the elevation gear shaft.

[0527] Embodiment 62. A generally vertical banknote recycling bay arrangement comprising:

[0528] a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end;

[0529] an elevator comprising an elevator banknote platform or support configured to move upward and downward within the recycler bay, the elevator banknote platform or support supporting a stack of banknotes thereon;

[0530] an elevator motor configured to move the elevator upward and downward within the recycler bay;

[0531] a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the dispensing assembly being positioned above the recycling bay;

[0532] a pressure sensor configured to generate a pressure signal; and

[0533] a processor communicatively coupled to the pressure sensor and the elevator motor and configured to control the operation of the elevator motor and receive the pressure signal from the pressure sensor;

[0534] wherein during a dispensing operation,

[0535] the elevator motor raises the elevator so as a top banknote residing in the stack of banknotes contacts the dispensing assembly,

[0536] wherein the pressure sensor is configured to measure the amount of pressure the top banknote applies to the dispensing assembly and communicate the amount of pressure to the processor via the pressure signal,

[0537] wherein the processor monitors the pressure signal and

[0538] a) when the processor detects the amount of pressure exceeds a first target threshold, the processor instructs the elevator motor to stop, and

[0539] b) when the processor detects the amount of pressure falls below a first lower threshold, the processor instructs the motor to raise the elevator.

[0540] Embodiment 63. The generally vertical banknote recycling bay arrangement of embodiment 62 wherein the processor is communicatively coupled to the dispensing assembly and wherein the processor instructs the dispensing assembly to begin feeding banknotes out of the recycling bay.

[0541] Embodiment 64. The generally vertical banknote recycling bay arrangement of any of embodiments 62-63 wherein the dispensing assembly comprises a stripping wheel mounted on a stripping wheel shaft and wherein the top banknote residing in the stack of banknotes contacts the dispensing assembly by contacting the stripping wheel and wherein the stripping wheel shaft is configured to deflect upward under contact pressure from the top banknote, and wherein the pressure sensor measures the amount of pressure by measuring the amount of deflection exhibited by the stripping wheel shaft.

[0542] 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

1-6. (canceled)

7. A generally vertical banknote recycling bay arrangement; comprising:

a generally vertically oriented banknote recycling bay for receiving banknotes therein, the recycling bay having an upper end and a lower end;

a banknote feeding assembly for feeding banknotes, one at a time, into the recycling bay, the banknote feeding assembly being positioned near the upper end of the recycling bay;

a banknote dispensing assembly for feeding banknotes, one at a time, out of the recycling bay, the banknote dispensing assembly being positioned near the upper end of the recycling bay;

a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft, each stacker wheel being laterally moveable along the driven stacker wheel shaft; and

a stacker wheel positioning mechanism configured to adjust lateral positions of the pair of stacker wheels along the stacker wheel shaft,

wherein, during operation in which banknotes are to be fed into the recycling bay, the lateral position of the pair of stacker wheels is adjusted by the stacker wheel positioning mechanism to an inward position such that banknotes to be fed into the recycling bay are received by the pair of stacker wheels and stacked in the recycling bay, and

wherein, during operation in which banknotes are to be fed out of the recycling bay, the lateral position of the pair of stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out the recycling bay are not engaged by the pair of stacker wheels but instead are engaged by the banknote dispensing assembly which

sequentially engages a topmost banknote stacked in the recycling bay and feeds banknotes out of the recycling bay, one bill at a time.

8. The generally vertical banknote recycling bay arrangement of claim **7**, wherein the stacker wheel positioning mechanism comprises:

a stacker wheel positioning screw; and

a pair of stacker wheel carriages, each carriage having a screw end and a stacker wheel end, the screw end of each carriage having a threaded aperture therein through which a portion of the stacker wheel positioning screw is threaded, each carriage having a pair of arms, each arm extending from the screw end toward the stacker wheel end and at least partially conforming about the stacker wheel shaft, the pair of arms of each carriage extending toward the stacker wheel shaft such that a corresponding stacker wheel is positioned about the stacker wheel shaft between the arms of a corresponding carriage,

wherein the lateral positions of the pair of stacker wheels are adjusted by rotational movement of the stacker wheel positioning screw which serves to laterally move the pair of stacker wheel carriages laterally toward each other when driven in a first rotational direction and to laterally move the pair of stacker wheel carriages laterally away each other when driven in a second rotational direction, lateral movement of the pair of stacker wheel carriages imparting a corresponding lateral movement on the pair of stacker wheels.

9. The generally vertical banknote recycling bay arrangement of claim **8**, wherein the stacker wheel positioning screw comprises threads oriented in a first direction on a first portion and threads oriented in a second opposite direction on a second portion, and wherein a first one of the pair of stacker wheel carriages threadingly engages the first portion of the stacker wheel positioning screw and a second one of the pair of stacker wheel carriages threadingly engages the second portion of the stacker wheel positioning screw.

10. The generally vertical banknote recycling bay arrangement of claim **7**, wherein the banknote dispensing assembly comprises:

one or more stripping wheels supported for rotational movement about the driven stacker wheel shaft, the one or more stripping wheels being laterally positioned about the stacker wheel shaft between the pair of stacker wheels; and

one or more drive rolls supported for rotational movement about a drive roll shaft,

wherein, during operation in which banknotes are to be fed out of the recycling bay, the lateral position of the pair of stacker wheels is adjusted by the stacker wheel positioning mechanism to the outward position such that banknotes to be fed out the recycling bay are not engaged by the pair of stacker wheels but instead are engaged by the one or more stripping wheels which sequentially engages the topmost banknote stacked in the recycling bay and urges the topmost banknote into contact with the one or more drive rolls which act to feed banknotes out of the recycling bay arrangement, one bill at a time.

11. The generally vertical banknote recycling bay arrangement of claim **7**, wherein the stacker wheel positioning mechanism comprises:

a stacker wheel positioning motor or solenoid, an elongated rotatable cam crank comprising two ends, a pair of linkage arms comprising two ends, and a pair of linkage arm supports.

12. The generally vertical banknote recycling bay arrangement of claim **11**, wherein one end of a first one of the pair of linkage arms is coupled to a first one of the ends of the cam crank and a second end of the first one of the pair of linkage arms is coupled to a first one of the pair of linkage arm supports,

wherein one end of a second one of the pair of linkage arms is coupled to a second one of the ends of the cam crank and a second end of the second one of the pair of linkage arms is coupled to a second one of the pair of linkage arm supports, and

wherein each stacker wheel is rotatably coupled to a respective one of the pair of linkage arm supports.

13. The generally vertical banknote recycling bay arrangement of claim **12**, wherein the stacker wheel positioning motor or solenoid is configured to rotate the elongated rotatable cam crank about a cam axis causing the ends of the cam crank to rotate about the cam axis thereby causing the pair of linkage arm supports and the pair of stacker wheels coupled thereto to move either laterally closer to each other or laterally away from each other.

14. The generally vertical banknote recycling bay arrangement of claim **13**, further comprising a controller or processor communicatively coupled to and controlling the stacker wheel positioning motor or solenoid.

15. The generally vertical banknote recycling bay arrangement of claim **14**, further comprising a pair of stacker wheel bases and wherein each stacker wheel is fixedly coupled to a respective one of the stacker wheel bases and wherein each stacker wheel base is rotatably coupled to a respective one of the pair of linkage arm supports.

16. A banknote stacker wheel assembly for stacking banknotes in a banknote receptacle, comprising:

a pair of stacker wheels supported for rotational movement about a driven stacker wheel shaft, each stacker wheel being laterally moveable along the driven stacker wheel shaft; and

an automatic stacker wheel positioning mechanism configured to adjust lateral positions of the pair of stacker wheels along the stacker wheel shaft,

wherein, during operation in which banknotes are to be fed into the banknote receptacle, the lateral position of the pair of stacker wheels is automatically adjusted by the automatic stacker wheel positioning mechanism to a position such that banknotes to be fed into the banknote receptacle are received by the pair of stacker wheels and stacked in the banknote receptacle.

17. The banknote stacker wheel assembly of claim **16**, wherein a stacker wheel positioning mechanism comprises:

a stacker wheel positioning motor or solenoid, an elongated rotatable cam crank comprising two ends, a pair of linkage arms comprising two ends, and a pair of linkage arm supports.

18. The banknote stacker wheel assembly of claim **17**,

wherein one end of a first one of the pair of linkage arms is coupled to a first one of the ends of the cam crank and a second end of the first one of the pair of linkage arms is coupled to a first one of the pair of linkage arm supports,

wherein one end of a second one of the pair of linkage arms is coupled to a second one of the ends of the cam crank and a second end of the second one of the pair of linkage arms is coupled to a second one of the pair of linkage arm supports, and

wherein each stacker wheel is rotatably coupled to a respective one of the pair of linkage arm supports.

19. The banknote stacker wheel assembly of claim **18**, wherein the stacker wheel positioning motor or solenoid is configured to rotate the elongated rotatable cam crank about a cam axis causing the ends of the cam crank to rotate about the cam axis thereby causing the pair of linkage arm supports and the pair of stacker wheels coupled thereto to move either laterally closer to each other or laterally away from each other.

20. The banknote stacker wheel assembly of claim **16**,

wherein the position is an inward position, and

wherein, during operation in which banknotes are to be fed out of the banknote receptacle, the lateral position of the pair of stacker wheels is adjusted by the automatic stacker wheel positioning mechanism to an outward position such that banknotes to be fed out a recycling bay are not engaged by the pair of stacker wheels but instead are engaged by a banknote dispensing assembly which sequentially engages a topmost banknote stacked in the banknote receptacle and feeds banknotes out of the banknote receptacle, one bill at a time.

21. The generally vertical banknote recycling bay arrangement of claim **9**, wherein the banknote dispensing assembly comprises:

one or more stripping wheels supported for rotational movement about the driven stacker wheel shaft, the one or more stripping wheels being laterally positioned about the stacker wheel shaft between the pair of stacker wheels; and

one or more drive rolls supported for rotational movement about a drive roll shaft,

wherein, during operation in which banknotes are to be fed out of the recycling bay, the lateral position of the pair of stacker wheels is adjusted by the stacker wheel positioning mechanism to the outward position such that banknotes to be fed out the recycling bay are not engaged by the pair of stacker wheels but instead are engaged by the one or more stripping wheels which sequentially engages the topmost banknote stacked in the recycling bay and urges the topmost banknote into contact with the one or more drive rolls which act to feed banknotes out of the recycling bay arrangement, one bill at a time.

22. The generally vertical banknote recycling bay arrangement of claim **11**, further comprising a controller or processor communicatively coupled to and controlling the stacker wheel positioning motor or solenoid.

23. The generally vertical banknote recycling bay arrangement of claim **11**, further comprising a pair of stacker wheel bases and wherein each stacker wheel is fixedly coupled to a respective one of the stacker wheel bases and wherein each stacker wheel base is rotatably coupled to a respective one of the pair of linkage arm supports.

24. The banknote stacker wheel assembly of claim **16**, wherein the automatic stacker wheel positioning mechanism comprises:

a stacker wheel positioning screw; and

a pair of stacker wheel carriages, each carriage having a screw end and a stacker wheel end, the screw end of each carriage having a threaded aperture therein through which a portion of the stacker wheel positioning screw is threaded, each carriage having a pair of arms, each arm extending from the screw end toward the stacker wheel end and at least partially conforming about the stacker wheel shaft, the pair of arms of each carriage extending toward the stacker wheel shaft such that a corresponding stacker wheel is positioned about the stacker wheel shaft between the arms of a corresponding carriage,

wherein the lateral positions of the pair of stacker wheels are adjusted by rotational movement of the stacker wheel positioning screw which serves to laterally move the pair of stacker wheel carriages laterally toward each other when driven in a first rotational direction and to laterally move the pair of stacker wheel carriages laterally away each other when driven in a second rotational direction, lateral movement of the pair of stacker wheel carriages imparting a corresponding lateral movement on the pair of stacker wheels.

25. The banknote stacker wheel assembly of claim **24**, wherein the stacker wheel positioning screw comprises threads oriented in a first direction on a first portion and threads oriented in a second opposite direction on a second portion, and wherein a first one of the pair of stacker wheel carriages threadingly engages the first portion of the stacker wheel positioning screw and a second one of the pair of stacker wheel carriages threadingly engages the second portion of the stacker wheel positioning screw.

26. The banknote stacker wheel assembly of claim **17**,

wherein the position is an inward position, and

wherein, during operation in which banknotes are to be fed out of the banknote receptacle, the lateral position of the pair of stacker wheels is adjusted by the stacker wheel positioning mechanism to an outward position such that banknotes to be fed out a recycling bay are not engaged by the pair of stacker wheels but instead are engaged by a banknote dispensing assembly which sequentially engages a topmost banknote stacked in the banknote receptacle and feeds banknotes out of the banknote receptacle, one bill at a time.

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