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(72) Inventor: **Jantsch, Gregory**
Gulfport
Mississippi 39507 (US)

(74) Representative: **Deans, Michael John Percy**
Lane End House
Hookley Lane
Elstead
Surrey GU8 6JE (GB)

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(71) Applicant: **Delaware Capital Formation, Inc.**
Wilmington, DE 19803 (US)

(54) **Dispensing of currency**

(57) A paper passageway delivers bills that have been picked from a bill supply container to a location at which the bills are to be dispensed, the paper passageway and the bill supply container are structurally coupled together at least temporarily to form an integrated bill dispensing structure, and at least one of the bill supply container and the paper passageway are functionally incomplete in the absence of the other. The paper passageway delivers bills alternatively to a location at which the bills are to be rejected, a reject container holds rejected bills in a stack in which the bills are oriented vertically, and the bills are accessible to a user from an open top of the container. The paper passageway and the bill supply container are coupled at least temporarily to form a structure, a picker is positioned within the structure to enable the picker to pick bills from the bill supply container and move them along a predetermined path for delivery to the paper passageway, and the picker is removable from the position within the structure by sliding the picker in a direction perpendicular to the predetermined path. A mounting mechanism supports the bill dispensing structure on a wall through which the bill is to be dispensed to a user, the bill dispensing structure being self supporting and rigid without additional support.

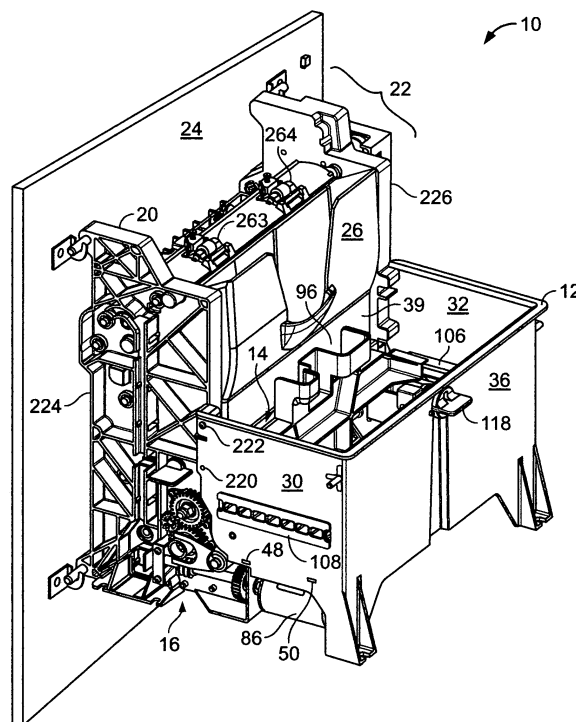


FIG. 1

Description

[0001] This description relates to dispensing of currency.

[0002] Currency dispensers are found, for example, in automatic teller machines (ATMs), including those for so-called off-premises use (for example, at an airport, grocery store, or other location not controlled by a financial institution).

[0003] A typical currency dispenser includes a removable supply container called a cassette. A stack of currency is loaded into the cassette and then delivered to and loaded into the dispenser.

[0004] The dispenser receives signals from control circuitry in the ATM when a user asks for cash. The signals could, for example, instruct the dispenser to dispense \$300 in \$20 bills to the user.

[0005] The dispenser includes paper transporting mechanisms that remove the needed number of bills from the supply container, one after another. Each removed bill is fed along a paper path to a position at which the bill is ejected to the outside world, where the user can reach it.

[0006] If the dispenser determines that a bill traveling along the path should not be dispensed, the bill is diverted into a locked reject cassette.

[0007] An example of a bill dispenser is shown in United States published application number 20050098622, published May 12, 2005, the contents of which are incorporated here by reference.

[0008] In general, in one aspect of the present invention, a paper passageway delivers bills that have been picked from a bill supply container to a location at which the bills are to be dispensed, the paper passageway and the bill supply container are structurally coupled together at least temporarily to form an integrated bill dispensing structure, and at least one of the bill supply container and the paper passageway are functionally incomplete in the absence of the other.

[0009] Implementations may include one or more of the following features. The bill supply container lacks a wall to support bills, the wall being provided by the paper passageway in the integrated bill dispensing structure. Side walls of the bill supply container are coupled to the wall provided by the paper passageway. Each of the side walls of the bill supply container is coupled to the passageway wall at an upper location and a lower location. The bill supply container is configured to enable access by a picker to bills stored in the supply container, and the paper passageway is configured to receive bills delivered from the picker. The bill supply container is generally box-shaped and includes an integral extension from the box to couple the bill supply container to the paper passageway. The integral extension extends under the picker and is attached to the paper passageway. Opposite sides of the integral extension are coupled to side walls of the picker when the picker is installed. An underside of a base of the bill supply container includes molded

strengthening features that provide structural strength to the integrated bill dispensing structure. Control electronics are housed in the base of the bill supply container and supported by the strengthening features. The bill supply container includes molded feet for mounting the integrated bill dispensing structure. The bill supply container includes electrical terminals to which the picker mates. The bill supply container includes a plate to apply pressure to a stack of the bills that are in the container and ready for dispensing and a one-piece guide rail to guide the plate back and forth toward and away from the stack of bills, the guide rail piece forming a floor of the bill supply container. The one-piece guide rail is snapped at its ends to respective side walls of the bill supply container and provides structural strength for the side walls. The plate is biased toward the bill stack and the apparatus also includes a locking mechanism to hold the plate away from the bill stack for loading of bills. The locking mechanism comprises a rotating key formed of two plastic elements that mate through a hole in a front wall of the bill supply container.

[0010] In general, in another alternative aspect of this invention, a paper passageway delivers bills that have been picked from a bill supply container to a location at which the bills are to be dispensed or a location at which the bills are to be rejected, a reject container holds rejected bills in a stack in which the bills are oriented vertically, and the bills are accessible to a user from an open top of the container.

[0011] Implementations may include one or more of the following features. The reject container comprises a single integral piece. The reject container comprises a vertically configured box open at the top to receive bills fed by gravity from a reject path of the paper passageway.

The reject container comprises a rear wall sloped to direct bills fed by gravity into the reject container attached to the paper passageway. The reject container comprises an angled bottom floor to cause each of the bills fed by gravity into the reject container to be oriented vertically and in a position that causes each successive bill to be placed in front of the prior bill until the tray is full.

[0012] In general, in another alternative aspect of this invention, a paper passageway to deliver bills that have been picked from a bill supply container to a location at which the bills are to be dispensed, the paper passageway and the bill supply container are coupled at least temporarily to form a structure, a picker is positioned within the structure to enable the picker to pick bills from the bill supply container and move them along a predetermined path for delivery to the paper passageway, and the picker is removable from the position within the structure by sliding the picker in a direction perpendicular to the predetermined path.

[0013] Implementations may include one or more of the following features. The picker includes an anti-back-up roller requiring periodic maintenance. The picker is latched into and unlatched from the position using a single hand-operated knob. Guide features aid the sliding

of the picker.

[0014] In general, in another aspect of this invention, a bill dispensing structure including a bill supply container, a paper passageway to deliver bills that have been picked from a bill supply container to a location at which the bills are to be dispensed through a wall to a user, a reject tray to receive bills that are diverted from the paper passageway and are not dispensed through the wall, and a mounting mechanism to support the bill dispensing structure on the wall, the bill dispensing structure being self supporting and rigid without additional support.

[0015] Implementations may include one or more of the following features. The mounting mechanism comprises mounting elements near the top of a side of the bill dispensing structure that faces the wall. The mounting elements comprise pins each having an end connected to the bill dispensing structure and a free end projecting from the bill dispensing structure in a direction parallel to the wall. The mounting mechanism comprises four pins any two of which are adequate to support the bill dispensing mechanism on the wall.

[0016] In general, in another aspect of this invention, a picker is removed from a position at which the picker can pick bills from a bill supply container and move them along a predetermined path for delivery to a paper passageway from which they are to be dispensed, the picker being removed by sliding it in a direction perpendicular to the predetermined path. Implementations may include one or more of the following features.

[0017] Implementations may include one or more of the following features. Locators on one end of the picker are mated with receptors on the paper passageway. A tab lock is activated to hold the picker in place.

[0018] Other advantages and features will become apparent from the following description with reference to the accompanying drawings.

[0019] In the drawings:

Figures 1, 2, 5, 6, 9, 10, and 14 are, respectively, front left perspective, front right perspective, bottom perspective, rear, rear left perspective, left side, and partial left side views, respectively, of a bill dispenser.

Figures 3 and 4 are left rear perspective and right bottom perspective views, respectively, of a bill supply container.

Figures 7 and 8 are perspective views of a lock.

Figures 11 and 12 are perspective and side views, respectively, of a reject tray.

Figure 13 is a partial internal perspective view of a bill supply container.

Figures 15, 16, 17, 18, and 19 are left side, perspective, right side, perspective (showing relationship

with other parts of the bill dispenser), and perspective (showing drive mechanism) views of a picker.

Figure 20 is a perspective view of one side of the paper passageway housing.

[0020] As shown in the figures, a bill dispenser 10 includes a bill supply container 12 from which bills 14 that are stacked are withdrawn by a picker 16 one at a time from an opening 18 of the container and delivered to the bottom end of a paper passageway assembly 20. After testing the bill to see if there is a reason to reject it (for example, if a double bill has been fed), each bill is then driven up along the paper passageway to an upper location 22 at which it is dispensed through a wall 24, such as a wall of an automated teller machine (ATM). A customer on the other side of the wall can then take the bill. If the bill is to be rejected, it is diverted (before reaching the dispensing location) by a vane 25 that routes the bill to a reject tray 26.

[0021] The bill supply container 12 is molded of PC-ABS blended plastic and has two side walls 30, 32, and a front wall 36 that are integrally formed. A rear wall for the container is provided by a front wall 37 of the paper passageway and a front wall 39 of the picker. A floor 38 of the container is molded as a separate piece to include a central guide 40, and two grooved regions 42, 43 that permit a stack of bills to slide along in the direction 46 of the picker as bills are withdrawn and the stack gets thinner. Spring side guides fit into the opposite side walls at locations 48, 50, 52, 53 in a way that helps to support and maintain the flatness of the sidewalls. The guide rails 106, 108 also support and maintain flatness of the sidewalls.

[0022] An arm 54 extends from one edge of the floor of the container toward the bottom of the paper passageway and leaves clearance for the picker which rests in space 56 between the paper passageway and the bill supply container. The arm includes a hole 57 through which a bolt 58 can be used to attach the arm to the bottom of the paper passageway and two ribs 59 for guiding a location guide tab 61 on the picker frame as the picker is inserted or removed.

[0023] The ribs 59 along the arm of the bill container guide the tab 61 so the picker is led across the surface of the container arm.

[0024] One side 60 of the arm 54 includes two pins 64, 66, and a hole 68. The pins fit within two holes 70, 72 in an end wall of the picker when the picker is in an installed position. A screw 71 connects to the hole 68 through a hole 75 in the frame 225 when the picker is the installed position. The pins aid alignment and registration for the picker when it is installed. The other end of the picker has shaft ends 51, 53, that mate with two pin locator holes 41, 43, on frame 226. A quarter-turn snap fastener 169 mounted on the other frame 224 rotates to hold the picker in place. No permanent fasteners are used.

[0025] The bottom 76 of the bill supply container, in-

cluding the arm, bear a pattern of ridges 78 designed to provide rigidity and strength to the container. The pattern of ridges also provides an available space for mounting a circuit board 80 that is used to control the operations of the bill dispenser and its components. One end of the circuit board includes socket 82 into which a plug 84 on the picker fits when the picker is inserted into its installed position. The connection of the socket and plug provides power to a motor 86 on the picker.

[0026] The other end of the circuit board bears two sockets 88, 90 that are used for power and communication respectively. A channel 92 in the bottom of the arm can carry a cable between a port 94 on the board and a double detect circuit and other sensors on the paper passageway.

[0027] Inside the bill supply container, a pressure plate 96 includes a flat surface 98 that bears against a stack of bills 100 (only a portion of which is shown), two ends 102, 104 that ride on supports 106, 108, two finger grips 110, 112, that enable a user to pull the plate back away from the stack for loading or reloading the stack, and a latching structure 114 that mates with a related grip 116 on a rotating lock 118 that is mounted on the front wall of the container.

[0028] The two supports 106, 108 are mounted through slots 120, 122, on opposite side walls of the container.

[0029] On each side of the container, beneath the supports 106, 108 are spring-loaded drive wheels 124, which are connected to the ends 102, 104 to pull the plate towards that stack of bills.

[0030] Also inside the bill supply container are two vertical guides 128, 130 and two horizontal guides 130, 134 that define a channel within which the stack of bills rides.

[0031] The rotating lock 118 is formed of two plastic pieces 140, 142 that mate and form an integrated lock when the two pieces are inserted in opposite directions through a mounting hole in the front wall of the container and are pressed together. Once mounted, the lock can be rotated so that the grip 116 can be mated to and unmated from the latching structure 114 in order to hold the plate and prevent it from springing back on the stack of bills or to release the plate, as desired. A finger 144 on the grip presses against a surface 114 of the plate in the locked position.

[0032] The container includes two feet 150, 152 that permit it to be securely mounted on a base, for example, a part of an ATM.

[0033] The picker has three drive wheels 154, 156, 158 that rotate to pick individual bills from the top of the stack and drive each of them downward and with assistance of additional drive wheels 155, 157, into the double detector (see arrow 159) where it can be picked up by the paper passageway. The drive wheels 154, 156, 158, are held on a shaft 160 that is rotationally mounted on both ends of the picker and is driven by a gear 162 on one end of the picker. Gear 162 is driven by a gear train including gears 164, 166, and in turn driven by a worm gear

168 on a shaft of the motor. Drive wheels 155, 157 are driven by gear 166.

[0034] The arm of the container includes guiding surfaces 170, 172 and ribs 59 that correspond to surfaces and slots on the picker and enable the picker to be inserted and removed easily and with good alignment.

[0035] To insert the picker, the end 171 of the picker opposite the motor is inserted into the space between the bill supply container and the paper passageway with the guiding surfaces and tab of the picker mated with the corresponding guiding slots and ribs of the container arm. The picker is slid into place. Two pins on the end of the picker fit into two corresponding holes of a side piece of the paper passageway. The electrical terminal 84 automatically makes connection with the circuit board beneath the bill supply container, as explained earlier. The picker is held in place using the quarter turn knob 169, figure 10. To remove the picker a reverse series of steps is used.

[0036] The picker is easily removed and replaced which makes maintenance and cleaning of its parts simple and easy. When installed, the picker is precisely aligned as required for reliable picking.

[0037] The reject tray 26 is an integral molded plastic unit that has an open top 181 and is easily accessible at any time to a person who has authority to maintain the bill dispenser or unload the reject bills. The reject tray is not a locked cassette. Rather, bills may be unloaded at any time directly from the bill dispenser.

[0038] The reject tray has two parallel side walls 180, 182, spanned by a front wall 184 and a rear wall 186. The rear wall is generally flat and has a projection 188 away from the inside of the tray that provides finger room to reach behind a stack of bills when the stack is to be removed. The front wall has a cutout 190 to permit a user to reach down to retrieve a stack of bills and another finger projection 192 to make it easier to grasp the stack. The contours of the front and rear walls and the bottom 194 are arranged so that bills dropped by gravity from the reject path into the tray will automatically stack themselves into a vertically oriented stack of bills. When a bill 196 is delivered from the gentle curve of the paper passageway reject path, the bill follows a path 198. Driven by gravity downward and by inertia towards the front wall of the reject tray, the bill strikes the front wall at curved surface 200 and follows the curve downward. The leading edge of the bill strikes the bottom wall at point 212 and slides down to point 214. Eventually the upper edge of the bill falls over 216 to take its place on stack 218. Even if a given bill does not fall over to join the stack, the next bill or bills will feed themselves onto the front-wall side of the previously received bill and eventually the bills will fall over onto the stack.

[0039] The paper passageway 18 is defined within a bill delivery assembly 22. The bill supply container is bolted to the bill delivery assembly to form a strong rigid structure. Two bolts 220, 222, on each side of the bill supply container connect the container to two side frames

224, 226 of the bill delivery assembly. In addition, the end of the arm 54 of the bill supply container is bolted to the bottom of bill delivery assembly on a piece 228 that spans between the two side frames.

[0040] The picker is arranged to peel one bill at a time from the stack in the supply container and to deliver it to the paper passageway. The picker also reorients the bills from their vertical arrangement in the supply container to a horizontal orientation for delivery to the paper passageway. The picker is held in position, but can be removed and reinserted easily and quickly by sliding it in a direction that is perpendicular to a path along which bill moves from the supply container to the paper passageway.

[0041] A bill that has been delivered from the supply container to the paper passageway is driven upward along the paper passageway by four pairs of frictional rollers 230, 232, 234, 236 that are mounted on two parallel shafts 238, 240.

[0042] At the lower end of the paper passageway a curved surface 241 reorients the bill from horizontal to vertical for its trip up the paper passageway a direction of motion that is perpendicular to the direction in which the bill leaves the supply container.

[0043] At the upper end of the paper passageway, the traveling bill can either be diverted by a curved surface 250 into the reject tray or by a curved surface 256 to the dispensing location. Which way the bill travels depends on the position of a control vane 25 that can be rotated (about an axle) between two positions. The vane is spring-biased to a default position that rejects bills into the reject tray and must be driven to the dispensing position. (The default routing is applied only to the first bill in the series after which the remaining bills in the series are routed by default to the dispensing location, unless one of those remaining bills is also determined to be flawed.)

[0044] A bill that is diverted to the dispensing location is driven out of the paper passageway by two additional pairs of frictional rollers 263, 264. A bill that is diverted to the reject tray is driven by two pairs of frictional rollers 258, 259.

[0045] The bottom end of the paper passageway supports a double-detect mechanism 270 that is used to determine, for example, when more than one bill has been withdrawn from the supply container at one time. If so, the dispenser leaves the vane in the rejection position and the multiple bills are rejected into the reject tray. Otherwise, the vane is forced to the dispensing position and the single bill is dispensed to the customer.

[0046] The double-detect mechanism uses a Hall effect sensor to determine whether more than one bill has been withdrawn from the supply container by measuring the thickness of the bill and comparing it to a maximum thickness value.

[0047] Each of the frames 224, 226 of the bill dispenser includes holes 302, 304, 306, 308 at the top and bottom to receive mounting pins 310, 312, 314, 316. The pins

may be used for purposes of mounting the dispenser to a wall 24 or door of, for example, an ATM. Each of the pins could be held by a hook-latch mechanism 318, 320, 322, 324 (in figure 1 only simple hooks are shown, but hook-latch mechanisms could be substituted).

[0048] Each of the hook-latch mechanisms could be operated independently. By releasing all four, the dispenser could be removed completely from wall 24. By releasing only the upper two mechanisms, the dispenser could pivot around the bottom two pins with the top of the dispenser moving away from the wall to open a space for clearing jams in the paper passageway.

[0049] The frames including molded elements to assure that the dispenser can be supported on the pins without distortion or breaking of the frames or other elements of the dispenser being caused by the stress of the dispenser hanging from all four, or just two, of the pins.

[0050] In addition, when the dispenser is hung from the pins connected to the frames, the paper supply container is securely supported both to the fronts of the frames and the bottom of the paper passageway. A rib formation at the bottom of the paper supply container accepts a boss from the two frames, to stop movement of the container relative to the frames.

[0051] Thus, even though the bill supply container is not functional as a standalone container, unlike typical self-contained currency cassettes. Even though the picker is removable from the dispenser, when the container is mounted on the frames and the picker is installed its position, the dispenser behaves as a strong self supporting unit that resists distortion or breaking and can be hung on a wall 24 using supports that are mounted only on the frames.

[0052] Additional details concerning the paper passageway, the components that embody it, and the steps to assemble it, can be found in the published United States patent application cited earlier which describes similar features of a paper passageway.

[0053] Because the dispenser is assembled from a small number of lightweight, easy to manipulate parts, assembly is fast and inexpensive, and the resulting dispenser is small, lightweight, and inexpensive. Maintenance can be done easily and inexpensively in case any part breaks or malfunctions.

[0054] The bill dispenser is designed for a low volume bill dispensing environment, for example, in a small retail context. A store owner, for example, can fill the bill supply container with money directly from the cash register in the store. The cassette is filled in place inside the safe that holds the dispenser. The dispenser is filled "in the public eye", or before a store opens. The safe may, for example, not be stronger than a business hour rating so it must be near a human and not hidden away from public. Bank filling or "cash in transit" typically would not be used for this dispenser which does not have a removable or sealed cassette.

Claims

1. An apparatus comprising
a paper passageway to deliver bills that have been
picked from a bill supply container to a location at
which the bills are to be dispensed, the paper pas-
sageway and the bill supply container being struc-
turally coupled together at least temporarily to form
an integrated bill dispensing structure, at least one
of the bill supply container and the paper passage-
way being functionally incomplete in the absence of
the other.
2. The apparatus of claim 1 in which the bill supply con-
tainer lacks a wall to support bills, the wall being pro-
vided by the paper passageway in the integrated bill
dispensing structure.
3. The apparatus of claim 2 in which side walls of the
bill supply container are coupled to the wall provided
by the paper passageway.
4. The apparatus of claim 2 in which each of the side
walls of the bill supply container is coupled to the
passageway wall at an upper location and a lower
location.
5. The apparatus of claim 1 in which the bill supply con-
tainer is configured to enable access by a picker to
bills stored in the supply container, and the paper
passageway is configured to receive bills delivered
from the picker.
6. The apparatus of claim 5 in which the bill supply con-
tainer is generally box-shaped and includes an inte-
gral extension from the box to couple the bill supply
container to the paper passageway.
7. The apparatus of claim 6 in which the integral exten-
sion extends under the picker and is attached to the
paper passageway.
8. The apparatus of claim 6 in which opposite sides of
the integral extension are coupled to side walls of
the picker when the picker is installed.
9. The apparatus of claim 1 in which an underside of a
base of the bill supply container includes molded
strengthening features that provide structural
strength to the integrated bill dispensing structure.
10. The apparatus of claim 9 in which control electronics
is housed in the base of the bill supply container and
supported by the strengthening features.
11. The apparatus of claim 1 in which the bill supply con-
tainer includes molded feet for mounting the integrat-
ed bill dispensing structure.
12. The apparatus of claim 5 in which the bill supply con-
tainer includes electrical terminals to which the pick-
er mates.
13. The apparatus of claim 1 in which the bill supply con-
tainer includes a plate to apply pressure to a stack
of the bills that are in the container and ready for
dispensing and a one-piece guide rail to guide the
plate back and forth toward and away from the stack
of bills, the guide rail piece forming a floor of the bill
supply container.
14. The apparatus of claim 13 in which the one-piece
guide rail is snapped at its ends to respective side
walls of the bill supply container and provides struc-
tural strength for the side walls.
15. The apparatus of claim 13 in which the plate is biased
toward the bill stack and the apparatus also includes
a locking mechanism to hold the plate away from the
bill stack for loading of bills.
16. The apparatus of claim 15 in which the locking mech-
anism comprises a rotating key formed of two plastic
elements that mate through a hole in a front wall of
the bill supply container.
17. An apparatus comprising
a paper passageway to deliver bills that have been
picked from a bill supply container to a location at
which the bills are to be dispensed or a location at
which the bills are to be rejected,
a reject container configured to hold rejected bills in
a stack in which the bills are oriented vertically and
the bills are accessible to a user from an open top
of the container.
18. The apparatus of claim 17 in which the reject con-
tainer comprises a single integral piece.
19. The apparatus of claim 17 in which the reject con-
tainer comprises a vertically configured box open at
the top to receive bills fed by gravity from a reject
path of the paper passageway.
20. The apparatus of claim 19 in which the reject con-
tainer comprises a rear wall sloped to direct bills fed
by gravity into the reject container attached to the
paper passageway.
21. The apparatus of claim 19 in which the reject con-
tainer comprises an angled bottom floor to cause
each of the bills fed by gravity into the reject container
to be oriented vertically and in a position that causes
each successive bill to be placed in front of the prior
bill until the tray is full.
22. An apparatus comprising

- a paper passageway to deliver bills that have been picked from a bill supply container to a location at which the bills are to be dispensed, the paper passageway and the bill supply container being coupled at least temporarily to form a structure, and a picker at a position within the structure to enable the picker to pick bills from the bill supply container and move them along a predetermined path for delivery to the paper passageway, the picker being removable from the position within the structure by sliding the picker in a direction perpendicular to the predetermined path.
- 23.** The apparatus of claim 22 in which the picker includes an anti-backup roller requiring periodic maintenance.
- 24.** The apparatus of claim 22 in which the picker is latched into and unlatched from the position using a single hand-operated knob.
- 25.** The apparatus of claim 22 including guide features to aid the sliding of the picker.
- 26.** An apparatus comprising a bill dispensing structure including a bill supply container, a paper passageway to deliver bills that have been picked from a bill supply container to a location at which the bills are to be dispensed through a wall to a user, and a reject tray to receive bills that are diverted from the paper passageway and are not dispensed through the wall, and a mounting mechanism to support the bill dispensing structure on the wall, the bill dispensing structure being self supporting and rigid without additional support.
- 27.** The apparatus of claim 26 in which the mounting mechanism comprises mounting elements near the top of a side of the bill dispensing structure that faces the wall.
- 28.** The apparatus of claim 27 in which the mounting elements comprise pins each having an end connected to the bill dispensing structure and a free end projecting from the bill dispensing structure in a direction parallel to the wall.
- 29.** The apparatus of claim 27 in which the mounting mechanism comprises four pins any two of which are adequate to support the bill dispensing mechanism on the wall.
- 30.** A method comprising removing a picker from a position at which the picker can pick bills from a bill supply container and move them along a predetermined path for delivery to a paper passageway from which they are to be dispensed, the picker being removed by sliding it in a direction perpendicular to the predetermined path.
- 31.** The method of claim 30 also including mating locators on one end of the picker with receptors on the paper passageway.
- 32.** The method of claim 30 also including activating a tab lock to hold the picker in place.

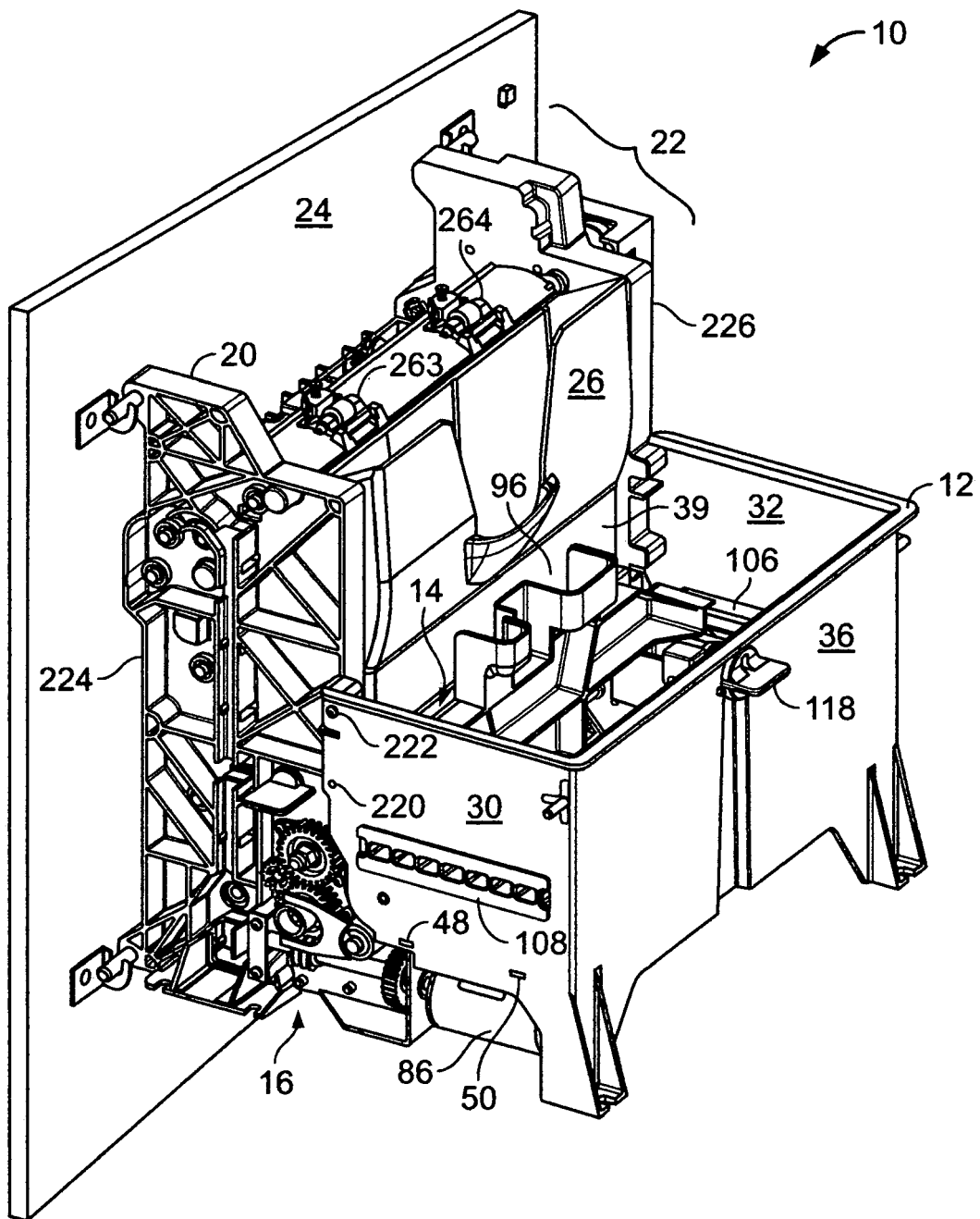


FIG. 1

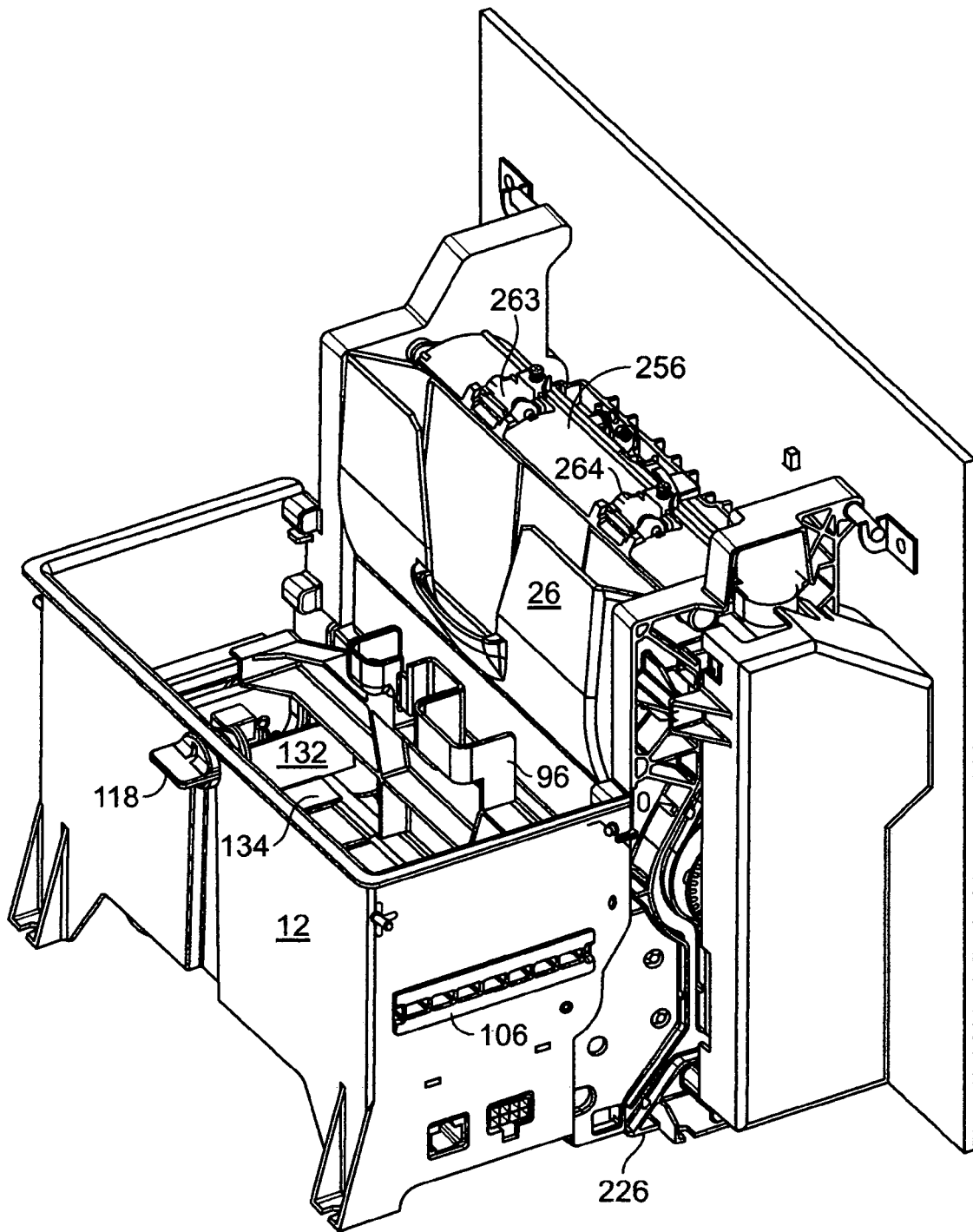


FIG. 2

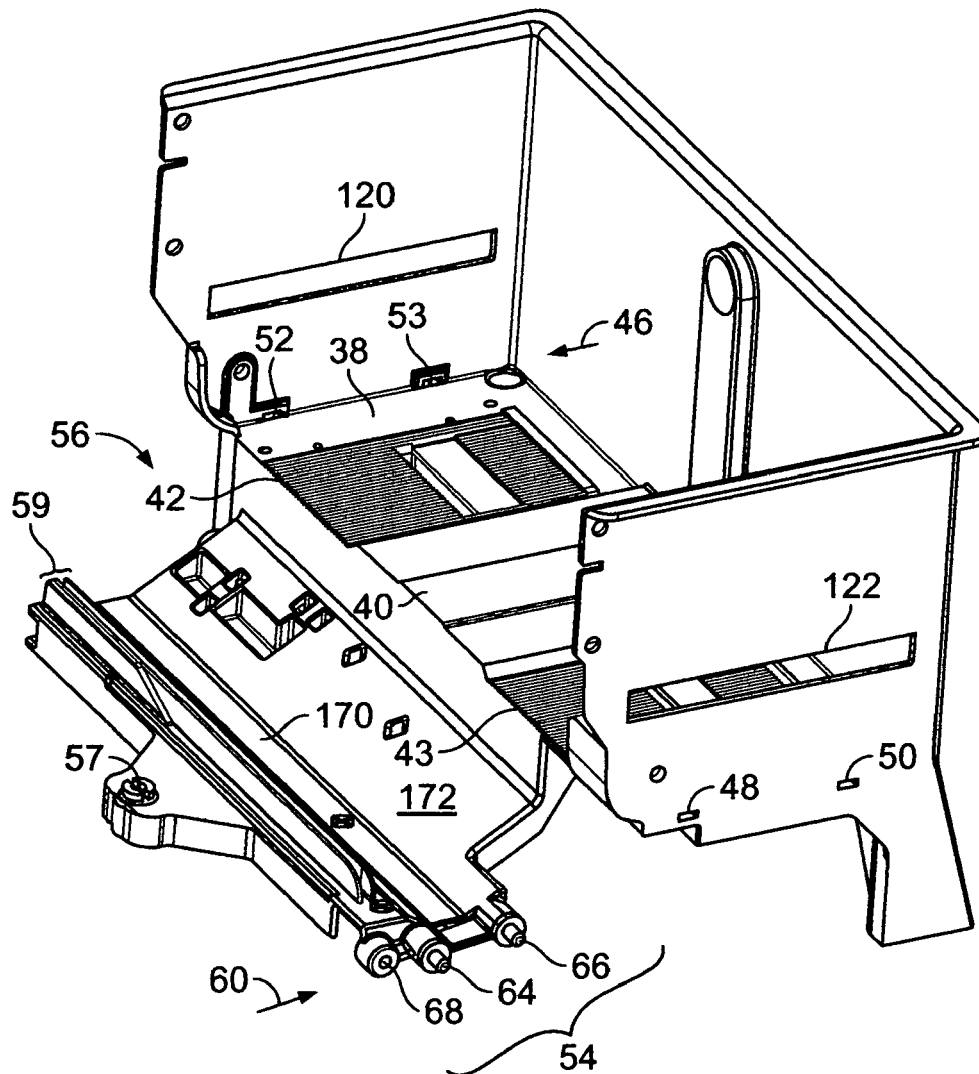


FIG. 3

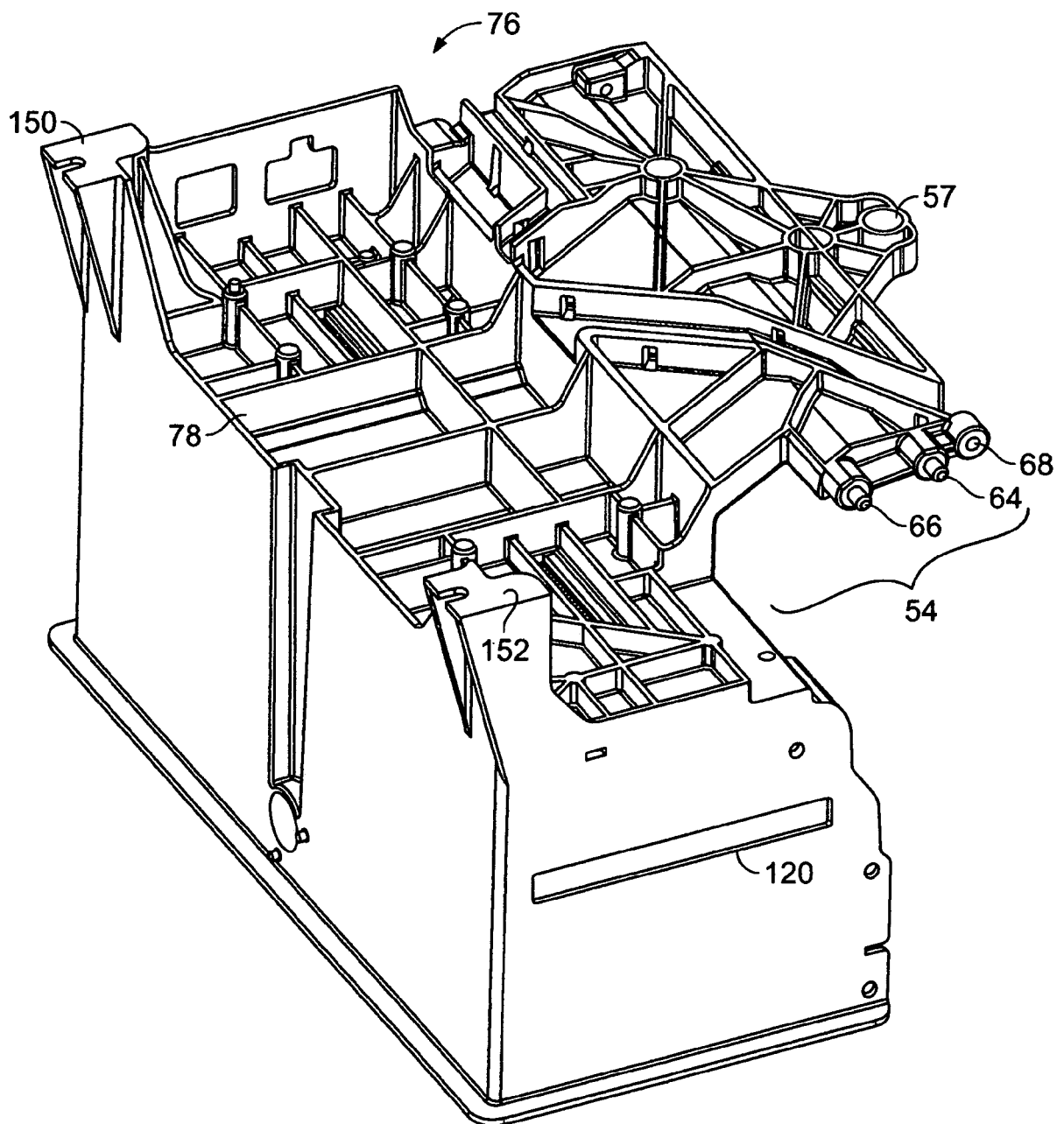


FIG. 4

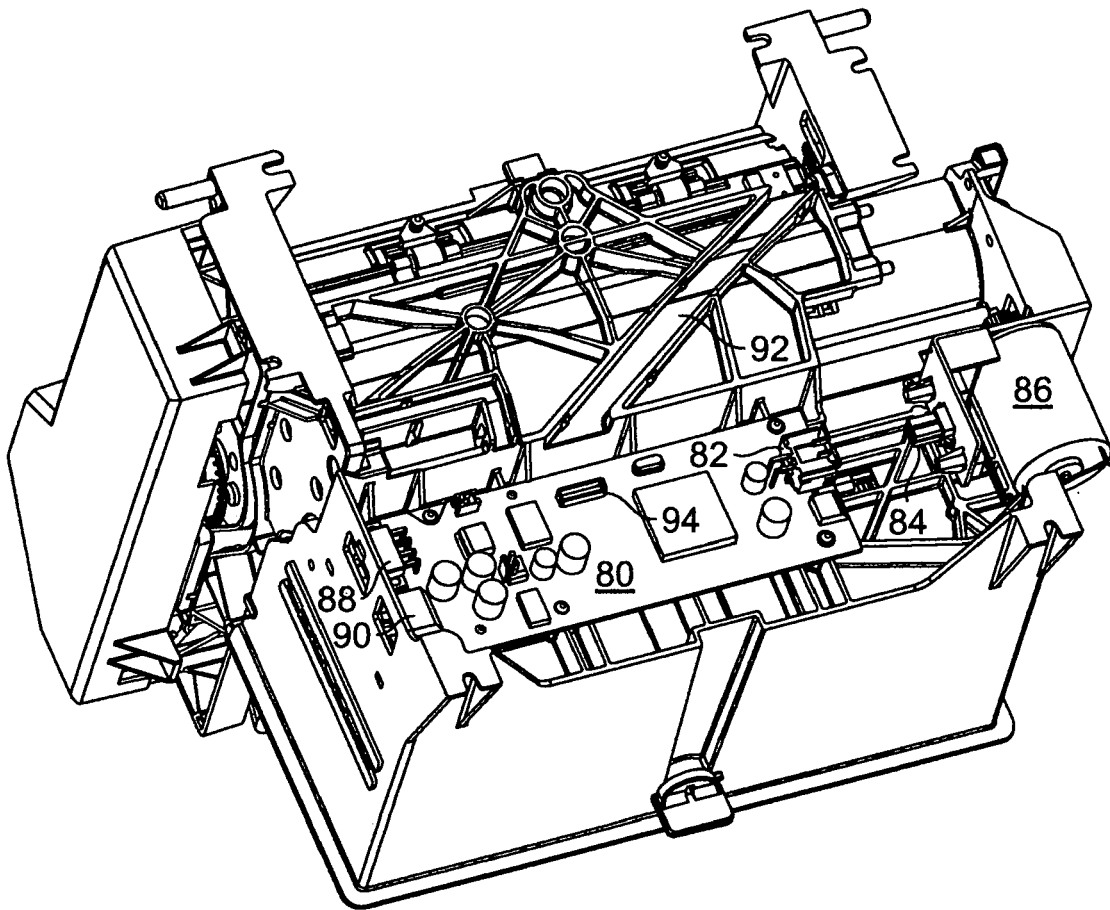


FIG. 5

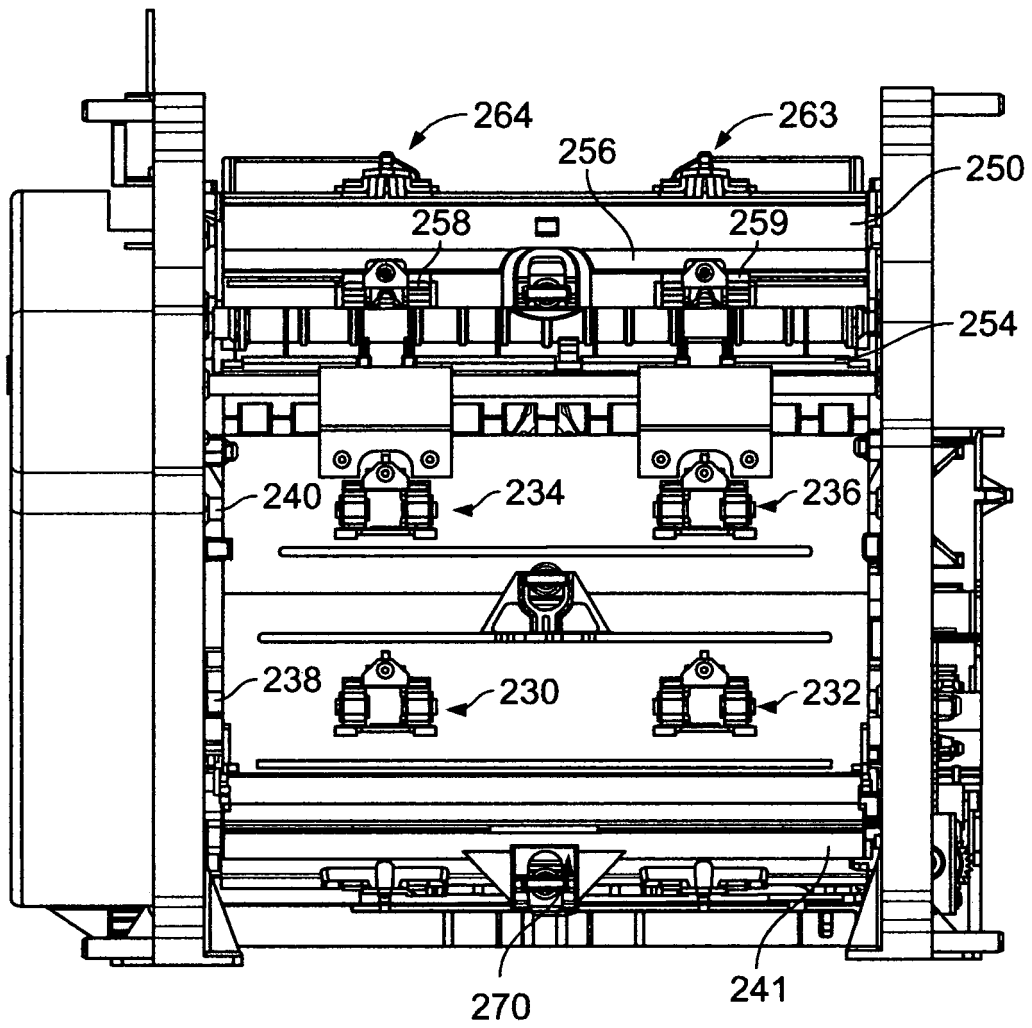


FIG. 6

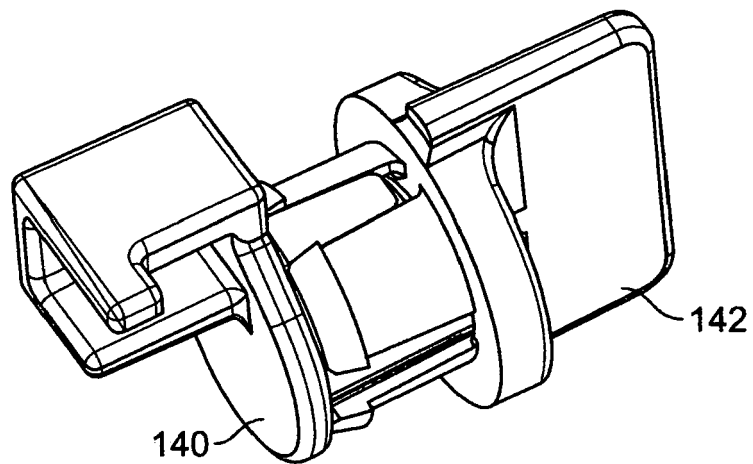


FIG. 7

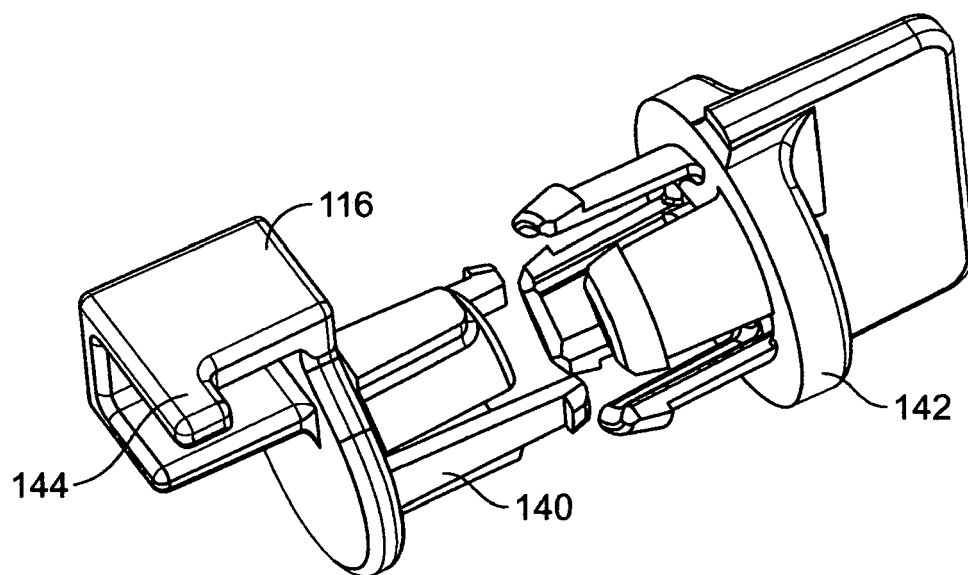


FIG. 8

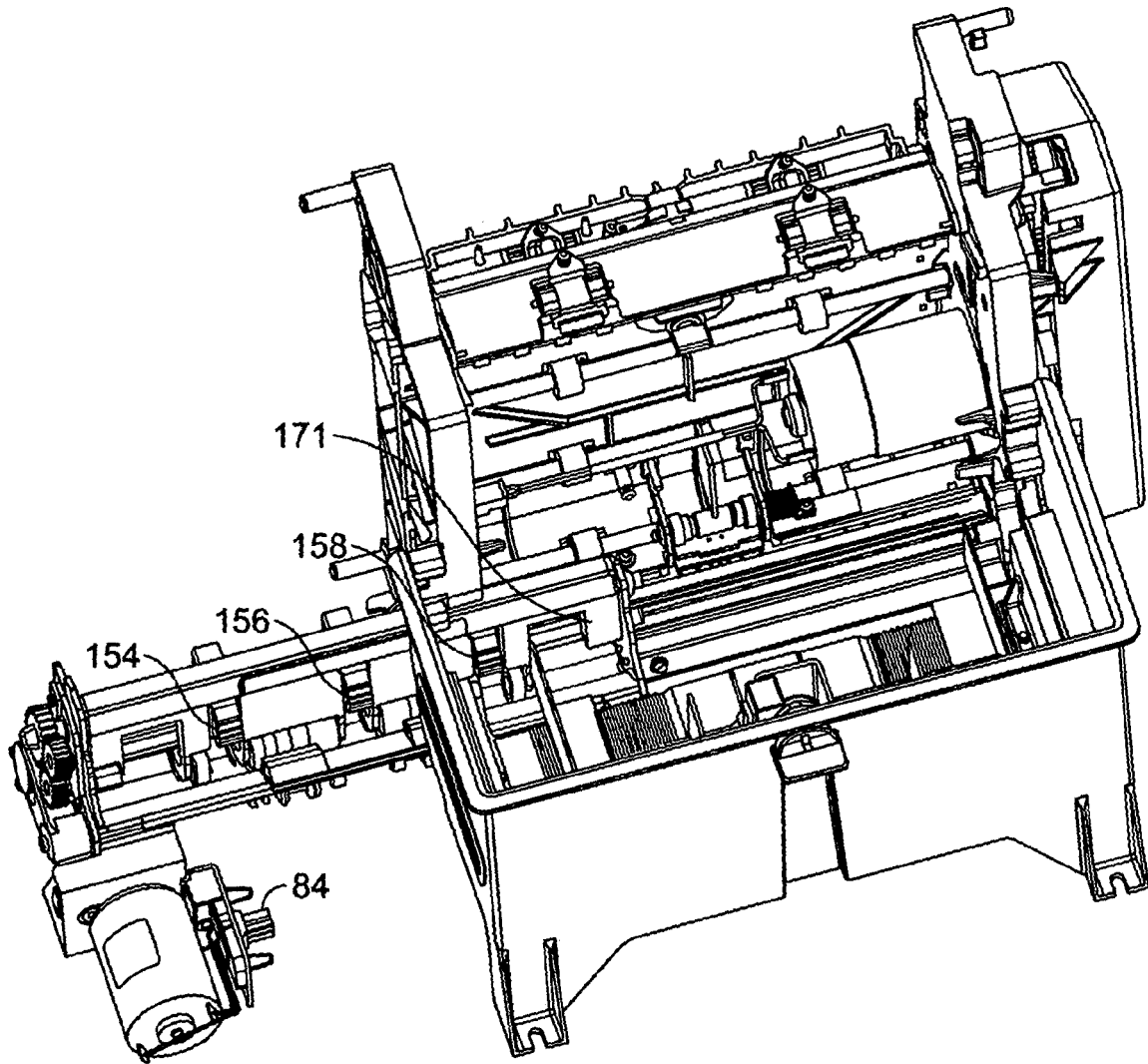


FIG. 9

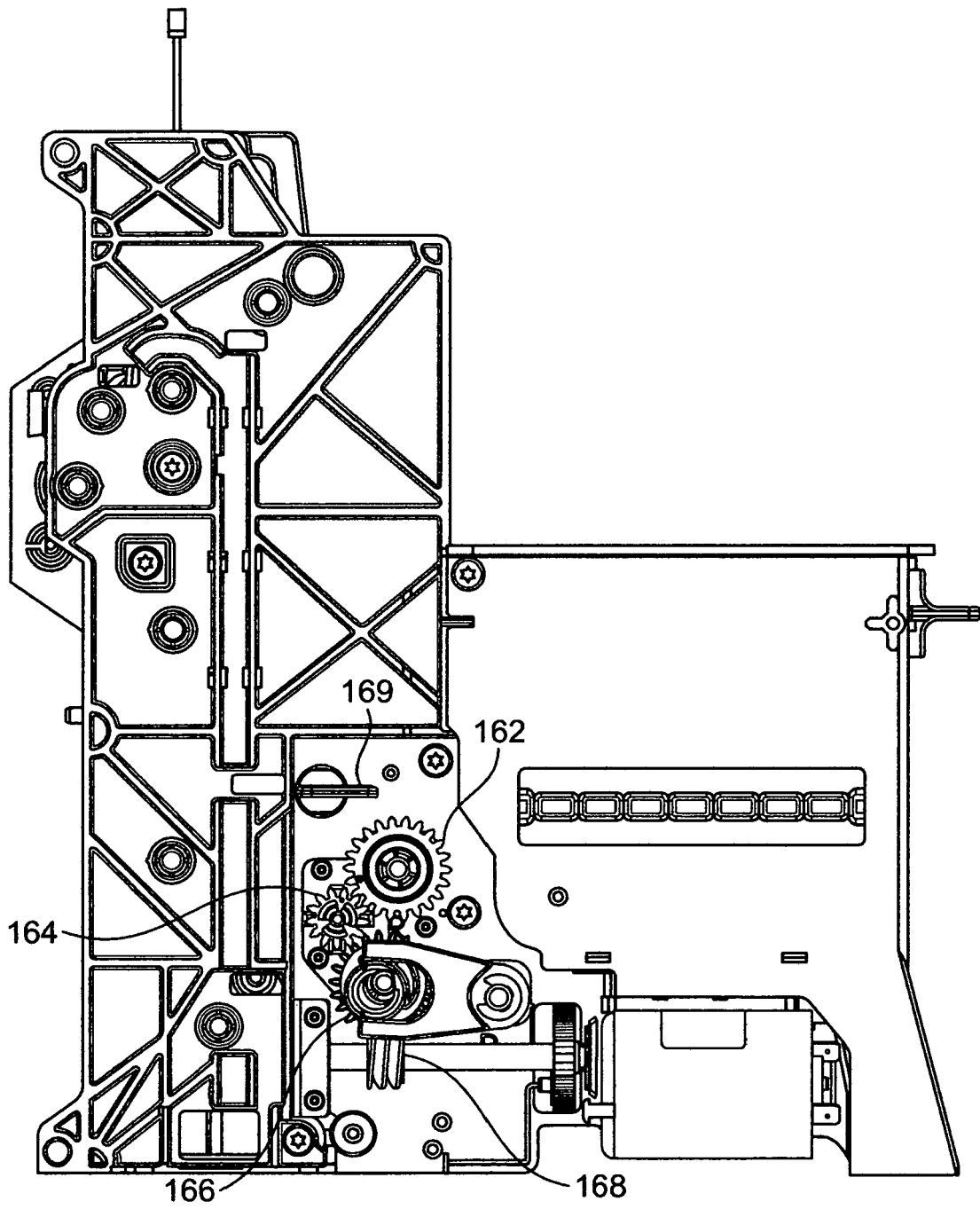


FIG. 10

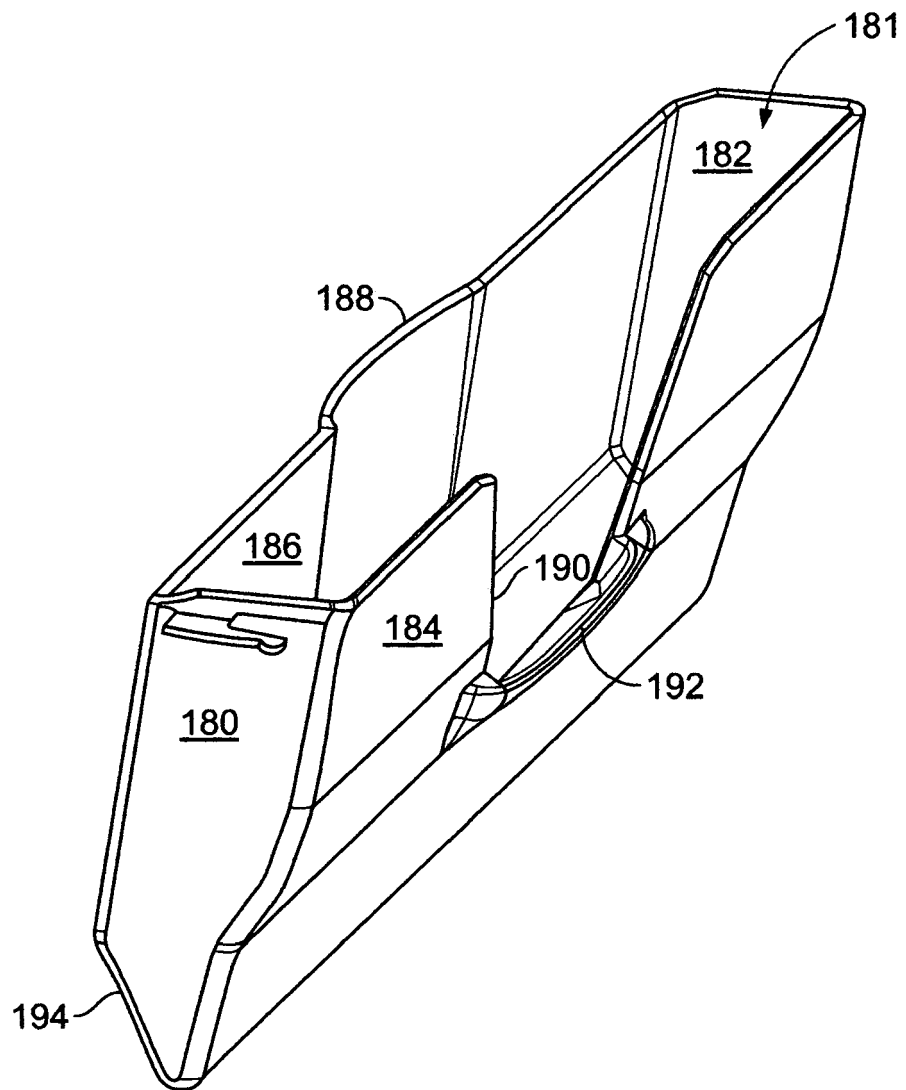


FIG. 11

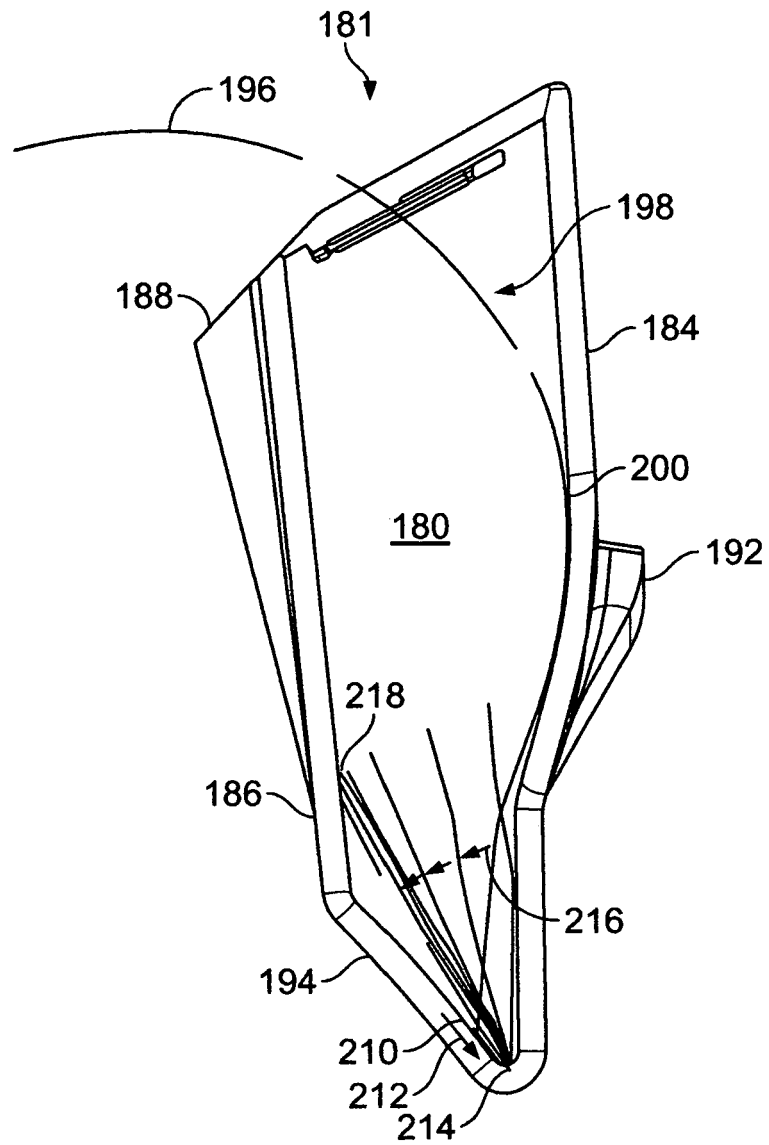


FIG. 12

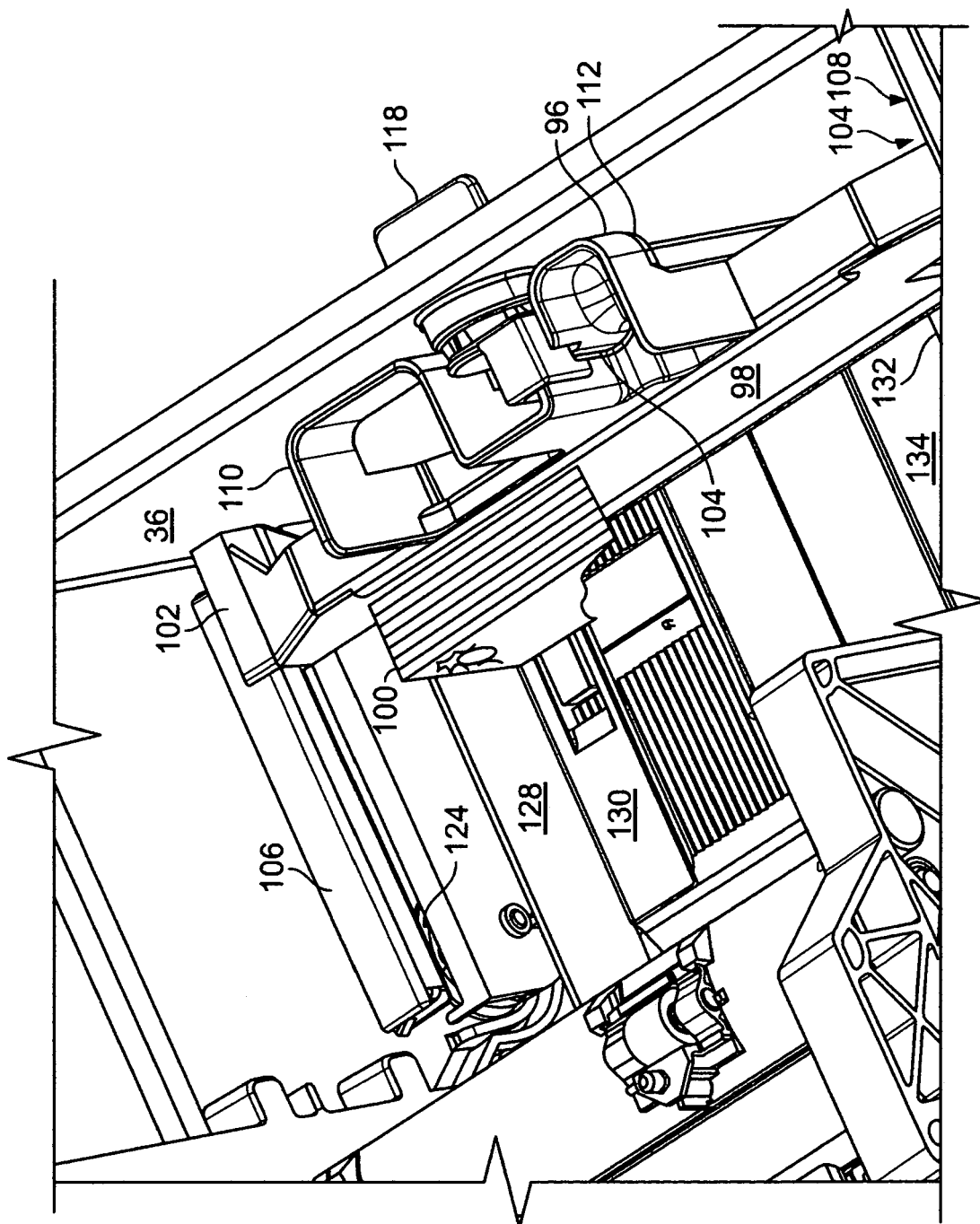


FIG. 13

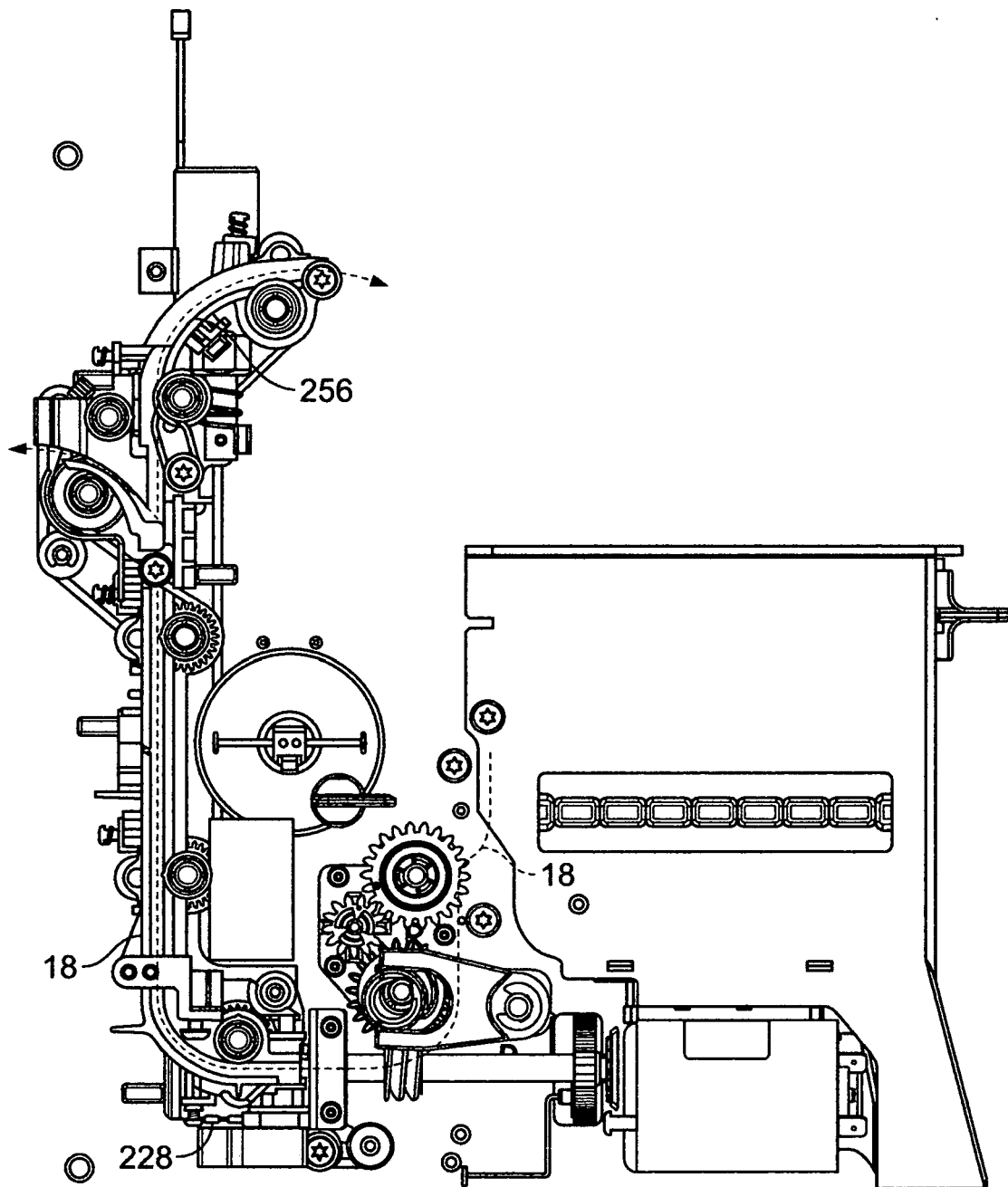


FIG. 14

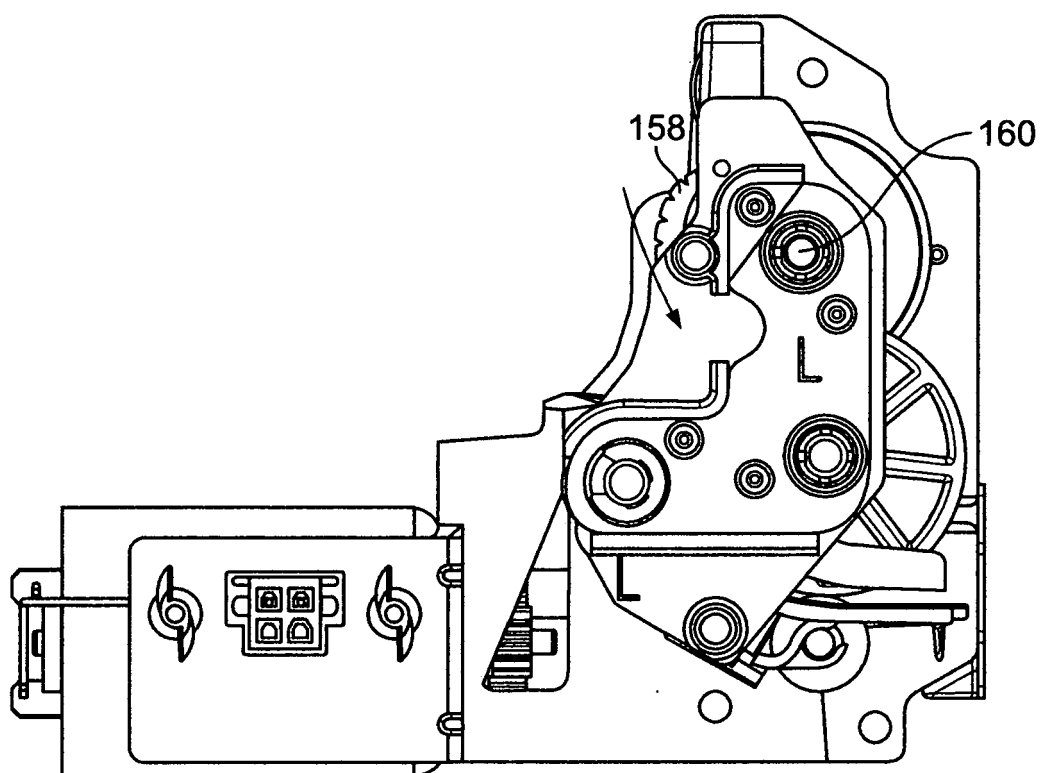


FIG. 15

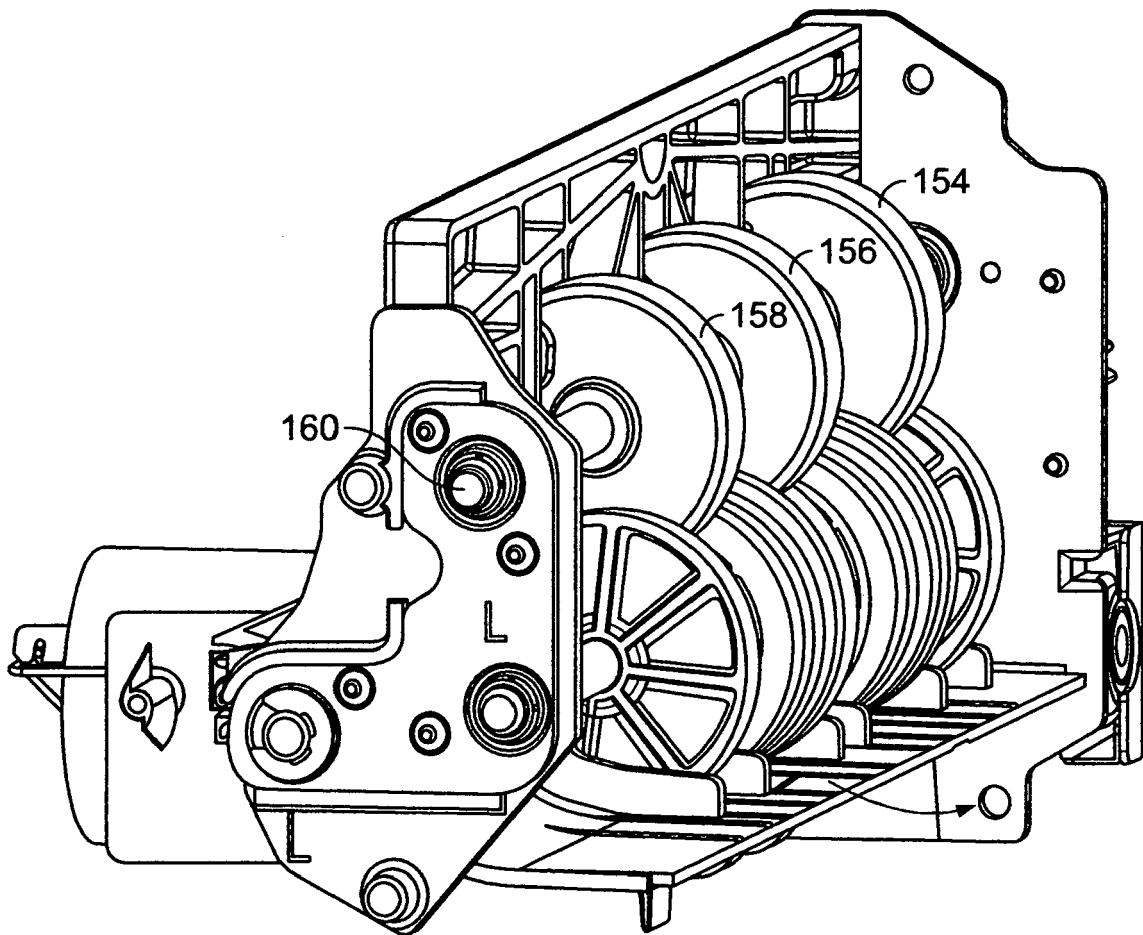


FIG. 16

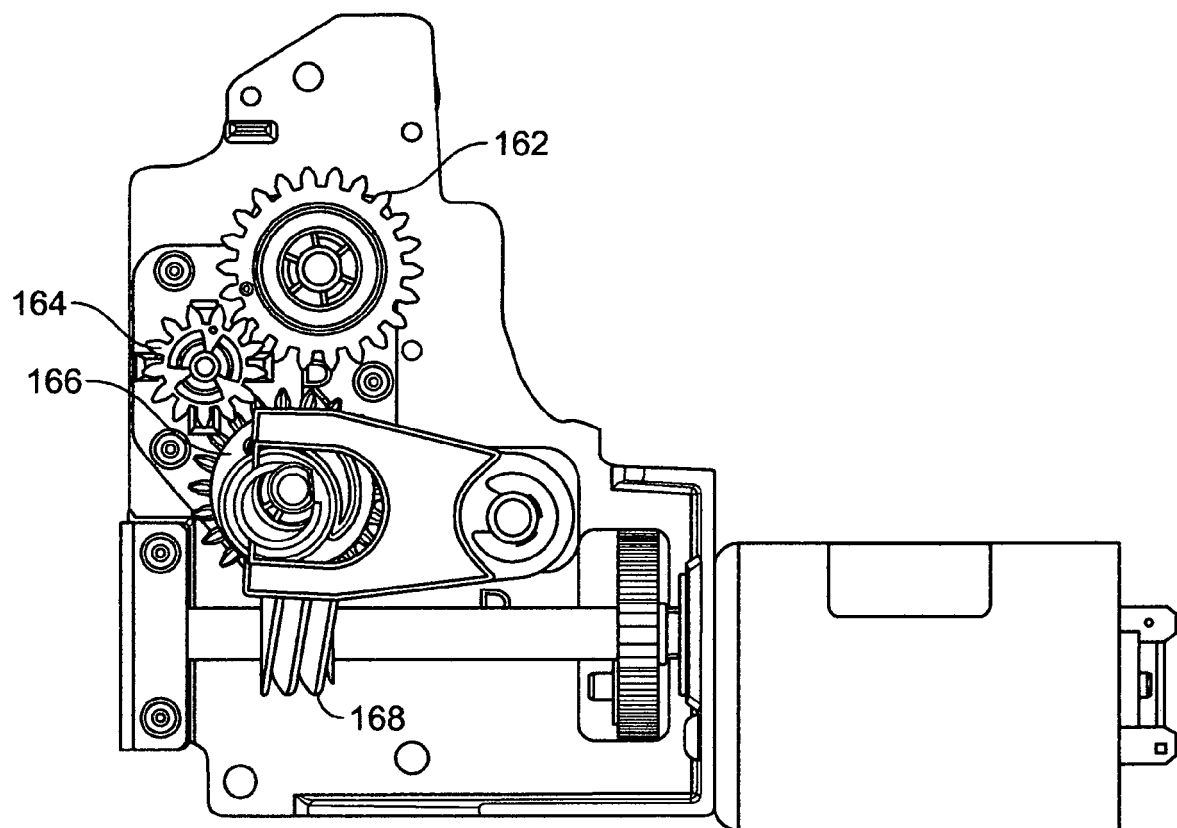


FIG. 17

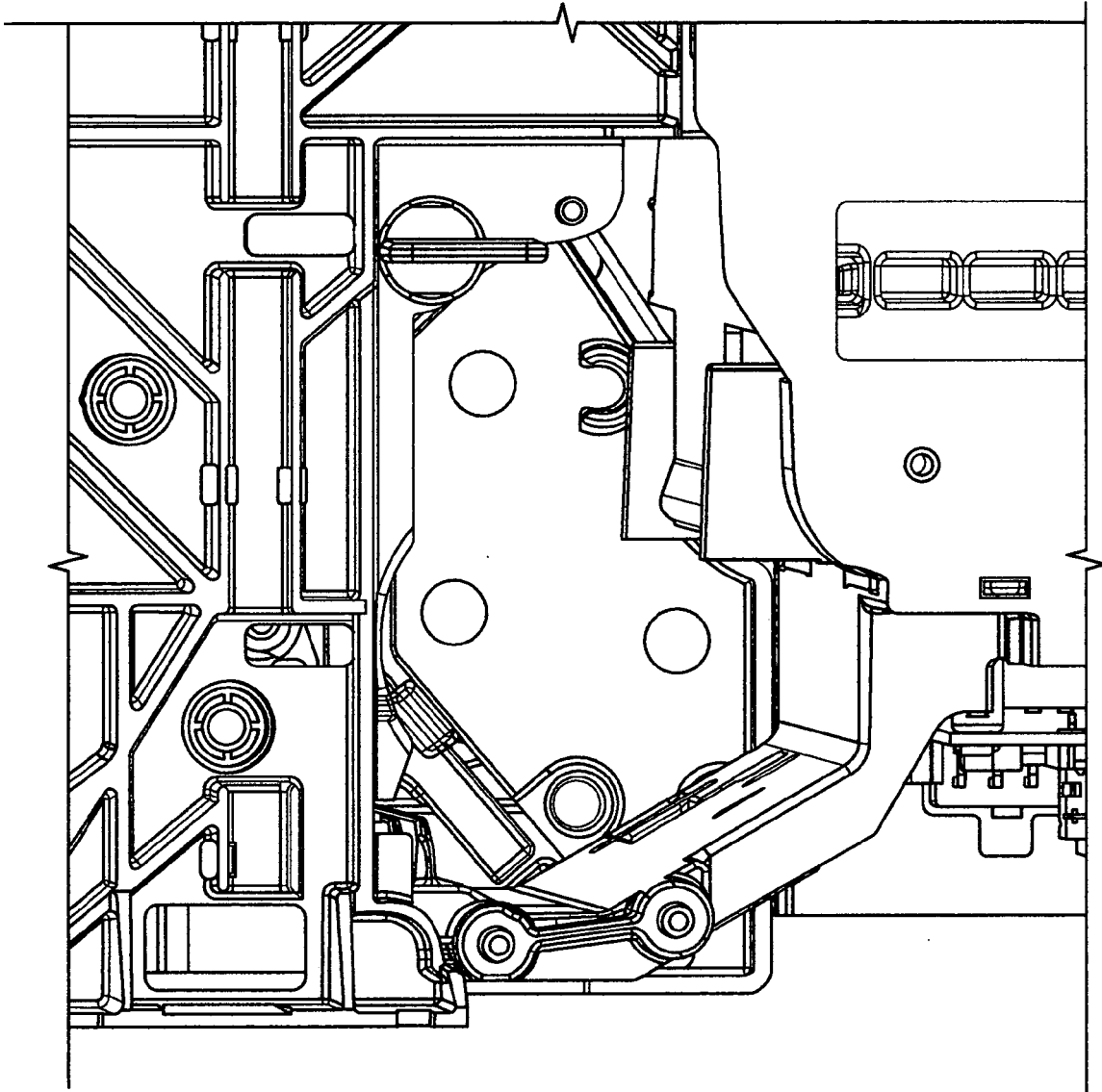


FIG. 18

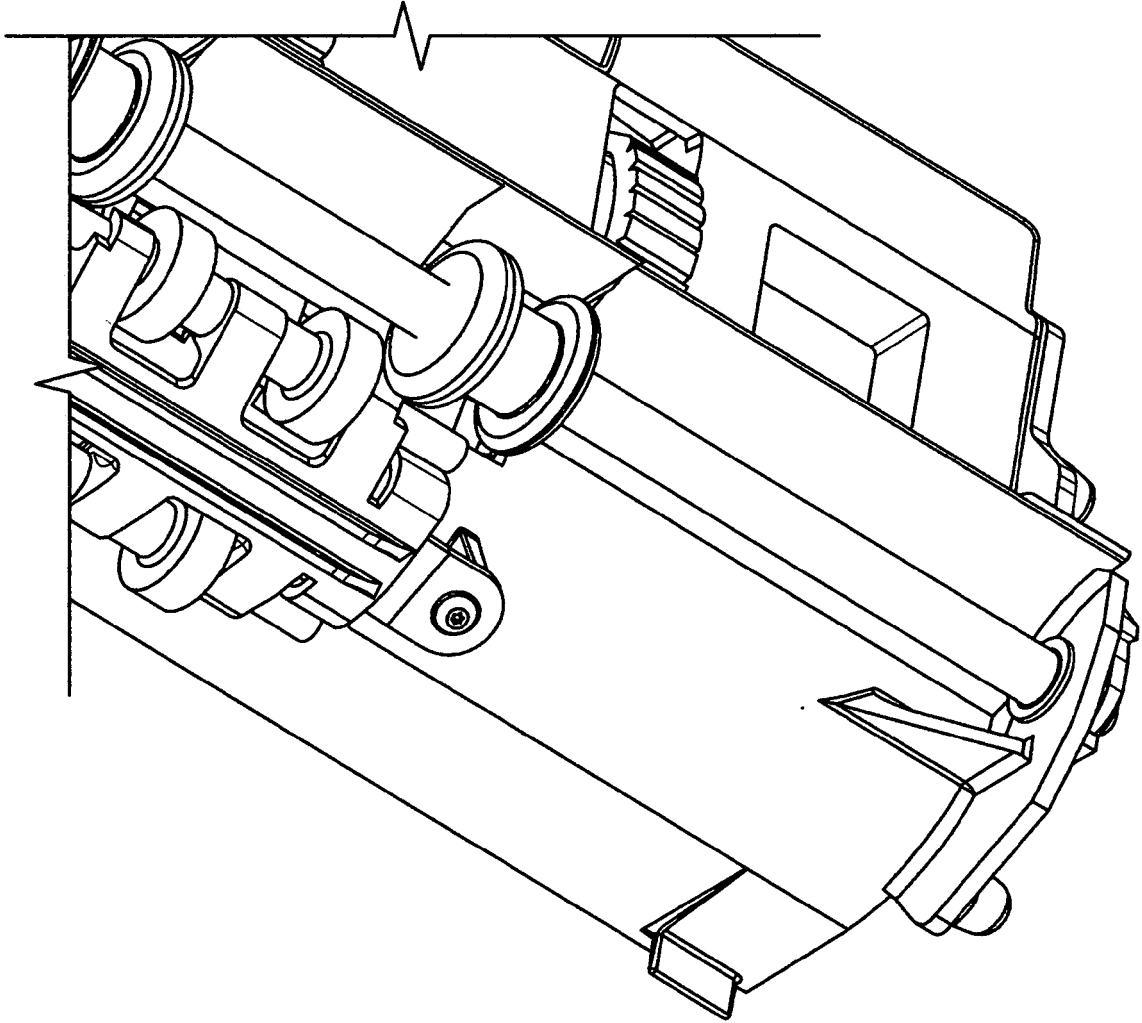


FIG. 19

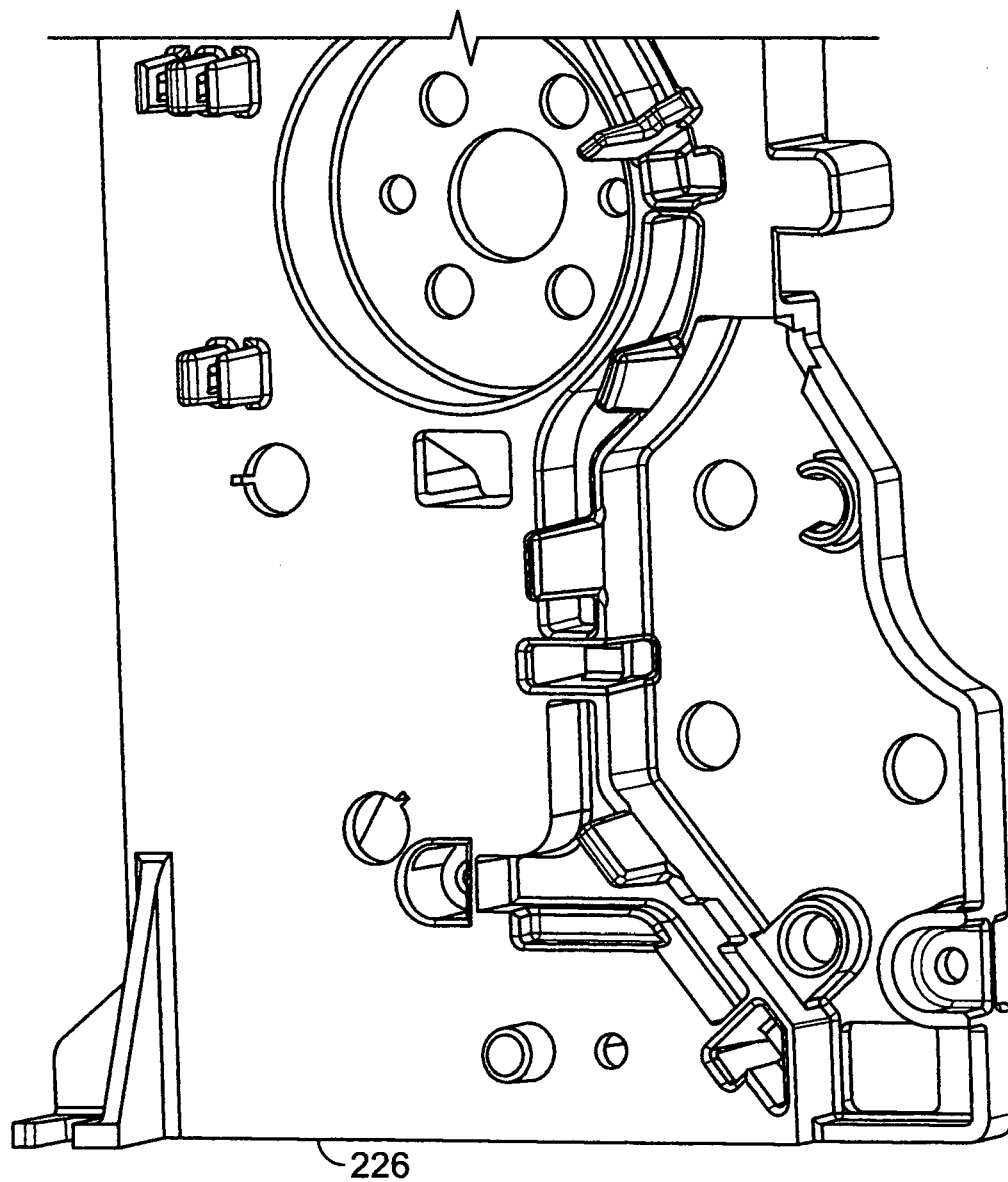


FIG. 20

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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