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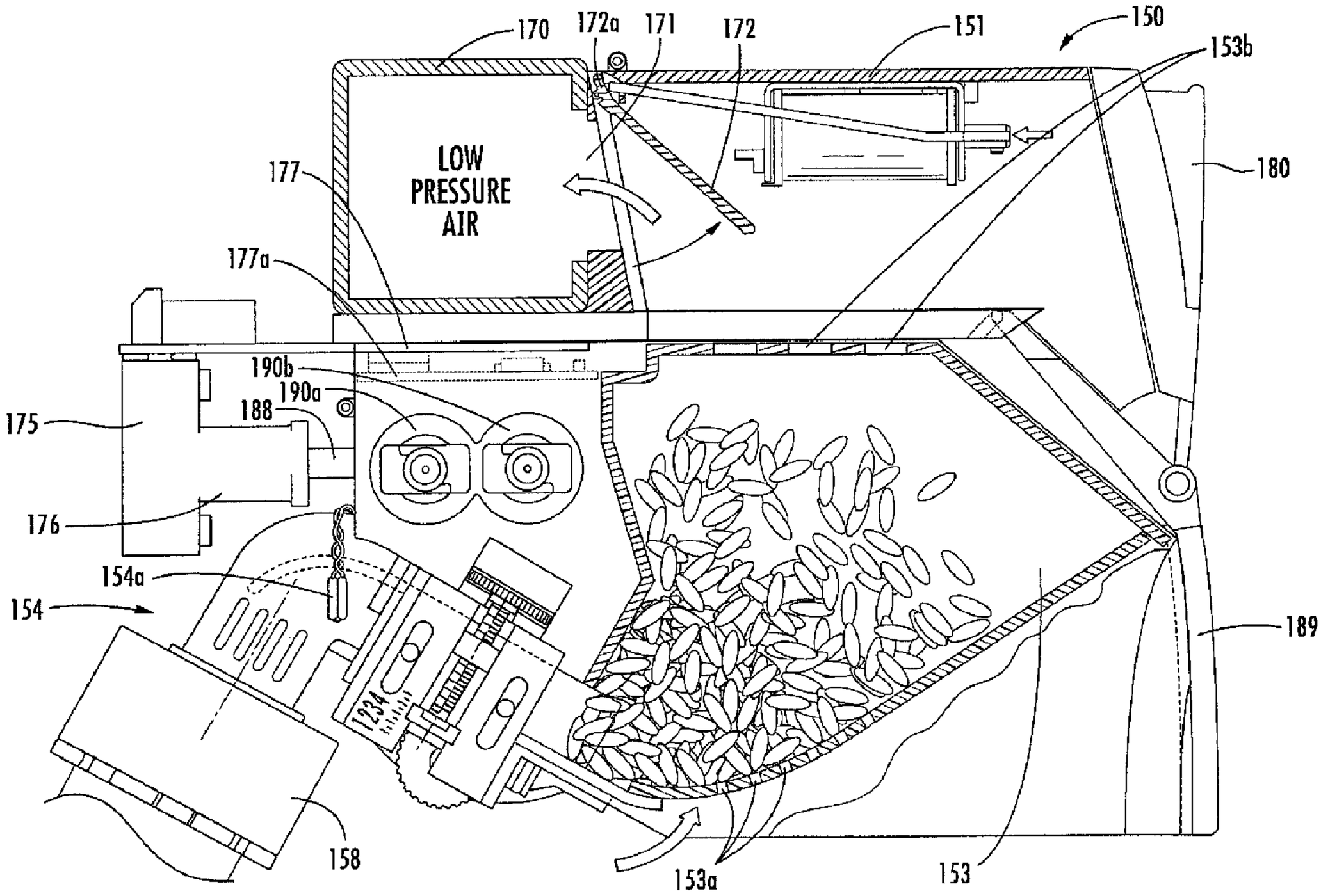
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(57) Abrégé/Abstract:
An aspect of the invention is to increase the speed of automated dispensing of solid pharmaceutical items, particularly tablets and capsules. An apparatus according to the invention comprises a dispensing station comprising a plurality of bins for storing the items, each of the bins containing items of substantially identical size and configuration, and at least some of the bins containing items that differ in size and/or composition from the items contained in others of the bins; each of the bins including a dispensing

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(57) Abrégé(suite)/Abstract(continued):
outlet on one side and a replenishment opening on an opposite side, and an electronic unit that monitors the counting of items traveling through the dispensing outlet; the bins being mounted on a frame such that the dispensing outlets face an access region within the frame; a dispensing carrier with a control to transport containers to be filled with the items.

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SYSTEM AND METHOD FOR DISPENSING PRESCRIPTIONS

Abstract of the Disclosure

An aspect of the invention is to increase the speed of automated dispensing of solid pharmaceutical items, particularly tablets and capsules. An apparatus according to the invention comprises a dispensing station comprising a plurality of bins for storing the items, each of the bins containing items of substantially identical size and configuration, and at least some of the bins containing items that differ in size and/or composition from the items contained in others of the bins; each of the bins including a dispensing outlet on one side and a replenishment opening on an opposite side, and an electronic unit that monitors the counting of items traveling through the dispensing outlet; the bins being mounted on a frame such that the dispensing outlets face an access region within the frame; a dispensing carrier with a control to transport containers to be filled with the items.

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SYSTEM AND METHOD FOR DISPENSING PRESCRIPTIONS

Related Application

This application is a divisional application of Canadian Patent Application No. 2,428,556 filed on May 13, 2003 and claims priority from therein.

Field of the Invention

The present invention is directed generally to the dispensing of prescriptions of pharmaceuticals, and more specifically is directed to the automated dispensing of pharmaceuticals.

Background of the Invention

Pharmacy generally began with the compounding of medicines which entailed the actual mixing and preparing of medications. Heretofore, pharmacy has been, to a great extent, a profession of dispensing, that is, the pouring, counting, and labeling of a prescription, and subsequently transferring the dispensed medication to the patient. Because of the repetitiveness of many of the pharmacist's tasks, automation of these tasks has been desirable.

Some attempts have been made to automate the pharmacy environment. Different exemplary approaches are shown in U.S. Patent Nos. 5,337,919 to Spaulding et al. and U.S Patent Nos. 6,006,946; 6,036,812 and 6,176,392 to Williams et al. These systems utilize robotic arms to grasp a container, carry it to one of a number of bins containing tablets (from which a designated number of tablets are dispensed), carry it to a printer, where a prescription label is applied, and release the filled container in a desired location. Tablets are counted and dispensed with any number of counting devices. Drawbacks to these systems typically include the relatively low speed at which prescriptions are filled and the absence in these systems of securing a closure (i.e., a lid) on the container after it is filled.

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Summary of the Invention

The present invention is directed to an automated system and method for dispensing pharmaceuticals, particularly tablets and capsules, and other small discrete objects. Embodiments of the system and method are capable of receiving a patient's prescription information, selecting a container, labeling the container, dispensing the tablets or capsules into the labeled container, applying a closure to the filled, labeled container, and offloading the container to a designated location. Preferably, the tablets are dispensed with high speed dispensing bins that employ forced air to agitate and singulate the tablets. The other functions within the system are typically carried out at stations designed to offer speed, flexibility and precision to the dispensing operation.

As a first aspect, embodiments of the invention are directed to a method of dispensing solid pharmaceutical items of substantially identical size and configuration from a bulk of such solid pharmaceutical items stored in a housing. The method comprises the steps of: providing a singulating bin comprising a hopper and a dispensing channel fluidly connected thereto, the dispensing channel defining a flow path; applying a forwardly-directed jet into the dispensing channel; passing a series of solid pharmaceutical items in single file from the hopper into the dispensing channel; accelerating the solid pharmaceutical items in the dispensing channel with the forwardly-directed jet; counting the number of solid pharmaceutical items that pass a predetermined point in the dispensing channel; comparing the number of solid pharmaceutical items that have passed the predetermined point with a predetermined number; and applying a rearwardly-directed jet into the dispensing channel after a predetermined number of solid pharmaceutical items have passed the predetermined point to draw any additional items in the dispensing channel back into the hopper. This method can provide dispensed, labeled, capped pharmaceutical items rapidly and accurately.

As a second aspect, embodiments of the present invention are directed to an apparatus for dispensing solid pharmaceutical items, comprising: a frame; a container dispensing station attached to the frame; a labeling station attached to the frame; a labeling carrier configured to grasp a container, transport the container from the container dispensing station to the labeling station, and rotate the container so that the container can receive a label from the labeling station; a dispensing station having a plurality of bins that receive and dispense solid pharmaceutical items; a closure dispensing station that applies a closure to a filled container;

a dispensing carrier that receives a labeled container from the labeling carrier, transports the labeled container to the dispensing station for filling with solid pharmaceutical items from one of the bins, and transports a filled, labeled container to the closure dispensing station; and a controller operatively connected with and controlling the operation of the container dispensing station, the labeling station, the labeling carrier, the dispensing station, the closure dispensing station, and the dispensing carrier. Such an apparatus can dispense filled, labeled, capped pharmaceuticals rapidly and accurately.

As a third aspect, embodiments of the present invention are directed to an apparatus for dispensing solid pharmaceutical items, comprising: a dispensing station comprising a plurality of bins for storing the items, each of the bins containing items of substantially identical size and configuration, and at least some of the bins containing items that differ in size and/or composition from the items contained in others of the housings. Each of the bins includes a dispensing outlet on one side that dispenses items; the bins being mounted on a frame such that the dispensing outlets face generally in a first direction to define an access region; a dispensing carrier configured to transport containers to be filled with the items. The dispensing carrier is positioned within the access region, and each of the bins includes a replenishment gate on a side thereof opposite the dispensing outlet. In this configuration, bins can be replenished without removing them from the frame or interfering with the operation of the apparatus as it dispenses from other bins.

In another aspect, there is provided a method of dispensing solid pharmaceutical items of substantially identical size and configuration from a bulk of such solid pharmaceutical items stored in a housing, comprising the steps of: providing a singulating bin comprising a hopper and a dispensing channel fluidly connected thereto, the dispensing channel defining a flow path; applying a forwardly-directed jet into the dispensing channel; passing a series of solid pharmaceutical items in single file from the hopper into the dispensing channel; accelerating the solid pharmaceutical items in the dispensing channel with the forwardly-directed jet; counting the number of solid pharmaceutical items that pass a predetermined point in the dispensing channel; comparing the number of solid pharmaceutical items that have passed the predetermined point with a predetermined number; and applying a rearwardly-directed jet into the dispensing channel after a predetermined number of solid pharmaceutical items have passed the predetermined point to draw any additional items in the dispensing channel back into the hopper.

Those skilled in this art will recognize that many of the individual stations within the apparatus described above and combinations thereof also represent additional embodiments of the invention.

Brief Description of the Drawings

Figure 1 is a flow chart illustrating an embodiment of a method according to the present invention.

Figure 2 is a perspective view of a pharmaceutical tablet dispensing system according to the present invention.

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Figure 3 is a cutaway view of the system of **Figure 2** illustrating the container dispensing station, the labeling carrier, the dispensing carrier, and the closure dispensing station.

Figure 4 is a top view of the container dispensing station of the system of **Figure 2** showing the cup holding a container in the donating position.

Figure 5 is a top view of the container dispensing station of **Figure 4** showing the cup holding a container in the receiving position.

Figure 6 is an enlarged perspective view of the container dispensing station of **Figure 4.**

Figure 7 is a perspective view of the gripping unit of the label carrier of the system of **Figure 2** with the fingers thereof rotated to a radially inward position and the unit itself in a raised position above the container-dispensing cup.

Figure 7A is a section view of the gripping unit of **Figure 7**.

Figure 8 is a perspective view of the gripping unit of **Figure 7** with the fingers thereof in the process of rotating radially outwardly and the unit itself in a lowered position into a container in the container dispensing cup.

Figure 9 is a perspective view of the gripping unit of **Figure 7** with the fingers thereof rotated to a radially outward position and the unit itself rising with the container above the container dispensing cup.

Figure 10 is a bottom view of the gripping unit of **Figure 7** with the fingers thereof in rotated to a radially inward position.

Figure 11 is a bottom view of the gripping unit of **Figure 7** with the figners thereof rotated to an intermediate position.

Figure 12 is a bottom view of the gripping unit of **Figure 7** with the fingers thereof in rotated to a radially outward position.

Figure 13 is a schematic top view of the labeling station of the system of **Figure 2** prior to the application of a label on a container.

Figures 14-16 are schematic top views of the labeling station of **Figure 13** during the application of a label on a container as the container is held and rotated by the gripping unit of **Figure 7**.

Figures 17a-17c are enlarged perspective views illustrating the transfer of a container from the labeling carrier of **Figure 7** to the dispensing carrier of the system of **Figure 2**.

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Figure 18 is an enlarged perspective view of the lower carriage and the grip unit of the dispensing carrier of **Figures 17a-17c** illustrating that the lower carriage can be moved vertically and horizontally and that the grip unit can be rotated about two axes.

Figure 19 is an enlarged perspective view of a dispensing bin employed in the system of **Figure 2**.

Figures 20A and **20B** are section views of the dispensing bin of **Figure 19** showing how the size of the dispensing channel of the dispensing bin can be adjusted.

Figure 21 is a greatly enlarged side view of the dispending bin of **Figure 19** showing how the height of the dispensing channel can be adjusted.

Figure 22 is a bottom view of the dispensing bin of **Figure 19** showing how the width of the dispensing channel can be adjusted.

Figure 23 is an enlarged exploded view of the dispensing bin of **Figure 19** showing its interconnection with the low pressure manifold, the high pressure conduit, and the electronics mounted on the frame of **Figure 3**.

Figure 23A is a schematic diagram of the controller and three exemplary connector boards from the frame and three exemplary bin-controlling circuit boards.

Figure 23B is a schematic diagram of another embodiment of the controller of the system of **Figure 2**.

Figure 24 is an enlarged assembled view of the dispensing bin of **Figure 19** with the low pressure manifold, the high pressure conduit, and the electronics mounted on the frame.

Figure 25 is an enlarged side view of the securing member of the dispensing bin of **Figure 19** showing how the securing member locks the dispensing bin in place on the frame.

Figure 26 is an enlarged section view of the assembled dispensing bin and frame of **Figure 24** with tablets loaded into the bin.

Figure 27 is an enlarged section view of the assembled dispensing bin and frame of **Figure 24** with tablets being agitated by low pressure air flowing upwardly through the bin.

Figure 28 is an enlarged section view of the assembled dispensing bin and frame of **Figure 24** with high pressure air being applied to the dispensing channel, such that tablets are drawn therein in single file in a lengthwise orientation.

Figure 29 is an enlarged section view of the assembled dispensing bin and frame of **Figure 24** with a desired number of tablets dispensed into the container.

Figure 30 is an enlarged perspective view of the closure dispenser of the closure dispensing station of the system of **Figure 2**.

Figure 31 is an enlarged perspective view of the closure dispenser of **Figure 30** with the closure bin removed.

Figure 32 is a greatly enlarged section view of a closure unable to be oriented with the closure dispenser of **Figure 30**.

Figure 33 is a greatly enlarged section view of a closure able to be oriented with the closure dispenser of **Figure 30**.

Figure 34 is a bottom perspective view of the closure dispenser of **Figure 30**.

Figure 35 is an enlarged side perspective view of the closure holder of the system of **Figure 2** with a filled container in a lower position.

Figure 36 is an enlarged side perspective view of the closure holder of **Figure 35** with the container raised to engage a closure.

Figure 37 is an enlarged side perspective view of the closure holder of **Figure 35** with the filled, closed container lowered.

Detailed Description of the Invention

The present invention will now be described more fully hereinafter, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, like numbers refer to like elements throughout. Thicknesses and dimensions of some components may be exaggerated for clarity. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

As described above, the invention relates to a system and process for dispensing pharmaceuticals. The process is described generally with reference to **Figure 1**. The process begins with the identification of the proper container, tablets or capsules and closure to be

dispensed based on a patient's prescription information (**Box 20**). A container of the proper size is dispensed at a container dispensing station (**Box 22**), then grasped and moved to a labeling station (**Box 24**). The labeling station applies a label (**Box 26**), after which the container is transferred to a transport system and moved to a tablet dispensing station (**Box 28**), from which the designated tablets are dispensed in the designated amount into the container (**Box 30**). The filled container is then grasped again and moved to a closure dispensing station (**Box 32**), where a closure of the proper size has been dispensed (**Box 34**). The filled container is secured with a closure (**Box 36**), then transported to an offload station and offloaded (**Box 38**).

A system that can carry out this process is illustrated in **Figures 2-37** and designated broadly therein at **40**. Referring first to **Figures 2** and **3**, the system **40** includes a support frame **44** for the mounting of its various components. The illustrated support frame **40** includes a base **46** that rests on an underlying surface. Four uprights **48** extend vertically from the base **46** and define an internal cavity **45** within which the operable components of the system **40** generally reside. A pair of top rails **50** are attached to the upper ends of the uprights **48**, and two cross-members **52** span the distance between the front and rear ends of the top rails **50**. Top, intermediate and bottom arches **54, 55, 56** are mounted to extend from the front surfaces of the front uprights **48**. The frame **44** also includes two lower rails **51** that extend between pairs of uprights **48** well below the top rails **52**, and further includes a pair of intermediate rails **53** that are mounted in vertical alignment between two uprights **48** below one of the top rails **52**.

Those skilled in this art will recognize that the frame **40** illustrated herein is exemplary and can take many configurations that would be suitable for use with the present invention. The frame **40** provides a strong, rigid foundation to which other components can be attached at desired locations, and other frame forms able to serve this purpose may also be acceptable for use with this invention.

Referring again to **Figures 2** and **3**, the system **40** generally includes as operative stations a controller **42**, a container dispensing station **58**, a labeling station **60**, a tablet dispensing station **62**, a closure dispensing station **64**, and an offloading station **66**. Containers, tablets and closures are moved between these stations with two different conveying devices: a labeling carrier **68** and a dispensing carrier **70**. Each of the operative stations and the conveying devices is described in detail below.

The controller **42**, which is mounted to and below the top arch **54**, controls the operation of remainder of the system **40**. In some embodiments, the controller **42** will be operatively connected with an external device, such as a personal or mainframe computer, that provides input information regarding prescriptions. In other embodiments, the controller **42** may be a stand-alone computer that directly receives manual input from a pharmacist or other operator. An exemplary controller is a conventional microprocessor-based personal computer.

Referring now to **Figures 4-6**, the container dispensing station **58**, which is mounted to the bottom arch **56**, comprises a plurality of tubes **80** oriented generally vertically and about a common axis of rotation. In the illustrated embodiment, three sets of tubes **80** of different sizes are illustrated; the ensuing discussion is equally applicable to each.

A bottom plate **82** is fixed to the bottom ends of the tubes **80** and a top plate **84** fixed to the top ends of the tubes **80**. Each of the bottom and top plates **82, 84** have apertures that correspond to the ends of the tubes **80**. The tubes **80** and bottom and top plates **82, 84** are free to rotate as a unit about the axis of rotation **A1** and are driven by a motor or other rotary drive unit attached to the bottom plate **82** (the motor is not shown). A sorting plate **86** or other member is fixed to the lower arch **56** below and parallel to the bottom plate **82**. The sorting plate **86** includes a slotted opening **87** at one edge. As is shown in **Figures 5** and **5**, a cup **88** or other receiving member is pivotally attached to lower surface of the sorting plate **86** such that it may move between a receiving position below the opening **87** (**Figure 5**) and a donating position beyond the perimeter of the sorting plate **86** (**Figure 4**) (pivoting of the cup **88** is controlled by the controller **42** through a second motor (not shown)).

Prior to operation, the tubes **80** within each set are filled with containers of similar size, with each set of tubes **80** housing containers of different sizes. Filling can be carried out by loading the containers in a preferred orientation through an orientation tube **84a** (see **Figure 2**), which has an opening **85a** with a downward extending finger **86a** that ensure that the containers are loaded with their open ends facing upwardly. The containers travel through the orientation tube **84** through the openings in the top plate **84** in an upright orientation with their open ends facing upwardly, so that they are vertically stacked within the tubes **80**. In some embodiments, each set of tubes **80** is filled with different sizes of containers, while in other embodiments, individual tubes **80** within the same set of tubes may be filled with different sizes of containers.

In operation, the controller **42** signals the container dispensing station **58** that a container of a specified size is desired. The bottom and top plates **82, 84** rotate until a tube **80** that houses a container is positioned above the opening **87**. At this point, the cup **88** is in its receiving position beneath the opening **87** (**Figure 5**). The lowermost container drops downwardly through the opening **87** and into the cup **88**. The controller **42** then signals the cup **88** to pivot to its donating position (**Figures 4** and **6**), wherein the container can be grasped by the labeling carrier **68**. The cup **88** includes a support finger **89** trailing the receptacle portion of the cup **88** to support containers remaining in the tubes **80** when the cup **88** is in the donating position.

Those skilled in this art will appreciate that other container dispensing apparatus may be employed with the present invention. For example, the containers may be presented for grasping in a horizontal disposition, or the dispensing apparatus may include a conveyor unit that presents the containers one at a time for grasping. The skilled artisan will recognize additional embodiments that would be suitable for use with the inventive system.

From the container dispensing station **58**, the container is moved to the labeling station **60**; this movement is carried out by the labeling carrier **68** (see **Figures 3** and **7-12**). The labeling carrier **68** comprises an upright support member **91** fixed to the base of the frame **40**, a carriage **92** attached to and moveable vertically on the support member **91**, a swing arm **94** attached thereto that pivots about a vertical axis **A2**, and a gripping unit **96** attached to the free end of the swing arm **94**. Both the vertical movement of the carriage **92** and the pivoting of the swing arm **94** and gripping unit **96** can be induced with conventional robotic techniques that need not be described in detail herein.

The gripping unit **96** has a body portion **98**, a base **102** rotatably attached to the body portion **98** for rotation about an axis **A3**, a clutch mechanism **101** attached to the body portion **98** and coupled to the base **102**, a plurality of fingers **104** (three are illustrated herein) that are rotatable and eccentrically mounted to the base **102** and extend downwardly therefrom generally parallel to each other, and a motor **100** attached to the body portion **98** and coupled to the fingers **104**. Each finger **104** is fixed to a finger shaft **105**, which in turn is fixed to a planet gear **106** such that, as the planet gear **106** rotates, so must the attached finger **104**. Each planet gear **106** is attached to the base **102** in such a way as to be able to rotate freely relative thereto. A sun gear **107** is rotatably mounted onto the base **102** and can freely rotate

in relation thereto about the axis **A3**. Each planet gear **106** engages the sun gear **107**, so that when the sun gear **107** rotates in relation to the base **102**, the planet gears **106** also rotate relative to the base **102** about a respective axis **A4, A5, A6**. A motor shaft **108** is fixed to the sun gear **107** along the axis **A3** and is coupled to the motor **100** via a motor gear train **109**.

Each finger **104** has an arcuate outer surface **104a** that defines a portion of a circle, such that, when all of the fingers **104** are rotated to a radially inward position (**Figure 7** and **10**), the outer surfaces **104a** of the fingers **104** form a stepped vertical cylinder, with their vertices **104b** adjacent to one another. The fingers **104** can be rotated about their eccentric axes of rotation **A4, A5, A6** (**Figure 11**) so that their vertices **104b** move radially outwardly from each other; rotation in this manner expands the circle defined by the radially outwardmost portions of the outer surfaces **104a** of the fingers **104** (see **Figures 8, 9** and **12**). In operation, after the container of the desired size has been dispensed in one of the cups **88** as discussed above, the controller **42** signals the labeling carrier **68** to grasp the container. The carriage **92** slides on the support member **91**, thereby moving the swing arm **94** to a height such that the lower ends of the fingers **104** are above the upper edge of the container. Also, the swing arm **94** pivots relative to the carriage **92** such that the fingers **104** are positioned directly over the container. At this point, the fingers **104** are rotated radially inwardly (**Figures 7** and **10**) to a retracted position. The carriage **92** then descends, which action lowers the fingers **104** into the cavity of the container. The motor **100** then exerts a torque on the sun gear **107** via the motor gear train **109** and the motor shaft **108**, thereby causing the sun gear **107** to exert a torque on the planet gears **106** and a torque on the base **102** (via the planet gears **106** and finger shafts **105**). Because the clutch **101** restrains the base **102** from rotating (via a pulley **101a** and a belt **101b**), the planet gears **106** rotate about axes **A4, A5, A6** in response to this torque, causing the fingers **104** to turn and expand radially outward (see **Figures 8** and **11**) until they contact the inside surface of the container (see **Figures 9** and **12**). At this point, the container wall resists further expansion of the fingers **104**, thereby inducing an opposing torque on the base **102** transmitted via the fingers **104**, finger shafts **105**, and planet gears **106**. Once this opposing torque exceeds the breaking torque of the clutch **101**, the base **102** and container -- now held by the fingers **104** -- rotates about the axis **A3**. The clutch **101** continues to exert a restraining torque on the base **102** as the base **102** rotates. The fingers **104** continue to exert pressure on the inside of the container

(as explained above) as the base **102** rotates, thereby inducing the container to rotate and enabling the fingers **104** to lift the container from the cup **88**. The controller **42** signals the carriage **92** to rise on the support member **91**. As this occurs, the fingers **104** lift and carry the container from the cup **88**, and the container continues to rotate relative to the body portion **98** due to the rotation of the base **102**.

Other techniques for grasping and moving the container from the container dispensing station **58** will be apparent to those skilled in this art. For example, the gripping fingers may take a different configuration (e.g., they may not form a cylinder when rotated inwardly). As another example, gripping fingers may be used that grip the outer surface of the container. Alternatively, suction may be employed to temporarily grasp and move the container.

Once the labeling carrier **68** has retrieved the container from the cup **88**, it carries the container to the labeling station **60** (see **Figures 3** and **13-16**). The labeling station **60** includes a printer **110** that is controlled by the controller **42**. The printer **110**, which is mounted to one side of the base **46**, prints and presents an adhesive label that is to be affixed to the container. The labeling station **60** also includes a wiping device, such as the brush **112** illustrated in **Figure 8**, that is positioned adjacent to the exit port **114** of the printer **110**.

Returning to the operation of the system **40**, once the container has been grasped and is being rotated by the labeling carrier **68**, it is moved (under the direction of the controller **42**) to the exit port **114** of the printer **110** through appropriate translation of the carriage **92** on the support member **91** and pivoting of the swing arm **94** relative to the carriage **92** (**Figure 13**). Once the printed label has exited the exit port **114**, the labeling carrier **68** presents the rotating container to the label (**Figure 13**); the rotation of the container enables the wiping device to smoothly apply the label to the container (augmented by the brush **112** – see **Figures 14-16**).

Those skilled in this art will appreciate that other structures and components for affixing a printed label to a container may also be employed with the present invention. For example, the container may be transferred to pinch rollers located at the exit port **114**.

After the container has been labeled, the labeling carrier **68** moves to a transfer position (through appropriate movements of the carriage **92**, swing arm **94**, and body portion **98**, as directed by the controller **42**) and transfers the labeled container to the dispensing carrier **70** (**Figures 3, 17a-17c** and **18**). The dispensing carrier **70** includes an upper carriage **120**

that slides upon a rail **122** extending between the cross-members **52**, a rail **124** that extends downwardly from the carriage **120**, a lower carriage **126** that slides vertically along the rail **124**, and a grip unit **128** that is mounted on the lower carriage **126** via horizontally disposed circular tracks **130** that revolve around the lower carriage **126**. The grip unit **128** includes a traveler unit **132** that is mounted to the tracks **130**, an axle **134** that is rotatably mounted in and extends from the traveler unit **132**, and a gripping mechanism **136** that is attached to and is rotatable with the axle **134**. The gripping mechanism **136** has two jaws **138** that can confront each other and exert clamping force on an object (such as a container of the type discussed herein). Notably, the jaws **138** have a curved portion **139** that assists in gripping the cylindrical container. Also, the jaws **138** may be configured such that they compress the container only to a desired torque level (e.g. with a clutch mechanism) in order to prevent crushing of the container, or such that they compress only to predetermined positions selected to match the sizes of the different containers used with the system **40**.

The dispensing carrier **70** has the capability of moving the gripping mechanism **136** (and, in turn, an object grasped therein) to designated locations within the cavity **45** of the frame **44**. Movement from end to end within the cavity **45** (i.e., toward and away from the arches **54, 55, 56**) is accomplished by inducing movement of the upper carriage **120** on the rail **122**. Vertical movement is accomplished by inducing movement of the lower carriage **126** on the rail **124**. The grip unit **128** may also revolve around the rail **124** about an axis **A7** through revolution of the tracks **130** around the carriage **126**. The gripping mechanism **136** may rotate relative to the traveler unit **132** about an axis **A8** defined by the axle **134**. Induction and control of these movements may be achieved through conventional robotic techniques that need not be described in detail herein. The skilled artisan will also appreciate that other components for grasping and maneuvering a container may also be employed with the present invention.

Returning to operation of the system **40**, transfer of the labeled container from the labeling carrier **68** to the dispensing carrier **70** is achieved by the controller **42** directing the dispensing carrier **70** to move the gripping mechanism **136** to a position in which the jaws **138** can clamp onto the outer surface of the container as it is presented by the labeling carrier **68**. Preferably, the position for transfer is proximate to the printer **110** and the tablet dispensing station **62**. The controller **42** first signals the dispensing carrier **70** to close the

jaws **138** onto the outer surface of the container, then directs the labeling carrier **68** to retract the fingers **104** to their radially inward positions so that the container is held only by the jaws **138**. The fingers **104** are then withdrawn from the container (through either upward movement of the fingers **104** by the labeling carrier **68** or downward movement of the labeled container by the dispensing container **70**), and the labeled container is ready to be filled with tablets.

Filling of labeled containers with tablets is carried out by the tablet dispensing station **62** (see **Figures 2** and **19-29**). The tablet dispensing station **62** comprises a plurality of tablet dispensing bins **150**, each of which holds a bulk supply of individual tablets (typically the bins **150** will hold different tablets). The dispensing bins **150**, which are typically substantially identical in size and configuration, are organized in an array mounted on the intermediate rails **53** of the frame **44**, and each has a dispensing channel **154** with an outlet that faces generally in the same direction, to create an access region for the dispensing carrier **70**. The identity of the tablets in each bins is known by the controller **42**, which can direct the dispensing carrier **70** to transport the container to the proper bin **150**. In some embodiments, the bins **150** may be labeled with a bar code or other indicia to allow the dispensing carrier **70** to confirm that it has arrived at the proper bin **150**.

The dispensing bins **150** are configured to singulate, count, and dispense the tablets contained therein, with the operation of the bins **150** and the counting of the tablets being controlled by the controller **42**. Some embodiments may employ the controller **42** as the device which monitors the locations and contents of the bins **150**; others may employ the controller **42** to monitor the locations of the bins, with the bins **150** including indicia (such as a bar code or electronic transmitter) to identify the contents to the controller **42**; in still other embodiments the bins **150** may generate and provide location and content information to the controller **42**, with the result that the bins **150** may be moved to different positions on the frame **42** without the need for manual modification of the controller **42** (i.e., the bins **150** will update the controller **42** automatically).

Any of a number of dispensing units that singulate and count discrete objects may be employed; however, dispensing units that rely upon targeted air flow and a singulating nozzle assembly, such as the devices described in U.S. Patent No. 6,631,826, filed

August 22, 2001 and entitled DEVICE TO COUNT AND DISPENSE ARTICLES, are preferred. Bins of this variety may also include additional features, such as those described below.

Referring now to **Figures 19** and **23-29**, the bins **150** can be described generally as having a tablet-filled hopper **153** through which air flows and agitates the tablets contained therein, and the aforementioned dispensing channel **154** through which the tablets are dispensed one at a time. Suction can be applied to the channel **154** through a forwardly-directed jet **155**; a rearwardly-directed jet **156** is also included that can reverse the motion of tablets within the channel **154**. The jets **155, 156** are controlled by the controller **42**, which initiates forward air flow in response to a customer order and activates rearward air flow in response to the passage of a certain quantity of tablets through in the dispensing channel **154** (as detected by a counting sensor **154a** located in the dispensing channel **154**). Alternatively, the jets **155, 156** may be controlled by a local controller unique to each bin **150** (as described in some detail below). The bins **150** can filled or replenished with tablets via access from a pivoting door **180** located at the upper rear portion of the bin **150**. Notably, the location of the door **180** opposite the outlet of the dispensing channel **154** enables an operator to replenish the bin **150** without disconnecting it from the frame **44** or interfering with the dispensing from this or another bin **150**. Also, the pivoting of the lower end portion of the door **180** and the inclusion of side walls **180a** causes an open door **180** to form a funnel-like configuration, which configuration can facilitate pouring of pharmaceuticals into the bin **150**.

Referring now to **Figures 20A** through **22**, the bins **150** may include components that permit the entry to the dispensing channel **154** to be adjusted in size to complement the size and configuration of the tablet to be dispensed. This can be achieved through a stationary wall **160**, a moveable wall **161**, a moveable ceiling **162** and a moveable floor **163** that form the entry to (and in some instances the perimeter of) the dispensing channel **154**. In the illustrated embodiment, the stationary wall **160** is a portion **151a** of the housing **151** of the bin **150**. The stationary wall **160** also forms a portion of a recess **301** that extends inwardly into the housing **151**. The ceiling **162** is part of a ceiling unit **302** that fits within the recess **301**. The ceiling unit **302** also includes a vertical panel **304** extends downwardly from a lateral edge of the ceiling **162**. The vertical panel **304** includes two apertures and an

engagement projection **306** that engages a slot in a wall of the recess **301**. Also, an adjustment knob **320** and attached threaded shank **322** insert through a threaded nut **324** attached to the vertical panel **304**; the knob **320** is held in place within a recess in the housing **151**. The moveable wall **161** is part of a moveable wall unit **308** that includes front and rear panels **310, 312** that extend transversely from front and rear portions of the moveable wall **161**. Two posts **314** extend from the moveable wall **161** and pass through the apertures of the vertical panel **304** of the ceiling unit **302** into elongated slots **316** of the housing. A front projection **318** extends beyond the front panel **310** and is received in a slot **319** in the housing. The moveable floor **163** is part of a floor unit **326** that also includes a front portion **328** with a slot **330** that receives the front projection **318** of the moveable wall **161**, gussets **331, 332, 333** that help to guide the moveable wall **161**, and an adjustment knob **334** and an attached threaded shank **336** that extend into and through an attached nut **338**. The adjustment knob **334** is maintained in place within a slot **340** in the housing of the bin **150**, and the floor **163** is maintained in vertical position by two tines **342**. Two springs **344** surround the posts **314** between the moveable wall **161** and the vertical panel **304**.

In addition, the floor **163** includes a series of apertures **349** located to the side of the dispensing channel **154**. These apertures **349** can provide additional flow to this region of the bin **150**. The additional flow can encourage tablets that tumble to a position adjacent the dispensing channel **154** during agitation to rejoin the remaining tablets; otherwise, they may remain in this "dead" area, which can tend to clog entry into the dispensing channel **154**.

To adjust the width of the dispensing channel **154** (**Figure 22**), the adjustment knob **334** is rotated about its axis. Rotation of the shank **336** within the nut **338** induces the floor **163** to slide horizontally between the housing **151** and the tines **342**. In doing so, the posts **314** are free to slide through the apertures in the vertical panel **304**; the moveable wall **161** is maintained in contact with the floor **163** by compression from the springs **344**. In the illustrated embodiment, the exact position of the moveable wall **161** can be monitored with markings **346** located on the rear portion of the floor **163**.

To adjust the height of the ceiling **162** (**Figure 21**), the adjustment knob **320** is rotated. Interaction between the shank **322** and the nut **324** causes the ceiling unit **302** to slide within the recess **301**. The posts **314** slide within the slots **316** in the housing **151**, and the moveable wall **161** is driven upwardly or downwardly by the ceiling **162**. The front

projection **318** of the moveable wall **161** remains in the slots **319, 330**. The exact position of the ceiling **162** can be monitored with markings **348** located on the side of the housing **151**.

Notably, the configuration of the dispensing channel **154** described above can provide an essentially "gapless" channel for the tablets to travel in, which can improve performance of the system **40**. Also, the floor **163** and the stationary wall **160** of the dispensing channel **154** remain in place, which provides a constant location to which the container receiving tablets can be delivered.

A further optional feature of the illustrated dispensing channel **154** is a splash guard **158 (Figure 28)**, which is located at the outlet of the dispensing channel **154**. The splash guard **158** can reduce or eliminate the risk that a tablet traveling to the container falls or bounces outside the container. In one embodiment, the splash guard **158** is formed of a spongy foam material (such as polyethylene foam); such a material enables the container to be compressed against the splash guard **158**, causing it to deform around the upper edge of the container and seal it so that tablets do not stray from the container. With a splash guard of this construction, the presentation of the container to the dispensing channel **154** by the dispensing carrier **70** can occur with a larger margin for error in positioning.

Another feature of the tablet dispensing station **62** that may be included with the present invention is illustrated in **Figures 3** and **23-25**. As can be seen therein, a low pressure manifold **170** having a number of inlets **171** is mounted to the frame **44** and extends horizontally; the manifold **170**, which is fluidly connected to a low pressure source such as a vacuum motor (not shown), provides low level (i.e., about 2 psi) suction to the bin **150** to either (a) maintain a door **172** in a closed position when the particular bin **150** is not in use or (b) agitate tablets within the bin when the door **172** is opened by a solenoid **173** or other actuating unit within the bin **150**. Of course, individual blowers may be used for each bin in lieu of the manifold **170** with multiple inlets **171**. Also, a high pressure (i.e., about 30 psi) conduit **175** with a fitting **176** also extends horizontally from its mounting point on the frame **44**, with the fitting **176** projecting toward the bin **150**. The fitting **176** may be a check valve, so that high pressure air is not expelled if the bin **150** is not present. The high pressure conduit **175** is fluidly connected to a high pressure source (not shown). Further, a connector circuit board **177** is mounted horizontally below the manifold **170**; the circuit board **177** or other electrical connector provides an electrical connection between the controller **42** and the

bin-controlling circuit board **177a** (or other electronic component) of the bin **150** for power and data signals from the controller **42**, such as those that control the opening and closing of the door **172**, the application of suction and/or positive pressure through the conduit **175**, and the counting sensor **154a**. Thus, all three of these connections should be made for the bin **150** to operate.

Despite the presence of the hopper door **180** through which the hopper **153** can be refilled, there are instances for which it would be desirable to remove the bin **150** from the frame **44** (for example, to adjust the size of the entry to the dispensing channel **154**). When the bin **150** has been removed, reinstallation requires that connections be re-established between the bin **150** and the manifold **170**, the conduit **175**, and the connector circuit board **177**.

The frame **44** illustrated herein includes prongs **183** (**Figure 23**) that facilitate re-establishment of the aforementioned connections. The prongs **183** are positioned below the manifold **170** and are configured for slidable movement with slots **184** on the housing **151** that receives the prongs **183**. The prongs **183** include recesses **183a** that receive pins **187** located on a pivoting member **189**. As the prongs **183** slide to completely fill the slots **184**, an opening **172b** of the housing **151** aligns with an inlet **171** of the manifold **170**, the bin-controlling circuit board **177a** located on the front edge of the hopper **153** comes into contact with the connector circuit board **177**, and a fitting **188** that extends from the front of the housing **151** below the bin-controlling circuit board **177a** locks with the fitting **176** of the conduit **175**. As such, simply sliding the bin **150** back into place (**Figures 23** and **24**) can re-establish all of these operative connections without additional steps. The bin **150** can be secured firmly into place by pivoting the member **189** so that the posts **187** fill the slots **183a** (**Figures 24** and **25**).

Referring now to **Figure 23A**, the connector board **177** is mounted to the frame **44** and supports electronic circuitry which contains a "location identifier" unique to the physical location of the connector board **177** on the frame **44**. The connector board **177** provides its mating bin-controlling circuit board **177a** with regulated and unregulated power, a physical connection to the data bus **177b**, and the location identifier for the connector board **177**. The connector board **177** communicates power and data to the bin-controlling circuit board **177a** via the bus **177b** (which is a power and data bus).

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Still referring to **Figure 23A**, the bin-controlling circuit board **177a** contains a "bin identifier" unique to that bin that can be read by the controller **42**. The bin–controlling circuit board **177a** processes counting and dispensing functions such as triggering the solenoid **173**, triggering the air valves **190**, and processing signals from the sensor **154a**. The bin-controlling circuit board **177a** can receive dispense instructions and communicate its unique identifier and other information relative to its counting function, such as count status, empty condition, and the like. In some embodiments the bin-controlling circuit board **177a** may also send or receive data such as inventory levels or sensor condition. Upon command from the controller **42** the bin controlling circuit board **177a** can initiate and control the dispense and count process.

With this configuration, the controller **42** can search for a unique bin identifier and associate it with a certain location identifier. The controller **42** may then direct the dispensing carrier **70** to carry the container to the appropriate position for dispensing. Thus, once a pharmaceutical has been associated with a particular bin **150** via its "bin identifier", accurate dispensing of the pharmaceutical becomes independent of *a priori* knowledge of the pharmaceutical's physical location on the frame **44**. This gives the user the ability to quickly re-arrange the bin locations according to changing requirements such as alphabetization or utilization ranking.

Referring now to **Figure 23B**, in other embodiments of the system **42**, each bin **150** may contain an additional machine readable identifier **150a** which is more readily accessible to an operator wielding a reader **150b** which is connected to the controller **42**. Using this reader **150b**, the operator may select and read the bin identifier **150a** to automatically associate various external data such as pharmaceutical identifiers, replenishment quantities, etc., to the bins' information set. This identifier **150a** may be placed on the inside of the replenishment door **180** so that the door **180** must be opened before the reader can access the identifier **150a**.

To fill the container, the dispensing carrier 70, directed by the controller 42, moves the container to the exit port of the selected dispensing bin 150. The controller 42 signals the solenoid 173 to open the door **172** (more specifically, the solenoid **173** retracts, and a plunger **173a** moves toward the door **172**, striking a finger **172a** located on the top portion of the door **172** and causing it to pivot open – see **Figure 27**). This opening of the door **172** draws low

pressure air up through the hopper **153** from a screen **153a** on the bottom of the hopper **153**, through another screen **153b** on the top portion of the hopper **153**, and to the opening **172b**, thereby agitating the tablets contained in the hopper **153** (**Figure 27**). Once agitation has commenced, the controller **42** signals a valve **190a** connected with the forwardly-directed jets to open, which causes high pressure air to be drawn outwardly through the dispensing channel **154** (**Figure 28**). Tablets are oriented into a preferred orientation by the shape of the entry to the dispensing channel **154** and dispensed into the container through the dispensing channel **154**. The counting sensor **154a** counts the tablets as they pass through a predetermined point in the dispensing channel **154**. Once dispensing is complete (i.e., a predetermined number of tablets has been dispensed), the controller **42** activates the valve **190b** associated with the rearwardly-directed jet **56** and deactivates the dispensing bin **150**, the solenoid **173** deactivates, thereby closing the door **172** (**Figure 29**), and the dispensing carrier **70** moves the filled container to the closure dispensing station **64**.

Referring now to **Figures 30-37**, the closure dispensing station **64** includes two closure dispensers **200** and two closure holders **202**, each of which is mounted to the intermediate arch **55** of the frame **44** between the container dispensing station **58** and the labeling station **60**. Typically, each closure dispenser **200** and closure holder **202** contains and manipulates a single size of closure. The closure dispensers **200** house a bulk supply of closures and dispense them, in a preferred orientation, one at a time to a respective closure holder **202**, where they are secured onto a filled container. One each of a closure dispenser **200** and a closure holder **202** are described in detail below; those skilled in this art will appreciate that any number of closure dispensers and closure holders may be employed with the present invention.

The closure dispenser **200** (**Figures 30-34**) includes an open-ended bin **204** that feeds a rotatable hopper **206**. The hopper **206** has an open top end to receive closures from the bin **204** and a circumferential groove **208** at its lower end that surrounds a central circular island **209**. The groove **208** has a depth that is approximately the diameter of a closure and a width that is approximately the width of the closure. A circumferential protrusion **210** juts radially inwardly from the wall **207** of the hopper **206** above the groove **208** and island **209**. The sizes and configurations of the groove **208**, island **209** and protrusion **210** are such that a closure (which is a flat, open-ended cylinder) can enter the groove **208** from above only when

the closure is oriented so that the open end of the closure faces the island **209**. This occurs because the open end of the closure can receive a portion of the edge of the island **209**, thereby allowing the closure to be positioned slightly farther from the wall **207** (and, therefore, slide into the groove **208**) than a closure oriented with the closed end facing the island **209**, which cannot pass between the island **209** and the protrusion **210** in this manner (compare **Figures 32** and **33**).

The floor **211** of the hopper **206** has an opening **213** through which one closure can pass. The floor **211** abuts a plate **214** (**Figure 34**) that also includes at least one opening **212** that has a length in a direction substantially tangent to the groove **208** that is sufficient to pass one closure. The hopper **206** is rotatably mounted on the plate **214**. A channel **218** is positioned below the opening **212** and leads to the closure holder **202**; the channel **218** is sized such that the closure substantially maintains the orientation it takes upon exiting the opening **212**.

Closures are dispensed by filling the bin with closures and rotating the hopper **206** relative to the plate **214**. As the hopper **206** rotates, each closure tumbles until it eventually reaches the desired orientation and slides into the groove **208** (tumbling of the closures is augmented by two agitating projections **209a**). As the hopper **206** continues to rotate, the closure eventually reaches the opening **213**, at which point it passes through the opening **212** and falls into the channel **218**. The channel **218** conveys the closure in its desired orientation to the closure holder **202**.

Those skilled in this art will appreciate that other techniques for separating and orienting closures may also be employed. For example, a conventional "pick-and-place" device may be used. Additional sensors and controllers may also be used.

Referring now to **Figure 35**, the closure holder **202** includes a vertical mounting post **222** upon which are mounted a container receiving stage **224** and a closure holding stage **226**. The container receiving stage **226** comprises a block **228** that is slidable relative to the mounting post **222** driven by a rack-and-pinion drive unit **227**. A platform **230** extends generally horizontally away from the block **228**. Two open-ended cups **232a, 232b** sized to receive filled containers are mounted on the upper surface of the platform **230**. A rotatable drive wheel **233** or other rotary drive unit is positioned between the cups **232a, 232b** that

rotates the cups **232a, 232b** about their respective longitudinal axes; rotation of the drive wheel **233** is controlled by the controller **42**.

Referring still to **Figure 35**, the closure holding stage **226** has a ceiling **234** and three downwardly-extending walls **236** that form two closure securing compartments **238**. A fork **239** is mounted to the mounting post **222** and forms the rear wall of the securing compartments **238**; the fork **239** includes openings that receive closures from the channels **218**. A pair of ledges **240a, 240b** extend into each compartment **238** from the opposing surfaces of the walls **236**. The ledges **240a, 240b** extend a sufficient distance from the walls **236** that a closure cannot pass downwardly between the ledges **240a, 240b**, but a container can pass upwardly between them. The ledges **240a, 240b**, walls **236** and ceiling **234** are also configured so that a closure can pass forwardly (i.e., away from the fork **239**) to allow a combined container and closure to pass out of the compartments **238**.

Returning to the operation of the system **40**, after the container is filled with tablets at the tablet dispensing station **62**, the dispensing carrier **70** grasps the filled container, conveys it to the closure dispensing station **64**, and places it in a selected cup **232a, 232b** as directed by the controller **42** (**Figure 35**). The block **228** slides upwardly relative to the mounting post **222**, thereby moving the platform **230** upwardly. The platform **230** ascends, and the upper end of the container contacts and intercepts the closure positioned in the compartment **238**. The container and closure continue to rise until the container compresses the closure against the ceiling **234** (**Figure 36**). The selected cup **232a** then rotates, thereby rotating the container, as the ceiling **234** holds the closure in place, causing the container to rotate relative to the closure. This rotation secures the closure to the container. The platform **230** then lowers; the closed container descends until the closure contacts the ledges **240a, 240b**, with the closed container dangling therefrom (**Figure 37**). The dispensing carrier **70** then moves to the closed container, grasps it, and moves it to the offloading station **66**.

Referring now to **Figure 2**, the offloading station **66** includes a plurality of compartments **250** positioned between the intermediate and upper arches **55, 54**. These can be organized in any manner desired by the operator; for example, they may be organized by customer name, time of dispensing, contents of the container, or any other scheme. The dispensing carrier **70** conveys the closed container to the compartment directed by the

controller **42** and releases it there. The dispensing carrier is then free to grasp another labeled container at the labeling station **60** and perform its operations again.

The foregoing is illustrative of the present invention, and is not to be construed as limiting thereof. Although exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. As such, all such modifications are intended to be included within the scope of this invention. The scope of the invention is to be defined by the following claims.

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CLAIMS:

1. A method of dispensing solid pharmaceutical items of substantially identical size and configuration from a bulk of such solid pharmaceutical items stored in a housing, comprising the steps of:

providing a singulating bin comprising a hopper and a dispensing channel fluidly connected thereto, the dispensing channel defining a flow path;

applying a forwardly-directed jet into the dispensing channel;

passing a series of solid pharmaceutical items in single file from the hopper into the dispensing channel;

accelerating the solid pharmaceutical items in the dispensing channel with the forwardly-directed jet;

counting the number of solid pharmaceutical items that pass a predetermined point in the dispensing channel;

comparing the number of solid pharmaceutical items that have passed the predetermined point with a predetermined number; and

applying a rearwardly-directed jet into the dispensing channel after a predetermined number of solid pharmaceutical items have passed the predetermined point to draw any additional items in the dispensing channel back into the hopper.

2. The method defined in Claim 1, comprising the further step of agitating the solid pharmaceutical items during the step of applying a forwardly-directed jet.

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3. The method defined in Claim 2, wherein the step of agitating comprises drawing a gas through the hopper at a sufficient pressure to agitate the solid pharmaceutical items in the hopper.

4. The method defined in Claim 1, comprising the further step of adjusting the dimensions of an inlet of the dispensing channel to complement the dimensions of the solid pharmaceutical items.

SMART & BIGGAR

OTTAWA, CANADA

PATENT AGENTS

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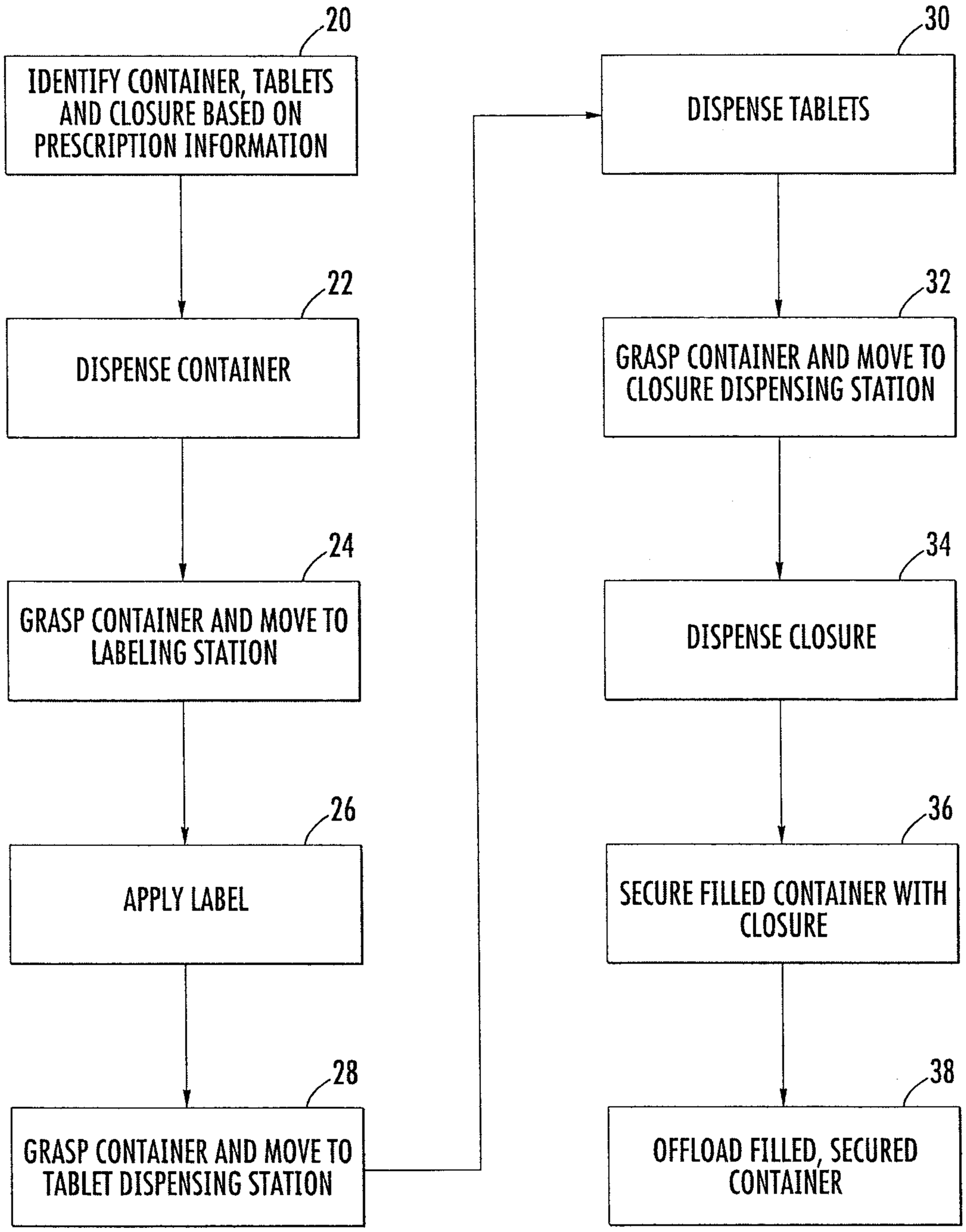


FIG. 1.

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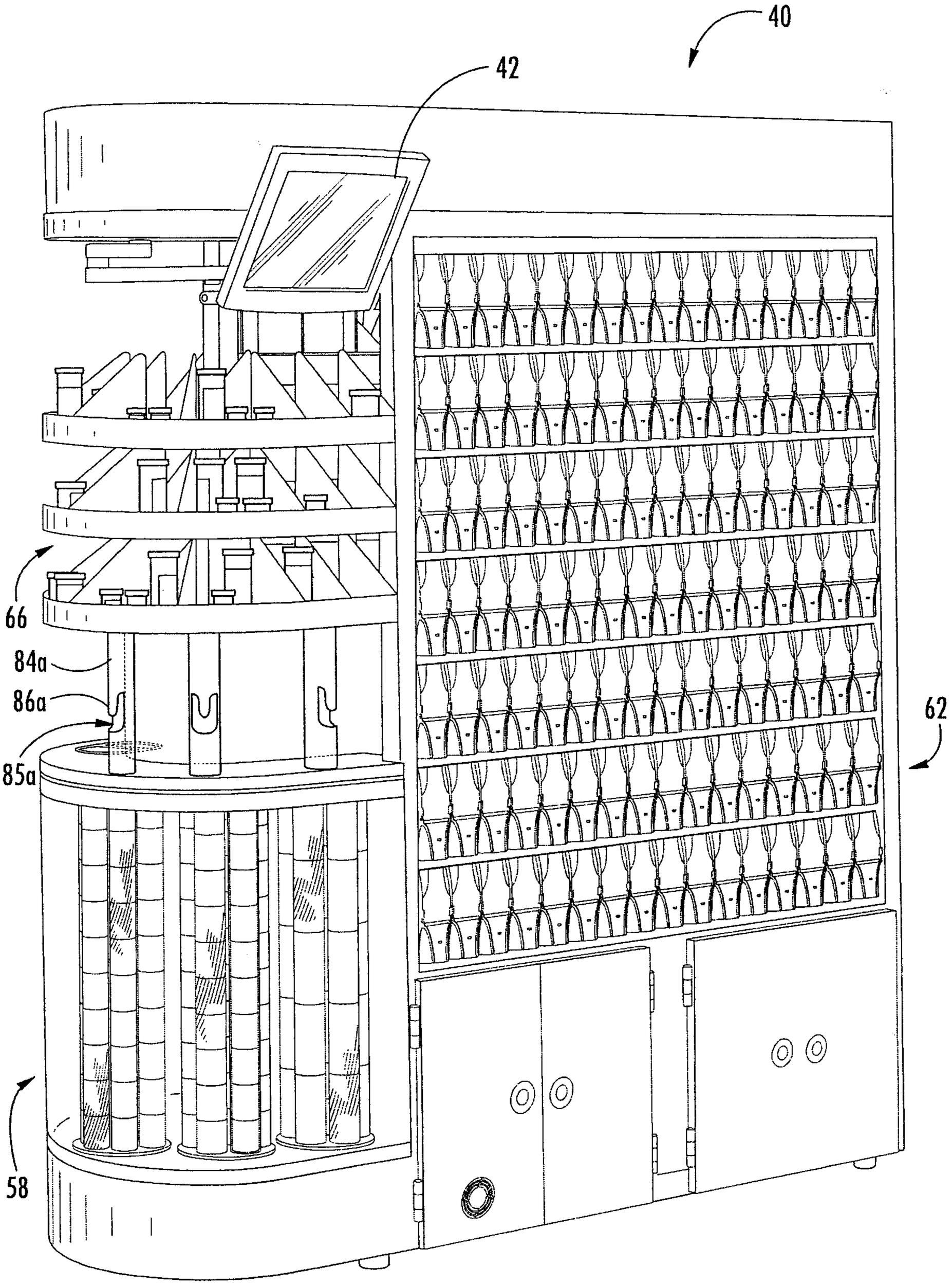


FIG. 2.

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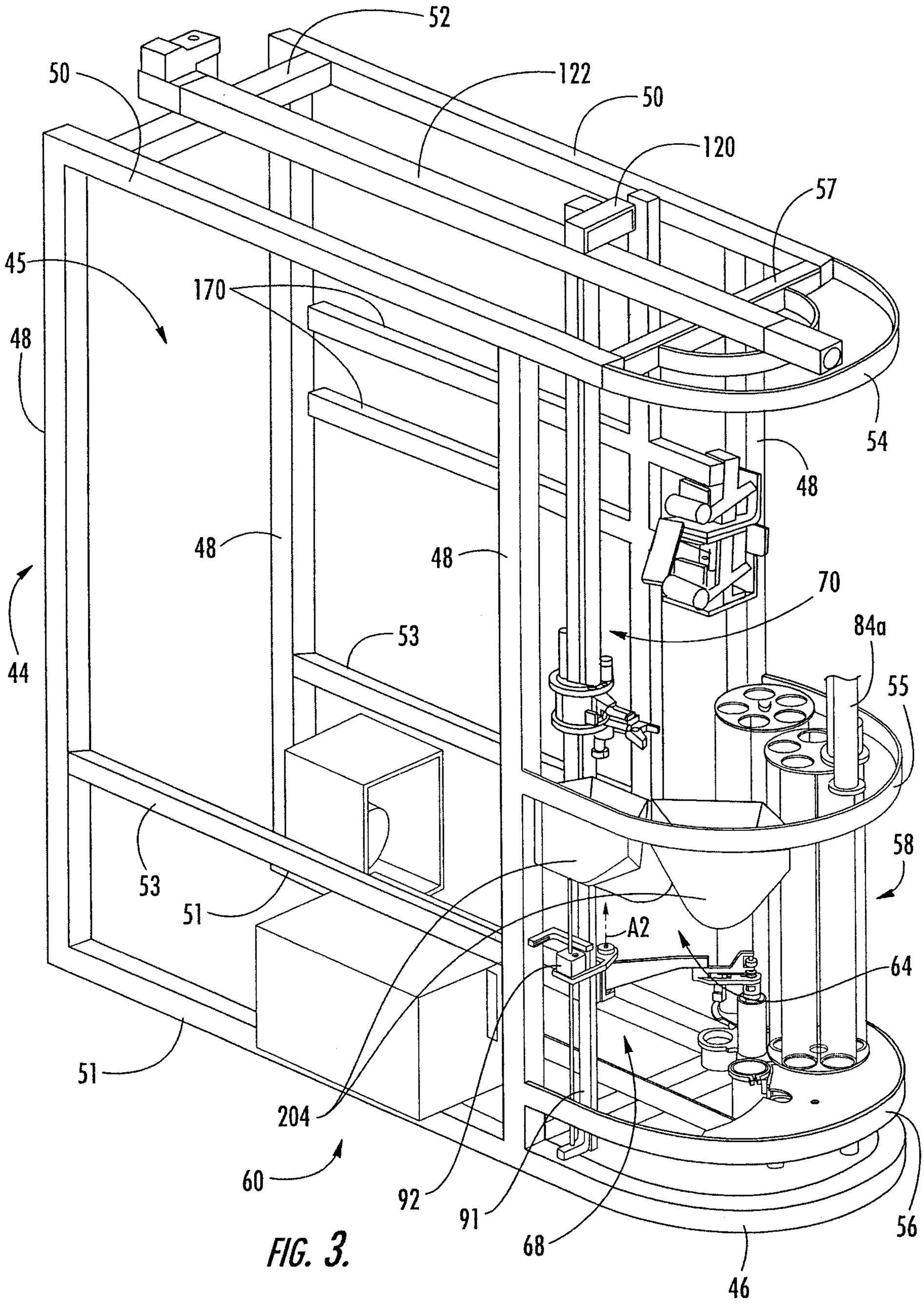


FIG. 3.

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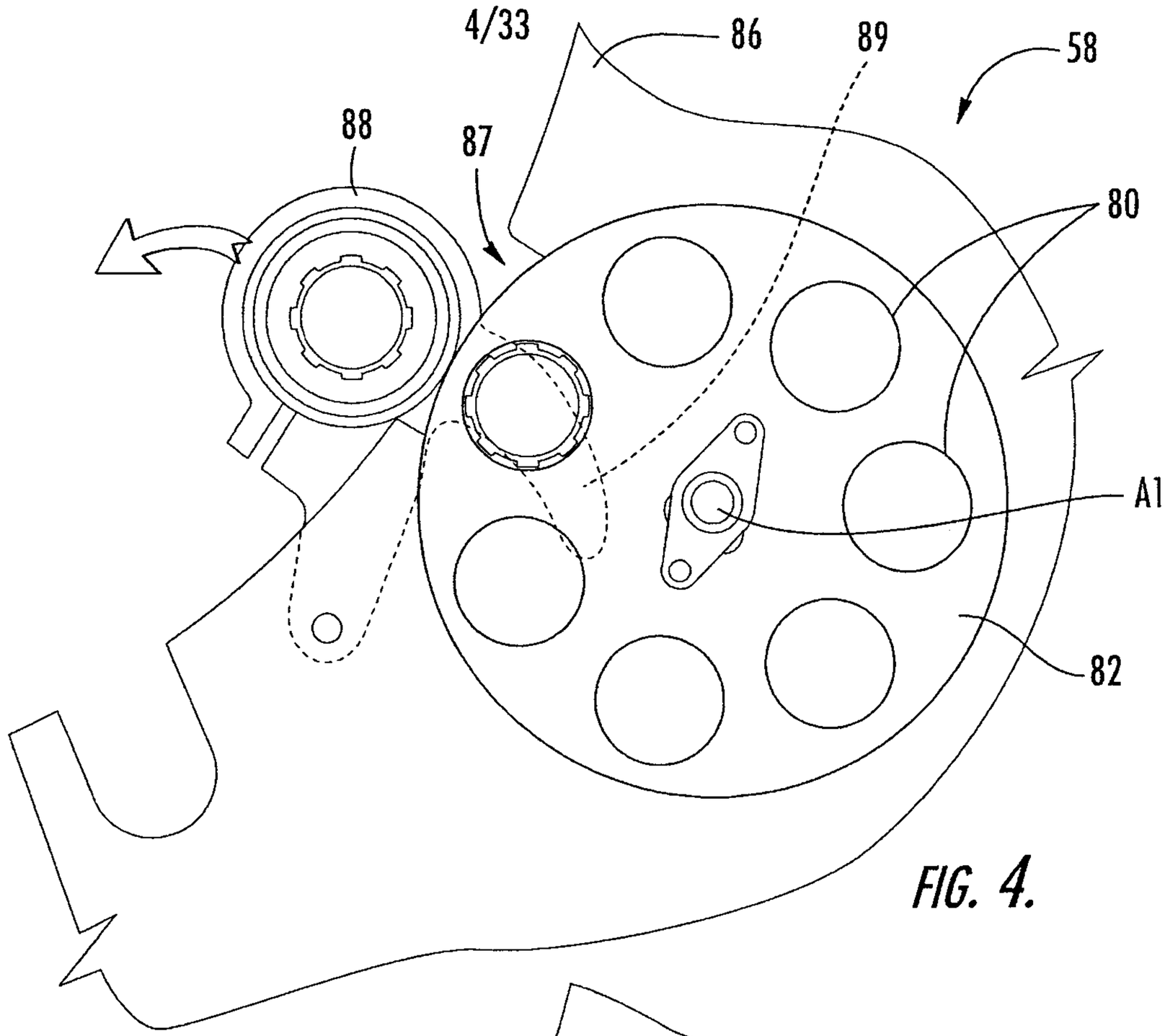


FIG. 4.

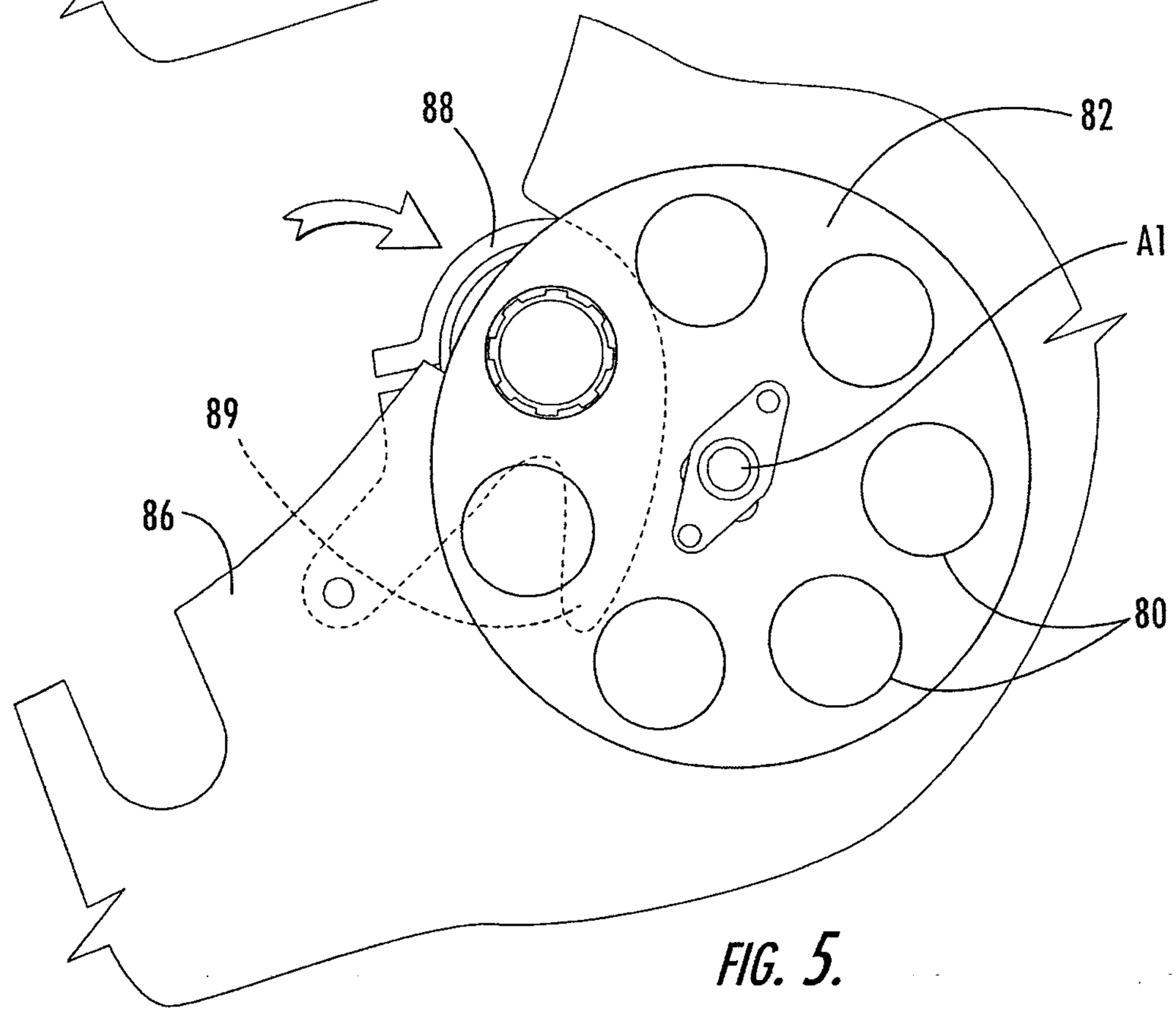


FIG. 5.

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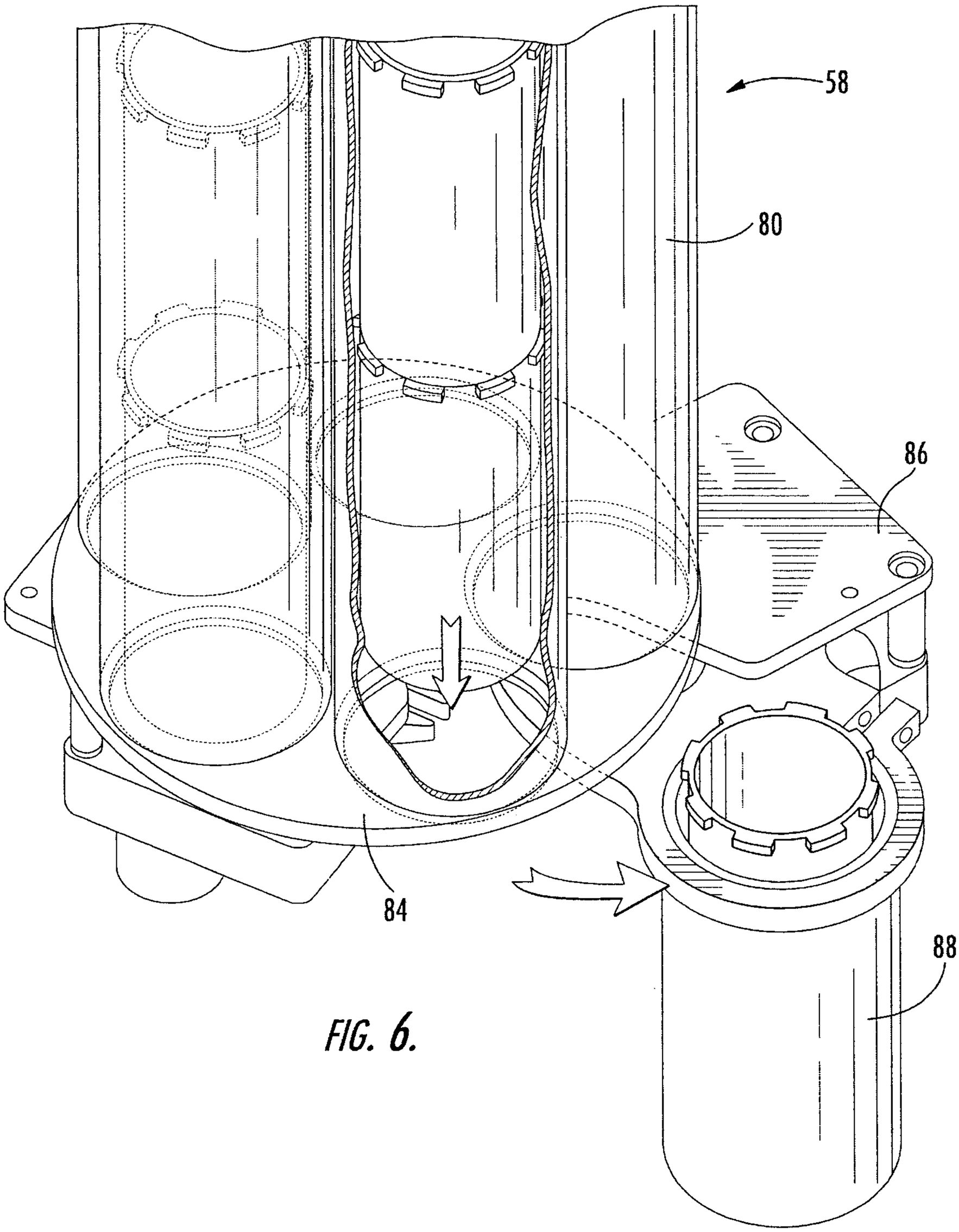


FIG. 6.

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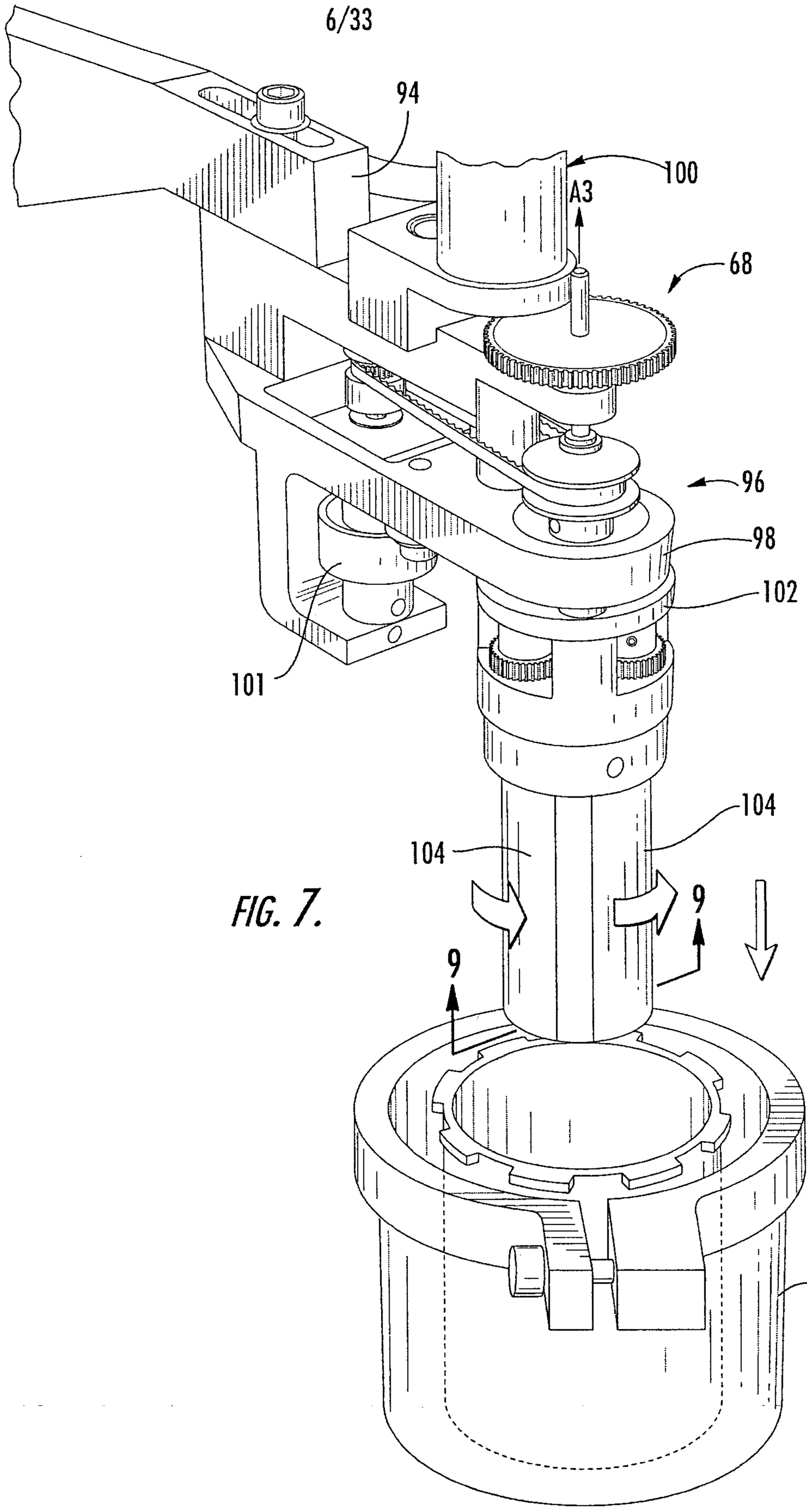


FIG. 7.

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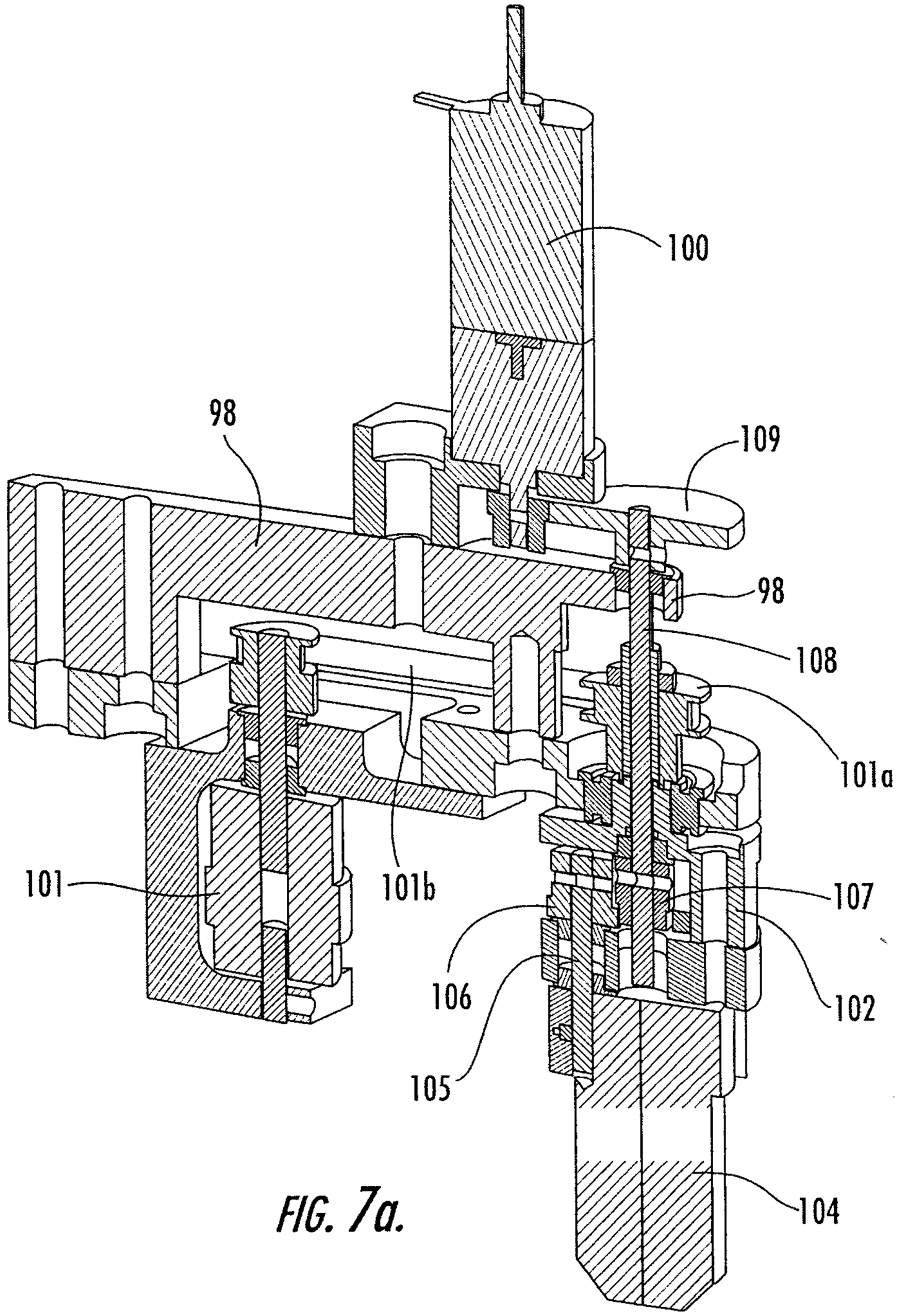


FIG. 7a.

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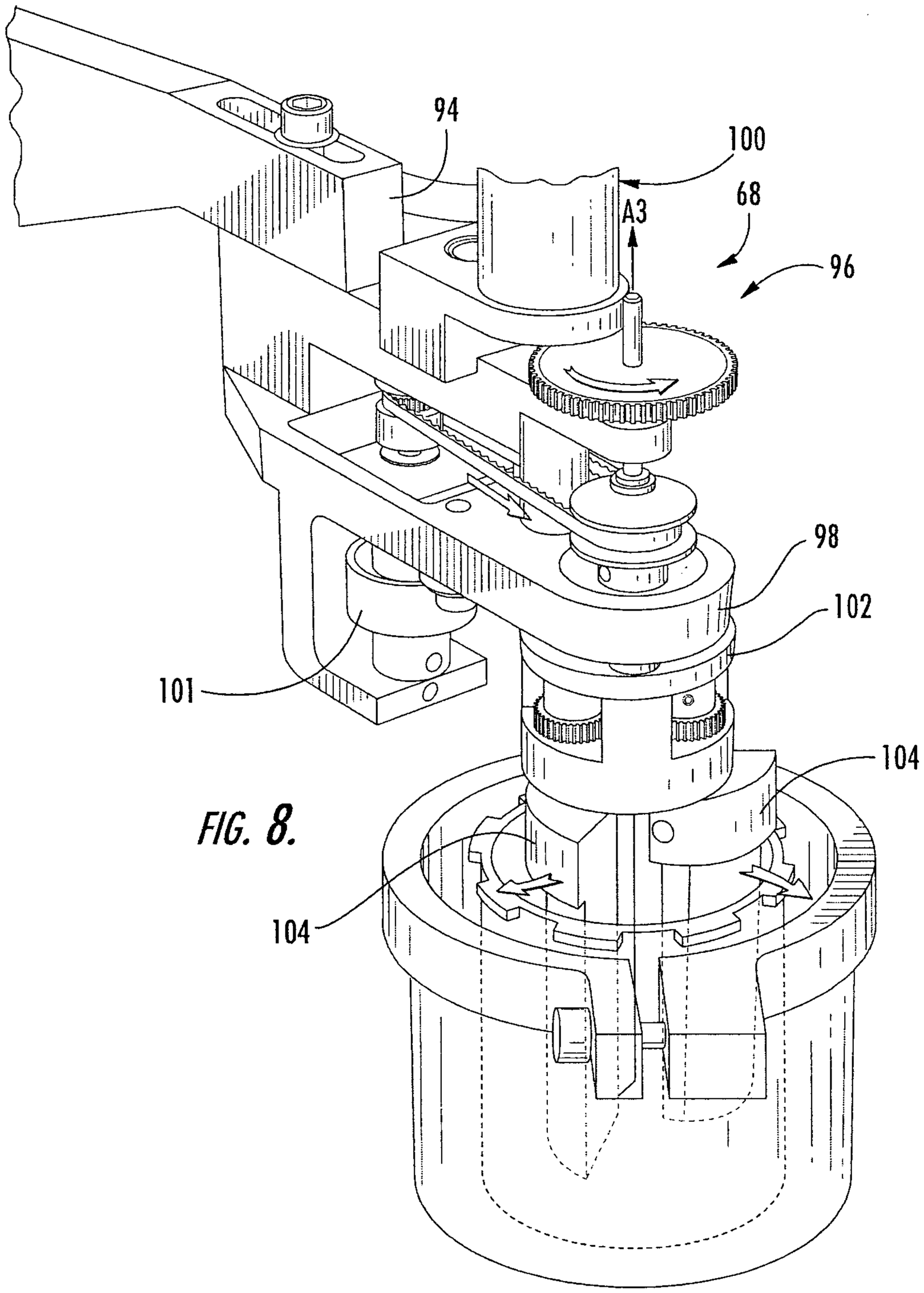


FIG. 8.

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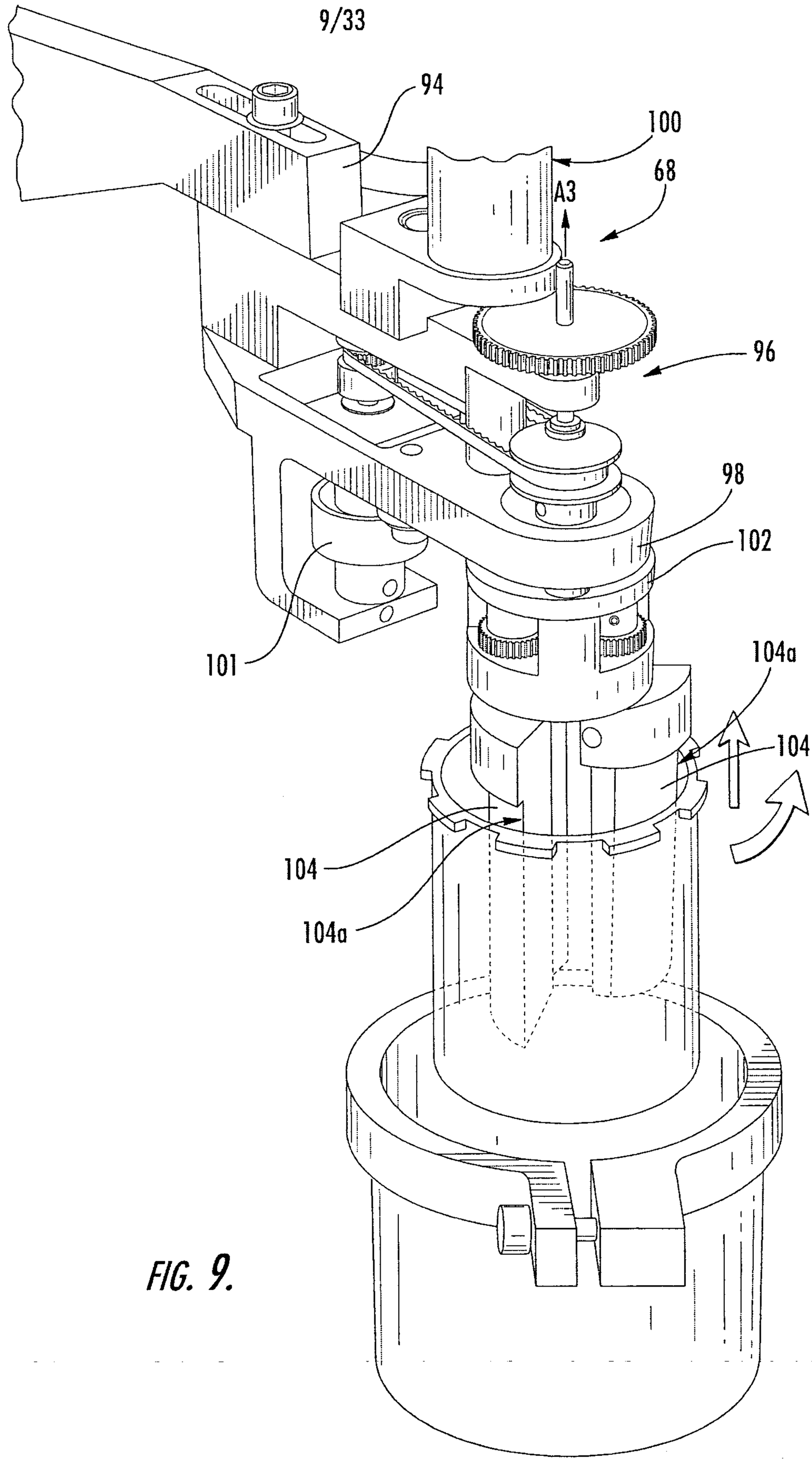


FIG. 9.

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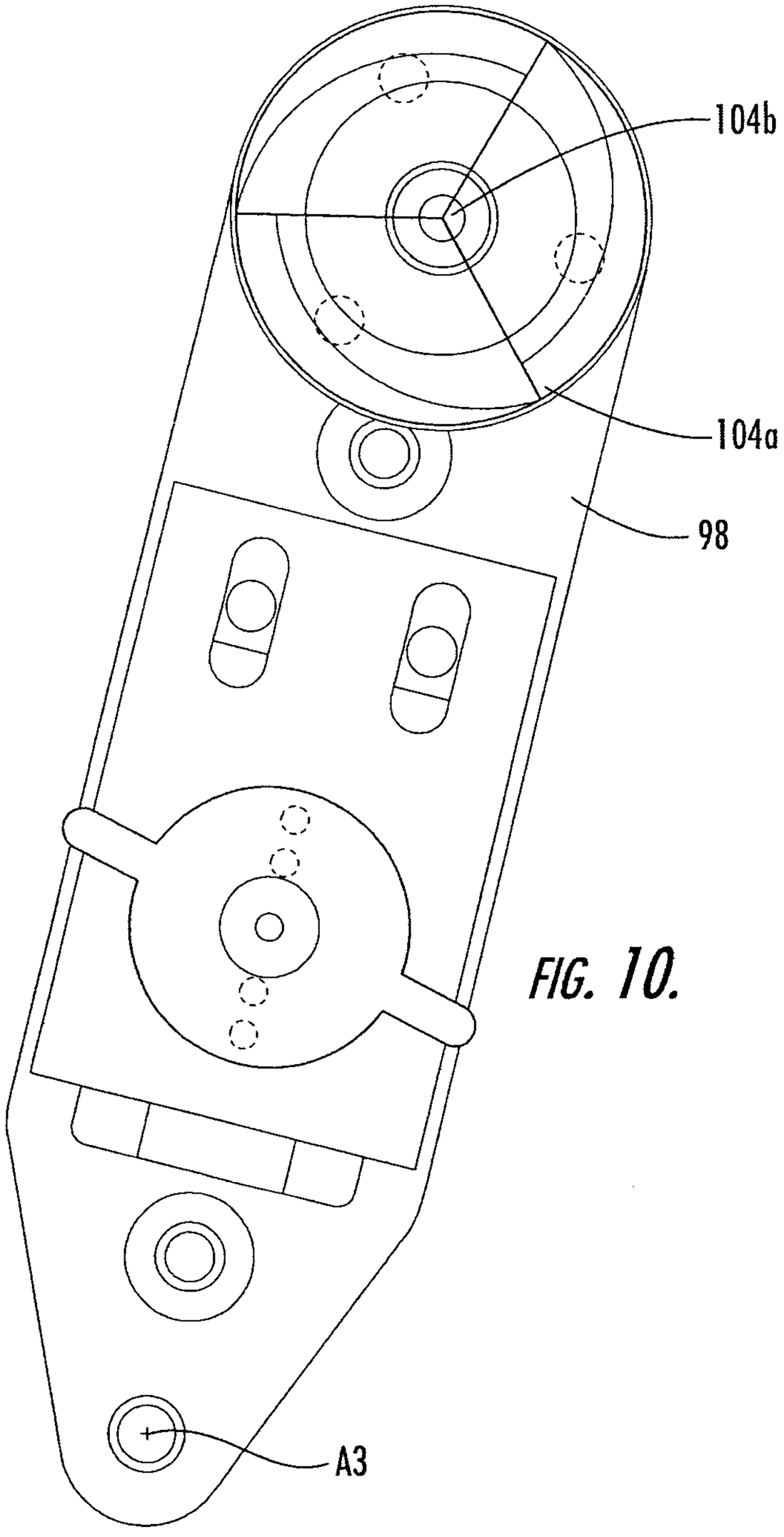


FIG. 10.

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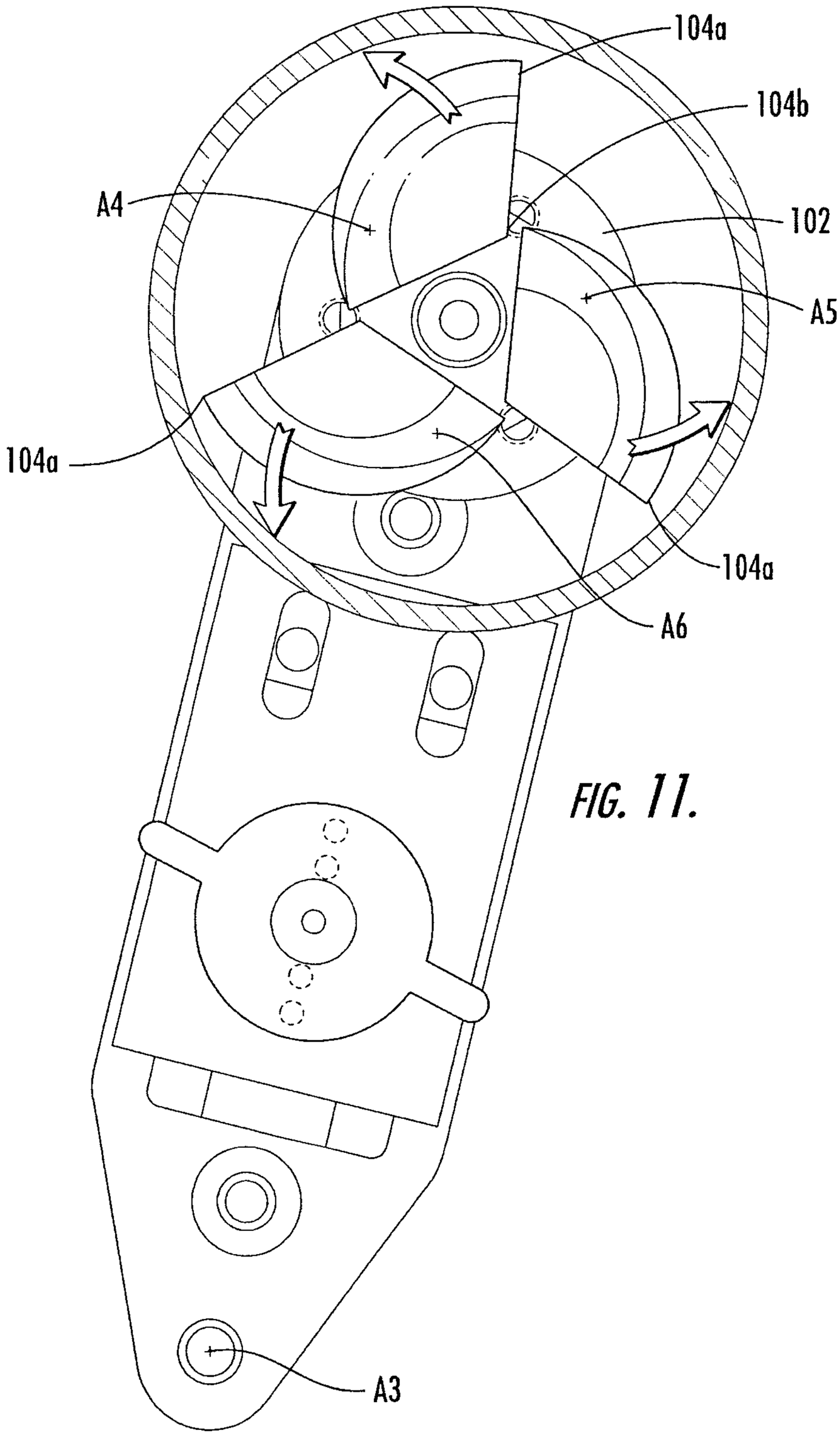


FIG. 11.

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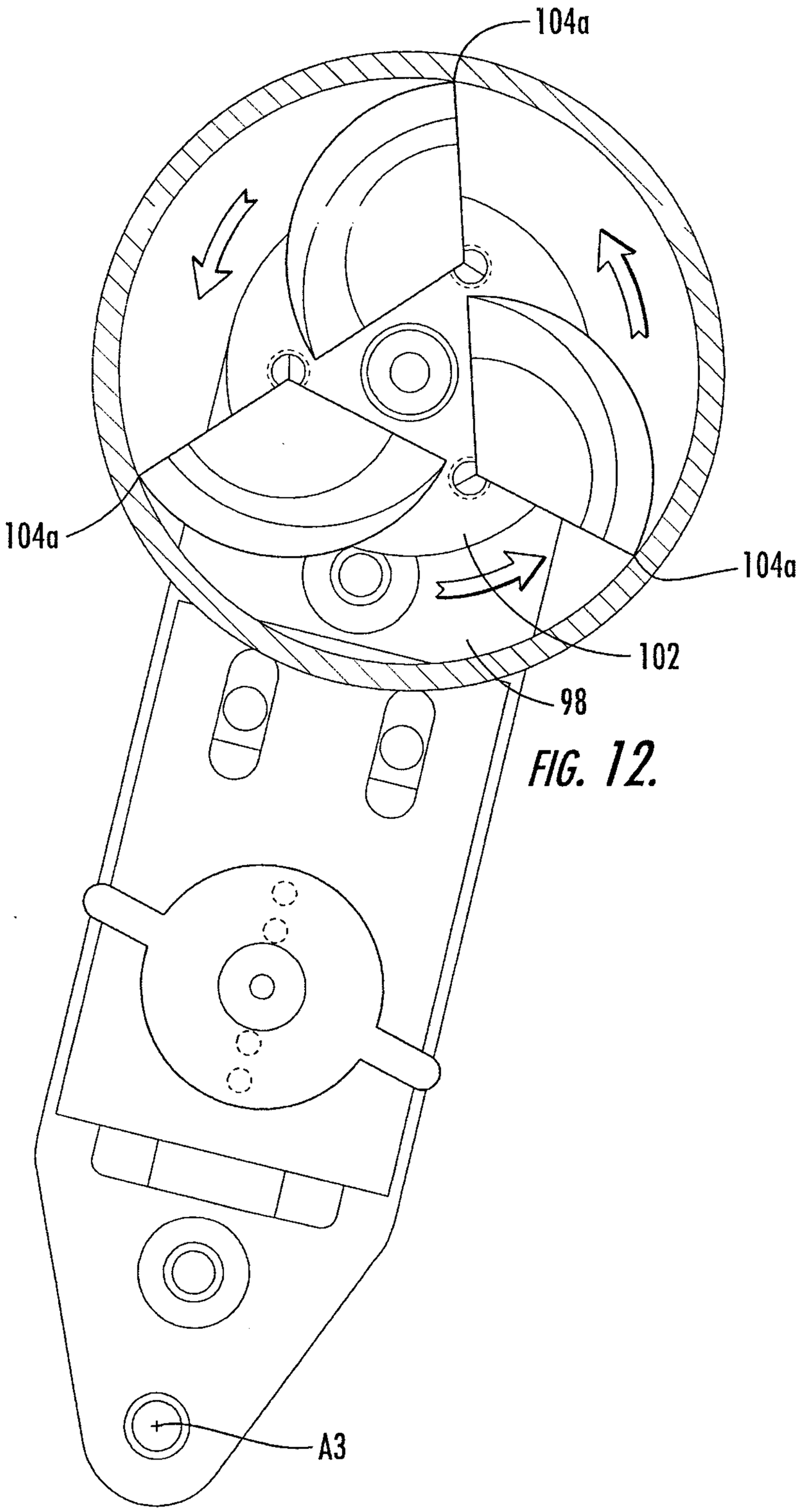


FIG. 12.

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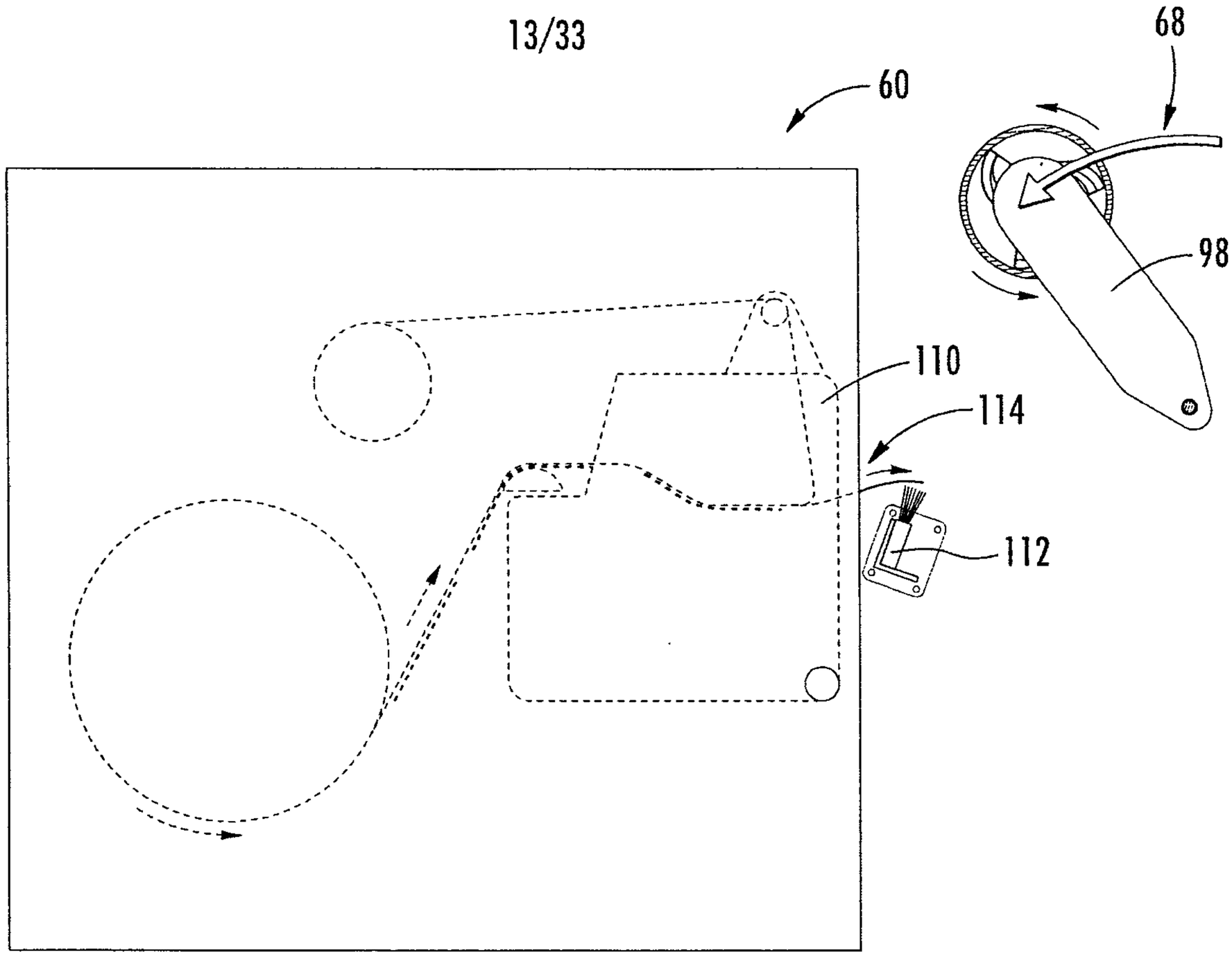


FIG. 13.

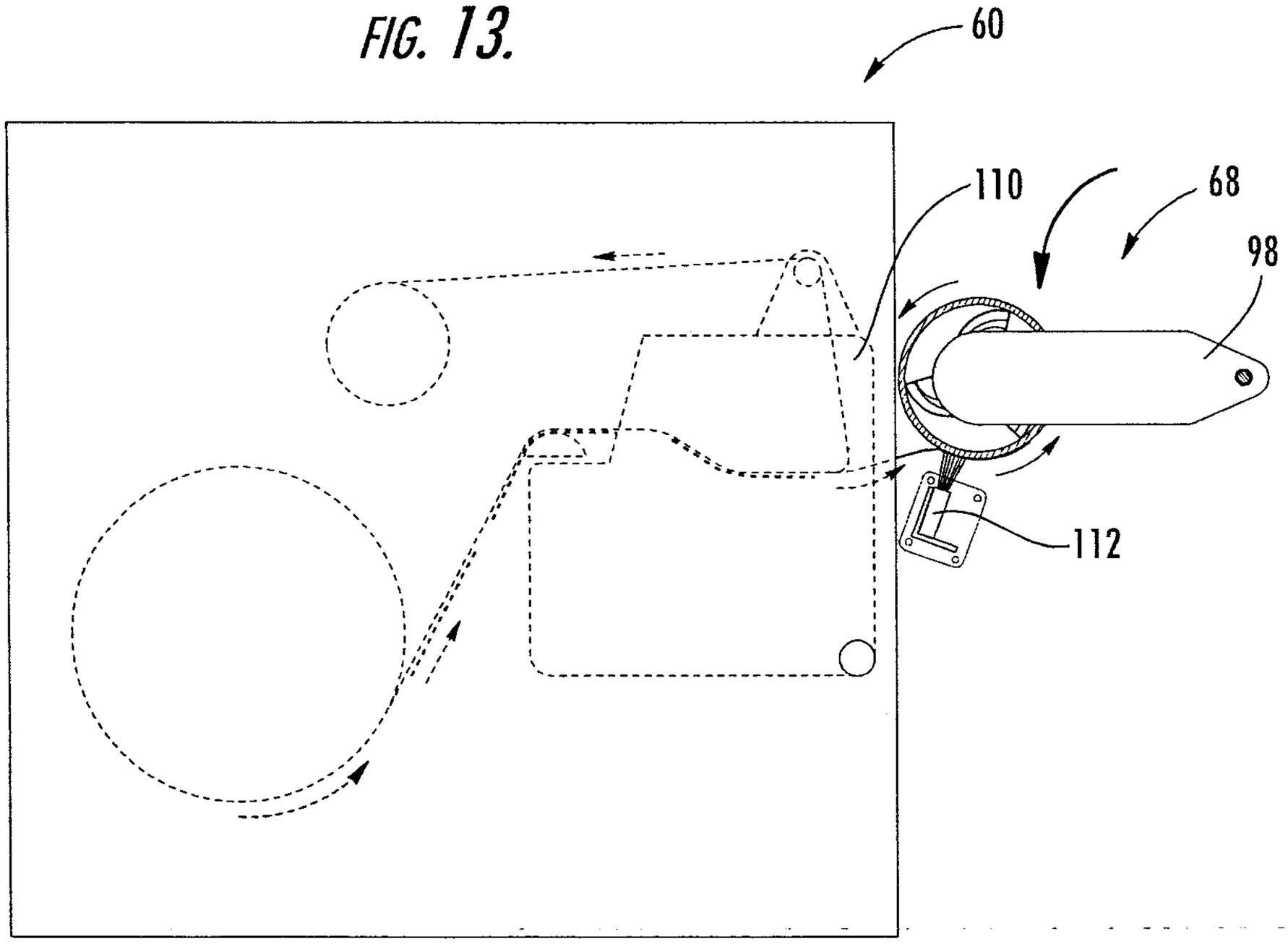


FIG. 14.

77203-76D

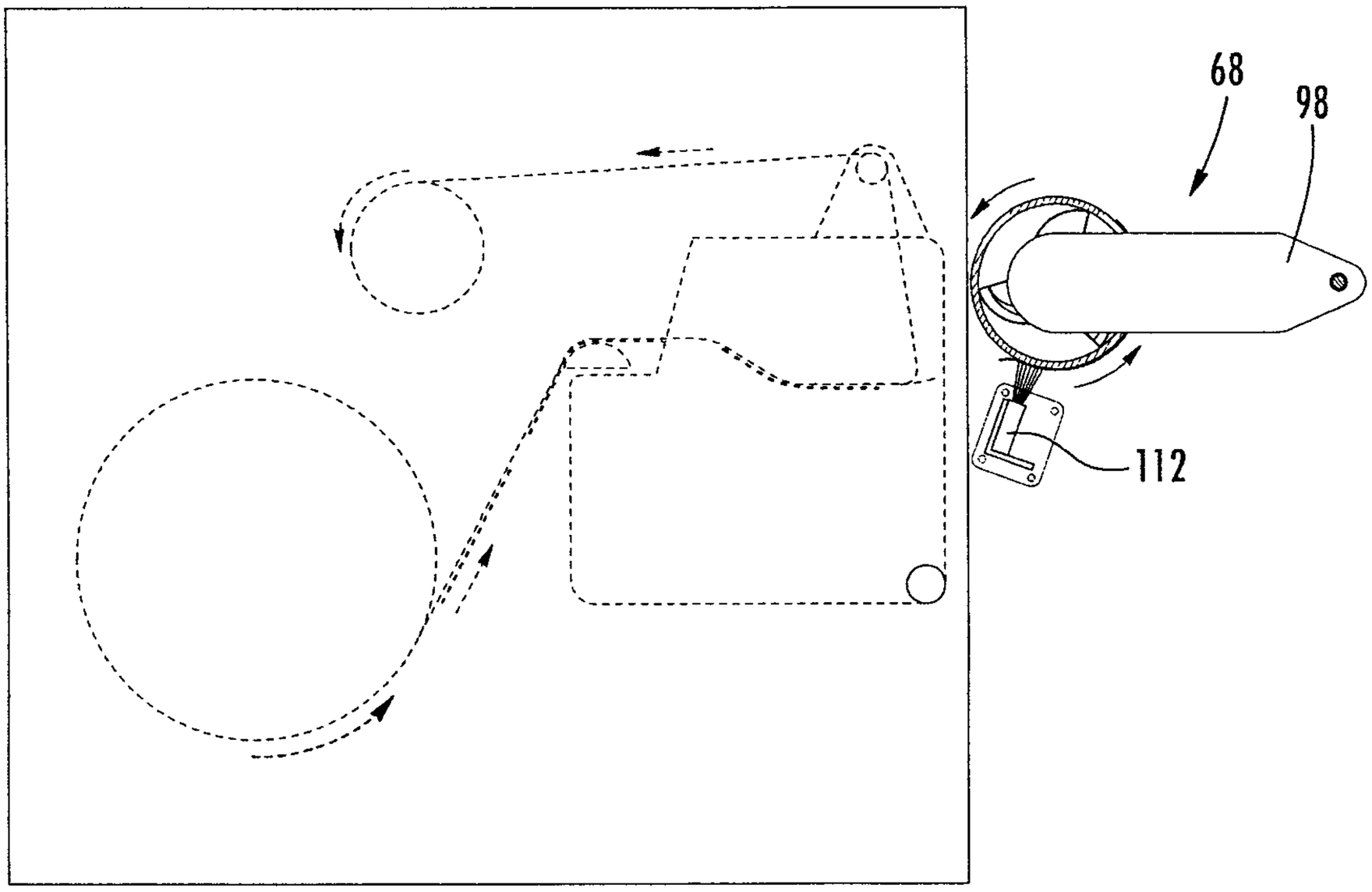


FIG. 15.

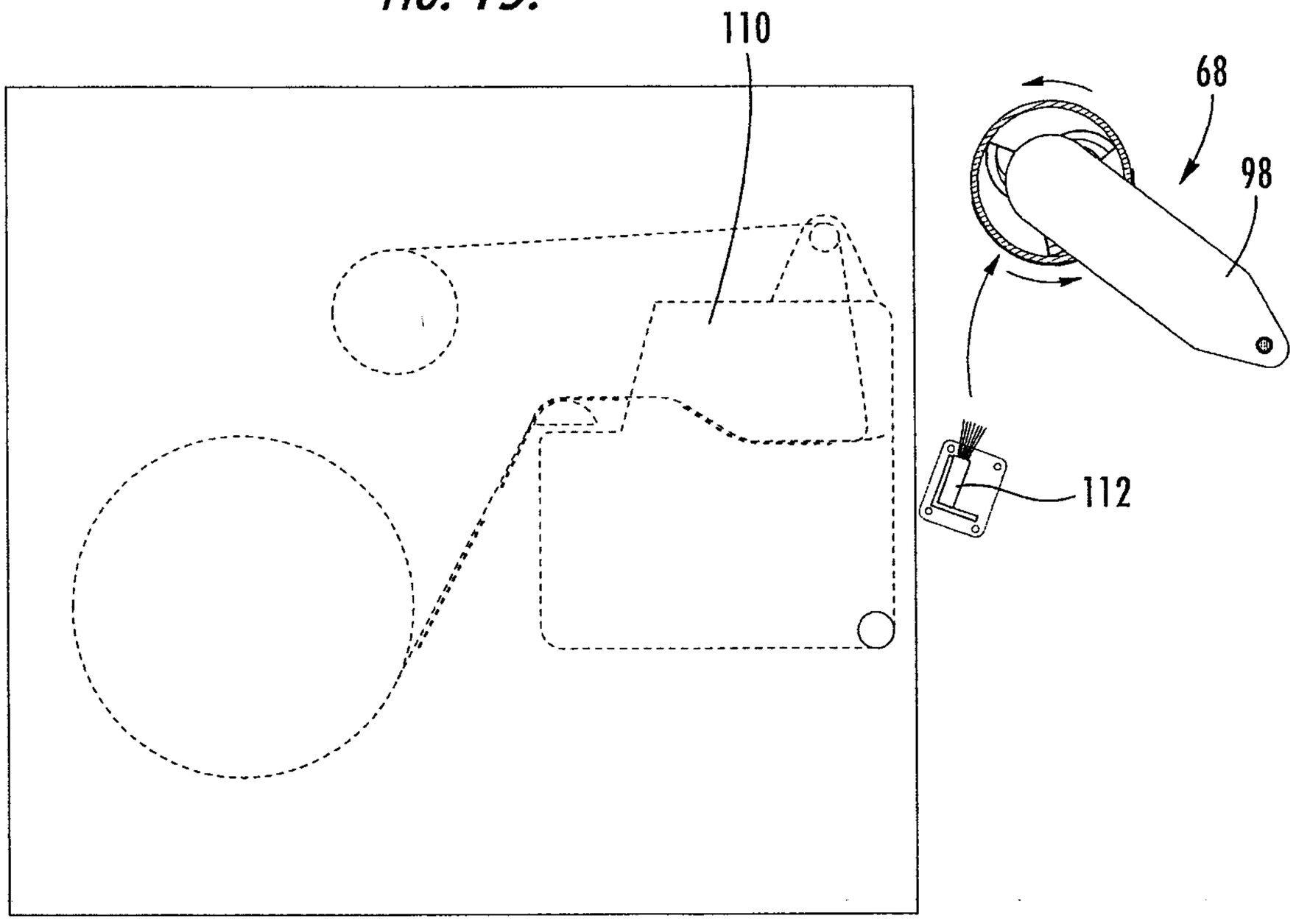


FIG. 16.

77203-76D

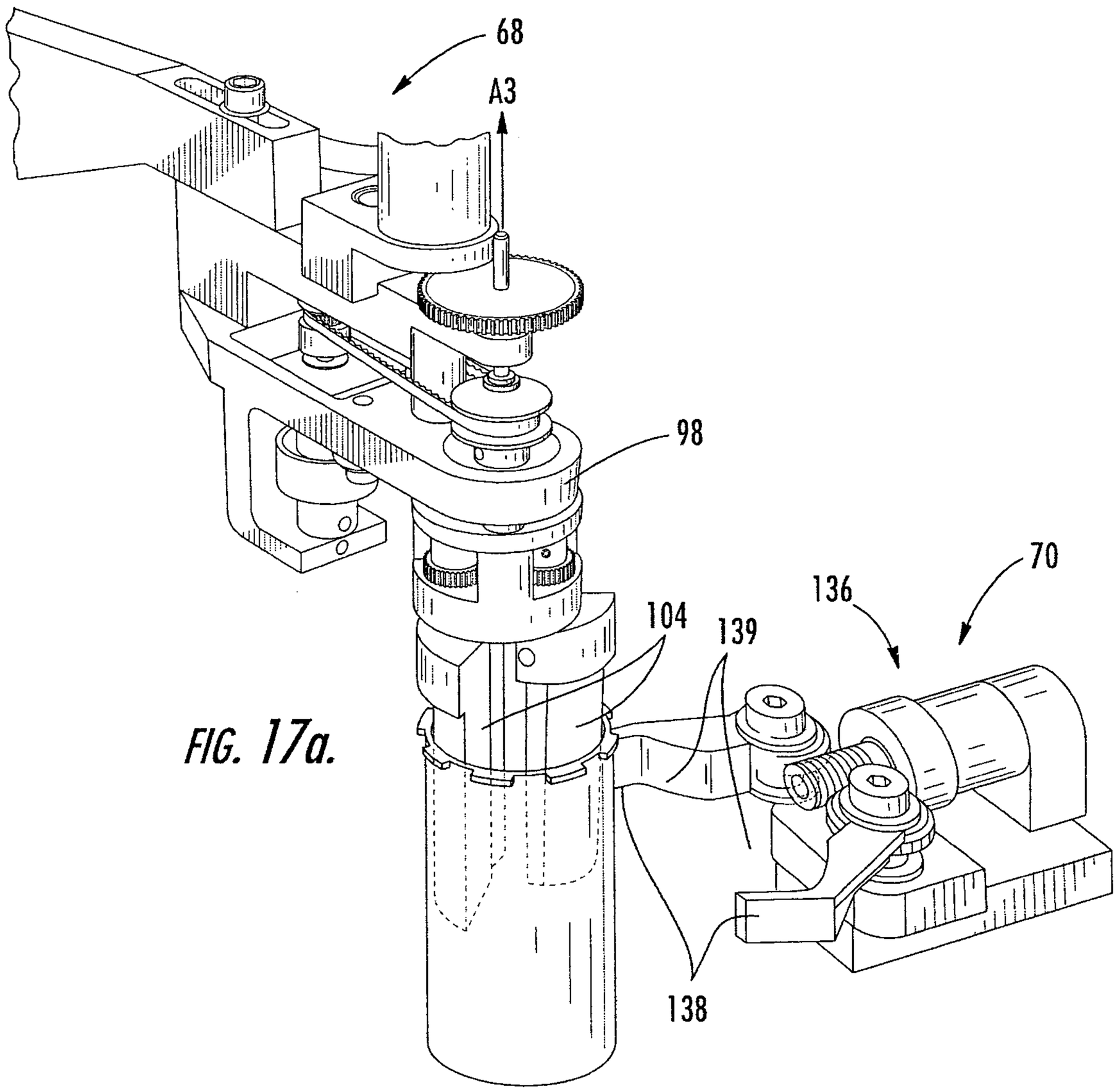


FIG. 17a.

77203-76D

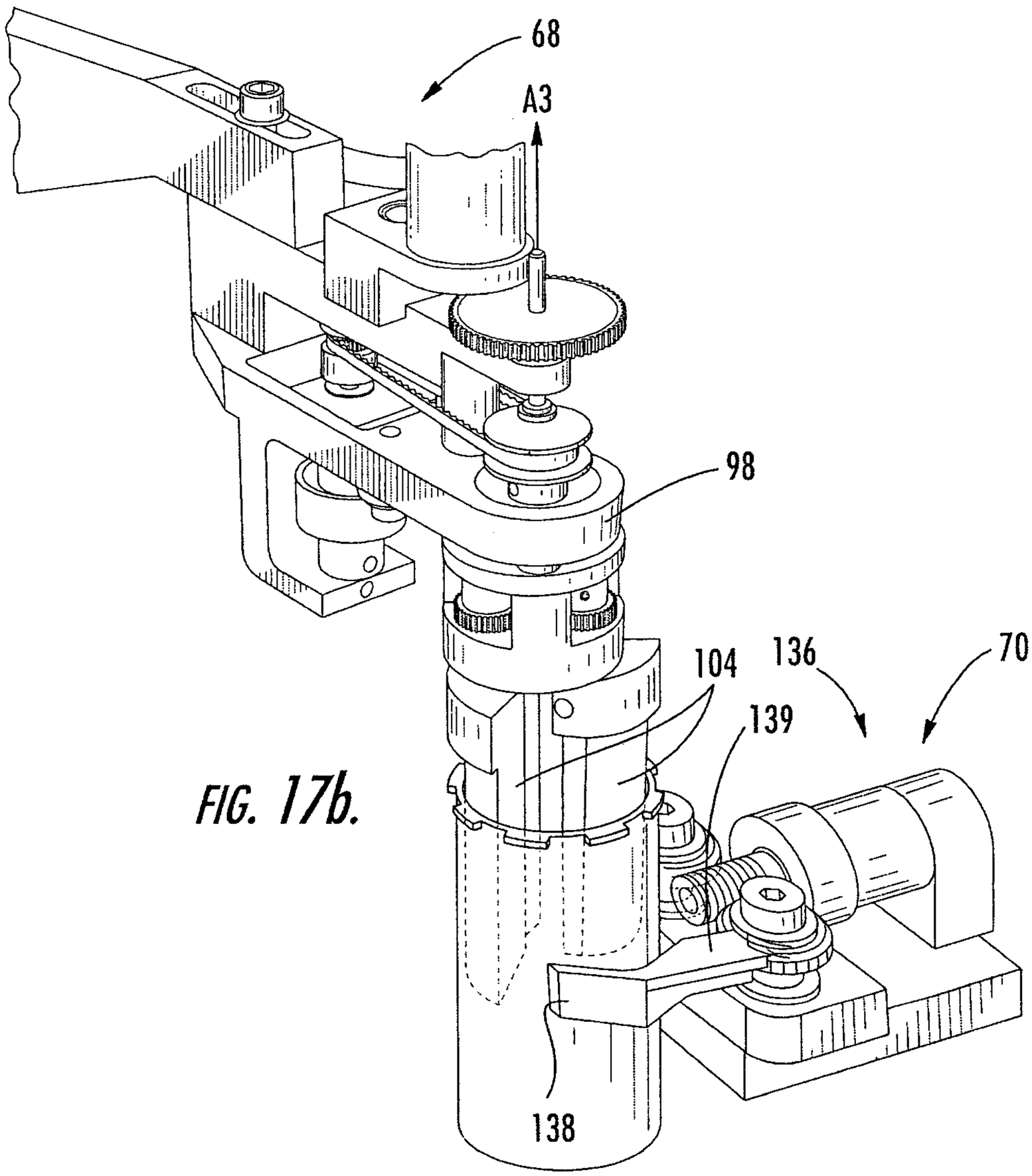


FIG. 17b.

77203-76D

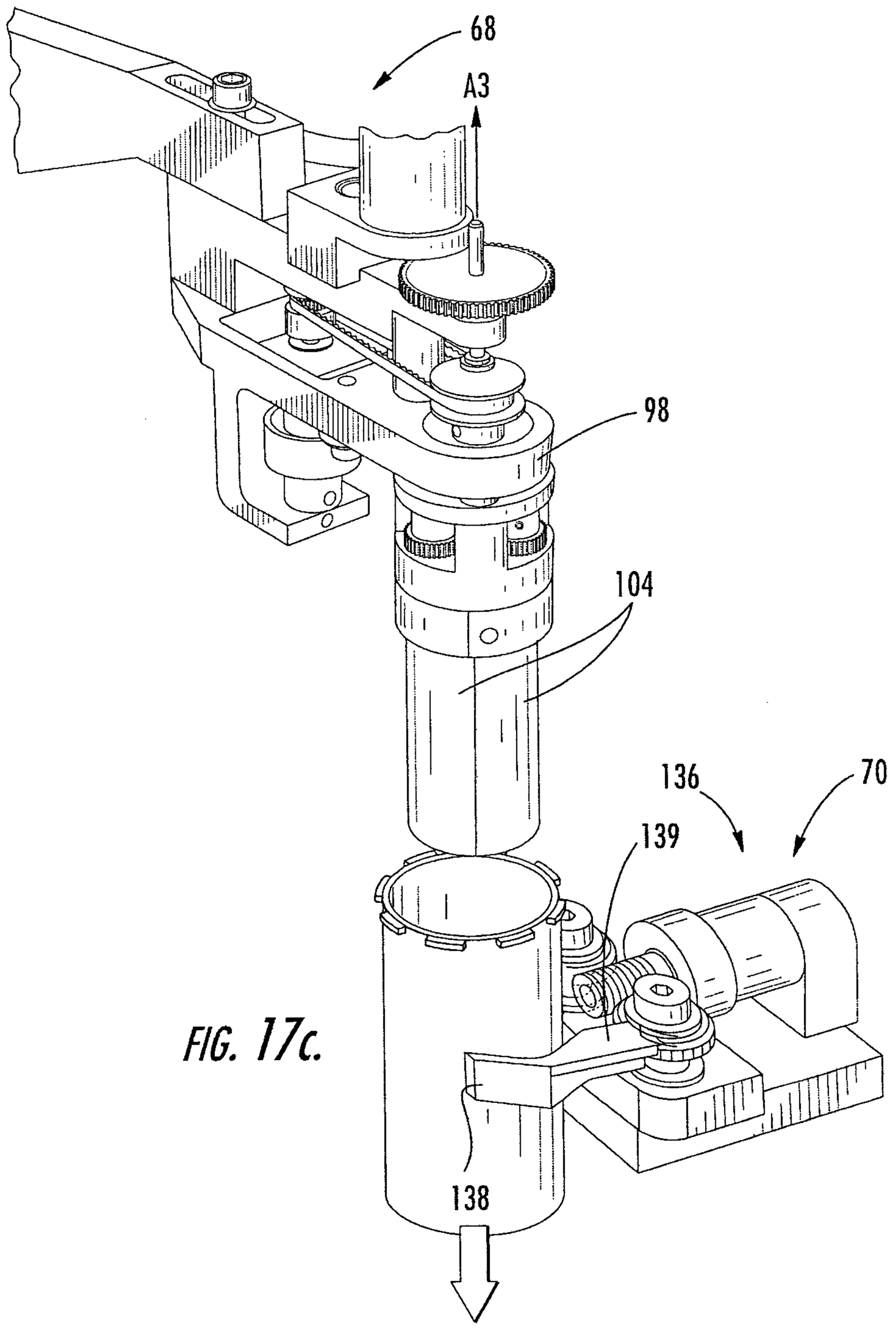


FIG. 17c.

77203-76D

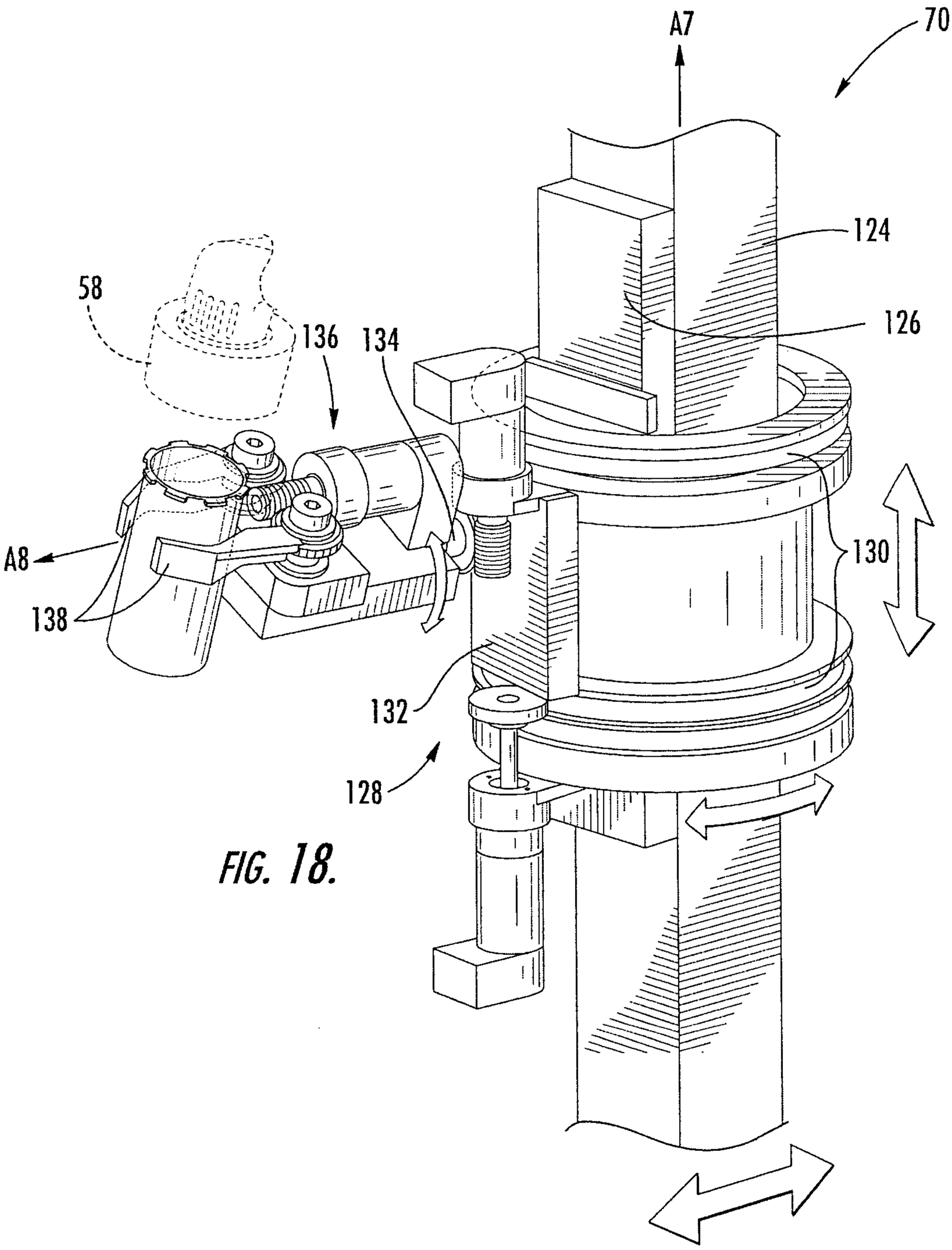


FIG. 18.

77203-76D

FIG. 19.

77203-76D

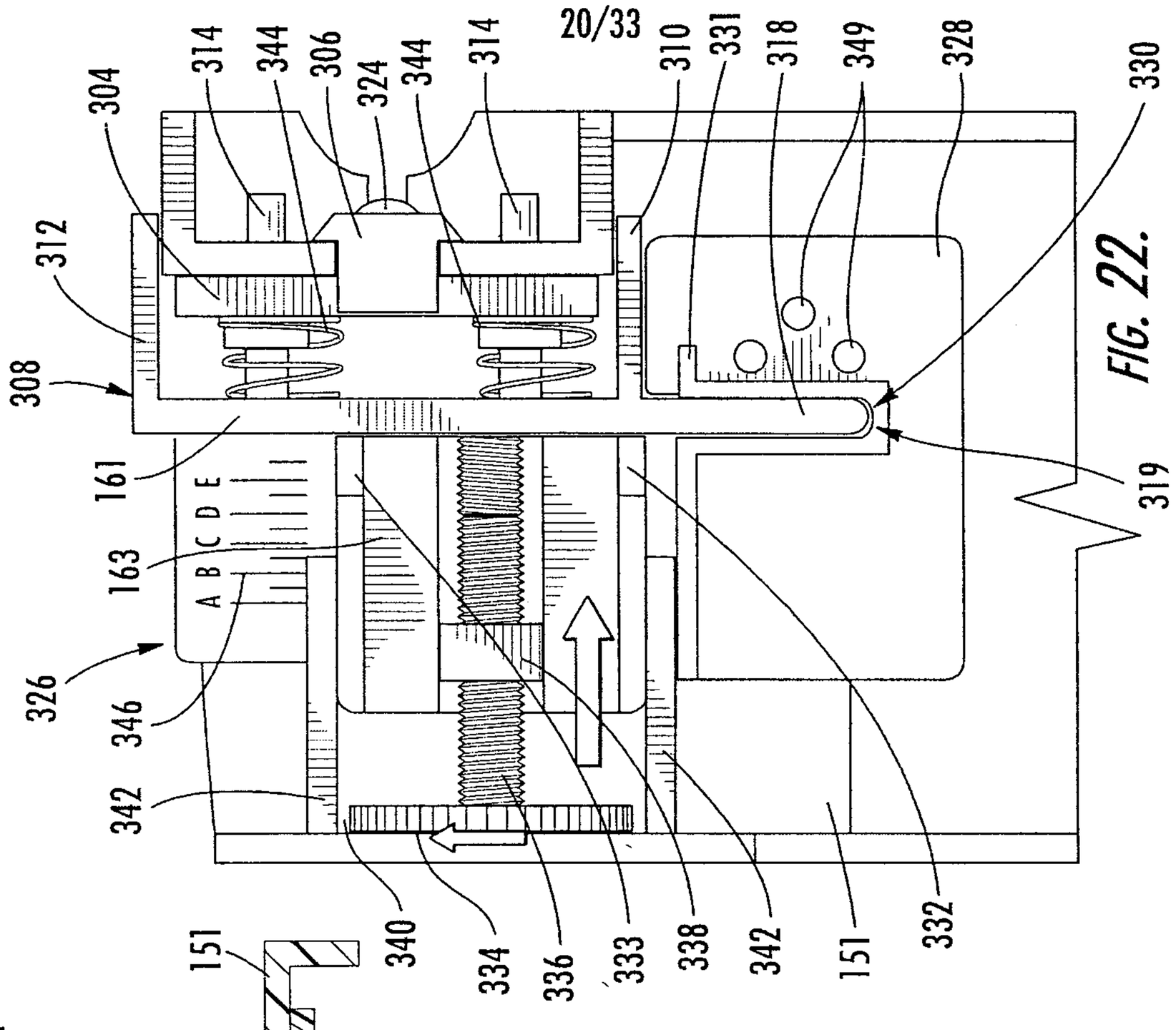


FIG. 22.

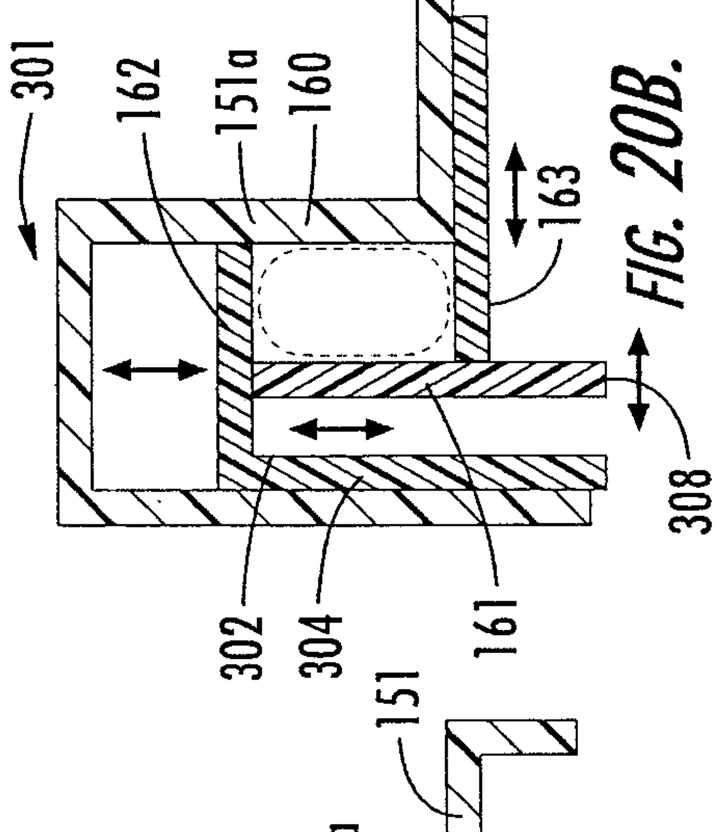


FIG. 20B.

FIG. 20A.

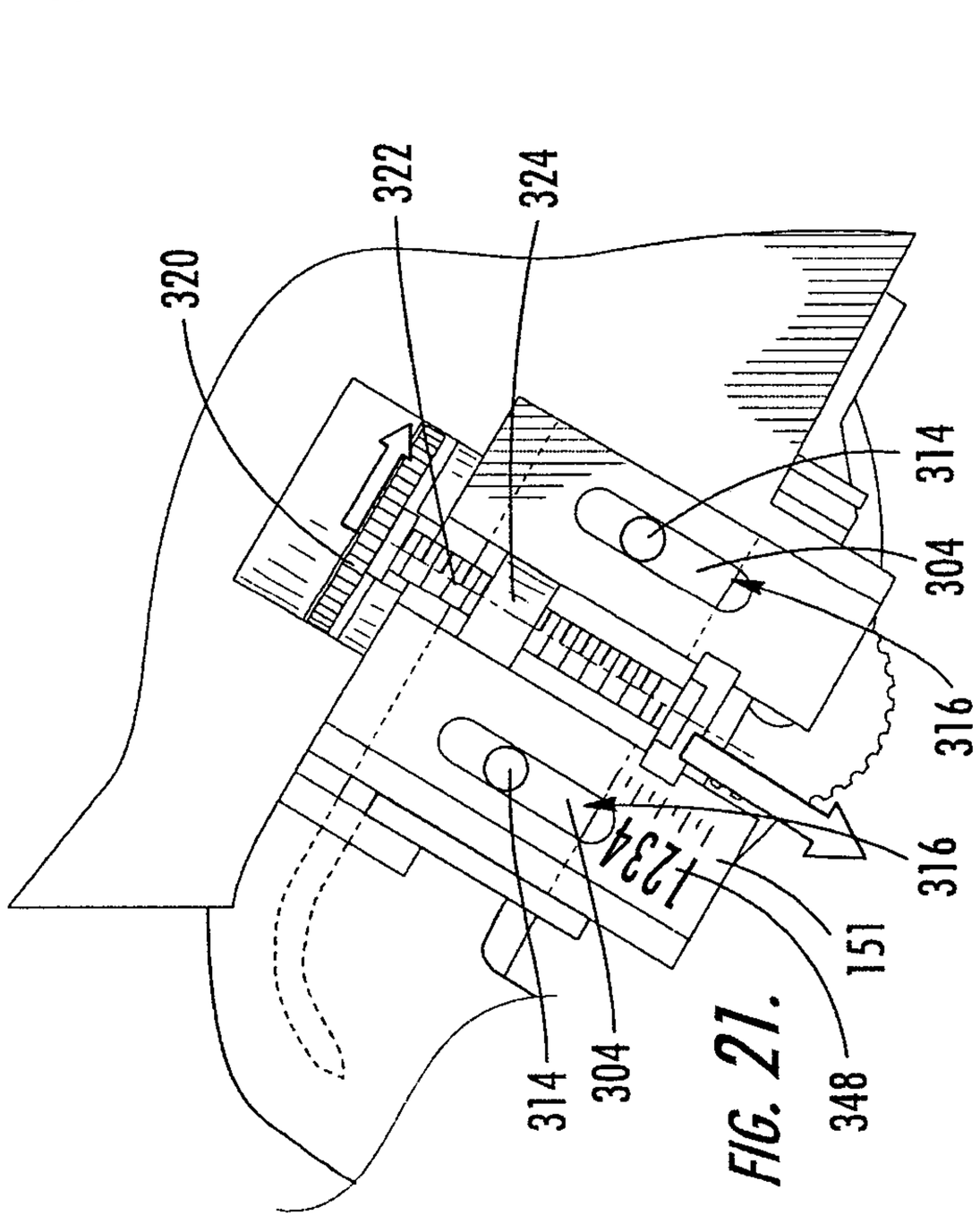


FIG. 21.

77203-76D

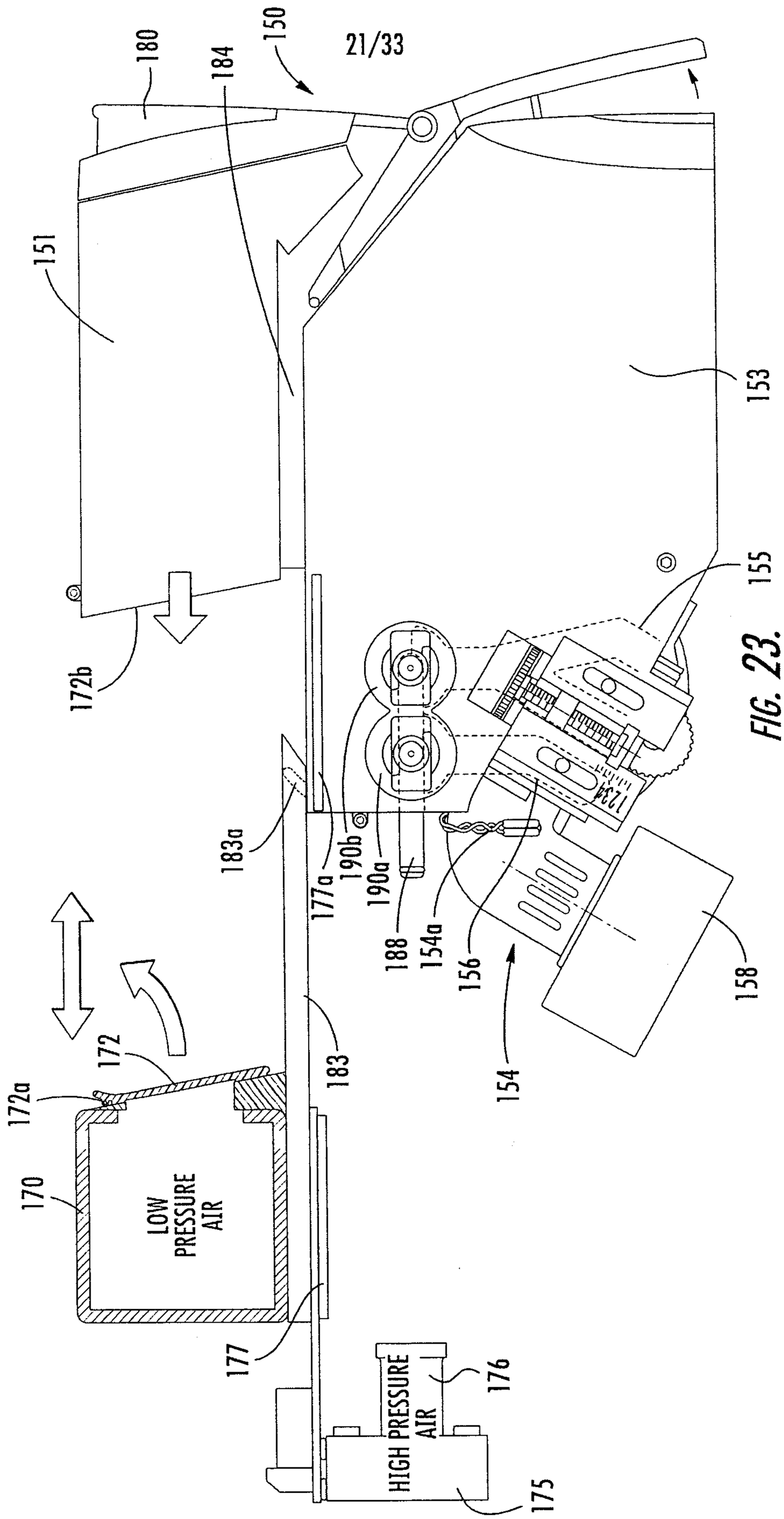


FIG. 23.

77203-76D

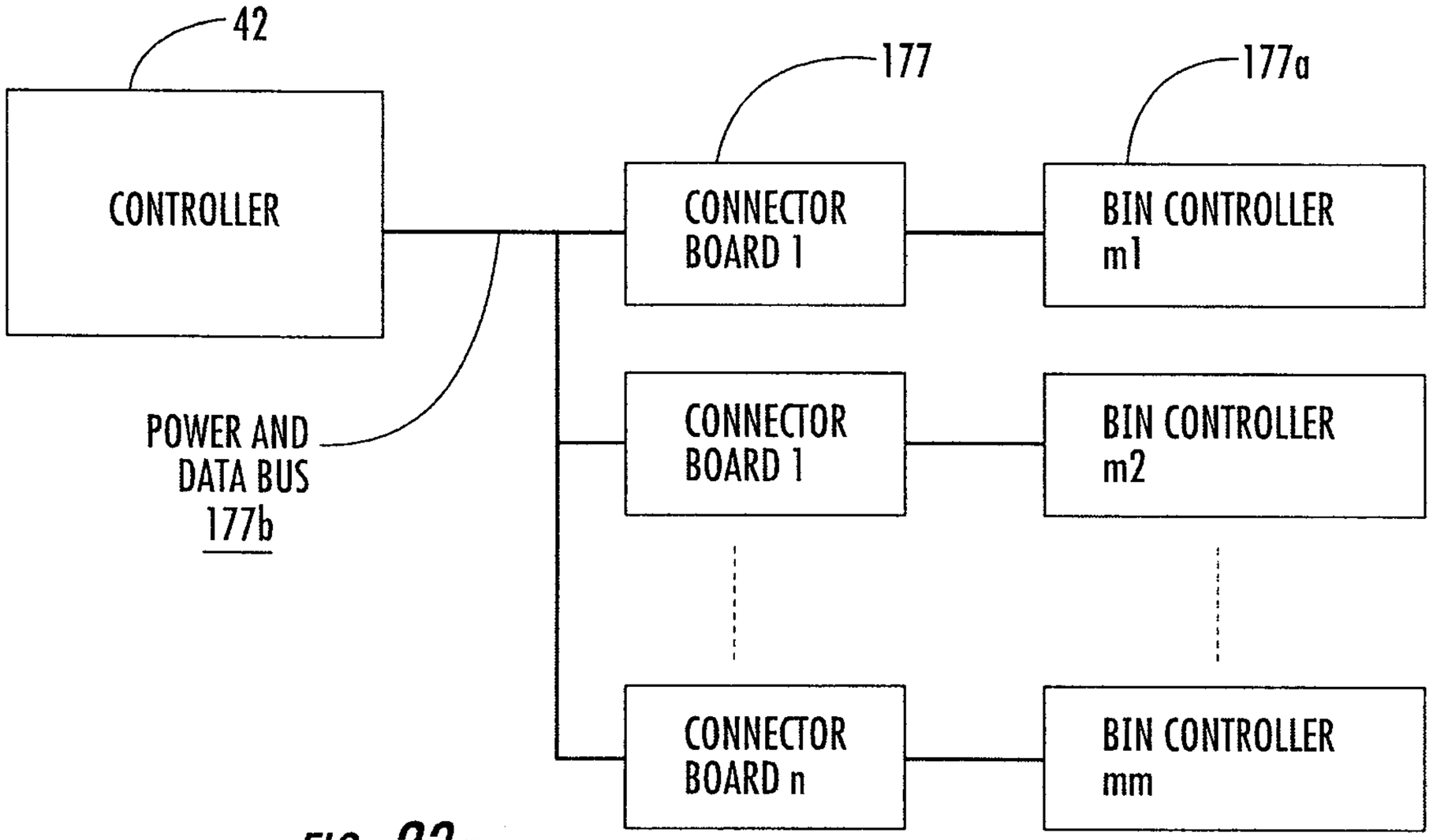


FIG. 23a.

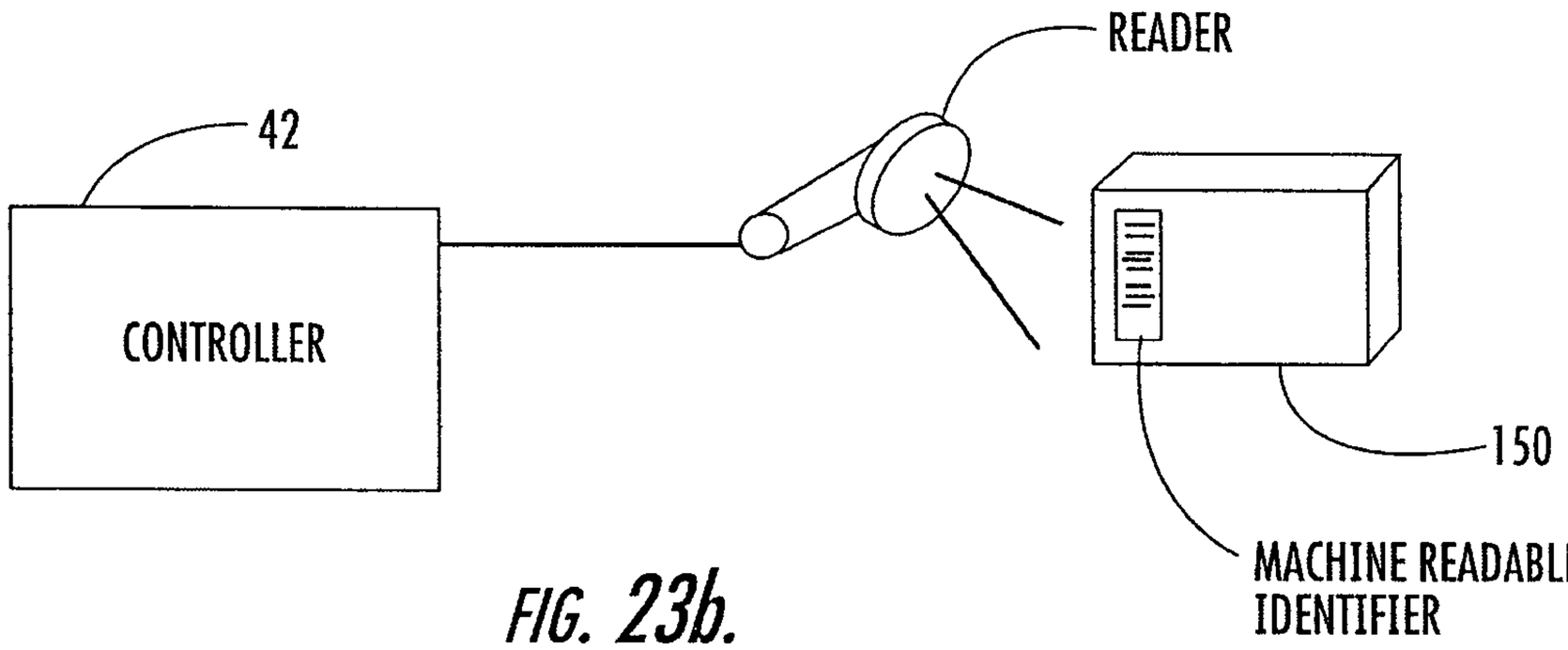


FIG. 23b.

77203-76D

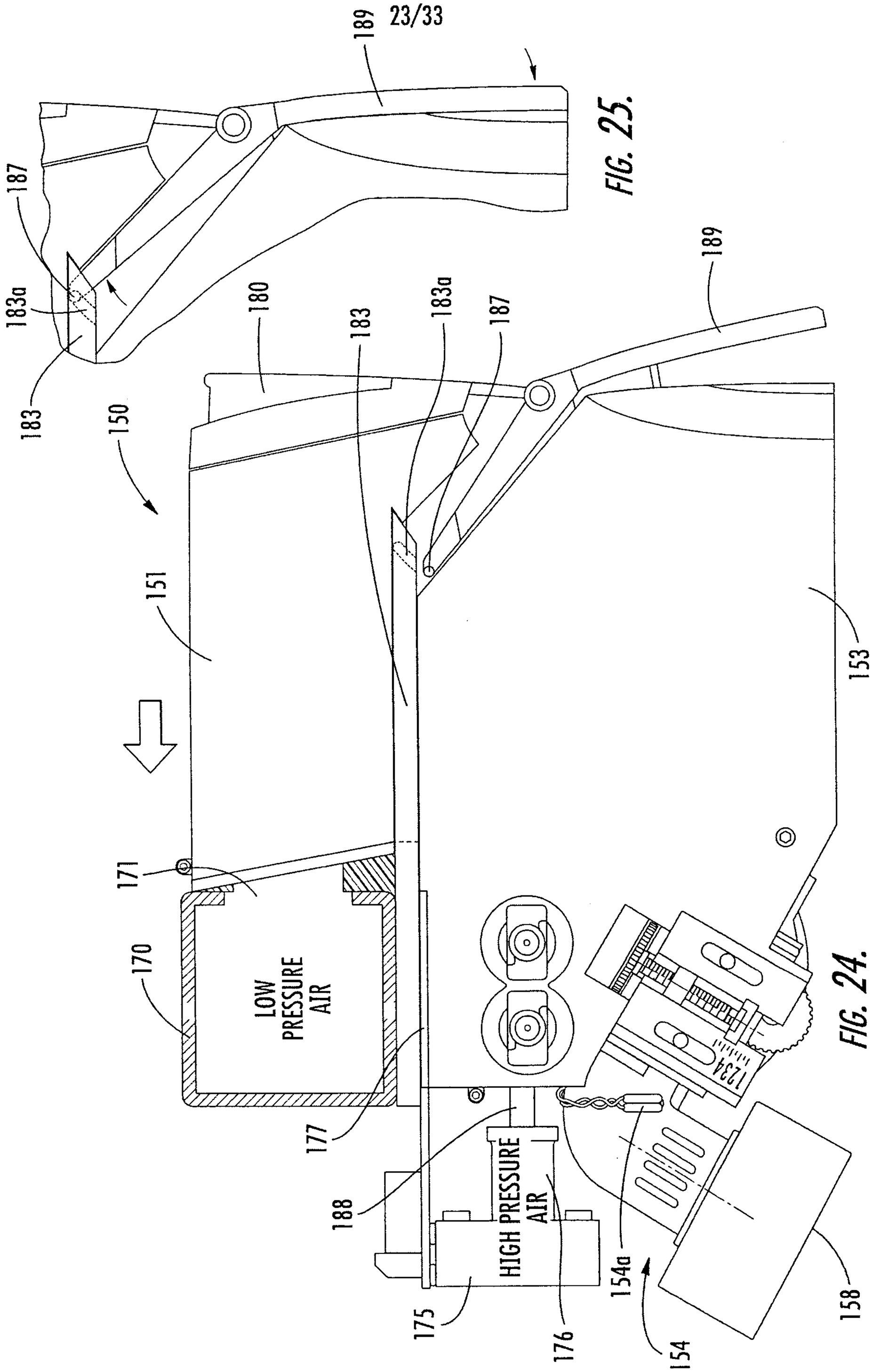


FIG. 25.

FIG. 24.

77203-76D

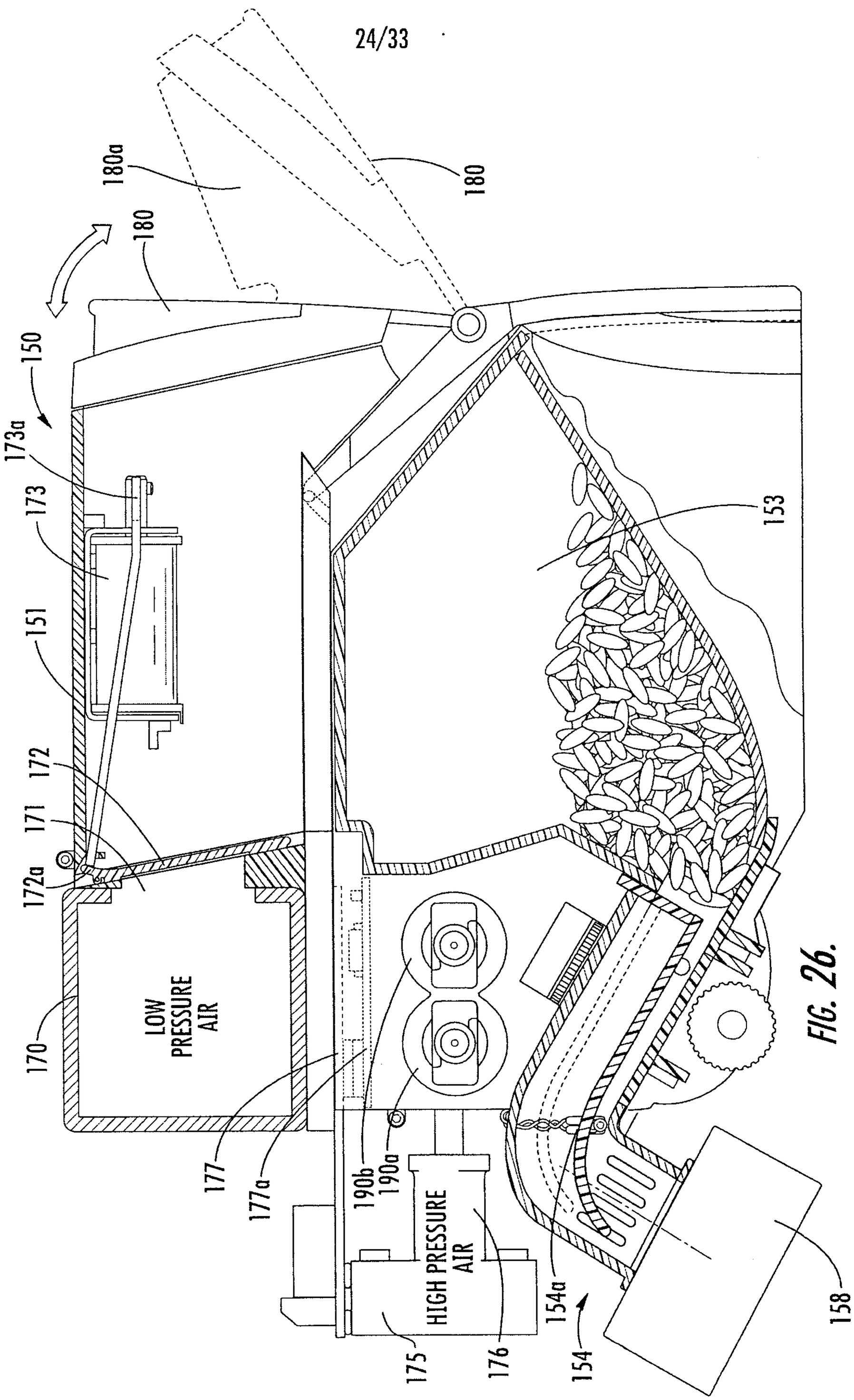


FIG. 26.

77203-76D

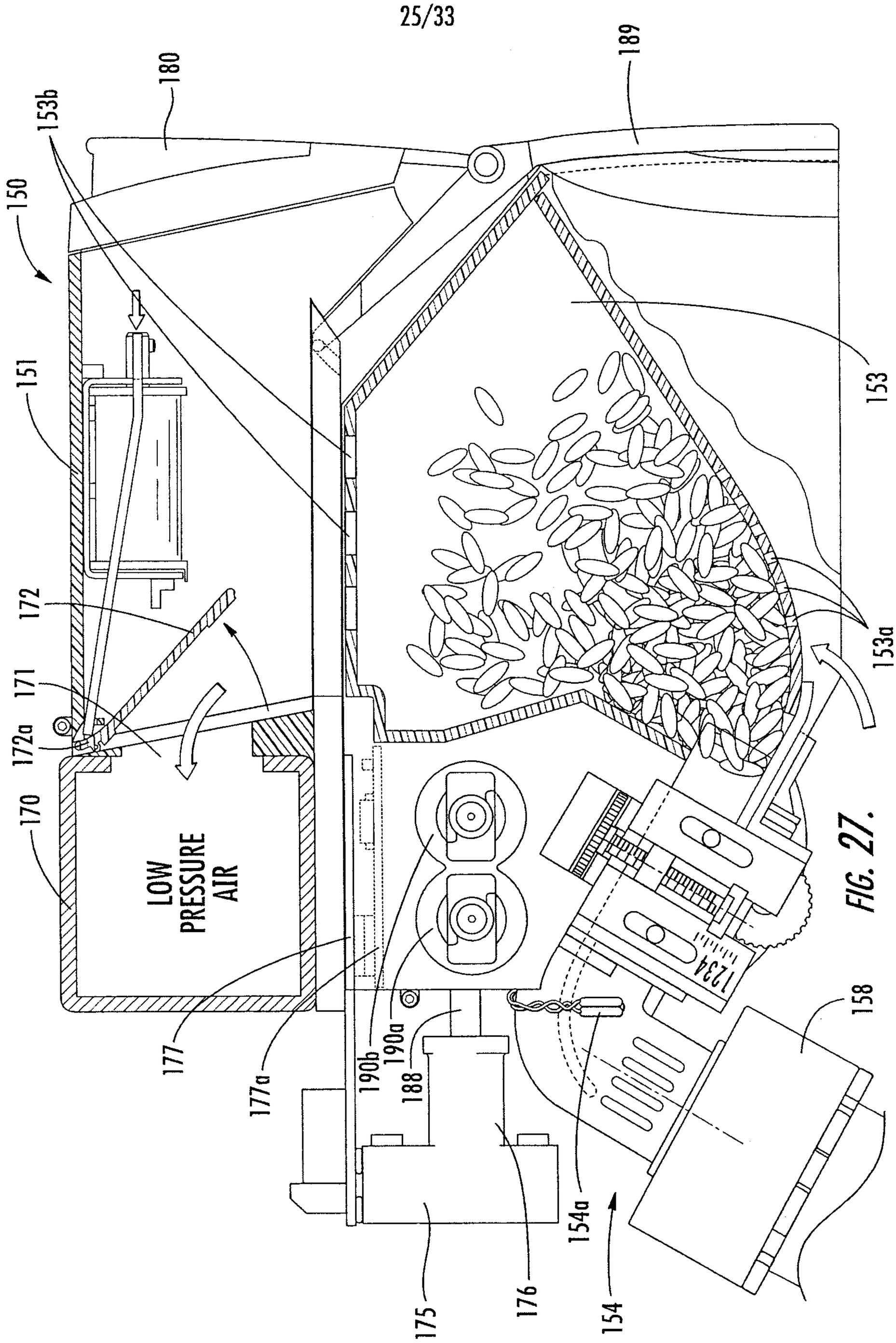


FIG. 27.

77203-76D

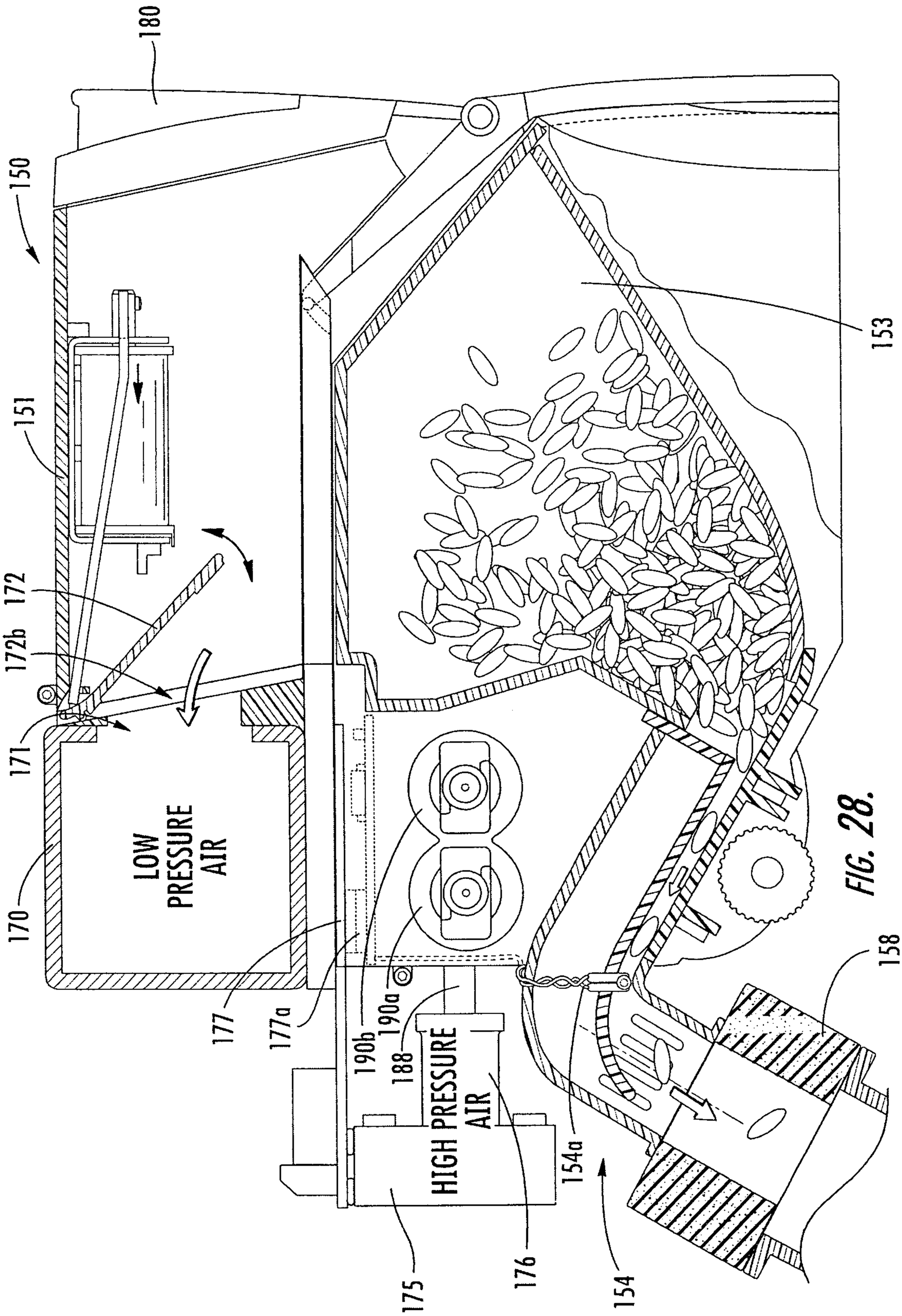


FIG. 28.

77203-76D

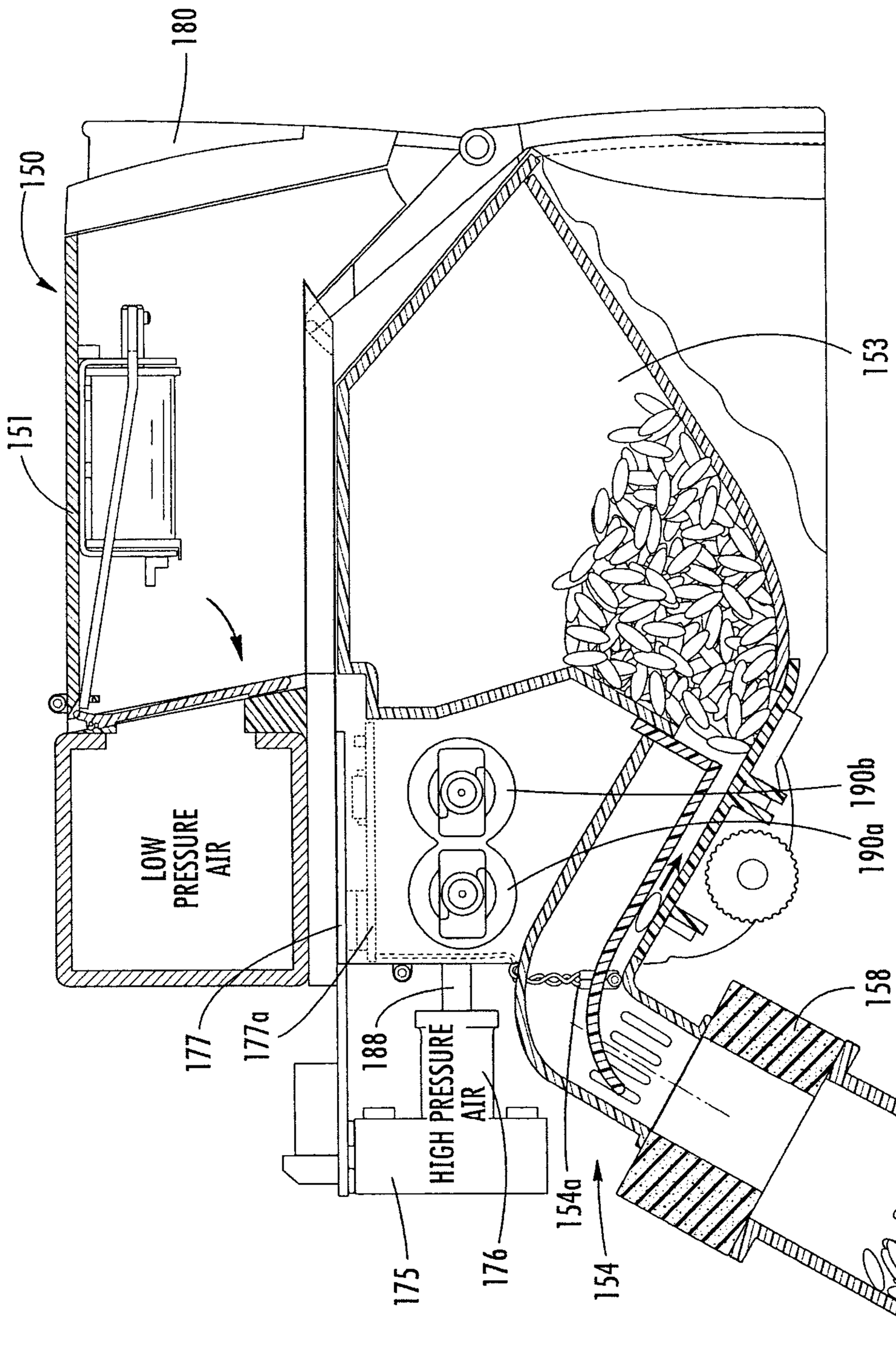


FIG. 29.

77203-76D

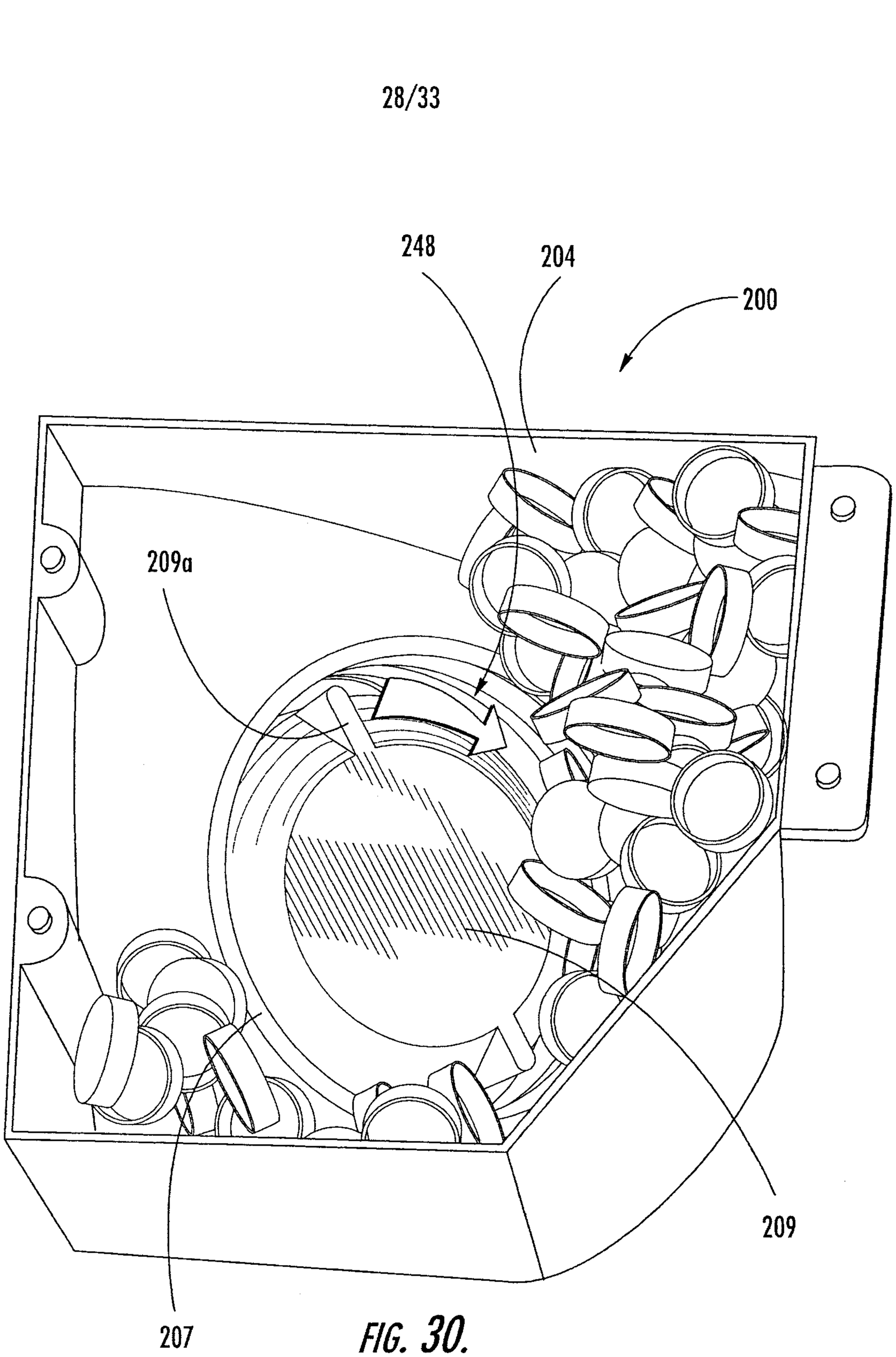


FIG. 30.

77203-76D

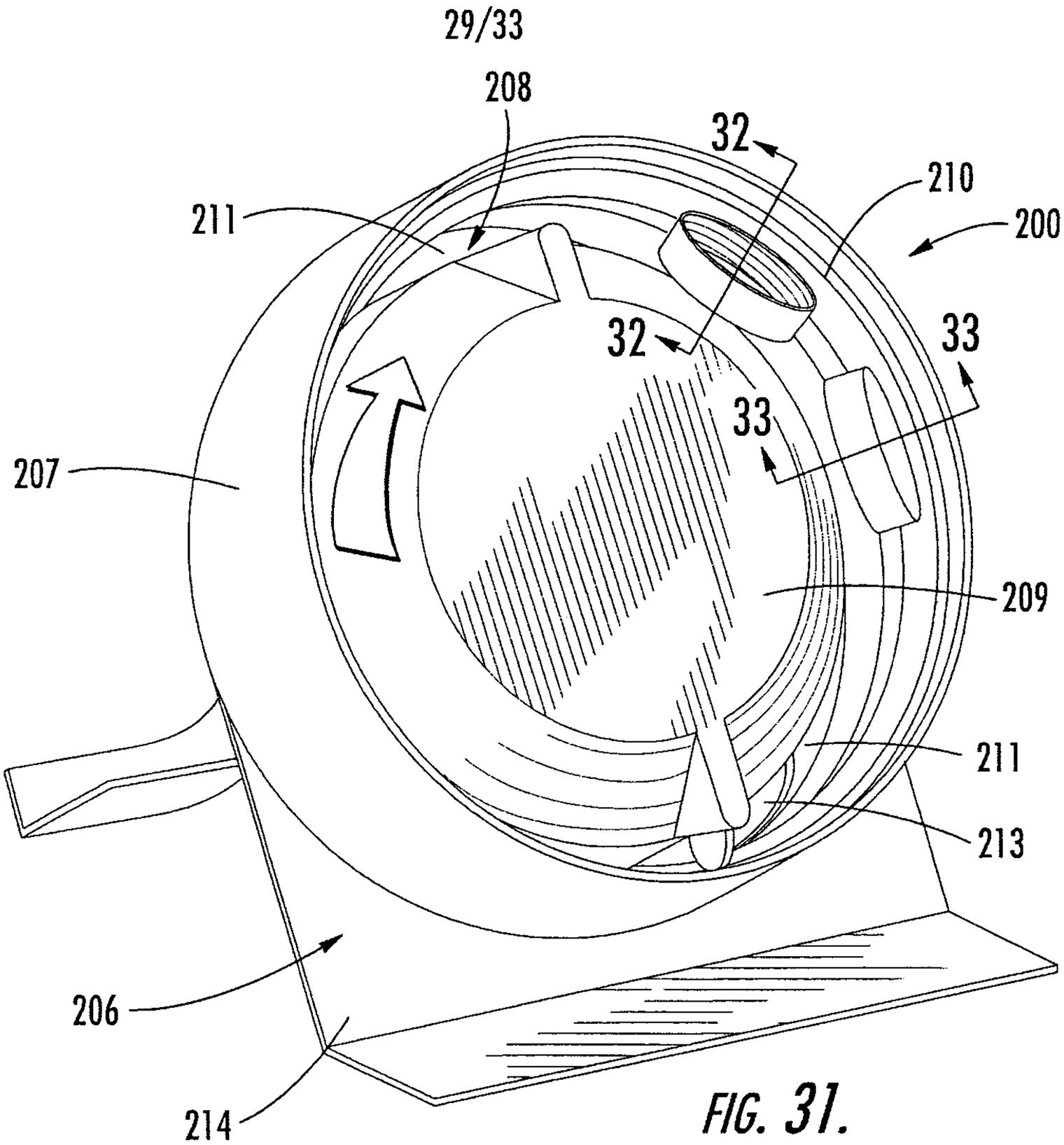


FIG. 31.

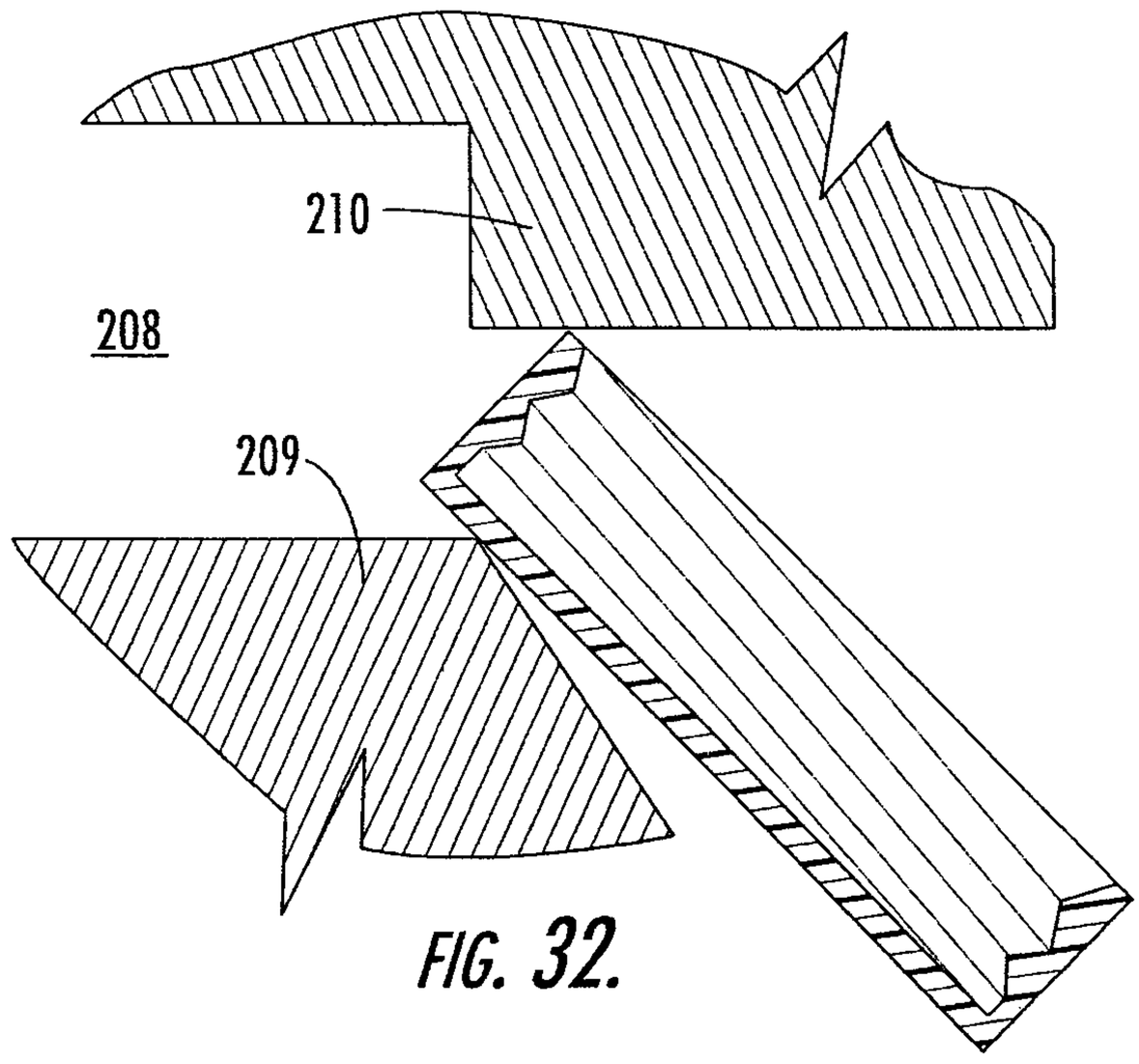


FIG. 32.

77203-76D

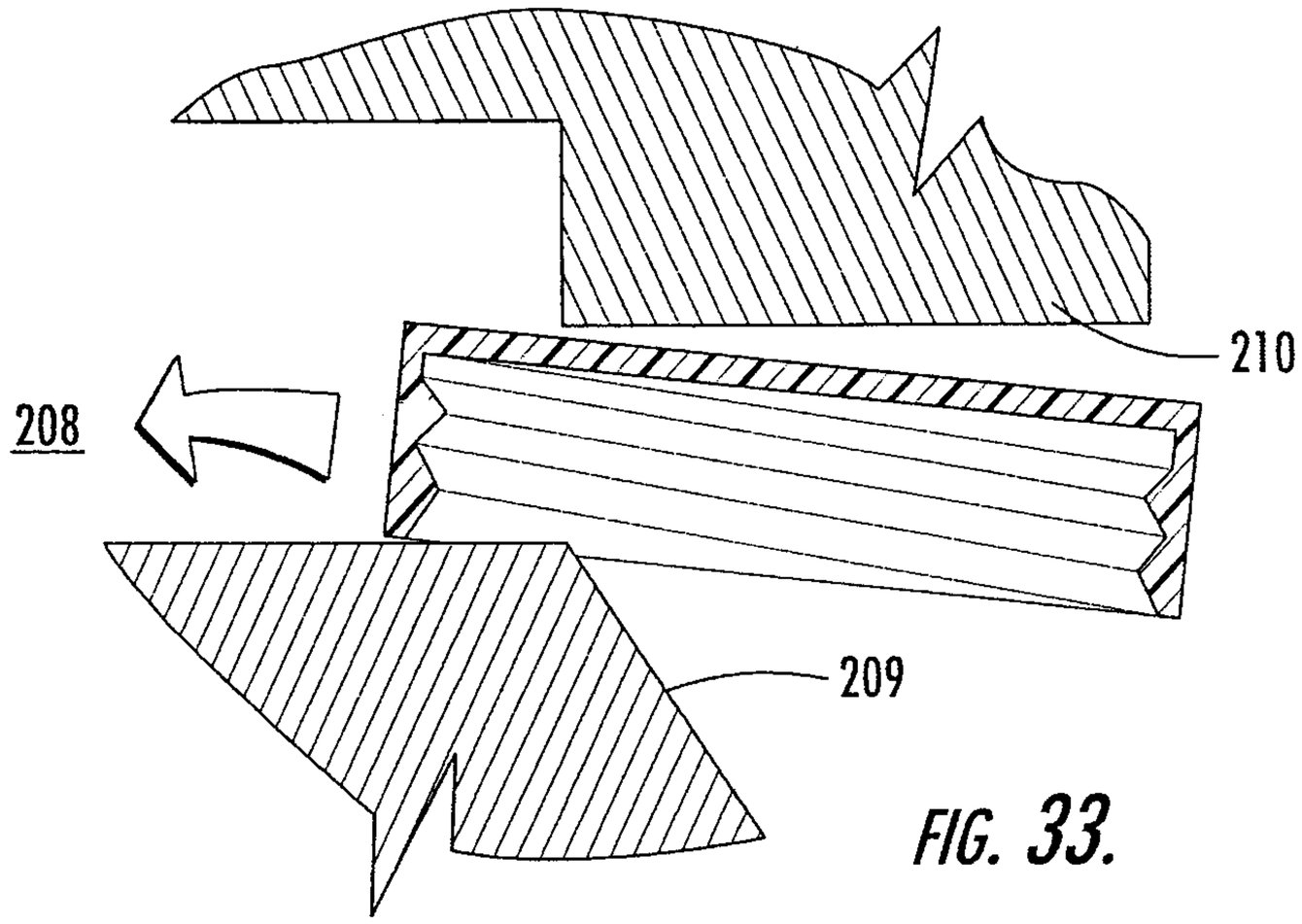


FIG. 33.

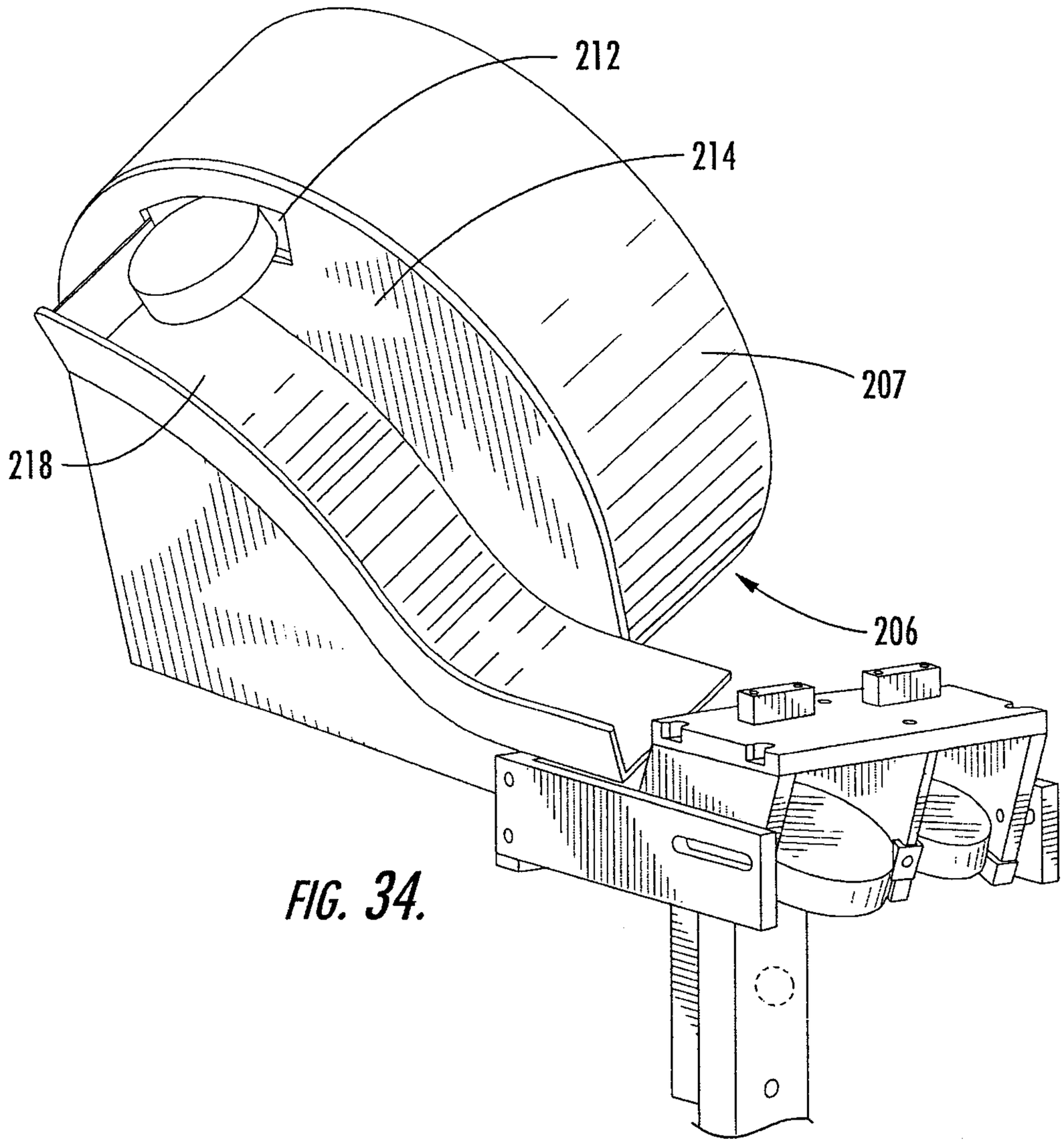


FIG. 34.

77203-76D

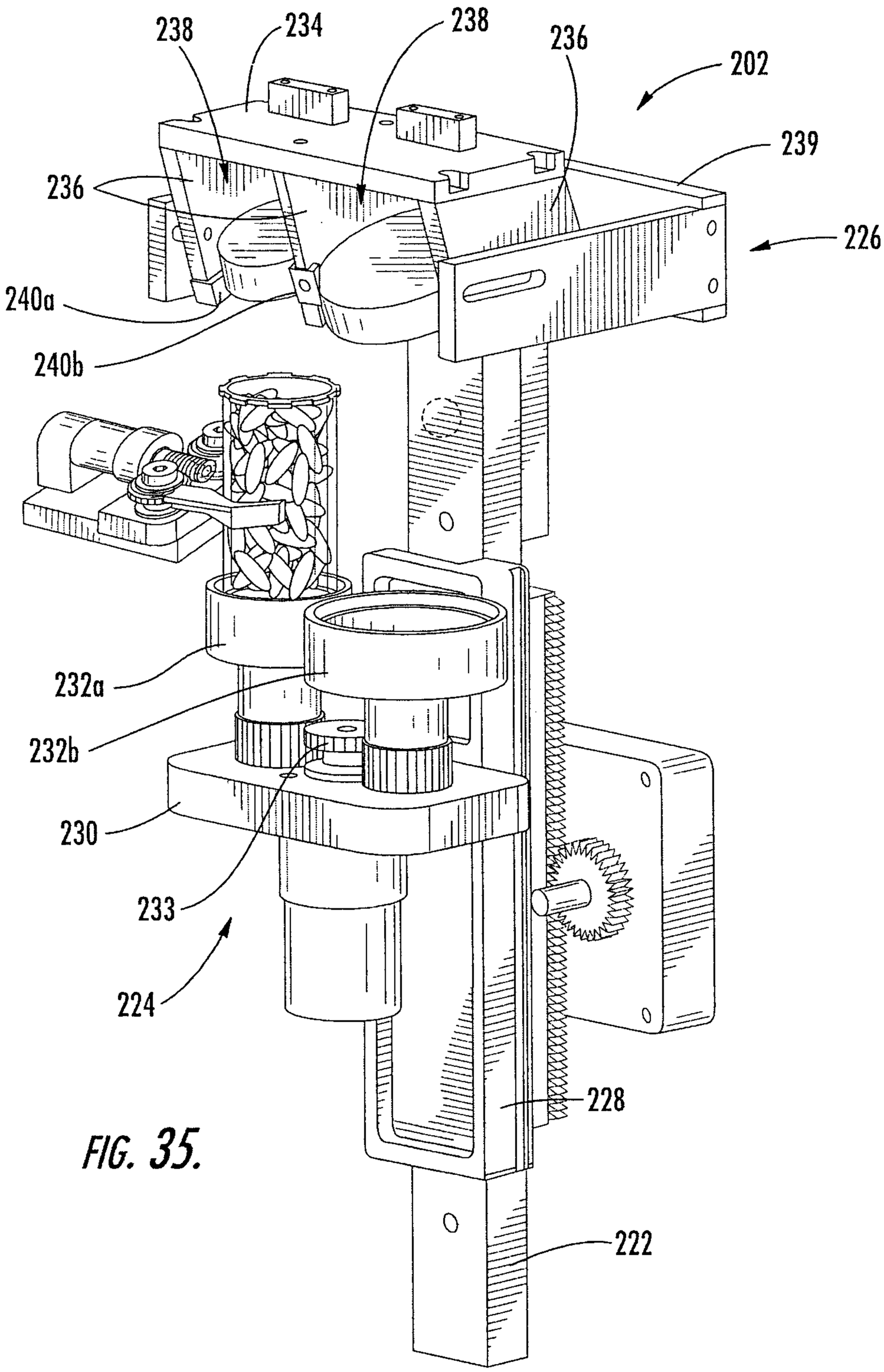


FIG. 35.

77203-76D

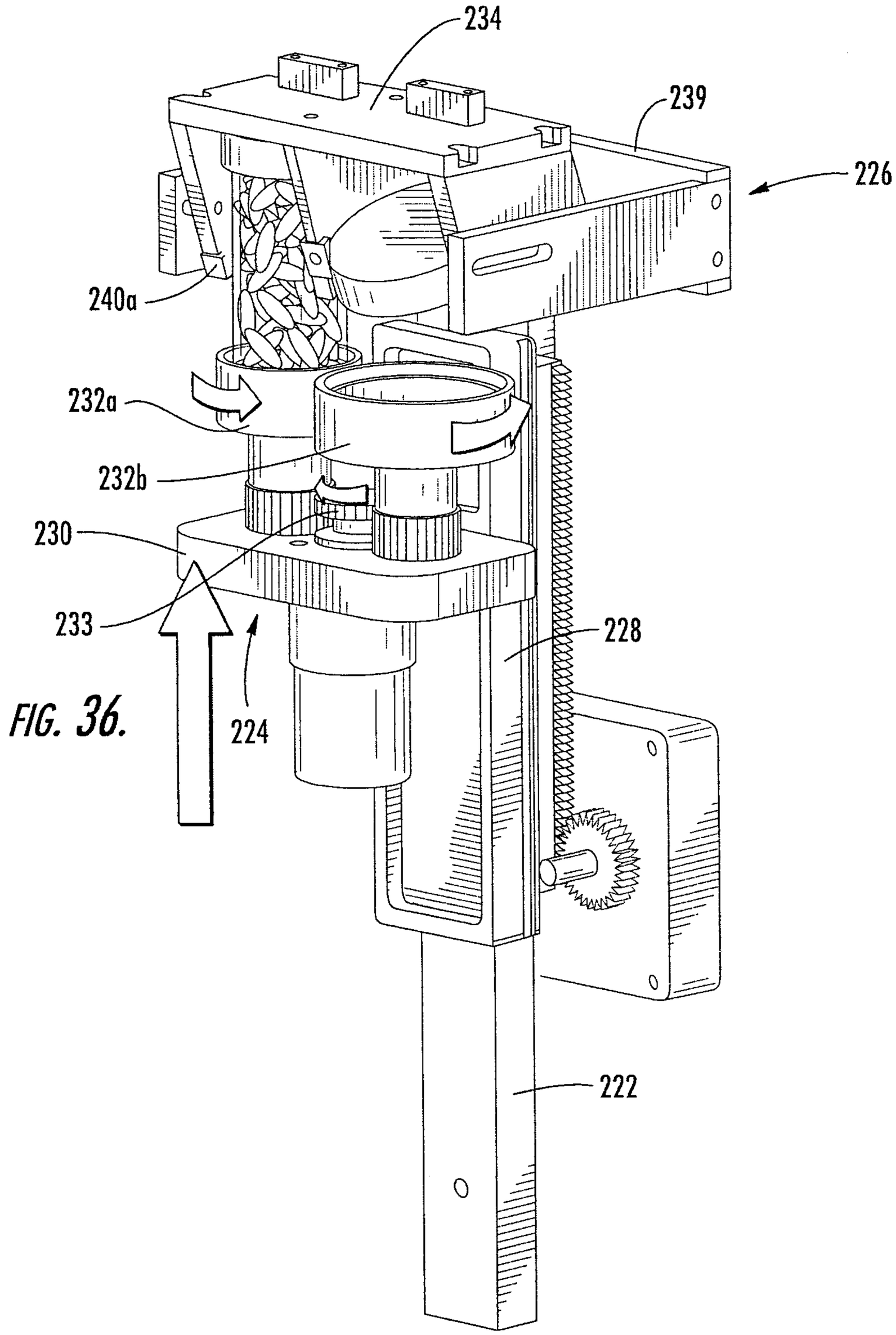


FIG. 36.

77203-76D

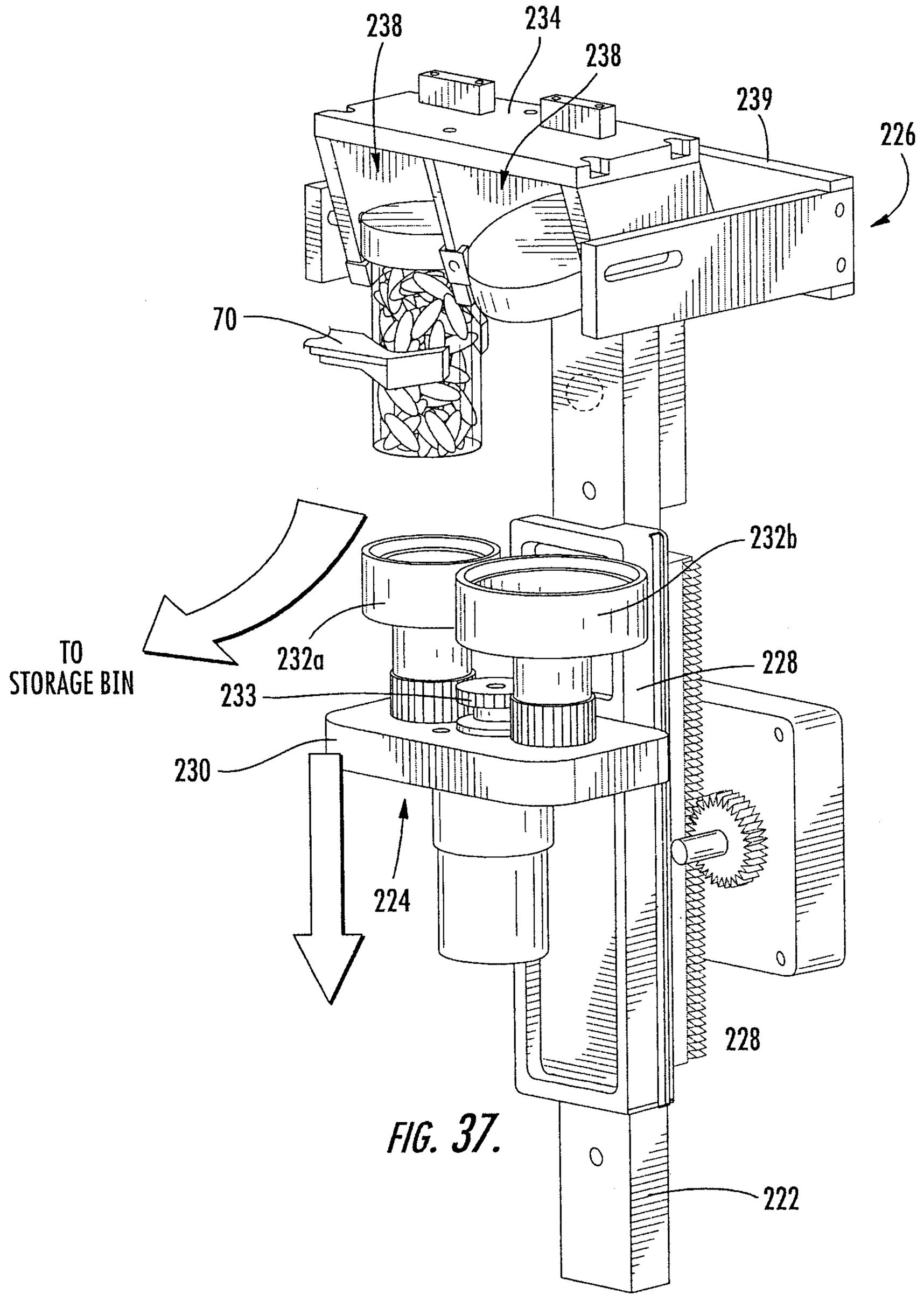
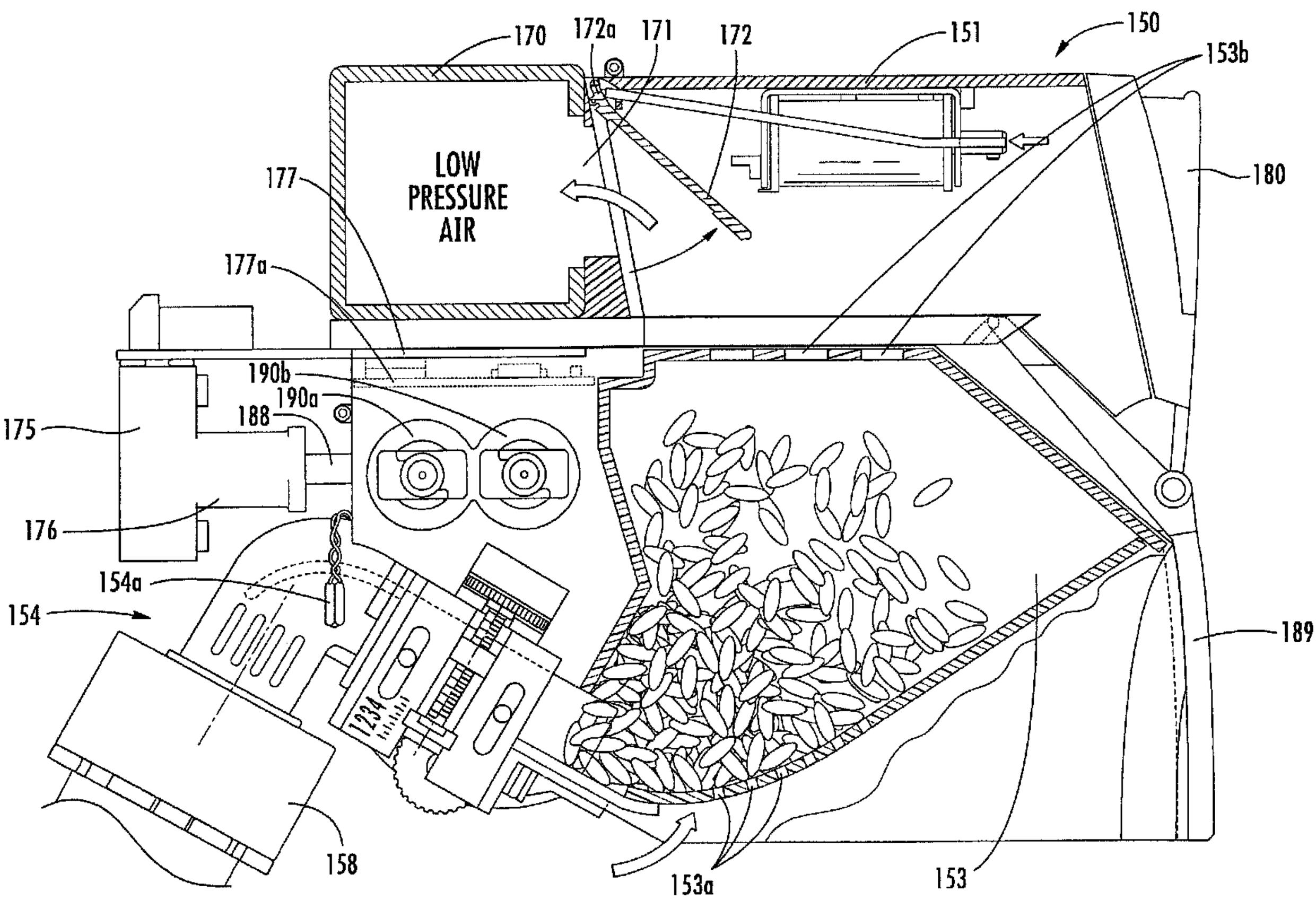


FIG. 37.


170
172a
171
172
151
150
153b
LOW
PRESSURE
AIR
177
180
177a
190b
190a
188
175
176
154a
154
1234
158
153a
153
189