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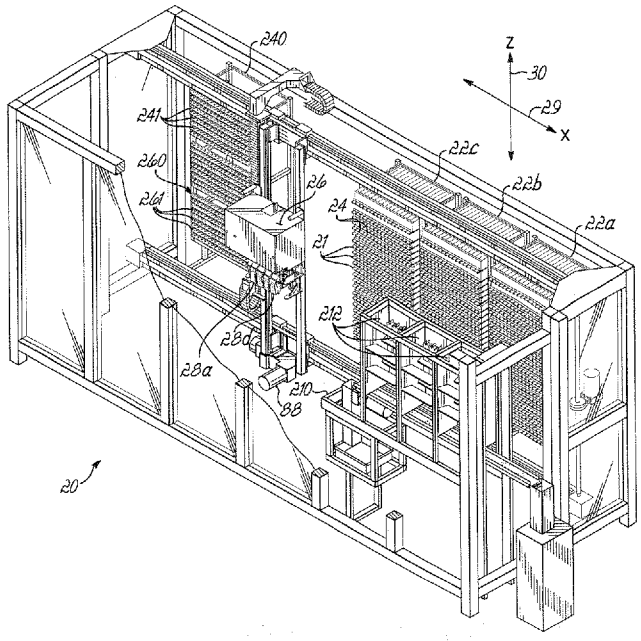
(54) Title: PHARMACEUTICAL PACKAGE DISPENSING SYSTEM



(57) Abstract: A pharmaceutical package dispensing system (20) that may be used to select and dispense multiple orders for pharmaceutical packages substantially simultaneously. The pharmaceutical package dispensing system (20) permits multiple individual pharmaceutical packages to be stored at a single location for reuse. The pharmaceutical package dispensing system (20) then automatically selects and bags those individual packages with packages cut from package strips to fill individual orders.

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PHARMACEUTICAL PACKAGE DISPENSING SYSTEM

Other Applications

[0001] This claims the benefit of U.S. Provisional Application Serial No. 60/883,419, filed on January 4, 2007. Another U.S. patent application with a common inventor and owned by the assignee of this application is U.S. Patent Application Serial No. 09/995,907, entitled Pharmaceutical Dispenser and filed on November 28, 2001. Each of these applications is hereby incorporated in their entireties by reference.

Technical Field

[0002] This invention relates generally to systems for distributing pharmaceutical products and, more particularly, to systems for distributing pharmaceutical products that utilize one or more automated dispensers and packaging machines.

Background

[0003] Hospitals and other health care facilities distribute and administer medications to patients in individual doses numerous times per day. Pharmaceutical products are often stored in bulk by pharmacies and are repackaged into containers based on individual prescriptions for retail or outpatient distribution. For inpatient or in-facility distribution, pharmacies also often repackage bulk pharmaceuticals into "unit of use" or "unit dose" packages, for example, blister packs that are connected together in a strip. The traditional method for distributing individual dosage units of medication to patients begins with the generation of a patient order by a physician for particular medications. The patient order is delivered to the pharmacy. There, the process of interpreting the patient order, pulling the specified medication from the drug storage areas, packaging the medication, and labeling the package is routinely done manually by pharmacy support personnel. After a final check by the facility pharmacist, the packaged individual dosage units are ready for distribution. In large facilities, the packages containing the patient's order are forwarded to individual nursing units where nursing staffers distribute and administer them to the patients.

[0004] There are several disadvantages associated with the traditional method of distributing individual dosage units of medication. To begin with, the process is labor and cost intensive. Many separate labor steps are required to fill a single patient order. In large facilities servicing hundreds of patients each day, the staffing requirements to rapidly process patient orders may be substantial. In addition, with so many human inputs required for the existing process, there may also be risk of human error.

[0005] One known pharmaceutical package dispensing system is described in U.S. Patent Application Serial No. 09/995,907 entitled Pharmaceutical Dispenser and automates various aspects of the task of filling patient orders for unit of use pharmaceuticals. The system employs a plurality of storage cartridges arranged in stacked rows on a frame. The cartridges contain strips of unit of use packages of pharmaceutical products. The packages consist of individual blisters. Each of the blisters contains a unit of use, e.g., a single tablet or capsule. Several blisters are joined together to form the linear strips such that a given cartridge may contain several such strips stacked vertically. Each cartridge is provided with a forward-facing opening through which a portion of the lowermost blister strip contained therein projects. Multiple stacked pickheads are movable simultaneously, but each pickhead is movable only adjacent a respective row of cartridges in a horizontal direction. A pickhead is movable along its row to a desired location adjacent a cartridge and has an electronic eye to sense a presence and position of a given blister strip. The pickhead is operable to advance a blister strip out of the cartridge using an upwardly-projecting fork with two tines that engage the blister strip. A cutting blade mounted on the pickhead is operable to cut an individual blister from the strip. A cut blister is collected in a bin on the pickhead; and when the pickhead has finished picking blisters for the order, it discharges the blisters in the bin onto a tray. The tray serves as an accumulation point servicing multiple pick heads. The tray is moved up an inclined path by a cylinder driven slide to dump the blisters on the tray into a funnel of a packaging station. This dispensing system also may have another group of storage locations, wherein each storage location stores an individual unit of use blister, that is, not a blister strip. A second pickhead utilizes a suction pickup that is operable to engage one of the

individual unit of use blisters and move it directly to the bagging station. The second pickhead releases the one of the individual unit of use blisters onto a ramp that directs the blister into the bagging station funnel using gravity.

[0006] The drug dispensing machine described above has several disadvantages. To begin with, there is only one tray and discharge slide for the multiple pickheads. Therefore, a pickhead may have to wait for a tray to empty, which may reduce the picking efficiency of the pickheads and throughput of the dispensing machine. Second, the cartridge design can lead to difficulties when a given blister strip is engaged by the upwardly-projecting fork. The opening through which the blister strips project allows for significant lateral play by the strips. This can lead to misalignments with the cutting blade and instances where the fork misses the strip. A third disadvantage concerns the fixed tines of the fork. Fixed tines may be used on blister strips with a fixed range of dimensions. Those strips with dimensions falling outside of the range permitted by the fixed tines may not be successfully used with the machine. In addition, picking the individual unit of use blisters with a separate pickhead is costly and complicated and further, storing only a single individual unit dose blister at a single location limits the utility of the system.

[0007] Hence, there is a continuing need to improve a system of selecting and packaging medications to fill a medication order for individual patients.

Definitions

[0008] "Pickhead" means any device that is movable with respect to a storage grid of pharmaceutical packages and that is able retrieve a pharmaceutical package from the storage grid and transfer it to another location.

[0009] "Pharmaceutical package" means a package containing a pharmaceutical, and any reference to a pharmaceutical package is understood to also refer to the pharmaceutical contained therein.

[0010] "Individual pharmaceutical package" means a pharmaceutical package that is separate and not connected to another pharmaceutical package.

Summary

[0011] A pharmaceutical package dispensing system that automatically selects and collects pharmaceutical packages of medications for orders faster and more efficient than known systems. Further, the pharmaceutical package dispensing system may be used to select and dispense multiple orders of pharmaceutical packages of medications substantially simultaneously. In addition, the pharmaceutical package dispensing system permits multiple individual pharmaceutical packages to be loaded into the dispensing system at a single location. The pharmaceutical package dispensing system may then automatically select and dispense those individual pharmaceutical packages with pharmaceutical packages cut from strips to fill individual orders. The pharmaceutical package dispensing system may be especially useful in long term care and other facilities where a high volume of medications are required to be distributed to patients multiple times a day.

[0012] More specifically, in one embodiment, a pharmaceutical package dispensing system for dispensing pharmaceuticals has a module that supports pharmaceutical packages. A pickhead is movable with respect to the module in two nonparallel directions, and a picker on the pickhead is extendable and retractable with respect to the pickhead and is operable to remove pharmaceutical packages from the module. A plurality of bins are supported on, movable with respect to, the pickhead; and the picker is operable to transfer the pharmaceutical packages to one of the bins.

[0013] In one aspect of the pharmaceutical package dispensing system, the picker has a pickarm extendable and retractable with respect to the pickhead; and the pickarm has a sensor and a gripper supported on a distal end of the pickarm. The sensor is operable to detect a physical aspect or feature, for example, a leading edge, of the pharmaceutical package; and the gripper is commanded to close its jaws in response to the sensor detecting the aspect of the pharmaceutical package.

[0014] In a further aspect of the pharmaceutical package dispensing system, the pickhead is movable to a position adjacent a module supporting a pharmaceutical

package. The pickhead has a sensor for detecting a physical feature, for example, a hole, on the module to confirm that it is in the desired position with respect to the module. The pickhead is then further operable to remove the pharmaceutical package from the module.

[0015] In a still further aspect of the pharmaceutical package dispensing system, a first module is used to support strips of pharmaceutical packages; and a second module is used to support individual pharmaceutical packages. A single pickhead is operable to move to different locations with respect to the first and second modules and cut pharmaceutical packages from the strips in the first module and/or remove one or more individual packages from the second module. The cut and/or removed pharmaceutical packages are transferred to a bin on the pickhead.

[0016] In yet another aspect of the pharmaceutical package dispensing system, the pickhead has multiple bins mounted thereon, and each bin may hold a complete individual order of pharmaceutical packages. The pickhead is movable to the different locations with respect to the module and operable to remove different pharmaceutical packages. The different pharmaceuticals are transferred to the multiple bins in a manner consistent with the requirements of the respective multiple individual orders. When the orders are filled, the pickhead is operable to transfer the contents of the multiple bins to respective multiple discharge chutes. Thereafter, the multiple discharge chutes are individually operable to successively discharge the pharmaceutical packages of the multiple individual orders onto a conveyor in a timed relationship, such that multiple individual orders are separately transferred from the dispensing system and separately packaged.

[0017] In one more aspect of the pharmaceutical package dispensing system, a method is provided for receiving into a control a patient's daily pharmaceutical requirements in the form of multiple orders of pharmaceuticals to be taken by the patient during a 24 hour period. A pickhead is movable to successive locations adjacent pharmaceutical packages identified in the orders of pharmaceuticals, and the pickhead is operated at each successive location to remove pharmaceutical packages from the module. The pharmaceutical packages are then transferred to multiple bins supported on the

pickhead, wherein each bin may be assigned to hold one complete order of pharmaceuticals. The pharmaceutical packages in each of the multiple bins are then transferred, one at a time, to an output of the pharmaceutical package dispensing system. Thus, the multiple orders of pharmaceuticals can be successively collected in respective separate receptacles and provided to a caregiver together as a package representing a patient's daily pharmaceutical requirements.

[0018] These and other objects and advantages of the present invention will become more readily apparent during the following detailed description taken in conjunction with the drawings herein.

Brief Description of the Drawings

[0019] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the general description of the invention given above and the detailed description of the embodiments given below, serve to explain the principles of the present invention. In the drawings described below, reference numerals are generally repeated where identical elements appear in more than one figure.

[0020] Fig. 1 is a perspective view of an exemplary embodiment of a pharmaceutical package dispensing system.

[0021] Fig. 2 is a perspective view of an exemplary embodiment of an inventory module that has channels for holding strips of pharmaceutical packages to be dispensed by the pharmaceutical package dispensing system shown in Fig. 1.

[0022] Fig. 3 is a perspective view of an outer end of an exemplary embodiment of an inventory module channel shown in Fig. 2 into which a strip of pharmaceutical packages is loaded.

[0023] Fig. 4 is a perspective view of the exemplary embodiment of the inventory module channel of Fig. 2, which illustrates how strips pharmaceutical packages are layered in the channel.

[0024] Fig. 5 is an enlarged perspective view of inner ends of the exemplary embodiment of the inventory module channel of Fig. 2.

[0025] Fig. 6 is one an exemplary embodiment of a multiaxis drive system for a pickhead used in the pharmaceutical package dispensing system shown in Fig. 1.

[0026] Fig. 7 is a partially disassembled perspective view of an exemplary embodiment of a pickhead used in the pharmaceutical package dispensing system shown in Fig. 1.

[0027] Fig. 8 is a partial perspective view of an exemplary embodiment of a pickhead positioned adjacent the opposite end of the inventory module channel of Fig. 2.

[0028] Fig. 9A is a side elevation view of an exemplary embodiment of a pickarm and gripper mounted on the pickhead of Fig. 7.

[0029] Fig. 9B is a side elevation view of an exemplary embodiment of a cutter mounted on the pickhead of Fig. 7.

[0030] Fig. 10 is a partial perspective view of a transfer station usable in the pharmaceutical package dispensing system of Fig. 1.

[0031] Fig. 11 is a partial perspective view of an individual pharmaceutical package return module usable in the pharmaceutical package dispensing system of Fig. 1.

[0032] Fig. 12 is a first perspective view of an exemplary embodiment of a multipackage return rack usable with the pharmaceutical package dispensing system of Fig. 1.

[0033] Fig. 13 is a cross-sectional view taken along the line 13-13 in Fig. 12.

[0034] Fig. 14 is a second perspective view of an exemplary embodiment of a multipackage return rack usable with the pharmaceutical package dispensing system of Fig. 1.

[0035] Fig. 15 is a general schematic diagram of an exemplary embodiment of a control system usable with the pharmaceutical package dispensing system of Fig. 1.

[0036] Fig. 16 is a flow chart of an exemplary process for loading pharmaceutical package strips into the pharmaceutical package dispensing system of Fig. 1.

[0037] Figs. 17A and 17B are flow charts of an exemplary process for operating a pickhead to pick pharmaceutical packages from an inventory in the pharmaceutical package dispensing system of Fig. 1.

[0038] Fig. 18 is a flow chart of an exemplary general process of resolving a detected error condition in the pharmaceutical package dispensing system of Fig. 1.

[0039] Fig. 19 is a flow chart of an exemplary process of using a pickhead to search for pharmaceutical packages at an inventory location in the pharmaceutical package dispensing system of Fig. 1.

[0040] Fig. 20 is a flow chart of an exemplary process for scanning a return module containing individual pharmaceutical packages in the pharmaceutical package dispensing system of Fig. 1.

[0041] Fig. 21 is a flow chart of an exemplary process for operating a pickhead to pick individual pharmaceutical packages from a return module in the pharmaceutical package dispensing system of Fig. 1.

[0042] Fig. 22 is a flow chart of an exemplary process of a transfer station operation in the pharmaceutical package dispensing system of Fig. 1.

[0043] Fig. 23 is a general schematic diagram of another exemplary embodiment of a system utilizing the pharmaceutical package dispensing system of Fig. 1.

Detailed Description

[0044] Referring to Fig. 1, an exemplary embodiment of a pharmaceutical package dispensing system 20 includes a plurality of substantially similar inventory modules 22a, 22b, 22c. Each module has stacked rows 21 of substantially similar channels 24; and each channel supports one or more unit dose strips of blisters or packages of a pharmaceutical to be dispensed by the system 20. Thus, the rows 21 of channels 24 form a grid of points or locations at which the strips of unit dose pharmaceutical packages are stored. The dispensing operation is executed by a pickhead that is movable by a multiaxis positioning system 88, which moves the pickhead 26 in mutually perpendicular X and Z axes of motion as represented by the arrows 29, 30, respectively. Upon picking or removing a first unit dose pharmaceutical package from a channel, the pickhead 26 is operative to deposit the first unit dose in one of four pickhead bins 28a-28d. In this application, each of the pickhead bins 28a-28d may be sufficiently large to hold a complete individual order of pharmaceuticals, that is, a number of unit dose pharmaceutical packages that are to be administered to an individual at one time, that is, during a single med pass. Thus, with the four pickhead

bins 28a-28d, the pickhead 26 and dispensing system 20 may be operated to simultaneously fill four complete orders of unit dose pharmaceutical packages.

[0045] After all orders are filled, the pickhead 26 moves to one of the output queues 212 of a transfer station 210. As shown in Fig. 10, each output queue 212 is substantially identical and has four discharge chutes 214a-214d that correspond in number and spacing to respective pickhead bins 28a-28d. The four individual orders of unit dose pharmaceutical packages in the pickhead bins 28a-28d are simultaneously transferred into corresponding discharge chutes 214a-214d of the transfer station 210. Thereafter, doors 215a-215d on respective discharge chutes are successively opened; and the four individual orders of unit dose pharmaceutical packages are successively dropped onto a conveyor 228 that transports the individual orders to a bagging station 222. The bagging station prints a label on a bag identifying its contents and seals the bag with its individual order of unit dose packages therein, in a known manner. The bags of individual orders may then be distributed to patients.

[0046] Referring to Fig. 2, inventory module 22a, which is typical of modules 22b, 22c, has stacked rows 21 of substantially similar channels 24 that are supported on a module frame 46. Referring to Fig. 3, unit dose pharmaceutical packages 66, for example, blister packs, are connected end to end to form a unit dose strip, for example, strips 64a, 64b. Each unit dose package 66 has opposed side edge flanges 68, 70; and one or more unit dose strips 64a, 64b is loaded into a channel 24, so that a unit dose blisters 72 extend downward in the channel 24. Referring back to Fig. 2, the rows of channels 21a and 21b have a different height than other rows of channels, for example, row 21c. Thus, if there are pharmaceuticals that, on average, are distributed in greater volume, more strips of those pharmaceuticals may be loaded in the rows of channels 21a and 21b. Thus, the sizes of the channels 24 may be customized to optimize the inventories of pharmaceuticals depending on their average usage.

[0047] As shown in Fig. 3, each channel 24 has a rear cover or door 74 at a rear or outer end that may be hinged to the channel 24. Upon opening the cover 74, a bar code label is exposed behind the cover 74 as represented by the bar code label 84. The bar code label 84 is mounted on an upward extending flange 80 and contains data

identifying a location of an associated channel 24 in the module 22a. Using a bar code reader 319 as shown in Fig. 15, a user scans a bar code label 84 of the open channel and also scans a bar code 146 on the unit dose strip 64a to be loaded. The bar code reader 319 is a hand held device that generally may have one or more user input devices and a display screen that displays messages and may or may not have a facility to accept user inputs. In a process to be more fully described with respect to Fig. 16, a programmable control 310 (Fig. 15) confirms that the correct unit dose strip is being loaded in the correct channel, and then, the user inserts a first unit dose strip 64a through a channel opening 76. The strip 64a is generally pushed the length of the channel 24 as shown in Fig. 4 until, as shown in Fig. 3, a rear flange 75 of the strip 64a is moved past an upward extending channel flange 80. A guide tab 78 may be used to facilitate sliding the unit dose strip 64 over an upward extending flange 80 and into the channel 24. Thereafter, a second unit dose strip 64b may then be stacked over unit dose strip 64a and also located with respect to channel flange 80; and if desired, additional unit dose strips may be loaded depending on the size of the channel 24. The rear cover 74 is then closed covering the bar code label 84, and the contents of the channel 24 may be visually inspected by means of a slot 82 in the door 74. Placing the bar code label 84 behind the door 74 has an advantage of making sure that only one label, and the correct label, is being read by the user operated bar code reader 319. The rear loading of the new inventory modules 22 permits the modules to be loaded and serviced while the pickhead is executing a picking cycle. Thus, the dispensing system 20 does not have to be turned off while the modules are being loaded or otherwise serviced.

[0048] Referring to Fig. 5, viewing the channels 24 from their forward or inner ends, each channel 24 is generally U shaped with opposed lower, inner side walls 48, 50 extending generally upward from, and perpendicular to, lateral edges of a base 61. The side walls 48, 50 have respective top surfaces 52, 54 that extend laterally outward from, and are generally perpendicular to, the respective side walls 48, 50. A pair of resilient members 56, 58, for example, a leaf springs, are connected at respective proximal ends to the channel 24. The resilient members 56, 58 have respective distal ends that

contact, and apply a biasing force against, respective top surfaces 52, 54. Upper, outer side walls 60, 62 are generally perpendicular to, and extend upward from outer, lateral edges of, the top surfaces 52, 54.

[0049] Upon being loaded from the channel outer or rear end as shown in Fig. 3, the unit dose strip 64 extends through and interior of the channel 24 with side flanges 68, 70 sliding over respective top surfaces 52, 54. Lateral motion of the unit dose strip 64 in the channel 24 is limited by the outer side walls 60, 62 containing respective side flanges 68, 70. Blisters 72 move between the lower side walls 48, 50. Upon reaching the inner end of the channel 24, the side flanges 68, 70 move between respective top surfaces 52, 54 and opposed respective resilient members 56, 58 to a position that permits the bar code 146 to be read.

[0050] Referring to Fig. 6, the pickhead 26 is moved to different positions in front of the channels in the modules by a multi-axis positioning system 88. The positioning system 88 is operable to move the pickhead 26 in two nonparallel, generally perpendicular directions, as indicated by the X-axis and Z-axis direction arrows 29, 30, respectively. An X-axis drive system 90 is mounted to frame members 92 shown in phantom and includes a servodrive 94, drive shaft 96 and drive belts 98a, 98b coupled to the ends of the shaft 98. A gantry or carriage 100 is connected near its ends to the drive belts 98a, 98b and is moveable bidirectionally in the X-axis 29 by operation of the servodrive 94. A Z-axis drive system 102 has a servodrive 104 and a driving member that is not shown but is located within the housing 106. The driving member may be a drive screw, a drive belt or other known driver suitable for moving the pickhead 26. A driven member 108 is mechanically coupled to the driving member and is moveable bidirectionally in the Z-axis 30 with respect to the housing 106 by operation of the servodrive 104. A pickhead mounting plate 109 is connected to the driven member 108 by fasteners or other suitable means in a known manner.

[0051] Referring to Fig. 7, the pickhead 26 is made up of a cutter subassembly 126, a picker subassembly 128, a pickhead chute subassembly 130 and a pickhead bin subassembly 132. The picker 128 has a pickarm motor 134, for example, a stepper motor, servomotor or other comparable motor, mechanically connected via a drive belt

136 to a drive screw 138. The drive screw 138 is operative to bidirectionally translate a driven element, for example, a nut, (not shown), in a known manner. The driven element is connected to a pickarm slide 140 that supports a pickarm 142, which, in turn, has gripper 144 mounted on its distal end. Thus, the motor 134 is operable to move the pickarm 142 and gripper 144 bidirectionally in a Y-axis of motion as indicated by the arrow 149.

[0052] Referring to Fig. 15, the pharmaceutical package dispensing system 20 has a programmable control 310 that is connected to the various input and output devices on the dispensing system 20. The dispensing system control 310 is comprised of one or more programmable controls that are centrally located or distributed throughout the dispensing system 20. The control 310 has a pickhead control portion 312 that has the necessary hardware and/or software to operate the pickhead in the manner described. The control 310 further includes a dispensing system database 316 that in an exemplary embodiment is structured with multiple data tables. Exemplary tables include a first table that may contain the details of orders to be picked, for example, the identity of the patients/residents, the identities and quantities of the pharmaceuticals to be included in each order and other data. Another table may contain detailed information relating to each of the pharmaceuticals that may be included in the orders, for example, the pharmaceutical name, a pharmaceutical strength, the pharmaceutical form and other data. A further table may contain, for example, a map of all locations in all the modules, the identity of the pharmaceuticals to be contained therein, a bar code and other data. Another table may contain data associated with the bar code, for example, the expiration date, the verification code and other data. Other tables and data may also be implemented depending on the application. Thus, the database 316 contains the composition of the orders to be filled, all of the necessary information relating to the pharmaceuticals being used to fill the orders and the locations of the pharmaceuticals in the modules.

[0053] The dispensing system control 310 is in communications with, and receives data relating to the individual orders and the pharmaceuticals from, a pharmacy information computer system 311. The locations of the pharmaceuticals in the new inventory

modules 22 are determined and entered into the database using user I/O 322 or from another computer 336 operated by the user. The information in the database 316 is then used by the control 310 to control dispensing system operations.

[0054] For example, referring to Figs. 3 and 16, in a process of loading the unit dose strip into a channel 24 of module 22a, the control 310 determines at 400 whether a user has scanned a channel bar code 84 located behind a door 74. Thereafter, at 402, the control 310 waits for the user to scan bar code 146 on the strip to be loaded into that channel. The control 310 compares, at 404, the two bar code readings to data in the database 316 to determine whether the unit dose strip is the correct pharmaceutical for that module location. In addition, the control 310 determines, at 406, whether the expiration date has expired and further, at 408, checks for the presence of a pharmacist's verification code. If the pharmaceutical is correct for the location, the expiration date is not expired and a pharmacist's verification code is detected, the control 310 provides, at 412, a message instructing the user to load the unit dose strip into the channel 24.

[0055] If any of the above checks fail, the control 310 executes an error subroutine shown in Fig. 18. This error subroutine will vary, as will be described, for different error conditions. In the current situation, the control 310 first determines, at 350, whether the error is one that may be automatically recovered. For example, all of the error conditions in Fig. 16 arise from the bar code being manually scanned at 402 by the user; and there is nothing the control 310 can automatically do to correct those errors. Therefore, the control 310 creates, at 358 of Fig. 18, an error message identifying the error condition and requesting a user action. The user may check the strip to see if it is the right one and/or scan the bar code again. Thereafter, the user may, at 360, provide a retry input, afterwhich the control will retry the action at 354; and if the error is fixed, the control, at 370, returns to a test condition passed and provides, at 412 of Fig. 16 a message to load the strip. If the error is not fixed, the above process is repeated until the error condition is cleared.

[0056] A picking cycle program 318 utilizes a robot control 313, for example, a programmable computer, and information in the database 316 to generate motion

commands to the pickhead X-axis and Z-axis servodrives 90, 102 to move the pickhead 26 to a desired channel. Thereafter, a pickhead control 312, for example, a programmable logic controller or other programmable control, operates the pickhead in a desired manner to remove a desired unit dose package from the channel and deposit it in one of the pickhead bins 28a-28d.

[0057] Referring to Figs. 6, 7, 8 and 17A, to initiate a picking operation, the control 310 first, at 450, identifies a module location in which the next pharmaceutical in the current order is located. If the control 310 determines, at 452, the module location is not in a return channel to be subsequently described but in a channel 24 of a new inventory module 22, the control 310 then commands, at 456, the positioning system 88 to move the pickhead 26 to a location in front of a channel 24. At the end of the positioning cycle, the system pauses or dwells briefly to permit structural vibrations to settle. Then, a first sensor 110, for example, a digital laser sensor or other photoelectric sensor, is used, at 458, to check whether the pickhead 26 is accurately positioned with respect to the channel. The sensor 110 is directed toward a registration feature 112, for example, a hole in a forward wall 114 of the module 22a. The control 310 uses a feedback signal from the sensor 110 to confirm whether the pickhead 26 is in its desired position. If the sensor 110 detects that the pickhead 26 is not at the desired position, the control 310 executes, at 460, the error subroutine of Fig. 18.

[0058] The control 310 first determines, at 350, whether the error is one that may be automatically recovered. For example, it is possible that the positioning error may be cleared by again attempting to move the pickhead to the desired channel location. In addition, the control 310 has the capability, at 356, to retry the repositioning move any number of times. The number of retries will differ depending on the error condition. In this example, the control 310 would, at 352, again execute the move called for in step 456 of Fig. 17A. The control 310 may or may not move the pickhead a small distance away from its current position before retrying the move. The sensor 110 is again checked; and at 354, the control 310 determines whether the error is fixed, that is, whether the pickhead is accurately positioned. Thereafter, control 310 has the capability, at 356, to retry the repositioning move any number of times. The iteration of

the retry action will differ depending on the error condition. If the error condition is removed by the above process, the control 310 proceeds, at 370, to continue the picking process at step 461 of Fig. 17A. If the error condition remains unresolved after a maximum number of retries as determined at 456, the control 310 then, at 358, provides an error message to the operator identifying the error condition, pauses the operation of the pickhead and requests action by the user.

[0059] At this point, the user has several options. For example, the user may be able to determine the source of the error and fix it. After fixing the problem, the user would enter, at 360, a retry input; and the control 310 would retry the action at 352 and again, attempt to move the pickhead to the desired channel position. If the sensor 110 determines that the pickhead is accurately positioned, the error condition is determined, at 354, to be fixed; and at 370, the control returns to the picking process of Fig. 17A continues.

[0060] Alternatively, the user may provide, at 364 of Fig. 18, a condition fail input, which at 366, cause the control 310 to indicate in the database 317 that the module location is being skipped. Further, the pharmaceutical is identified as not picked, and the order is identified as being an exception or incomplete. The control 310 then returns to step 450 of Fig. 17A to identify the next pharmaceutical to be picked. The order exception status is tracked throughout the process, and the bagged order of pharmaceuticals is labeled as an exception and shunted by a bagging station to an exceptions collector. The order exception may then be manually completed. Alternatively, the pickhead 26 may subsequently be operated to pick only the missing pharmaceutical or completely repick the whole order. In the latter example, the first picked pharmaceuticals in the exception or incomplete order may be placed in a return module to be subsequently described.

[0061] As a further option, the user may provide, at 368 of Fig. 18, an ignore error condition input. Upon inspection of the system, the user may determine that ignoring the error is not detrimental to the picking operation; and therefore, the control 310 may, at 370, continue the operation as if the pickhead were determined to be accurately positioned. Using this option, the control would continue the process at step 461 of Fig. 17A.

[0062] In another exemplary embodiment, if the control 310 determines, at 356. that the error condition cannot be automatically resolved, the control 310 may then identify another channel in module 22 with the same pharmaceutical; and the pickhead 26 may be moved to that other channel. Again, a test is made, at 458, to determine whether the pickhead 26 is accurately positioned. If an error condition still persists, the control 310 would proceed to steps 358-370 as described above.

[0063] When a channel 24 is loaded with a unit dose strip 64 by a user, the exact position of a leading unit dose package 66a is not known to the pickhead 26; and most probably, the unit dose package 66a is not located in an engaged position permitting its bar code 146 to be read by bar code reader 147. Therefore, if the sensor 110 determines that the pickhead 26 is accurately positioned, the control 310 moves, at 461, a desired bin to a receiving position on the pickhead 26. Next, at 462, a sensor 116, for example, a diffusive reflective laser or other photoelectric sensor, determines whether a unit dose, for example, package 66a is present. If the sensor 116 does not detect a unit dose package, the control 310 initiates, at 464, a picker search subroutine shown in Fig. 19, which uses the picker 128 to search for and locate the leading package 66a.

[0064] Referring to Figs. 8, 9A and 19, the control 310 activates, at 500, a pickarm motor 134 to rotate the drive screw 138 and extend the pickarm 142 and gripper 144 outward toward the channel 24. A V-block 148 is mounted at the distal end of the pickarm 142 generally in parallel with the gripper 144. The V-block 148 has opposed angled walls that form a V-shaped opening, which is generally the same shape as, and parallel with, an open state of jaws of the gripper 144. A sensor 150, for example a photoelectric sensor, is mounted in an angled wall of the V-block opening and is effective to detect a presence of an object, for example, the leading edge 118, between the V-block angled walls. Therefore, as the pickarm 142 and gripper 144 are moved toward the leading package 66a. Upon the sensor 150 detecting, at 502, the leading edge 118, the control 310 commands, at 506, the picker motor 134 to stop, and a gripper cylinder 151 to change state, thereby closing the gripper 144 over the leading flange of the package 66a. Any one of several known linkages and mechanisms may be used to open and close the gripper 144 with the cylinder 151.

[0065] After the sensor 150 detects the leading edge 118 and closes the gripper 144, the control 310 commands, at 508, the motor 134 to retract the pickarm 142 to a ready or engaged position, which places bar code 146 at a location permitting it to be read by bar code reader 147. In moving to the engaged position, the pickarm 142 pulls the unit dose strip 64 toward the pickhead 26 and beneath the biasing members 56, 58 (Fig. 5). When the package 66a is at the engaged position, the gripper 144 may interfere with reading the bar code 146. Therefore, generally simultaneously with the pickarm 142 achieving the engaged position, the control 310 commands, at 510, the gripper cylinder 151 (Fig. 9A) to open the gripper 144; and a return spring 153 biases the gripper 144 to an open position. Generally simultaneously with the gripper opening, the picker motor 134 is also commanded to further retract the pickarm 142 and gripper 144 a sufficient amount to first, permit the bar code reader 147 to read the bar code 146 (Fig. 8) and second, clear the shearing blades 122, 172 (Fig. 9B).

[0066] It should be noted that during the pickarm's initial search for a leading edge, the sensor 150 may fail to detect any edge. In that event, as shown at 504 in Fig. 19, the pickarm 142 may be extended through its full stroke; the gripper 144 is closed; and the pickarm is retracted to the engaged position.

[0067] The sensor 116 again, at 512, tests for the presence of a package, for example, package 66a. If the package present test fails, the control 310 again implements the error subroutine of Fig. 18; however, the process would be slightly different for this error condition. For example, assume that, at 350, this is not an error condition that is considered automatically recoverable. Therefore, the control 310 will create, at 358, an error message to the user, pause the operation and await a user input. The user may determine that the channel is empty, load the channel as previously described and at 360, enter a retry input. In this example, the control 310 will return to the beginning of the search routine and again, at 500, extend the pickarm. Presumably, the pickarm will bring a leading package of a strip to a position at which it is detected as present at 512.

[0068] Alternatively, the user may enter, at 364, a condition fail input; and the location is skipped as indicated at 366. As a further option, upon receiving the error message at 358 of Fig. 18, the user may, upon inspection, determine that a package is, in fact,

present and enter, at 368, an ignore input. The process would then continue at step 466 of Fig. 17A.

[0069] If the package is detected as present, the control proceeds to determine, at 466 of Fig. 17A, whether a bar code for this strip 64a was previously read and validated. Since this is the first package in the strip 64a, a prior validation has not occurred in the current picking cycle; and the control 310 proceeds to read, at 468, the bar code 146. Thereafter, the control 310 determines, at 470, whether the bar code 146 identifies a pharmaceutical in the leading pack 66a that matches the pharmaceutical called for by the order in the database 316. If not, the control 310 again executes the error subroutine at 472. The error subroutine of Fig. 18 will again vary slightly to match this particular error condition; however, it will be generally similar in its process to the error subroutine executions previously described. The failure of the bar code to match the order is not an error that can be automatically recovered; and therefore, the control 310 will provide an appropriate error message, pause the operation and await a user input.

[0070] If the control 310 determines, at 470 of Fig. 17A, that the bar code on the pharmaceutical package 66a matches that called for by the order in the database 316, the control 310 commands, at 474, the pickarm motor 134 to again extend the pickarm 142. If, at 476, a leading edge is not detected, the pickarm search subroutine 464 is again executed. Upon detecting the leading edge 118, at 476, using sensor 150, control 310 commands, at 478 of Fig. 17B, the pickarm 142 to stop. The control 310 then determines, at 479, whether the correct bin is in position. If not, the control 310, by a process to be subsequently described, moves, at 480, the correct bin below the discharge chute opening 188 (Fig. 7) and again, at 481, checks whether the correct bin is in position. If not, the control executes, at 482, the error subroutine of Fig. 18; and the subroutine is varies to match this error condition. For example, and incorrect bin position is an error that may be automatically corrected by attempting to reposition the bin one or more time. If that fails, an appropriate error message is created, the picking process is paused to await an operator input in a manner similar to that previously described.

[0071] If the correct bin is in position, the control commands, at 483, the gripper cylinder 151 to close the gripper 144 over the leading edge 118. The control 310 then commands, at 484, the picker motor 134 to pull the pickarm 142 and leading package 66a past the shearing blade 122. In this motion, the control 310 samples the output of sensor 120 (Fig. 8) to detect, at 485, a physical aspect of the package 66a, for example, a leading face 73b (Fig. 9B), at which point the control 310 commands, at 486 Fig. 17B, the pickarm motor 134 to move the pickarm 142 through an incremental displacement. The length of the incremental displacement and the speed of the pickarm are chosen so that, upon the pickarm 142 and unit dose package 66a coming to rest, it is in the proper position for being cut or severed from the strip. In an alternative embodiment, the control, at 480, may command a higher pickarm speed, so that upon the sensor 120 (Fig. 8) detecting a different physical aspect, for example, a space between the first and second unit dose packages 66a, 66b, the control 310 commands the picker servodrive to stop. The higher inertia of the pickarm 142 and unit dose strip 64 results in unit dose package 66a stopping at the desired position for cutting.

[0072] The control 310 then commands, at 487, the gripper cylinder 151 to open to release the leading package 66a; and the picker motor 134 is again commanded to further retract the pickarm 142 and gripper 144 to a retracted home position. Substantially simultaneously with the gripper being commanded to open, the control commands, at 488, the shearing blades 122 and 172 (Fig 9B) to pivot toward each other to cut or sever the leading package 66a from the unit dose strip 64.

[0073] As shown in Fig. 9B, the cutter subassembly 126 has an upper shearing blade 122 mounted on a distal end of an upper cutter arm 152 and a lower shearing blade 172 mounted on a distal end of a lower cutter arm 124. The upper shearing blade 122 is pivoted toward a lower shearing blade 172 by means of a pivot pin 154 that is fixed to the pickhead 26. A cutter link 155 pivotally connects a distal end of an actuator shaft 156 with the cutter arm 152. A first drive link 158 is pivotally connected between a fixed pivot 159 and a slot 160 in the actuator shaft 156. A second drive link 162 is pivotally connected between the slot 160 and a proximal end of the lower cutter arm 124. A proximal end of the actuator shaft 156 is pivotally connected by a clevis 164 to an axle

166. To operate the cutter, a piston 168 of a cutter cylinder 170 is moved to the right as viewed in Fig. 9B. As the actuator shaft 156 moves to the right, the upper cutter arm 152 is driven clockwise as viewed in Fig. 9A. Simultaneously, the pivoting motion of the drive links 158, 162 causes the lower cutter arm 124 to move counter-clockwise as viewed in Fig. 9B. The upper and lower shearing blades 122, 172 move toward each other; and as an edge of the upper shearing blade 122 passes an edge of the lower shearing blade 172, a unit dose package 66a is severed from the strip.

[0074] As the cutter arm 152 rotates clockwise, a kicker bar 174, which is resiliently mounted in the cutter arm 152, contacts a unit dose package prior to it being cut from the unit dose strip. Further, the kicker bar 174 is effective to kick a severed unit dose package downward into a pickhead chute 184 (Fig. 7). After the cutting action, a resilient bumper 176 (Fig. 8) contacts a bumper seat 178 to cushion the impact of the cutting motion on the upper and lower cutter arms 152, 124. At the end of the cutting stroke, the cylinder 170 is commanded to change state; and the piston 168 is moved to the left as viewed in Fig. 9B. A compression spring 180 is effective to move the actuator shaft 156 to the left as viewed in Fig. 9B, thereby separating the distal ends of the upper and lower cutter arms 152, 124.

[0075] Referring to Fig. 7, after being severed from the unit dose strip, a unit dose package drops through an opening 182 of pickhead chute 184. An orifice 186 is in fluid communication with an air supply solenoid 187 (Fig. 15) and provides a stream of pressurized air though the pickhead chute 184. The pressurized air pushes the severed unit dose package through a pickhead chute outlet 188 and into one of the pickhead bins 28a-28d.

[0076] Referring to Fig; 17B, the control 310 determines, at 490, whether all the pharmaceuticals at the present location have been picked for all of the bins. If not, control 310 repeats the process described with respect to steps 461-490 in Figs. 17A and 17B. In this process, the sensor 120 is again sampled to determine whether a package is present. In this example, package 66b should be detected as present. If it is not, the pickarm search cycle of Fig. 19 is again executed. If the package 66b is detected as present, the control 310 determines, at 466, whether the bar code has been

previously validated in this cycle. The bar code 146 was validated during the picking of package 66a; and therefore, the control 310 skips the process steps 468 and 470 and does not read the bar code on package 66b. This process continues until all of the pharmaceuticals at the current channel location have been picked. Thereafter, the control 310 determines, at 492, whether all of the pharmaceutical packages for all of the bins have been picked. If not, process steps 450-492 of Figs. 17A and 17B are repeated until all of the pharmaceutical packages have been picked.

[0077] Referring to Fig. 7, as discussed earlier, the pickhead bins 28a-28d permit the pickhead 26 to fill multiple individual orders for pharmaceuticals substantially simultaneously. However, it is necessary that the pickhead bins 28a-28d be individually locatable with respect to the pickhead chute outlet 188. Thus, the pickhead bins 28a-28d are mounted on a bin slide 190 that is moveable in a direction parallel to the X-axis motion indicated by the arrow of 29. The translating bin slide 190 must be movable to four different positions with respect to the outlet opening 188. In this exemplary embodiment, the four slide bin positions are accomplished using two cylinders 192, 194. The ends of strokes of the cylinders 192, 194 may be sensed using respective limit switches 196, 197 in a known manner. The stroke of cylinder 194 is set to be generally twice the stroke of cylinder 192. The cylinders 192,194 are rigidly connected to each other; and the piston 198 of cylinder 192 is connected to an end plate 200 of a chute support bracket 202. A piston 204 of cylinder 192 is rigidly connected to an end wall 206 of the bin slide 190. The cylinders 192, 194 essentially float as a unit between the rigid connections of the pistons 198, 204.

[0078] Assume for purposes of illustration that with the cylinder states shown in Fig. 7, the bin 28a is in a receive position, that is, a bin inlet is aligned with the chute outlet opening 188, so that it may receive a unit dose pharmaceutical package dispensed by the pickhead. Actuating cylinder 192 would extend piston 198, thereby moving the bin slide 190 to the left as viewed in Fig. 7 and placing bin 28b in the receive position, which aligns an inlet of bin 28b with the chute outlet opening 188. If the cylinder 192 is actuated to retract its piston 198 and the cylinder 194 is actuated to extend its piston 204, the bin slide 190 moves further to the left as viewed in Fig. 7 to move bin 28c to the

receive position and align its inlet with the chute outlet opening 188. Further, with the piston 204 fully extended, if cylinder 192 is actuated to extend its piston 198, the bin slide 190 moves further to the left as viewed in Fig. 7 to place pickhead bin 28d in the receive position with its inlet aligned with chute outlet opening 188.

[0079] Referring to Fig. 17B, when the control 310 determines, at 492, that all of the packages for all of the bins have been picked, the picking cycle is over; and the control 310 commands, at 494, the positioning system 88 to move the pickhead 26 to a transfer station 210, as shown in Fig. 10. The transfer station 210 has output queues 212 that are arranged in stacked rows. Each output queue is substantially similar in structure and operation; and therefore, the structure and operation of only one output queue will be described in detail. In this exemplary embodiment, each output queue has multiple sets of discharge chutes, for example, four discharge chutes 213 and four discharge chutes 214a, 214b, 214c, 214d. All of the discharge chutes are substantially similar in size and construction and have a width and spacing that substantially matches the width and spacing of pickhead bin doors 216a, 216b, 216c, 216d, respectively. The control 310 commands the pickhead to move the pickhead bins 28a-28d to a position at which the pickhead bin doors 216a-216d are immediately adjacent one set of discharge chutes, for example, discharge chutes 214a-214d. The control 310 further actuates, at 494, a bin pivot cylinder 218 to pivot the bins 28a-28d to a position immediately adjacent the discharge chutes 214a-214d. The control 310 also actuates, at 494, a bin door cylinder 220 (Fig. 7) to simultaneously open the pickhead bin doors 216a-216d, and the contents of the bins 28a-28d are simultaneously dropped by gravity into respective discharge chutes 214a-214d. Thereafter, the control 310 commands, at 494, the bin pivot cylinder 218 and bin door cylinder 220 to retract, thereby closing the pickhead bin doors and pivoting the pickhead bins back to their home position.

[0080] The control 310 then determines, at 496, if there are more orders to pick; and if so, the picking steps of 450-496 of Figs. 17A and 17B are repeated, thereby moving the pickhead 26 then proceeds through subsequent picking cycles and continuously discharging individual unit dose orders into empty discharge chutes 214 of the output queues 212. Simultaneously and independently, the transfer station control 314 and

bagging station control 330 are operating to transfer the unit dose orders to a bagging station 222 positioned adjacent the frame 92 and the output queues 212. The bagging station control 330 may be a programmable logic controller or other programmable control and communicates with the bagging station 222. In this exemplary embodiment, the bagging station control 330 also controls the operation of the conveyor drive 230 (Fig. 10). An exemplary operation of the transfer station 210 is shown in Fig. 20; and the control 310 first determines, at 550, whether a conveyor 228 and bagging station 222 are running. If not, the control 310 commands, at 552, the bagging station 222 to start and a conveyor drive 230 to operate a conveyor 228. The conveyor 228 is moveable bidirectionally in the X direction 29 but is normally moved in a left to right direction as viewed in Fig. 10.

[0081] The control 310 must keep track of which orders are in which discharge chutes 214a-214d of output queues 212 and coordinate the operation of the discharge station 210 with the operation of the bagging station 222. The control 310 first determines, at 554, whether there are completed orders in a set of discharge chutes and, if so, further determines, at 556, whether the conveyor and bagging station are clear. One or more sensors, for example, a conveyor sensor 332 of Fig. 15, may be used to detect the presence of objects on the conveyor 228 and bagging station funnel 232. If unknown objects are detected, the control 310 then determines, at 557, whether the objects are related to the discharge and bagging process. If so, the process continues to check for the conveyor and bagging station to clear. If it does not clear, the control 310 determines, at 557, that the problem is a machine problem and then, executes, at 558, the error subroutine of Fig. 18. The subroutine operates in a manner consistent with this error condition but generally in a manner similar to that previously described. If the conveyor 228 and bagging station 232 are clear, the control 310 commands, at 560, an appropriate discharge chute door cylinder, for example, cylinder 226a (Fig. 15), to open door 215a (Fig. 10) of discharge chute 214a, thereby discharging the unit dose packages therefrom. A series of vertically stacked V-shaped ramps or guides 229 direct or funnel the unit dose packages onto a conveyor 228, which moves the discharged unit dose packages generally left to right as viewed in Fig. 10. After a period of time

sufficient to allow the packages to drop from the discharge chute 214a, which is determined, at 562, by the control 310, the control 310 commands, at 564, the discharge chute door cylinder 226a to close the door 215a.

[0082] Thus, one or more unit dose packages of an order are transferred to a funnel 232 of the bagging station 222; and the control 310 then uses a sensor 334 of Fig. 15, for example, a camera, to determine, at 566 of Fig. 20, whether the unit dose packages are in the funnel 232. Thereafter, the bagging station control 330 determines, at 568, when a bag has been printed or labeled and positioned in the bagging station, so that it can receive the unit dose packages. Thereafter, the bagging station control 330 commands, at 570. a door at the bottom of the funnel 232 to open, which allows the packages to drop from the funnel into the bag. After a period of time, determined, at 572, by the bagging station control 330, the control 330 commands, at 574, the funnel door to close. Thereafter, the control 310 determines, at 576, using the camera 334, whether the funnel 232 is empty. If not, the error subroutine of Fig. 18 is executed in a manner consistent with this error condition. For example, the subroutine may determine, at 350, that this error condition may be automatically cleared and command the bagging station control 330 to again open and close the funnel door. If repeated operation of the funnel door does not clear the funnel, the control 310 will create, at 358, an error message to the user requesting user action and pause the operation of the bagging station. The user may provide one of three inputs in a manner similar to that previously described. If, at 576, the control 310 determines that the funnel is empty, the control 310 provides via the bagging station interface a seal bag signal to the bagging station control 330; and the control 330 then proceeds, at 578. to seal the bag.

[0083] Returning to Fig. 20, the control 310 determines, at 580, whether all discharge chutes in the current queue are empty. If not, the control 310 repeats the process of steps 560-580 and activates an appropriate discharge chute door cylinder to open, for example, discharge chute door 215b of discharge chute 214b, thereby dropping the unit dose packages from discharge chute 214b onto the conveyor 228. That process continues until the control 310 determines, at 580, that all of the discharge chutes in the current output queue are empty, which in this example are discharge chutes 213 and

214a-214d. The control 310 then determines, at 582, whether all of the output queues 212 are empty; and if not, the control 310 selects, at 584, and another output queue to be emptied. The transfer station process of Fig. 20 of transferring unit dose packages for individual orders from the discharge chutes of the various output queues 212 to the funnel 232 may be continuously executed as long as there are completed orders in any output queue. To achieve maximum efficiency, the picking and transfer station have respective rates of operations that permit the bagging station 222 to operate at its maximum capacity.

[0084] In the picking cycles described above, the pickhead 26 is effective to identify and pick a unit dose package from a unit dose strip. However, on occasion, after a unit dose package has been bagged into an individual order, there are circumstances in which that unit dose may not be used. For example, the prescription itself may change; the patient may have been released or moved; or an exception or incomplete order may have been picked and not completed. In those situations, a user may return those unused individual unit dose packages to a pharmacy or use those packages to manually fill orders. The manual handling of individual unit dose packages is labor intensive, time consuming and expensive. Therefore, referring to Fig. 1, the pharmaceutical dispensing system 20 has an additional module, a return module 240 that has stacked rows 241 of return module locations for handling individual unit dose packages. Referring to Fig. 11, each row 241 provides a plurality of return module locations 242 for individual unit dose packages. Thus, the rows 241 of return module locations 242 form a grid of points or locations at which individual pharmaceutical packages are stored. The grid of locations is formed by an inclined shelf 244 and a support bracket 244 that has a plurality of opposed support arms 248 extending therefrom. The support arms 248 have a lateral spacing permitting them to support side flanges 250 of an individual unit dose package 252. Each support arm 248 has a pair of resilient members 254, for example, leaf springs, with respective distal ends that apply respective biasing forces against distal ends of a respective support arm 248. Thus, a user is able to insert an individual unit dose package 252 from an outer side 255 of the single unit dose module 240. The user simply slides the package 252 between the arms 248 at one of the return module

locations 242. The side flanges 250 slide over upper surfaces of the arms 248, and the user pushes the side flanges 250 between the resilient members 254 and the arms 248. When the package 252 is pushed sufficiently far, it is captured by the resilient members 254; and its bar code 256 and leading edge 257 may be respectively read and detected in a manner similar to that previously described.

[0085] In one exemplary mode of operation, during a time period in which the pickhead is not being used to fill orders, the control 310 may determine at 498 of Fig. 17B to run, at 499, a return module scan as shown in Fig. 21. The purpose of the return module scan is to construct a memory map in the database 316 of the inventory in the return module 240. After the return module 240 is initially installed, the user is able to put, at any time, any individual unit dose pharmaceutical package in any return module location at any location in the return module 240. Therefore, on a first scan, the control will move the pickhead 26 to every return module location and sample data to construct the memory map; however, on subsequent scans, the pickhead is moved to only empty return module locations. Therefore, the control 310 first, at 602, commands the pickhead 26 to move to a return module location to be scanned. The positioning of the pickhead 26 may use sensors in a manner similar to that described with respect to Fig. 8; or in other embodiments, the pickhead 26 position may be determined by the commands given to the servodrives 94, 104 of Fig. 1.

[0086] When in position, the sensor 116 (Fig. 8) determines whether a package is present. If not, the control 310 identifies, at 605, that return module location in the database 316 as an empty location; and the control 310 commands, at 602, the pickhead to move to the next empty return module location. If a package is present, the bar code reader 147 reads, at 606, a bar code 256. The control 310 checks, at 608, for an expired expiration date and checks, at 610, for the presence of a pharmacist's verification code. If the expiration date has expired or there is no pharmacist's verification code, the control 310 identifies, at 612, the current return module location in the database 316 as a location to be purged or emptied. A purge of the return module may occur in a separate pickhead cycle in which all packages with invalid bar code data are purged in a single cycle. If the expiration date is not expired and a pharmacist's

verification code is detected, the control 310 writes, at 614, the package bar code and the current return module location into the database 316. The control 310 then determines, at 616, whether all locations have been scanned; and if not, the scanning process of steps 602-616 is repeated.

[0087] In subsequent picking cycles, the control 310 may execute a return module pick cycle as shown in Fig. 22 in which the pickhead 26 is moved to locations in the return module 240 to pick individual unit dose pharmaceutical packages. These packages may be used to fill orders prior to picking new unit dose packages from the new inventory modules 22. Referring to Fig. 17A, the control 310 determines, at 452, whether to execute a return module pick cycle; and if so, executes, at 454, the subroutine of Fig. 21. In a manner similar to that previously described, the control 310 commands, at 650, the servodrives 94, 104 (Fig. 6) to move the pickhead 26 to a package location in the return module 240. The checking of the position of the pickhead 26 may be accomplished in a manner similar to that described in Fig. 8 using sensor 110 and a feature 112. Alternatively, the pickhead positioning may be accomplished using the servodrives 94, 104. When in position, the control 310 uses sensor 116 to determine whether a package is present. If no package is found, the control 310 identifies, at 653, the return module location as empty in the database 316. The control 310 then determines, at 655, whether the desired pharmaceutical is in another return module location in the return module 240; and if so, the control commands, at 650, the pickhead to move to the next return module location having the desired pharmaceutical. If the desired pharmaceutical is not in the return module 240, the control 310 returns to picking from the new inventory module 22 as described in Figs. 17A and 17B.

[0088] If a package is present in return module location 242, the bar code 256 is read at 654; and the control 310 tests, at 656, if the bar code matches the order. If the pharmaceutical at the current location does not match the order, the control 310 identifies, at 657, the current return module location in the database 316 as a location to be purged. Again, the control 310 then determines, at 655, whether the desired pharmaceutical is in another return module location in the return module 240; and if so, the control commands, at 650, the pickhead to move to the next return module location

having the desired pharmaceutical. If the desired pharmaceutical is not in the return module 240, the control 310 returns to picking from the new inventory module 22 as described in Figs. 17A and 17B.

[0089] If, at 656, the control 310 determines that the bar code matches the order, the control 310 then, extends the pickarm at 658, senses the package edge at 660, or moves the pickarm to the end of its stroke at 662. Upon sensing the leading edge, the control 310 stops the pickarm motion 664. Thereafter, the control 310 determines, at 666, whether the correct bin is in position to receive the package. If not, the control 310, moves, at 668, the correct bin below the discharge chute opening 188 (Fig. 7) and again, at 670, checks whether the correct bin is in position. If not, the control executes, at 672, the error subroutine of Fig. 18 in a manner similar to that described at step 482 of Fig. 17B. If the correct bin is in position, the control commands, at 674, the gripper cylinder 151 to close the gripper 144 over the leading edge 257. The control 310 then commands, at 676, the pickarm to retract to a release position. Thereafter, the control 310 commands, at 678, the gripper to open; and the package drops into the desired bin on the pickhead.

[0090] While making single unit dose packages available for picking one-at-a-time is more efficient than a manual handling technique, there are applications where improved efficiencies may be realized by permitting multiple single dose units to be stacked at each location in a return module. Referring to Figs. 12 and 14, one exemplary embodiment of a multidose return module 260 is made by stacking an upper rack 262a on a lower rack 262b to form a row 261 of multidose return channels 263. The upper and lower racks 262a and 262b are substantially similar in construction. When placed together, the racks 262a, 262b form a channel 263 that receives and stores a number of returned single dose unit packages. Fig. 13 is a cross-sectional view of the channel 263, and thus, it is understood that the following description with respect to one side of the channel 263 is equally applicable to the opposite side of the channel 263. Referring to Figs. 12 and 13, each rack 262a, 262b has a series of stepped guide rails 264, 266, 268, 270. In addition, each rack 262a, 262b has a lower guide surface 272 having a curved guide surface 274. When placed together as shown in Fig. 13, the racks 262a,

262b form the channel 263 therebetween, which is sized and shaped to accept four single unit dose packages 278a, 278b, 278c, 278d. As will be subsequently explained, three of the four single unit dose packages may be automatically dispensed by the pickhead without user intervention.

[0091] The upper rack 262a has a shoulder 280 with a lower surface 282 that cooperates with the upper guide rail 264 to present a relatively narrow window or opening 284 through which a flange portion 286 of a single unit dose package 278 can be inserted. Thus, to load a single unit dose package, for example, 278d, it must be supported in a substantially horizontal orientation and pushed to the left as viewed in Fig. 13 in order to pass through the opening 284 and be located over the upper guide rail 264. If the package 278d is pushed further to the left it's leading flange edge 288d contacts the curved surface 274, which prevent further horizontal motion; and thus, the package 278d rests on the rails 264 until further action is taken. The lower guide surface 272 has a through slot or opening 296 that is aligned with a rear window or opening 298, and these openings 296, 298 permit a user to quickly determine how many packages are in a channel 263. If one or more of the packages 278a-278c has been picked, the package 278d may be moved into the queue available for picking.

[0092] Assume in this example, that the channel 263 is empty except for single unit dose package 278d. To make the package 278d available for picking, the single unit dose package 278d is pushed to the left as viewed in Fig. 13 until its leading edge 288d contacts the lower guide surface 274. Next, a rear portion of the package 278d is pivoted upward, which guides the leading edge 278 over the surface 274; and its trailing edge 290 clears inner wall 292. This permits the unit dose package to slide over the intermediate guide rails 266, 268 until it comes to rest at a picking station on the lower guide rails 270 as represented by the single unit dose 278a in Fig. 13. A stop 294 contacts a forward portion of the blister thereby holding the pack 278a in the picking station and preventing the unit dose pack 278a from inadvertently falling out of the rack. The stop, 294 at the picking station is positioned such that a bar code 300 is readable by the bar code reader on the pickhead. Thus, with this module design, upon an individual unit dose pharmaceutical package being loaded from the rear, the package is

automatically oriented for picking with the bar code presented for reading without the pickhead having to search for the package.

[0093] If another single unit dose package is loaded as described in the previous paragraph, it slides down to a position illustrated by the package 278b. In that position, its leading flange edge 288 rests on top of the lower package 278d; and its side flange 286 rests on the lower intermediate guide rail 268. Inserting a third single unit dose package as described above results in a third unit dose package 278c having a flange side 286 resting on the upper intermediate guide rail 268 and a leading flange edge 288 over the unit dose package 278b. A fourth package may be inserted as described above and will be located at a position indicated by the package 278d. Upon the pickhead removing the lower unit dose package 278a, the packages 278b and 278c will, by the force of gravity, move over the guide rails until the package 278b rests on lower guide rails 270. At that point, the bar code on package 278b is readable by the pickhead before it moves away from that location, thereby checking whether the bar code for that individual unit dose pharmaceutical package 278b is valid and recording the location of the package 278b in the database. The package 278c will be located immediately behind it resting on the lower intermediate guide rail 268. At that time, the upper most package 278d can be pivoted upward so its leading edge is guided curved surface 274; and it then slides down to a position resting on upper intermediate guide rail 266. A further package may then be inserted so that it is located on the upper guide rails 264.

[0094] The structure of racks 262a, 262b shown in Figs. 12 and 14 may be replicated in a horizontal direction to provide any number of channels 263. Additionally, the racks 262 may be stacked vertically to provide any number of rows 261 of return channels 263, thereby forming the multidose return module 260 as shown in Figs. 1 and 12. Thus, the rows 261 of channels 263 form a grid of points or locations at which pharmaceuticals are stored. The upper and lower racks 262a, 262b may be connected together by self tapping fasteners extending through holes 298. Further, the rear loading of the multidose return module 260 permits it to be loaded or otherwise serviced while the pickhead is running and filling orders.

[0095] In a manner similar to that described with respect to module 240, during time periods in which the pickhead is not being used to actively fill orders, the control 310 may command, at 499 of Fig. 17B may command the pickhead to move through a scan cycle of multidose return module 260, which is substantially similar to the scan cycle of Fig. 21 previously described. Thereafter, the control 310 may determine, at 452 of Fig. 17A, to execute a return module picking cycle shown in Fig. 21. The picking cycle for the return modules 240, 260 is substantially similar; however, when using the return module 260, there is one difference. Referring to Figs. 13 and 22 at 666, upon the pickarm 142 retracting to the release position, a package 278a is removed from the return module. As described earlier, if present, the package 278b drops into the open space with its bar code 300 positioned to be read as shown in Fig. 14. Therefore, in the process of picking the package 278a, the bar code reader 147 (Fig. 8) on the pickhead 26 may be used to read the bar code on the next package 278b at that location. Therefore, a read bar code step would be used after step 678 in Fig. 22 when using the return module 260. In a manner similar to that described earlier, if the control 310 verifies with the database that the package 278b is a valid pharmaceutical and records its location in the database, the package 278b continues to be available for picking. If the bar code read fails any of the three tests described earlier, the package 278b is identified in the database 316 as one to be purged.

[0096] In one exemplary embodiment, the pharmaceuticals are located within the modules 22a, 22b, 22c such that pharmaceuticals having the highest rates of usage are placed in locations closest to the transfer station 210. Further, pharmaceuticals having a higher rate of usage may be loaded into a cluster of several channels to accommodate the higher rate of expected use. Also, as described earlier, channels holding pharmaceuticals having higher rates of usage may be physically larger to hold a greater quantity. In addition, the picking cycle program 318 identifies single unit dose packages in the return modules and their respective expiration dates and utilizes those packages as appropriate to optimize throughput of the dispensing system 20.

[0097] Further, at various times, as determined by the picking cycle program 318, the pickhead can be moved to channels in the modules that contain unit dose packages

with expired expiration dates. The picking cycle program 318 commands the pickhead 26 to load the unit dose packages that have expired into a pickhead bin that is subsequently unloaded into a discharge chute at the transfer station 210 (Fig. 10). At the appropriate time, the transfer station control 314 releases those expired unit dose packages onto the conveyor 228; and these are bagged and labeled as expired unit dose packages. Although the system has the capability of purging all of the modules using the pickhead 26, as noted earlier, it may be more efficient for the user to manually remove unit dose strips from the new inventory modules 22. If desired, the user may also manually purge the return modules 240, 260.

[0098] In another exemplary embodiment, a user may utilize other user I/O 322 (Fig. 15) to enter the daily requirements of a patient's pharmaceuticals needs, which represents the pharmaceuticals to be taken by the patient in the morning, at noon, in the evening and at night. Thus, a patient's daily needs may be filled by four individual orders representing pharmaceuticals to be taken at those four respective times. The picking cycle program 318 generates a picking cycle, so that individual orders for those four daily requirements are filled simultaneously and placed in the pickhead bins 28a-28d. Those four orders then are simultaneously discharged into discharge chutes 214a-214d and thereafter, individually dropped onto the conveyor 228 and transported to the bagging station 222. Thus, the bagging station provides four successive bags representing the daily medication needs for a patient at four different times of the day. Those four bags may be subsequently connected together for easy handling on a per patient bases.

[0099] The pharmaceutical package dispensing system 20 described herein has a first advantage of automatically selecting and dispensing multiple unit doses of medications for individual orders faster and more efficient than known systems. Another advantage of the pharmaceutical package dispensing system 20 is that it substantially simultaneously selects and dispenses multiple individual orders of unit dose medications. Each individual order may represent all the pharmaceuticals that are to be administered during a single med pass, that is, at the same time. Thus, the dispensing system 20 is able to individually package all of a patient's med passes for a single day.

If a daily requirement is only two med passes, which requires only two of the four pickhead bins, the control 310 is able to allocate the other two pickhead bins to another patient order that has two daily med passes. An additional advantage is that the pharmaceutical package dispensing system utilizes a single pickhead to pick both unit dose pharmaceutical packages from a strip and individual unit dose pharmaceutical packages. The pharmaceutical package dispensing system 20 then automatically selects those returned unit doses with new unit doses to fill individual orders. This capability substantially reduces labor costs previously associated with the manually handling of such medications. An additional advantage of the pharmaceutical package dispensing system 20 is that can automatically purge itself of pharmaceuticals with expired expiration dates. The pharmaceutical package dispensing system 20 is especially useful in long term care and other facilities where a high volume of unit dose medications are required to be distributed to patients multiple times a day.

[00100] While the invention has been set forth by description of exemplary embodiments in considerable detail it is not intended to restrict or in any way limit the claims in such detail additional advantages and modifications for those skilled in the art. For example in the described embodiments, the pickhead 26 picks only a single unit dose package at a time. However, in alternative embodiments the pickarm 142 may be provided with a translation that permits multiple unit doses to be pulled from a unit dose strip prior to cutting. Further, in the described embodiments, the dispensing system is handling pharmaceutical packages containing unit doses of medications; however, in other embodiments, the pharmaceutical packages may contain dosages other than unit doses.

[00101] In the exemplary embodiments, the pickhead utilizes four pickhead bins. However, in other embodiments fewer or more pickhead bins may be utilized. Similarly, in the described embodiments, a particular number of output queues 212 and discharge chutes 214 are shown. However, in alternative embodiments, the number of output queues 12 and discharge chutes 214 may be greater or less depending on the rate of operation of the pickhead 26, the quantity of unit dose packages in the system, the size

and number of modules 22, 240, 260, the rate of operation of the bagging station and other parameters that affect the through put of the dispensing system 20.

[00102] In the described embodiments, various photoelectric sensors are used to confirm pickhead position, unit dose pack presence, etc.; however, in alternative embodiments, cameras and/or other sensors may also be used to perform those functions either alone or in conjunction with the described sensors. In the described embodiments, various cylinders are shown and described to operate two state devices. In different embodiments, those cylinders may be pneumatic or electric cylinders; or in alternative embodiments, other comparable known actuators may be used. Also, the embodiments shown and described refer to various servodrives; however, in alternative embodiments, other known drive systems may be used that are effective to move the pickhead 26 and conveyor 228 in a desired manner.

[00103] It should be noted that in some applications, the pharmacist's verification code may not be checked depending on how pre-verified unit dose pharmaceutical packages are provided to a user. The embodiments shown and described use a bar code on the unit dose pharmaceutical package. The bar code stores data relating to the pharmaceutical in the package. In other embodiments, devices other than a bar code may be used, for example, a radio frequency identification device (RFID), or other device that may be readily applied to the pharmaceutical package and store data relating to its contents.

[00104] In the described embodiments, Fig. 1 illustrates a single pickhead 26, modules 22, 240, 260 and transfer station 222 that are used to provide individual orders of unit dose packages to the bagging station 222. In an alternative embodiment shown in Fig. 23, a dispensing system 20 may have additional unit dose strip modules 22d, 22e, 22f substantially similar to module 22a described earlier and an individual unit dose return module 260 as previously described. In addition, a second, independently operating pickhead 26a, substantially similar to pickhead 26, may be used to pick unit dose pharmaceutical packages from the modules 22a-22f and 260. In Fig. 23, the discharges chutes shown and described in Fig. 10 on one side of the output queues 212 are replicated on respective opposite sides of the output queues 212 to service the

pickhead 26a. In a manner similar to that previously described, the pickhead 26a transfers unit dose pharmaceutical packages to discharge chutes 211 on the opposite side of output queues 212. The second pickhead 26a shares the bagging station 222 and associated funnel 232. In the embodiment of Fig. 23, some elements of the structure of the control 310 shown in Fig. 15 are duplicated and used to control the second pickhead 26a. Further, a server computer may be connected between the pharmacy information system 311 and the control system 310. The server may contain a database that is comprehensive for all of the modules 22a-22f, 240, 260; and a database management system may be used to synchronize the databases between the server and the dispensing control system 310 in a known manner.

[00105] The dispensing system 20 of Fig. 23 has a first advantage of substantially increasing the rate at which unit dose pharmaceutical packages can be bagged as individual orders. Further, with this configuration, both pickheads can be used to fill a single individual order. For example, pickhead 26 may be used to place some unit dose packages for an order in a first discharge chute on one side of the output queue 212; and the second pickhead 26a may be used to place the remaining unit dose packages for the order in a second discharge chute on an opposite side of the output queue 212. The first and second discharge chutes may be opened substantially simultaneously, so that all of the unit dose packages for the order are dropped onto the conveyor 228 and bagged at the same time. It should be noted that the pickheads 26, 26a may load the respective discharge chutes either substantially simultaneously or at different times.

[00106] In the described embodiments of the return modules 240, 260, the individual dose pharmaceutical packages are able to be randomly loaded in the module locations by a user. In an alternative embodiment, the location of the packages in the return modules may be determined by information entered into the database by a user or pharmacy similar to the process described with respect to the new inventory modules 22.

[00107] In yet another alternative embodiment, locations in the new inventory modules 22 and the return modules 240, 260 may contain pharmaceutical packages of different lengths. For example, referring to Fig. 3, first strips 64 have unit dose

pharmaceutical packages 66 of a first length. However, vials of pharmaceuticals may be packaged in respective packages 67 and formed into a pharmaceutical package strip 65. The pharmaceutical packages 67 have a greater length and height than the unit dose packages 66. Further, a channel 24a may be designed to accept the packages 67 by providing opposed sidewall ledges or surfaces 53 similar in function to the surfaces 52 of Fig. 5 described earlier. The pharmaceutical package strips 67 are loaded into the channel in a manner substantially identical to that described with respect to Figs. 3, 5 and 16. Further, the longer pharmaceutical packages may be picked in a manner substantially similar to that described in Figs. 17A and 17B. The alignment feature 112 of Fig. 8 may be adjusted for channels having unit dose packages of different heights. Further, the picking process described at steps 485 and 486 in Fig. 17B is independent of the length of the pharmaceutical packages 66, 67 and may be used to pick unit dose packages of different lengths from the pharmaceutical package strip modules 22. Similarly, the process step 676 of Fig. 22 may be varied as a function of a particular module location and thus, be used to pick an individual pharmaceutical package having a different size packages from a location in the return modules 240, 260.

[00108] Therefore, the invention in its broadest aspects is not limited to the specific embodiments shown and described. Consequently, departures may be made from the details described herein without departing from the spirit and scope of the claims that follow.

[00109] What is claimed is:

1. A pharmaceutical dispensing system for dispensing pharmaceutical packages containing pharmaceuticals comprising:

a module comprising a plurality of locations adapted to support respective strips of the pharmaceutical packages;

a control for storing data relating to the pharmaceuticals and their locations in the module;

a pickhead operable by the control to move with respect to the module in two nonparallel directions to a position adjacent one of the plurality of locations, the pickhead comprising

a pickarm extendable and retractable with respect to the pickhead, the pickarm comprising a gripper adapted to grip and pull a first pharmaceutical package on a strip of pharmaceutical packages toward the pickhead;

a reader adapted to read data contained on, and relating to, the first pharmaceutical package;

a cutter adapted to separate the first pharmaceutical package from the strip of pharmaceutical packages; and

a plurality of bins, each of the plurality of bins being movable by the control to a receive position with respect to the cutter, the first pharmaceutical package being transferred to one of the plurality of bins at the receive position after being separated by the cutter from the strip of pharmaceutical packages.

2. The pharmaceutical dispensing system of claim 1 wherein the gripper comprises at least one movable jaw, and the pickarm comprises a first sensor adapted to detect a physical aspect of the first pharmaceutical package in response to the pickarm extending toward the first pharmaceutical package.

3. The pharmaceutical dispensing system of claim 2 wherein the first sensor is adapted to detect a leading edge of the first pharmaceutical package and the gripper closes the at least one movable jaw to grip the first pharmaceutical package in response to the first sensor detecting the leading edge.

4. The pharmaceutical dispensing system of claim 1 wherein the pickhead comprises a sensor for detecting a physical aspect of the first pharmaceutical package in a process of the pickarm pulling the first pharmaceutical package out of the module.

5. The pharmaceutical dispensing system of claim 1 wherein the data comprises a bar code and the reader comprises a bar code reader.

6. The pharmaceutical dispensing system of claim 1 wherein the pickhead comprises a sensor for detecting a presence of the first pharmaceutical package.

7. The pharmaceutical dispensing system of claim 1 wherein the pickarm is operable to be moved to programmable positions with respect to the module.

8. A pharmaceutical dispensing system for dispensing pharmaceutical packages containing pharmaceuticals comprising:

first storage locations, each of the first storage locations adapted to receive and support at least one strip of pharmaceutical packages;

second storage locations, each of the second storage locations adapted to receive and support an individual pharmaceutical package;

a control for storing data relating to the pharmaceutical packages and the first and the second storage locations; and

a pickhead operable by the control to move in two nonparallel directions with respect to the first and the second storage locations, the pickhead comprising a picker extendable and retractable with respect to the pickhead and adapted to remove pharmaceutical packages from the first and the second storage locations.

9. A pharmaceutical dispensing system for dispensing pharmaceutical packages containing pharmaceuticals comprising:

a plurality of storage locations, each of the storage locations adapted to receive and support a plurality of individual pharmaceutical packages and each of the storage locations automatically presenting each of individual pharmaceutical packages to permit a respective pharmaceutical package bar code to be read; and

a pickhead operable to first, be moved to a storage location and thereafter, remove an individual pharmaceutical package from the storage location.

10. The pharmaceutical dispensing system of claim 9 wherein each of the storage locations further comprises a respective channel, and each channel comprises:

an input adapted to support a first individual pharmaceutical package upon it being loaded into the channel;

an output adapted to support a second individual pharmaceutical package, the output automatically presenting each of individual pharmaceutical packages to permit a respective pharmaceutical package bar code to be read; and

an intermediate queue connecting the input and the output and adapted to support a third individual pharmaceutical package between the input and the output.

11. The pharmaceutical dispensing system of claim 10 wherein the input comprises an input support surface adapted to maintain the first individual pharmaceutical package at the input until moved by an external force to the intermediate queue.

12. The pharmaceutical dispensing system of claim 11 wherein the output comprises an output support surface adapted to maintain the second individual pharmaceutical package at an orientation facilitating removal by the pickhead.

13. The pharmaceutical dispensing system of claim 12 wherein the intermediate queue comprises an angled support surface adapted to support the third individual pharmaceutical package in the intermediate queue, the angled surface permitting the

third individual pharmaceutical package to slide by force of gravity from the intermediate queue to the output in response to the second individual pharmaceutical package being removed from the output by the pickhead.

14. The pharmaceutical dispensing system of claim 13 wherein the angled support surface is adapted to support a plurality of individual pharmaceutical packages.

15. A method for dispensing pharmaceutical packages containing pharmaceuticals from a pharmaceutical dispensing system comprising:

storing a first inventory of pharmaceutical packages at first locations;

removing a pharmaceutical package from the first inventory;

transferring the pharmaceutical package to one of a first plurality of bins supported on a first pickhead;

moving another of the first plurality of bins to a receive position with respect to the first pickhead;

iterating the steps of removing, transferring and moving for other bins of the first plurality of bins on the first pickhead; and thereafter

transferring the pharmaceutical packages in a first bin of the first plurality of bins from the pharmaceutical dispensing system; and thereafter

successively and separately transferring the pharmaceutical packages in each of the other bins of the first plurality of bins from the pharmaceutical dispensing system.

16. The method of claim 15 wherein the method further comprises:

moving the first pickhead to one of the first locations; and

iterating the steps of removing, transferring and moving until all of the first plurality of bins supported on the first pickhead have received all required pharmaceutical packages from the one of the first locations.

17. The method of claim 15 wherein storing a first inventory of pharmaceutical packages further comprises:

storing strips of pharmaceutical packages at a first plurality of the first locations; and

storing individual pharmaceutical packages at a second plurality of the first locations.

18. The method of claim 17 further comprising:

moving the first pickhead adjacent one of the first plurality of the first locations;

removing a first pharmaceutical package from a first strip of pharmaceutical packages stored at the one of the first plurality of the first locations; and

transferring the first pharmaceutical package to one of the first plurality of bins;

19. The method of claim 18 wherein after depositing the first pharmaceutical package, the method further comprises:

moving another of the first plurality of bins to the receiving position on the first pickhead;

removing a second pharmaceutical package from the first strip of pharmaceutical packages; and

transferring the second pharmaceutical package to the other of the first plurality of bins supported on a pickhead.

20. The method of claim 18 further comprising:

moving the first pickhead adjacent one of the second plurality of the first locations;

picking an individual pharmaceutical package stored at the one of the second plurality of the first locations; and

depositing the individual pharmaceutical package in the one of the first plurality of bins.

21. The method of claim 17 further comprising:

loading multiple individual pharmaceutical packages at one of the second plurality of the first locations;

moving the first pickhead adjacent the one of the second plurality of the first locations;

removing one of the multiple individual pharmaceutical packages from the one of the second plurality of the first locations with the first pickhead, thereby permitting another of the multiple individual pharmaceutical packages in the one of the second plurality of the first locations to move by gravity into a space previously occupied by the one of the multiple individual pharmaceutical packages; and

reading a bar code on the other of the multiple individual pharmaceutical packages with a reader on the first pickhead prior to moving the first pickhead away from the one of the second plurality of the first locations.

22. The method of claim 15 further comprising:

storing at one of the first locations a first pharmaceutical package having a first size;

storing at another of the first locations a second pharmaceutical package having a second size;

moving the first pickhead to a position adjacent the one of the first locations;

extending a pickarm on the first pickhead to engage the first pharmaceutical package;

retracting the pickarm to pull the first pharmaceutical package from the one of the first locations;

commanding the pickarm to stop retracting in response to detecting a first aspect of the first pharmaceutical package;

releasing the first pharmaceutical package from the first pickhead;

moving the first pickhead to a position adjacent the other of the first locations;

extending the pickarm on the first pickhead to engage the second pharmaceutical package;

retracting the pickarm to pull the second pharmaceutical package from the other of the first locations;

commanding the pickarm to stop retracting in response to detecting a second aspect of the second pharmaceutical package, wherein the first aspect and the second aspect are substantially similar; and

releasing the second pharmaceutical from the pickarm.

23. The method of claim 22 wherein the first aspect and the second aspect relate to respective lengths of the first pharmaceutical package and the second pharmaceutical package.

24. The method of claim 15 further comprising:

storing a second inventory of pharmaceutical packages at second locations;

removing a second pharmaceutical package from the second inventory;

transferring the second pharmaceutical package to one of a second plurality of bins supported on a second pickhead;

moving another of the second plurality of bins to a receive position with respect to the second pickhead;

iterating the steps of removing, transferring and moving for other bins of the second plurality of bins on the second pickhead; and thereafter

transferring pharmaceutical packages in a first bin of the second plurality of bins from the pharmaceutical dispensing system; and thereafter

successively and separately transferring pharmaceutical packages in each of the other bins of the second plurality of bins from the pharmaceutical dispensing system.

25. The method of claim 24 further comprising:

transferring the first pharmaceutical package from the one of the first plurality of bins on the first pickhead;

substantially simultaneously therewith transferring the second pharmaceutical package from the one of the second plurality of bins on the second pickhead; and

transferring the first pharmaceutical package together with the second pharmaceutical package from the dispensing system.

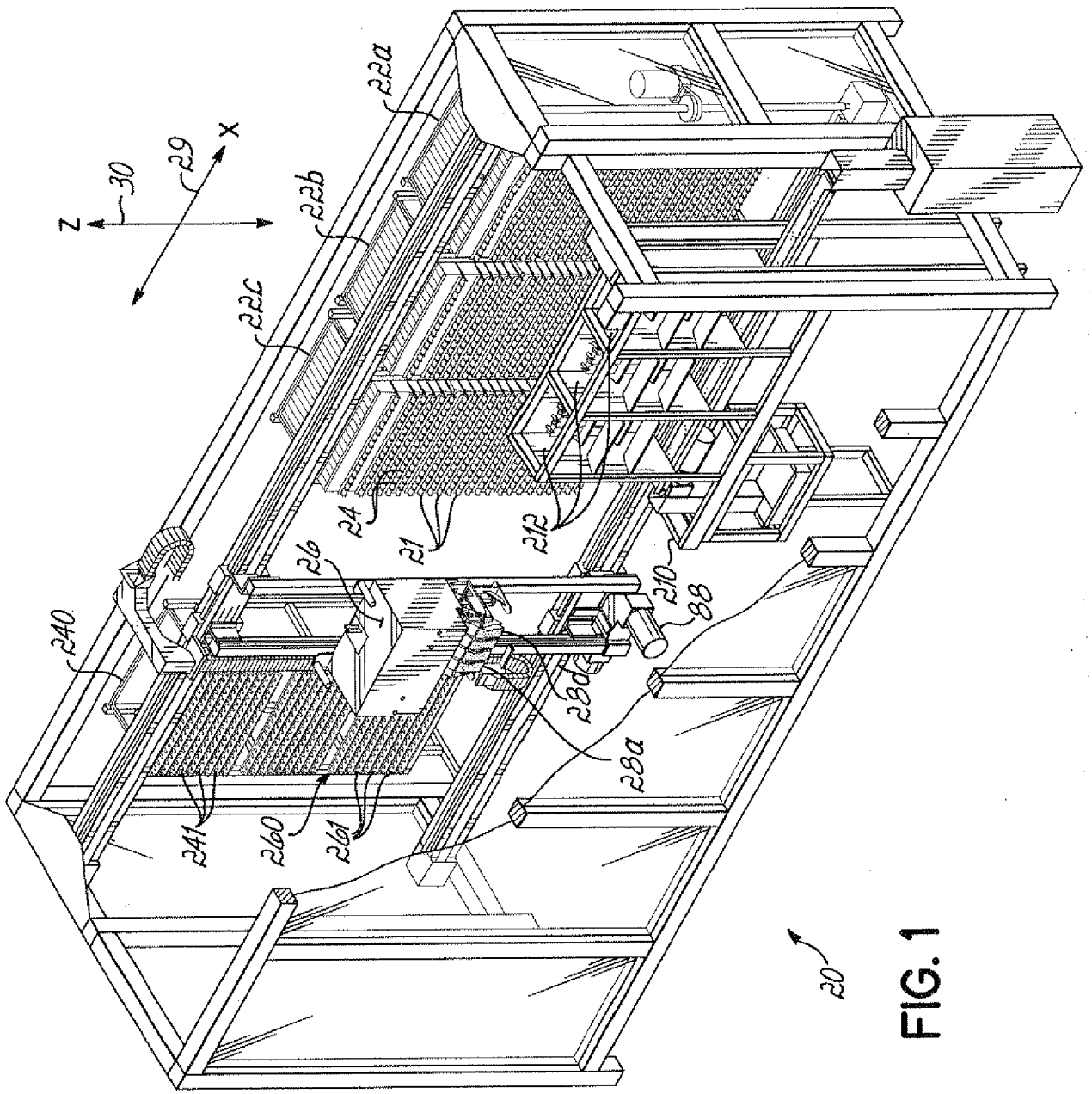

FIG. 1

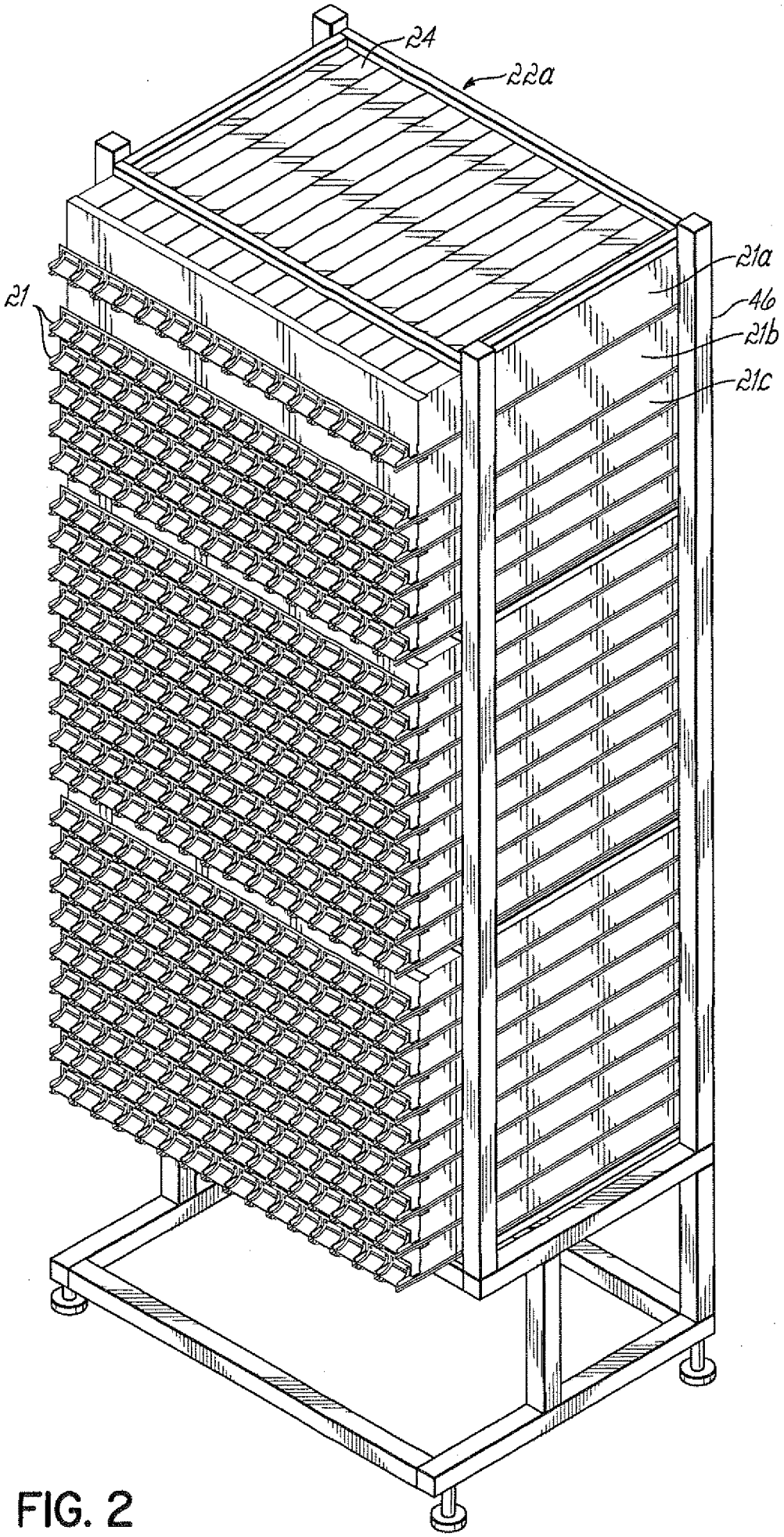

FIG. 2

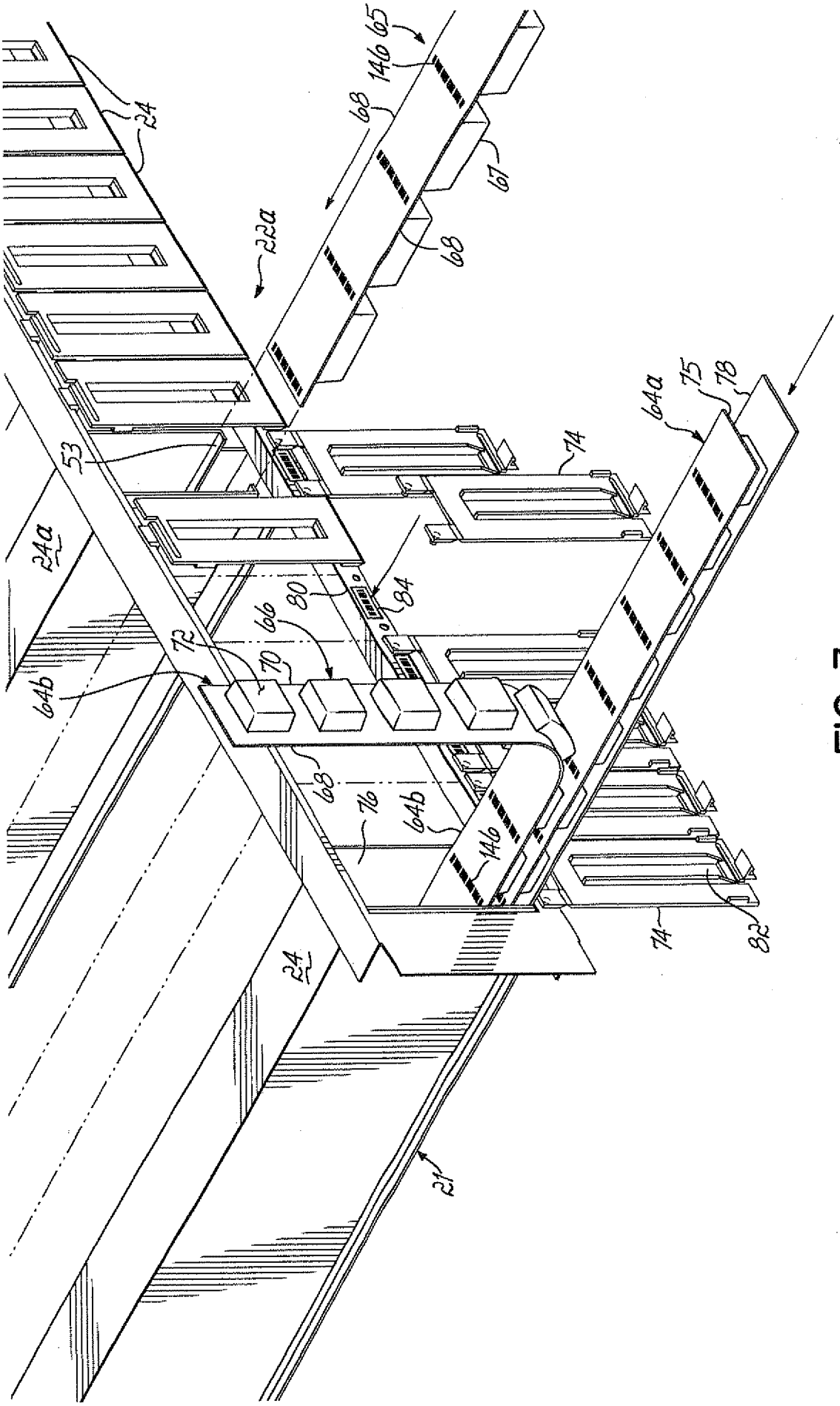
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FIG. 3

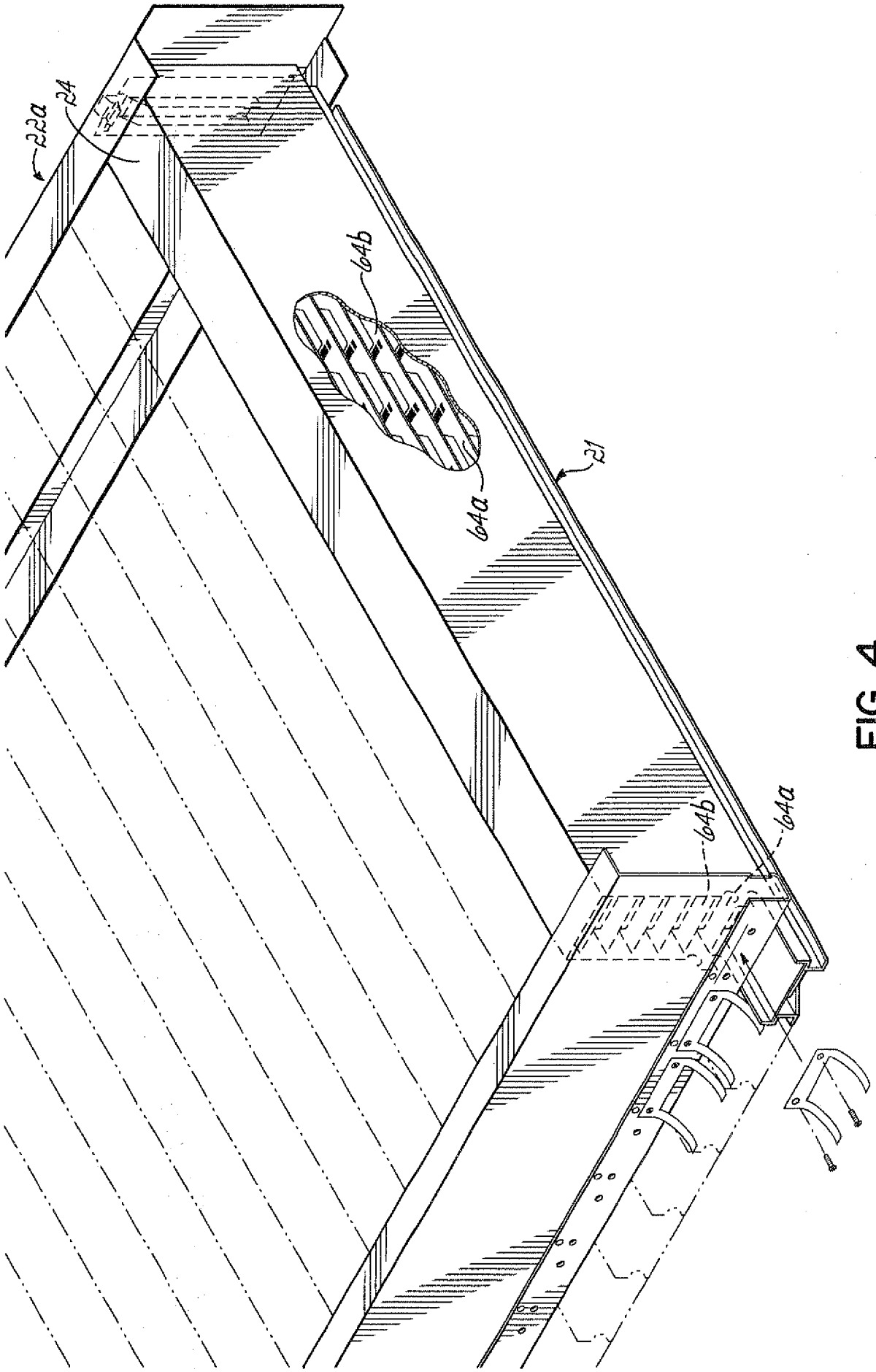


FIG. 4

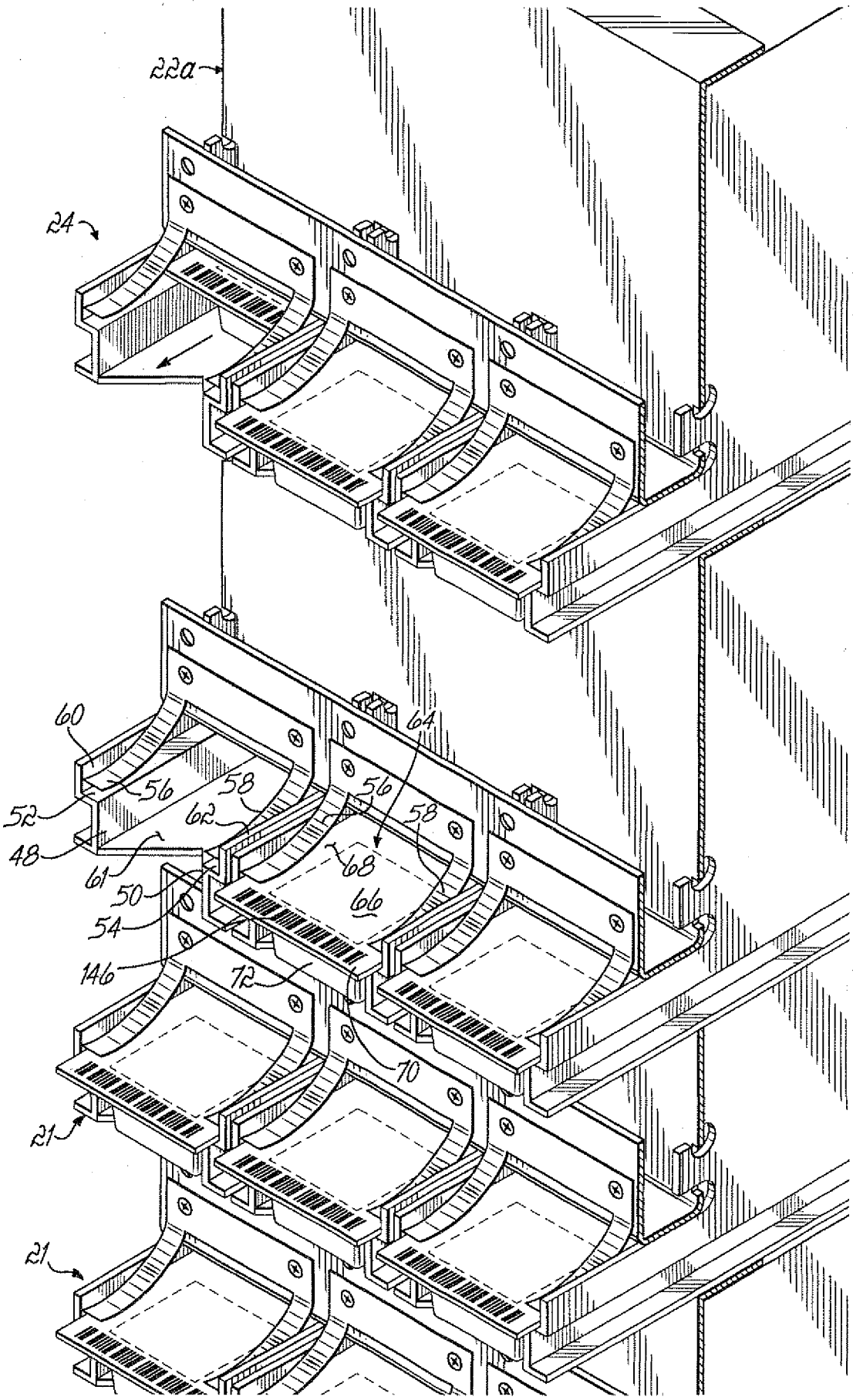
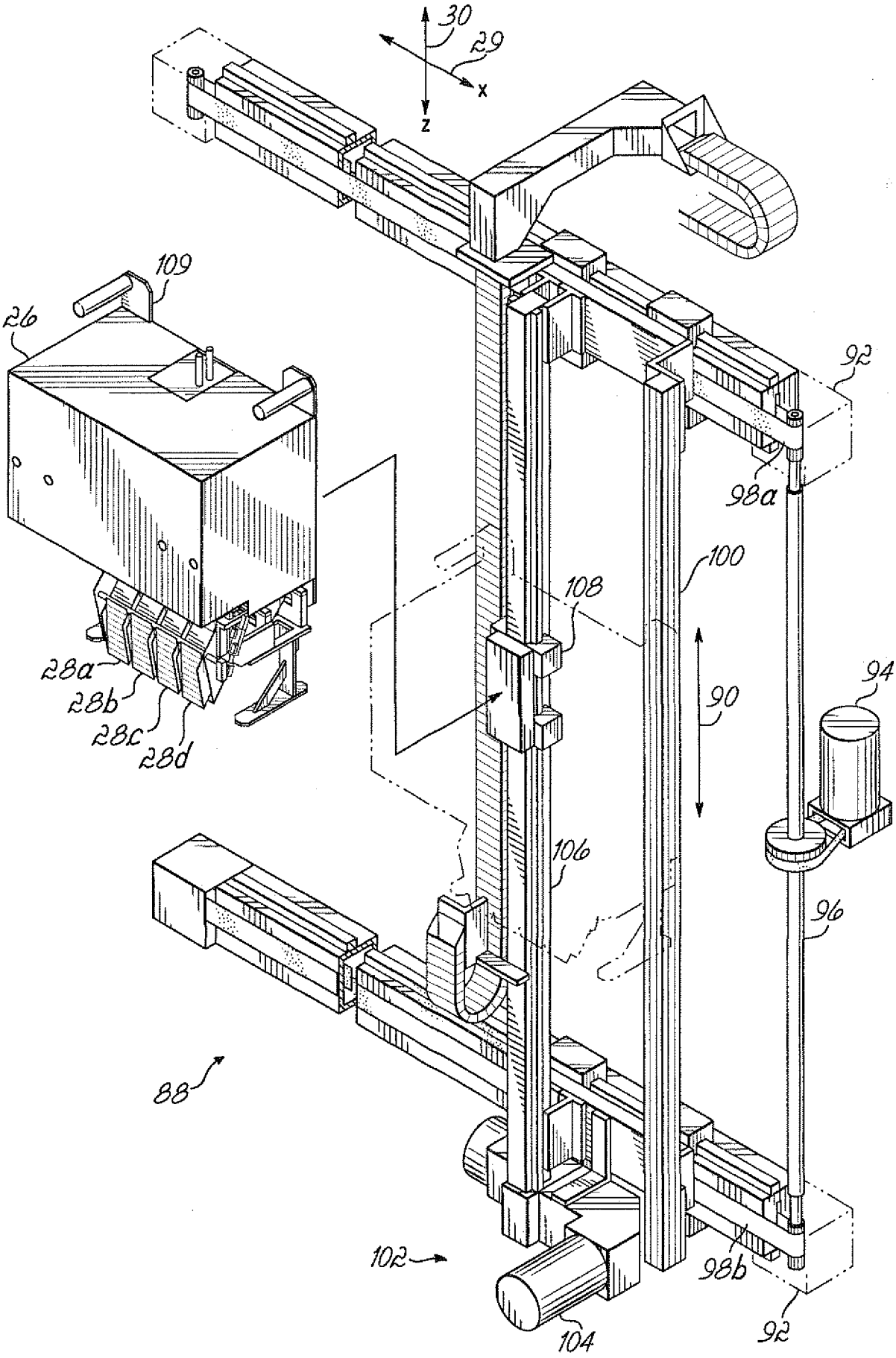


FIG. 5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98b
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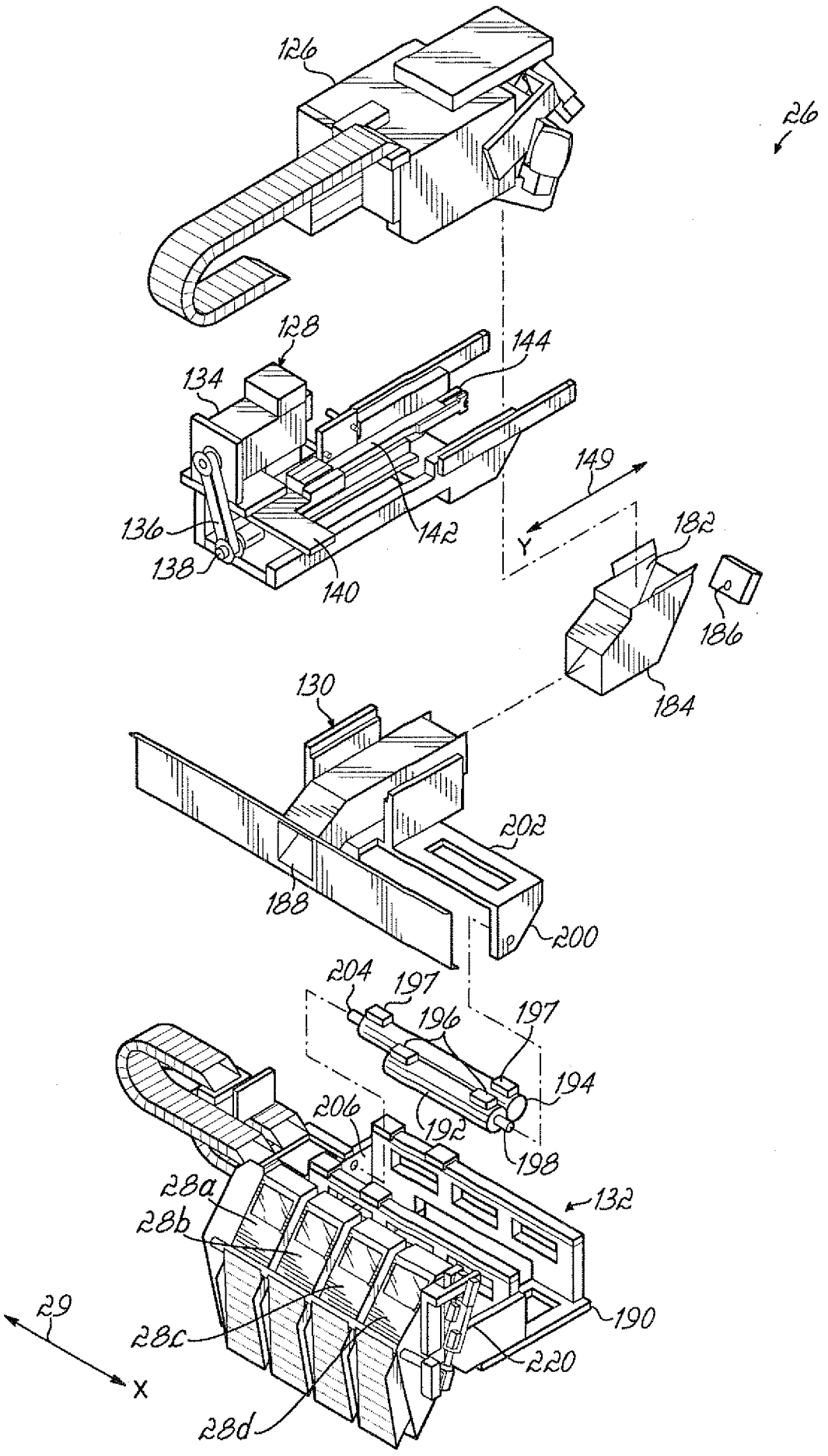
92

FIG. 6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28c
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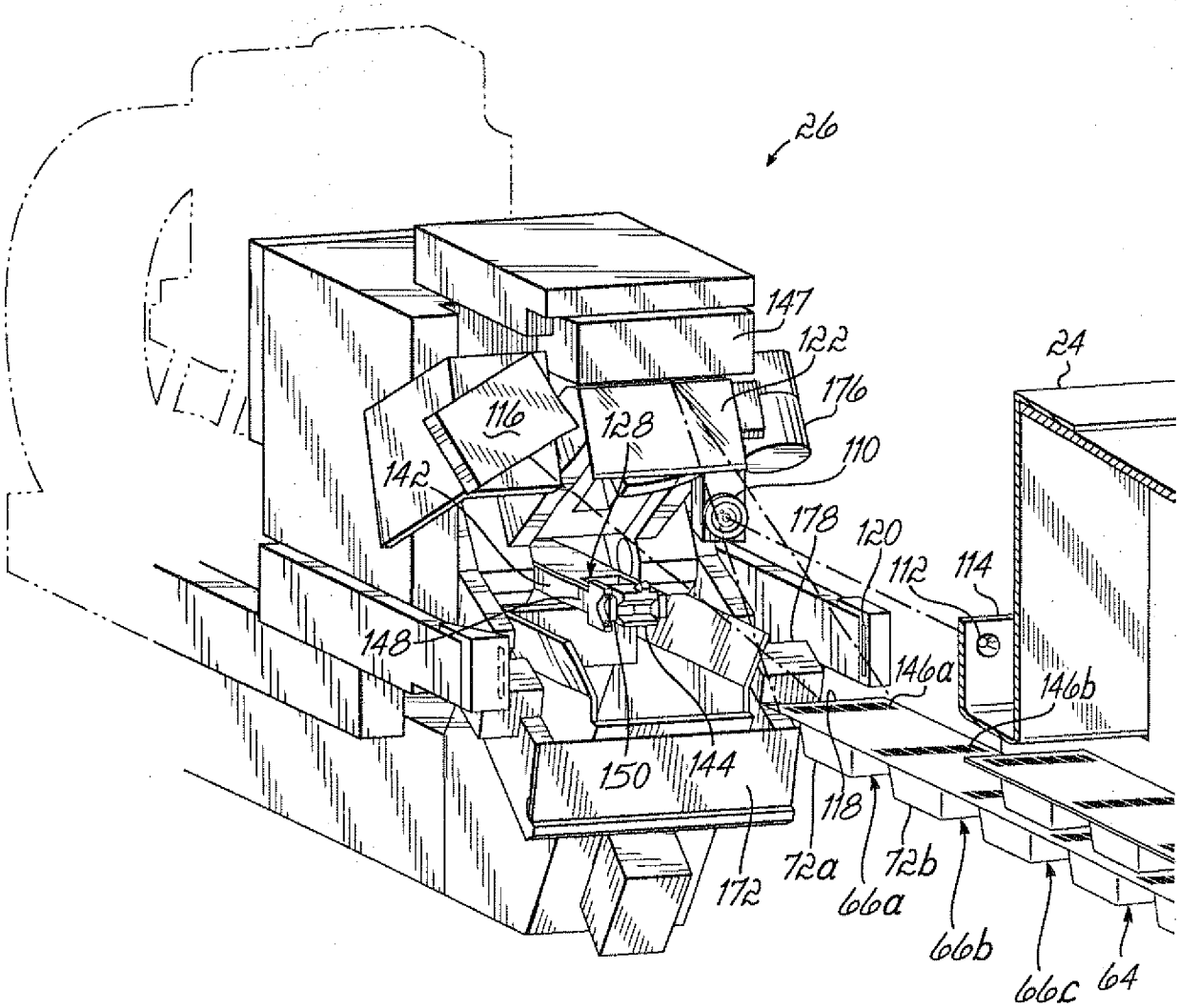
28d

FIG. 7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72b
66a
66b
66c
64

FIG. 8

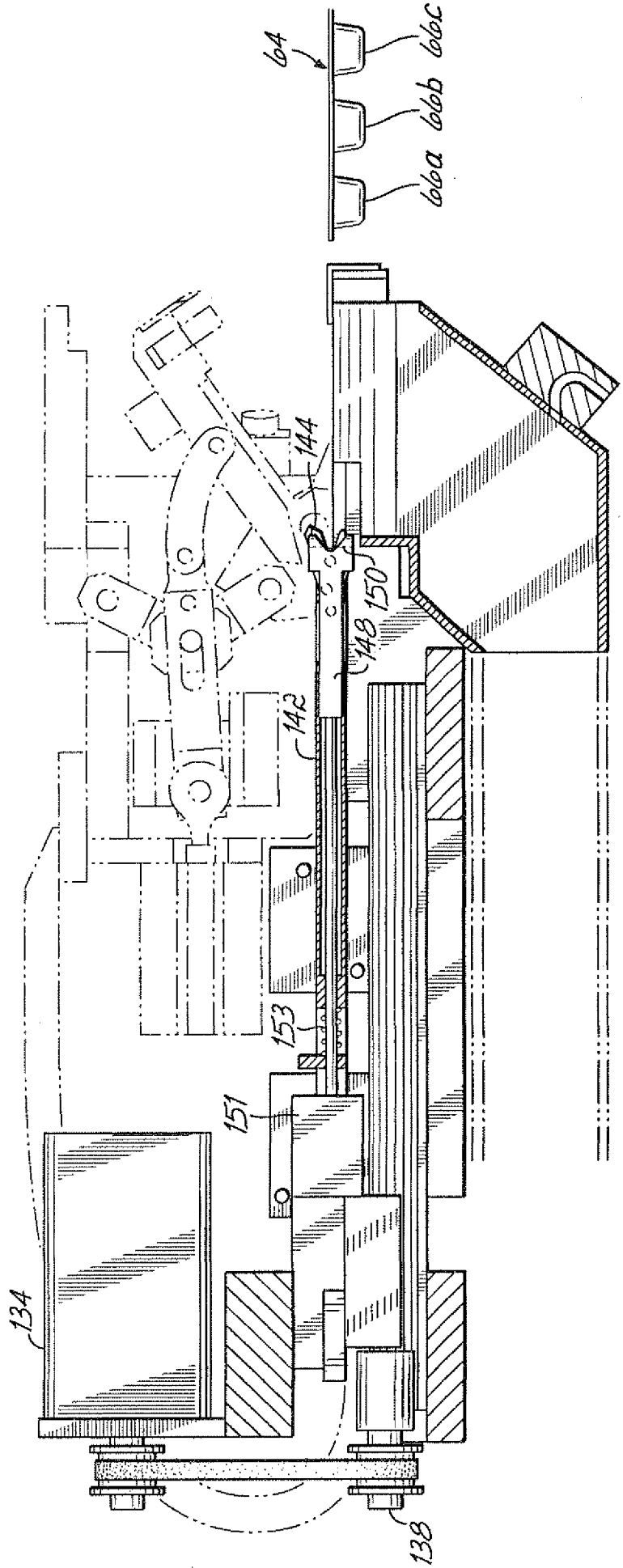
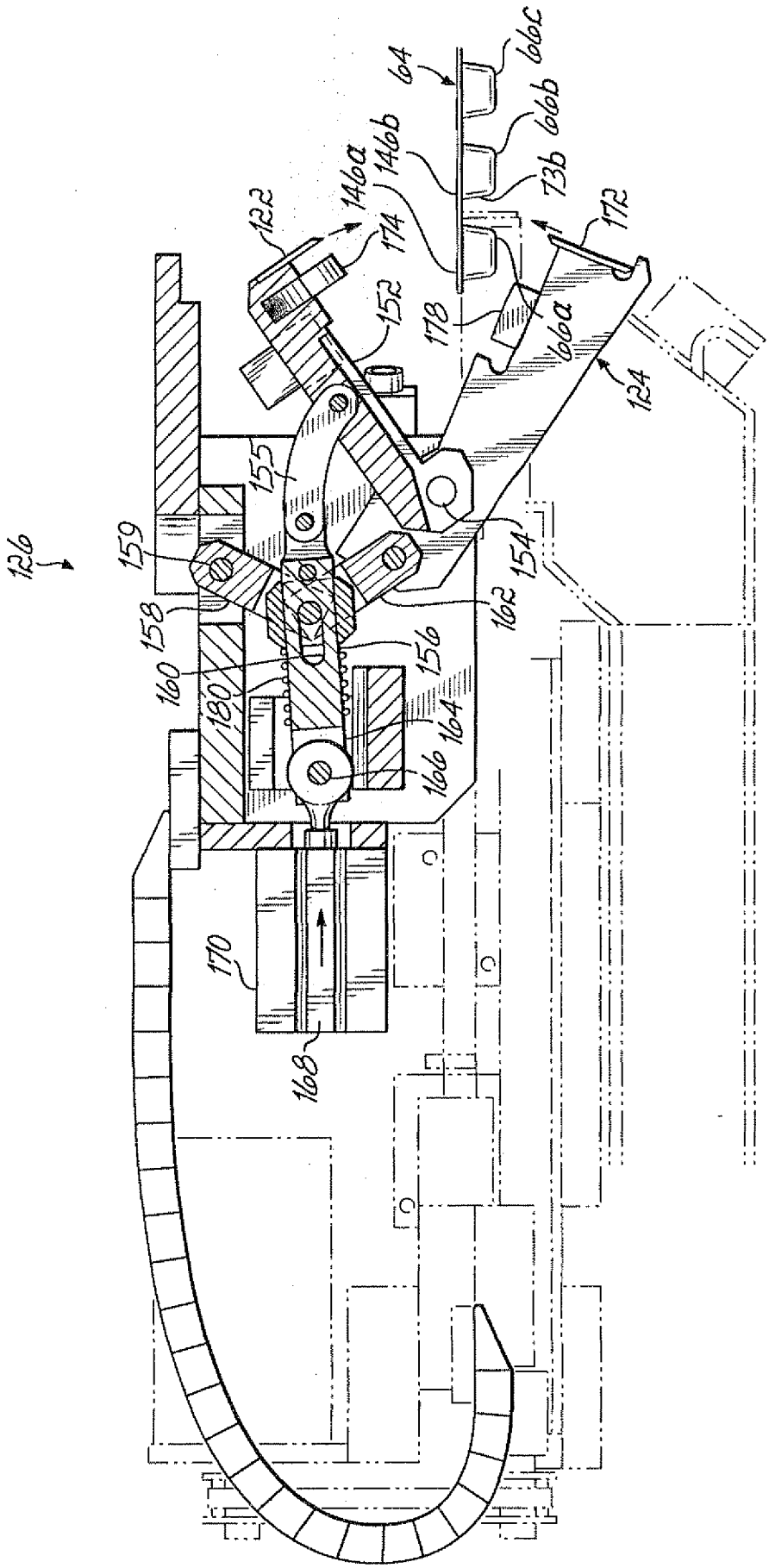


FIG. 9A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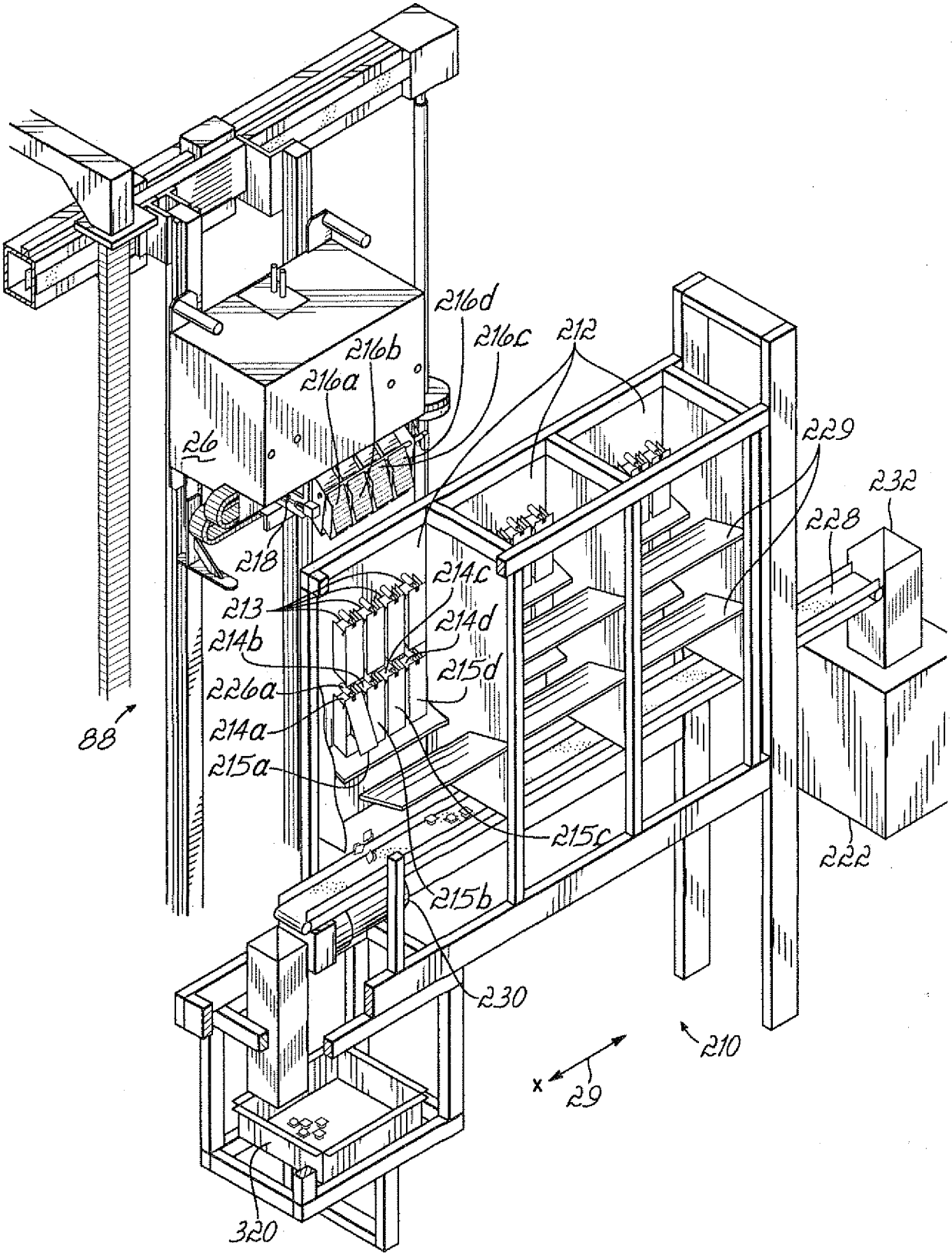
168

FIG. 9B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216b
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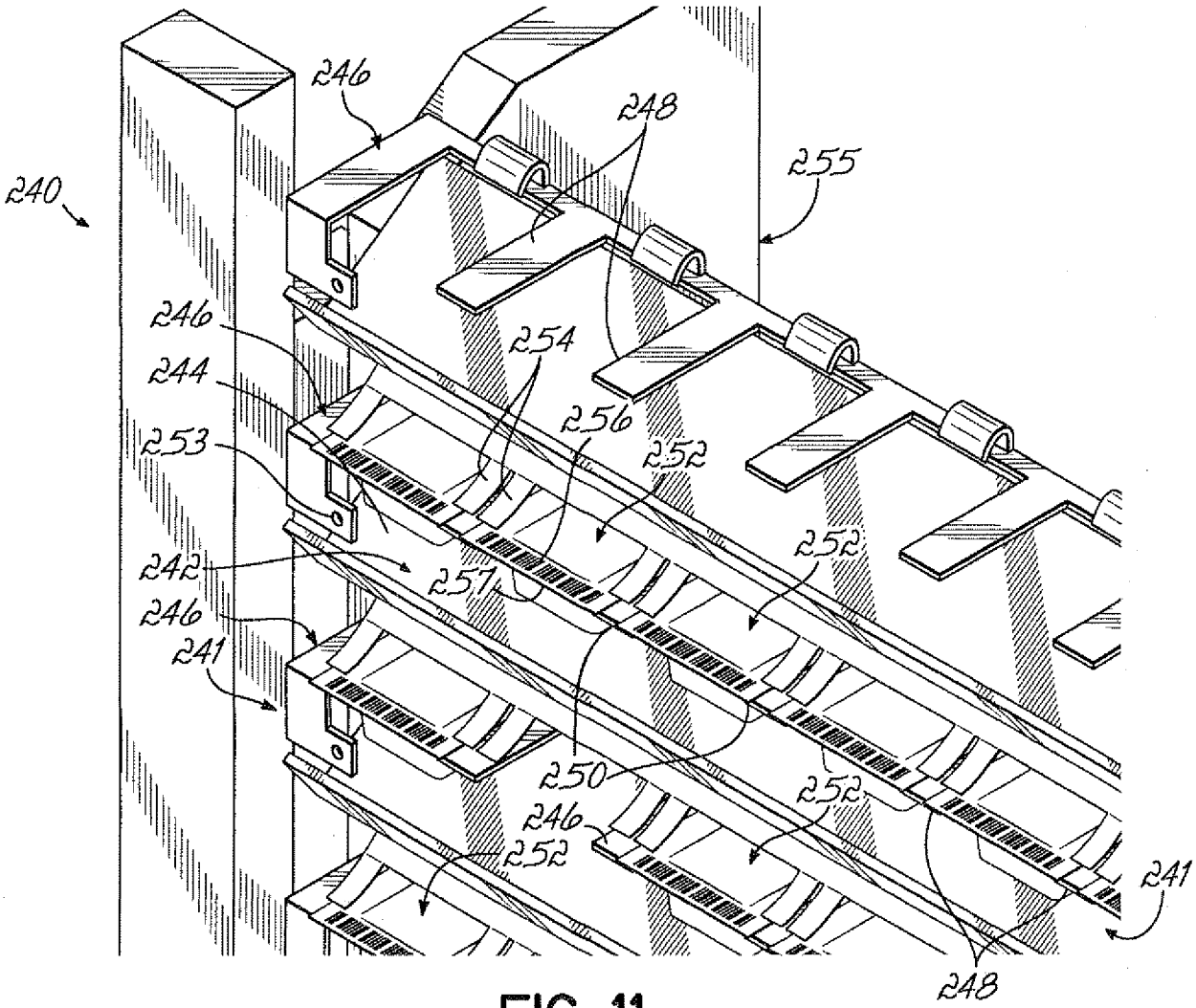
88
215c
222
215b
230
210
x
29
320

FIG. 10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248

FIG. 11

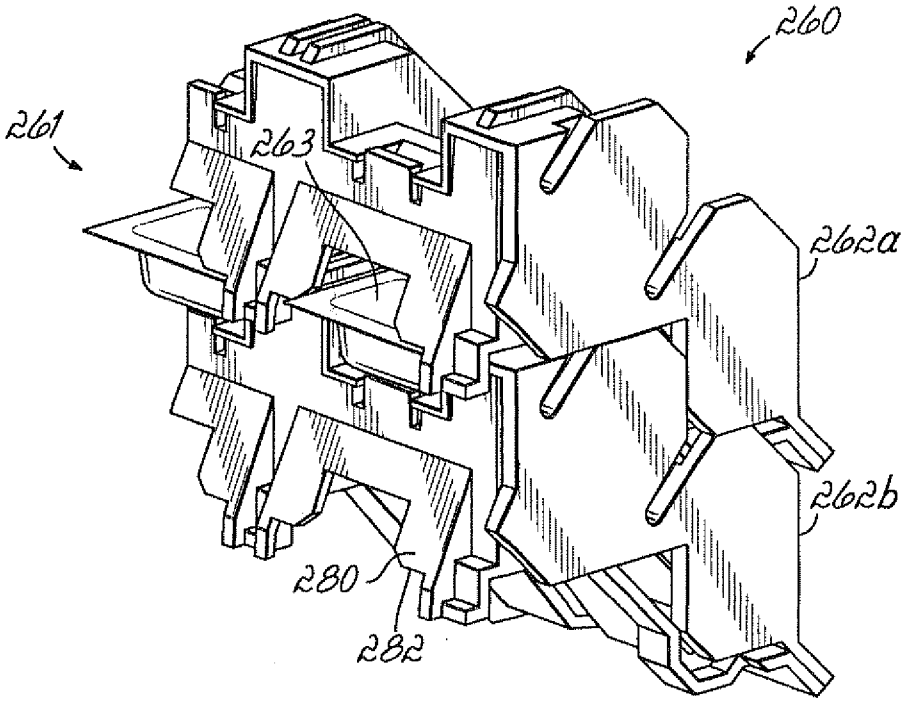
260
261
263
262a
262b
280
282

FIG. 12

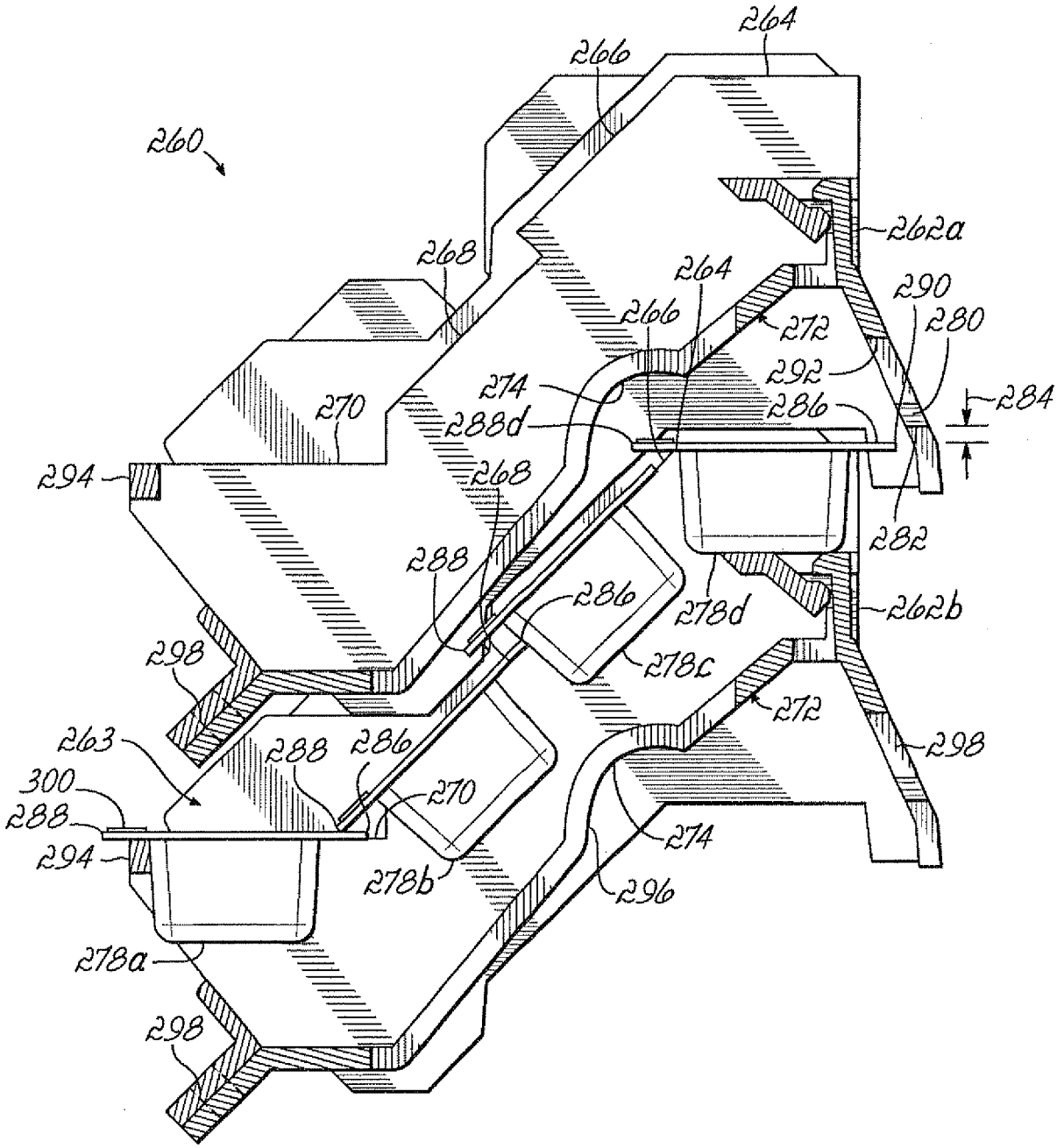
260
264
266
262a
268
264
290
280
266
272
292
274
284
270
288d
286
294
268
282
288
286
278d
262b
298
278c
272
263
288
286
298
300
270
288
274
294
278b
296
278a
298

FIG. 13

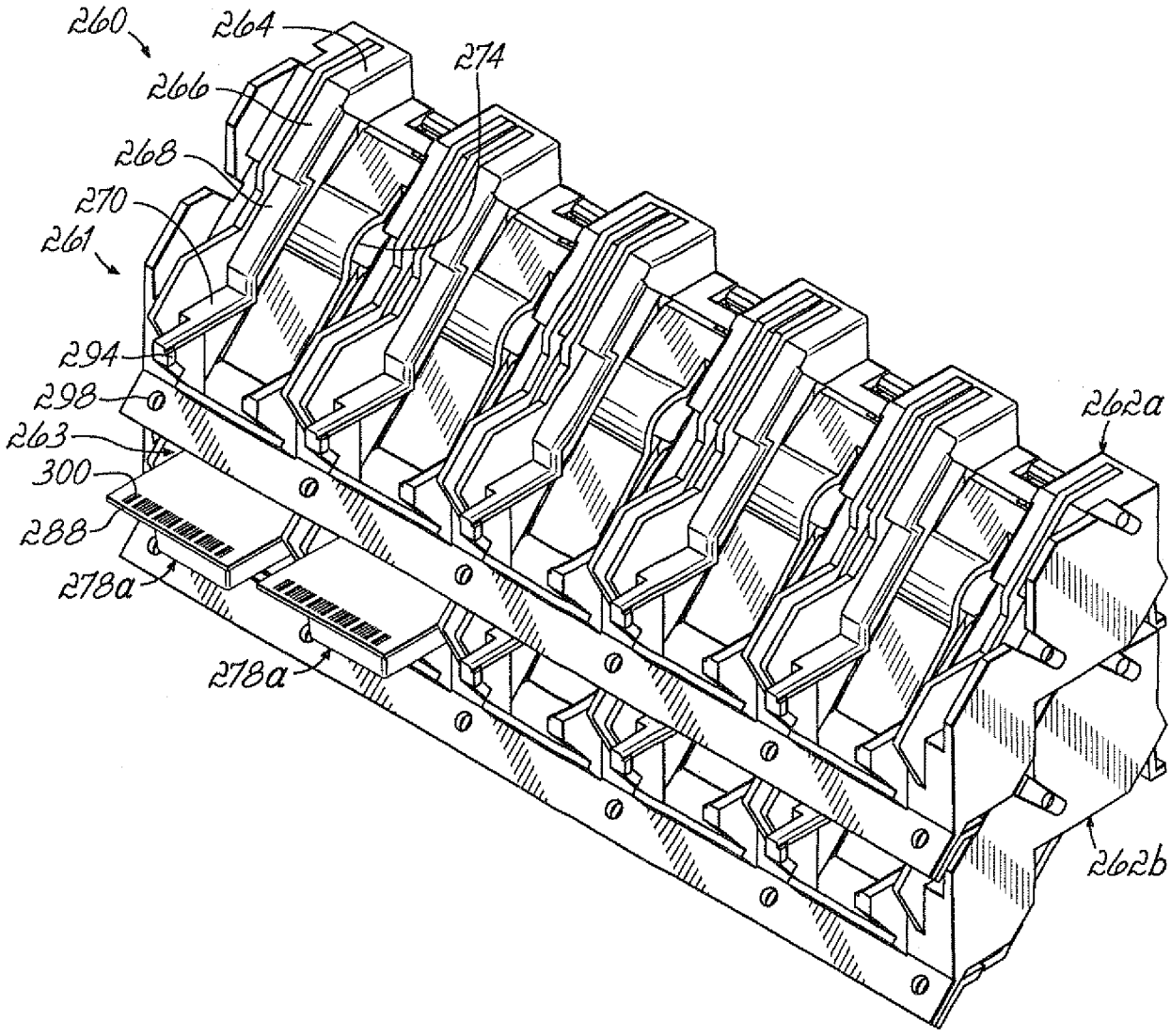
260
264
274
266
268
270
261
294
298
263
300
288
278a
278a
262a
262b

FIG. 14

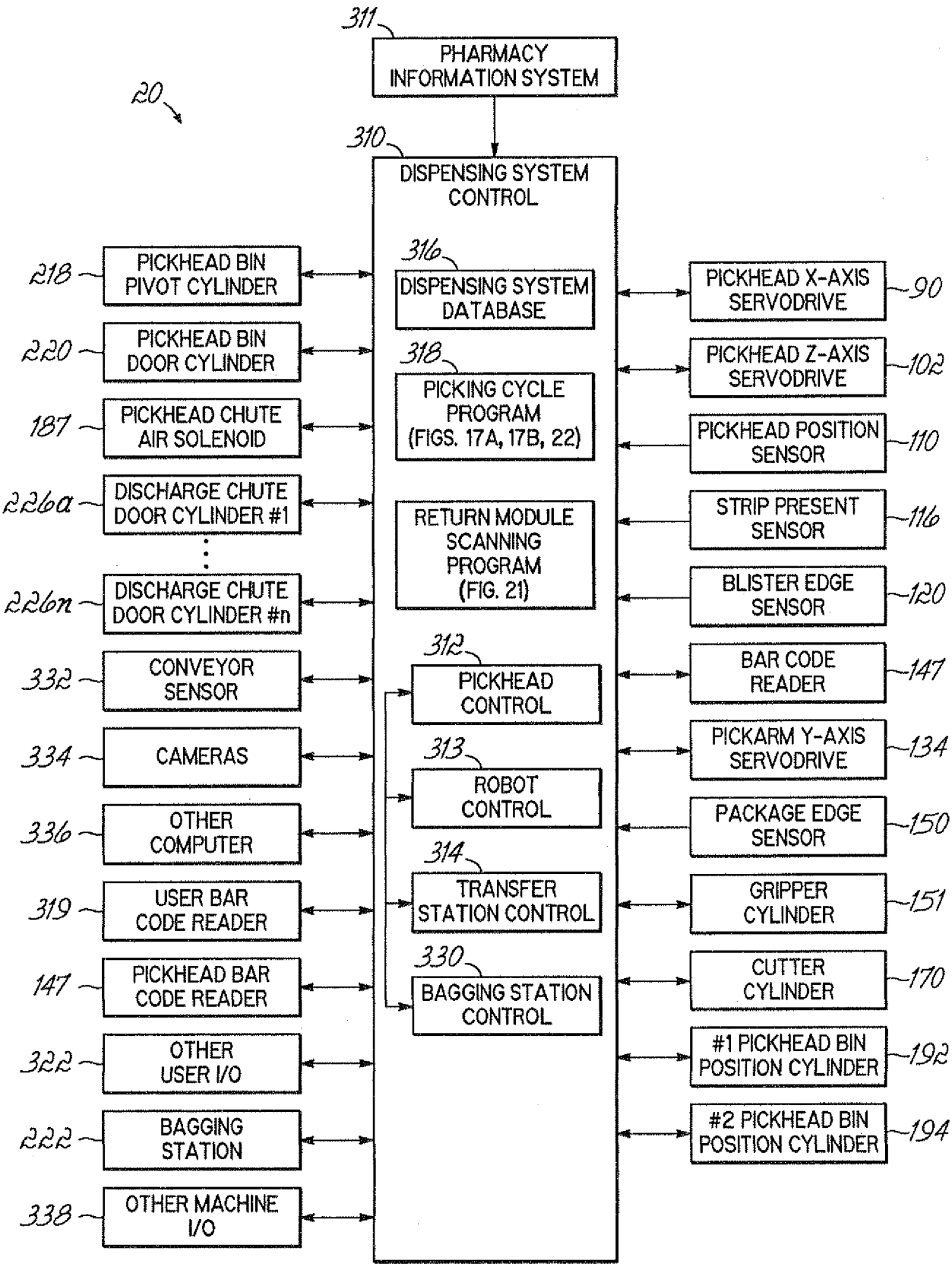
311
PHARMACY INFORMATION SYSTEM
20
310
DISPENSING SYSTEM CONTROL
316
DISPENSING SYSTEM DATABASE
318
PICKING CYCLE PROGRAM (FIGS. 17A, 17B, 22)
RETURN MODULE SCANNING PROGRAM (FIG. 21)
312
PICKHEAD CONTROL
313
ROBOT CONTROL
314
TRANSFER STATION CONTROL
330
BAGGING STATION CONTROL
218 PICKHEAD BIN PIVOT CYLINDER
220 PICKHEAD BIN DOOR CYLINDER
187 PICKHEAD CHUTE AIR SOLENOID
226a DISCHARGE CHUTE DOOR CYLINDER #1
226n DISCHARGE CHUTE DOOR CYLINDER #n
332 CONVEYOR SENSOR
334 CAMERAS
336 OTHER COMPUTER
319 USER BAR CODE READER
147 PICKHEAD BAR CODE READER
322 OTHER USER I/O
222 BAGGING STATION
338 OTHER MACHINE I/O
PICKHEAD X-AXIS SERVODRIVE 90
PICKHEAD Z-AXIS SERVODRIVE 102
PICKHEAD POSITION SENSOR 110
STRIP PRESENT SENSOR 116
BLISTER EDGE SENSOR 120
BAR CODE READER 147
PICKARM Y-AXIS SERVODRIVE 134
PACKAGE EDGE SENSOR 150
GRIPPER CYLINDER 151
CUTTER CYLINDER 170
#1 PICKHEAD BIN POSITION CYLINDER 192
#2 PICKHEAD BIN POSITION CYLINDER 194

FIG. 15

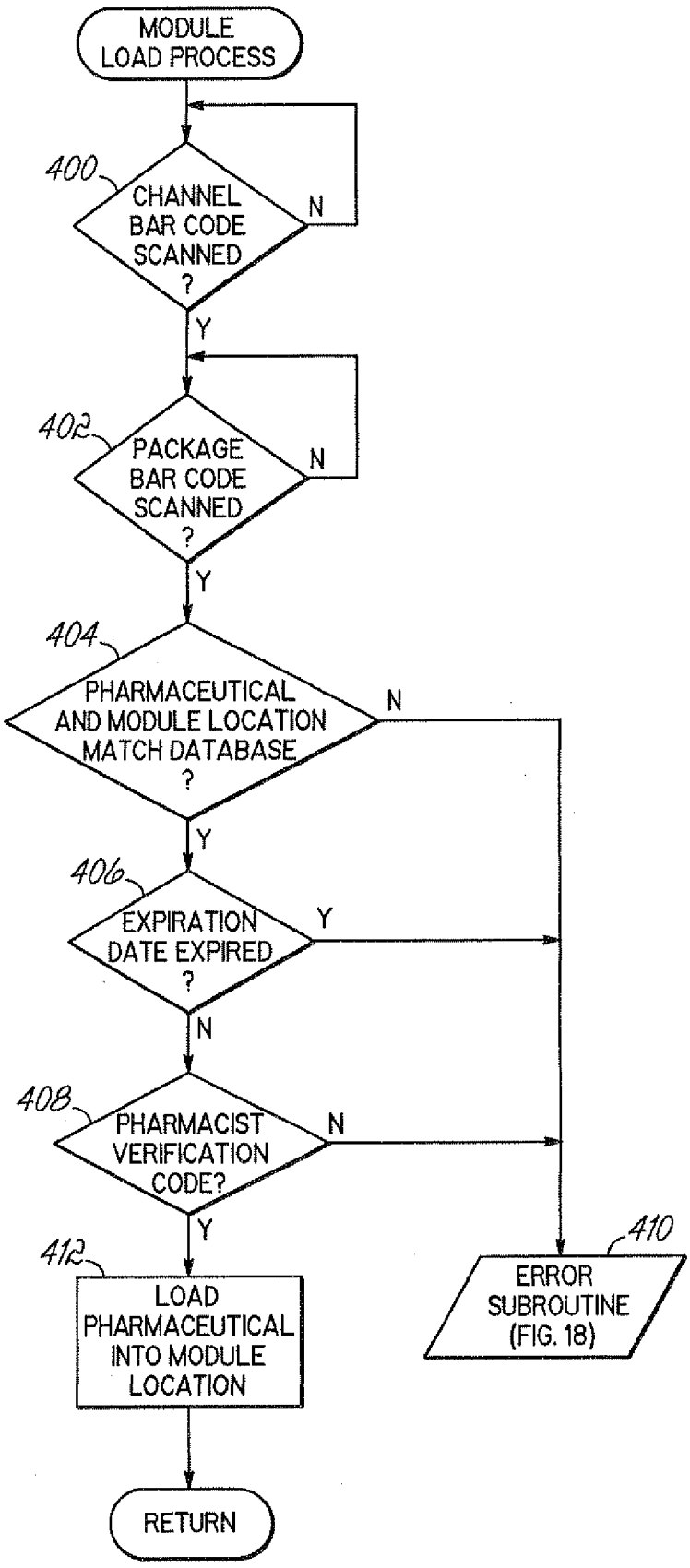
MODULE LOAD PROCESS
400
CHANNEL BAR CODE SCANNED ?
N
Y
402
PACKAGE BAR CODE SCANNED ?
N
Y
404
PHARMACEUTICAL AND MODULE LOCATION MATCH DATABASE ?
N
Y
406
EXPIRATION DATE EXPIRED ?
Y
N
408
PHARMACIST VERIFICATION CODE?
N
Y
410
ERROR SUBROUTINE (FIG. 18)
412
LOAD PHARMACEUTICAL INTO MODULE LOCATION
RETURN

FIG. 16

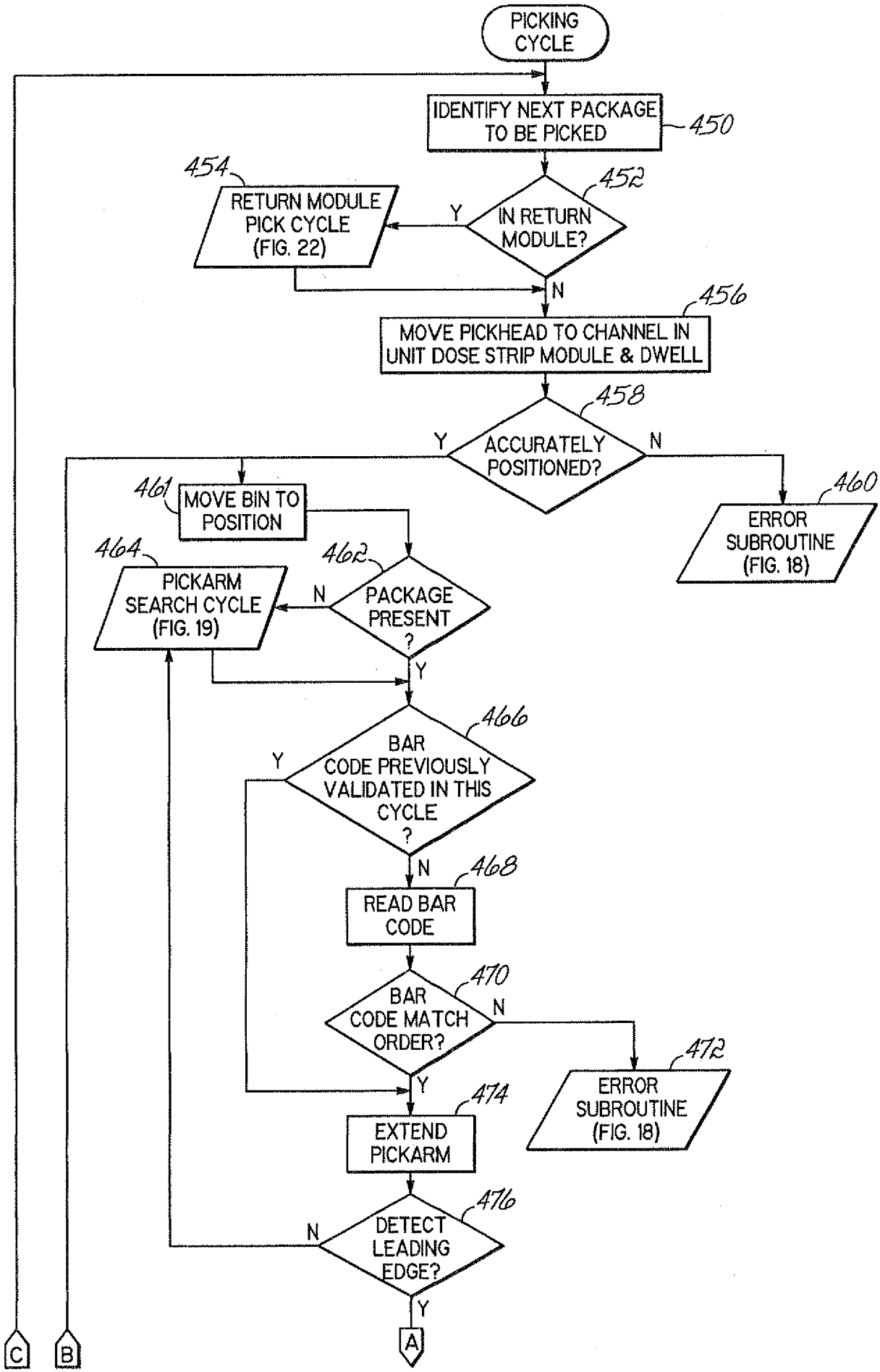
PICKING CYCLE
IDENTIFY NEXT PACKAGE TO BE PICKED
450
IN RETURN MODULE?
452
Y
RETURN MODULE PICK CYCLE (FIG. 22)
454
N
MOVE PICKHEAD TO CHANNEL IN UNIT DOSE STRIP MODULE & DWELL
456
ACCURATELY POSITIONED?
458
Y
N
ERROR SUBROUTINE (FIG. 18)
460
MOVE BIN TO POSITION
461
PACKAGE PRESENT ?
462
N
PICKARM SEARCH CYCLE (FIG. 19)
464
Y
BAR CODE PREVIOUSLY VALIDATED IN THIS CYCLE ?
466
Y
N
READ BAR CODE
468
BAR CODE MATCH ORDER?
470
N
ERROR SUBROUTINE (FIG. 18)
472
Y
EXTEND PICKARM
474
DETECT LEADING EDGE?
476
N
Y
A
B
C

FIG. 17A

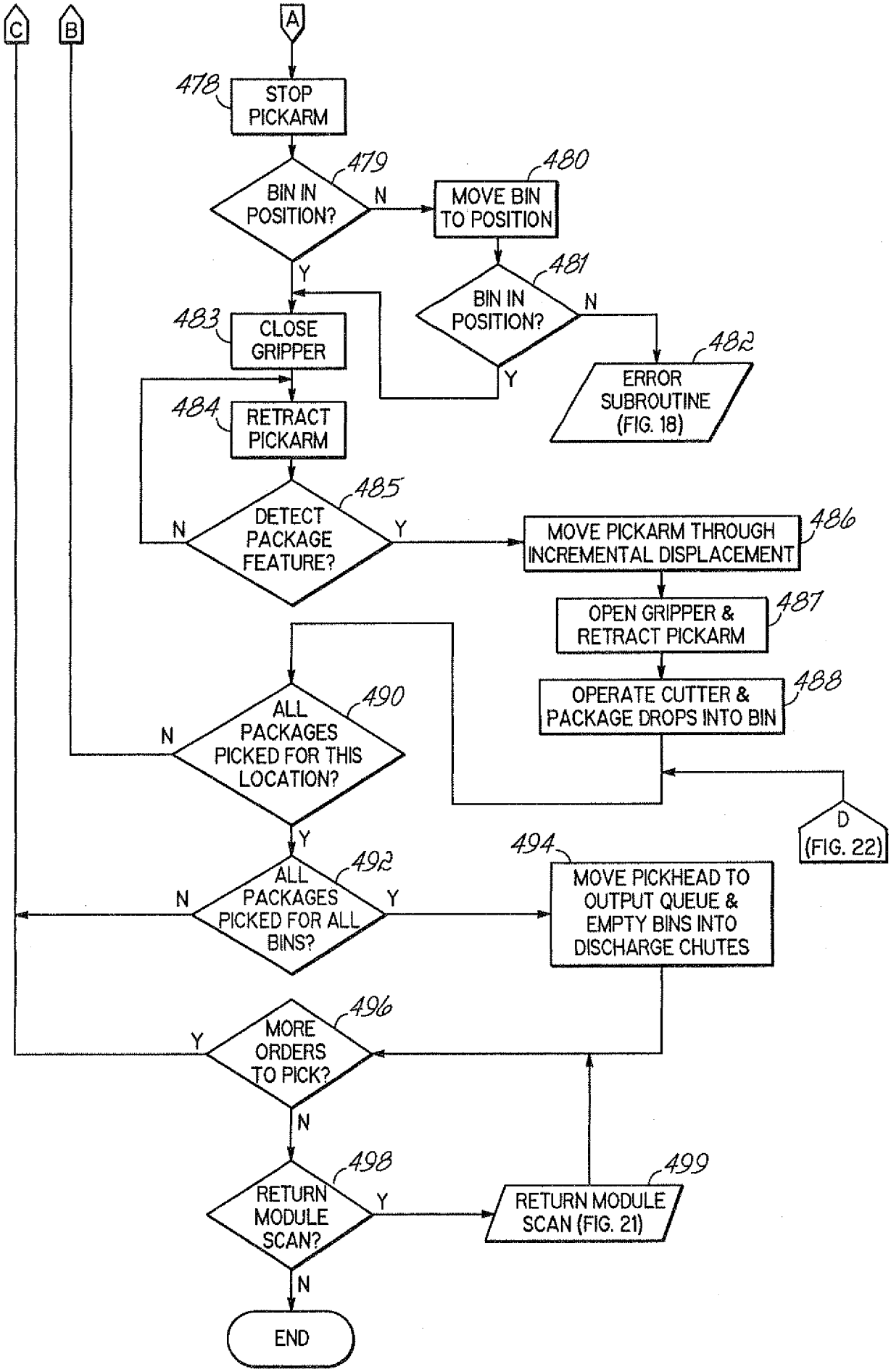
A
B
C
478
STOP PICKARM
479
BIN IN POSITION?
N
480
MOVE BIN TO POSITION
Y
481
BIN IN POSITION?
N
Y
482
ERROR SUBROUTINE (FIG. 18)
483
CLOSE GRIPPER
484
RETRACT PICKARM
485
DETECT PACKAGE FEATURE?
N
Y
486
MOVE PICKARM THROUGH INCREMENTAL DISPLACEMENT
487
OPEN GRIPPER & RETRACT PICKARM
488
OPERATE CUTTER & PACKAGE DROPS INTO BIN
D (FIG. 22)
490
ALL PACKAGES PICKED FOR THIS LOCATION?
N
Y
492
ALL PACKAGES PICKED FOR ALL BINS?
N
Y
494
MOVE PICKHEAD TO OUTPUT QUEUE & EMPTY BINS INTO DISCHARGE CHUTES
496
MORE ORDERS TO PICK?
Y
N
498
RETURN MODULE SCAN?
Y
N
499
RETURN MODULE SCAN (FIG. 21)
END

FIG. 17B

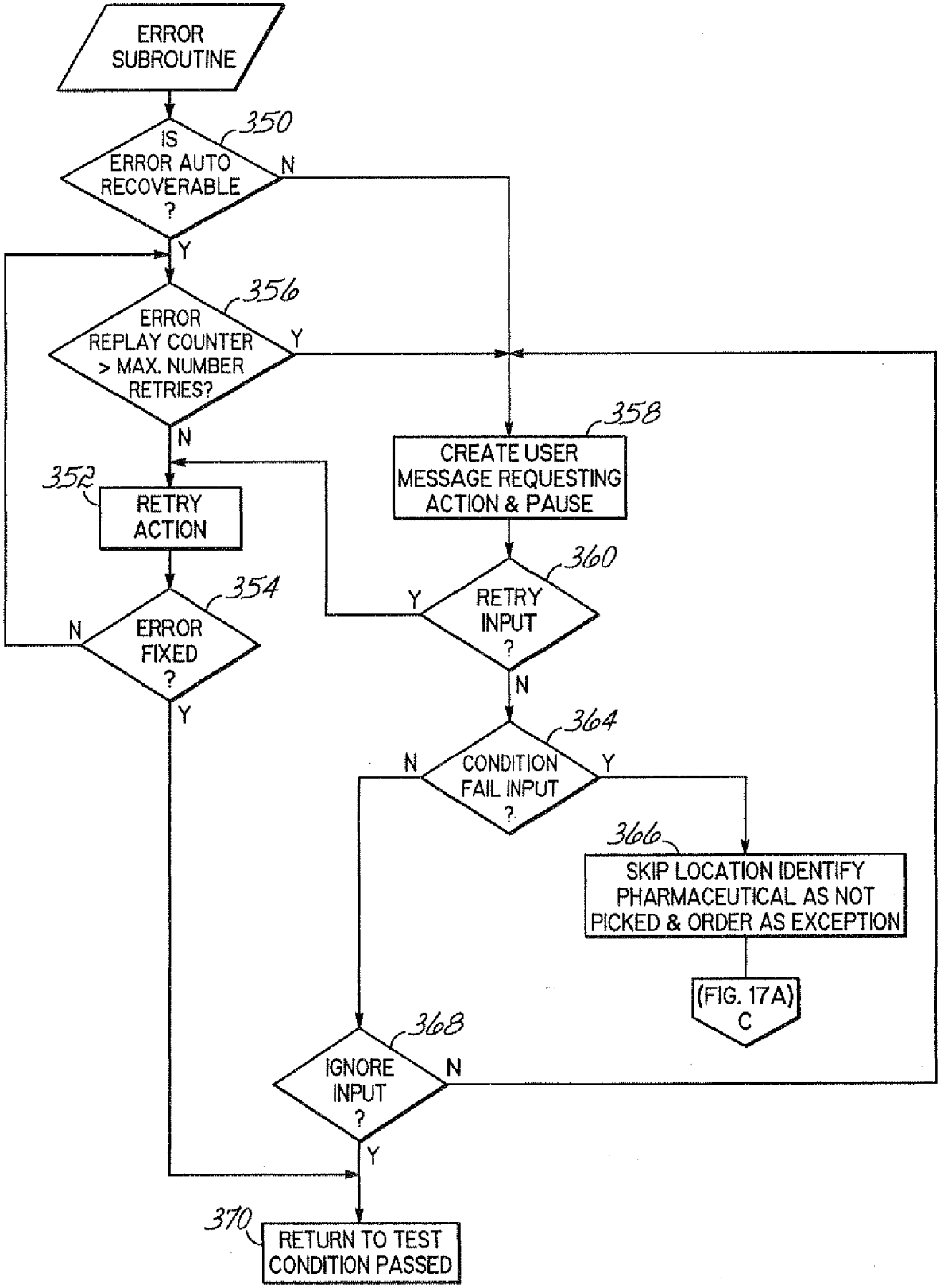
ERROR SUBROUTINE
350
IS ERROR AUTO RECOVERABLE ?
N
Y
356
ERROR REPLAY COUNTER > MAX. NUMBER RETRIES?
Y
N
358
CREATE USER MESSAGE REQUESTING ACTION & PAUSE
352
RETRY ACTION
354
ERROR FIXED ?
N
Y
360
RETRY INPUT ?
Y
N
364
CONDITION FAIL INPUT ?
N
Y
366
SKIP LOCATION IDENTIFY PHARMACEUTICAL AS NOT PICKED & ORDER AS EXCEPTION
(FIG. 17A) C
368
IGNORE INPUT ?
N
Y
370
RETURN TO TEST CONDITION PASSED

FIG. 18

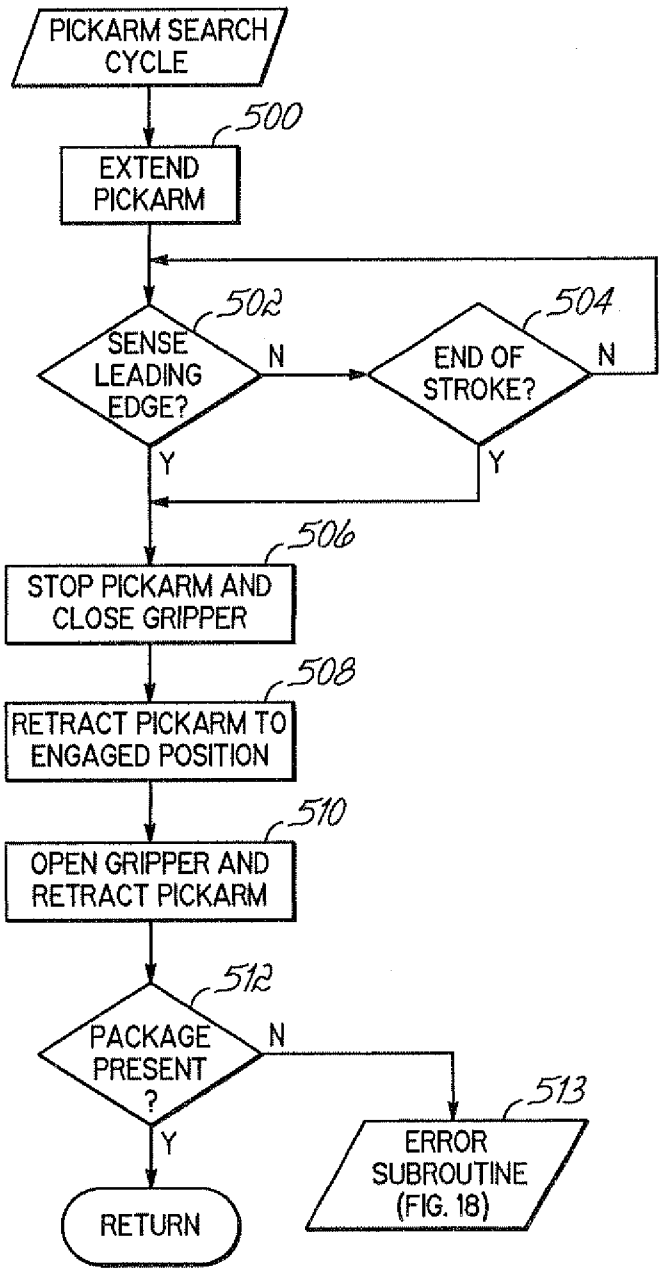
PICKARM SEARCH CYCLE
500
EXTEND PICKARM
502
SENSE LEADING EDGE?
N
504
END OF STROKE?
N
Y
Y
506
STOP PICKARM AND CLOSE GRIPPER
508
RETRACT PICKARM TO ENGAGED POSITION
510
OPEN GRIPPER AND RETRACT PICKARM
512
PACKAGE PRESENT ?
N
513
ERROR SUBROUTINE (FIG. 18)
Y
RETURN

FIG. 19

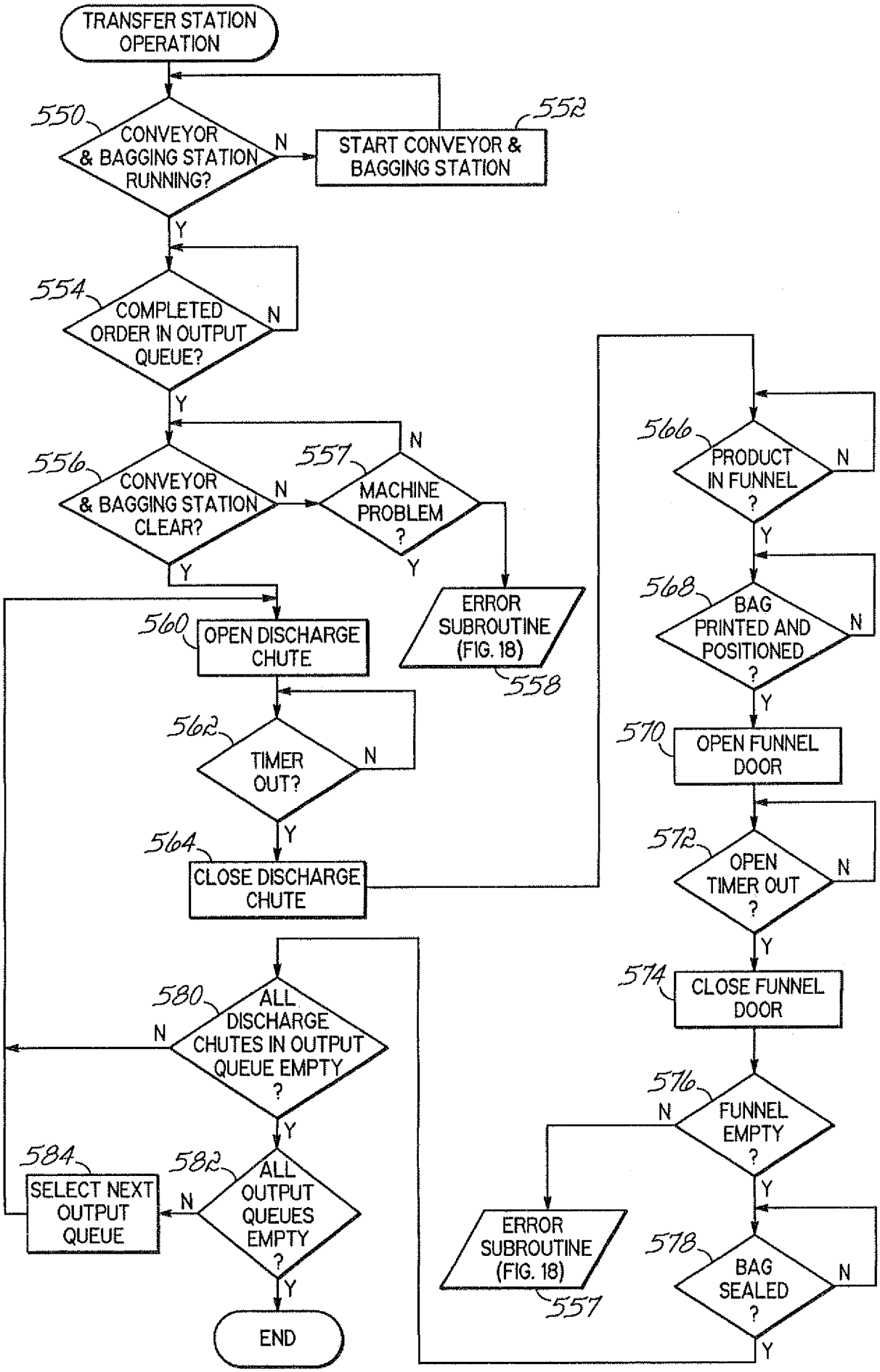
TRANSFER STATION OPERATION
550
CONVEYOR & BAGGING STATION RUNNING?
N
552
START CONVEYOR & BAGGING STATION
Y
554
COMPLETED ORDER IN OUTPUT QUEUE?
N
Y
556
CONVEYOR & BAGGING STATION CLEAR?
N
557
MACHINE PROBLEM ?
N
Y
ERROR SUBROUTINE (FIG. 18)
558
Y
560
OPEN DISCHARGE CHUTE
562
TIMER OUT?
N
Y
564
CLOSE DISCHARGE CHUTE
566
PRODUCT IN FUNNEL ?
N
Y
568
BAG PRINTED AND POSITIONED ?
N
Y
570
OPEN FUNNEL DOOR
572
OPEN TIMER OUT ?
N
Y
574
CLOSE FUNNEL DOOR
576
FUNNEL EMPTY ?
N
Y
ERROR SUBROUTINE (FIG. 18)
557
578
BAG SEALED ?
N
Y
580
ALL DISCHARGE CHUTES IN OUTPUT QUEUE EMPTY ?
N
Y
582
ALL OUTPUT QUEUES EMPTY ?
N
Y
584
SELECT NEXT OUTPUT QUEUE
END

FIG. 20

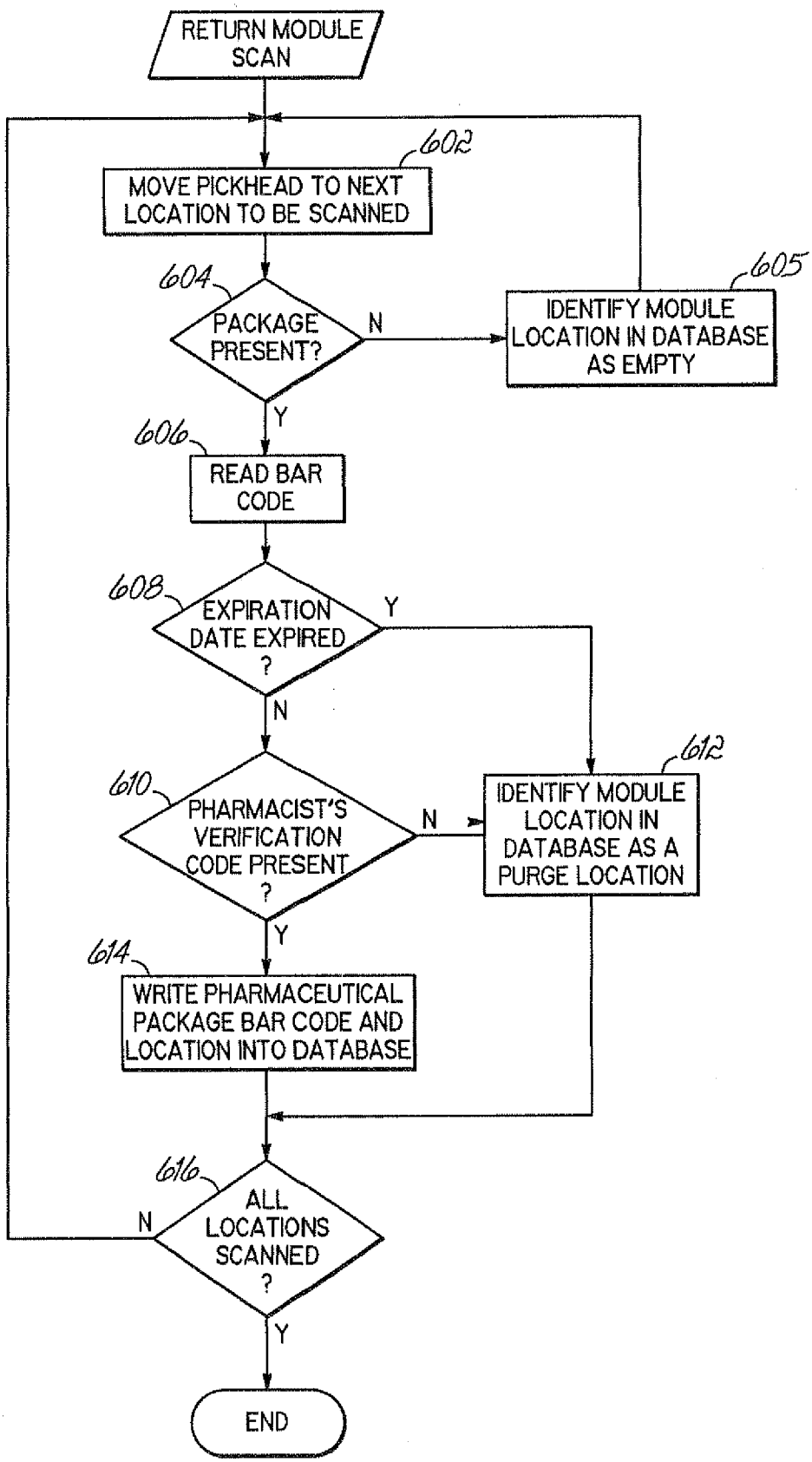
RETURN MODULE SCAN
602
MOVE PICKHEAD TO NEXT LOCATION TO BE SCANNED
604
PACKAGE PRESENT?
N
605
IDENTIFY MODULE LOCATION IN DATABASE AS EMPTY
Y
606
READ BAR CODE
608
EXPIRATION DATE EXPIRED ?
Y
N
610
PHARMACIST'S VERIFICATION CODE PRESENT ?
N
612
IDENTIFY MODULE LOCATION IN DATABASE AS A PURGE LOCATION
Y
614
WRITE PHARMACEUTICAL PACKAGE BAR CODE AND LOCATION INTO DATABASE
616
ALL LOCATIONS SCANNED ?
N
Y
END

FIG. 21

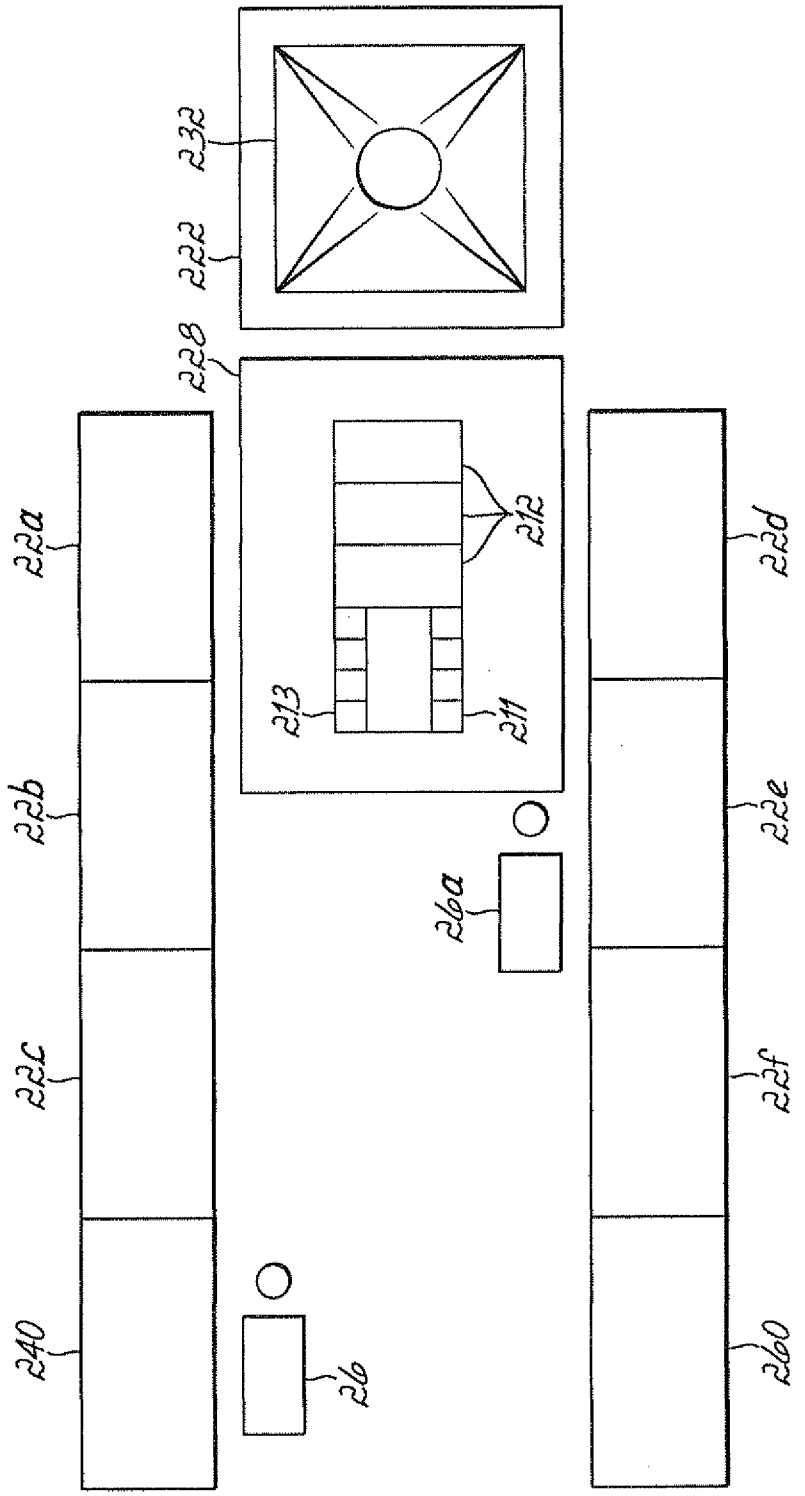
232
222
220
212
213
211
222a
222b
222c
222d
222e
222f
240
260
26
26a

FIG. 23

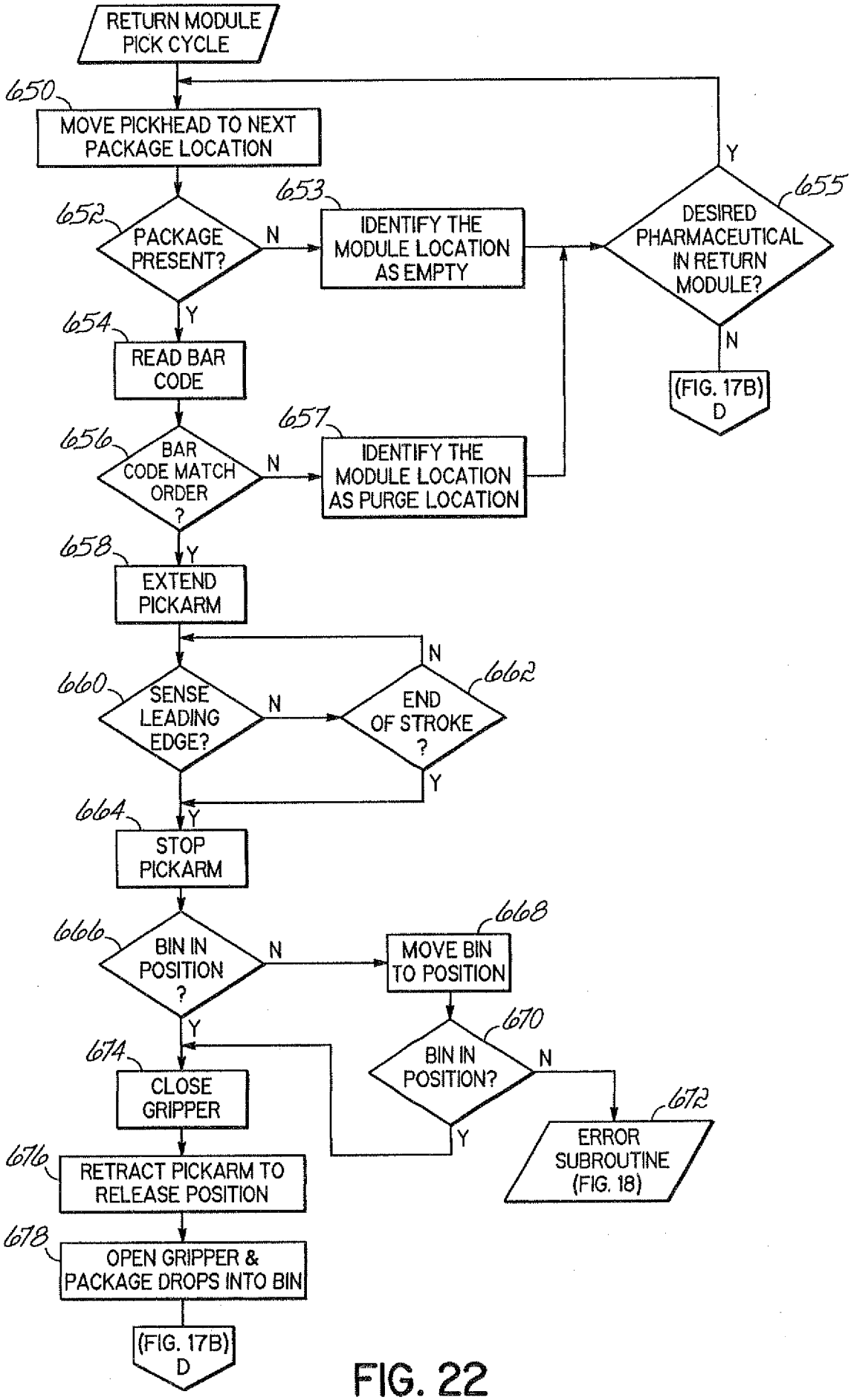
RETURN MODULE PICK CYCLE
650
MOVE PICKHEAD TO NEXT PACKAGE LOCATION
652
PACKAGE PRESENT?
N
653
IDENTIFY THE MODULE LOCATION AS EMPTY
655
DESIRED PHARMACEUTICAL IN RETURN MODULE?
Y
N
(FIG. 17B) D
Y
654
READ BAR CODE
656
BAR CODE MATCH ORDER ?
N
657
IDENTIFY THE MODULE LOCATION AS PURGE LOCATION
Y
658
EXTEND PICKARM
660
SENSE LEADING EDGE?
N
662
END OF STROKE ?
N
Y
Y
664
STOP PICKARM
666
BIN IN POSITION ?
N
668
MOVE BIN TO POSITION
670
BIN IN POSITION?
N
672
ERROR SUBROUTINE (FIG. 18)
Y
Y
674
CLOSE GRIPPER
676
RETRACT PICKARM TO RELEASE POSITION
678
OPEN GRIPPER & PACKAGE DROPS INTO BIN
(FIG. 17B) D

FIG. 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 07/87905

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61J 1/00 (2008.04)
USPC - 221/2
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 221/2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8): A61J 1/00 (2008.04)
USPC: 221/2, 92; 221/

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (USPT, PGPB, EPAB, JPAB); Google/Patents; Google/Scholar
Search Terms: medicine, pharmaceutical, medication, drug, dispenser, distribution, administer, robot, arm, pickhead, jaw, arm, selector, grabber, gripper, finger, belt, ribbon, strip, container, package, pouch, bottle, bin, bag, cut, sever, slice, sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US 6,230,927 B1 (Schoonen et al.) 15 May 2001 (15.05.2001), entire document, especially Figs. 1A and 3A;col 2, lns 31-51	9-12 ----- 1-8, 13-25
Y	US 6,690,998 B1 (Yuyama) 10 Februrary 2004 (10.02.2004), col 7, lns 29-36	1-8, 15-25
Y	US 2005/0065645 A1 (Liff et al.) 24 March 2005 (24.03.2005), Fig. 32, paras [0010], [0012], and [0083]	13-25

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 May 2008 (28.05.2008)	09 JUN 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)