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DISCHARGE CHUTE CONTROL SYSTEM****Publication Classification**(51) **Int. Cl.***A01D 34/71* (2006.01)*A01D 34/66* (2006.01)*A01D 101/00* (2006.01)(52) **U.S. Cl.**CPC *A01D 34/71* (2013.01); *A01D 34/667*
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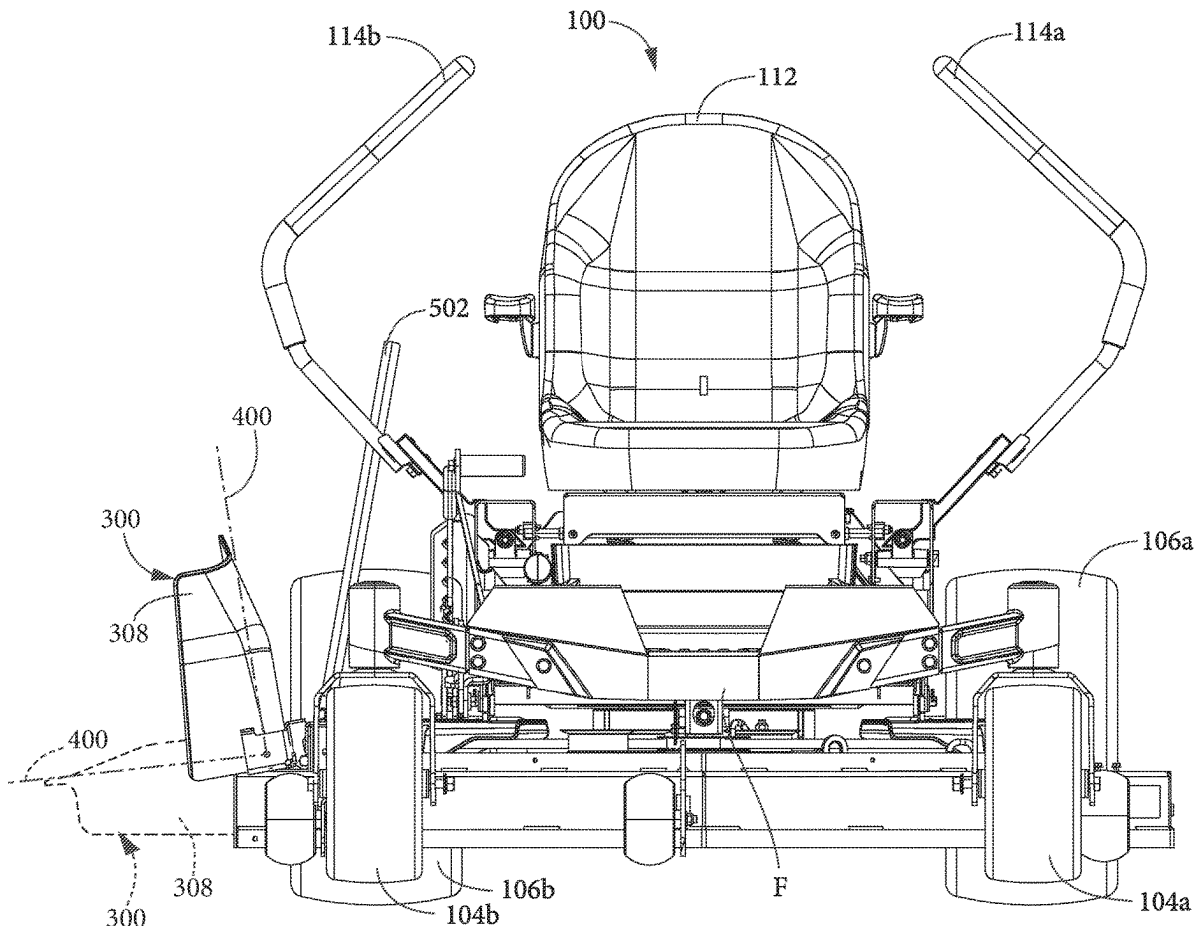
§ 371 (c)(1),

(2) Date: **Oct. 17, 2024****Related U.S. Application Data**(60) Provisional application No. 63/337,690, filed on May
3, 2022.

(57)

ABSTRACT

A lawn mower having a cutting deck with a chute control system having a moveable discharge chute. The discharge chute is adapted to move from an operative position to an inoperative position, whereby such movement results in corresponding movement of a blocking plate used to selectively block a discharge outlet of the cutting deck from an open position to a closed position, respectively.



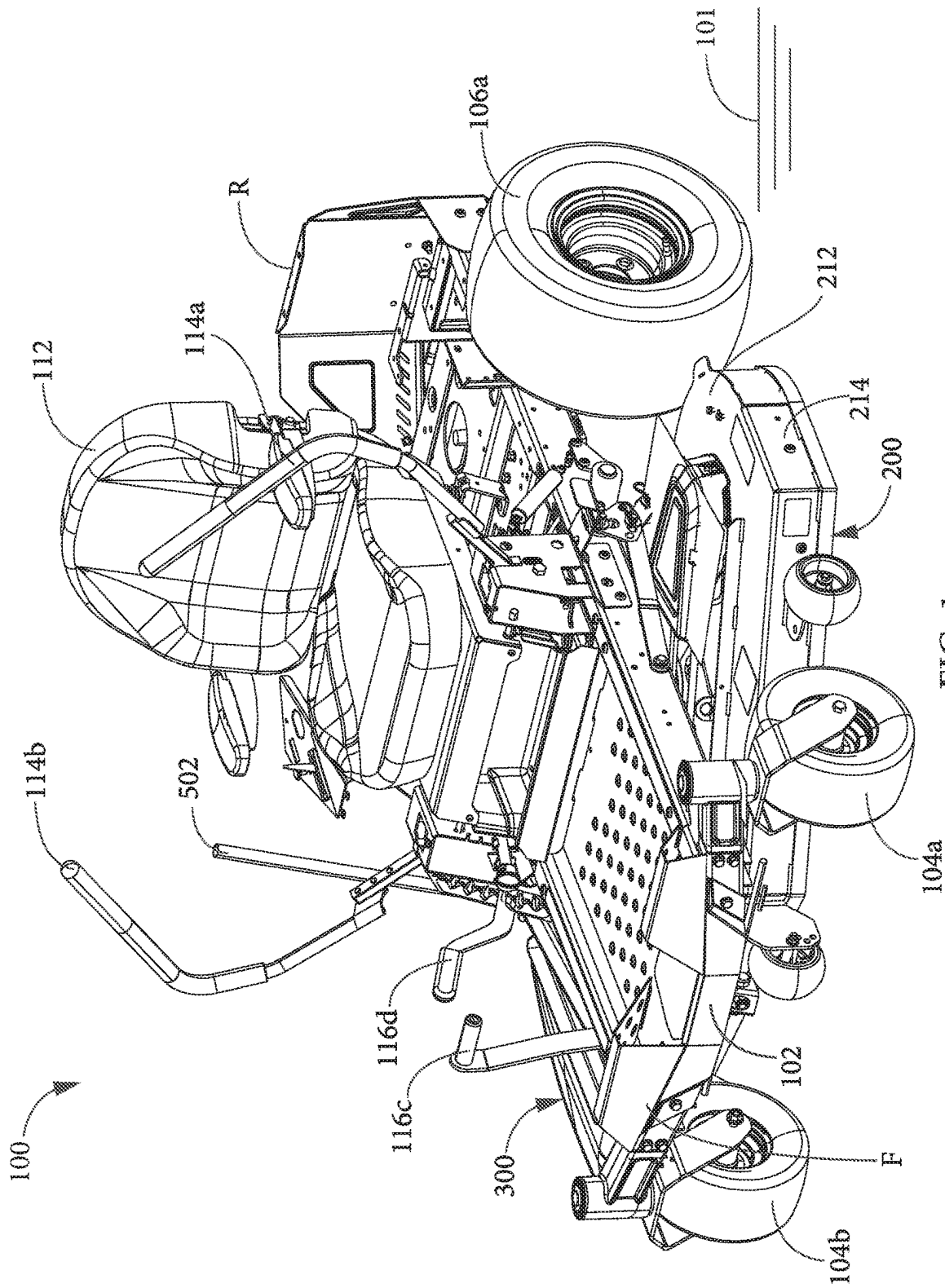
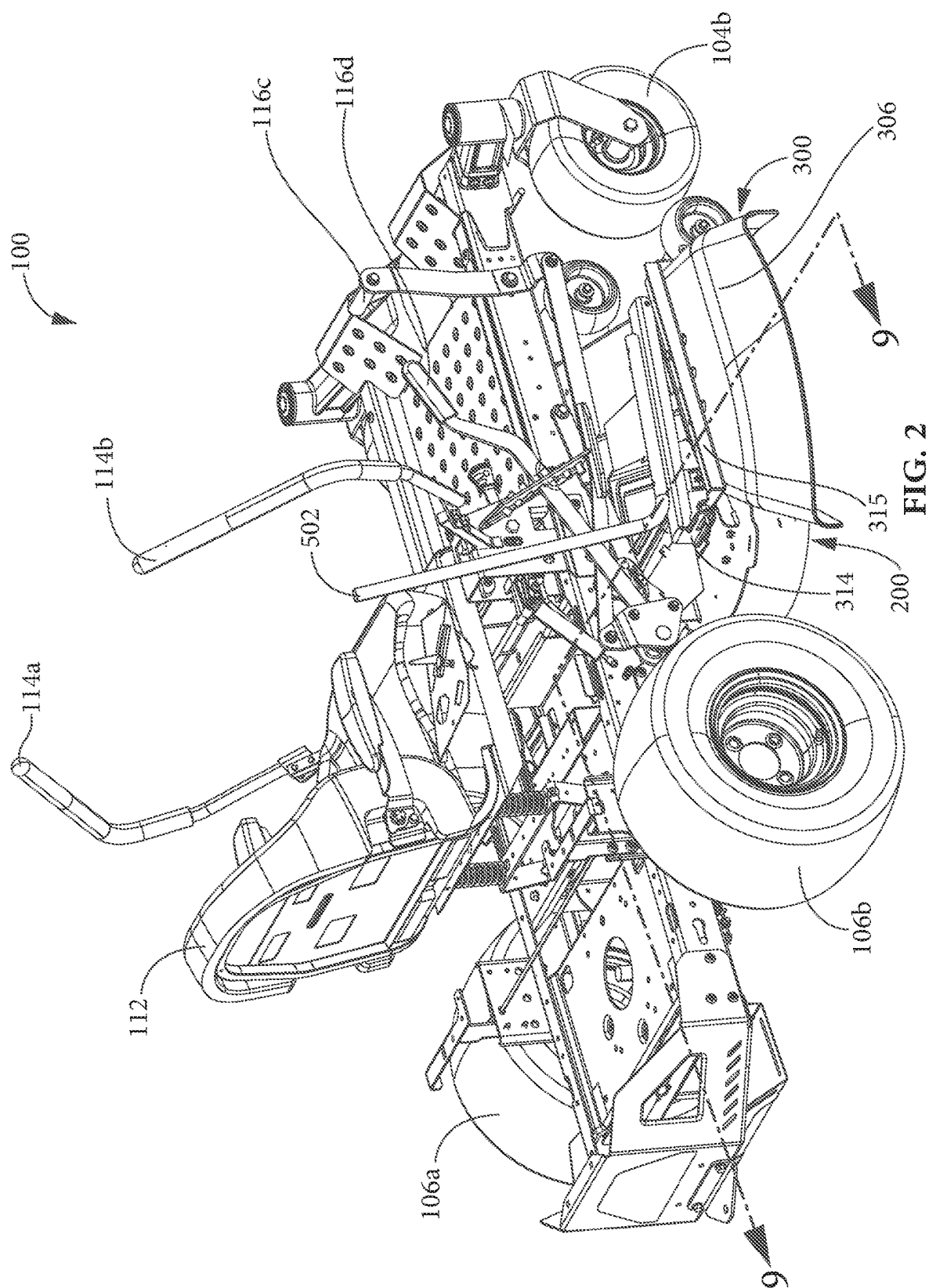


FIG. 1



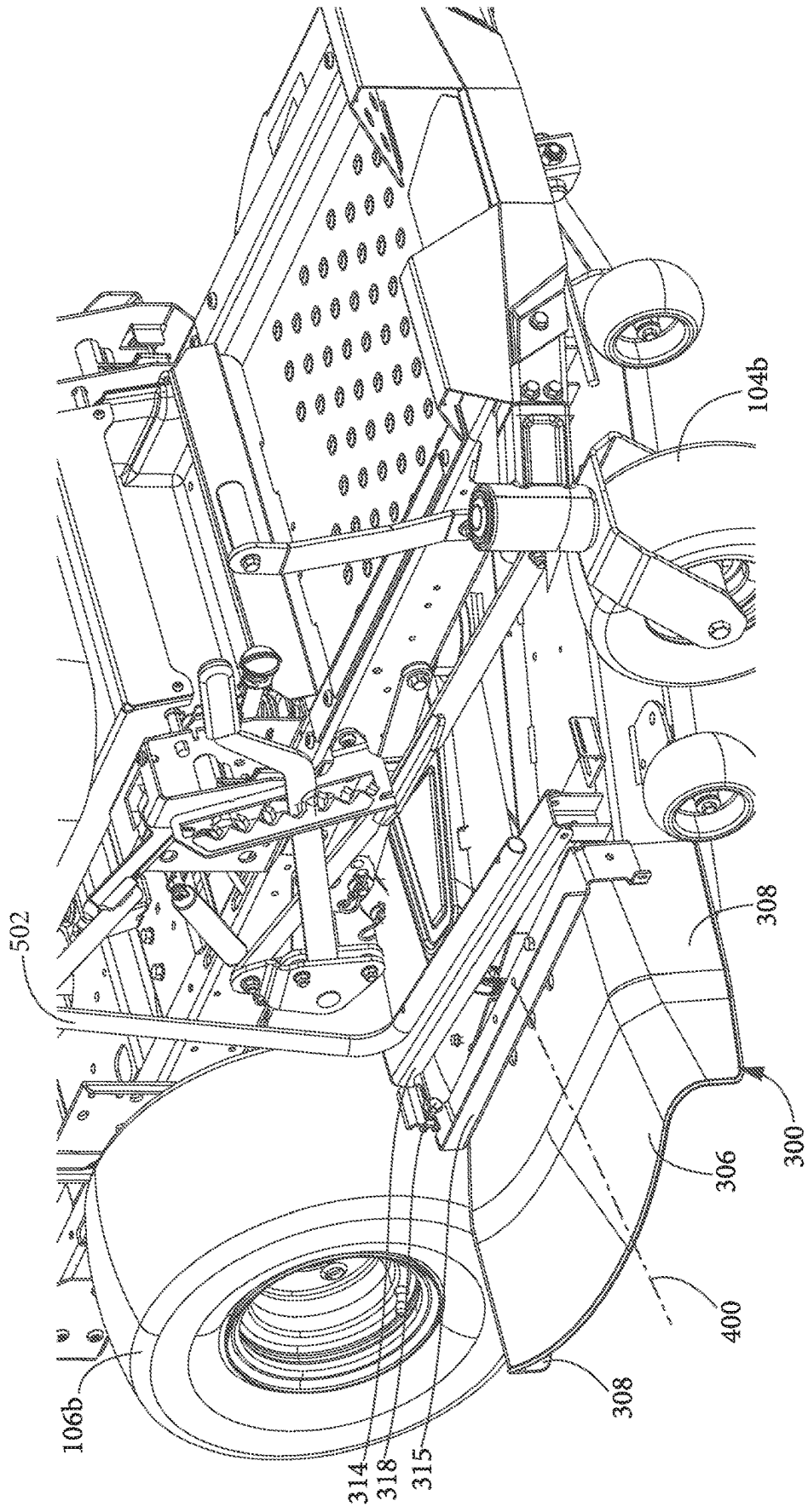


FIG. 3

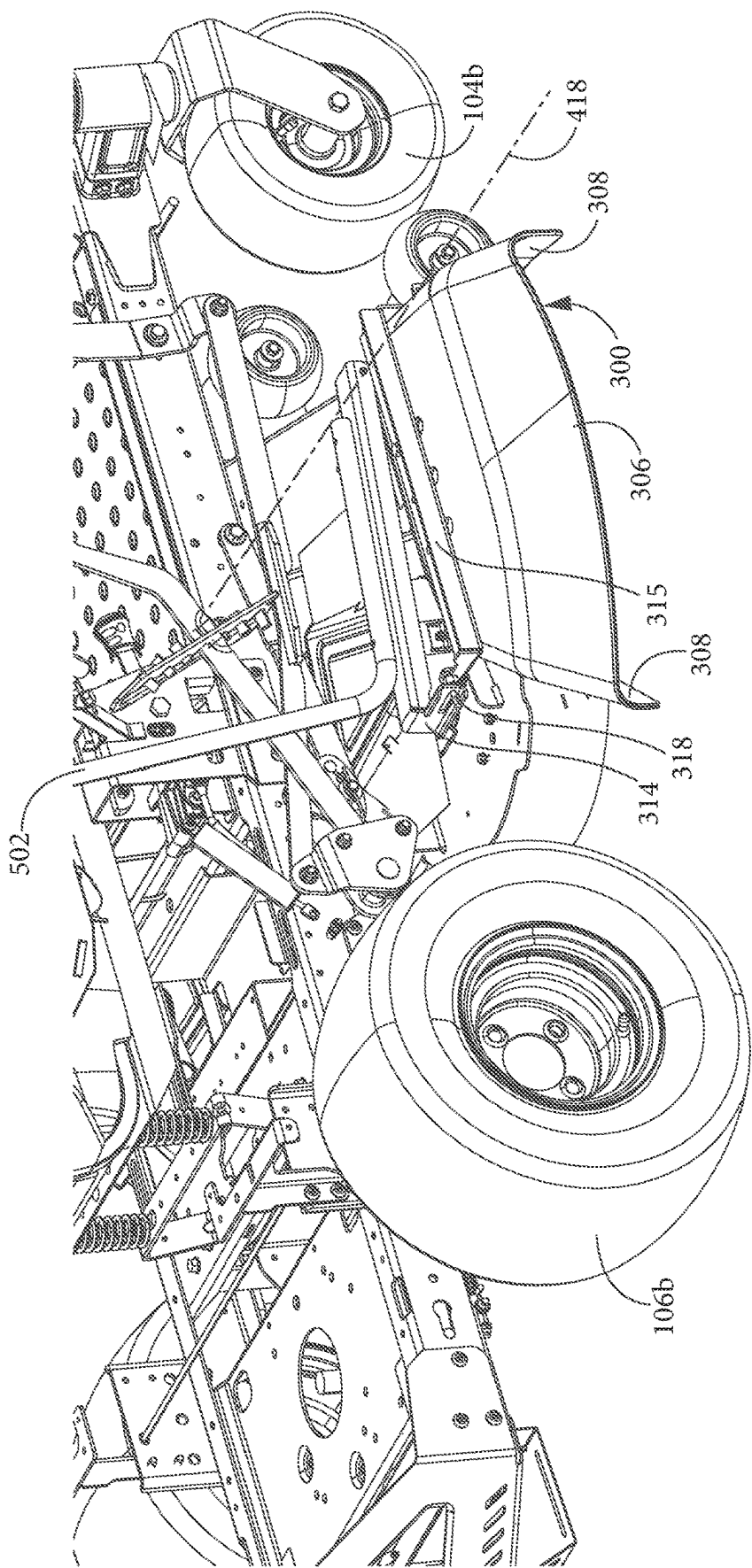


FIG. 4

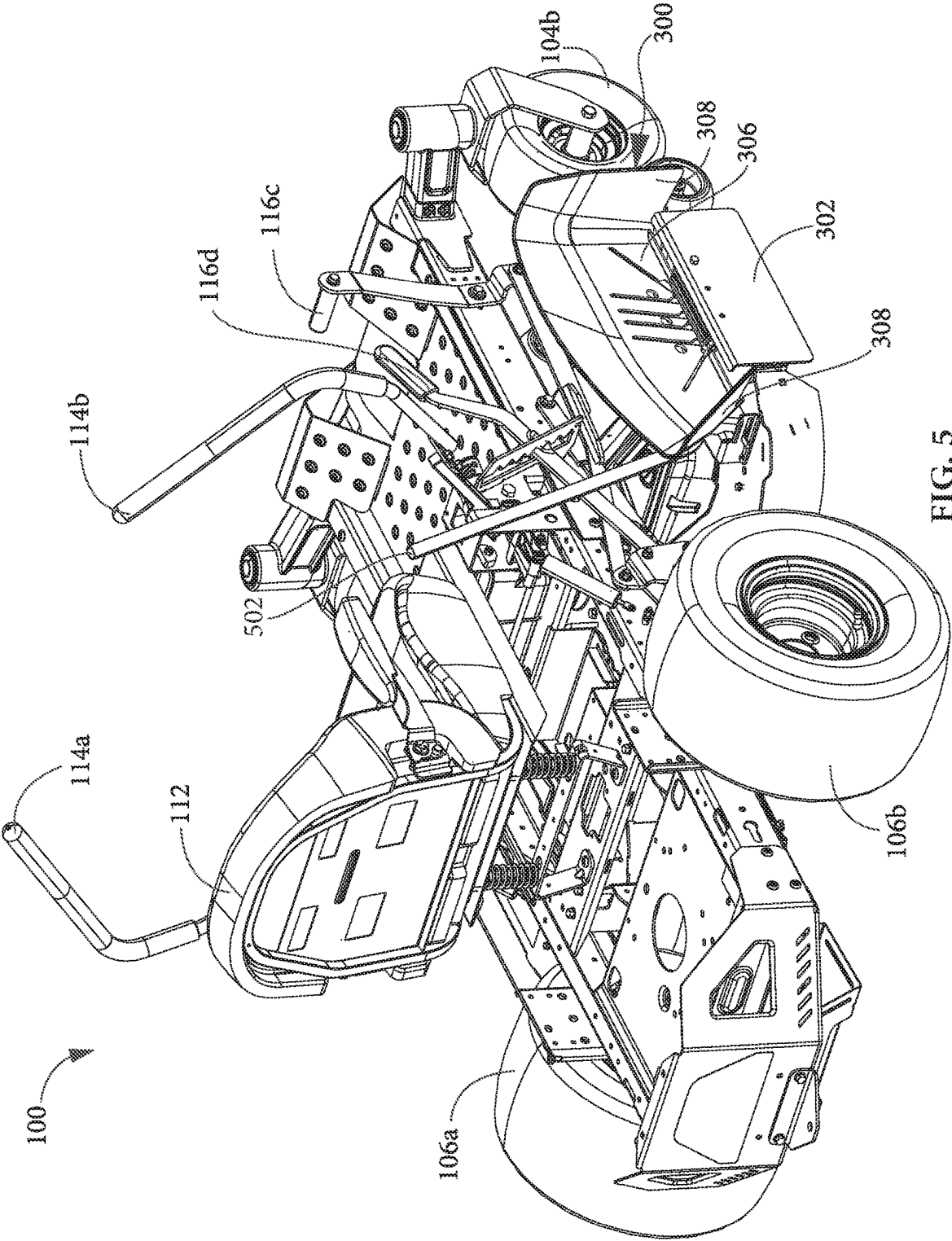


FIG. 5

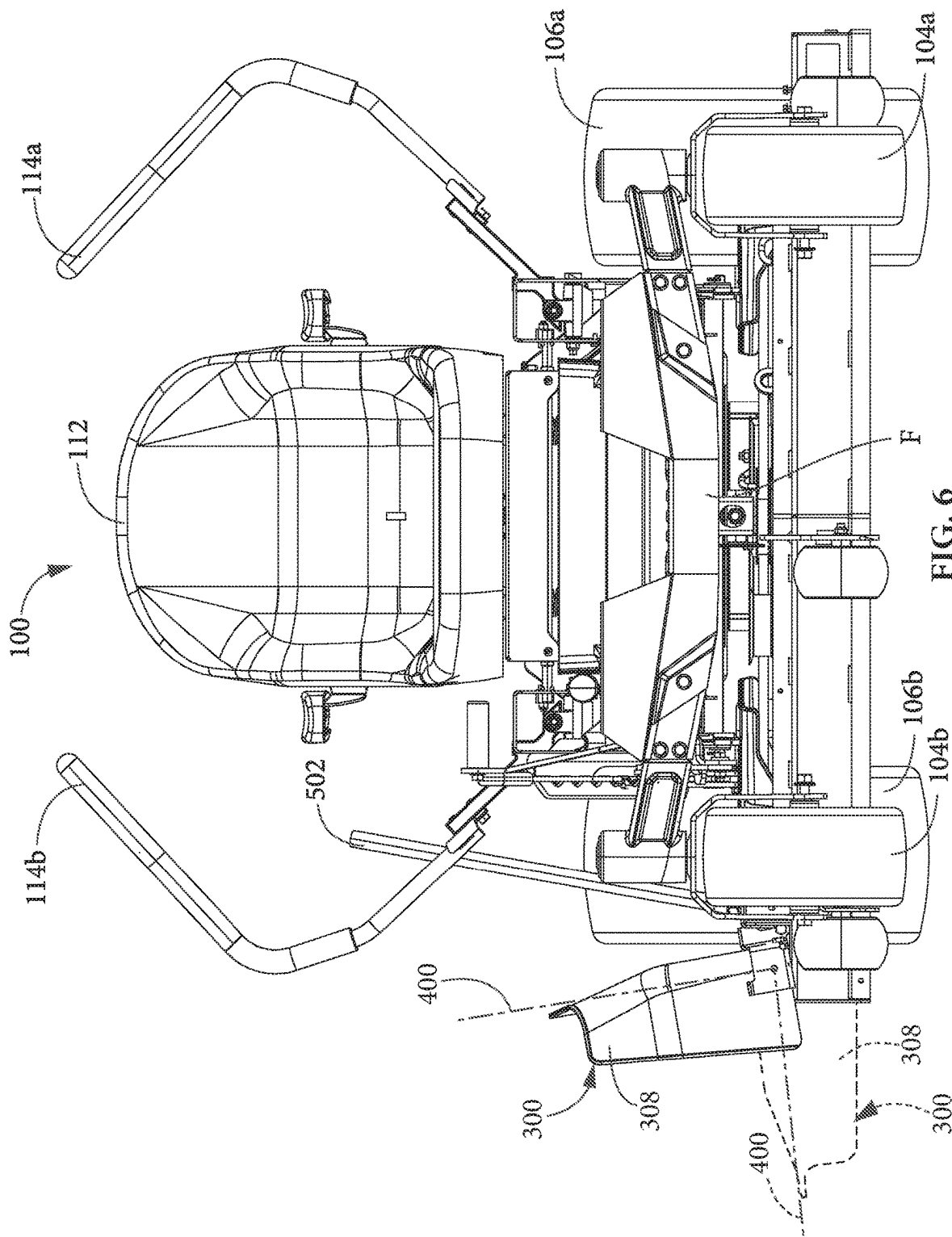


FIG. 6

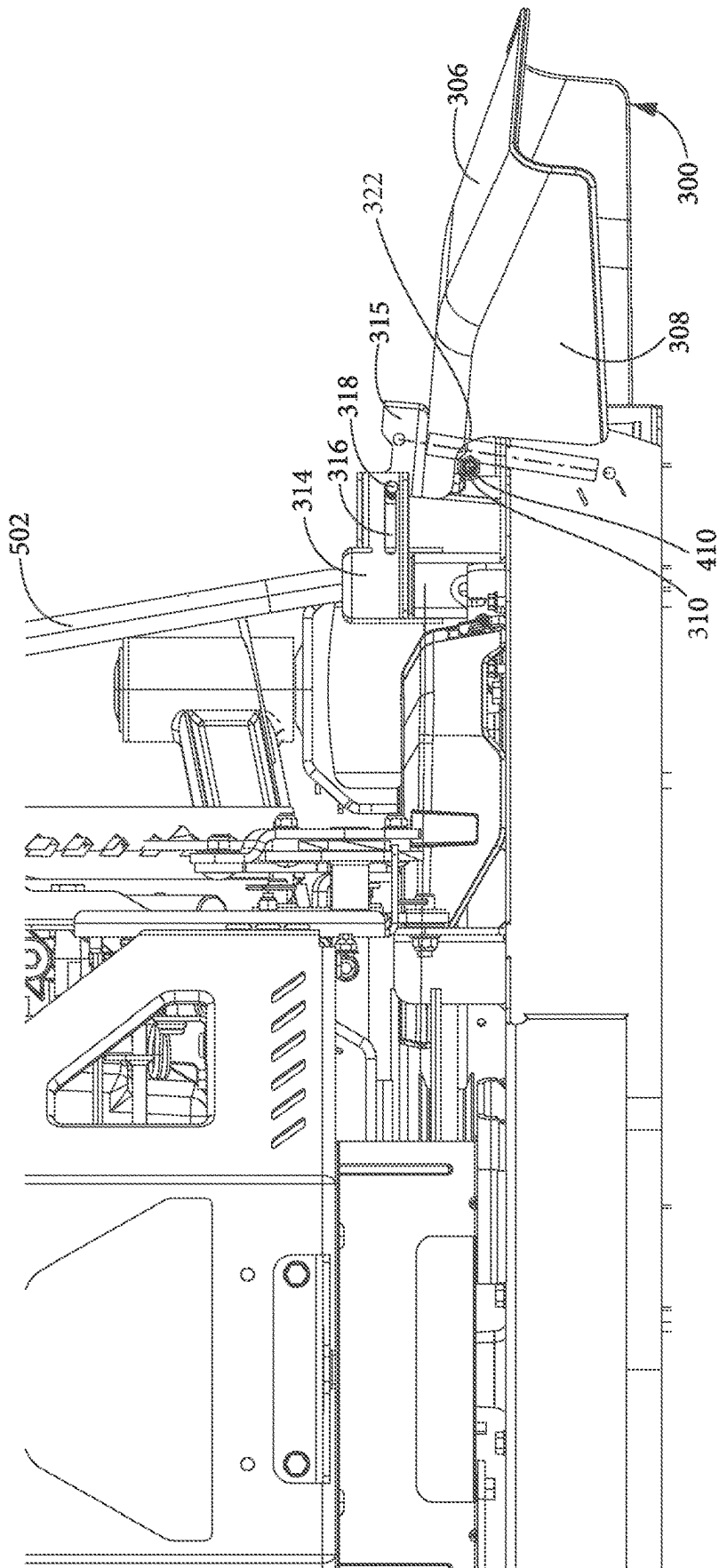
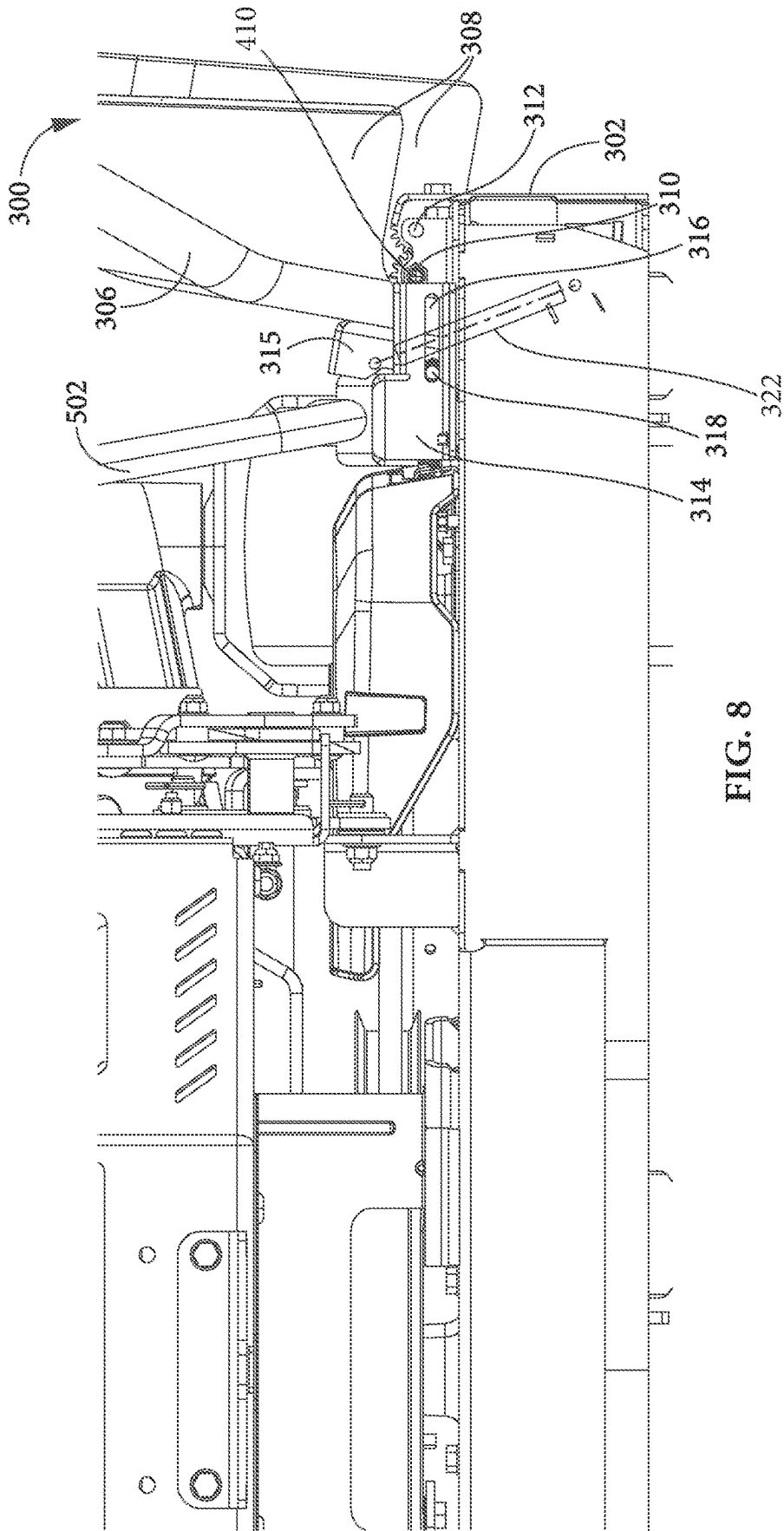
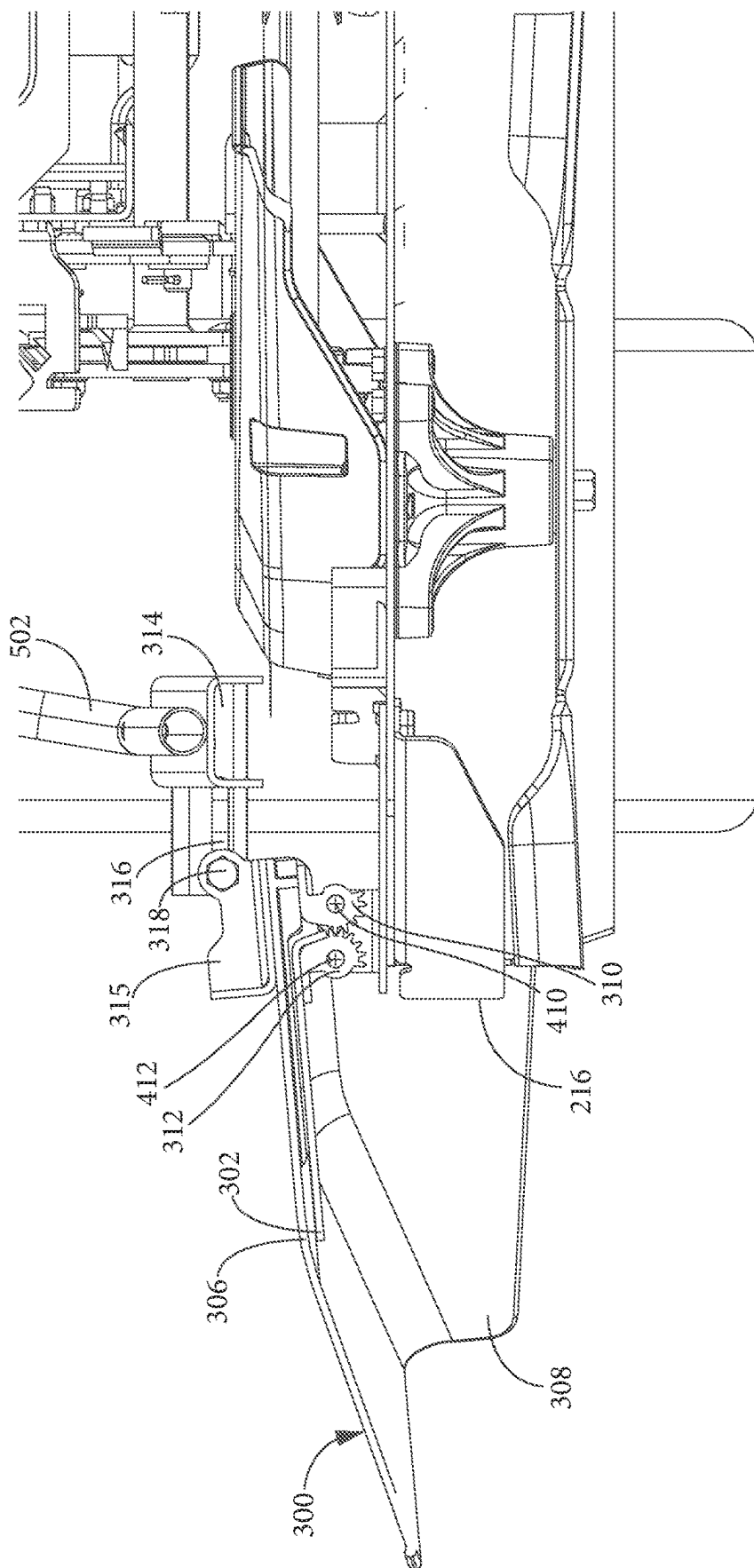


FIG. 7





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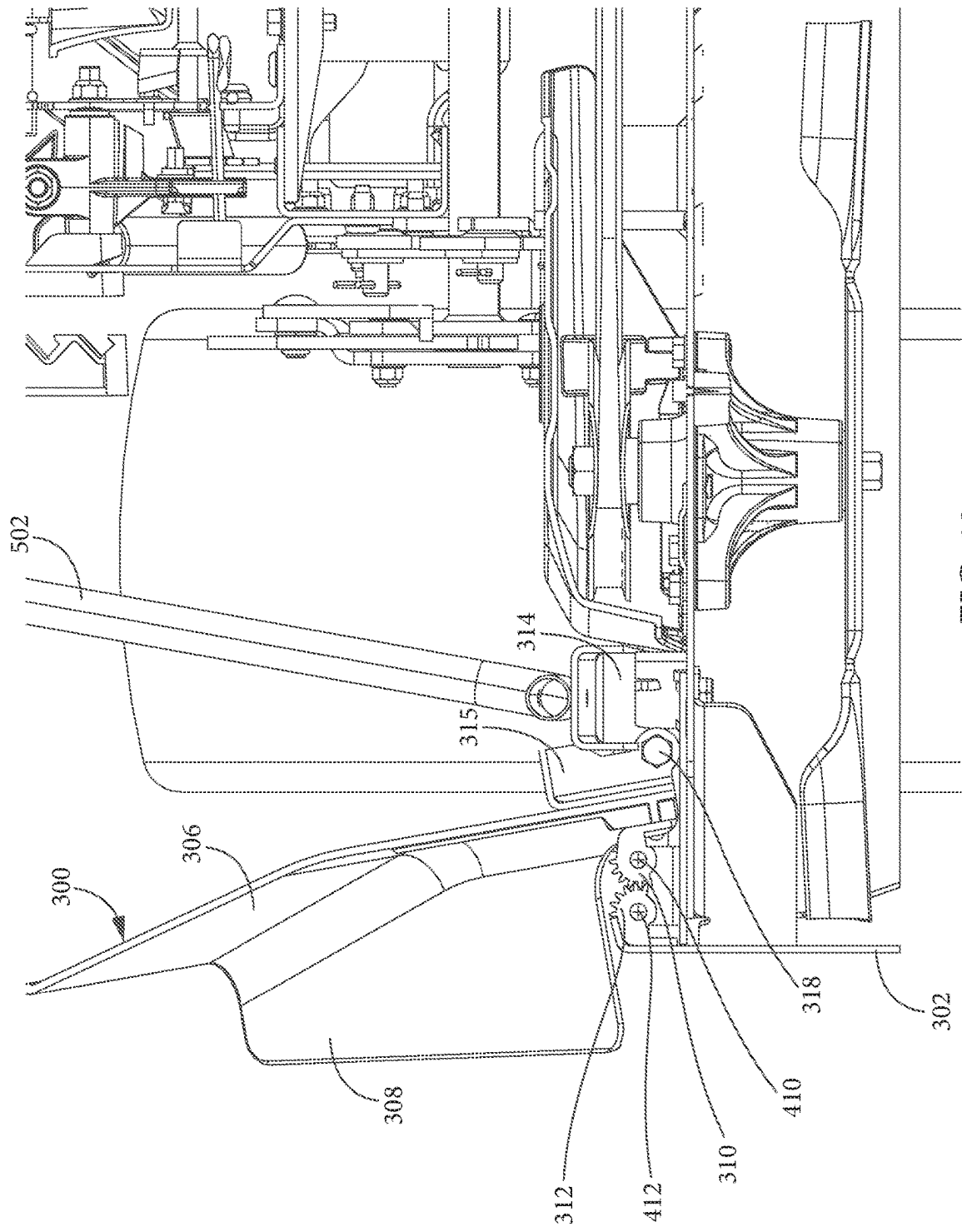
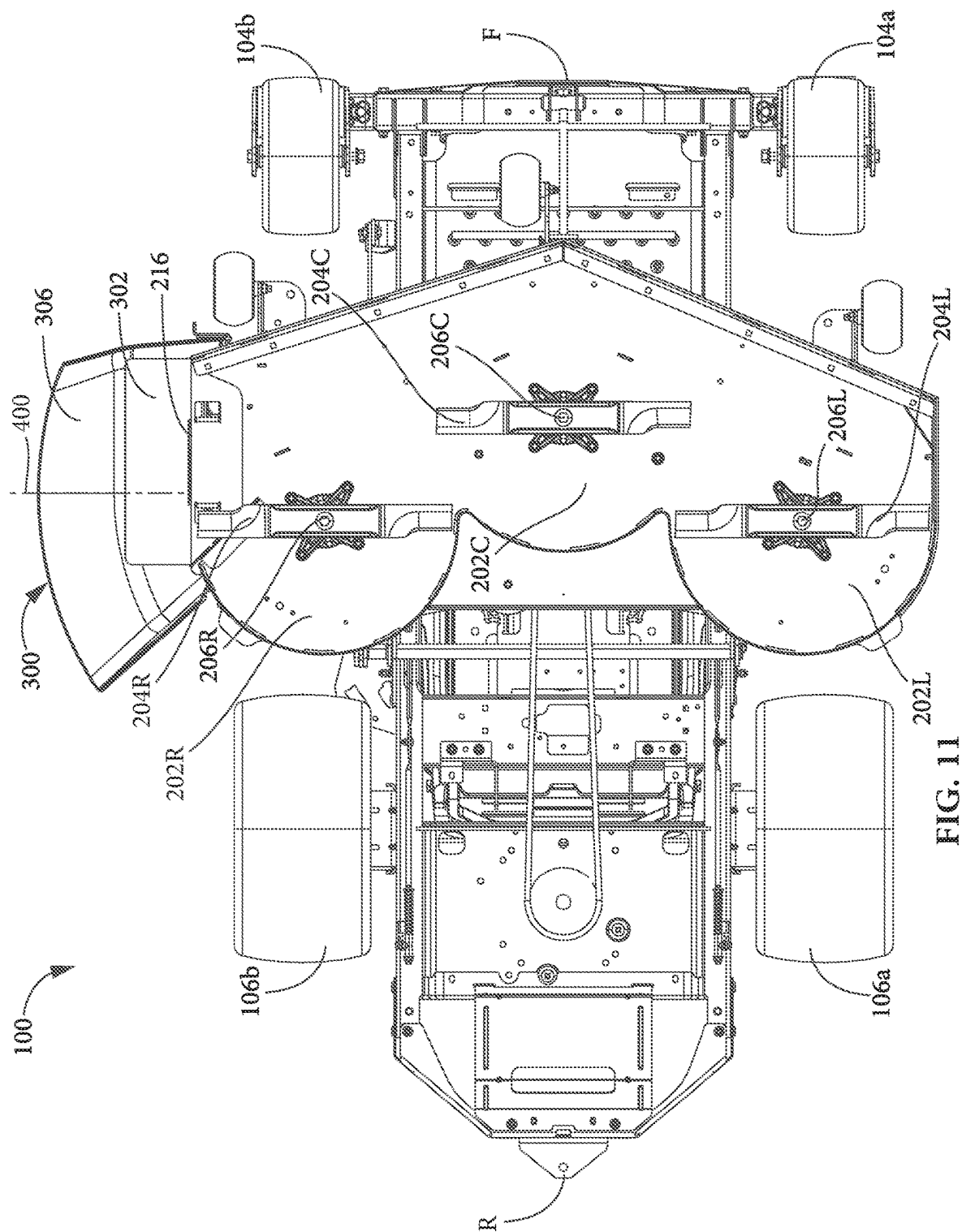


FIG. 10



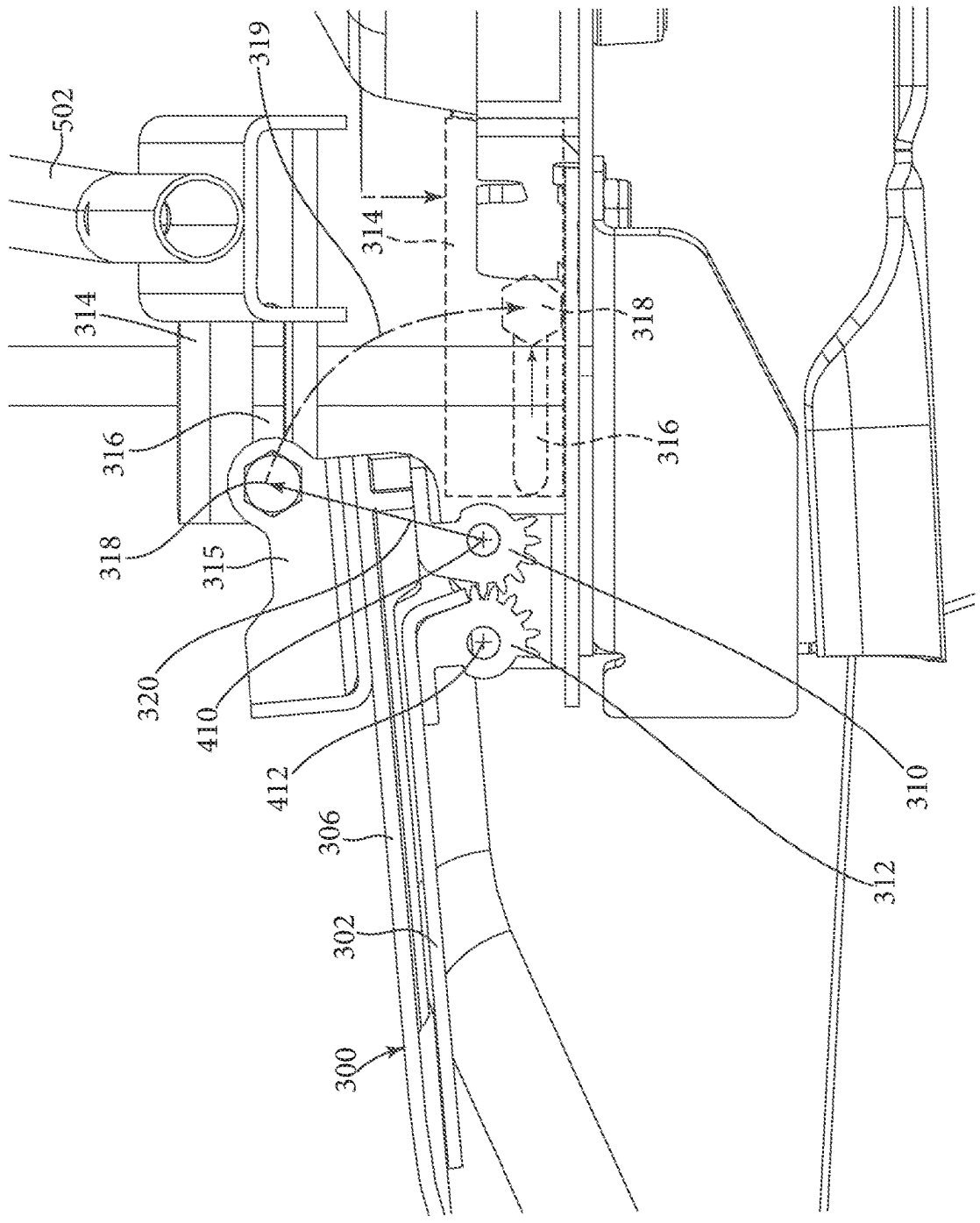


FIG. 12

LAWN MOWER AND CUTTING DECK WITH DISCHARGE CHUTE CONTROL SYSTEM

[0001] The present application claims priority to and/or the benefit of U.S. Provisional Patent Application No. 63/337,690, filed May 3, 2022, which is incorporated herein by reference in its entirety.

[0002] Embodiments of the present disclosure are related to lawn mowers, and more particularly, to cutting decks incorporating a movable grass discharge chute and associated control system.

BACKGROUND

[0003] Riding and walk-behind ground working vehicles such as lawn mowers are used by homeowners and professionals alike. These vehicles typically include a prime mover, e.g., one or more internal combustion engines and/or electric motors, to power not only an implement (e.g., cutting deck) attached to the vehicle, but also a traction drive system, the latter adapted to propel the vehicle over a ground surface.

[0004] Lawn mowers may generally include a discharge chute, e.g., side discharge chute, to direct clippings or other debris exiting the cutting deck. While effective at directing debris, the discharge chute may extend laterally in such a way that it interferes with the mower's ability to mow close to an edge of a work area and/or allow the mower to pass through narrow openings such as gates. For example, the discharge chute may hamper the ability to mow a portion of the work area immediately adjacent a building or other obstruction. Moreover, there may be instances in which the operator desires to block the mower's side discharge altogether, e.g., to prevent ejection of clippings into flower beds.

SUMMARY

[0005] Embodiments of the present disclosure may address these and other issues by providing, in one embodiment, a lawn mower including a cutting deck comprising a top surface and at least one sidewall that together form a downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet. A discharge chute is also provided and coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position. The mower further includes a blocking plate coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate. The discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute and the blocking plate.

[0006] In another embodiment, a lawn mower is provided that includes: a cutting deck having a top surface and at least one sidewall that together form a downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet; and a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position. A blocking plate is coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge

outlet is obstructed by the blocking plate. A first gear is coupled to the discharge chute and a meshing second gear is coupled to the blocking plate, wherein the first gear rotates about a first axis and the second gear rotates about a second axis parallel to the first axis. The mower also includes an actuator configured to move at least one of the chute and the blocking plate.

[0007] In still another embodiment, a cutting deck is provided that includes: a top surface and at least one sidewall that together form a downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet; a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position; and a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate. The discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute and the blocking plate.

[0008] The above summary is not intended to describe each embodiment or every implementation. Rather, a more complete understanding of illustrative embodiments will become apparent and appreciated by reference to the following Detailed Description of Exemplary Embodiments and claims in view of the accompanying figures of the drawing.

BRIEF DESCRIPTION OF THE VIEWS OF THE DRAWING

[0009] Exemplary embodiments will be further described with reference to the views of the drawing, wherein:

[0010] FIG. 1 is a left front perspective view of a lawn mower in accordance with embodiments of the present disclosure.

[0011] FIG. 2 is a right rear perspective view of a lawn mower consistent with the example of FIG. 1 and illustrating an exemplary discharge chute and chute control system of the present disclosure, the chute shown in an operative position.

[0012] FIG. 3 is a partial right front perspective view of a lawn mower and discharge chute consistent with the example of FIGS. 1-2.

[0013] FIG. 4 is a partial right rear perspective view of a lawn mower and discharge chute consistent with the example of FIGS. 1-2.

[0014] FIG. 5 is a right rear perspective view of a lawn mower consistent with the example of FIGS. 1-2 illustrating the discharge chute in an inoperative position, wherein an exemplary blocking plate is visible in a closed position corresponding to the inoperative position of the chute.

[0015] FIG. 6 is a front elevation view of a lawn mower consistent with the example of FIG. 5 illustrating the chute in the inoperative position (solid lines) and the operative position (broken lines).

[0016] FIG. 7 is a partial rear elevation view of a lawn mower consistent with the example of FIGS. 1-2 showing the discharge chute in the operative position.

[0017] FIG. 8 is a partial rear elevation view of the lawn mower consistent with the example of FIG. 7 but illustrating

the discharge chute in the inoperative position and the blocking plate in a closed position.

[0018] FIG. 9 is a partial section view of the lawn mower taken along line 9-9 of FIG. 2 illustrating the discharge chute in the operative position and the blocking plate in the open position.

[0019] FIG. 10 is a partial section view similar to that of FIG. 9 but illustrating the discharge chute in the inoperative position and the blocking plate in the closed position.

[0020] FIG. 11 is a bottom plan view of a lawn mower consistent with the example of FIGS. 1-2 and illustrating the discharge chute in an operative position and the blocking plate in an open position.

[0021] FIG. 12 is an enlarged section view similar to that of FIG. 9 illustrating the chute in an operative position and the blocking plate in an open position.

[0022] The figures are rendered primarily for clarity and, as a result, are not necessarily drawn to scale. Moreover, various structure/components, including but not limited to fasteners, electrical components (wiring, cables, etc.), and the like, may be shown diagrammatically or removed from some or all of the views to better illustrate aspects of the depicted embodiments, or where inclusion of such structure/components is not necessary to an understanding of the various exemplary embodiments described herein. The lack of illustration/description of such structure/components in a particular figure is, however, not to be interpreted as limiting the scope of the various embodiments in any way.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0023] In the following detailed description of illustrative embodiments, reference is made to the accompanying figures of the drawing which form a part hereof. It is to be understood that other embodiments, which may not be described and/or illustrated herein, are certainly contemplated.

[0024] All headings provided herein are for the convenience of the reader and should not be used to limit the meaning of any text that follows the heading, unless so specified. Moreover, unless otherwise indicated, all numbers expressing quantities, and all terms expressing direction/orientation (e.g., vertical, horizontal, parallel, perpendicular, etc.) in the specification and claims are to be understood as being modified in all instances by the term “about.” Furthermore, the terms “having,” “including,” “comprises” and variations thereof do not have a limiting meaning where these terms appear in this description and claims, and the terms “a,” “an,” “the,” “at least one,” and “one or more” are used interchangeably herein. The term “and/or” (if used) means one or all of the listed elements or a combination of any two or more of the listed elements. “I.e.” is used as an abbreviation for the Latin phrase *id est* and means “that is.” “E.g.,” is used as an abbreviation for Latin phrase *exempli gratia* and means “for example.”

[0025] Still further, relative terms such as “left,” “right,” “front,” “fore,” “forward,” “rear,” “aft,” “rearward,” “top,” “bottom,” “side,” “upper,” “lower,” “above,” “below,” “horizontal,” “vertical,” and the like may be used herein and, if so, are from the perspective of one operating the mower 100 while the mower is in an operating configuration, e.g., while it is positioned such that ground-engaging members (e.g., wheels) rest upon a generally horizontal ground surface 101 as shown in FIG. 1. These terms are used only to

simplify the description, however, and not to limit the interpretation of any embodiment described.

[0026] Embodiments described and illustrated herein are directed to lawn mowers incorporating a cutting deck. The deck may define a discharge outlet and include an associated discharge chute control system for controlling one or both of: a discharge chute coupled to the deck and adapted to selectively direct debris ejected from the discharge outlet; and a blocking plate coupled to the deck and adapted to selectively open and close the discharge outlet. For example, the discharge chute may be moveable between an inoperative position and an operative position, while the blocking plate may be moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate. In exemplary embodiments, the discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute or the blocking plate.

[0027] Repositioning the discharge chute and blocking plate can be accomplished manually or automatically. For example, in one or more embodiments, the mower can include various manually powered actuators (e.g., a lever, cable) that can be manipulated by an operator to move the discharge chute and blocking plate as described herein. In other embodiments, the mower can include one or more powered actuators (e.g., electrically, pneumatically, or hydraulically powered actuator) that can be selectively energized (e.g., by the mower operator) to produce movement of the discharge chute and blocking plate. In still other embodiments, the mower may include one or more controllers that automatically control a powered actuator(s) to move the discharge chute and/or the blocking plate. Such automation may be useful, for example, with application to remotely-controlled or autonomous mowers.

[0028] With reference to the figures of the drawing, wherein like reference numerals designate like parts and assemblies throughout the several views, FIG. 1 illustrates a self-propelled vehicle, e.g., a riding lawn mower 100, including a cutting deck 200 (e.g., belly-mounted deck) having a discharge chute 300 (see also FIG. 2). While, for the sake of brevity, embodiments of the disclosure are herein described with reference to a sit-on mower (hereinafter generically referred to simply as a “mower”), those of skill in the art will realize that the concepts described herein are equally applicable to other types of walk-behind and stand-on mowers, as well as to most any other walk-behind, sit-on, stand-on, remotely-controlled, or autonomous ground working vehicle having a ground-engaging implement incorporating a discharge outlet.

[0029] It is noted that the reference numeral suffixes “a” and “b” may be used throughout this description to denote various left- and right-side parts/features, respectively. However, in most pertinent respects, the parts/features denoted with “a” and “b” suffixes are substantially identical to, or mirror images of, one another. It is understood that, unless otherwise noted, the description of an individual part/feature (e.g., part/feature identified with an “a” suffix) also applies to the opposing part/feature (e.g., part/feature identified with a “b” suffix). Similarly, the description of a

part/feature identified with no suffix may apply, unless noted otherwise, to both the corresponding left and right part/feature.

[0030] While not necessarily central to an understanding of exemplary embodiments of the present disclosure, the general construction of the illustrative mower **100** is now briefly described. As shown in FIG. 1, the mower **100** may include a frame or chassis **102** having a front end F and a rear end R, the chassis **102** supporting a power source or prime mover (not shown) such as one or more internal combustion engines and/or one or more electric motors. For example, one engine could power both the cutting deck and a vehicle propulsion system (e.g., the engine could power a hydrostatic pump connected to separate drive wheel motors). In other embodiments, multiple electric motors may be used to separately power the cutting deck (e.g., one motor powering all blade spindles, or a separate motor powering each spindle) and the propulsion system (e.g., one motor powering a single transaxle, or separate motors powering each drive wheel).

[0031] A pair of transversely opposing, ground-engaging drive members, e.g., first and second (left and right) rear drive wheels **106** (e.g., a left wheel **106a** and a right wheel **106b**) as shown in FIG. 2, may be coupled to opposite (left and right) rear sides of the chassis **102** to support the mower **100** upon, and propel the mower **100** relative to, the ground surface **101**.

[0032] Operator controls may permit independent control of the speed and direction of each drive wheel **106**, allowing operator control of mower **100** speed and direction from an operator platform, e.g., an operator seat **112**. The operator controls may include drive control levers **114** (e.g., a left drive control lever **114a** and a right drive control lever **114b**) operable to independently control speed and direction of their respective drive wheels **106** via manipulation of the mower's drive system as is known in the art. While illustrated herein as incorporating separate drive control levers **114**, other controls, e.g., single or multiple joysticks or joystick-type levers, steering wheels, etc. may also be used without departing from the scope of this disclosure. The mower **100** may further include various other controls (power take-off (PTO) engagement, ignition, throttle, etc.), as are known in the art. While shown as incorporating various operator controls, such embodiments are not limiting as embodiments of the present disclosure may also be utilized with mowers lacking some or all on-board controls, e.g., mowers intended for remote control operation and/or autonomous operation.

[0033] A pair of front ground-engaging members or wheels **104** (e.g., a left caster wheel **104a** and a right caster wheel **104b**), which may be connected to forwardly extending portions of the chassis **102**, may support a front portion of the mower **100** in rolling engagement with the ground surface **101**. Although the illustrated mower **100** has the drive wheels **106** towards the rear of the chassis **102** and the caster wheels **104** towards the front, this configuration is not limiting. For example, other embodiments may reverse the location of the wheels, e.g., the drive wheels in front and the driven or undriven wheels in back. Moreover, other configurations may use different wheel configurations altogether, e.g., a tri-wheel configuration or a vehicle having conventionally-steered wheels. Moreover, while illustrated herein as wheels, other ground-engaging members (e.g., tracks, skids, rollers, etc.) are also contemplated.

[0034] The mower **100** may further include the mower cutting deck **200** mounted to a lower side of the chassis **102**, e.g., generally between the drive wheels **106** and the caster wheels **104**. The cutting deck **200**, which is described in more detail below, may form a deck housing defining at least one downwardly-opening and partially enclosed cutting chamber **202** as shown in FIG. 11. Within each cutting chamber **202** (e.g., a center chamber **202C**, a right chamber **202R**, and a left chamber **202L**) may be one or more rotatable cutting blades **204** (e.g., a center blade **204C**, a right blade **204R**, and a left blade **204L**), each attached to a rotatable blade spindle **206** (e.g., a center spindle **206C**, a right spindle **206R**, and a left spindle **206L**) journaled to the respective deck housing. Once again, while illustrated herein as a belly-mount deck, other mower configurations may, alternatively or in addition, utilize other deck configurations (e.g., an out-front or rear-mounted (e.g., towed) deck, a laterally-mounted deck).

[0035] During operation, power may be selectively provided by the prime mover(s) to at least one of the cutting deck **200** (e.g., to the spindles **206**) and the drive wheels **106**, whereby the cutting blades rotate at a speed sufficient to sever grass and other vegetation as the deck passes over the ground surface **101**. Typically, the mower **100** includes an operator-selectable height-of-cut control system **116** (e.g., a deck lift pedal **116c** and a deck position lever **116d**, see FIG. 1) to allow deck height adjustment relative to the ground surface **101**.

[0036] As illustrated in FIG. 1, the cutting deck **200** may include a top surface **212** and at least one sidewall **214** extending downwardly therefrom, where the top surface **212** and the at least one sidewall **214** together form the cutting chamber(s) **202** that open in a downwardly-facing direction (e.g., towards the ground surface **101** during operation). The at least one sidewall **214** may wrap around a perimeter of the top surface **212** such that the at least one sidewall **214** surrounds the cutting chamber(s) **202**. In some embodiments, the at least one sidewall **214** defines a discharge outlet **216** (as illustrated in FIGS. 9 and 11). The discharge outlet **216** may be positioned such that grass clippings and other debris may be ejected in a certain direction from the cutting chamber(s) **202** during mower operation. While the position of the discharge outlet **216** may be at most any location along the sidewall(s) (e.g., along a left side of the deck or along a rear side of the deck, etc.), it may in some embodiments be positioned along the right side of the deck as shown in FIG. 2.

[0037] The discharge outlet **216** may define a window through the at least one sidewall **214** of most any size that effectively permits the desired flow of debris (e.g., grass clippings) through the discharge outlet. As indicated above, other mowers **100** may locate the cutting deck **200** and the discharge outlet **216** at other locations relative to the chassis **102** (e.g., a forwardly-mounted or "out-front" deck, towed deck, or laterally-mounted deck).

[0038] With this general overview of an exemplary mower and cutting deck, discharge chute systems in accordance with embodiments of the present disclosure are now described with initial reference to FIGS. 2 and 5. As shown in FIG. 2, the discharge chute ("chute") **300**, may be coupled to the cutting deck **200** such that the chute **300** may effectively guide ejected debris during cutting deck operation when the chute is in the operative position as shown in FIG. 2. As further described below, the chute **300** may be

moved between at least this operative position as shown in FIG. 2 and the inoperative position as shown in FIG. 5. When the chute 300 is in the operative position, the chute 300 may be connected or joined to the discharge outlet 216 to effectively guide debris exiting the discharge outlet 216, while in the inoperative position, the chute may be disconnected or disjointed from the discharge outlet 216.

[0039] To permit chute motion relative to the deck, the chute 300 may be coupled to the cutting deck 200 using any means known in the art (e.g., bolts, hinges, pins, slides, etc.) that permits the desired motion. While the shape of the chute 300 may vary, it may in some embodiments form an inverted (downwardly-opening) generally U-shaped channel adapted to guide debris ejected through the discharge outlet 216 (see FIG. 11) from the cutting chamber(s) 202.

[0040] The chute 300 may be of most any suitable shape that effectively guides grass clipping and other debris out from beneath mower 100, e.g., out from the cutting chamber (s) of the cutting deck 200. As illustrated in FIG. 7, the chute 300 may, in some embodiments, slope downwardly and away from the cutting deck when the chute 300 is in the operative position. Moreover, in the operative position, the chute 300 may be suspended above the ground surface 101 so that it does not drag along the ground surface during mower operation. As stated above, the chute 300 may be generally U-shaped having a chute top wall 306 and at least one (e.g., two) chute sidewall 308. The chute top wall 306 and the chute sidewalls 308 may abut, or may otherwise be positioned close to, the sidewall 214 (around the discharge outlet 216) when the chute is in the operative position.

[0041] The chute 300 may extend generally along a chute axis 400 as illustrated in FIGS. 6 and 11. As used herein, “chute axis 400” may refer to an axis that extends from an inner end of the chute 300 (proximate the sidewall 214) to an opposite (distal or outer end) of the chute 300 (distal to the at least one sidewall 214). In the illustrated embodiments, the chute 300 is pivotally coupled to the cutting deck 200 (e.g., above and proximate the discharge outlet 216) about a first axis 410 as shown in FIG. 9. As a result, as the chute 300 is pivoted from the operative position (broken line rendering in FIG. 6) to the inoperative position (solid line rendering in FIG. 6), the chute axis 400 moves between the two positions illustrated. While not wishing to be bound to a specific chute axis, it may in some embodiments be described as extending orthogonal to the first axis 410.

[0042] As shown in FIG. 6, when the chute 300 is in the operative position, the chute 300 (e.g., the chute axis 400) could extend in a generally horizontal direction (parallel with the ground surface 101). However, in other embodiments, the operative position may not be horizontal, but may instead extend at a downward (or, alternatively, upward) angle relative to horizontal (e.g., up to ± 45 degrees from horizontal, or up to ± 15 degrees from horizontal).

[0043] As stated above, when the chute 300 is in the inoperative position, it is not intended to guide debris exiting the discharge outlet 216, but rather is positioned to reduce interference with surrounding obstacles. For instance, in the inoperative position, the chute 300 (e.g., the chute axis 400) may be positioned such that it extends generally orthogonally with respect to the ground surface 101. In other exemplary embodiments, however, the chute/chute axis may extend upwardly at a non-orthogonal angle from the ground surface 101 when in the inoperative position. Regardless, the inoperative position may allow the chute 300 to avoid

contact with obstacles that the chute 300 may otherwise encounter if in the operative position. Exemplary non-orthogonal angles of the chute axis 400 (when the chute is in the inoperative position) may be any angle up to 180 degrees from the operative position (e.g., folded over onto the top surface 212 of the deck). In other embodiments, the chute axis 400 may form an angle of between 75 degrees and 105 degrees from horizontal when in the inoperative position.

[0044] As shown in FIG. 5, a blocking plate 302 may also be coupled (e.g., pivotally coupled) to the cutting deck 200 using any pivotal means known in the art (e.g., bolts, hinges, pins, etc.). In the illustrated, embodiments, the blocking plate 302 may be coupled to the cutting deck 200 (e.g., to the top surface 212 or sidewall 214) proximate the discharge outlet 216 such that the blocking plate 302 is able to selectively block the discharge outlet 216 when in a closed position as shown in FIG. 5, and permit passage of debris when in an open position as shown in FIG. 9.

[0045] As shown in FIG. 5, when the chute 300 is in the inoperative position, the blocking plate 302 may be in the closed position such that the blocking plate 302 obstructs, blocks, or otherwise occludes the discharge outlet 216. Conversely, when the chute 300 is in the operative position shown in FIG. 9, the blocking plate 302 may be in the open position such that the blocking plate 302 does not block the discharge outlet 216, permitting debris to freely exit the discharge outlet 216 via the chute 300.

[0046] As further shown in FIG. 9, when in the open position, the blocking plate 302 may extend outwardly beyond the at least one sidewall. For example, as discussed above with respect to the chute 300, the blocking plate 302 may extend in a generally horizontal direction (parallel with the ground surface 101) when the blocking plate 302 is in the open position and may extend generally orthogonally to the ground surface 101 when in the closed position. However, in other embodiments, the open position may instead extend at an angle downwards or upwards relative to horizontal (e.g., up to ± 45 degrees from horizontal, or up to ± 15 degrees from horizontal). When in the closed position, the blocking plate 302 may be at most any angle relative to horizontal that permits the blocking plate to effectively block the discharge outlet. While shown as being generally planar, the blocking plate may be of most any shape (e.g., curved) that suitably blocks the discharge outlet when in the closed position.

[0047] As stated above, the chute 300 may be pivotally coupled to the cutting deck 200 about the first axis 410 as shown in FIGS. 9 and 10. Similarly, the blocking plate 302 may be pivotally coupled to the cutting deck 200 about a second axis 412 that is offset from and parallel to the first axis 410. In the illustrated embodiments, the first axis 410 and the second axis 412 may be generally transverse to the chute axis 400, and they may be parallel to the ground surface 101.

[0048] As shown in FIGS. 9-10 the chute 300 and the blocking plate 302 may include a first gear 310 and a second gear 312, respectively, wherein the first gear is adapted to rotate about the first axis 410 and the second gear is adapted to rotate about the second axis 412. That is to say, the first gear 310 may be operatively coupled to the discharge chute 300 (e.g., be integrally formed with or otherwise attached to the chute), while the second gear 312 is operatively coupled to the blocking plate 302 such that each gear moves in direct relation with its attached component. Moreover, the first

gear 310 and the second gear 312 may mesh with one another such that rotation of one gear produces corresponding rotation in the other, and vice versa. Stated alternatively, as either one of the chute 300 or the blocking plate 302 moves, corresponding movement of the other will result due to the meshing of the first gear 310 and the second gear 312 as further described below. Accordingly, the chute 300 may be characterized as being operatively connected to the blocking plate 302 such that movement of one causes movement of the other.

[0049] In illustrated embodiments, the first gear 310 and the second gear 312 have identical constructions (pitch diameters) such that the chute 300 and the blocking plate 302 rotate in a 1:1 ratio (e.g., if the chute 300/first gear 310 moves 90 degrees, the blocking plate 302/second gear 312 also move 90 degrees). In alternative embodiments, the two gears may have different geometries to allow a different angular rotations of either the chute or the blocking plate relative to the other.

[0050] In the illustrated embodiments, the first gear 310 and the second gear 312 may have an elongate shape. Such a gear configuration may allow reduced pressure on the gear teeth, allowing the gears to be constructed of inexpensive materials such as injection molded plastic or extruded aluminum. However, such an elongate structure is exemplary only as more conventional gears are certainly possible without departing from the scope of this disclosure.

[0051] Movement of the chute 300 and the blocking plate 302 may be initiated and controlled manually. For example, a user may directly or manually move the chute 300 between the operative and the inoperative positions (or, alternatively, the blocking plate 302 between the open and closed positions), thus causing the blocking plate 302 to move between the open and closed positions (or, if the blocking plate 302 is moved, causing the chute 300 to move between the operative and inoperative positions). However, in other embodiments, the mower 100 may include an actuator connected to the chute 300 and/or blocking plate 302, whereby the actuator may, upon operator manipulation, cause movement of at least one of the chute 300 and the blocking plate 302.

[0052] As illustrated in FIGS. 2-4, the actuator may include a pivot arm 314, a handle 502 attached to the pivot arm, and a pin 318 affixed to the chute 300, e.g., via a bracket 315. As further illustrated in FIGS. 7, 8, and 12, the pivot arm 314 may define a slot 316. The pivot arm may be pivotally coupled to the cutting deck 200 (e.g., to the top surface 212) such that it may pivot relative to the cutting deck about a third axis 418 (see FIG. 4). While not wishing to be bound to any specific orientation, the third axis 418 may be oriented orthogonal to a direction of the first axis 410 and/or the second axis 412.

[0053] The pivot arm 314/handle 502 may be moveable between a first position and a second position. The first position of the pivot arm 314 may correspond to the chute 300 being in the operative position and the blocking plate 302 being in the open position (see, for example, FIGS. 2, 4, 7, and 9). The second position of the pivot arm 314/handle 502 may correspond to the chute 300 being in the inoperative position and the blocking plate 302 being in the closed position (see, e.g., FIGS. 5, 8, and 10).

[0054] The slot 316 of the pivot arm 314 may be configured to receive the pin 318. As stated above, the pin may be fixed to the bracket 315 which is, in turn, fastened or

attached to (or alternatively, integrally formed as part of) the chute 300. The pin 318 may move freely within the slot between the slot ends. As shown in FIG. 9, the pin 318 may be offset from the first axis 410 such that movement of the pin may produce movement of the chute 300 about the first axis.

[0055] During operation, the operator may manipulate the handle 502/pivot arm 314 by pivoting the handle 502 from the first position (see FIG. 7) to the second position (see FIG. 8). As the handle 502 and pivot arm 314 pivot about the third axis 418 (see FIG. 4), the slot 316 moves downwardly. As the slot 316 moves, the pin 318 will translate along the slot 316 from the position shown in FIG. 7 to the position shown in FIG. 8. As the pin 318 is attached to the bracket 315, such movement of the pin causes desired rotation of the chute 300 from the operative to the inoperative position.

[0056] This motion is further depicted in FIG. 12, wherein the pivot arm 314, slot 316, and pin 318 are shown in solid lines for the first position of the handle, and in broken lines for the second position of the handle. As is evident in this view, as the pivot arm 314 pivots about the third axis 418 (see FIG. 4), the pivot arm 314, the pin 318, and the slot 316 move between the solid line position and the broken line position. That is to say, pivotal movement of the pivot arm causes the slot to move downwardly as shown. As the pin 318 (connected to the chute 300) is constrained to move only within the slot 316, the pin 318 moves through an arc of motion 319 about the first axis 410 (due to the pin being spaced from the first axis by a distance 320). Such movement causes the first gear 310 to rotate and accordingly the chute to move from the operative to the inoperative positions. Moreover, as the first gear 310 meshes with the second gear 312 of the blocking plate 302, the blocking plate also moves to the closed position as a result of the movement of the pin 318.

[0057] As shown in FIGS. 7 and 8, the chute control system may include one or more biasing members, e.g., extension springs, that assist in biasing the chute and/or the blocking plate toward one or both of their respective positions. For example, an extension spring 322 may have a first end coupled to a sidewall of the cutting deck 200 (as illustrated in FIGS. 1 and 2) and a second end coupled to the bracket 315 as shown. When the chute 300 is in the operative position as shown in FIG. 7, the spring 322 biases the chute in the clockwise direction (as viewed in FIG. 7) about the first axis 410, thereby biasing the chute to its operative position (and thus the blocking plate to its open position). However, as shown in FIG. 8, when the chute 300 is in the inoperative position, the spring 322 may apply a force to the chute in the counterclockwise direction (as viewed in FIG. 8) about the first axis 410, thereby biasing the chute to its inoperative position (and thus the blocking plate to its closed position). That is to say, the spring 322 may connect to the chute (e.g., to the bracket 315) such that its over-center movement (relative to the first axis 410), allows it to bias or hold the chute in both positions. While illustrated as a single spring connected to the bracket 315, such an embodiment is exemplary only as other biasing devices, and other attachment configurations, are certainly possible.

[0058] While described as moving the handle back and down to initiate chute/blocking plate movement, such a construction is exemplary only. In other embodiments, the handle may be configured to move in the reverse direction to effectuate such movement, move side-to-side, rotate,

translate, or move in most any other manner that causes the desired slot movement. In other embodiments, chute motion may occur with other actuators controlled by the operator's hand or foot.

[0059] In exemplary embodiments described above, movement of the chute **300** and the blocking plate **302** may be initiated and controlled by manual actuation. In other embodiments, other actuators may be provided to initiate and control movement of at least one of the chute **300** and the blocking plate **302**. For example, the actuator may be configured as a cable and/or a link or linkages operatively connected to the chute **300** or the blocking plate **302**. In still other embodiments, the actuator may be a powered actuator, e.g., a pneumatic, hydraulic, or electrical actuator, solenoid, or motor capable of producing linear or rotational output. Such actuator may be controlled by an operator input (e.g., switch, button, pedal, valve, or the like).

[0060] In yet other embodiments, the mower **100** may also include an electronic controller, whereby the controller may control the powered actuator. As with the powered actuators described above, the controller may be coupled to the operator input (e.g., switch, button, pedal, valve, or the like) used to energize the actuator.

[0061] In still other embodiments, movement of the chute **300** and the blocking plate **302** may be initiated and controlled automatically without user input. For example, the mower **100** may include a sensor or sensors, such as one or more cameras, or one or more motion sensors. Such sensors may sense an object in the path of the mower **100** (or in the path of the chute **300**) and send a signal or signals to the controller. The controller may then energize the actuator to initiate or control movement of the chute **300** and the blocking plate **302** in response to the sensor signal(s). Such a configuration may be suitable for autonomous mowing operations.

[0062] Various illustrative embodiments are within the scope of this disclosure, some examples of which are identified below.

[0063] Embodiment 1. A lawn mower comprising: a cutting deck comprising a top surface and at least one sidewall that together form a downwardly opening cutting chamber; the at least one sidewall defining a discharge outlet; a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position; and a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate, wherein the discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute and the blocking plate.

[0064] Embodiment 2. The lawn mower of embodiment 1, wherein the discharge chute, when in the operative position, is joined to the discharge outlet to effectively guide debris exiting the discharge outlet, and when in the inoperative position, is disjoined from the discharge outlet.

[0065] Embodiment 3. The lawn mower of embodiment 2, wherein the discharge chute defines a chute axis, wherein the chute axis extends: in a first direction when the discharge chute is in the operative position; and in a second direction when the discharge chute is in the inoperative position.

[0066] Embodiment 4. The lawn mower of any one of embodiments 1-3, wherein the blocking plate is coupled to the cutting deck proximate the discharge outlet.

[0067] Embodiment 5. The lawn mower of any one of embodiments 1-4, wherein the discharge chute is pivotally coupled to the cutting deck about a first axis and the blocking plate is pivotally coupled to the cutting deck about a second axis parallel to the first axis.

[0068] Embodiment 6. The lawn mower of embodiment 5, further comprising a first gear associated with the discharge chute and a meshing second gear associated with the blocking plate, wherein the first gear rotates about the first axis and the second gear rotates about the second axis.

[0069] Embodiment 7. The lawn mower of any one of embodiments 1-6, further comprising an actuator configured to move at least one of the discharge chute and the blocking plate.

[0070] Embodiment 8. A lawn mower comprising: a cutting deck comprising a top surface and at least one sidewall that together form a downwardly opening cutting chamber; the at least one sidewall defining a discharge outlet; a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position; a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate; a first gear coupled to the discharge chute and a meshing second gear coupled to the blocking plate, wherein the first gear rotates about a first axis and the second gear rotates about a second axis parallel to the first axis; and an actuator configured to move at least one of the chute and the blocking plate.

[0071] Embodiment 9. The lawn mower of embodiment 8, wherein the actuator comprises: a pivot arm coupled to the cutting deck and configured for movement relative thereto, the pivot arm defining a slot configured to receive a pin associated with the discharge chute, the pin offset from the first axis.

[0072] Embodiment 10. The lawn mower of embodiment 9, wherein the pivot arm is pivotally coupled to the cutting deck for pivoting about a third axis, the third axis oriented orthogonal to a direction of the first axis.

[0073] Embodiment 11. The lawn mower of any one of embodiments 9-10, wherein the actuator further comprises a handle operatively connected to the pivot arm.

[0074] Embodiment 12. The lawn mower of any one of embodiments 8-11, wherein the discharge chute, when in the operative position, is joined to the discharge outlet to effectively guide debris exiting the discharge outlet, and when in the inoperative position, is disjoined from the discharge outlet.

[0075] Embodiment 13. The lawn mower of any one of embodiments 8-12, wherein the discharge chute defines a chute axis, wherein the chute axis extends: in a first direction when the discharge chute is in the operative position; and in a second direction when the discharge chute is in the inoperative position.

[0076] Embodiment 14. The lawn mower of any one of embodiments 8-13, wherein the blocking plate is coupled to the cutting deck proximate the discharge outlet.

[0077] Embodiment 15. A cutting deck comprising: a top surface and at least one sidewall that together form a

downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet; a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position; and a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate, wherein the discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute and the blocking plate.

[0078] Illustrative embodiments are described, and reference has been made to possible variations of the same. These and other variations, combinations, and modifications will be apparent to those skilled in the art, and it should be understood that the claims are not limited to the illustrative embodiments set forth herein.

1. A lawn mower comprising:

- a cutting deck comprising a top surface and at least one sidewall that together form a downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet;
- a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position; and
- a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate,

wherein the discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute and the blocking plate.

2. The lawn mower of claim 1, wherein the discharge chute, when in the operative position, is joined to the discharge outlet to effectively guide debris exiting the discharge outlet, and when in the inoperative position, is disjoined from the discharge outlet.

3. The lawn mower of claim 2, wherein the discharge chute defines a chute axis, wherein the chute axis extends: in a first direction when the discharge chute is in the operative position; and in a second direction when the discharge chute is in the inoperative position.

4. The lawn mower of claim 1, wherein the blocking plate is coupled to the cutting deck proximate the discharge outlet.

5. The lawn mower of 1, wherein the discharge chute is pivotally coupled to the cutting deck about a first axis and the blocking plate is pivotally coupled to the cutting deck about a second axis parallel to the first axis.

6. The lawn mower of claim 5, further comprising a first gear associated with the discharge chute and a meshing second gear associated with the blocking plate, wherein the first gear rotates about the first axis and the second gear rotates about the second axis.

7. The lawn mower of 1, further comprising an actuator configured to move at least one of the discharge chute and the blocking plate.

8. A lawn mower comprising:

- a cutting deck comprising a top surface and at least one sidewall that together form a downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet;
- a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position;
- a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate;
- a first gear coupled to the discharge chute and a meshing second gear coupled to the blocking plate, wherein the first gear rotates about a first axis and the second gear rotates about a second axis parallel to the first axis; and
- an actuator configured to move at least one of the chute and the blocking plate.

9. The lawn mower of claim 8, wherein the actuator comprises:

- a pivot arm coupled to the cutting deck and configured for movement relative thereto, the pivot arm defining a slot configured to receive a pin associated with the discharge chute, the pin offset from the first axis.

10. The lawn mower of claim 9, wherein the pivot arm is pivotally coupled to the cutting deck for pivoting about a third axis, the third axis oriented orthogonal to a direction of the first axis.

11. The lawn mower of claim 9, wherein the actuator further comprises a handle operatively connected to the pivot arm.

12. The lawn mower of claim 8, wherein the discharge chute, when in the operative position, is joined to the discharge outlet to effectively guide debris exiting the discharge outlet, and when in the inoperative position, is disjoined from the discharge outlet.

13. The lawn mower of claim 8, wherein the discharge chute defines a chute axis, wherein the chute axis extends: in a first direction when the discharge chute is in the operative position; and in a second direction when the discharge chute is in the inoperative position.

14. The lawn mower of claim 8, wherein the blocking plate is coupled to the cutting deck proximate the discharge outlet.

15. A cutting deck comprising:

- a top surface and at least one sidewall that together form a downwardly opening cutting chamber, the at least one sidewall defining a discharge outlet;
- a discharge chute coupled to the cutting deck and positioned proximate the discharge outlet, wherein the discharge chute is movable between an inoperative position and an operative position; and
- a blocking plate also coupled to the cutting deck and moveable between an open position, wherein the discharge outlet is unobstructed by the blocking plate, and a closed position, wherein the discharge outlet is obstructed by the blocking plate,

wherein the discharge chute is operatively connected to the blocking plate such that movement of either the discharge chute or the blocking plate produces corresponding movement of the other of the discharge chute and the blocking plate.