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REARWARD SIDE DISCHARGE MOW DECK AND DECK INSERTS FOR BAGGING AND SIDE DISCHARGE

Abstract

Various embodiments comprise rearward discharge housings and lawn maintenance apparatuses comprising or employing such rearward discharge housings. One example embodiment is a rearward discharge housing, comprising: an intake interface that defines a first opening in the housing and is configured to couple with a discharge port of the mow deck, wherein the intake interface is configured to receive material from the mow deck at a first horizontal angle that is at least 55° away from a rear direction relative to the mow deck; an inner surface configured to redirect material received via the intake interface to a second horizontal angle that is within 45° of the rear direction; and an output configured to expel the material from the housing.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] The present application for patent claims the benefit of priority from U.S. Provisional Application No. 63/551,787 filed Feb. 9, 2024 and titled REARWARD SIDE DISCHARGE MOW DECK AND DECK INSERTS FOR BAGGING AND SIDE DISCHARGE, which is hereby incorporated by reference herein in its entirety and for all purposes.

FIELD OF DISCLOSURE

[0002] The disclosed subject matter pertains to apparatuses and methods for an outdoor power equipment, for instance, systems and apparatuses for redirecting and/or bagging material from the outdoor power equipment, such as turf clippings from a mowing implement of a turf maintenance machine.

BACKGROUND

[0003] Manufacturers of power equipment for outdoor maintenance applications offer many types of machines for general maintenance and mowing applications. These machines can have a variety of forms depending on application, from general urban or suburban lawn maintenance, rural farm and field maintenance, to specialty applications. Even specialty applications can vary significantly. For example, mowing machines suitable for sporting events requiring moderately precise turf, such as soccer fields or baseball outfields may not be suitable for events requiring very high-precision surfaces such as golf course greens, tennis courts and the like.

[0004] Modern maintenance machines also offer multiple options for a power source. The various advantages associated with electric motor engines, gasoline engines, natural gas engines, diesel engines and so forth also impact the mechanical design and engineering that go into these different maintenance devices. Meeting the various challenges associated with different maintenance and mowing applications and the benefits and limitations of different power sources results in a large variety of maintenance machines to meet consumer preferences.

BRIEF SUMMARY

[0005] The following presents a simplified summary in order to provide a basic understanding of some aspects of the disclosure. This summary is not an extensive overview of the disclosure. It is not intended to identify key/critical elements or to delineate the scope of the disclosure. Its sole purpose is to present some concepts of the disclosure in a simplified form as a prelude to the more detailed description that is presented later.

[0006] Embodiments of the present disclosure provide a rearward directed side discharge housing or rearward discharge housing, as well as lawn maintenance apparatuses comprising or employing such discharge housings. Rearward discharge housings discussed herein can redirected material from a mow deck to a bagging system, etc., while retaining substantially more kinetic energy in the material than existing discharge apparatuses (e.g., side discharge, etc.).

[0007] In one or more embodiments, disclosed is an apparatus, comprising: an intake interface that defines a first opening in the apparatus and is configured to couple with a discharge port of a mow deck of a mowing machine, wherein the intake interface is configured to receive material from the mow deck at a first horizontal angle that is at least 55° away from a rear direction relative to the mow deck; an inner surface configured to redirect material received via the intake interface to a second horizontal angle that is within 45° of the rear direction; and an output configured to expel the material from the apparatus.

[0008] In further embodiments, disclosed is a lawn maintenance apparatus, comprising: a frame; a mow deck attached to the frame; and a rearward discharge housing, comprising: an intake interface that defines a first opening in the housing and is configured to couple with a discharge port of the mow deck, wherein the intake interface is configured to receive material from the mow deck at a

first horizontal angle that is at least 55° away from a rear direction relative to the mow deck; an inner surface configured to redirect material received via the intake interface to a second horizontal angle that is within 45° of the rear direction; and an output configured to expel the material from the housing.

[0009] To accomplish the foregoing and related ends, certain illustrative aspects of the disclosure are described herein in connection with the following description and the drawings. These aspects are indicative, however, of but a few of the various ways in which the principles of the disclosure can be employed and the subject disclosure is intended to include all such aspects and their equivalents. Other advantages and features of the disclosure will become apparent from the following detailed description of the disclosure when considered in conjunction with the drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIGS. **1**A and **1**B depict a mow deck with a side discharge opening in connection with various embodiments.

[0011] FIGS. **2**A and **2**B illustrate a mow deck with a first example embodiment of a rearward-directed discharge opening according to various embodiments.

[0012] FIG. **3** depicts a mow deck with a detachable front-edge baffle for implementing a second example embodiment of a rearward-directed discharge opening according to yet other aspects of the disclosure.

[0013] FIG. **4** illustrates a mow deck with a detachable front-edge baffle and third example embodiment according to still further aspects disclosed herein.

[0014] FIG. **5** illustrates a photograph of a prototype embodiment of a mow deck with a rearward side discharge, according to various aspects discussed herein.

[0015] FIG. **6** illustrates four photographs of a prototype embodiment of a mow deck with a rearward side discharge illustrating the separation between the mow blade and discharge housing at various angles, according to various aspects discussed herein.

[0016] FIG. **7** illustrates an inside perspective view of a fourth example housing, according to various aspects discussed herein.

[0017] FIG. **8** illustrates a top view of the fourth example housing, according to various aspects discussed herein.

[0018] FIG. **9** illustrates a bottom view of the fourth example housing, according to various aspects discussed herein.

[0019] FIG. **10** illustrates an outside view of the fourth example housing, according to various aspects discussed herein.

[0020] FIG. **11** illustrates an outside perspective view of the fourth example baffle, according to various aspects discussed herein.

[0021] FIG. **12** illustrates a photograph of an example prototype of the fourth example embodiment, according to various aspects discussed herein.

[0022] FIG. **13** illustrates photographs showing a top view (top image) and outside view (bottom image) of a prototype of a fifth example embodiment of a rearward side discharge, according to various aspects discussed herein.

[0023] FIG. **14** illustrates a photograph of an interior of the prototype of the fifth example embodiment of a rearward discharge housing according to various aspects discussed herein.

[0024] FIG. **15** illustrates three photographs of a prototype of a sixth example embodiment of a rearward side discharge, according to various aspects discussed herein.

[0025] FIG. **16** illustrates an inside view (top) and an inside perspective view (bottom) of a seventh example embodiment of a rearward discharge housing, according to various aspects discussed

herein.
[0026] FIG. **17** illustrates a rear view (left) and an elevated rear view (right) of the seventh example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0027] FIG. **18** illustrates an outside view (top) and a front view (bottom) of the seventh example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0028] FIG. **19** illustrates a top view (top) and a bottom view (bottom) of the seventh example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0029] FIG. **20** illustrates an inside view (top) and an inside perspective view (bottom) of the eighth example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0030] FIG. **21** illustrates a rear view (left) and an elevated rear view (right) of the eighth example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0031] FIG. **22** illustrates an outside view (top) and a front view (bottom) of the eighth example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0032] FIG. **23** illustrates a top view (top) and a bottom view (bottom) of the eighth example embodiment of a rearward discharge housing, according to various aspects discussed herein.
[0033] FIG. **24** depicts a rear edge of an ejection port of a mow deck coupled to a rear edge of a rearward discharge intake in one or more additional aspects of the disclosure.
[0034] FIG. **25** illustrates a top view of rear surfaces of an example rearward discharge intake including a discharge surface and recirculation surface in further aspects of the disclosure.
[0035] FIG. **26** depicts a side interior view of the rearward discharge intake and the recirculation surface thereof, in an aspect(s).
[0036] FIG. **27** illustrates a bottom interior view of the rearward discharge intake and an interface of the recirculation surface and rear interior surface of a mow deck in other aspects.
[0037] FIG. **28** depicts a front perspective interior view of the rearward discharge intake in still further aspects of the present disclosure.
[0038] FIG. **29** illustrates a front interior view of the rearward discharge intake in one or more additional aspects of the present disclosure.
[0039] FIG. **30** illustrates an image of interior surfaces of an rearward discharge intake coupled to a discharge port of a mow deck, according to further disclosed aspects.
[0040] FIG. **31** illustrates an example baffle structure within an interior of a mow deck usable in conjunction with the intake structure of FIG. **30**, in further aspects of the disclosure.
[0041] FIG. **32** depicts an underside view of the baffle structure of FIG. **31**.
[0042] FIG. **33** illustrates left perspective (top) and right (bottom) views of an example embodiment of a lawn maintenance apparatus in a seated configuration, according to various aspects discussed herein.
[0043] FIG. **34** illustrates top (top) and front (bottom) views of the example embodiment in the seated configuration, according to various aspects discussed herein.
[0044] FIG. **35** illustrates rear (top) and left (bottom) views of the example embodiment in the seated configuration, according to various aspects discussed herein.
[0045] FIG. **36** illustrates left perspective (top) and right (bottom) views of the example embodiment in a standing configuration, according to various aspects discussed herein.
[0046] FIG. **37** illustrates top (top) and front (bottom) views of the example embodiment in the standing configuration, according to various aspects discussed herein.
[0047] FIG. **38** illustrates rear (top) and left (bottom) views of the example embodiment in the standing configuration, according to various aspects discussed herein.
[0048] It should be noted that the drawings are diagrammatic and not drawn to scale. Relative dimensions and proportions of parts of the figures have been shown exaggerated or reduced in size for the sake of clarity and convenience in the drawings. The same reference numbers are generally used to refer to corresponding or similar features in the different embodiments, except where clear

from context that same reference numbers refer to disparate features. Accordingly, the drawings and description are to be regarded as illustrative in nature and not as restrictive.

[0049] While embodiments of the disclosure pertaining to transporting turf clippings from a mow deck of power equipment machines are described herein, it should be understood that the disclosed machines, electronic and computing devices and methods are not so limited and modifications may be made without departing from the scope of the present disclosure. The scope of the devices, components of such devices, coupling apparatuses and power sources are defined by the appended claims, and all devices, components, and apparatuses that come within the meaning of the claims, either literally or by equivalence, are intended to be embraced therein.

DETAILED DESCRIPTION

[0050] The following terms are used throughout the description, the definitions of which are provided herein to assist in understanding various aspects of the subject disclosure.

[0051] As used in this application, the terms “outdoor power equipment”, “outdoor power equipment machine”, “power equipment”, “maintenance machine” “turf maintenance machine” and “power equipment machine” are used interchangeably and are intended to refer to any of robotic, partially robotic ride-on, manually operated ride-on, walk-behind, sulky equipped, autonomous, semi-autonomous (e.g., user-assisted automation), remote control, or multi-function variants of any of the following: powered carts and wheel barrows, motorized or non-motorized trailers, lawn mowers, lawn and garden tractors, cars, trucks, go-karts, scooters, buggies, powered four-wheel riding devices, powered three-wheel riding devices, lawn trimmers, lawn edgers, lawn and leaf blowers or sweepers, hedge trimmers, pruners, loppers, chainsaws, rakes, pole saws, tillers, cultivators, aerators, log splitters, post hole diggers, trenchers, stump grinders, snow throwers (or any other snow or ice cleaning or clearing implements), lawn, wood and leaf shredders and chippers, lawn and/or leaf vacuums, pressure washers, lawn equipment, garden equipment, driveway sprayers and spreaders, and sports field marking equipment.

[0052] As utilized herein, terms of degree such as approximately, substantially, about, roughly and so forth, are intended to incorporate ranges and variations about a qualified term reasonably encountered by one of ordinary skill in the art in fabricating or compiling the embodiments disclosed herein, where not explicitly specified otherwise. For instance, a term of degree can refer to ranges of manufacturing tolerances associated with suitable manufacturing equipment (e.g., injection molding equipment, extrusion equipment, metal stamping equipment, and so forth) for realizing a mechanical structure from a disclosed illustration or description. In some embodiments, depending on context and the capabilities of one of ordinary skill in the art, terms of degree can refer to a variation in a disclosed value or characteristic; e.g., a zero to five-percent variance or a zero to ten-percent variance from precise mathematically defined value or characteristic, or any suitable value or range there between can define a scope for a disclosed term of degree. As an example, a rear discharge angle (e.g., see FIGS. **1**A and **1**B, infra) can define an angle to a fixed direction (e.g., a rear direction; 180 degrees from a forward direction of travel; etc.) with a variance within reasonable manufacturing tolerances, a variance of zero to five-percent of a disclosed angle(s), a variance of 5-6 degrees or less of the disclosed angle(s), a variance of 2-3 degrees or less of the disclosed angle(s), or any suitable value or range there between. These or similar variances can be applicable to other contexts in which a term of degree is utilized herein such as timing of a computer-controlled signal, power applied by a motor onto a component of a disclosed maintenance apparatus, accuracy of measurement of a physical effect (e.g., a dimension, a torque output, an electric power consumption, etc.) or the like.

[0053] FIGS. **1**A and **1**B depict an overhead view of a mow deck **100** with side discharge, in connection with various embodiments of the present disclosure. Mow deck **100** can be a side discharge mow deck or a top discharge mow deck, or a suitable combination of the foregoing. Mow deck **100** includes a discharge opening from which turf clippings, leaves, vegetation, loose dirt and other material can be expelled during operation of a cutting unit beneath mow deck **100**. As is

shown at FIG. **1**A, discharge opening **110** defines an angle to rear **130** suitable to distribute turf clippings and other material in a relatively uniform distribution out a lateral direction from mow deck **100** through discharge opening **110**. In an embodiment, angle to rear **130** can be in a range from about 55 degrees to about 75 degrees from a rearward direction as shown, or any suitable value or range there between.

[0054] FIG. **1**B illustrates an outline of a housing **140** coupled to discharge opening **110** and configured to capture turf clippings and other material expelled from discharge opening **110** therein. Housing **140** can comprise a disclosed conveyor apparatus in various embodiments, including a conveyor/deck interface immediately adjacent to (and in fluid communication with) discharge opening **110** such that material expelled from discharge opening **110** can be received by a bagging system (e.g., passive bagging or active bagging, such as assisted by a blower or any other powered system that assists or facilitates movement of material in connection with a bagging system, etc.) through discharge opening **110**, as described herein. A curved interior surface can redirect material moving in a direction shown by angle to rear **130** further rearward as shown at angle turn **150**. The angle turn **150** can slow down the momentum of the material, potentially causing a backup of material within housing **140** at angle turn **150** in the event of very high volumes of material, high density of material, wet material, or the like entering housing **140**.

[0055] FIGS. **2**A and **2**B disclose a drawing of a first example embodiment of a rearward directed discharge for a mow deck **200** according to various embodiments of the present disclosure. Referring to FIG. **2**A, mow deck **200** has a rearward directed side discharge opening **210**. Rearward directed discharge opening **210** has an angle to rear **230** smaller than angle to rear **130** of FIGS. **1**A and **1**B. In various embodiments, rearward directed discharge housing can have an inner surface around 0.25 in. away from the tips of mow blades (e.g., 0.125-0.375 in., etc.) throughout a front portion of the inner surface, which can have a shape substantially the same as the arc of a circle centered around the center of rotation of the mow blades, until departing from the circular arc at an angle above horizontal in FIGS. **2**A and **2**B equal to around the angle to rear **230**, behind which the inner surface can be substantially straight, piecewise straight, curved at a greater radius of curvature, etc.

[0056] In various embodiments, rearward-directed discharge opening **210** can be implemented with a front-edge baffle **215** that contains turf clippings and material driven within mow deck **200** by a cutting unit along a further arc than discharge opening **110** of mow deck **100**, as shown by the shaded arrow within rearward-directed discharge opening **210**. Front-edge baffle **215** can maintain contact between the cutting unit (e.g., edge of a blade) and turf clippings and other material until front-edge baffle ends and the material exits rearward-directed discharge opening **210**. This causes the material to maintain energy provided by the cutting unit until the material exits the discharge opening. The location of rearward directed side discharge opening **210** in mow deck **200** can be similar (or identical, depending on the embodiment) to that of side discharge opening **110** in mow deck **100**, but the use of front-edge baffle **215** or similar redirection surface(s) (e.g., a piecewise approximation of the curve of front-edge baffle **215**, etc.) can provide for more efficient movement of material to the rear of a vehicle employing rearward-directed discharge opening **210** (and similarly with other embodiments discussed herein).

[0057] Additionally, rearward-directed discharge opening **210** can optionally be implemented with a deck cut-away **212** that removes a section of mow deck **200** and opens a rearward arc of the mow deck **200**. The rearward arc opened by deck cut-away **212** is shown between the gray dotted line and the new rear opening in rearward-directed discharge opening **210** as shown in FIG. **2**A. In an embodiment, angle to rear **230** can be less than thirty degrees. In another embodiment, angle to rear **230** can be in a range from about ten to about thirty degrees, or any suitable value or range there between (e.g., 10, 12, 15, 17, 20, 24, 28, 30 degrees, etc., or 10 to 15, 12 to 17, 15 to 20, 20 to 25, 23 to 28 degrees, and so forth).

[0058] As shown in FIG. **2**B, a housing **240** can be secured to mow deck **200** covering rearward-

directed discharge opening **210** and optionally covering front-edge baffle **215**. Housing **240** receives turf material output from rearward-directed discharge opening **210** with minimal angle disturbance **250** together with directing the turf material toward a rear of housing **240**. This significantly improves retention of momentum and kinetic energy of the turf material as it transitions from mow deck **200** into and through housing **240**, optimizing energy efficiency associated with transferring turf material into and through housing **240** (e.g., to a passive or active bagging system). By maintaining a substantially greater portion of the kinetic energy of material entering housing **240** in material exiting housing **240**, passive bagging (e.g., wherein material moves through a tube, etc. to a bagging system based on its momentum, etc.) can be enabled in scenarios not possible with existing discharge systems and/or apparatuses, and active bagging systems can operate with substantially less energy than in connection with existing discharge systems and/or apparatuses. This energy savings can provide increased runtime for battery-powered lawn maintenance equipment.

[0059] Various embodiments can be or comprise a rearward discharge housing with any of a variety of aspects or features discussed herein, which can receive material from a mow deck via a discharge opening, intake interface, or input to the discharge housing and expel the material via a second opening or output near the rear of the discharge housing. Material received via the discharge opening can be received at a first angle (e.g., substantially equal to angle to rear **130**, 55° or greater from the rear direction relative to the mow deck, etc.) and redirected to be discharged via the second opening at a second angle (e.g., such as angle to rear **230**, or any angle 45° or less from the rear direction relative to the mow deck, etc.). In contrast to the side discharge of FIGS. **1**A-**1**B, rearward directed discharge housings discussed herein can redirect material through a more gradual and smoother transition that maintains a significantly greater portion of the kinetic energy of the material.

[0060] FIG. **3** depicts a perspective view **300** of a mow deck **310** according to a second example embodiment of the present disclosure. Mow deck **310** defines a rearward-directed discharge opening **210** in mow deck **310**. A cutting radius **312** of a cutting unit secured to mow deck **310** provides kinetic energy to loose material within mow deck **310**. Front-edge baffle **315** extends an exterior wall around an arc of cutting radius **312** beyond an opening defined in mow deck **310** by rearward-directed discharge opening **210**. The loose material maintains the kinetic energy until the extended wall of front-edge baffle **315** is exceeded in rotation direction **314**. A deck cut-away portion **210** maintains the opening following the extended exterior wall provided by front-edge baffle **315** up to an angle to rear **230** as shown in FIGS. **2**A and **2**B, supra.

[0061] FIG. **4** depicts an alternative baffle **400** for a rearward discharge mow deck according to a third example embodiment of the present disclosure. Mow deck **402** defines a discharge opening **410**, including a deck cut-away **420** opening the discharge opening to an angle to rear similar to angle to rear **230** as shown in FIGS. **8**A and **8**B. A front-edge baffle **415** is shown that is removably attachable to mow deck **402** to extend an arc of a perimeter of mow deck **402** through discharge opening **410** in rotation direction **414** toward the deck cut-away portion **420**. Front-edge baffle **415** can be attached to mow deck **402** as shown to implement rearward-directed discharge into a passive or active bagging system to implement a bagging mode for mow deck **402**.

[0062] For a side-discharge mode, front-edge baffle **415** can be removed and a side-discharge chute can be inserted into discharge opening **410**. In one or more embodiments, side-discharge chute can have a deck cut-away material attached, formed, molded or otherwise integral to the side-discharge chute. The deck cut-away material can restore a portion of a rear of mow deck **402** removed as shown in FIG. **2**A (dotted gray arrow) compared with FIG. **1**A. Stated differently, the deck cut-away material can restore the mow deck discharge opening to have angle to rear **130** as shown in FIG. **1**A, to implement the side-discharge mode.

[0063] Referring to FIG. **5**, illustrated is a photograph of a prototype embodiment of a mow deck with a rearward side discharge similar to the first, second, and third example embodiments. FIG. **6**

shows four photographs of a prototype embodiment of a mow deck with a rearward side discharge illustrating the separation between the mow blade and discharge housing at various angles. As can be seen in FIG. **6**, the separation between the mow blade and discharge housing remains close in the top two images but increases in the bottom two images.

[0064] FIGS. **7-11** show various views of a fourth example embodiment of a rearward discharge housing **700**. Referring to FIG. **7**, illustrated is an inside perspective view of the fourth example housing **700**, according to various aspects discussed herein. Referring to FIG. **8**, illustrated is a top view of the fourth example housing **700**, according to various aspects discussed herein. Referring to FIG. **9**, illustrated is a bottom view of the fourth example housing **700**, according to various aspects discussed herein. Referring to FIG. **10**, illustrated is an outside view of the fourth example housing **700**, according to various aspects discussed herein. Referring to FIG. **11**, illustrated is an outside perspective view of the fourth example baffle **700**, according to various aspects discussed herein.

[0065] Housing **700** comprises a curved inner surface that maintains a substantially constant separation **750** (e.g., 0.125-0.375 in or any range or value therein, such as around 0.25 in, etc.) from the tips of the adjacent mow blades through an arc (defined by a front portion of inner surface **710**) from a front of housing **700** until a straight portion of inner surface **710** (near the front end of bottom surface **720**), which can have an angle to rear **730** of 20-30° or any range or value therein, such as around 26-28°, around 27°, etc. The relatively small separation **750** can maintain the kinetic energy of material (e.g., turf clippings, etc.) as they are directed from mow blades through housing **700** to angle to rear **730**, reducing energy loss caused by redirections such as angle turn **150** of FIG. **1** and similar features of existing side discharge mow decks.

[0066] Material passing beyond inner surface **710** can be further redirected by bottom surface **720** rearward (e.g., via a surface with angle to rear **740**, which can be 10-20° or any range or value therein, such as around 14-16°, around 15°, etc.) and/or upward by both the kinetic energy of the material and the upward angle **760** (e.g., 10-20° or any range or value therein, such as around 14-16°, around 15°, etc.) of bottom surface **720** into a range of trajectories (e.g., ranging from upward angle **760** to around 45° or greater, etc.). Additionally, as can be seen in FIG. **11**, a top edge of inner surface **710** of housing **700** slopes inward over a portion of bottom surface **720**. Referring to FIG. **12**, illustrated is a photograph of an example prototype of the fourth example embodiment, according to various aspects discussed herein.

[0067] Referring to FIG. **13**, illustrated are photographs showing a top view (top image) and outside view (bottom image) of a prototype of a fifth example embodiment **1300** of a rearward side discharge, according to various aspects discussed herein. FIG. **14** shows a photograph of an interior of the prototype of the fifth example embodiment **1300** of a rearward discharge housing according to various aspects discussed herein. In contrast to the fourth example embodiment, the fifth example embodiment has an elevated hood on the housing, and the upper part of the inner surface has been moved outward away from the bottom surface, which creates a flow pattern that draws air and material entering the fifth example embodiment upward and away from the mow deck into the fifth example embodiment. Additionally, the bottom surface of the fifth example embodiment comprises a curved surface **1310** that creates a smooth transition from the curve of the inner surface to the discharge opening of the fifth example embodiment, reducing loss of kinetic energy in material. Circled in FIG. **14** is grass buildup **1320** that occurred during testing of the prototype at a corner between the curved surface **1310** and an inside surface of the fifth example embodiment. Additional grass buildup **1330** occurred above a vertical portion of the inner surface of the fifth example embodiment. The fifth example embodiment also has a top surface **1340** that rises significantly above the surface of the mow deck (e.g., the height of top surface **1340** can be more than the height of the inner surface of the rearward discharge housing, more than 1.5× the height of the inner surface, more than 2× the height of the inner surface, more than 2.5× the height of the inner surface, more than 3× the height of the inner surface, etc.). This elevated top surface **1340** can

allow space for a range of trajectories of material (e.g., ranging from an upward angle of curved surface **1310** for material moving along curved surface **1310** to an upper trajectory that can make an angle of up to 45° above horizontal or potentially more, which can depend on factors such as the material (e.g., type, density, moisture content, etc.), mow blade tip speed, etc. The elevated top surface **1340** allows material to retain a greater portion of its kinetic energy by not losing energy via impact with top surface **1340**, allowing for more efficient movement of material through the housing (e.g., to an active or passive bagging system, etc.).

[0068] Referring to FIG. **15**, illustrated are three photographs of a prototype of a sixth example embodiment **1500** of a rearward side discharge, according to various aspects discussed herein. The sixth example embodiment **1500** is similar to the fifth example embodiment **1300**, but curved surface **1510** removes the corner where grass buildup **1320** occurred in embodiment **1300**.

[0069] FIGS. **16-19** show various views of a seventh example embodiment **1600** of a rearward discharge housing. FIG. **16** shows an inside view (top) and an inside perspective view (bottom) of the seventh example embodiment **1600** of a rearward discharge housing, according to various aspects discussed herein. FIG. **17** shows a rear view (left) and an elevated rear view (right) of the seventh example embodiment **1600** of a rearward discharge housing, according to various aspects discussed herein. FIG. **18** shows an outside view (top) and a front view (bottom) of the seventh example embodiment **1600** of a rearward discharge housing, according to various aspects discussed herein. FIG. **19** shows a top view (top) and a bottom view (bottom) of the seventh example embodiment **1600** of a rearward discharge housing, according to various aspects discussed herein. The inner surface **1610** of the seventh example embodiment **1600** can be substantially vertical near the front of embodiment **1600**. A lower portion **1612** of the inner surface **1610** of embodiment **1600** is substantially vertical throughout its length. An upper portion **1614** of inner surface **1610** can be vertical near the front of embodiment **1600** and can tilt outward at an angle relative to vertical that can gradually increase along the upper portion **1614** to a maximum angle relative to vertical (e.g., 45° or less, 40° or less, 35° or less, etc.), creating a flow pattern that draws air and material entering embodiment **1600** upward and away from the mow deck while maintaining the majority of its kinetic energy, similarly to the fifth embodiment. However, because of the gradual transition of upper portion **1614** and the non-horizontal angle maintained throughout upper portion, turf or other material is less likely to accumulate on upper portion **1614** than in similar portions of the fifth embodiment (e.g., grass buildup **1330**).

[0070] FIGS. **20-23** show various views of an eighth example embodiment of a rearward discharge housing **2000**. FIG. **20** shows an inside view (top) and an inside perspective view (bottom) of the eighth example embodiment **2000** of a rearward discharge housing, according to various aspects discussed herein. FIG. **21** shows a rear view (left) and an elevated rear view (right) of the eighth example embodiment **2000** of a rearward discharge housing, according to various aspects discussed herein. FIG. **22** shows an outside view (top) and a front view (bottom) of the eighth example embodiment **2000** of a rearward discharge housing, according to various aspects discussed herein. FIG. **23** shows a top view (top) and a bottom view (bottom) of the eighth example embodiment **2000** of a rearward discharge housing, according to various aspects discussed herein. The eighth example embodiment **2000** can be similar to the seventh example embodiment with respect to the inner surface **2010** and bottom surface **2020**. Additionally, however, eighth example embodiment **2000** can comprise a curved surface **2022** similar to curved surface **1310** of fifth embodiment **1300** or to curved surface **1510** of sixth embodiment **1500**, which can facilitate flow of material through the eighth example embodiment **2000** with greater kinetic energy, enabling more effective and efficient bagging of material. Eighth example embodiment **2000** can also comprise an elevated top surface **2030** that can be similar to top surface **1340** of the fifth embodiment or top surface **1540** of the sixth embodiment, allowing material to move freely along a range of trajectories through the rearward discharge housing. In general, inner surface **2010** can be around **0.25** in. away from the tips of mow blades (e.g., 0.125-0.375 in., etc.) throughout a front portion of the inner surface,

which can have a shape substantially the same as the arc of a circle centered around the center of rotation of the mow blades, until departing from the circular arc (at or near the front end of bottom surface **2020**) at an angle above horizontal (e.g., 35° or less, 30° or less, 25° or less, 20° or less, etc.), behind which the inner surface can be substantially straight, piecewise straight, curved at a greater radius of curvature, etc. The front end of bottom surface **2020** can continue the circular arc of the front portion of inner surface **2010** until the arc ends adjacent to the mow deck.

[0071] FIG. **24** shows grass buildup on an edge between the mow deck and a prototype of an embodiment similar to the eighth embodiment, according to various aspects discussed herein. As can be seen in FIG. **24**, the rear of multiple discharge housing embodiments discussed herein can form a relatively sharp edge where it meets the mow deck, and grass or other material can build up on that edge. Buildup of grass or other material at this interface can be minimized in multiple ways, such as by providing a baffle or other surface to eliminate the sharp edge at the interface (e.g., such as employed in the ninth example embodiment, discussed below, etc.) and/or by preventing/minimizing grass from being directed toward that edge (e.g., such as via the center baffle discussed below, which can be employed in one or more grass discharge systems with any of a variety of discharge housings discussed herein, etc.).

[0072] FIGS. **25-29** show various views of a ninth example embodiment of a rearward discharge housing **2500** comprising a bottom surface that facilitates discharge of material moving with the outer edge of mow blades and recirculation of other material, employable as or in connection with various embodiments discussed herein. FIG. **25** shows a top front view of the ninth example embodiment **2500** along with mow deck **2502** and a mow blade **2504**, according to various aspects discussed herein. FIG. **26** shows an inside view of the ninth example embodiment **2500** along with a mow blade **2504**, according to various aspects discussed herein. FIG. **27** shows a bottom inside view of the ninth example embodiment **2500** along with mow deck **2502** and a mow blade **2504**, according to various aspects discussed herein. FIG. **28** shows a front view of the ninth example embodiment **2500**, according to various aspects discussed herein. FIG. **29** shows a front inside view of the ninth example embodiment **2500** along with mow deck **2502** and a mow blade **2504**, according to various aspects discussed herein. Ninth example embodiment **2500** can be similar to the eighth example embodiment **2000** (e.g., inner surface **2510** can have a similar lower portion **2512** and upper portion **2514** to inner surface **2000**, etc.), but can include a bottom surface **2520** that facilitates more efficient discharge of material (e.g., grass clippings, leaves, etc.) without buildup of material at the interface between the rear of housing **2500** and mow deck **2502**.

[0073] Bottom surface **2520** can comprise a discharge surface **2522** that can direct material moving along the inner surface of mow deck **2502** with or near the tips of mow blades **2504** upward and out through housing **2500**. The shape, angle, and/or elevation of discharge surface **2522** can vary between embodiments (e.g., compare curved surface **2022**, bottom surface **1620**, curved surface **1510**, curved surface **1310**, bottom surface **720**, etc.). For material not moving with or near the tips of mow blades **2504**, recirculation surface **2524** can direct that material to the inside surface of mow deck **2502** to be recirculated by mow blades **2504** for subsequent discharge via discharge surface **2522**.

[0074] In various embodiments, recirculation surface **2524** can meet discharge surface at an edge that can be a sharp transition (e.g., as shown in FIGS. **25-29**, etc.) or can be a more gradual (e.g., rounded, comprising one or more intermediate surfaces, etc.) transition. In some embodiments, recirculation surface **2524** can have a vertical cross-section that can be one or more of (e.g., at different positions along its length, etc.): the same as or similar to the vertical cross-section of mow deck **2502**, vertical, sloped or curved such that a lower edge is farther from the center of a nearest mow spindle than an upper edge, etc. In various embodiments, a vertical cross-section of bottom surface **2520** at a rear interface **2506** with mow deck **2502** can match the vertical cross-section of mow deck **2502** at the rear interface **2506**, such that material does not have a relatively sharp edge on which to collect (e.g., as in FIG. **24**) but a relatively smooth transition from bottom surface **2520**

to mow deck **2502** at the rear interface **2506**. In example embodiment **2500**, bottom surface **2520** is shown as a separate component from inner surface **2510**, in other embodiments bottom surface **2520** and inner surface **2510** can be formed as portions of a single component.

[0075] Referring to FIG. **30**, illustrated is an image of an example prototype of a discharge housing with bottom surface similar to the ninth example embodiment **2500**, according to various aspects discussed herein. FIG. **30** has arrows showing flow of air material up the discharge surface (the top left arrow) and past the recirculation surface (the bottom right arrow).

[0076] Referring to FIG. **31**, illustrated is a bottom perspective view of a mow deck **3102** with center baffle **3110**, according to various aspects discussed herein. Center baffle **3110** can be employed in mow decks with more than one mow spindle (e.g., discharge mow spindle **3104** adjacent to deck discharge opening **3108**, adjacent mow spindle **3106**, and optionally one or more other mow spindles). Center baffle **3110** can be arranged between discharge mow spindle **3104** and an adjacent mow spindle **3106**. Center baffle **3110** can prevent flow of material directly from adjacent mow spindle **3106** to deck discharge opening **3108** (and to any discharge housing such as those discussed herein), as such material is more likely to cause grass buildup and blockages than material flowing along the inner surface of the mow deck adjacent to blade tips of mow blades of discharge mow spindle **3104**. Center baffle **3110** can block a direct path of material from mow spindle **3106** to the discharge opening **3108**. With the inclusion of center baffle **3110**, material that would otherwise flow directly from adjacent mow spindle **3106** to discharge opening **3108** instead flows with discharge mow spindle **3104** and is more likely to be flowing with blade tips of mow spindle **3104** as it reaches discharge opening **3108**, for more efficient discharge of material. The example center baffle **3110** has a substantially vertical face and is mounted between mow spindles **3104** and **3106**, with a first end adjacent to and behind mow spindle **3106** and a second end adjacent to and in front of mow spindle **3104**. The arrangement of center baffle **3110** shown in FIG. **31** is based on the arrangement of mow spindles for mow deck **3102**, and in various embodiments, center baffles can be employed differing from center baffle **3110** in one or more of size, shape, or position, while providing similar benefits to center baffle **3110** in connection with discharge of material from the associated mow deck to which that center baffle is connected. Referring to FIG. **32**, illustrated is a photograph of a prototype center baffle installed on a mow deck, in connection with various aspects discussed herein.

[0077] Various embodiments can be or comprise a rearward discharge housing with any of a variety of aspects or features discussed herein, which can receive material from a mow deck via a discharge opening, intake interface, or input to the discharge housing and expel the material via a second opening or output near the rear of the discharge housing. Additional embodiments can be or comprise a grass discharge system employable in connection with a mow deck, comprising one or more of a rearward discharge housing and/or center baffle, either of which can be with any of a variety of aspects or features discussed herein. Further embodiments can comprise a lawn maintenance apparatus comprising one or more of a rearward discharge housing and/or center baffle, either of which can be with any of a variety of aspects or features discussed herein. Although several specific example embodiments are shown and discussed, other embodiments can vary from embodiments discussed herein in one or more ways. For example, as discussed above in connection with FIG. **2**, a rearward-directed discharge opening can optionally be implemented with a deck cut-away that removes a section of mow deck and opens a rearward arc of the mow deck. The extent of the cut-away can vary between embodiments, and in some embodiments can have a greater or lesser angle between the rearward discharge housing and the rear end of the cut-away than shown in various embodiments. As another example, a front portion of the inner surface can define a circular arc of a length that can vary, and in various embodiments, the circular arc defined by the front portion of the inner surface can redirect material to a discharge angle or to an intermediate angle closer (e.g., 20-30° from rear, etc.) to the discharge angle (e.g., 10-20° from rear, etc.) than an intake angle (e.g., around angle to rear **130**, etc.). Additional aspects can also

vary, such as the angle to rear of the rearward discharge housing, the extent or angle of lift of the rearward discharge housing, etc.

[0078] Various embodiments can be employed on a seated lawn maintenance apparatus and/or a standing lawn maintenance apparatus. FIGS. **33-38** below illustrate various views of an example embodiment of a convertible seated/standing lawn-maintenance apparatus that can employ a mow deck and/or grass discharge according to any of a variety of embodiments discussed herein. FIGS. **33-38** illustrate line images of an example embodiment of a lawn maintenance apparatus **3300** in a seated configuration (FIGS. **33-35**) and a standing configuration (FIGS. **36-38**). FIG. **33** illustrates left perspective (top) and right (bottom) views of the example embodiment **3300** in the seated configuration, according to various aspects discussed herein. FIG. **34** illustrates top (top) and front (bottom) views of the example embodiment **3300** in the seated configuration, according to various aspects discussed herein. FIG. **35** illustrates rear (top) and left (bottom) views of the example embodiment **3300** in the seated configuration, according to various aspects discussed herein. FIG. **36** illustrates left perspective (top) and right (bottom) views of the example embodiment **3300** in the standing configuration, according to various aspects discussed herein. FIG. **37** illustrates top (top) and front (bottom) views of the example embodiment **3300** in the standing configuration, according to various aspects discussed herein. FIG. **38** illustrates rear (top) and left (bottom) views of the example embodiment **3300** in the standing configuration, according to various aspects discussed herein.

[0079] Embodiment **3300** is an example lawn maintenance apparatus that can comprise or employ a mow deck as discussed herein (e.g., mow deck **100**, etc.), with exceptions and/or additions as discussed below. Embodiment **300** can be powered electrically, based on an engine (e.g., gas, diesel, etc.), hybrid, etc. The prime mover (not shown) of embodiment **3300** can power various powered components of embodiment **3300**, such as mow deck **3340** and drive wheels **3350**. Embodiment **3300** can also comprise one or more non-driven wheels **3360**, which can be caster wheels and/or actively steered wheels, etc.

[0080] Embodiment **3300** comprises mower controls **3310** (e.g., comprising lap bars, armrest mounted controls, etc.) that can be moved along control mounts **3320** via depressing triggers **3324** on handles **3322** and pushing or pulling the controls **3310** to the seated (forward) or standing (rearward) position where control mount **3320** can be again locked into position. The control adjustment mechanism includes a user handle or grip **3322** along with a trigger or actuator **3324** for adjusting the controls **3310** between standing mode operation in a rearward position and sitting mode operation in a forward position.

[0081] Additionally, in embodiment **3300** display screen **3330** and keypad **3332** can be mounted from the rollover protection (ROP) bar **3370**, allowing access in both the seated and standing modes of operation.

[0082] Generally, the illustrated embodiments are not provided as strict limitations on how the disclosed aspects can be practiced by one of ordinary skill in the art but are intended to be provided as examples that can be modified, interchanged, added to or subtracted from as would be suitable to one of ordinary skill in the art to accomplish the purposes and objectives described herein. As an example, aspects (e.g., an arrangement, shape, or positioning of components, etc.) depicted in one embodiment can be swapped with aspects of another embodiment, optionally excluding some aspects or including other aspects illustrated in a third embodiment, according to design creativity of one of ordinary skill in the art. Still further, components of disclosed machines/devices/motors can also interact with one or more other components not specifically described herein but known by those of skill in the art.

[0083] In regard to the various functions performed by the above described components, machines, apparatuses, devices, processes, control operations and the like, the terms (including a reference to a “means”) used to describe such components, etc., are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component

(e.g., a functional equivalent), even though not structurally equivalent to the disclosed structure, which performs the function in the herein illustrated exemplary aspects of the embodiments. In this regard, it will also be recognized that the embodiments include a system as well as mechanical structures, as well as lawn maintenance equipment comprising rearward discharge systems or structures as discussed herein.

[0084] In addition, while a particular feature may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application. Furthermore, to the extent that the terms “includes,” and “including” and variants thereof are used in either the detailed description or the claims, these terms are intended to be inclusive in a manner similar to the term “comprising.”

[0085] As used in this application, the term “or” is intended to mean an inclusive “or” rather than an exclusive “or”. That is, unless specified otherwise, or clear from context, “X employs A or B” is intended to mean any of the natural inclusive permutations. That is, if X employs A; X employs B; or X employs both A and B, then “X employs A or B” is satisfied under any of the foregoing instances. In addition, the articles “a” and “an” as used in this application and the appended claims should generally be construed to mean “one or more” unless specified otherwise or clear from context to be directed to a singular form.

[0086] In other embodiments, combinations or sub-combinations of the above disclosed embodiments can be advantageously made. Moreover, embodiments described in a particular drawing or group of drawings should not be construed as being limited to those illustrations. Rather, any suitable combination or subset of elements from one drawing(s) can be applied to other embodiments in other drawings where suitable to one of ordinary skill in the art to accomplish objectives disclosed herein, objectives known in the art, or objectives and operation reasonably conveyed to one of ordinary skill in the art by way of the context provided in this specification. Where utilized, block diagrams of the disclosed embodiments or flow charts are grouped for ease of understanding. However, it should be understood that combinations of blocks, additions of new blocks, re-arrangement of blocks, and the like are contemplated in alternative embodiments of the present disclosure.

[0087] Based on the foregoing it should be understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims.

Claims

1. An apparatus, comprising: an intake interface that defines a first opening in the apparatus and is configured to couple with a discharge port of a mow deck of a mowing machine, wherein the intake interface is configured to receive material from the mow deck at a first horizontal angle that is at least 55° away from a rear direction relative to the mow deck; an inner surface configured to redirect material received via the intake interface to a second horizontal angle that is within 45° of the rear direction; and an output configured to expel the material from the apparatus.

2. The apparatus of claim 1, wherein a front portion of the inner surface defines a circular arc segment having a substantially constant distance from a tip of a mow blade closest to the discharge port within the mow deck, wherein the front portion is configured to redirect the material from the first horizontal angle to a third horizontal angle that is within 20° of the rear direction.

3. The apparatus of claim 2, wherein the substantially constant distance is at least 0.125 in. and at most 0.375 in.

4. The apparatus of claim 1, wherein the second horizontal angle is within 30° of the rear direction.

5. The apparatus of claim 1, further comprising a bottom surface configured to redirect the material

upward into a range of trajectories having vertical angles equal to or greater than a first vertical angle defined by at least a portion of the bottom surface.

6. The apparatus of claim 5, wherein the first vertical angle is at least 10° above horizontal.

7. The apparatus of claim 5, wherein: a front portion of the bottom surface defines a circular arc at a substantially constant distance from a tip of a mow blade of the mow deck, wherein the substantially constant distance is at least 0.125 in. and at most 0.375 in; and the bottom surface further comprises a recirculation surface configured to direct a portion of the material away from the intake interface to recirculate within an interior of the mow deck.

8. The apparatus of claim 1, wherein at least part of an upper portion of the inner surface is sloped outward away from the mow deck at a vertical angle of 45° or more above horizontal.

9. The apparatus of claim 8, wherein the upper portion of the inner surface defines a discharge surface and a recirculation surface separated from the discharge surface by a surface edge, wherein the recirculation surface is approximately vertical and the discharge surface has the vertical angle of 45° or more above horizontal.

10. The apparatus of claim 1, wherein the output is configured to expel the material into one of an active bagging system or a passive bagging system.

11. A lawn maintenance apparatus, comprising: a frame; a mow deck attached to the frame; and a rearward discharge housing, comprising: an intake interface that defines a first opening in the housing and is configured to couple with a discharge port of the mow deck, wherein the intake interface is configured to receive material from the mow deck at a first horizontal angle that is at least 55° away from a rear direction relative to the mow deck; an inner surface configured to redirect material received via the intake interface to a second horizontal angle that is within 45° of the rear direction; and an output configured to expel the material from the housing.

12. The lawn maintenance apparatus of claim 11, wherein a front portion of the inner surface defines a circular arc segment at a substantially constant distance from a tip of a mow blade of the mow deck, wherein the front portion is configured to redirect the material from the first horizontal angle to a third horizontal angle that is within 20° of the rear direction.

13. The lawn maintenance apparatus of claim 12, wherein the substantially constant distance is at least 0.125 in. and at most 0.375 in.

14. The lawn maintenance apparatus of claim 11, further comprising a bottom surface configured to redirect the material upward into a range of trajectories having vertical angles equal to or greater than a first vertical angle defined by at least a portion of the bottom surface.

15. The lawn maintenance apparatus of claim 14, wherein the first vertical angle is at least 10° above horizontal.

16. The lawn maintenance apparatus of claim 14, wherein: a front portion of the bottom surface defines a circular arc at a substantially constant distance from tips of mow blades of the mow deck, wherein the substantially constant distance is at least 0.125 in. and at most 0.375 in; and the bottom surface further comprises a recirculation surface configured to direct a portion of the material away from the intake interface to recirculate within an interior of the mow deck.

17. The lawn maintenance apparatus of claim 11, wherein at least part of an upper portion of the inner surface is sloped outward away from the mow deck at a vertical angle of 45° or more above horizontal.

18. The lawn maintenance apparatus of claim 17, wherein the upper portion of the inner surface defines a discharge surface and a recirculation surface separated from the discharge surface by a surface edge, wherein the recirculation surface is approximately vertical and the discharge surface has the vertical angle of 45° or more above horizontal.

19. The lawn maintenance apparatus of claim 11, wherein the output is configured to expel the material into one of an active bagging system or a passive bagging system.

20. The lawn maintenance apparatus of claim 11, further comprising a center baffle arranged between a first mow spindle adjacent to the discharge port and a second mow spindle farther from

the discharge port than the first mow spindle, wherein the center baffle is configured to block a direct path of material from the second mow spindle to the discharge port.