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CUTTER HOLDER FOR FACILITATING PLANT MATERIAL CUTTING

Abstract

A cutter holder for facilitating plant material cutting includes a base configured to rotationally couple to a driver and to rotate about an axis of rotation of the base during operation, one or more cutter mounts coupled to the base, each of the one or more cutter mounts configured to hold a respective cutter and to facilitate cutting of plant material by the cutter when the cutter is held and the base is rotated about the axis of rotation by the driver, a first coupler coupled to the base, and, a second coupler coupled to the base, the second coupler axially spaced from the first coupler and configured to rotationally couple to a first coupler of a further cutter holder. Other apparatuses, systems, and methods are disclosed.

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Background/Summary

CROSS REFERENCES [0001] This application claims the benefit of U.S. provisional patent application No. 63/326,038 entitled “CUTTER HOLDER FOR FACILITATING PLANT MATERIAL CUTTING”, filed on Mar. 31, 2022, which is hereby incorporated by reference herein in its entirety.

BACKGROUND
1. Field
[0002] Embodiments of this disclosure relate to plant material cutting and more particularly to facilitating plant material cutting with at least one cutter holder.
2. Description of Related Art
[0003] Some known mulching arbor devices may use teeth or tooth holders welded to the outside of a single rotatable drum. Such devices may require extensive machining, fabrication and welding to manufacture. Further, such devices may be difficult and/or costly to maintain, such as, for example, when damage occurs.
SUMMARY
[0004] In accordance with various embodiments, there is provided a cutter holder for facilitating plant material cutting, the cutter holder including a base configured to rotationally couple to a driver and to rotate about an axis of rotation of the base during operation, one or more cutter mounts coupled to the base, each of the one or more cutter mounts configured to hold a respective cutter and to facilitate cutting of plant material by the cutter when the cutter is held and the base is rotated about the axis of rotation by the driver, a first coupler coupled to the base, and, a second coupler coupled to the base, the second coupler axially spaced from the first coupler and configured to rotationally couple to a first coupler of a further cutter holder.
[0005] Each of the one or more cutter mounts may include an integral mount portion integral with the base and disposed radially outward from the base.
[0006] The integral mount portion of each of the one or more cutter mounts may include a cutter engaging face configured to abut a cutter when the cutter is held by the cutter mount, the cutter engaging face generally perpendicular to a direction of travel of the cutter engaging face when the base is rotated about the axis of rotation.
[0007] The integral mount portion of each of the one or more cutter mounts may include a bite limiter.
[0008] The integral mount portion may include a cutter mount body, the bite limiter extending from the cutter mount body and axially narrower than the cutter mount body.
[0009] The first and second couplers may be integral with the base.
[0010] The base may include a ring configured to engage and encircle a drive shaft configured to be driven by the driver.
[0011] The base may include at least one convex outer surface portion disposed radially inward of the one or more cutter mounts.
[0012] The at least one convex outer surface portion may include one or more cylindrical surface portions centered on the axis of rotation.
[0013] The one or more cutter mounts may include a plurality of cutter mounts each of the plurality of cutter mounts configured to hold a respective cutter.
[0014] The one or more cutter mounts may include a first cutter mount and a second cutter mount,

the second cutter mount angularly displaced from the first cutter mount by about 180 degrees about the axis of rotation.
[0015] The second coupler may be configured to removably couple to the first coupler of the further cutter holder.
[0016] The first coupler may include at least one first coupler face that extends radially from and parallel to the axis of rotation and the second coupler includes at least one second coupler face that extends radially from and parallel to the axis of rotation such that at least one second coupler face is configured to engage at least one first coupling face of the further cutter holder to rotationally couple to the first coupler of the further cutter holder.
[0017] The first coupler may include three protrusions extending axially and the second coupler may include three protrusions extending axially.
[0018] Each of the one or more cutter mounts may be configured to releasably hold the respective cutter.
[0019] In accordance with various embodiments, there is provided an apparatus for facilitating plant material cutting, the apparatus including a first cutter holder according to the above and a second cutter holder according to the above, the first coupler of the second cutter holder coupled to the second coupler of the first cutter holder to rotationally couple the first and second cutter holders.
[0020] The first coupler of the second cutter holder may be coupled to the second coupler of the first cutter holder such that the first cutter holder is rotationally offset from the second cutter holder by a first offset angle.
[0021] The apparatus may include a third cutter holder according to the above, the first coupler of the third cutter holder coupled to the second coupler of the second cutter holder to rotationally couple the first, second, and third cutter holders such that the first cutter holder is rotationally offset from the third cutter holder by a second offset angle.
[0022] In accordance with various embodiments, there is provided a system for facilitating plant material cutting, the system including the apparatus including the first and second cutter holders according to the above, each of the cutter mounts of the cutter holders of the apparatus holding a respective one of the plurality of cutters.
[0023] The system may include a driver coupled to the bases of the cutter holders of the apparatus, the driver configured to rotate the cutter holders and the plurality of cutters to cause the cutters to cut plant material.
[0024] In accordance with various embodiments, there is provided a method of manufacturing a cutter holder for facilitating plant material cutting, the method including machining a single integral workpiece of material by removal of material to produce the cutter holder described above.
[0025] In accordance with various embodiments, there is provided a system for manufacturing a cutter holder for facilitating plant material cutting, the system comprising a milling machine configured to perform the above method of manufacturing a cutter holder.
[0026] In accordance with various embodiments, there is provided a method of manufacturing a cutter holder for facilitating plant material cutting, the method comprising casting the cutter holder described above.
[0027] In accordance with various embodiments, there is provided a method of manufacturing a cutter holder for facilitating plant material cutting, the method comprising forging the cutter holder described above
[0028] Other aspects and features of embodiments of the present disclosure will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the present disclosure in conjunction with the accompanying figures.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In drawings which illustrate embodiments of the present disclosure,

[0030] FIG. **1** is a first perspective view of a first cutter holder for facilitating plant material cutting, according to various embodiments;

[0031] FIG. **2** is a second perspective view of a first cutter holder for facilitating plant material cutting, according to various embodiments;

[0032] FIG. **3** is a perspective view of an apparatus for facilitating plant material cutting, including the first cutter holder shown in FIGS. **1** and **2**, according to various embodiments;

[0033] FIG. **4** is a side view of a system for facilitating plant material cutting, according to various embodiments, the system including the apparatus shown in FIG. **3**;

[0034] FIG. **5** is a first perspective exploded view of the apparatus shown in FIG. **3**, according to various embodiments;

[0035] FIG. **6** is a second perspective exploded view of the apparatus shown in FIG. **3**, according to various embodiments;

[0036] FIG. **7** is an enlarged view of a portion of the apparatus shown in FIG. **5**, according to various embodiments;

[0037] FIG. **8** is an enlarged view of a portion of the apparatus shown in FIG. **6**, according to various embodiments;

[0038] FIG. **9** is an end view of the apparatus shown in FIG. **3**, according to various embodiments;

[0039] FIG. **10** is a schematic view of a system for manufacturing the first cutter holder shown in FIGS. **1** and **2**, according to various embodiments; and

[0040] FIG. **11** is a perspective view of a boom mountable system including the apparatus shown in FIG. **3**, according to various embodiments;

DETAILED DESCRIPTION

[0041] Referring to FIGS. **1** and **2**, there is shown a first cutter holder **100** or apparatus for facilitating plant material cutting, according to various embodiments, from two different perspective views. In various embodiments, the first cutter holder **100** may facilitate plant material cutting or mulching using a modular system having replaceable elements, which may facilitate ease of manufacturing and/or maintenance resulting in reduced manufacturing and/or maintenance costs.

[0042] Referring to FIG. **3**, there is shown an apparatus **180** for facilitating plant material cutting, the apparatus **180** including a plurality of cutter holders, including the first cutter holder **100** and a second cutter holder **182**, coupled together. In some embodiments, the apparatus **180** may include a third cutter holder **184** and/or additional cutter holders. For example, in some embodiments, the apparatus **180** may include a fourth cutter holder **186**, a fifth cutter holder **188**, a sixth cutter holder **190**, a seventh cutter holder **192**, an eighth cutter holder **194**, a ninth cutter holder **196**, a tenth cutter holder **198**, an eleventh cutter holder **200**, and a twelfth cutter holder **202**. In various embodiments, the apparatus **180** may include a plurality of cutters, each of the cutters held by one of the cutter holders. For example, in some embodiments, each of the cutter holders **100** and **182-202** may include two cutter mounts, each cutter mount configured to hold a cutter, and the apparatus **180** may include 24 cutters, each cutter coupled to a respective cutter mount of one of the cutter holders **100** and **182-202**.

[0043] Referring to FIG. **4**, there is shown a system **210** for facilitating plant material cutting, according to various embodiments, the system including the apparatus **180** and a driver **220** coupled to the apparatus **180**. In various embodiments, the driver **220** may be configured to rotate the apparatus **180** to cause the cutter holders and the cutters thereon to cut plant material. In various embodiments, the modularity of the apparatus **180** as derived from features of the cutter holders **100** and **182-202** shown in FIG. **3** may facilitate plant material cutting or mulching while also facilitating ease of manufacturing and/or maintenance, which may result in reduced manufacturing and/or maintenance costs.

[0044] Referring back to FIGS. **1** and **2**, the first cutter holder **100** will be described in detail. In various embodiments, the first cutter holder **100** may be exemplary and each of the cutter holders **182**-**202** included in the apparatus **180** shown in FIG. **3** may be generally the same as the first cutter holder **100**.

[0045] Referring to FIGS. **1** and **2**, in various embodiments, the first cutter holder **100** may include a base **102** configured to rotationally couple to the driver (shown at **220** in FIG. **4**) and to rotate about an axis of rotation **104** of the base during operation. In some embodiments, the base **102** may include a ring configured to engage and encircle a drive shaft (shown at **222** in FIGS. **3** and **5**, for example) configured to be driven by the driver **220** shown in FIG. **4**. In some embodiments, the base **102** including a ring configured to engage and encircle the drive shaft **222** may facilitate a strong connection between the base **102** and the driver **220**, which may facilitate robust driving of the first cutter holder **100** by the driver **220** during operation. In various embodiments, the base **102** including a ring configured to engage and encircle the drive shaft **222** may facilitate reduced likelihood that the first cutter holder **100** may slip relative to or disengage with the other cutter holders of the apparatus **180** shown in FIG. **3**. In various embodiments, the base **102** may include an inner surface that is generally cylindrical and centered around the axis of rotation **104**.

[0046] Referring to FIGS. **1** and **2**, in various embodiments, the first cutter holder **100** may include first and second cutter mounts **110** and **112** coupled to the base **102**, each of the first and second cutter mounts **110** and **112** configured to hold a respective cutter and to facilitate cutting of plant material by the cutter when the cutter is held and the base **102** is rotated about the axis of rotation **104** by the driver. In various embodiments, including the cutter mounts **110** and **112** for holding cutters instead of cutters alone may facilitate the use of various cutters with the first cutter holder **100**, including for example cutters that are made of different material compared to the cutter holder **100**. In some embodiments, this may facilitate improved versatility, performance and/or manufacturing costs for the first cutter holder **100** and cutters held therein. In various embodiments, including the cutter mounts **110** and **112** may facilitate ease of manufacturing the cutter holder **100**, such as by machining, casting, and/or forging, which may require materials having different strength and hardness properties compared to a cutter which may be held by the cutter mounts **110** and **112**. In various embodiments, including the cutter mounts **110** and **112** for holding cutters may facilitate ease of maintenance of the first cutter holder **100** by facilitating replacement of cutters. In various embodiments, the first cutter holder **100** including more than one cutter mount may facilitate fast and/or efficient cutting of plant material. In various embodiments, the first and second cutter mounts **110** and **112** may be generally similar.

[0047] In various embodiments, the cutter mounts **110** and **112** may include integral mount portions **120** and **122**, respectively, each of the integral mount portions **120** and **122** being integral with the base **102** and disposed radially outward from the base **102**.

[0048] In various embodiments, the second cutter mount **112** may be angularly displaced from the first cutter mount **110** by about 180 degrees about the axis of rotation **104**. In various embodiments, the first and second cutter mounts **110** and **112** being angularly offset by about 180 degrees may facilitate even spacing of the cutters on the cutter mounts **110** and **112**, which may facilitate improved performance during cutting.

[0049] In various embodiments, the integral mount portion **120** may include a cutter engaging face **124** configured to abut a cutter when the cutter is held by the cutter mount **110**, the cutter engaging face generally perpendicular to a direction of travel of the cutter engaging face when the base **102** is rotated about the axis of rotation **104**. For example, in some embodiments, the cutter engaging face **124** may be angled inward toward the axis of rotation **104** by an angle of less than 10 degrees. In various embodiments, the cutter engaging face **124** may form an angle of between about 80-100 degrees with the direction of travel of the cutter engaging face. In various embodiments, the cutter engaging face **124** being generally perpendicular to the direction of travel of the cutter engaging face may facilitate a strong connection between the cutter engaging face **124** and a cutter engaged

by the cutter engaging face **124**, which may facilitate reduced damage and robust use of the first cutter holder **100** and cutters for high impact cutting.
[0050] In various embodiments, the integral mount portion **120** may include a mounting hole **126** for use with a fastener, such as a bolt, to rigidly hold a cutter against the cutter engaging face **124**. In various embodiments, the integral mount portion **120** may include a cutter mount body **128** including the cutter engaging face **124**. In various embodiments, the cutter mount body **128** may have a width generally similar to a width of the cutter engaging face **124** and a cutter to be held on the cutter engaging face.
[0051] Referring still to FIGS. **1** and **2**, in various embodiments, the integral mount portion **120** may include a bite limiter **130**. In some embodiments, the bite limiter **130** may include a flange or fin extending from the cutter mount body **128** opposite from the cutter engaging face **124** partially around the circumference of cutter holder **100**. In some embodiments, the fin may extend radially from an outer surface of base **102**. In various embodiments, the bite limiter **130** may extend from the cutter mount body **128** at an opposite end from the cutter engaging face **124**, away from the cutter engaging face **124**. In various embodiments, the bite limiter **130** may be axially narrower than the cutter mount body **128**. In various embodiments, the bite limiter **130** may be axially narrower than the cutter engaging face **124**. In some embodiments, the bite limiter **130** may help to control the amount of material being removed per instance of contact, which may extend the amount of time the apparatus **180** shown in FIG. **3** is in contact with material prior to decaying in RPM to a point where the driver **220** stalls when in use with the system **210** shown in FIG. **4**. In various embodiments, the bite limiter **130** being axially narrower than the cutter mount body **128** may facilitate controlling the amount of material being removed or cut, without unnecessarily limiting the amount of material being removed or cut.
[0052] In various embodiments, the integral mount portion **122** may include elements generally similar to those of the integral mount portion **120**.
[0053] Referring to FIGS. **1** and **2**, in some embodiments, the base **102** may include convex outer surface portions, including convex outer surface portions **132** and **134**, for example, disposed radially inward of the cutter mounts **110** and **112**. In some embodiments, the convex outer surface portions **132** and **134** may be adjacent to a bite limiter **131**, for example, but disposed radially inward of the bite limiter **131**. In some embodiments, the base **102** may include additional convex outer surface portions, such as, for example, convex surface portions adjacent to the bite limiter **130**, for example, but disposed radially inward of the bite limiter **130**. In various embodiments, the convex outer surface portions may facilitate reduction and/or avoidance of jamming and/or overloading of the cutters when the apparatus **180** is in use. In some embodiments, the convex outer surface portions, including the convex surface portions **132** and **134**, may each include a cylindrical surface portion centered on the axis of rotation **104**. In various embodiments, the convex outer surface portions being cylindrical in shape around the axis of rotation **104** may facilitate ease of sliding of material thereon and/or may facilitate reduction of jamming and/or overloading of the cutters when the apparatus **180** is in use. In various embodiments, a diameter of the cylinder corresponding to the convex outer surface portions **132** and **134** may be about 4 inches.
[0054] In various embodiments, the integral mount portions **120** and **122** being integral with the base **102** may facilitate strong coupling between the first and second cutter mounts **110** and **112** and the base **102**. In various embodiments, the integral mount portions **120** and **122** being integral with the base **102** may facilitate ease of manufacturing of the first cutter holder **100**, such as, for example, by machining a single integral workpiece, casting, and/or forging.
[0055] In some embodiments, the integral mount portions **120** and **122** and the base **102** may be manufactured by machining a single integral workpiece of material. In some embodiments, for example, the integral mount portions **120** and **122** and the base **102** may be manufactured by milling a piece of hard strong material, such as, steel, for example. In various embodiments, this

may provide more consistent results and/or reduced costs compared to fabricating the first cutter holder **100** by another method, such as, welding or assembly of parts, for example.

[0056] Referring to FIG. **3**, the first cutter holder **100** is shown holding first and second cutters **240** and **242** in the first and second cutter mounts **110** and **112**. In various embodiments, each of the cutter mounts **110** and **112** may be configured to releasably hold the respective cutters **240** and **242**. For example, in various embodiments, each of the first and second cutters **240** and **242** may be fastened or held against a respective cutter engaging face via a respective bolt, passing through a mounting hole and threaded into the cutter. In various embodiments, releasable holding of the cutters **240** and **242** may facilitate ease of maintenance by facilitating the replacement of a cutter when the cutter is damaged or worn. In some embodiments, even though the first cutter holder **100** may be itself removable and replaceable from the apparatus **180**, it may be desirable to be able to releasably hold the cutters **240** and **242** because the ability to replace the cutters while keeping the apparatus **180** assembled may reduce maintenance time and/or costs.

[0057] In some embodiments, the cutters **240** and **242** may each include a cutting tooth, such as, for example, a quad tooth, a carbide tipped single point (bullet) tooth, another tooth type, or a combination thereof. In various embodiments, each of the cutters **240** and **242** may be configured to cut or mulch plant material when held by the first cutter holder **100** and driven by the driver **220** shown in FIG. **4**.

[0058] Referring to FIGS. **1** and **2**, in various embodiments, the first cutter holder **100** may include a first coupler **140** (shown in FIG. **1**) coupled to the base **102** and a second coupler **142** (shown in FIG. **2**) coupled to the base **102**, the second coupler **142** axially spaced from the first coupler **140** and configured to rotationally couple to a first coupler of a further cutter holder. For example, referring to FIG. **3**, in various embodiments the second cutter holder **182** may be generally identical to the first cutter holder **100** and may include a second coupler coupled to the first coupler **140** of the first cutter holder **100**. In various embodiments, the first and second couplers **140** and **142** may act as rotational mounts or connectors and/or each may include one or more protrusions for meshing with or engaging with other couplers, to rotationally couple the couplers. In various embodiments, the cutter holders including first and second couplers for rotationally coupling the cutter holders may facilitate ease of assembly and/or rotational resilience during cutting. In various embodiments, including generally identical couplers on each of the cutter holders may facilitate ease of maintenance and/or manufacturing.

[0059] Referring to FIG. **1**, in some embodiments, the first coupler **140** may include first coupler faces **143**, **144**, **146**, **148**, **150**, and **152**, each of which extends radially from the axis of rotation **104** and is parallel to the axis of rotation. In various embodiments, the first coupler faces **143**, **144**, **146**, **148**, **150**, and **152** may be generally planar and lie in a plane, which the axis of rotation **104** would also lie on. In various embodiments, the second coupler may include second coupler faces **154**, **156**, **158**, **160**, **162**, and **164**, each of which extends radially from the axis of rotation **104** and is parallel to the axis of rotation. In various embodiments, the second coupler faces **154**, **156**, **158**, **160**, **162**, and **164** may be generally planar and lie in a plane, which the axis of rotation **104** would also lie on.

[0060] In various embodiments, the second coupler faces **154-164** of the first cutter holder **100** may be configured to engage the first coupler faces of a further cutter holder to rotationally couple to the first coupler of the further cutter holder. In various embodiments, the first coupler face **143** may engage a second coupler face corresponding to the second coupler face **162** of the further cutter holder. In various embodiments, first coupler faces **144**, **146**, **148**, **150**, and **152** may engage second coupler faces corresponding to the second coupler faces **164**, **154**, **156**, **158**, and **160** of the further cutter holder. In various embodiments, the first and second coupler faces **143-152** and **154-164** extending radially from the axis of rotation and being parallel thereto may facilitate strong engagement and reduce slipping when cutting, because forces are transferred in a direction generally normal to the faces.

[0061] In various embodiments, the first coupler **140** may include three protrusions extending axially, including first, second, and third protrusions **170**, **172**, and **174** shown in FIG. **1** and the second coupler **142** may include three protrusions extending axially, including first, second, and third protrusions **176**, **178**, and **179** shown in FIG. **2**. In various embodiments, extending axially may involve extending in a direction aligned with the axis of rotation **104**.
[0062] In various embodiments, the first protrusion **170** of the first coupler **140** may include the first coupler faces **143** and **152**, the second protrusion **172** of the first coupler **140** may include the first coupler faces **144** and **146**, and the third protrusion **174** of the first coupler **140** may include the first coupler faces **148** and **150**. In various embodiments, the first protrusion **176** of the second coupler **142** may include the second coupler faces **154** and **156**, the second protrusion **178** of the second coupler **142** may include the second coupler faces **158** and **160**, and the third protrusion **179** of the second coupler **142** may include the first coupler faces **162** and **164**.
[0063] In various embodiments, the first and second couplers **140** and **142** each including three protrusions extending axially may facilitate strong coupling and/or may facilitate use of a variety of angles when coupling first and second couplers. In various embodiments, the protrusions may facilitate removable coupling between the cutter holders, which may facilitate ease of maintenance and/or replacement of cutter holders in the apparatus **180** shown in FIG. **3**. In various embodiments, the cutter holders may be decoupled by moving them apart axially.
[0064] In various embodiments, the first and second couplers **140** and **142** may be integral with the base **102**. For example, in various embodiments, the protrusions **170**, **172**, **174**, **176**, **178**, and **179** may be integral with the base **102**. In various embodiments, the first and second couplers **140** and **142** being integral with the base **102** may facilitate strong coupling with the base **102**. In various embodiments, the first and second couplers **140** and **142** being integral with the base **102** may facilitate ease of manufacturing of the first cutter holder **100**, such as, for example, by machining a single integral workpiece, casting, and/or forging.
[0065] Referring to FIG. **5**, the apparatus **180** of FIG. **3** is shown from a first exploded view, wherein the cutter holders **100** and **182-202** and the drive shaft **222** are shown separated along the axis of rotation **104**. Referring to FIG. **6**, the apparatus **180** of FIG. **3** is shown from a second exploded view, wherein the cutter holders **100** and **182-202** and the drive shaft **222** are shown separated along the axis of rotation **104**.
[0066] FIGS. **7** and **8** show enlarged views of the first, second, and third cutter holders **100**, **182**, and **184** from FIGS. **5** and **6** respectively. Referring to FIGS. **7** and **8**, in various embodiments, a first coupler **300** of the second cutter holder **182** may be coupled to the second coupler **142** of the first cutter holder **100** such that the first cutter holder **100** is rotationally offset from the second cutter holder **182** by a first offset angle. In various embodiments, the offset may facilitate improved cutting of plant material during use and/or may reduce jamming of the apparatus **180** during use.
[0067] Referring to FIG. **7**, in various embodiments, the second cutter holder **182** includes first coupler faces, which are generally similar to the first coupler faces **144**, **146**, **148**, **150**, **152**, and **143** shown in FIG. **1**, configured to abut or engage second coupler faces **164**, **154**, **156**, **158**, **160**, and **162**, of the first cutter holder **100**. For example, in some embodiments, the second cutter holder **182** includes a first coupler face **302** (which is generally similar to the first coupler face **143** of the first cutter holder **100**), which is configured to abut or engage with the second coupler face **162** (shown in FIG. **8**, for example, of the first cutter holder **100** when the first and second couplers of the second and first cutter holders are engaged as shown in FIG. **3**.
[0068] In some embodiments, the rotational offset between the first and second cutter holders **100** and **182** may facilitate an angular displacement between adjacent cutters on the apparatus **180**, which may facilitate improved cutting performance. In some embodiments, the rotational offset may be set such that the cutters in the apparatus **180** are adjacent to bite limiters, which are not as wide (measured in the direction of the axis of rotation **104**) as a cutter mount body. In various embodiments, this may facilitate improved cutting performance.

[0069] Referring to FIG. **9**, the apparatus **180** is shown from an end view. In various embodiments, a first offset angle **320** between the first and second cutter holders **100** and **182** may be about 80 degrees, for example. In various embodiments, the first offset angle **320** being about 80 degrees may facilitate the cutters in the apparatus **180** being adjacent to bite limiters, which are not as wide (measured in the direction of the axis of rotation **104**) as a cutter mount body. In various embodiments, this may facilitate improved cutting performance. In various embodiments, an apparatus generally similar to the apparatus **180** may use a first offset angle of about 100 degrees in the opposite direction from the first offset angle **320** between first and second cutter holders, which may similarly facilitate the cutters in the apparatus being adjacent to bite limiters. In various embodiments, the first offset angle may be near 90 degrees, such as about 10 degrees different from a 90 degree angle (i.e., 80 degrees or 100 degrees) and this may facilitate cutters in the apparatus being adjacent to bite limiters.

[0070] Referring to FIGS. **7** and **8**, in various embodiments, a first coupler **330** of the third cutter holder **184** may be coupled to a second coupler **340** of the second cutter holder **182** to rotationally couple the first, second, and third cutter holders such that the first cutter holder **100** is rotationally offset from the third cutter holder **184** by a second offset angle. In various embodiments, angular displacement between cutters next to adjacent cutters on the apparatus **180** may facilitate improved cutting performance. In some embodiments, the rotational offset may be set such that the cutters that are two cutter holders apart in the apparatus **180** are slightly rotationally offset, such that they may fall on a generally helical path. In various embodiments, this may facilitate improved cutting performance.

[0071] Referring to FIG. **9**, in various embodiments, the second offset angle **350** between the first and third cutter holders **100** and **184** may be about 160 degrees or equivalent to 200 degrees measured in the opposite direction, for example. In some embodiments, where the first and third cutter holders **100** and **184** each include first and second cutter mounts angularly displaced by about 180 degrees, this arrangement may facilitate angular offset between a first cutter mount of the third cutter holder **184** and the second cutter mount of the first cutter holder **100** of about 180−160=20 degrees.

[0072] Referring to FIG. **10**, there is shown a system **500** for manufacturing the first cutter holder **100** shown in FIGS. **1** and **2**, in accordance with various embodiments. Referring to FIG. **10**, in various embodiments, the system **500** includes a milling machine or mill **502** configured to machine a single integral workpiece **504** of material by removal of material to produce the first cutter holder **100** shown in FIGS. **1** and **2**. In some embodiments, the workpiece **504** may be a hard strong material, such as, steel, for example. In various embodiments, the milling machine **502** may include a vertical milling machine as shown in FIG. **10**. In some embodiments, the milling machine **502** may include a horizontal milling machine. In various embodiments, the milling machine **502** may include a computer numerical control (CNC) milling machine configured to take as an input, a model, representing the first cutter holder **100** and to machine the workpiece **504** by removal of material to produce the first cutter holder **100** shown in FIGS. **1** and **2**. In some embodiments, such manufacturing of the first cutter holder **100** by machining the workpiece **504** by removal of material may provide more consistent results and/or reduced costs compared to fabricating the first cutter holder **100** by some other methods, such as, welding or assembly of parts, for example.

[0073] In various embodiments, the milling machine **502** may manufacture the first cutter holder **100** by machining the workpiece **504** by removal of material. In some embodiments, the milling machine **502** or one generally similar thereto may similarly manufacture the cutter holders **182-202** shown in FIGS. **3**, **5** and **6**. In some embodiments, some features of the cutter holders, such as, for example, the mounting hole for the cutter mount may be cut using another machine, such as, for example, using a horizontal mill, because of the individual machine capabilities. In various embodiments, the apparatus **180** may be assembled by sliding each of the cutter holders **100** and **182-202** over the drive shaft **222** shown in FIG. **5**. In various embodiments, the drive shaft **222**

may include a coupler **224** shown in FIG. **5**, shaped generally similarly to the second coupler **142** of the first cutter holder **100** shown in FIGS. **1** and **2**. In various embodiments, the first coupler **140** of the first cutter holder **100** may rotationally couple to the coupler **224** of the drive shaft **222** to rotationally lock the first cutter holder **100** and thereby rotationally lock the cutter holders **182-202** with the drive shaft **222**.

[0074] In various embodiments, machining the cutter holder from a single integral workpiece may facilitate avoidance or reduction of fabrication and/or welding, which may otherwise need to be done manually using a manual fabricator and/or a robotic welding system, for example. In some embodiments, machining out of one piece may facilitate consistency, automation and/or lights out production, which may reduce costs for manufacturing labour.

[0075] In some embodiments, a method of manufacturing the first cutter holder **100** shown in FIGS. **1** and **2** may involve casting the first cutter holder. In some embodiments, there may be provided a mold including walls defining a cavity having a shape corresponding to the first cutter holder **100** shown in FIGS. **1** and **2**. In various embodiments, a method of manufacturing the first cutter holder **100** may involve pouring liquid metal into the mold to cast the first cutter holder **100**.

[0076] In some embodiments, a method of manufacturing the first cutter holder **100** shown in FIGS. **1** and **2** may involve forging the first cutter holder **100** from a single integral workpiece of material.

[0077] In various embodiments, casting and/or forging the cutter holder to form a single integral cutter holder may facilitate avoidance or reduction of fabrication and/or welding, which may otherwise need to be done manually using a manual fabricator and/or a robotic welding system, for example. In some embodiments, casting and/or forging into one piece may facilitate consistency, automation and/or lights out production, which may reduce costs for manufacturing labour.

[0078] In some embodiments, a combination of techniques may be employed to manufacture the first cutter holder **100**. For example, in some embodiments, a method of manufacturing the first cutter holder **100** may involve casting and/or forging a base material, which may be used as a workpiece for subsequent machining, which may be required for manufacturing of the first cutter holder **100**.

[0079] Referring to FIG. **11**, in various embodiments, in operation, the apparatus **180** may be included in a boom mountable system **600** shown in FIG. **11**. Referring to FIG. **11**, in various embodiments, the boom mountable system **600** includes a boom mount **602** for mounting to a boom of a driver, such as the driver **220** shown in FIG. **4** and a drive shaft coupler **604** configured to provide rotational drive to the drive shaft **222** of the apparatus **180** shown in FIG. **3**. In various embodiments, in operation, an operator of the driver **220** may cause a hydraulic system of the driver **220** to drive the drive shaft coupler **604** to cause the drive shaft **222** to rotate and thereby cause the apparatus **180** to rotate. For example, in some embodiments, the drive shaft may rotate at about 2000 RPM. In various embodiments, while the cutters of the apparatus **180** are rotating, the operator of the driver **220** may move the apparatus **180** into engagement with plant material, for cutting and/or mulching the material.

[0080] In various embodiments, if a cutter of the apparatus **180** is damaged during use, the cutter may be removed from the cutter holder upon which it is mounted and replaced or repaired. In some embodiments, if one of the cutter holders of the apparatus **180** is damaged during use, then the damaged cutter holder may be removed and replaced or repaired.

[0081] While FIG. **4** shows an excavator acting as the driver **220**, in various embodiments another driver may be used, such as, for example, a tractor, a skidsteer, or another host carrier configured to move and drive the apparatus **180**.

[0082] While the apparatus **180** shown in FIGS. **3-9** includes 12 cutter holders, in various embodiments an apparatus configured to function generally similarly to the apparatus **180** may include additional or fewer cutter holders.

[0083] While the first cutter holder **100** shown in FIGS. **1** and **2** includes two cutter mounts, in

various embodiments, a cutter holder configured to function generally similarly to the first cutter holder **100** may include additional or fewer cutter mounts.
[0084] In various embodiments, first and second elements being integral with one another may mean that the first and second elements are made from the same material and that there are no gaps between the first and second elements. For example, in some embodiments, elements that are welded together may not be considered integral, for example, because although a perimeter of the elements may be bonded, there may be a gap between the elements that is not considered bonded. In various embodiments, being integral with one another may be reached by milling the elements from a single block of material, from forging the elements together, and/or from casting the elements together, for example.
[0085] While specific embodiments of the present disclosure have been described and illustrated, such embodiments should be considered illustrative of the present disclosure only and not as limiting the present disclosure as construed in accordance with the accompanying claims.

Claims

1. A cutter holder for facilitating plant material cutting, the cutter holder comprising: a base configured to rotationally couple to a driver and to rotate about an axis of rotation of the base during operation; one or more cutter mounts coupled to the base, each of the one or more cutter mounts configured to hold a respective cutter and to facilitate cutting of plant material by the cutter when the cutter is held and the base is rotated about the axis of rotation by the driver; a first coupler coupled to the base; and a second coupler coupled to the base, the second coupler axially spaced from the first coupler and configured to rotationally couple to a first coupler of a further cutter holder.
2. The cutter holder of claim 1 wherein each of the one or more cutter mounts includes an integral mount portion integral with the base and disposed radially outward from the base.
3. The cutter holder of claim 2 wherein the integral mount portion of each of the one or more cutter mounts includes a cutter engaging face configured to abut a cutter when the cutter is held by the cutter mount, the cutter engaging face generally perpendicular to a direction of travel of the cutter engaging face when the base is rotated about the axis of rotation.
4. The cutter holder of claim 2 or 3 wherein the integral mount portion of each of the one or more cutter mounts includes a bite limiter.
5. The cutter holder of claim 4 wherein the integral mount portion includes a cutter mount body, the bite limiter extending from the cutter mount body and axially narrower than the cutter mount body.
6. The cutter holder of any one of claims 1 to 5 wherein the first and second couplers are integral with the base.
7. The cutter holder of any one of claims 1 to 6 wherein the base includes a ring configured to engage and encircle a drive shaft configured to be driven by the driver.
8. The cutter holder of any one of claims 1 to 7 wherein the base includes at least one convex outer surface portion disposed radially inward of the one or more cutter mounts.
9. The cutter holder of claim 8 wherein the at least one convex outer surface portion includes one or more cylindrical surface portions centered on the axis of rotation.
10. The cutter holder of any one of claims 1 to 9 wherein the one or more cutter mounts include a plurality of cutter mounts each of the plurality of cutter mounts configured to hold a respective cutter.
11. The cutter holder of claim 10 wherein the one or more cutter mounts include a first cutter mount and a second cutter mount, the second cutter mount angularly displaced from the first cutter mount by about 180 degrees about the axis of rotation.
12. The cutter holder of any one of claims 1 to 11 wherein the second coupler is configured to removably couple to the first coupler of the further cutter holder.

13. The cutter holder of any one of claims 1 to 12 wherein the first coupler includes at least one first coupler face that extends radially from and parallel to the axis of rotation and the second coupler includes at least one second coupler face that extends radially from and parallel to the axis of rotation such that at least one second coupler face is configured to engage at least one first coupling face of the further cutter holder to rotationally couple to the first coupler of the further cutter holder.

14. The cutter holder of any one of claims 1 to 13 wherein the first coupler includes three protrusions extending axially and the second coupler includes three protrusions extending axially.

15. The cutter holder of any one of claims 1 to 14 wherein each of the one or more cutter mounts is configured to releasably hold the respective cutter.

16. An apparatus for facilitating plant material cutting, the apparatus comprising: a first cutter holder according to any one of claims **1** to **15**; a second cutter holder according any one of claims **1** to **15**, the first coupler of the second cutter holder coupled to the second coupler of the first cutter holder to rotationally couple the first and second cutter holders.

17. The apparatus of claim 16 wherein the first coupler of the second cutter holder is coupled to the second coupler of the first cutter holder such that the first cutter holder is rotationally offset from the second cutter holder by a first offset angle.

18. The apparatus of claim 16 or 17 further comprising a third cutter holder according to any one of claims 1 to 15, the first coupler of the third cutter holder coupled to the second coupler of the second cutter holder to rotationally couple the first, second, and third cutter holders such that the first cutter holder is rotationally offset from the third cutter holder by a second offset angle.

19. A system for facilitating plant material cutting, the system comprising the apparatus of any one of claims 16 to 18 and a plurality of cutters, each of the cutter mounts of the cutter holders of the apparatus holding a respective one of the plurality of cutters.

20. The system of claim 19 further comprising a driver coupled to the bases of the cutter holders of the apparatus, the driver configured to rotate the cutter holders and the plurality of cutters to cause the cutters to cut plant material.

21. A method of manufacturing a cutter holder for facilitating plant material cutting, the method comprising machining a single integral workpiece of material by removal of material to produce the cutter holder of any one of claims 1 to 15.

22. A system for manufacturing a cutter holder for facilitating plant material cutting, the system comprising a milling machine configured to perform the method of claim 21.

23. A method of manufacturing a cutter holder for facilitating plant material cutting, the method comprising casting the cutter holder of any one of claims 1 to 15.

24. A method of manufacturing a cutter holder for facilitating plant material cutting, the method comprising forging the cutter holder of any one of claims 1 to 15 from a single integral workpiece of material.