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ASSISTED STEERING APPARATUS AND ASSOCIATED SYSTEMS AND METHODS

Abstract

The assisted steering unit includes a motor drive unit and a ring assembly constructed and arranged to couple to and rotate a steering wheel. The assisted steering unit may include a ring assembly where the ring assembly includes a housing, a ring gear disposed within the housing, an anti-rotation pin operatively engaged with the housing. The assisted steering unit may also include a motor drive unit (MDU) including a motor and a drive gear rotatably engaged with the motor. The ring assembly and motor drive unit are constructed and arranged to be releasably engaged to each other.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) [0001] This application is a continuation of U.S. patent application Ser. No. 17/323,649, filed May 19, 2021, and entitled “Assisted Steering Apparatus and Associated Systems and Methods,” which claims the benefit under 35 U.S.C. § 119(e) to U.S. Provisional Application 63/026,208, filed May 18, 2020, and entitled “Assisted Steering Apparatus and Associated Systems and Methods,” each of which are hereby incorporated herein by reference in its entirety for all purposes.

TECHNICAL FIELD
[0002] The disclosed technology relates generally to devices, systems and methods for use in agriculture, including various self-propelled agricultural vehicles, and in particular, to assisted steering devices for use in agricultural applications.
BACKGROUND
[0003] Various assisted steering devices exist in the art. There is a need for improved assisted steering devices.
BRIEF SUMMARY
[0004] Disclosed herein are various assisted steering devices, particularly assisted steering devices for use in agricultural applications although other uses with other applications are possible and contemplated herein.
[0005] Example 1 relates to an assisted steering unit, comprising a ring assembly and a motor drive unit (MDU). The ring assembly comprising a housing, a ring gear disposed within the housing, and an anti-rotation pin operatively engaged with the housing. The motor drive unit (MDU) comprising a motor and a drive gear rotatably engaged with the motor, wherein the ring assembly and motor drive unit are constructed and arranged to be releasably engaged to each other.
[0006] Example 2 relates to the assisted steering unit of Example 1, wherein the motor is a brushless DC motor.
[0007] Example 3 relates to the assisted steering unit of Example 1, further comprising a latching mechanism configured for attachment of the MDU to the ring assembly.
[0008] Example 4 relates to the assisted steering unit of Example 1, wherein the housing comprises one or more depressions corresponding to a location of one or more spokes on a steering wheel.
[0009] Example 5 relates to the assisted steering unit of Example 1, wherein the drive gear is configured to interface with the ring gear when the MDU is engaged with the ring assembly.
[0010] Example 6 relates to the assisted steering unit of Example 1, wherein the ring assembly is divided into two sections for placement around a steering column.
[0011] Example 7 relates to the assisted steering unit of Example 1, further comprising a circuit board in communication with the motor configured to control rotation of the drive gear.
[0012] Example 8 relates to a steering system comprising a modular ring assembly and a motor drive unit configured to be releasably engaged with the modular ring assembly. The modular ring assembly comprising a stationary ring, a rotatable ring fitted to the stationary ring, and a ring gear attached to the rotatable ring, wherein the stationary ring and the rotatable ring form a housing for the ring gear. The motor drive unit comprising a motor and a drive gear driven by the motor, the drive gear configured to be engaged with the ring gear when the motor drive unit is engaged with the modular ring assembly, wherein the motor drives the drive gear, that causes rotation of the ring gear that causes rotation of the rotatable ring, that causes rotation of a steering wheel.
[0013] Example 9 relates to the system of Example 8, further comprising a clamping ring configured to be attached ring assembly and to secure the modular ring assembly to a steering wheel.
[0014] Example 10 relates to the system of Example 8, further comprising an anti-rotation pin

engaged with the stationary ring and configured to be attached to a steering column.
[0015] Example 11 relates to the system of Example 10, further comprising a bracket configured to be disposed on the steering column for engaging with the anti-rotation pin.
[0016] Example 12 relates to the system of Example 8, further comprising a roller assembly configured to align and guide the rotation of the ring gear.
[0017] Example 13 relates to the system of Example 8, further comprising a sensor within the motor drive unit for sensing rotation of the drive gear, the ring gear, and a steering wheel.
[0018] Example 14 relates to the system of Example 13, further comprising a power adaptor for providing power to the motor drive unit.
[0019] Example 15 relates to an assisted steering system comprising a first ring unit configured to be operatively engaged with a first steering column of a first vehicle; a motor drive unit (MDU) configured to be releasably engaged with the first ring unit; and a power supply in communication with the MDU, wherein the MDU controls motion of the first ring unit, and wherein the first ring unit is configured to turn a steering wheel of the first vehicle.
[0020] Example 16 relates to the assisted steering system of Example 15, further comprising a second ring unit configured to be operatively engaged with a second steering column of a second vehicle, wherein the MDU is configured to be releasably engaged with the second ring unit when not engaged with the first ring unit.
[0021] Example 17 relates to the assisted steering system of Example 15, wherein the first ring unit comprises a stationary ring, a rotatable ring fitted to the stationary ring, and a ring gear attached to the rotatable ring, wherein the stationary ring and the rotatable ring form a housing for the ring gear.
[0022] Example 18 relates to the assisted steering system of Example 17, wherein the MDU comprises a motor and a drive gear driven by the motor, the drive gear configured to be engaged with the ring gear when the MDU is engaged with the first ring unit.
[0023] Example 19 relates to the assisted steering system of Example 17, wherein the first ring unit further comprises a cartridge comprising at least one spring and a roller, wherein the cartridge is configured to maintain operational contact between the ring gear and the roller.
[0024] Example 20 relates to the assisted steering system of Example 19, wherein the cartridge is modular and field replaceable.
[0025] While multiple embodiments are disclosed, still other embodiments of the disclosure will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the disclosure is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the disclosure. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0026] FIG. **1** is a perspective view of the system, according to one implementation.
[0027] FIG. **2** is a side view of the system, according to one implementation.
[0028] FIG. **3** is a top view of the system engaged with a steering wheel, according to one implementation.
[0029] FIG. **4** is a top view of the system engaged with a steering wheel, according to one implementation.
[0030] FIG. **5** is a side view of the system engaged with a steering wheel, according to one implementation.
[0031] FIG. **6** is a side perspective view of the ring assembly, according to one implementation.

[0032] FIG. **7** is an exploded side view of the roller assembly, according to one implementation.
[0033] FIG. **8** is a cross sectional view of the roller assembly, according to one implementation.
[0034] FIG. **9** is an exploded side view of various internal components of the ring assembly, according to one implementation.
[0035] FIG. **10** is an exploded view of the ring assembly, according to one implementation.
[0036] FIG. **11** is a cross sectional view of the ring assembly, according to one implementation.
[0037] FIG. **12** is a side view of the ring assembly, according to one implementation.
[0038] FIG. **13** is a side view of the ring assembly, according to one implementation.
[0039] FIG. **14** is a perspective view of the MDU, according to one implementation.
[0040] FIG. **15** is a cross sectional view of the MDU, according to one implementation.
[0041] FIG. **16** is an exploded view of the MDU, according to one implementation.
[0042] FIG. **17** is an exploded view of the MDU with part of the housing removed, according to one implementation.
[0043] FIG. **18** depicts an exploded view of the motor and drive gear, according to one implementation.
[0044] FIG. **19** depicts an exploded view of one side of the housing, according to one implementation.
[0045] FIG. **20** is an exploded view of the housing and circuit board, according to one implementation.
[0046] FIG. **21** is a flow diagram of a navigation system, according to one implementation.
[0047] FIG. **22** is an exploded side perspective view of the housing, according to one implementation.

DETAILED DESCRIPTION

[0048] The various implementations disclosed and contemplated herein relate to compact, quick-release assisted steering devices and systems, particularly for use in agricultural applications, although use in various alternative applications is contemplated herein. The various assisted steering devices and associated systems and methods are of minimal size or form factor, and only have the essential drive components so as to maximize ease of use and transportability. It is understood that the various assisted steering technologies disclosed or contemplated herein can be incorporated into any known agricultural implement or application having a steering system such as, but not limited to, planters, combines, tractors, and harvesters.

[0049] Certain of the disclosed implementations can be used in conjunction with any of the devices, systems or methods taught or otherwise disclosed in U.S. application Ser. No. 16/121,065, filed Sep. 1, 2018, and entitled “Planter Down Pressure and Uplift Devices, Systems, and Associated Methods,” U.S. Pat. No. 10,743,460, filed Oct. 3, 2018, and entitled “Controlled Air Pulse Metering Apparatus for an Agricultural Planter and Related Systems and Methods,” U.S. application Ser. No. 16/272,590, filed Feb. 11, 2019, and entitled “Seed Spacing Device for an Agricultural Planter and Related Systems and Methods,” U.S. application Ser. No. 16/142,522, filed Sep. 26, 2018, and entitled “Planter Downforce and Uplift Monitoring and Control Feedback Devices, Systems and Associated Methods,” U.S. application Ser. No. 16/280,572, filed Feb. 20, 2019 and entitled “Apparatus, Systems and Methods for Applying Fluid,” U.S. application Ser. No. 16/371,815, filed Apr. 1, 2019, and entitled “Devices, Systems, and Methods for Seed Trench Protection,” U.S. application Ser. No. 16/523,343, filed Jul. 26, 2019, and entitled “Closing Wheel Downforce Adjustment Devices, Systems, and Methods,” U.S. application Ser. No. 16/670,692, filed Oct. 31, 2019, and entitled “Soil Sensing Control Devices, Systems, and Associated Methods,” U.S. application Ser. No. 16/684,877, filed Nov. 15, 2019, and entitled “On-The-Go Organic Matter Sensor and Associated Systems and Methods,” U.S. application Ser. No. 16/752,989, filed Jan. 27, 2020, and entitled “Dual Seed Meter and Related Systems and Methods,” U.S. application Ser. No. 16/891,812, filed Jun. 3, 2020, and entitled “Apparatus, Systems, and Methods for Row Cleaner Depth Adjustment On-The-Go,” U.S. application Ser. No. 16/921,828,

filed Jul. 6, 2020, and entitled “Apparatus, Systems and Methods for Automatic Steering Guidance and Visualization of Guidance Paths,” U.S. application Ser. No. 16/939,785, filed Jul. 27, 2020, and entitled “Apparatus, Systems and Methods for Automated Navigation of Agricultural Equipment,” U.S. application Ser. No. 16/997,361, filed Aug. 19, 2020, and entitled “Apparatus, Systems, and Methods for Steerable Toolbars,” U.S. application Ser. No. 16/997,040, filed Aug. 19, 2020, and entitled “Adjustable Seed Meter and Related Systems and Methods,” U.S. application Ser. No. 17/011,737, filed Aug. 3, 2020, and entitled “Planter Row Unit and Associated Systems and Methods,” U.S. application Ser. No. 17/060,844, filed Oct. 1, 2020, and entitled “Agricultural Vacuum and Electrical Generator Devices, Systems, and Methods,” U.S. application Ser. No. 17/105,437, filed Nov. 25, 2020, and entitled “Devices, Systems And Methods For Seed Trench Monitoring And Closing,” U.S. application Ser. No. 17/127,812, filed Dec. 18, 2020, and entitled “Seed Meter Controller and Associated Devices, Systems, and Methods,” U.S. Application 17/132,152, filed Dec. 23, 2020, and entitled “Use of Aerial Imagery For Vehicle Path Guidance And Associated Devices, Systems, And Methods,” and U.S. application Ser. No. 17/164,213 filed Feb. 1, 2021 and entitled “Row Unit Parallel Arm Sensor and Associated Systems and Methods,” U.S. Pat. No. 10,684,305 issued Jun. 16, 2020, entitled “Apparatus, Systems and Methods for Cross Track Error Calculation From Active Sensors,” U.S. patent application 16/445,161, filed Jun. 18, 2019, entitled “Agricultural Systems Having Stalk Sensors and/or Data Visualization Systems and Related Devices and Methods,” U.S. patent application Ser. No. 16/800,469, filed Feb. 25, 2020, entitled “Vision Based Stalk Sensors and Associated Systems and Methods,” U.S. patent application Ser. No. 17/013,037, filed Sep. 4, 2020, entitled “Apparatus, Systems and Methods for Stalk Sensing,” U.S. patent application Ser. No. 16/918,300, filed Jul. 1, 2020, entitled “Apparatus, Systems, and Methods for Eliminating Cross-Track Error,” U.S. Patent Application 63/048,797, filed Jul. 7, 2020, entitled “Apparatus, Systems, and Methods for Grain Cart-Grain Truck Alignment and Control Using GNSS and/or Distance Sensors,” U.S. Patent Application 63/074,737, filed Sep. 4, 2020, entitled “Apparatus, Systems and Methods for an Electric Corn Head,” U.S. Patent Application 63/137,946, filed Jan. 15, 2021, entitled “Apparatus, Systems, and Methods for Row Crop Headers,” U.S. patent application Ser. No. 17/226,002, filed Apr. 8, 2021, and entitled “Apparatus, Systems and Methods For Stalk Sensing,” U.S. patent application Ser. No. 17/225,586, filed Apr. 8, 2021, and entitled “Devices, Systems, and Methods for Corn Headers,” and U.S. patent application Ser. No. 17/225,740, filed Apr. 8, 2021, and entitled “Devices, Systems, and Methods For Sensing The Cross-Sectional Area of Stalks,” each of which are incorporated herein by reference.

[0050] Turning to the drawings in greater detail, FIG. **1** depicts one implementation of an assisted steering device **10** including a ring assembly **20** and a motor drive unit (“MDU”) **60**. It is readily appreciated that in such implementations, the MDU **60** is selectively and operably coupled to the ring assembly **20** so as to facilitate the rotation of the ring assembly **20** for use in automated steering operations, such as assisted steering. That is, in these implementations, the MDU **60** drives the rotation of the ring assembly **20** and, accordingly, the corresponding rotation of the steering wheel (shown for example in FIG. **3** at **2**) of the agricultural implement.

[0051] Continuing with FIG. **1**, and as also shown in FIG. **2**, in various implementations the ring assembly **20** and MDU **60** are configured to be slidably engaged with one another to aid in the positioning and securing of the device **10** on a steering column in a vehicle. As shown for example in the implementation of FIG. **2**, the MDU **60** can be operably secured to the ring assembly **20** by sliding the MDU **60** into position on the ring assembly **20**, such as in the directions of reference arrows A and B. While FIG. **2** depicts some such examples of the coupling of the ring assembly **20** to the MDU **60**, further implementations are of course possible.

[0052] In some implementations, the secured MDU **60** is also configured to be quickly released from the ring assembly **20**, such as by releasing a latch **96** (shown in FIGS. **1**, **14**, and **22**), as will be discussed further below. Further, the MDU **60** according to these implementations is compact

and allows for easy transportation between various vehicles, such that an operator can utilize the device **10** in a variety of applications, as would be readily appreciated. Additionally, the compact nature of the MDU **60** allows for quick release, as well as easy storage, such as to protect the MDU **60**/housing **62** against theft and/or inclement weather, as would be understood.

[0053] It is readily appreciated that the assisted steering device **10** according to certain implementations is configured to be operatively engaged with a steering wheel **2**, as shown for example in FIGS. **3**-**5**. It is understood that such operative engagement allows the device **10** to apply a rotating force, such as a turning motion on the steering wheel **2** to automatically steer the vehicle or assist an operator in steering the vehicle via the driven application of rotational force to the steering wheel **2**. Such application of rotating force can be achieved through the securement of the ring assembly **20** to the steering wheel **2** or other approaches that would be readily appreciated by the skilled artisan, and it is appreciated that such operation may be performed in conjunction with any of the technologies described in the incorporated references, such as on the basis of GPS or GNSS or other stored data or the like, or in conjunction with a display unit that is operationally integrated with the overall guidance system, as further discussed in conjunction with the implementation of FIG. **20**.

[0054] Returning to the implementation of FIG. **3**, the assisted steering device **10** is configured for quick release or disengagement from the steering wheel **2**. In these implementations, shown for example in FIG. **4**, the ring assembly **20** of the device **10** has a detachable clamping ring **12** and is therefore configured to be attached to the steering wheel **2** via the clamping ring **12**. In these and other implementations, the clamping ring **12** is shaped to be fitted around the spokes **3** of the steering wheel **2** and secured to the ring assembly **20**. In certain implementations, the spokes **3** of the steering wheel **2** are disposed in the corresponding depressions **5** (shown best in FIG. **3**) of the ring assembly **20**, such that the spokes **3** are between the ring assembly **20** and the clamping ring **12**. Various alternative clamping/attachment devices and methods may be used as would be appreciated by those of skill in the art. In some implementations, the clamping mechanism allows for forward-rearward positioning of the device **10**.

[0055] In certain implementations, as shown in FIG. **3**, the depressions **5** allow for the steering wheel **2** spokes **3** to be seated, at least partially, within the ring assembly **20**, creating a lower profile device **10**. The optionally low profile of the device **10** allows for placement of the device **10**, in particular the ring assembly **20**, in smaller/tighter spaces, including between the underside of the steering wheel **2** and various shrouds, switches, levers, and/or other equipment components as would be appreciated.

[0056] In alternative implementations, the steering wheel **2** spokes **3** may be located on the surface of the ring assembly **20**. In these implementations, the ring assembly **20** may not have depressions **5**, such that the spokes **3** are located on the substantially flat upper surface of the ring assembly **20**/inner ring **22**. This configuration may allow for the device **10** to be accepted on more flat-style steering wheels **2** without the need for one or more spacers, as would be appreciated.

[0057] By locating the spokes **3** in-between the depressions **5**, rather than within them, the ring assembly **20** acts as the spacer, orienting the ring assembly **20** and MDU **60** further away from the steering wheel **2**. The ring assembly **20** may act as a spacer by having both depressions **5** and raised portions **5**A between the depressions **5**. In these implementations, there may be additional space created for an operator's hands to be placed between the MDU **60**/ring assembly **20** and the steering wheel **2** thereby improving grip. In various implementations, one or more spacers (not pictured) may also be used, as would be understood by those of skill in the art.

[0058] Continuing with FIG. **4**, in various implementations the device **10** and ring assembly **20** are mounted to the steering wheel **2** and steering column **4** in such an arrangement so as to provide ample clearance for an operator's hands to grip the steering wheel **2**. Of course, other devices and methods are possible and would be appreciated by those of skill in the art.

[0059] Turning to FIG. **5**, in certain implementations, an anti-rotation pin **14** or other stop is

attached to the ring assembly **20** and extends in the direction of the steering column **4**. In various implementations, the anti-rotation pin **14** is arranged on the ring assembly **20** such that the anti-rotation pin **14** remains affixed to the ring assembly **20** even when the MDU **60** is detached from the ring assembly **20**. Said another way, in these implementations, the MDU **60** can be disengaged from the ring assembly **20** without removal of the anti-rotation pin **14** from the ring assembly **20**.
[0060] In various implementations, the anti-rotation pin **14** may be mounted or otherwise attached to the ring assembly **20** in a variety of orientations. The anti-rotation pin **14** may be orientated to maximize visibility and access to various vehicle functions. In some implementations, the anti-rotation pin **14** may be mounted or otherwise attached to the ring assembly **20** at any point along the steering wheel **2**/ring assembly **20**. That is, the anti-rotation pin **14** may be attached at any point along the 360 degrees of the ring assembly **20**.
[0061] In further implementations, the device **10** includes a mounting bracket **16**. The mounting bracket **16** is fixedly attached to the steering column **4** such that the anti-rotation pin **14** may be mounted within the mounting bracket **16**. In these implementations, torque provided by the device **10** is countered by the anti-rotation pin **14** within the bracket **16** during operation of the device **10** causing the steering wheel **2** to turn.
[0062] FIGS. **6**-**13** depict various views of the ring assembly **20** and components thereof: FIG. **6** depicts a side perspective view of the ring assembly **20**; FIG. **7** depicts an exploded view of the roller assembly **30**; FIG. **8** depicts a cross sectional view of the roller assembly **30**; FIG. **9** depicts an exploded side view of various internal components of the ring assembly **20**; FIG. **10** depicts an exploded side view of the ring assembly **20**; FIG. **11** depicts a cross sectional view of the ring assembly **20**; FIG. **12** depicts a side view of the ring gear **50** opening **56**; and FIG. **13** shows a side view of the ring assembly **20** with the MDU **60** detached.
[0063] In various implementations, and as shown variously in FIGS. **6** and **9**-**10**, the ring assembly **20** includes ring assembly sections **22**A, **22**B. The ring assembly sections **22**A, **22**B are shaped to divide the ring assembly **20** into two or more portions, such that the ring assembly **20** can be fitted around a steering column **4**, without removal of the steering wheel **2**. In certain implementations, the ring assembly sections **22**A, **22**B may be fitted together and held in place via one or more fasteners **24**, such as screws **24**. Other fasteners **24** are possible and contemplated herein, as would be understood.
[0064] Continuing with FIG. **6**, the ring assembly **20** may also include an inner ring **26** and an outer ring **28**. In these implementations, the inner ring **26** and outer ring **28** are shaped to be interlocking or otherwise fitted together. In various implementations, the inner ring **26** is constructed and arranged to rotate within the outer ring **28** in response to force applied by the MDU **60**, as will be discussed further below. In these implementations, the outer ring **28** remains stationary while the inner ring **26** rotates. The outer ring **28** is held in place by the anti-rotation pin **14**, discussed above.
[0065] In further implementations, the ring assembly **20** includes a roller assembly **30** (also referred to herein as a cartridge **30**) with a cover **32**. Shown best in FIGS. **7** and **8**, in various implementations, the roller assembly **30** includes a roller **34** and socket **36** to align and guide the rotation of the ring gear **50**, discussed further below. In some implementations, the roller **34** and socket **36** are disposed on a carriage **38**. In some implementations, various portions of the roller assembly **30** may be encased in a roller sleeve **42** and may also be disposed within a roller cover **32**.
[0066] The roller assembly **30** may further include one or more springs **40**. In various implementations, the springs **40** are constructed and arranged to provide a force to the roller **34** to maintain operational contact between the roller **34** and the ring gear **50**. In various implementations, the ring gear **50** and inner ring **26** may not be perfectly circular, often due to manufacturing tolerances, and the springs **40** act to ensure smooth rotation of the ring gear **50** within the device **10** at all times. That is, the cartridge **30** applies pressure to the ring gear **50** and

tensions the device **10** such that the ring gear **50** floats within various rollers **34**, discussed further below, and does not wobble during rotation.
[0067] In various implementations, the roller assembly **30** is located substantially opposite the MDU **60** on the ring assembly **20**, as shown in FIG. **6**. In these and other implementations, the springs **40** provide force to maintain operational contact between the ring gear **50** and the drive gear (shown in FIG. **14** at **80**), counteracting the forces from the torque transfer between the drive gear **80** and the ring gear **50** which may act to force the gear mesh apart.
[0068] In some implementations, the roller assembly **30** and springs **40** are manually adjustable. That is, the user may service the roller assembly **30** to adjust the suspension and tension of the opposing gear reduction interface. In certain additional implementations, the cartridge **30** is a modular component of the ring assembly **20** and is field replaceable such that a user may disengage the cartridge **30** from the ring assembly **20** and replace it with a different cartridge **30**, shown for example in FIG. **6**. In various implementations, the cover **32** is removed from the cartridge **30**, the cartridge **30** then can be removed and replaced, and then the cover **32** can be returned.
[0069] Turning to the implementations of FIGS. **9-11**, the ring assembly **20** further includes an inner ring gear **50**. In some implementations, the inner ring gear **50** includes ring gear sections **52**A, **52**B corresponding to the ring assembly sections **22**A, **22**B of the overall ring assembly **20**, such that the ring assembly **20** can be placed on a steering column **4** without removal of the steering wheel **2**. The ring gear **50** may be affixed to the inner ring **26** via a plurality of fasteners **54**, such as screws **54**. Of course, other fastener **54** types are possible and would be recognized by those of skill in the art.
[0070] In some implementations, the ring gear **50** includes a track **51** or groove. The track **51** is shaped to be operatively engaged with the rollers **34** such that ring gear **50** and rollers **34** rotate together and maintain operational contact. In various implementations, the track **51** may be substantially V-shaped. Of course, other shapes are possible.
[0071] In various implementations, the ring gear **50** is fully or partially enclosed by the inner ring **26** and outer ring **28**. By fully enclosing the ring gear **50**, the device **10**, according to certain implementations, can be safer to operate and has a cleaner appearance. In various implementations, the ring assembly **20** includes an opening **56** where the ring gear **50** is at least partially exposed, as shown in FIGS. **12** and **13**. In these implementations, the MDU may attach to the ring assembly **20** at the opening **56**. Further approaches to the attachment of the MDU **60** to the ring assembly **20** are of course possible.
[0072] In various implementations, the ring gear **50** may be made by injection molding or any other process known to those of skill in the art for the formation of such components.
[0073] The ring assembly **20** may further include one or more additional guide rollers **34** and sockets **36**, such as those described above. In certain implementations, these additional guide rollers **34** are disposed at the junction point between the ring assembly sections **22**A, **22**B of the ring assembly **20**.
[0074] Turning to FIGS. **14-20** and **22** which depict various views and portions of the MDU **60**: FIG. **14** depicts a perspective view of the MDU **60**; FIG. **15** depicts a cross sectional view of the MDU **60**; FIG. **16** depicts and exploded view of the MDU **60**; FIG. **17** shows an exploded view of the MDU **60** with the second side **66** removed; FIG. **18** shows the motor **72** and drive gear **80**; FIG. **19** shows the second side **66** of the housing **62**; FIG. **20** shows the first side **64** of the housing **62** and circuit board **90**; and FIG. **22** shows an exploded side perspective view of the first side **64** of the housing **62**.
[0075] Turning to FIGS. **14-15** in more detail, in various implementations, the MDU **60** includes a housing **62** having and first side **64** and a second side **66**. The housing **62** is shaped to enclose various portions of the MDU **60** to provide a safe and easily transportable MDU **60**. In some implementations, the drive gear **80** is partially or completely exposed.
[0076] The first side **64** and second side **66** may be fitted together via any known mechanism or

configuration. In some implementations, the first side **64** and second side **66** are secured together via one or more fasteners **68**, as shown in FIG. **16**. These fasteners **68** may be screws **68** or any other known fastener **68** type. The housing **62** may further include a gasket **70** or other O-ring **70** type mechanism disposed between the first side **64** and second side **66** to seal the housing **62**, shown for example in the implementations of FIGS. **16-17**.

[0077] In certain implementations, the MDU **60** includes a motor **72** disposed within the housing **62**. In some implementations, the motor **72** is a brushless DC "pancake" motor **72** with no internal gear reduction. The brushless DC motor **72** provides for single gear reduction from the drive gear **80** to the ring gear **50**. The use of the brushless DC motor **72** may provide for improved torque and speed allowing for overall improved performance. The motor **72** may provide hall-effect sensor outputs for providing "encoder" counts for accurate steering wheel **2** positioning and control.

[0078] In various implementations, the motor **72** is attached to the housing **62** via fasteners **74**. These fasteners **74** may be screws **74** or any other known fastening mechanism as would be appreciated. In some implementations, the motor **72** is mounted to the first side **64** of the housing **62** via a mounting bracket **76**.

[0079] Turning to FIG. **18**, in certain implementations, the MDU **60** includes an O-ring **78** disposed between the motor **72** and a drive gear **80**. Additional O-rings **82** or gaskets **82** may be provided for environmental sealing of the motor **72** through the interface of a drive shaft and support bearing of the motor **72**. A retaining ring **84** may be disposed between the drive gear **80** and the housing **62**.

[0080] In various implementations, the drive gear **80** is shaped to couple the ring gear **50** when the MDU **60** is coupled to the ring assembly **20**. In these implementations, motor **72** drives the drive gear **80** which in turn drives the ring gear **50**. The ring gear **50** then drives the steering wheel **2** to assist in steering of a vehicle.

[0081] In some implementations, the drive gear **80** is field-replaceable. In these and other implementations, the drive gear **80** is visible and accessible when the MDU **60** is disengaged from the ring assembly. In these implementations, the drive gear **80** may be serviced and/or replaced without disassembling the housing **62**.

[0082] The motor **72** may further include a plug **86** or other type of electrical connection **86** to connect the motor **72** to the circuit board **90**, described below.

[0083] As shown in FIG. **19**, the second side **66** of the housing may include a switch **87** and vent **88**. In some implementations, the switch **87** is an on/off switch to turn the MDU **60** and device **10** on or off, as desired. The vent **88** may be configured to allow for the equalization of pressure between the internal pressure in the MDU **60** and the external environment (atmospheric pressure). Further, in some implementations, the vent **88** is configured to prevent water vapor molecules from entering the internal environment of the MDU **60**. The vent **88** may be made from a mesh type material such as Gortex® or other appropriate material or materials as would be recognized by those of skill in the art.

[0084] The MDU **60** according to certain implementations may further include control processing or electrical components such as a circuit board **90**. In these implementations, the circuit board **90** may be affixed to the first side **64** of the housing **62** via one or more fasteners **92**. The fasteners **92** may be screws **92** or any other type of fastener **92** as would be appreciated. In various implementations, the circuit board **90** controls the motor **72**. In various implementations, a magnetometer **91** is located on the circuit board **90**.

[0085] In further implementations, the circuit board **90** is in communication with an external unit, such as a processor via an external connector **93** or other recognized mechanism, shown in FIG. **20**. Further electronic communications and guidance components such as GPS units may also be in electrical communication with the circuit board **90**, as would be readily appreciated. For example, the circuit board may be operably integrated with a field computer, a steering controller, and/or a GPS receiver, such as the SteerCommand® system.

[0086] In various implementations, the assisted steering device **10** described herein is part of a

navigational system **150**. In various implementations, the navigation system **150** includes a GPS receiver **152**, a display **154**, and a steering controller **156**, in addition to the assisted steering device **10**. Various navigational systems **150** and configurations would be appreciated by those of skill in the art. In one exemplary system **150**, shown in FIG. **21**, the GPS receiver **152** is located on an agricultural vehicle, such as a harvester. The GPS receiver **152** receives GPS signals related to the real time position of the vehicle. The GPS signal can then be relayed to a display **154**. In various implementations, the display **154** is located in the cab such that it can be viewed in real-time by an operator. The display **154** may be capable of calculating, downloading, or otherwise determining desired vehicle paths or guidelines via one or more processors or other computing components as would be understood. The steering controller **156** may receive both the GPS signal information and the desired path information to compare the actual location of the vehicle to the desired location. In some implementations, the steering controller **156** may then send a command to the assisted steer device **10** to steer the implement onto the desired path. In these and other implementations, the vehicle's position on the guidance path is established and maintained by the assisted steering device **10**.

[0087] In some implementations, the steering controller **156** and the assisted steering device **10** have bi-directional communication whereby the assisted steering device **10** can report its state to the steering controller **156** and the steering controller **156** can send instructions to the assisted steering device **10**. In some implementations, the steering controller **156** may in turn report the state of the assisted steering device **10** to the display **154**. In one example, the status of the assisted steering device **10** may include fault conditions.

[0088] Turning to FIG. **22**, which depicts a top view of the first side **64** of the housing **62**. In various implementations, the MDU **60** includes a latching mechanism **94**. In various implementations, the latching mechanism **94** may include a latch **96**, a spring **98** and a magnet **100**, also shown in FIG. **15**. Continuing with FIG. **22**, the latching mechanism **94** may be partially covered or encased by a lid **102**. Further, an outer layer **106** may be provided to create a flush or smooth outer surface.

[0089] According to various embodiments disclosed or contemplated herein, the device **10** is configured such that a user may determine the mounting state of the MDU **60** on the ring assembly **20** by viewing the position of the latching mechanism **94**.

[0090] The latching mechanism **94** may function as a safety mechanism by detecting the position of the latch **96** and magnet **100** in relation to the magnetometer **91**. In various implementations, the magnetometer **91** may be located on the circuit board **90**. In certain implementations, the magnetic field of the magnet **100** is strong enough to pass through the first side **64** of the housing **62** such that the magnetometer **91** may detect the position of the latch without direct contact with the circuit board **90** and/or an opening in the housing **62** that may require further sealing components.

[0091] In some implementations, the latching mechanism **94** is constructed and arranged to detect at least three latching positions: (1) MDU **60** not attached, spring **98** is relaxed and latch **96** in extents; (2) MDU **60** attached and secure, spring **98** is partially compressed and latch **96** is in a middle position; (3) MDU **60** attached but not secure, spring **98** is compressed and latch **96** is in opposite extents to the first position. In various implementations, when the MDU **60** is not secure (position **3** above) the latch **96** is not seated to lock the MDU **60** in place on the ring assembly **20**, as would be readily appreciated.

[0092] In various implementations, the system **10** may include an LED light or other indicator to alert a user when the MDU **60** is not securely attached to the ring assembly **20**. In some implementations, this indicator may function at all times when the MDU **60** is not securely attached or in alternative implementations the indicator may only alert an operator when attempting to engaged power to the MDU **60**. In this way, the latching mechanism **94** operates as a safety mechanism by disallowing power to the MDU **60**, motor **72**, and/or motor gear **80** when the MDU **60** is not securely engaged.

[0093] Although the disclosure has been described with references to various embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of this disclosure.

Claims

1. An assisted steering unit, comprising: (a) a ring assembly; and (b) a motor drive unit (MDU) comprising: (i) a motor; (ii) a drive gear rotatably engaged with the motor; and (iii) a latching mechanism configured for releasably engaging the MDU to the ring assembly, the latching mechanism comprising: (A) a latch; (B) a spring; (C) a magnet; and (D) a magnetometer, wherein the latching mechanism is configured to detect at least three latching positions by sensing the magnet in relation to the magnetometer.
2. The assisted steering unit of claim 1, wherein the at least three latching positions comprise a first latching position wherein the MDU is not engaged, a second latching position wherein the MDU is engaged and secure, and a third latching position wherein the MDU is engaged but not secure.
3. The assisted steering unit of claim 1, further comprising a circuit board in communication with the motor configured to control rotation of the drive gear.
4. The steering unit of claim 3, wherein the magnetometer is located on the circuit board.
5. The assisted steering unit of claim 4, wherein the magnetometer detects the position of the magnet without direct contact.
6. The assisted steering unit of claim 1, wherein the ring assembly comprises: (a) a housing; (b) a stationary ring; (c) a rotatable ring fitted to the stationary ring; (d) a ring gear attached to the rotatable ring disposed within the housing; and (e) an anti-rotation pin operatively engaged with the housing.
7. The assisted steering unit of claim 6, wherein the housing comprises one or more depressions corresponding to a location of one or more spokes on a steering wheel.
8. The assisted steering system of claim 6, wherein ring assembly further comprises a cartridge comprising at least one spring and a roller, wherein the cartridge is configured to maintain operational contact between the ring gear and the roller.
9. The assisted steering system of claim 8, wherein the cartridge is modular and field replaceable.
10. An assisted steering system comprising: (a) a first ring unit configured to be operatively engaged with a first steering column of a first vehicle; (b) a second ring unit configured to be operatively engaged with a second steering column of a second vehicle; and (c) a motor drive unit (MDU) configured to be releasably engaged with the first ring unit and the second ring unit when not engaged with the first ring unit, wherein the MDU controls motion of the first ring unit, and wherein the first ring unit is configured to turn a steering wheel of the first vehicle.
11. The assisted steering system of claim 10, wherein the MDU comprises: (a) a motor; (b) a drive gear driven by the motor, the drive gear configured to be engaged with the ring gear when the MDU is engaged with the first ring unit; and (c) a latching mechanism configured for releasably engaging the MDU to the first ring unit and the second ring unit when not engaged with the first ring unit, the latching mechanism comprising: (i) a latch; (ii) a magnet; and (iii) a magnetometer, wherein the latching mechanism is configured to detect at least three latching positions.
12. The assisted steering system of claim 11, wherein the latching mechanism is configured to detect the position of the magnet in relation to a magnetometer.
13. The assisted steering system of claim 12, wherein the at least three latching positions comprise a first latching position wherein the MDU is not engaged, a second latching position wherein the MDU is engaged and secure, and a third latching position wherein the MDU is engaged but not secure.
14. The assisted steering system of claim 10, wherein each of the first ring unit and the second ring unit comprise: (a) a stationary ring; (b) a rotatable ring fitted to the stationary ring; and (c) a ring

gear attached to the rotatable ring, wherein the stationary ring and the rotatable ring form a housing for the ring gear.

15. The assisted steering system of claim 14, wherein each of the first ring unit and second ring unit further comprise a cartridge comprising at least one spring and a roller, wherein the cartridge is configured to maintain operational contact between the ring gear and the roller.

16. The assisted steering system of claim 15, wherein the cartridge is modular and field replaceable.

17. A steering system, comprising: (a) a first ring unit configured to be operatively engaged with a first steering column of a first vehicle, the first ring unit comprising: (i) a stationary ring; (ii) a rotatable ring fitted to the stationary ring; and (iii) a ring gear attached to the rotatable ring, wherein the stationary ring and the rotatable ring from a housing for the ring gear; (b) a second ring unit configured to be operatively engaged with a second steering column of a second vehicle, the second ring unit comprising: (i) a stationary ring; (ii) a rotatable ring fitted to the stationary ring; and (iii) a ring gear attached to the rotatable ring, wherein the stationary ring and the rotatable ring from a housing for the ring gear; and (c) a motor drive unit (MDU), wherein the MDU comprises: (i) a motor; (ii) a drive gear rotatably engaged with the motor; and (iii) a latching mechanism configured for releasably engaging the MDU to the first ring unit or the second ring unit, the latching mechanism comprising: (A) a latch; (B) a spring; (C) a magnet; and (D) a magnetometer, wherein the latching mechanism is configured to detect at least three latching positions by sensing the magnet in relation to the magnetometer.

18. The system of claim 17, wherein the at least three latching positions comprise a first latching position wherein the MDU is not engaged with either the first ring unit or the second ring unit, a second latching position wherein the MDU is engaged and secured to the first ring unit or the second ring unit, and a third latching position wherein the MDU is engaged with either the first ring unit or the second ring unit but is not secure.

19. The system of claim 17, wherein the magnetometer detects the position of the magnet without direct contact.

20. The system of claim 17, wherein each of the first ring unit and second ring unit further comprise a cartridge comprising at least one spring and a roller, wherein the cartridge is configured to maintain operational contact between the ring gear and the roller.