An improved autopilot system securely attached to a steering helm unit and mounted within the dashboard or pedestal of a marine vessel for automatic control over a vessel’s direction of movement. One embodiment of an improved actuator utilizes endless belt members 212, a driven pulley 210 attached to a steering shaft extension 208 passing through an axial bore in a back wall of a steering helm unit 52, a drive pulley 206 to impart mechanical power to endless belt members 212, and a tensioning pulley 306 connected to a clutch unit for controlling belt tension. A control box 58 provides electrical control over drive pulley 206 and clutch unit using motors. A time varying rotational position of driven pulley 210 is measured, from which a vessel’s attempted steering direction can be deduced. The measurement of electrical current during clutch unit engagement and disengagement, can be used to gauge and control belt tension. A manual emergency override complements failsafe nature of clutch unit.
Fig. 3
Figure 12
METHOD AND APPARATUS FOR AUTOMATED CONTROL OF MARINE VESSEL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of PPA Ser. No. 61/801,923 filed 2013 Mar., 15 by the present inventor, which is incorporated by reference.

BACKGROUND

Prior Art

[0002] The following is a tabulation of some prior art that presently appears relevant.

CITED PATENTS

[0003]

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Issue Date</th>
<th>Patentee</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Pat. No. 3,603,167</td>
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<td>Control device</td>
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<td>Ronald A. Holland</td>
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<td>Self-locking mechanical steering helm</td>
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<td>Nautech Limited</td>
<td>Autopilot system for a vessel</td>
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<td>Wheel Drive</td>
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<td>U.S. Pat. No. 4,721,494</td>
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<td>Drive transmission structure for tractor</td>
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<td>U.S. Pat. No. 4,511,348</td>
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<td>Drive tensioning apparatus</td>
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<td>Belt tension mechanism</td>
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<td>U.S. Pat. No. 4,323,353</td>
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<td>Incom International, Inc.</td>
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</tr>
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<td>Mar. 22, 1977</td>
<td>Incom International Inc.</td>
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<td>Teleflex Canada Inc.</td>
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<td>Raytheon Anschütz GmbH</td>
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</table>

Background

Prior Art

[0004] A general field of use for one or more aspects of the currently envisioned apparatus relates to marine vessel autopilot systems. An autopilot system allows for the automated control of a marine vessel’s direction and speed along a predetermined path, thereby freeing human operators from the tedious duty of manually controlling a vessel’s progress over long distances or in treacherous conditions.

[0005] Early marine autopilot systems relied on a drive motor rigidly coupled to the rotating shaft of the vessel’s helm adding unnecessary steering drag and introducing a dangerous potential steering lockup failure, while others used various types of release mechanisms. Some of these prior autopilot systems also required modification to a vessel’s internal steering system or would simply clamp a drive motor directly onto the externally visible steering wheel, exposing components to the external environment in an unsightly fashion. U.S. Pat. No. 4,862,819

[0006] Several prior autopilot systems use only one method on each system to disengage the autopilot using either a manual clutch release mechanism with a handle that can be operably obscured by the steering wheel when engaged. Others use an electronic clutch release button required for the vessel’s steering system to perform an emergency disconnect operation in the event of a clutch release failure. Other prior art autopilot systems use mechanical interconnect techniques that do not allow a human operator to control the vessel steering system unless the system has been physically disconnected in a controlled manner. However, in such a system it is possible for the mechanical interlink to fail in a state that interferes with proper operation of the direct manual steering potion of the system. U.S. Pat. No. 4,862,819; U.S. Pat. No. 5,357,889; U.S. Pat. No. 5,357,889; U.S. Pat. No. 4,004,537

Advantages

[0007] Several advantages of one or more envisioned embodiments of an improved autopilot system are as follows:

[0008] A system that uniquely installs by directly attaching to the rotating shaft of a vessel’s steering system, which allows all aspects of the mechanical interconnect to be hidden from human operator view and protected from the external environment with minimal modification to the vessel’s steering system.

[0009] A system that has two unique safety features to minimize the risk of steering control loss due to an autopilot breakdown. First, intentional drive belt slippage is introduced that permits a human operator to remain in control of the vessel steering system, even if the attached autopilot system experiences an unexpected power loss or mechanical failure. Second, a manual override system which allows control to be restored in case of an electrical or mechanical failure.
A system that provides two methods to control an electronic clutch: a simple electronic push-button engage and disengage capability, and also a redundant manual clutch release intended for use as an emergency release mechanism in the unlikely event of primary clutch release failure. Furthermore, a manual override de-tensioner provides an intuitive linear pull-action emergency release mechanism, and can be installed in an ergonomic position chosen by the operator, to quickly provide a simple and complete mechanical disconnect from the vessel’s steering system.

A system that is capable of optionally interfacing and utilizing sensor data from a plurality of potential sources, including but not limited to, rudder position, compass, GPS, accelerometer, gyroscope, inertial navigation system, wind speed, wind direction, and chart plotter. Once properly installed in the vessel and engaged by the human operator, system utilizes available sensor data along with custom electronics, custom algorithms, and custom mechanical linkages to control the vessel, and maintain the desired heading in all varieties of sea conditions and vessel speeds.

A system that overcomes the aforementioned disadvantages of the prior art by providing an autopilot actuator utilizing a belt drive system.

A system that allows direct attachment of the driven pulley to the rotating steering shaft of a marine vessel without requiring shaft modification.

A system that provides a clutch unit apparatus with two control arms that control whether the belt drive system is tensioned into an operative condition or an inoperative condition. The apparatus requires both control arms to be in an operative position to tension the belt drive system in an operative condition. If either control arm transitions to an inoperative position, then the belt drive system transitions to an inoperative condition.

A system that uses a belt drive mechanism that improves safety by eliminating several sources of a catastrophic steering lockout condition that might otherwise occur due to a mechanical failure or corrosion within the autopilot actuator.

A system that uses a belt drive mechanism reduces gear-on-gear and gear-on-sprocket abraison, thereby reducing corrosion risk and maintenance in a salt water environment.

A system that does not require any springs within the autopilot actuator, thereby reducing corrosion risk and maintenance in a salt water environment.

Still other benefits and advantages of an improved autopilot system will become apparent to those skilled in the art to which it pertains upon a reading and understanding of the following detailed specification.

SUMMARY

In accordance with one embodiment an improved autopilot system attached to a steering helm unit of a marine vessel for automatic control over a vessel’s direction of movement providing improved steering safety and navigation accuracy.

DRAWINGS—FIGURES

In the drawings, closely related figures have the same number but different alphabetic suffixes.

The invention may take physical form in certain parts and arrangement of parts, a preferred embodiment of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIG. 1 shows a perspective view of one possible mounting configuration of actuator to a helm, and additional autopilot system components in accordance with one embodiment.

FIG. 2a shows a perspective view of one possible mounting configuration of actuator to a helm in accordance with one embodiment.

FIG. 2b shows a perspective, partially exploded view of actuator in accordance with one embodiment.

FIG. 3 shows a perspective view of actuator in accordance with one embodiment.

FIG. 4 shows an exploded view of actuator in accordance with one embodiment.

FIG. 5a shows a perspective view of driven pulley and hall sensors in accordance with one embodiment.

FIG. 5b shows a side view of driven pulley and hall sensors in accordance with one embodiment.

FIG. 5c shows a front view of driven pulley and hall sensors in accordance with one embodiment.

FIGS. 6a to 6e show various views of one possible attachment configuration of driven pulley to helm shaft in accordance with one embodiment.

FIG. 7 is a side view of actuator illustrating the relationship between pre-tensioner adjustment and resulting motion of motor in accordance with one embodiment.

FIG. 8a shows a front side view of actuator when belt system is tensioned into an inoperative condition with tensioning arm disengaged and manual override de-tensioner disengaged in accordance with one embodiment.

FIG. 8b shows a rear side view of actuator when belt system is tensioned into an inoperative condition with tensioning arm disengaged and manual override de-tensioner disengaged in accordance with one embodiment.

FIG. 9a shows a front side view of actuator when belt system is tensioned into an operative condition with tensioning arm engaged and manual override de-tensioner disengaged in accordance with one embodiment.

FIG. 9b shows a rear side view of actuator when belt system is tensioned into an operative condition with tensioning arm engaged and manual override de-tensioner disengaged in accordance with one embodiment.

FIG. 10a shows a front side view of actuator when belt system is tensioned into an inoperative condition with tensioning arm engaged and manual override tensioner engaged in accordance with one embodiment.

FIG. 10b shows a rear side view of actuator when belt system is tensioned into an inoperative condition with tensioning arm engaged and manual override tensioner engaged in accordance with one embodiment.

FIG. 11a shows a front side view of actuator when belt system is tensioned into an inoperative condition with tensioning arm disengaged and manual override tensioner engaged in accordance with one embodiment.

FIG. 11b shows a rear side view of actuator when belt system is tensioned into an inoperative condition with tensioning arm disengaged and manual override tensioner engaged in accordance with one embodiment.

FIG. 12 shows a schematic diagram of autopilot system in accordance with one embodiment.

FIG. 13 shows a flow diagram of autopilot control box in accordance with one embodiment.
DETAILED DESCRIPTION—FIGS. 1-6c

[0042] Referring now to the drawings wherein the showings are for purposes of illustrating an example embodiment of the invention only and not for purposes of limiting the same. Throughout the following detailed description, the same reference numerals refer to the same elements in all figures.

[0043] FIG. 1 is a perspective view of an improved autopilot system according to one embodiment, comprising an actuator assembly 100, a GPS sensor 60, an electronic compass 62, a general sensor or input device 64, a general wireless sensor or electronic device 66, a control box 58, a control box communication antenna 68, external user interface 70, a manual emergency override de-tensioner assembly 600, and cables 74, 76, 78, 80 and 72. Any cable or cable bundle described herein, may carry power or data or both. It can be appreciated that other embodiments might include only one or a multitude of additional sensors or electronic devices. Additional sensors, such as a wind direction sensor, a water speed sensor, an ultrasonic transducer, a water temperature sensor, a flux gate compass, a multi-axis accelerometer, a multi-axis attitude sensor, a multi-axis magnetic sensor, a multi-axis gyroscope, a chart plotter, or the like, could also be incorporated into the improved autopilot system, thereby providing added functionality. It can be appreciated that additional input devices such as a radar transducer, an ultrasonic proximity detector, a satellite communication device, an infrared FLIR device, an optical recognition device, a laser ranging device, a laser communication device, a Wi-Fi transceiver, a radio communication device, or the like, may also be incorporated into the improved autopilot system.

[0044] FIG. 1 also shows, for illustrative purposes, a general marine helm steering system comprising a rack and pinion gear box 52, a helm wheel 56, a cutaway portion of a console 50, and a rudder control wire 54.

[0045] In this embodiment, actuator assembly 100 is rigidly attached to existing marine vessel rack and pinion gear box 52, and rotationally affixed between an existing helm wheel shaft 208 and a driven pulley 210 (see FIG. 2b). Manual emergency override de-tensioner assembly 600 is installed through the wall of console 50, and all other improved autopilot system components can be installed in any convenient location.

[0046] Although this embodiment is directed to a marine vessel, it can be appreciated that such a system could be applied to watercraft with dashboards, automatic navigation of heavy equipment, automatic navigation of farm machinery, self-driving automobiles, and other such applications.

[0047] FIG. 2a provides another view of actuator assembly 100 rigidly attached to rack and pinion gear box 52.

[0048] FIG. 2b shows an exploded perspective view of actuator assembly 100 and its attachment to rack and pinion gear box 52. Actuator assembly 100 is also rotationally attached to helm wheel shaft 208 through driven pulley 210.

[0049] FIG. 3 shows actuator assembly 100 and details of emergency override de-tensioner assembly 600 that includes emergency override de-tensioner cable 614.

[0050] The exploded view of FIG. 4 shows the interrelationship of actuator assembly 100 components. Actuator frame 102 has a front surface 102F parallel to the face of driven pulley 210, and a back surface 102B on the reverse side, a left edge 102L, a nearest spacer 114, a right edge 102R, opposite edge 102L, and a lower surface 102LS, visible in this view. Actuator frame 102 rigidly mounts to rack and pinion gear box 52 near left edge 102L with two fasteners (not shown) passing upwards (away from 102L) through mounting tabs 118 (far side tab not shown) that are integral to frame 102, through two short spacers 114 and screwed into pre-threaded holes in rack and pinion gear box 52. Rack and pinion gear box 52 is also captured between actuator frame rack bar 108 and lower surface 102S in the following manner. Two additional fasteners (not shown) are inserted upwards through two mounting tabs 118 (near edge 102R), through two long spacers 110, and through actuator frame rack bar 108. All fasteners may be secured with locking nuts, or nuts and lock washers, or nuts with adhesive, or by any equivalent means.

[0051] FIG. 5a shows a perspective, partially exploded view of driven pulley 210. Hall sensor card 704 and Hall sensors 706 and 708. FIG. 5b shows how magnets 702 are uniformly distributed about a given radius and rigidly attached to the face of driven pulley 210 nearest Hall sensor card 704. FIG. 5c: shows the fixed proximity of Hall sensor card 704 with respect to rotating driven pulley 210.

[0052] As driven pulley 210 rotates, the resulting movement of magnets 702 near Hall sensors 706 and 708 on Hall sensor card 704, produces a time varying signal. If Hall sensors 706 and 708 are utilized as digital switches, then a discrete digital signal is produced from which, the rotational position and rate of driven pulley 210 is calculated by control box 58. If Hall sensors 706 and 708 are utilized as analog magnetic field strength sensors, then the signal will contain more positional information of driven pulley 210.

[0053] In another embodiment, a single Hall sensor could be used in an analog mode, thereby detecting a finer degree of driven pulley 210 rotation. In yet another embodiment, two or more Hall sensors operating in a digital or analog mode and having a relative spacing that is different from the circumferentially spaced magnets 702, could detect a still finer degree of rotational position and rotation rate. In still another embodiment, two or more Hall sensors operating in a digital or analog mode and in close proximity to two separate circumferential rows of magnets at different radii and having different relative spacing between magnets in each row, would permit the measurement of rotational position, rotational direction, rotational rate and absolute rotational position to a very fine degree of precision. In another embodiment, Hall sensors 706 and 708, Hall sensor card 704, and magnets 210, are replaced with an optical encoder that is installed between a stationery object such as actuator frame 102 and driven pulley 210. It can be appreciated that other equivalent methods of rotational measurement can be substituted for the methods already discussed.

[0054] FIGS. 6a to 6e illustrate how helm wheel shaft 208 attaches to driven pulley 210. The cross section view of FIG. 6a shows how driven pulley 210 is bored to approximately the same inside diameter as the outside diameter of helm wheel shaft 208. Further, a driven pulley slot 224 is provided through the thickness and across at least half of the diameter of driven pulley 210. Perpendicular to driven pulley slot 224, a threaded clamping hole 218 is provided such that the insertion and tightening of clamping bolt 216 produces a powerful clamping force on helm wheel shaft 208. To further strengthen the interface between driven pulley 210 and helm wheel shaft 208, various adhesives can be employed, such as anerobic sealants, high strength epoxy, urethane adhesives, etc. In another embodiment, driven pulley 210 is centrally
bored to a slightly smaller diameter than helm wheel shaft 208. is heated, then placed onto a cooler helm wheel shaft 208, thereby producing a robust heat shrink interference fit. In another embodiment, a shaft to pulley interference fit is produced by forcibly pressing the undersized driven pulley 210 bore onto helm wheel shaft 208. In yet another embodiment, driven pulley 210 may be welded onto helm wheel shaft 208. It can be appreciated that there are numerous ways to affix a pulley to a shaft -- bolts through shaft and pulley, through shaft into pulley, keyway between shaft and pulley, etc. -- that could substitute equally well for those methods already described.

[0055] FIG. 7 shows how a motor 202 slideably mounts to actuator frame 102. Three motor mount slots 104, are formed in actuator frame 102. Motor mount bolts 106, having a smooth shoulder near the head and having a head larger than the short dimension of motor mount slots 104, are passed through motor mount slots 104 and threaded into motor 202. When fully tightened, motor mount bolts 106 rigidly affix motor 202 to actuator frame 102. When slightly loosened, motor mount bolts 106 permit motor 202 to slide parallel to lower surface 102.S of frame 102 as shown.

From FIG. 4, output shaft 204 of motor 202 is rigidly affixed to a drive pulley 206 using any of the methods described herein. Endless belt members 212 reside within the grooves of drive pulley 206 and driven pulley 210. Driven pulley 210 is fixed with respect to actuator frame 102, and drive pulley 206 is coupled to motor 202 which can slide with respect to actuator frame 102. Therefore, by sliding motor 202, one can adjust the distance between the parallel rotation axes of drive pulley 206 and driven pulley 210, thereby tightening or loosening the tension on endless belt members 212.

FIG. 7 illustrates a pre-tensioning system that establishes a fixed initial distance between drive pulley 206 and driven pulley 210 and comprises a jam wingnut 408, a right angle bracket 402, a right hand thread thumbscrew 406, a locknut A 410, a right angle yoke 404, and a locknut B 410. Bracket 402 is a right angle bracket with three threaded holes, two holes being in the same plane and the third hole axially perpendicular to the first two holes. Bracket 402 is attached to actuator frame 102 on face 102F with two screws. Yoke 404 is a right angle bracket with two axially perpendicular unthreaded holes and is captured by one of three motor mount bolts 106, as shown, and therefore slides with motor 202 when motor mount bolts 106 are loosened during pre-tensioning adjustments.

Pre-tensioning elements are assembled by threading jam wingnut 408 fully onto thumbscrew 406, screwing resulting assembly parallel with surface 102.S into bracket 402, threading locknut A 410 onto resulting assembly, passing resulting assembly through the perpendicular face of bracket 404, and finally, threading locknut B 410 onto the distal end of resulting assembly. Locknuts A 410 and B 410 are adjusted such that they do not grip bracket 404 too tightly and allow for rotational play of thumbscrew 406. By rotating thumbscrew 406 counter-clockwise, rotation axis of drive pulley 206 is moved further from rotation axis of driven pulley 210 resulting in a tightening of endless belt members 212. And conversely, rotating thumbscrew 406 in a clockwise direction loosens endless belt members 212. Once a predetermined pre-tension in endless belt members 212 is achieved, jam wingnut 408 is tightened down to bracket 402, thereby locking in a desired pre-tension.

Operations—FIGS. 7-11b

[0059] A critical feature of an autopilot system is the ability to both connect the system for automated control over vessel movement and disconnect the system to allow for manual helm control. A currently envisioned embodiment of an improved autopilot system utilizes a powertrain with a belt system and clutched tension control. When the belt has been tensioned into an operative condition (see FIG. 9a), the autopilot system issues commands via control box 58 (see FIG. 1) to maintain the desired course. When the belt system has been tensioned into an inoperative condition, the vessel operator has manual helm control.

[0060] In FIG. 9a, clutch mechanism within actuator assembly 100 (see FIG. 1) comprises two control arms: a tensioner arm 310 and a manual override de-tensioner arm 508. Said clutch mechanism implements a boolean logic operation, such that endless belt members 212 can only be tensioned into an operative condition if tensioner arm 310 is engaged and manual override de-tensioner arm 508 is disengaged. FIG. 9b is a rear side-view of actuator assembly 100 showing the same aforementioned operative condition.

In FIG. 9a, a tensioner arm swing plate 502 is pivotally connected at 512 to actuator frame 102. A manual override de-tensioner link 506 has two ends. A first end of manual override de-tensioner link 506 is pivotally connected at 504 to tensioner arm swing plate 502. A second end of manual override de-tensioner link 506 is pivotally connected to a first end of manual override de-tensioner arm 508. A missection of manual override de-tensioner arm 508 is pivotally connected at 510 to actuator frame 102. A second end of manual override de-tensioner arm 508 is pivotally connected to a manual override de-tensioner cable pivot arm 620.

In FIG. 4, manual override de-tensioner cable pivot arm 620 is also fixedly attached to a distal end of a manual override de-tensioner cable 614. Manual override de-tensioner cable 614 is routed through the hollow interior of a manual override de-tensioner cable guide 616 with a proximal end of manual override de-tensioner cable 614 fixedly attached to a distal end of manual override de-tensioner pull shaft 602 (not shown). A distal end of manual override de-tensioner cable housing 616 is fixedly attached to back surface 102B of actuator frame 102 using a manual override de-tensioner cable housing clamp 618. Proximal end of manual override de-tensioner cable guide 616 is fixedly captured by a distal end of a manual override de-tensioner pull shaft housing 604.

In FIG. 4, manual override de-tensioner pull shaft 602 (not shown) slideably passes through an axial bore of manual override de-tensioner pull shaft housing 604. A proximal end of manual override de-tensioner pull shaft 602 (not shown) exits a proximal end of manual override de-tensioner pull shaft housing 604 and fixedly attaches to a manual override de-tensioner knob 610. Linear movement of manual override de-tensioner knob 610 relative to manual override de-tensioner pull shaft housing 604 will be transferred by manual override de-tensioner cable 614 to proximal end of a manual override de-tensioner arm 508. This linear motion will control the state of manual override de-tensioner arm 508 and allow the operator to choose between an engaged and disengaged state.

In FIG. 4, midsection of a tensioner arm 310 and an end of a tensioner arm body 302 are both pivotally connected at 308 to tensioner arm swing plate 502. Additionally, tensioner arm 310 and tensioner arm body 302 are rotatably
connected to a tensioning pulley 306. Tensioner arm 310 is pivotally connected to a first end of a pushrod 326. Together, the tensioning pulley 306, tensioner arm body 302, and tensioner arm 310 pivot together at 308 in response to movement from pushrod 326. A second end of pushrod 326 is pivotally connected to a servo arm 324. Servo arm 324 is fixedly attached to a servo motor shaft of a servo motor 322.

[0065] In FIG. 1, actuator assembly 100 provides a method to input mechanical power from motor 202 (see FIG. 4) into rack and pinion gear box 52 for purposes of controlling the direction of a vessel's movement. In FIG. 8a-8b, actuator assembly 100 (see FIG. 1) can be configured in an operative condition where endless belt members 212 are tensioned by tensioning pulley 306 thereby mechanical coupling drive pulley 206 to driven pulley 210. In FIG. 9a-11b, actuator assembly 100 (see FIG. 1) can be configured in an inoperative condition where endless belt members 212 are de-tensioned and slack, thereby allowing driven pulley 210 to freely rotate without any coupling to drive pulley 206.

[0066] Actuator assembly 100 (see FIG. 1) illustrates a clutched belt tensioning mechanism utilizing dual control arms; a first clutch control arm, tensioner arm 310 (see FIG. 8a), and a second clutch control arm, manual override de-tensioner arm 508 (see FIG. 8b). With dual clutch control arms, there are four possible internal states of the clutch:

- a) tensioner arm 302 disengaged and manual override de-tensioner arm 508 disengaged (see FIGS. 8a-8b);
- b) tensioner arm 302 engaged and manual override de-tensioner arm 508 disengaged (see FIGS. 9a-9b);
- c) tensioner arm 302 disengaged and manual override de-tensioner arm 508 engaged (see FIGS. 10a-10c); and
- d) tensioner arm 302 engaged and manual override de-tensioner arm 508 engaged (see FIGS. 11a-11b).

[0071] The only internal state of the clutch that results in endless belt members 212 being tensioned into an operative condition (see FIG. 8a-8b) occurs when tensioner arm 310 is engaged and manual override de-tensioner arm 508 is disengaged. The other three possible internal clutch states all result in endless belt members 212 being tensioned into an inoperative condition. (see FIG. 9a-11b).

[0072] In FIG. 7, the final tension of endless belt members 212 achieved by engaging tensioner arm 310 (when manual override de-tensioner arm 508 is disengaged) can be controlled by a thumbscrew 406 and jam wingnut 408. When utilizing a right hand threaded member for thumbscrew 406, rotating thumbscrew 406 in a counter-clockwise direction will slide motor 202 in a direction 414 (see FIG. 7b), thereby increasing the distance between drive shaft 204 and helm wheel shaft 208, which by extension also increases the distance between drive pulley 206 and driven pulley 210. As the distance between drive pulley 206 and driven pulley 210 increases, the available slack in endless belt members 212 when in an inoperative condition decreases. Jam wingnut 408 provides a mechanism to help minimize thumbscrew 406 rotation due to vibration or forces from the clutch tensioning or de-tensioning endless belt members 212. Snagging jam wingnut 408 against the outer wall of bracket 402 introduces additional friction between the threads of thumbscrew 406 and threaded hole of bracket 402. This added friction makes rotation of thumbscrew 406 more difficult, thereby decreasing the likelihood of unintended change the final tension of endless belt members 212.

[0073] FIG. 12 is a schematic view of an improved autopilot system according to one embodiment, comprising actuator assembly 100, GPS sensor 60, electronic compass 62, general sensor or electronic device 64, general wireless sensor or electronic device 66, control box 58, control box communication antenna 68, external user interface 70, and rack and pinion gear box 52, driven shaft 208, and cables 74, 76, 78, 80, and 72.

[0074] In FIG. 12, external user interface 70 represents any one or any combination of a plurality of possible user interface means, such as but not limited to, display output, keypad input, sound output, microphone input, and vibration module output.

[0075] This autopilot has a unique design that allows belt drag free motion while manually steering in either direction. This is accomplished by controlled deformation of the belt loop around the driven pulley using both the tensioner pulley in the detensioned state pushing down on the top of the drive belts and the detensioner pin simultaneously pushing up on the bottom of the drive belts, causing a larger diameter loop that greatly minimizes belt contact with the driven pulley. Without the both the tensioner pulley and detensioning pin operating together the drive belts would wedge in the driven pulley grooves causing greater steering resistance.

Alternative Embodiments

[0076] It will be understood that various changes in the details, material, steps and arrangement of parts which have been described and illustrated to explain the nature of the invention, will occur to and may be made by those skilled in the art upon a reading of the disclosure within the principles and scope of the invention. The foregoing description illustrates example embodiments of the invention. However, concepts, as based on such a description, may be employed in other embodiments without departing from the scope of the invention. Accordingly, the following claims are intended to protect the invention broadly, as well as in the specific form shown herein.

1. An autopilot actuator for use in a marine vessel comprising:
   - a frame securely mounted to a steering helm unit housing under a dashboard panel of a marine vessel;
   - a driven pulley mounted to the rotating steering shaft of said steering helm unit;
   - a drive pulley mounted to a rotating drive shaft;
   - a single drive belt;
   - a mechanical clutch unit mounted to said frame; wherein said mechanical clutch unit having a tensioner arm engaging said single drive belt to the said drive pulley and said driven pulley such that actuation of said mechanical clutch unit rotates said steering shaft of said steering helm unit to input a mechanical force from said rotating drive shaft for steering purposes;
   - a de-tensioning pin mounted to said frame; and
   - wherein mount point of said mechanical clutch unit tensioner arm coupled with the mount point of said de-tensioning pin deforms the said drive belt into a shape that minimizes friction between said drive belt and said drive pulley when said clutch is de-actuated.
2. The autopilot actuator according to claim 1, wherein said mechanical clutch unit further comprises:

- a clutch swing plate being pivotally connected to said frame;
- said tensioner arm comprising a proximal end, a distal end, and a midsection;
- a linkage comprising a proximal end and a distal end;
- a de-tensioner arm comprising a proximal end, a distal end, and a midsection;
- midsection of said tensioner arm being pivotally connected to said clutch swing plate;
- a tensioner pulley rotatably attached to distal end of said tensioner arm;
- distal end of said linkage being pivotally connected to said clutch swing plate;
- proximal end of said linkage being pivotally connected to distal end of said de-tensioner arm;
- midsection of said de-tensioner arm being pivotally connected to said actuator frame;
- a pivot arm comprising a proximal end and a distal end;
- a servo motor mounted to said actuator frame;
- a servo arm comprising a proximal end and a distal end;
- proximal end of said servo arm rigidly attached to the rotating drive shaft of said servo motor;
- distal end of said servo arm pivotally connected to proximal end of said pivot arm;
- proximal end of said pivot arm pivotally connected to proximal end of said tensioner arm;
- said servo motor electrically connected to said control box, such that the said mechanical clutch unit can be electrically controlled and electrically powered by said control box;
- such that tension of said drive belt or tension of said plurality of drive belts can be deduced by monitoring electrical current used during said servo motor actuation;
- such that actuation of said de-tensioner arm forces the clutch into an inoperative condition regardless of said tensioner arm state.

3. The autopilot actuator according to claim 2, further comprising:

- a cable pivot arm comprising a proximal end and a distal end;
- a cable comprising a proximal end and a distal end;
- a cable housing comprising a proximal end, a distal end, and being axially hollow with an internal diameter larger than said cable;
- a cable housing clamp mounted to said actuator frame;
- distal end of said cable guide mounted to said cable housing clamp;
- a cable routed through hollow interior of said cable housing such that both proximal and distal ends of said cable are accessible;
- distal end of said cable rigidly attached to proximal end of cable pivot arm;
- distal end of said cable pivot arm pivotally connected to proximal end of said secondary release arm;
- a pull-release housing containing an axial bore perpendicular to and branching both opposing faces of said pull-release housing;
- a rod with a diameter smaller than said pull-release housing bore diameter;
- a drive end of said cable guide mounted to said pull-release housing;
- a drive end of said cable attached to distal end of said rod;
- a handle directly attached to proximal end of said rod such that input linear mechanical force on said handle transmits the said input linear mechanical force to the said secondary release arm of said mechanical clutch.

4. The autopilot actuator according to claim 1, further comprising:

- said driven pulley has a plurality of embedded magnets equally spaced along a circular path perpendicular to the said steering shaft;

5. An autopilot system comprising:

- a frame securedly mounted to a steering helm unit housing under a dashboard panel of a marine vessel;
- a driven pulley mounted to the rotating steering shaft of said steering helm unit, a drive pulley mounted to a rotating drive shaft;
- an autopilot actuator having Hall Effect sensors electrically connected to an control box;
- a control box that can deduce both rotation angle and rotation direction of said driven pulley using Hall Effect sensor information;
- such that said control box can detect spurious rotation in said steering helm which corresponds to said drive belt slipping between the driven pulley and drive pulley;
- such that said spurious rotation can generate an alarm signal or some other corrective system action such as de-actuating the said clutch.

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