| | |
|---|---|
| United States Patent Application Publication | 20250257869 |
| Kind Code | A1 |
| Publication Date | August 14, 2025 |
| Inventor(s) | RENAUD; Benoit J. et al. |


## ADAPTIVE LIGHT FOR A WATERCRAFT

### Abstract


A lighting system for a watercraft includes a level sensor generating a level signal corresponding to a level of the watercraft. The system also includes a light source. The system also includes a plurality of elements optically coupled to the light source. The system also includes a controller coupled to the level sensor and the light source, said controller controlling the light source to illuminate selected elements less than all the elements to form a beam pattern.



**Inventors:** **RENAUD; Benoit J. (Elkhart, IN), DEWIRE; Jacob (Bristol, IN), MIERZWA; Kevin G. (Sylvan Lake, MI)**

**Applicant:** **POLARIS INDUSTRIES INC.** (Medina, MN)



**Family ID:** **87136367**

**Appl. No.:** **18/870897**

**Filed (or PCT Filed):** **June 06, 2023**

**PCT No.:** **PCT/US2023/024509**


### Related U.S. Application Data

us-provisional-application US 63350980 20220610

### Publication Classification

**Int. Cl.:** **F21V23/04** (20060101); **B63B45/02** (20060101); **B63B45/04** (20060101); **F21S41/63** (20180101); **F21S41/657** (20180101); **F21S41/663** (20180101); **F21S43/00** (20180101); **F21W111/04** (20060101); **H05B47/105** (20200101); **H05B47/155** (20200101)

**U.S. Cl.:**

CPC **F21V23/0492** (20130101); **B63B45/02** (20130101); **B63B45/04** (20130101); **F21S41/635** (20180101); **F21S41/657** (20180101); **F21S41/663** (20180101); **F21S43/601** (20240501); **H05B47/105** (20200101); **H05B47/155** (20200101); F21W2111/04 (20130101)

---

## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application claims the benefit of U.S. Provisional Application No. 63/350,980, filed on Jun. 10, 2022. The entire disclosure of the above application is incorporated herein by reference.

FIELD
[0002] The present disclosure relates to lights for watercraft and, more particularly, to an adaptive light for controllably illuminating a predetermined area.
BACKGROUND
[0003] Watercraft typically have exterior lights such as docking lights. When a watercraft is loaded unevenly, the lights may not be directed in the desired direction. For example, when the watercraft is a pontoon boat and the pontoon boat is loaded in the aft, the lights may shine brightly on the surrounding houses when docking. Conversely, when a significant load is in the front of a pontoon boat, the docking lights may be directed down into the surface of the water very close to the front of the boat and therefore not helpful in illuminating the dock.
[0004] Another type of light in a watercraft is a mast light or anchor light. The mast light is used to direct light outward from the watercraft so that the boat is visible for a predetermined distance. The light from the mast or anchor light is typically directed at a plane parallel to the surface of the water so that it is visible to other boats at a long distance. However, when a watercraft is loaded in an unbalanced manner, the light may be directed downward or upward depending upon where the loading is relative to the watercraft. In a roll direction, when the starboard side of the boat is heavily weighted, the mast light may be directed down on that side of the boat whereas the mast light on the port side of the boat may be directed upward. This may reduce the visibility of the boat to other users.
[0005] Another type of light that a watercraft may have a side light. A side light may be used for illuminating the dock when the watercraft is loading and unloading. During the loading and unloading process, the roll angle of the watercraft may change as people move toward the exit.
SUMMARY
[0006] The present disclosure provides a light system that adjusts to accommodate the level of the watercraft. Docking lights, side lights and mast lights may all benefit from the examples set forth below.
[0007] In a first example of the present disclosure, one general aspect includes a lighting system for a watercraft. The lighting system also includes a level sensor generating a level signal corresponding to a level of the watercraft. The system also includes a light source. The system also includes a plurality of elements optically coupled to the light source. The system also includes a controller coupled to the level sensor and the light source, said controller controlling the light source to illuminate selected elements less than all the elements to form a beam pattern.
[0008] Implementations may include one or more of the following features. The lighting system where the level sensor generates a pitch angle signal, and the controller controls the light source based on the pitch angle signal. The level sensor generates a roll angle signal, and the controller controls the light source based on the roll angle signal. The lighting system may include a user interface coupled to the controller for controlling an operation of the light source. The plurality of elements is disposed vertically. The plurality of elements is mounted to a curved surface. The

plurality of elements may include at least one positive angle element and a at least one negative angle element. The plurality of elements is disposed horizontally. The light source may include a plurality of light sources, each of the plurality of light sources corresponding to one of the plurality of elements. The plurality of elements may include groups of elements having the same angle of direction. An actuator is coupled to and moves the light source relative to the plurality of elements. The light source moves vertically relative to the plurality of elements. The plurality of elements is disposed on a side of the watercraft. The plurality of elements is disposed on a port side, a starboard side or both. The plurality of elements is disposed on a bow of the watercraft. The plurality of elements is disposed on a front side. The plurality of elements circumscribes a mast. The plurality of elements circumscribes the mast in a plurality of columns. The plurality of elements circumscribes the mast in a plurality of rows and columns.
[0009] One general aspect includes a light assembly for a watercraft may include. The light assembly also includes a housing. The assembly also includes a lens coupled to the housing. The assembly also includes a light source coupled withing the housing directing light through the lens. The assembly also includes a level sensor generating a level signal corresponding to a level of the watercraft. The assembly also includes an actuator moving the housing, the light source and the lens in response to the level signal.
[0010] One general aspect includes a light assembly for a watercraft may include. The light assembly also includes a lens. The assembly also includes a light source coupled optically coupled to the lens. The assembly also includes a level sensor generating a level signal corresponding to a level of the watercraft. The assembly also includes an actuator moving the lens relative to the light source in response to the level signal.
[0011] Additional features of the present disclosure will become apparent
[0012] to those skilled in the art upon consideration of the following detailed description of illustrative examples exemplifying the best mode of carrying out the disclosure as presently perceived.

---

## Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0013] The foregoing aspects and many additional features of the present system and method will become more readily appreciated and become better understood by reference to the following detailed description when taken in conjunction with the accompanying drawings, where:
[0014] FIG. **1** is a perspective view of a watercraft having a light system according to the present disclosure.
[0015] FIG. **2**A is a perspective view of various elements in a first example of a light assembly.
[0016] FIG. **2**B is a front view of the light assembly of FIG. **2**A.
[0017] FIG. **2**C is a side cross sectional view of the light assembly of FIGS. **2**A and **2**B.
[0018] FIG. **3** is a perspective view of a light assembly having light bars as elements.
[0019] FIG. **4**A is a side view of a first example of a light assembly used in a mast.
[0020] FIG. **4**B is a top view of a light assembly used in a mast.
[0021] FIG. **4**C is a side view of a second example of a light assembly for a mast.
[0022] FIG. **5**A is a side view of a light assembly having common elements.
[0023] FIG. **5**B is a front elevational view of the light assembly of FIG. **5**A.
[0024] FIG. **6**A is a side view of a light assembly having an actuator in a first position.
[0025] FIG. **6**B is a side view of the light assembly of FIG. **6**A having another position of the actuator.
[0026] FIG. **7** is a block diagrammatic view of a controller for controlling the light assembly of the watercraft.

[0027] FIG. **8** is a flowchart of a method for operating the light assembly.
[0028] FIG. **9** is a side view of a light assembly with a light source and lens that pivot.
[0029] FIG. **10** is a side view of a light assembly that has an actuator that moves the lens with a stationary light source.

DETAILED DESCRIPTION

[0030] For the purposes of promoting an understanding of the principles of the present disclosure, reference will now be made to the examples illustrated in the drawings, which are described below. The examples disclosed below are not intended to be exhaustive or limited to the precise form disclosed in the following detailed description. Rather, the examples are chosen and described so that others skilled in the art may utilize their teachings.

[0031] Referring now to FIG. **1**, a watercraft **10** is set forth as a pontoon boat. However, the teachings set forth herein apply to other types of watercraft including but not limited to personal watercrafts, ski, boats, surf boats, fishing boats and work boats and yachts. The watercraft has a longitudinal axis **12** and a lateral axis **14**.

[0032] The movement of the watercraft **10** about the longitudinal axis **12** is referred to as the roll angle or roll direction of the watercraft as indicated by the arrow **16**. The pitch of the watercraft **10** is indicated by the arrow **18** about the lateral axis **14**. A bow **20** of the watercraft **10** may be lower than a stern **22** of the watercraft **10** when a load such as passengers is greater in the bow **20**, the stern **22**, when loaded, without loading in the bow **20** may allow the bow **20** to be directed upward. Likewise, the port side **24** of the watercraft **10** may be lower than the starboard side **26** when a greater loading is on the port side **24**. Likewise, when a greater loading is on the starboard side **26** may be lower than the port side **24** so that the watercraft **10** has a different roll angle. When the watercraft **10** is pitched forward and rearward, the pitch angle denoted by **18** changes. The watercraft **10** may have a helm **30** that is used for controlling the watercraft **10**. The helm **30** may include various user interfaces and switches for controlling various functions of the vehicle including the lighting functions of the watercraft. The lighting functions of the watercraft are included within a lighting system **40**. The lighting system **40** is not limited to docking lights **42**. In this example, two docking lights **42** are illustrated on each side of a front wall **43** of the watercraft **10**. Details of the docking lights **42** are described in more detail below.

[0033] The lighting system **40** may also include a boarding light **44**. One boarding light **44** is illustrated on the port side **24** of the watercraft **10**. However, a boarding light **44** may also be located on the starboard side **26** of the watercraft **10**. The sides **24**, **26** and the helm **30** are mounted to a deck **32**. The level of the deck **32** is parallel to the plane of the water in calm conditions and under no or even loads.

[0034] A mast light **46** is coupled to a tower **48**. The mast light **46** may also be located in various positions within the watercraft included coupled to the stern **22** of the watercraft **10**.

[0035] Referring now to FIG. **2**A, **2**B and **2**C, a light assembly **200** is illustrated. The light assembly **200** has a plurality of optical elements **210**. The optical elements are each associated with and optically coupled to a light source **212**. In this example, one light source **212** is provided for each of the elements **210**. In the present example, the elements **210** are labeled 1-5. The elements labels correspond to negative angles in degrees that correspond to the degrees below the horizon. During the operation, all of the “1s” or “2s” or “3s” or “4s” or “5s” are illuminated together. The “1s”, “2s”, “3s”, “4s”, “5s” are groups of elements that have the same angle. Less than all the elements are illuminated at any one time. Of course, more than one element number may be illuminated at the same time. For example, elements 2 and 3 may be illuminated or 2, 3 and 4 depending upon the various conditions. As will be described in more detail below, the level of the deck **32** of the watercraft **10** may be measured as to the pitch angle and roll angles to determine which of the elements **210** to illuminate. That is, the light source **212** associated with the desired angle are illuminated while other light sources are not illuminated. Of course, other types of angles may be associated with the elements. For example, positive angles may also be associated with the elements **210**. This will allow front loaded watercrafts **10** to illuminate the area toward the dock while docking. Although the elements **210** are disposed horizontally, other layouts of the elements **210** are possible.

[0036] Referring now to FIG. **2**C, a side view of the light assembly **200** is illustrated. In this example, the angle of the light beams from the various elements are illustrated in the single figure to illustrate the differences. In this example, a horizontal line **220** that is parallel to the horizon and the water level at the watercraft **10**. The element labeled 1 in FIGS. **2**A and **2**B provides −1° of light direction relative to the horizontal line **220**. Elements 2-5 provide −2° to −5° of angle relative to the horizontal line **220**. Other examples may provide a positive angle illustrated as +1° relative to the horizontal line **220**. Angles greater than the horizontal may be used when the bow **20** of the watercraft **10** is more heavily loaded than the stern **22** of the watercraft **10**.

[0037] Referring now to FIG. **3**, a light assembly **300** is illustrated. The light assembly **300** has a plurality of elements **310** disposed vertically that have different optical characteristics or similar to that described above with respect to FIG. **2**A. In this example, the light elements **310** are labeled −1°, −2°, −3° and −4° from the vertically higher position to the vertically lower position. In this example, a plurality of light sources **312** may be associated with each of the elements. In this example, the dashed lines illustrate the position of the light sources **312** behind the elements **210**. When LEDs are used, a strip or line of LEDs mounted on a circuit board may be mounted parallel to correspond to positions behind each of the elements **210**.

[0038] The light assemblies **200**, **300** may form part of a docking light system and a boarding light system as the docking light **42** or the boarding light **44**.

[0039] Referring now to FIGS. **4**A and **4**B, examples of a mast light system **46**, **46**′ are illustrated. In FIG. **4**A, light elements **210** similar to those described above in FIG. **2**A are provided. In this example, the light elements **210** are illustrated around the mast **410**. As set forth in the example in FIG. **2**A, the angles of the elements may vary.

[0040] A controller, as described below, may illuminate one or more of the angles of the elements **210**. For example, the angle 1 may be illuminated in each position around the mast **410**. When the watercraft **10** pitches or rolls, other numbers of the elements may be illuminated to provide the light in the desired direction preferably nearly parallel to the surface of the water. The relative pitch and roll angles of the watercraft **10** may be determined and light elements on different sides of the mast **410** may be illuminated with different numbers of elements. That is, on one side of the watercraft **10**, the 1s may be illuminated while on the other side of the watercraft, 5s may be illuminated.

[0041] Referring now to FIG. **4**C, an example similar to that set forth in FIG. **3** is provided. That is, the elongated elements **310** may be shortened to provide the smaller areas thereof. From the top of the mast **410**, the elements may have the desired amount of angles, such as −1, −2, −3 and −4. However, as they circumscribe the mast **410**, the elements **310** may be individually controlled to allow various columns **420** of the lights to be illuminated individually to compensate for pitching or rolling of the watercraft **10**. The elements may further be disposed in rows **422**. The rows **422** and columns **420** may be individually addressable. The controller thus controls the elements to obtain the desired angle corresponding to the pitch angle, roll angle or both of the watercraft **10**. The shaded elements **310** illustrate the compensation of an illumination of various elements to compensate for the roll and pitch angles of the watercraft.

[0042] Referring now to FIGS. **5**A and **5**B, in this example, elements **510** may all be constructed with similar optics emitting the light in a direction perpendicular to a curved surface **512**. In this example, light sources **514** in combination with the elements direct light at various angles including +2, +1, which are positive angle elements, 0 which corresponds to horizontal, −1, −2, −3 and −4, which are negative angle elements. Each of the elements **510** are mounted on the surface **512** which positions the output of the light from the light sources in the desired direction. In a similar manner to that mentioned above, the one or more of the light sources **514** corresponding to the desired direction of the elements **510** may be illuminated at one time according to the level of the watercraft **10**.

[0043] Referring now to FIG. **6**A, a controller **610** is coupled to an actuator **612**. The actuator **612** is a movable structure that has a position controlled by the controller **610**. The actuator **612** may move a single light source **614** to illuminate through various elements **616** to form the desired beam pattern **618**. In this example, the light source **614** has a beam spread angle **620** illustrated by the arrow. The light source **614** is moved by the actuator **612** in a vertical direction. However, other directions such as horizontal or other non-orthogonal angles may be used. The angle **620** may thus be moved by the actuator **612** as illustrated by contrasting FIGS. **6**A and **6**B. In this example, the elements **616** represent −1°, −2°, −3° and −4°. As mentioned above, various types of angles may be used by the elements. The angles emitted by the light source **614** are controlled by the actuator rather than the optics of the elements **616**. However, optics may also be included within the element to spread and position the beam into the desired beam pattern **618**.

[0044] Referring now to FIG. **7**, a control system for controlling the lighting system **40** and illuminated selected elements less than the total number of elements is set forth. In this example, a controller **710** is set forth. The controller may be a microprocessor-based controller or another type of discrete circuitry. The controller **710** is coupled to a user interface **712**. The user interface **712** may be switches, dials or elements on a touch screen display. The user interface **712** may be used for turning on and off various lights within the watercraft **10**. Separate controls may be provided for the docking lights **42**, the boarding lights **44** and the mast light **46**.

[0045] The controller **710** is coupled to a level sensor **714**. The level sensor **714** generate a signal or signals corresponding to the level of the watercraft **10** relative to the water. In many examples, the deck **32** is parallel to the water. The level sensor **714** may therefore provide signals corresponding to the level of the deck **32**.

[0046] The level sensor **714** may be a gyroscopic-type sensor that generates a pitch angle signal corresponding to the pitch angle, and a roll angle signal corresponding to the roll angle. Similar sensors are incorporated into various consumer electronics including controllers for video games and controllers of a cell phone for controlling the displays thereof.

[0047] The controller **710** ultimately controls the various elements of the docking lights **42**, the boarding lights **44** and the mast light **46**. A number of control lines are illustrated associated with the mast light **46**. Each of the boarding lights and boarding lights **44** may have separate control wires used for controlling the various elements. In the case of the mast lights **46**, various columns of elements and the lights associated therewith may be provided.

[0048] The controller **710** may also be coupled to control an actuator **612** from FIGS. **6**A and **6**B. That is, the controller **710** may generate an angle signal to move the actuator **612** in the desired direction.

[0049] The controller **710** may have various modules therein for controlling the elements and the actuator **612**. In one example, the controller **710** has an angle determination module **720**. The angle determination module **720** uses the level signals from the level sensor **714** to determine the angle of the watercraft and thereafter determine the elements that are to be illuminated at the docking lights **42**, the boarding lights **44** and/or the mast light **46**. The angle determination module for the mast light **46** may determine different angles for different elements depending upon the side of the board, illustrations of which were provided in FIG. **4**C.

[0050] Referring now to FIG. **8**, a method for operating the light system **40** is illustrated. In step **810**, the watercraft angle is determined from the level sensor **714**. The angle of the watercraft may refer to the pitch angle, the roll angle or combination of the pitch and roll angle. In step **812**, the elements for illumination are determined. The determination of the elements and the illumination of the light sources corresponding to the elements is based upon a desired beam pattern. For docking lights, it is desirable to illuminate an area that the watercraft is headed toward. When the watercraft **10** is pitched so the bow is higher than the horizontal, negative beam elements directing the light in a negative direction relative to the deck is provided. This allows the lights to remain shining at the dock rather than the nearby surroundings such as a home. In step **814**, the elements continually illuminate in the desired direction. The process repeats continually during operation in step **810**. As long as the user interface indicates the desired lights to be operated, the system may continually determine the angle of the watercraft and continually adjust the elements used.

[0051] In wavy conditions and other unstable conditions, the continuous determination of the angle may allow the lights to maintain visibility for the watercraft operator. From side to side and bow to stern, the lights may be independently controlled if the weight or waves cause uneven distribution. For example, if the starboard bow corner is higher than the port bow then more negative angle may be applied to the docking light on the correspondingly higher corner.

[0052] Referring now to FIG. **9**, a light source **910** is illustrated with respect to an element or lens **912**. The lens **912** and the light source **910** are coupled to a housing **914**. The housing **914** is coupled to an actuator **916** by way of an arm **918**. The actuator **916** by way of the arm **918** rotates the housing **914** and thus the light source **910**, the lens **912** and the beam **920** generated thereby into the desired direction to compensate for the level of the watercraft **10**. Both the light source **910** and the lens **912** pivot in response to movement of the actuator **916**.

[0053] Referring now to FIG. **10**, a stationary light source **1010** is illustrated relative to an element or lens **1012**. The light source **1010** is mounted to a mount **1014** which is one example of a stationary structure. The lens **1012** is coupled to an actuator **1016**. The actuator **1016** moves the lens **1012** along a curved path **1018**. The curved path **1018** allows the optics within the lens **1012** changes the angle of the flood beam **1020** into the desired direction.

[0054] In both FIGS. **9** and **10**, the level sensor **714** provides an input to move the actuator **916** or **1016** so that the flood beams **920**, **1020** are directed in the desired direction to compensate for the watercraft being not level. The level signal of the level sensor **714** may be directed directly to the actuators **916**.**1016** or to the controller **710** that controls the actuator **916**, **1016**.

[0055] Examples are provided so that this disclosure will be thorough and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of examples of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that examples may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some examples, well-known processes, well-known device structures, and well-known technologies are not described in detail.

[0056] The foregoing description of the examples has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular example are generally not limited to that particular example, but, where applicable, are interchangeable and can be used in a selected example, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

## Claims

**1**. A lighting system for a watercraft comprising: a level sensor generating a level signal corresponding to a level of the watercraft; a light source; a plurality of elements optically coupled to the light source; and a controller coupled to the level sensor and the light source, said controller controlling the light source to illuminate selected elements less than all the elements to form a beam pattern; wherein the plurality of elements is mounted to a curved surface that is curved in a vertical direction, each element of the plurality of elements directing light perpendicular to the curved surface.

**2**. The lighting system of claim 1 wherein the level sensor generates a pitch angle signal, and the

controller controls the light source based on the pitch angle signal.
**3**. The lighting system of claim 1 wherein the level sensor generates a roll angle signal, and the controller controls the light source based on the roll angle signal.
**4**. The lighting system of claim 1 further comprising a user interface coupled to the controller for controlling an operation of the light source.
**5**. The lighting system of claim 1 wherein the plurality of elements is disposed vertically.
**6**. (canceled)
**7**. The lighting system of claim 1 wherein the plurality of elements comprises at least one positive angle element and at least one negative angle element.
**8**. The lighting system of claim 1 wherein the plurality of elements is disposed horizontally.
**9**. The lighting system of claim 1 wherein the light source comprises a plurality of light sources, each of the plurality of light sources corresponding to one of the plurality of elements.
**10**. A lighting system for a watercraft comprising: a level sensor generating a level signal corresponding to a level of the watercraft; a plurality of light sources; a plurality of elements optically coupled to the light sources, each of the plurality of light sources corresponding to one of the plurality of elements, wherein the elements of each group are spaced apart by elements of at least one other group, the plurality of elements comprises groups of elements having the same angle of direction; and a controller coupled to the level sensor and the light source, said controller controlling one of the groups of light sources to illuminate selected elements less than all the elements to form a beam pattern.
**11**. The lighting system of claim 1 wherein an actuator is coupled to and moves the light source relative to the plurality of elements.
**12**. The lighting system of claim 11 wherein the light source moves vertically relative to the plurality of elements.
**13**. A boarding light system for a watercraft comprising: the lighting system of claim 1; wherein the plurality of elements is disposed on a side of the watercraft.
**14**. The boarding light system as recited in claim 13 wherein the plurality of elements is disposed on a port side, a starboard side or both.
**15**. A docking light system for a watercraft comprising: the lighting system of claim 1; wherein the plurality of elements is disposed on a bow of the watercraft.
**16**. The docking light system as recited in claim 15 wherein the plurality of elements is disposed on a front side.
**17**. A mast light system for a watercraft comprising: a level sensor generating a level signal corresponding to a level of the watercraft, said level corresponding to pitch and roll of the watercraft; a light source; a plurality of elements optically coupled to the light source; and a controller coupled to the level sensor and the light source, said controller controlling the light source to illuminate selected elements less than all the elements to form a beam pattern; wherein the plurality of elements circumscribes a mast, wherein the plurality of elements circumscribes the mast in a plurality of rows and columns; said controller addressing individually addressable elements different elements in different rows and different columns to compensate for the pitch and the roll of the watercraft.
**18-19**. (canceled)
**20**. A light assembly for a watercraft comprising a housing; a lens coupled to the housing; a light source coupled withing the housing directing light through the lens; a level sensor generating a level signal corresponding to a level of the watercraft; an actuator moving the housing, the light source and the lens in response to the level signal.
**21**. A light assembly for a watercraft comprising a lens; a light source coupled optically coupled to the lens; a level sensor generating a level signal corresponding to a level of the watercraft; an actuator moving the lens relative to the light source in response to the level signal.

**22**. The light assembly as recited in claim 21 wherein the actuator moves the lens along a curved path.