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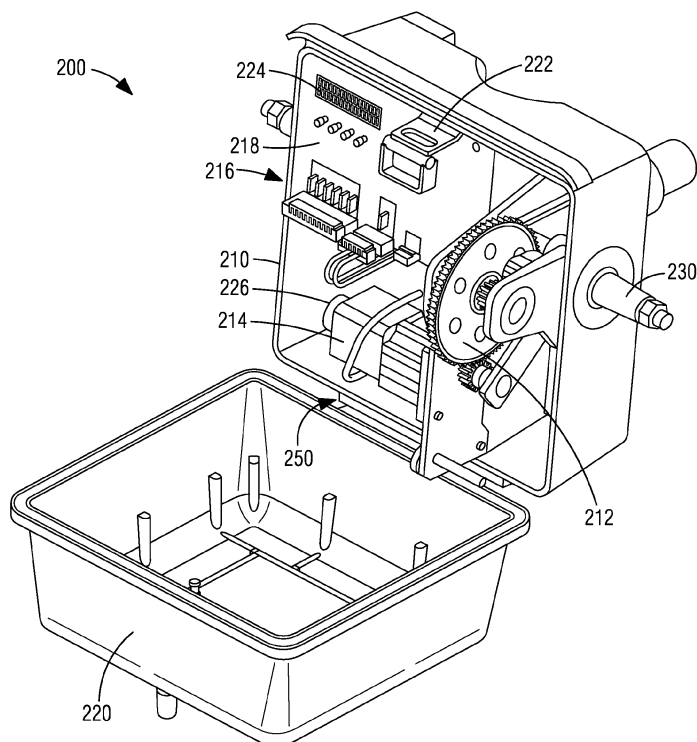
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(54) **CROSSING GATE MECHANISM WITH PROGRAMMABLE ELECTRONIC SWITCHING DEVICES**

(57) A crossing gate mechanism includes an electric motor driving a main shaft, wherein the main shaft is configured to couple to a crossing gate arm, a position detection unit configured to detect a position of the main shaft, an electronic switching device configured to oper-

ate in different switching states, and a programmable control unit configured to control operation of the switching device based on a detected position of the main shaft in combination with a programmed switching state for the detected position.

FIG. 2



Description

BACKGROUND

1. Field

[0001] Aspects of the present disclosure generally relate to railroad crossing gates and crossing gate mechanisms, more particularly, to a crossing gate mechanism with user programmable electronic switching devices.

2. Description of the Related Art

[0002] A railway crossing, also referred to as level crossing or grade crossing, is an intersection where a railway line crosses a road or path. To ensure safety of railway crossings, crossing control systems including signal control equipment are installed at railway crossings. Railroad signal control equipment includes for example a constant warning time device, also referred to as a grade crossing predictor (GCP) in the U.S. or a level crossing predictor in the U.K., which is an electronic device that is connected to rails of a railroad track and is configured to detect the presence of an approaching train and determine its speed and distance from a crossing, i.e., a location at which the tracks cross a road, sidewalk or other surface used by moving objects. The constant warning time device will use this information to generate a constant warning time signal for a crossing warning device.

[0003] A crossing warning device is a device that warns of the approach of a train at a crossing, examples of which include crossing gate arms, crossing lights (such as the red flashing lights often found at highway grade crossings in conjunction with the crossing gate arms), and/or crossing bells or other audio alarm devices. Constant warning time devices are typically configured to activate the crossing warning device(s) at a fixed time, also referred to as warning time (WT), which can be for example 30 seconds, prior to the approaching train arriving at the crossing.

[0004] Railroad crossing gates utilize electrical and mechanical components to ensure that the crossing gates perform their intended functions correctly. For example, gate arms are lowered using a motor located in a crossing gate mechanism, herein also referred to as gate control mechanism. A crossing gate mechanism may be described as gate control box housing multiple mechanical, electric, and electronic components for operating and controlling the signal control equipment and warning devices, such as the crossing gates.

SUMMARY

[0005] Briefly described, aspects of the present disclosure generally relate to railroad crossing gates and, more particularly to a crossing gate mechanism comprising user programmable electronic switching devices.

[0006] A first aspect of the present disclosure provides a crossing gate mechanism comprising an electric motor driving a main shaft, wherein the main shaft is configured to couple to a crossing gate arm, a position detection unit configured to detect a position of the main shaft, a least one electronic switching device configured to operate in different switching states, and a programmable control unit configured to control operation of the at least one switching device based on a detected position of the main shaft in combination with a programmed switching state for the detected position.

[0007] A second aspect of the present disclosure provides a crossing gate system comprising one or more crossing gate arm(s), and a crossing gate mechanism as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 illustrates an example railroad crossing gate in accordance with an exemplary embodiment of the present disclosure.

FIG. 2 illustrates a perspective view of a crossing gate mechanism in accordance with an exemplary embodiment of the present disclosure.

FIG. 3 and **FIG. 4** illustrate simplistic schematics in different views of a known arrangement of a main shaft in combination with a mechanical contact design.

FIG. 5 illustrates a schematic of an arrangement of a main shaft in combination with an electronic switching device for a crossing gate mechanism in accordance with an exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

[0009] To facilitate an understanding of embodiments, principles, and features of the present disclosure, they are explained hereinafter with reference to implementation in illustrative embodiments. In particular, they are described in the context of a crossing gate mechanism utilized in connection with railroad crossing gate applications.

[0010] The components and materials described hereinafter as making up the various embodiments are intended to be illustrative and not restrictive. Many suitable components and materials that would perform the same or a similar function as the materials described herein are intended to be embraced within the scope of embodiments of the present disclosure.

[0011] **FIG. 1** illustrates a railroad crossing gate 100 in a lowered or horizontal position. At many railroad crossings, at least one railroad crossing gate 100 may be

placed on either side of the railroad track to restrict roadway traffic in both directions. At some crossings, pedestrian paths or sidewalks may run parallel to the roadway. To restrict road and sidewalk traffic, the illustrated railroad crossing gate 100 includes a separate roadway gate 130 and pedestrian gate 140. The roadway gate 130 and pedestrian gate 140 may be raised and lowered, i.e., operated, by control mechanism 200.

[0012] The example railroad crossing gate 100 also includes a pole 110 and signal lights 120. The gate control mechanism 200 is attached to the pole 110 and is used to raise and lower the roadway and pedestrian gates 130, 140. The illustrated railroad crossing gate 100 is often referred to as a combined crossing gate. When a train approaches the crossing, the railroad crossing gate 100 may provide a visual warning using the signal lights 120. The gate control mechanism 200 will lower the roadway gate 130 and the pedestrian gate 140 to respectively restrict traffic and pedestrians from crossing the track until the train has passed.

[0013] As shown in **FIG. 1**, the roadway gate 130 comprises a roadway gate support arm 134 that attaches a roadway gate arm 132 to the gate control mechanism 200. Similarly, the pedestrian gate 140 comprises a pedestrian gate support arm 144 connecting a pedestrian gate arm 142 to the gate control mechanism 200. When raised, the gates 130 and 140 are positioned so that they do not interfere with either roadway or pedestrian traffic. This position is often referred to as the vertical position. A counterweight 160 is connected to a counterweight support arm 162 connected to the gate control mechanism 200 to counterbalance the roadway gate arm 132.

[0014] Typically, the gates 130, 140 are lowered from the vertical position using an electric motor contained within the gate control mechanism 200. The electric motor drives gearing connected to shafts (not shown) connected to the roadway gate support arm 134 and pedestrian gate support arm 144. The support arms 134, 144 are usually driven part of the way down by the motor (e.g., somewhere between 70 and 45 degrees) and then gravity and momentum are allowed to bring the arms 132, 142 and the support arms 134, 144 to the horizontal position. In another example, the support arms 134, 144 are driven all the way down to the horizontal position by the electric motor of the gate control mechanism 200.

[0015] **FIG. 2** illustrates a perspective view of crossing gate mechanism 200 in accordance with an exemplary embodiment of the present disclosure.

[0016] The crossing gate mechanism 200 comprises an enclosure 210 housing multiple mechanical, electrical, and electronic components, such as for example gearing 212, electric motor 214 driving the gearing 212, electric brake 226 and control unit 216. The electric motor 214 can be a gearmotor and can be a brushless direct current (DC) motor.

[0017] The electric motor 214 and gearing 212 are configured to drive main shaft 230. The main shaft 230

extends outside the gate mechanism 200, i.e., enclosure 210. The gate support arm 134 (see **FIG. 1**) is fixed to the main shaft 230 on the outside of the mechanism 200, and the gate support arm 134 is coupled to the roadway gate arm 132. Thus, motion/rotation of the main shaft 230 facilitates lowering and raising of the gate arm 132.

[0018] The control unit 216 comprises a printed circuit board (PCB) 218 with the necessary electronics for operating and controlling the gate mechanism 200 and associated crossing gate equipment, such as crossing gate arm(s), see for example **FIG. 1**. Further, the PCB 218 comprises for example display(s) 224 and/or light emitting diodes (LEDs), used for example to indicate or display status of the gate mechanism 200, such status including for example 'Power on', 'Gate Request', 'Brake On', 'Health', etc.

[0019] The enclosure 210 can be opened and closed via door or cover 220, for maintenance, repair, or other services. The cover 220 is moveable between a closed position and an open position, wherein **FIG. 2** shows the cover 220 in the open position. The cover 220 is closed via hinge 250 and latch plate 222 in connection with a latch rod (not shown).

[0020] **FIG. 3** and **FIG. 4** illustrate different schematics of a known arrangement of a main shaft in combination with a mechanical contact design. In an example, as described with reference to **FIG. 2**, the gate mechanism 200 comprises enclosure 210 housing multiple mechanical, electrical, and electronic components, such as for example main shaft 230 and control unit 216. The gate support arm 134 is coupled to the main shaft 230, and further the gate arm 132 is connected to the gate support arm 134 (see for example **FIG. 1**). The main shaft 230 is operated by the electric motor 214, e. g. gearmotor via gearing 212. Rotation of the main shaft 230 is indicated via arrow 234. As shown, the main shaft 230 extends outside the housing/enclosure 210 so that the gate support arm 134 can be coupled to the main shaft 230.

[0021] Further, with reference to **FIG. 3** and **FIG. 4**, the arrangement comprises one or more cam(s) 240 arranged at fixed position(s) on the main shaft 230. A cam 240 is a rotating piece in a mechanical linkage used for transforming rotary motion 234 (of the main shaft 230) into a linear motion, wherein the cam 240 for example provides a contact or strikes a lever or other device to provide shaft position information. The cam 240 provides a contact state for a receiving entity 244, such as control unit 216. Currently, with respect to a gate arm angle, mechanical relays with adjustable cams 240 determine up and down gate positions; however, resolution is limited and fixed during installation or maintenance via loosening and tightening screw(s). Further, mechanical contacts (relays) have contact wear, sticking and weather-related icing issues, which may lead to failure of the gate mechanism. Thus, it is desirable to provide and improved gate mechanism without mechanical switching devices to eliminate wear and/or failures of such mechanical devices.

[0022] FIG. 5 illustrates a schematic of an arrangement of a main shaft in combination with an electronic switching device for a crossing gate mechanism in accordance with an exemplary embodiment of the present disclosure. More specifically, the arrangement, included in a crossing gate mechanism such as mechanism 200 illustrated in FIG. 2, comprises main shaft 230, wherein the main shaft 230 is configured to couple to a crossing gate arm.

[0023] Gate mechanisms, such as mechanism 200, use contacts (switches) for various applications, either within the mechanism 200 itself, e.g., motor control, or externally, e.g., input into an adjacent crossing bungalow including a crossing controller for lamp control.

[0024] In an exemplary embodiment of the present disclosure, a position detection unit 260 is configured to detect a position of the main shaft 230. The position detection unit 260 determines an angle Θ of the main shaft 230, which can be accomplished in many ways. For example, the position detection unit 260 comprises at least one sensor selected from an accelerometer, gyroscope, magnetometer, a proximity detector, a rotary encoder, and a combination thereof, wherein the at least one sensor can be mounted to the main shaft 230, within the enclosure 210 of the mechanism 200.

[0025] At least one electronic switching device 272 is configured to operate in different switching states. A programmable control unit 264 is configured to control operation of the at least one switching device 272 based on a detected position of the main shaft 230 in combination with a programmed switching state for the detected position. The programmable control unit 264 is configured to receive angular information from the position detection unit 260 and determine, based on the angle, a position of the main shaft 230.

[0026] For programming purposes of the control unit 264, a user interface device 268 is connected to the control unit 264 for providing/entering, i.e., programming, the different switching states based on different main shaft positions. The user interface device 268 allows arm angle-based settings for switching, e.g., opening and closing, the switching device 272.

[0027] The main shaft 230 has a potential rotation of 0 to 90 degrees. For example, a main shaft angle of 90° corresponds to a main shaft position "Gate Up". When the main shaft 230 is in the position "Gate Up", a switching state of the electronic switching device 272 may be programmed in a first switching state, which is for example "Closed State". The switching state may relate to motor control or motor brake control of the mechanism 200, which is the entity 244 receiving the corresponding contact state or switching state. In another example, a main shaft angle of 0° corresponds to a position "Gate Down", and a switching state of the switching device 272 may be "Open State", or vice versa.

[0028] In an example, the at least one switching device 272 comprises a solid-state relay, utilizing power semiconductor devices to switch between the different states. It should be noted that the arrangement may comprise

more than one switching device 272. The one or more electronic switching device(s) 272 may comprise other types of electronic switches, such as for example electromechanical relay(s). A design of the electronic switch 272 incorporates necessary isolation such that it is effectively floating with respect to other circuits within the mechanism 200.

Further embodiments:

[0029]

1. A crossing gate mechanism comprising:

an electric motor driving a main shaft, wherein the main shaft is configured to couple to a crossing gate arm,
a position detection unit configured to detect a position of the main shaft,
a least one electronic switching device configured to operate in different switching states, and
a programmable control unit configured to control operation of the at least one switching device based on a detected position of the main shaft in combination with a programmed switching state for the detected position.

2. The crossing gate mechanism of embodiment 1, wherein the position detection unit is configured to determine an angle of the main shaft.

3. The crossing gate mechanism of embodiment 2, wherein the programmable control unit is configured to receive angular information from the position detection unit and determine, based on the angle, a position of the main shaft.

4. The crossing gate mechanism of embodiment 1, further comprising:
a user interface connected to the control unit for programming the different switching states based on different main shaft positions.

5. The crossing gate mechanism of embodiment 1, wherein the at least one switching device comprises a solid-state relay.

6. The crossing gate mechanism of embodiment 5, wherein the solid-state relay utilizes power semiconductor devices to switch between the different switching states.

7. The crossing gate mechanism of embodiment 5, wherein the different switching states comprise an open state and a closed state.

8. The crossing gate mechanism of embodiment 1, wherein the position detection unit comprises at least

one sensor selected from an accelerometer, gyroscope, magnetometer, a proximity detector, a rotary encoder, and a combination thereof.

9. The crossing gate mechanism of embodiment 1, comprising multiple electronic switching devices. 5

10. A crossing gate system comprising:

one or more crossing gate arm(s), and 10
a crossing gate mechanism comprising:

an electric motor driving a main shaft, wherein the main shaft is configured to couple to a crossing gate arm, 15
a position detection unit configured to detect a position of the main shaft,
at least one electronic switching device configured to operate in different switching states, and 20
a programmable control unit configured to control operation of the at least one switching device based on a detected position of the main shaft in combination with a programmed switching state for the detected position. 25

11. The crossing gate system of embodiment 10, comprising multiple electronic switching devices. 30

12. The crossing gate system of embodiment 10, wherein the programmable control unit is configured to receive angular information from the position detection unit and determine, based on the angular information, a position of the main shaft. 35

13. The crossing gate system of embodiment 10, further comprising:
a user interface connected to the control unit for programming the different switching states based on different main shaft positions or other detected information. 40

14. The crossing gate system of embodiment 10, wherein the at least one switching device comprises a solid-state relay or electromechanical relay. 45

15. The crossing gate system of embodiment 10, wherein the at least one switching device is configured to provide an input for a motor control. 50

Claims

1. A crossing gate mechanism comprising: 55

an electric motor driving a main shaft, wherein the main shaft is configured to couple to a cross-

ing gate arm,
a position detection unit configured to detect a position of the main shaft,
a least one electronic switching device configured to operate in different switching states, and
a programmable control unit configured to control operation of the at least one switching device based on a detected position of the main shaft in combination with a programmed switching state for the detected position.

2. The crossing gate mechanism of claim 1, wherein the position detection unit is configured to determine an angle of the main shaft.

3. The crossing gate mechanism of claim 2, wherein the programmable control unit is configured to receive angular information from the position detection unit and determine, based on the determined angle, a position of the main shaft.

4. The crossing gate mechanism according to any of the preceding claims, further comprising:
a user interface connected to the control unit for programming the different switching states based on different main shaft positions.

5. The crossing gate mechanism according to any of the preceding claims, wherein the at least one switching device comprises a solid-state relay.

6. The crossing gate mechanism of claim 5, wherein the solid-state relay utilizes power semiconductor devices to switch between the different switching states.

7. The crossing gate mechanism of claim 5 or 6, wherein the different switching states comprise an open state and a closed state.

8. The crossing gate mechanism according to any of the preceding claims, wherein the position detection unit comprises at least one sensor selected from an accelerometer, gyroscope, magnetometer, a proximity detector, a rotary encoder, and a combination thereof.

9. The crossing gate mechanism according to any of the preceding claims, comprising multiple electronic switching devices.

10. A crossing gate system comprising:

one or more crossing gate arm(s), and
a crossing gate mechanism, in particular a crossing gate mechanism according to any of the claims 1 to 9, the crossing gate mechanism

comprising:

an electric motor driving a main shaft,
wherein the main shaft is configured to
couple to a crossing gate arm, 5
a position detection unit configured to de-
tect a position of the main shaft,
at least one electronic switching device con-
figured to operate in different switching
states, and 10
a programmable control unit configured to
control operation of the at least one switch-
ing device based on a detected position of
the main shaft in combination with a pro-
grammed switching state for the detected 15
position.

11. The crossing gate system of claim 10,
comprising multiple electronic switching devices. 20
12. The crossing gate system according to any of the
preceding system-based claims,
wherein the programmable control unit is configured
to receive angular information from the position de-
tection unit and determine, based on the angular 25
information, a position of the main shaft.
13. The crossing gate system according to any of the
preceding system-based claims, further comprising:
a user interface connected to the control unit for 30
programming the different switching states based
on different main shaft positions or other detected
information.
14. The crossing gate system according to any of the 35
preceding system-based claims, wherein the at least
one switching device comprises a solid-state relay or
electromechanical relay.
15. The crossing gate system according to any of the 40
preceding system-based claims, wherein the at least
one switching device is configured to provide an
input for a motor control.

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FIG. 1

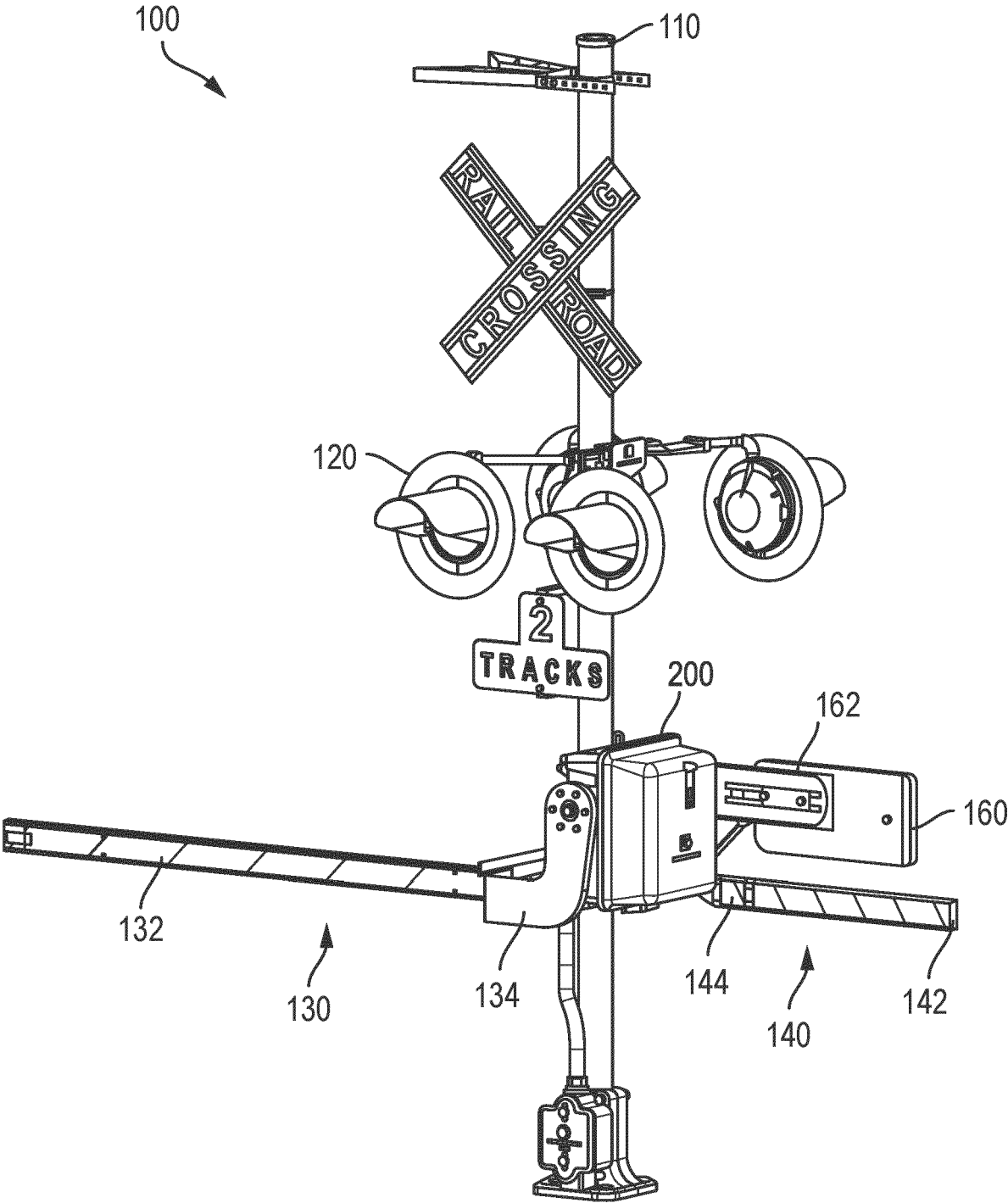


FIG. 2

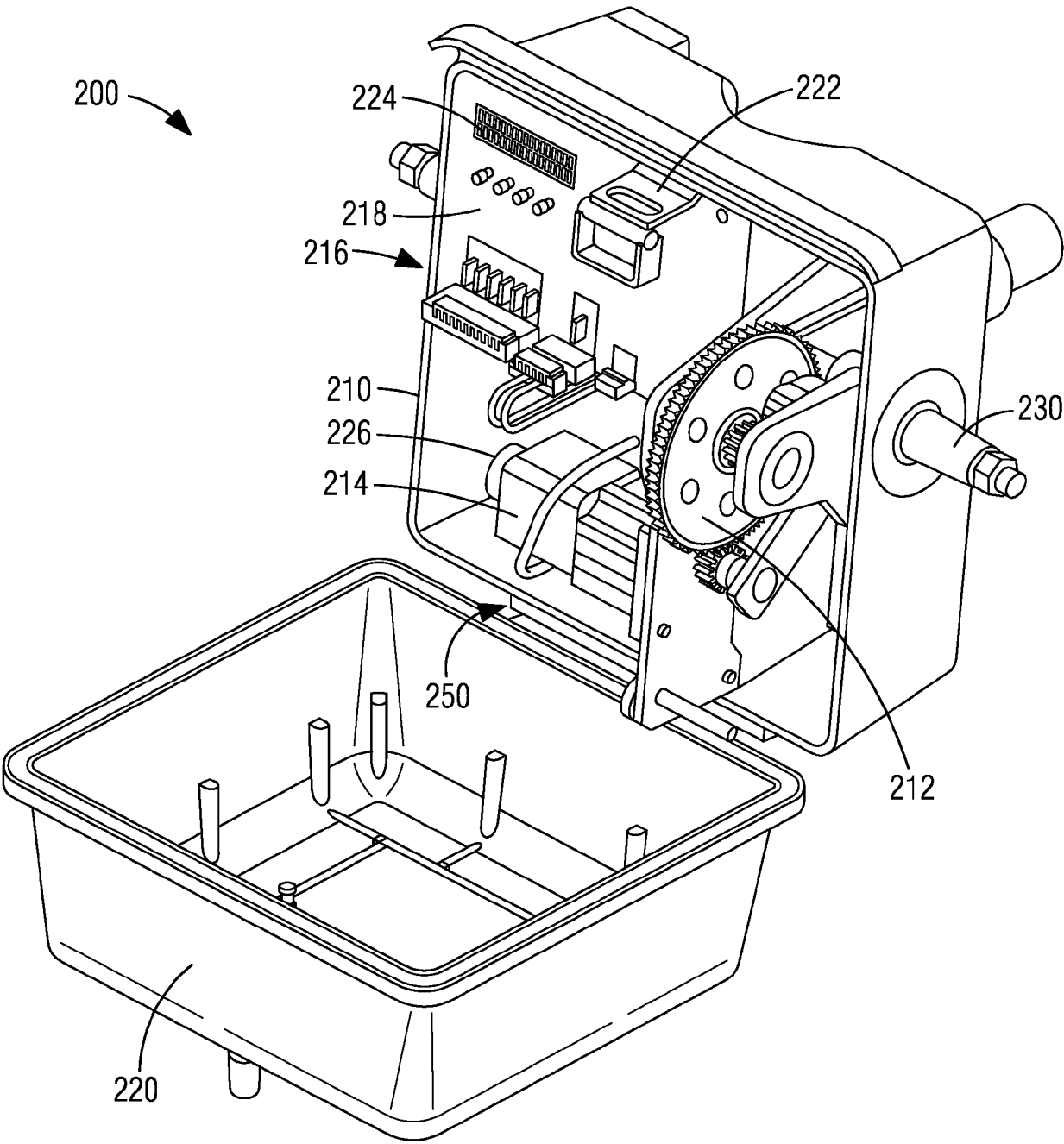


FIG. 3
PRIOR ART

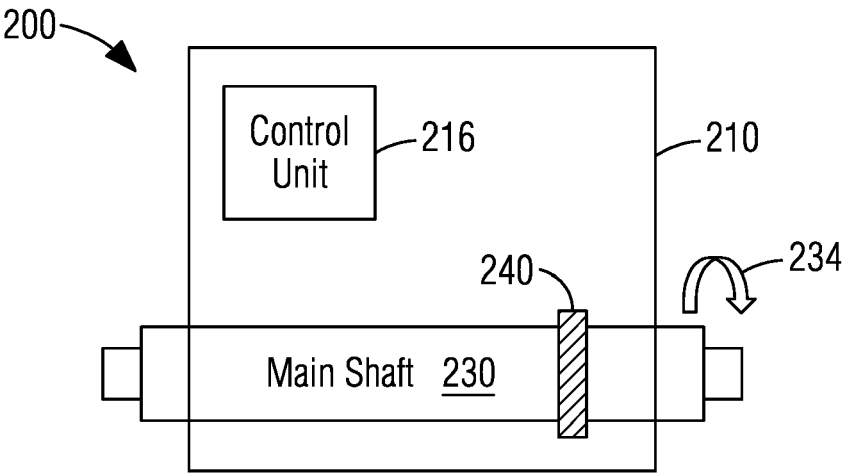


FIG. 4
PRIOR ART

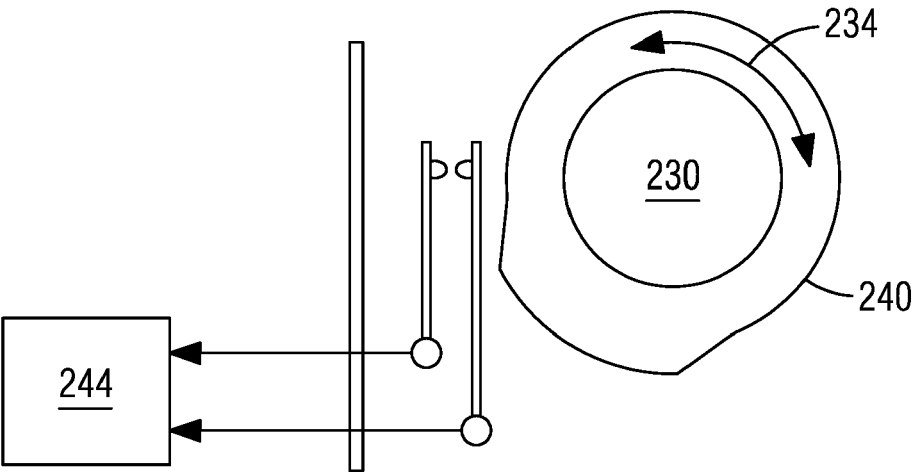
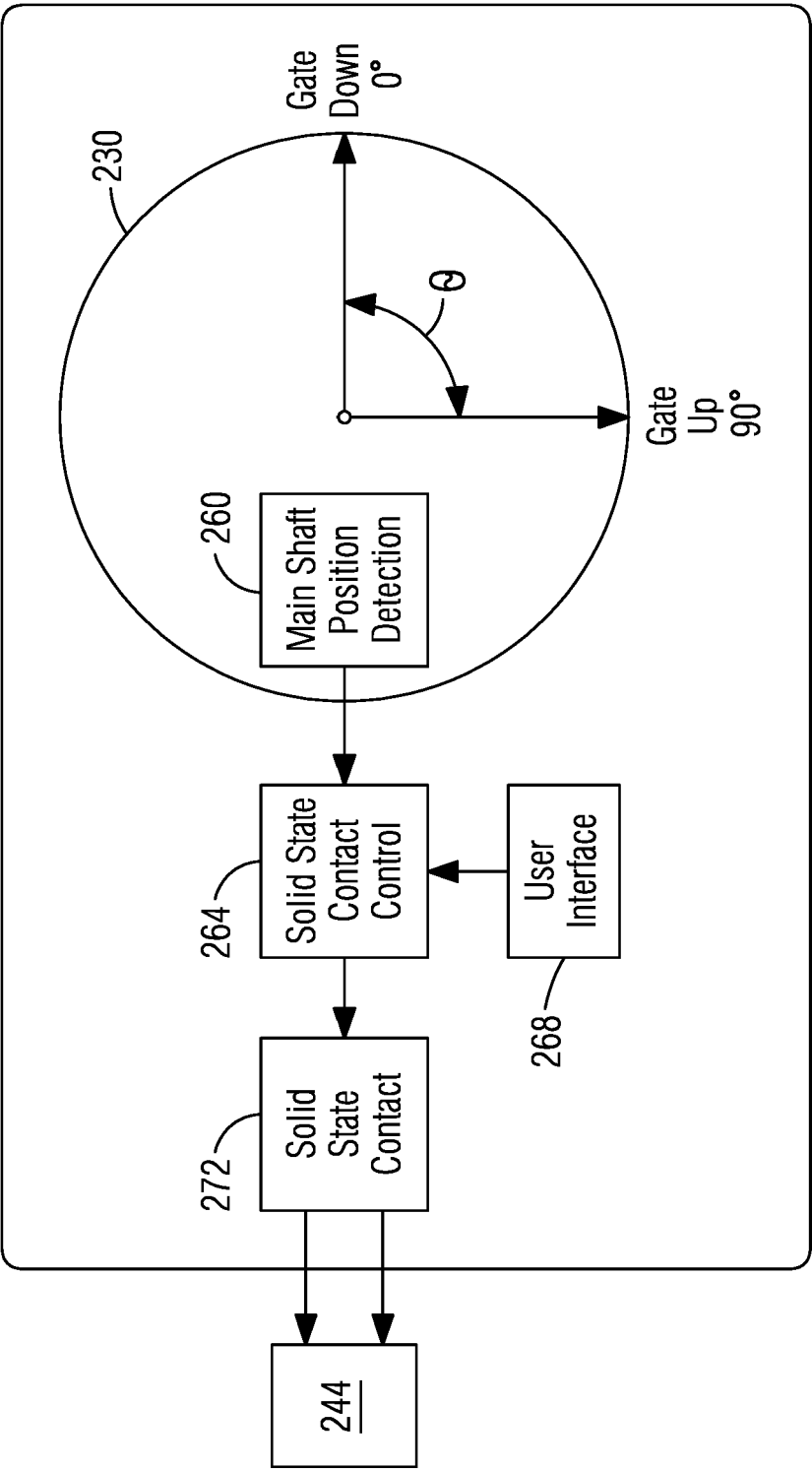


FIG. 5





EUROPEAN SEARCH REPORT

Application Number

EP 24 18 2386

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2019/226672 A1 (C D L ELECTRIC COMPANY INC [US]) 28 November 2019 (2019-11-28) * abstract; figures 1-25 * * paragraphs [0003] - [0011] * * paragraphs [0069] - [0126] * -----	1 - 15	INV. B61L29/04 B61L29/08 B61L29/30
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			B61L
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		22 November 2024	Robinson, Victoria
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