METHOD AND SYSTEM FOR CONTROLLING STEERING OF OVERHEAD HOIST VEHICLE

[0001] The present application claims the benefit of priority to Chinese Patent Application No. 202210188919.2 filed on March 1, 2022, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of the present disclosure relate to the field of manufacturing equipment for semiconductor wafer, and in particular to a method and a system for controlling steering of an overhead hoist vehicle in an automatic material handling system.

BACKGROUND

[0003] In a semiconductor automation plant, an overhead hoist vehicle in an automatic material handling system (AMHS, also referred to as system including overhead travelling carriages) is configured to transport a target clamped object from a certain location to a designated location as required. When the location of the clamped object (such as a wafer pod) and the target transport position are not arranged along a same track, the overhead hoist vehicle has to switch to another travelling track. In this case, a rotating electromagnet in a steering drive mechanism of the overhead hoist vehicle drives a guide wheel on a sliding rail to move to a designated position and the travelling track of the overhead hoist vehicle is changed under the interference of an upper guide track.

[0004] In view of the fact that the longer the electromagnet is energized, the greater the temperature rise, and the smaller the power, causing a reduced force, the existing solutions usually provide a constant voltage to the rotating electromagnet, and power off upon the rotating electromagnet turning to a desired position, in order to prevent the electromagnet from being energized for a long time and causing excessive temperature rise. However, after reaching the designated angle position, the rotating electromagnet is powered off and losses driving force, therefore the rotating electromagnet rebounds due to reaction force originating from inertia, resulting in collision between the guide wheel of the overhead hoist vehicle and the overhead track, or even jamming of the guide wheel, which seriously affects the normal

operation of the overhead hoist vehicle and reduces the production efficiency of the semiconductor plant.

[0005] In view of this, there is an urgent need of a new steering control solution.

SUMMARY

[0006] The present disclosure provides a method for controlling steering of an overhead hoist vehicle, including:

[0007] applying a first driving voltage to an electromagnet in response to receiving a steering control signal, where the first driving voltage is configured to control the electromagnet to drive a guide wheel to move on a sliding rail, and a difference between the first driving voltage and a target voltage is not less than a first threshold, and where the target voltage refers to a driving voltage configured to overcome a maximum static friction force during controlling the electromagnet to drive the guide wheel to move on the sliding rail;

[0008] determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to a first designated position on the sliding rail, and applying a second driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the first designated position, where the second driving voltage refers to another driving voltage configured to control the electromagnet to drive the guide wheel to move on the sliding rail, and the second driving voltage is not equal to the first driving voltage;

[0009] determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to a second designated position on the sliding rail, and applying a third driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the second designated position, where the second designated position refers to a preset dwelling position, under driving of the electromagnet, of the guide wheel on the sliding rail, and the third driving voltage is greater than the target voltage; and

[0010] determining whether applying of the third driving voltage meets a preset condition, and powering off the electromagnet in response to the applying of the third driving voltage meeting the preset condition.

[0011] The present disclosure further provides a system for controlling steering of an overhead hoist vehicle, including: an activating module and a switching module;

[0012] the activating module is configured to: apply a first driving voltage to an electromagnet in response to receiving a steering control signal, where the first driving voltage is configured to control the electromagnet to drive a guide wheel to move on a sliding rail, and a difference between the first driving voltage and a target voltage is not less than a first threshold, and where the target voltage refers to a driving voltage configured to overcome a maximum static friction force during controlling the electromagnet to drive the guide wheel to move on the sliding rail; and

[0013] the switching module is configured to:

[0014] determine whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to a first designated position on the sliding rail, and apply a second driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the first designated position, where the second driving voltage refers to another driving voltage configured to control the electromagnet to drive the guide wheel to move on the sliding rail, and the second driving voltage is not equal to the first driving voltage;

[0015] determine whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to a second designated position on the sliding rail, and apply a third driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the second designated position, where the second designated position refers to a preset dwelling position, under driving of the electromagnet, of the guide wheel on the sliding rail, and the third driving voltage is greater than the target voltage; and

[0016] determine whether applying of the third driving voltage meets a preset condition, and power off the electromagnet in response to the applying of the third driving voltage meeting the preset condition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] In order to illustrate the technical solutions in the embodiments of the present disclosure more clearly, the drawings involved in the embodiments will be briefly described below. It is obvious that the drawings mentioned in the following description are only some embodiments of the present disclosure. For those of ordinary skill in the art, other drawings may be obtained in accordance with these drawings without any inventive effort.

[0018] FIG. 1 is a schematic diagram of a structure of an overhead hoist vehicle used for steering guide according to some embodiments of the present disclosure.

[0019] FIG. 2 is a schematic diagram of a driving voltage applied during steering guide of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0020] FIG. 3 is a schematic diagram of steering positions of a guide wheel during steering guide of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0021] FIG. 4 is a schematic diagram of applied driving voltages in the method for controlling steering of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0022] FIG. 5 is a schematic diagram of positions of the guide wheel after applying the driving voltages in the method for controlling steering of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0023] FIG. 6 is a flowchart of the method for controlling steering of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0024] FIG. 7 is a structural schematic diagram of a mechanism for generating the driving voltages in the method for controlling steering of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0025] FIG. 8 is a structural schematic diagram of a system for controlling steering of the overhead hoist vehicle according to some embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0026] The following is detailed description of the embodiments of the present disclosure in conjunction with the accompanying drawings.

[0027] In the following, the embodiments of the present disclosure will be illustrated in detail using specific examples. Those skilled in the art can easily understand other advantages and benefits of the present disclosure according to the content disclosed in the present disclosure. Obviously, the described embodiments are only a part of the embodiments of the present disclosure, not all of them. The present disclosure may also be implemented or applied through different implementation methods, and the details in the present disclosure may be modified or changed based on different perspectives and applications without departing from the spirit of the present disclosure. It should be noted that, without conflict, the following embodiments and the features in the embodiments may be combined with each other. Based

on the embodiments of the present disclosure, other embodiments obtained by those skilled in the art without inventive efforts all fall within the scope of protection of the present disclosure.

[0028] It should be noted that various aspects of the embodiments falling within the scope of the attached claims are described below. It should be evident that the aspects described in the present disclosure may be embodied in a wide variety of forms, and any specific structures and/or functions described in the present disclosure are only illustrative. Based on the present disclosure, those skilled in the art should understand that one aspect described in the present disclosure may be implemented independent of any other aspect, and that two or more of these aspects may be combined in various ways. For example, any number and aspect described in the present disclosure may be used to implement the devices and/or practical methods. Moreover, other structures and/or functionalities other than one or more of the aspects described in the present disclosure may be used to implement the devices and/or practical methods.

[0029] It should further be noted that the diagrams mentioned in the following embodiments only illustrate the basic concept of the present disclosure in a schematic manner. The diagrams only illustrate the components related to the present disclosure and are not necessarily drawn according to the actual numbers, shapes, and sizes of the components in practice. The form, number, and scale of each component in practice may be arbitrarily changed, and the layout of the components may also be more complex.

[0030] Moreover, in the following description, specific details are provided to facilitate a thorough understanding of the examples. However, those skilled in the art shall understand that the described aspects can be implemented without these specific details. The terms “first”, “second”, or the like are only used for description and shall not be understood as indicating or implying relative importance or implying quantity of the described technical features. Therefore, a feature limited by “first”, “second”, or the like may explicitly or implicitly includes one or more features. In the description of the present disclosure, unless otherwise specified, “a plurality of” means two or more.

[0031] As shown in FIG. 1, steering of the overhead hoist vehicle 1 is guided by the overhead track 2, in other words, steering guide is implemented through the coordination of the guide wheel 11 of the overhead hoist vehicle 1 and the overhead track 2. When steering guide is required, the rotating electromagnet 13 in the overhead hoist vehicle 1 drives the lever 14, and the lever 14 in turn drives the guide wheel 11 to slide on the slide rail 17, thereby

implementing steering guide through the coordination of the guide wheel 11 and the overhead track 2.

[0032] It should be noted that the rotating electromagnet is a mechanism that can stop rotating after rotating to a fixed angle (such as 90 °) under driving of a voltage, and can return to an initial position by its own returning component after powering off. Therefore, the characteristics of the rotating electromagnet may be utilized to implement steering control of the overhead hoist vehicle during travelling at bends.

[0033] It should be noted that the rotation range of the rotating electromagnet may be detected by sensors 15 and 16 to prevent the rotation angle of the rotating electromagnet from exceeding the design range.

[0034] As shown in FIG. 2, in the control of the rotating electromagnet, in order to prevent excessive temperature rise caused by prolonged energization of the electromagnet, a fixed driving voltage U_0 is usually applied to the rotating electromagnet when a position of the rotating electromagnet is between a starting position A and a dwelling position B. When the rotating electromagnet turns to the dwelling position B, the driving voltage U_0 is immediately cut off.

[0035] However, in practical applications, it is found that the action of the rotating electromagnet is as shown in FIG. 3, that is, if the rotating electromagnet is immediately powered off upon reaching a designated position (i.e. the dwelling position B), a driving force acting on the rotating electromagnet disappears due to the power cut, and the rotating electromagnet rebounds due to reaction force originating from inertia. In other words, the rotating electromagnet would not stop at the dwelling position B due to the rebound, but stop at a final position B' after rebounding from the dwelling position B.

[0036] Therefore, when the rotating electromagnet rebounds and stops at the final position B', the rotating electromagnet drives the guide wheel to move back, causing the guide wheel of the overhead hoist vehicle to collide with the overhead track and even to be stuck, thereby seriously affecting the normal operation of the overhead hoist vehicle and reducing the handling efficiency of overhead hoist vehicles in the semiconductor plant.

[0037] Moreover, the driving voltage U_0 may be still applied after the rotating electromagnet reaches the dwelling position B, in order to make the rotating electromagnet to stay at the dwelling position B. However, in practice, it is found that the temperature rise of the

rotating electromagnet is too high due to prolonged application of the driving voltage U_0, which affects the operation stability, safety, reliability, and the like of the rotating electromagnet.

[0038] In view of this, after conducting in-depth research and improvement on the rotating electromagnet and steering control process, a new steering control solution is proposed: as shown in FIG. 4, different driving voltages are applied during operation of the rotating electromagnet between the starting position and the preset dwelling position. When the rotating electromagnet reaches the predetermined dwelling position, the rotating electromagnet is not immediately powered off, but is still applied with a keeping driving voltage and then powered off, in order to prevent excessive temperature rise caused by prolonged application of voltage. Moreover, the reaction force originating from inertia occurred after power outage can be overcome by continuously applying the keeping driving voltage, thereby preventing the rotating electromagnet from rebounding and not accurately staying at the preset position.

[0039] For example, as shown in FIGS. 4 and 5, a first driving voltage U_1 is applied to the rotating electromagnet when the position of the rotating electromagnet is between the starting position A and an intermediate position C, a second driving voltage U_2 is applied to the rotating electromagnet when the position of the rotating electromagnet is between the intermediate position C and the preset dwelling position B, and a third driving voltage U_3 is applied to the rotating electromagnet when the rotating electromagnet reaches the dwelling position B, and then power is cut off. In this way, under the action of the third driving voltage U_3, the rotating electromagnet overcomes the inertial reaction force caused by the power outage occurred at the dwelling position B. In other words, under the action of the third driving voltage U_3, the rotating electromagnet has a virtual anti-rebound position D (as shown in FIG. 5, where the shadow with dashed lines between B and D represents the virtual action distance generated by applying U_3 to the rotating electromagnet), in order to overcome the rebound caused by the inertial reaction force resulted from the power outage using the third driving voltage U_3, thereby enabling the rotating electromagnet to stay in the dwelling position B even being powered off.

[0040] It should be noted that the pairwise relationship among the first driving voltage U_1, second driving voltage U_2, and third driving voltage U_3 may be set according to actual conditions, such as U_1 being less than U_2, U_2 being greater than U_3, U_1 being greater than U_2, or U_2 being equal to U_3, and so on.

[0041] It should be noted that the above description is based on the movement positions to illustrate the rotation angles of the electromagnet, which will not be distinguished in the following description.

[0042] In the following, the technical solutions provided by embodiments of the present disclosure are described in conjunction with the accompanying drawings.

[0043] As shown in FIG. 6, the present disclosure provides embodiments of a method for controlling steering of an overhead hoist vehicle. The method may include:

[0044] At S202, the overhead hoist vehicle receives a steering control signal in real time during travelling along a track.

[0045] In some embodiments, a system for controlling steering receives the steering control signal in real time. The steering control signal may be a steering control command sent to the system for controlling steering when it is detected, by a real-time detection of travelling position, that a steering operation is needed during travelling of the overhead hoist vehicle along an overhead track. For example, the overhead hoist vehicle triggers and produce the steering control command in real time through detection markers arranged at the track, thereby enabling the system for controlling steering to perform steering control under the trigger of the command.

[0046] For example, when the overhead hoist vehicle needs to switch its travelling track due to the location of the clamped object and the target transport position not being arranged along a same track, the system for controlling steering may receive the steering control command at the switching point of the track, and then perform steering operations according to the steering control command.

[0047] In some embodiments, in order to prevent slow movement of the guide wheel on the sliding rail due to low driving voltage, and to prevent affecting the force of the electromagnet due to high driving voltage, a force that can move the guide wheel at a set speed on the sliding rail may be calculated and the required driving voltage may be determined based on the force.

[0048] For example, in view of the fact that only when the thrust is greater than the maximum static friction force, an object can be moved, a simple analysis shows that during the operation of the rotating electromagnet, the force required for movement of the guide wheel varies. The force required for the object to move at a constant speed, after starting of the movement, may be set as $F= \mu mg$ (where m represents the mass of the guide wheel assembly,

μ represents the coefficient of friction, g represents the acceleration of gravity), and it can be concluded that the force output by the electromagnet must be greater than F in order for the guide wheel to move. Because $P = \frac{W}{t} = UI$ and $P=FV$, then $FV=UI=\mu mgV$, and it can be concluded that $U=\frac{\mu mgV}{I}$, where V represents moving speed of the guide wheel assembly, I represents the current of the rotating electromagnet, and U represents the driving voltage.

[0049] Therefore, the electromagnet may operate in a corresponding current state by setting the driving voltage according to the need for moving speed. In other words, by operating the electromagnet in the corresponding current state, a corresponding torque may be obtained, and then the guide wheel may slide on the sliding rail at the preset moving speed under driving of the lever driven by the torque. In this way, the guide wheel can coordinate with the overhead guide track to implement steering guide.

[0050] At S204, it is determined whether steering control is needed, if yes, operation S206 is performed.

[0051] After being triggered by receiving the steering control command, the system for controlling steering may detect in real time whether steering control is needed and control the guide wheel in real time.

[0052] At S206, the first driving voltage is applied to the electromagnet. The first driving voltage is configured to control the electromagnet to drive the guide wheel to move on the sliding rail, and a difference between the first driving voltage and a target voltage is not less than a first threshold. The target voltage refers to a driving voltage configured to overcome a maximum static friction force during controlling the electromagnet to drive the guide wheel to move on the sliding rail.

[0053] In some embodiments, the first driving voltage is applied to the rotating electromagnet, and the rotating electromagnet drives, after being energized, the lever to move the guide wheel on the sliding rail, such that the guide wheel cooperates with the overhead guide track to implement turning guide, and the overhead hoist vehicle follows the track to travel at bends under the coordination and guide of the guide track and the guide wheel. During travelling at bends, the overhead hoist vehicle (or the system for controlling steering) still performs real-time detection of the travelling process, such as real-time detection of the position during travelling at bends, to determine an applying node of a next driving voltage.

[0054] At S208, it is determined whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to a first designated position on the sliding rail. If yes, operation S210 is performed; if no, go back to the operation S206 (i.e. keep applying the first driving voltage).

[0055] At S210, the second driving voltage is applied to the electromagnet. The second driving voltage refers to another driving voltage configured to control the electromagnet to drive the guide wheel to move on the sliding rail, and the second driving voltage is not equal to the first driving voltage.

[0056] In some embodiments, by using the second driving voltage different from the first driving voltage to drive the rotating electromagnet, the working voltage of the rotating electromagnet can be adjusted, in order to reduce the possibility of fast temperature rise due to applying a same driving voltage for a long time.

[0057] Correspondingly, during the application of the second driving voltage, that is, during travelling at bends, the overhead hoist vehicle (or the system for controlling steering) still performs real-time detection of the travel process, such as real-time detection of the position during travelling at bends, to determine an applying node of a next driving voltage.

[0058] At S212, it is determined whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to a second designated position on the sliding rail. If yes, operation S214 is performed; if no, go back to the operation S210 (i.e. keep applying the second driving voltage).

[0059] In some embodiments, the second designated position may refer to a preset dwelling position, under driving of the electromagnet, of the guide wheel on the sliding rail. It should be noted that the dwelling position may be a temporary stopping position. For example, a reversing point in reversing process on the track, a midpoint of a semi-circular bend, or the like. The second designated position may be designated according to actual situations, and will not be limited in detail herein.

[0060] At S214, a third driving voltage is applied to the electromagnet. The third driving voltage is greater than the target voltage.

[0061] In some embodiments, by applying the third driving voltage, the inertial reaction force caused by the power outage of the rotating electromagnet can be overcome, so that the rotating electromagnet can still accurately stay at the designated dwelling position under the driving of the third driving voltage. Correspondingly, during application of the third

driving voltage, the power outage timing may be detected in real time, i.e. performing operation S216.

[0062] At S216, it is determined whether applying of the third driving voltage meets a preset condition. If yes, operation S218 is performed. It should be noted that the preset condition may be the duration of applying the third drive voltage, or the real-time position condition of the overhead hoist vehicle during travelling at bends.

[0063] At S218, the electromagnet is powered off. By powering off after reaching the designated position under cooperation and guide of the guide wheel and the guide track, steering guide under cooperation of the guide wheel and the guide track is still possible due to driving of the lever by the returning mechanism in the electromagnet.

[0064] With the above operations S202 to S218, different driving voltages are applied to the rotating electromagnet during turning control, such that the rotating electromagnet operates under different driving voltages. After the rotating electromagnet reaches the specified rotation angle, a driving voltage is still applied. In this way, not only rapid temperature rise due to prolonged application of high driving voltage, but also failure of accurate arrival at the designated position due to the reaction force originating from inertia occurred after powering off the rotating electromagnet can be prevented. Therefore, the operation stability, safety, and reliability of the electromagnet, and the steering stability and reliability of the overhead hoist vehicle can be improved, thereby improving the efficiency of passing through bends, which is conducive to improving the handling efficiency of wafer pods in the semiconductor plant, thereby improving the production efficiency of the semiconductor plant.

[0065] In some embodiments, the second driving voltage may be equal to or different from the third driving voltage.

[0066] In some embodiments, the second driving voltage may be set to be lower than the first driving voltage. In this way, the prolonged high-power state of the rotating electromagnet can be prevented, thereby reducing the temperature rise and decreasing rising speed of temperature.

[0067] In some embodiments, the second driving voltage may be set to be equal to the third driving voltage. In this way, the overall design scheme for the driving voltages can be simplified.

[0068] In some embodiments, corresponding driving voltages may be provided to the rotating electromagnet by a voltage conversion circuit, an output control circuit, or the like.

[0069] In some embodiments, a voltage regulator is used to regulate a system voltage to obtain one or more of the first driving voltage, the second driving voltage, and the third driving voltage.

[0070] In some embodiments, driving voltages may be applied to the rotating electromagnet using relays. For example, applying the first driving voltage to the electromagnet includes: applying the first driving voltage to the electromagnet using a first solid-state relay; and/or applying the second driving voltage to the electromagnet includes: applying the second driving voltage to the electromagnet using a second solid-state relay; and/or applying the third driving voltage to the electromagnet includes: applying the third driving voltage to the electromagnet using a third solid-state relay.

[0071] It should be noted that relays may be relays having a single group of contacts or relays having a plurality of groups contacts.

[0072] As shown in FIG. 7, one or more preset voltages of power supply are individually regulated by a voltage regulator are used, to output the corresponding regulated first drive voltage, second drive voltage, and third drive voltage.

[0073] In some embodiments, the driving voltages may be applied to the rotating electromagnet through relays. In this case, a respective driving voltage may be applied to the rotating electromagnet by controlling a relay corresponding to the respective driving voltage to turn on or turn off. For example, the first driving voltage is applied to the rotating electromagnet through solid-state relay 1, and the second driving voltage is applied to the rotating electromagnet through solid-state relay 2.

[0074] In the above-mentioned example, the first driving voltage is used to move the guide wheel, against the static friction force, from position A to position C on the sliding rail. That is, when the overhead hoist vehicle reaches the position for switching track, the programmable logic controller (PLC) sends commands to turn on the solid-state relay 1, and the electromagnet rotates under action of the first driving voltage. When the electromagnet reaches position C, the PLC sends a command to turn off the solid-state relay 1 and turn on the solid-state relay 2, thereby using the second driving voltage to move the guide wheel, at a constant speed, to the designated position B on the sliding rail, and then the second driving voltage is maintained for a period of time before powering off (for example until reaching position D). In this way, the electromagnet can be prevented from rebounding due to the

reaction force, thereby preventing the handling operation from being affected due to unstable travelling or even malfunction of the overhead hoist vehicle.

[0075] In some embodiments, whether moving to the designated positions may be quickly and accurately determined by using a timer to calculate durations.

[0076] For example, determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail, includes: a first applying duration of the first driving voltage is acquired, and it is determined whether the first applying duration is greater than or equal to a first preset duration, in order to determine whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail.

[0077] It should be noted that the first applying duration may be determined depending on on-site debugging data in practical applications, and subsequent adjustments may be made based on experience data obtained in actual operation.

[0078] For example, determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail, includes: a second applying duration of the second driving voltage is acquired, and it is determined whether the second applying duration is greater than or equal to a second preset duration, in order to determine whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail.

[0079] For example, determining whether applying of the third driving voltage meets the preset condition, includes: a third applying duration of the third driving voltage is acquired, and it is determined whether the third applying duration is greater than or equal to a third preset duration, in order to determine whether applying of the third driving voltage meets the preset condition.

[0080] It should be noted that the first applying duration and/or the second applying duration and/or the third applying duration may be determined according to preset values, or may be set according to the experience data summarized during debugging in actual applications.

[0081] For example, the first applying duration may account for 20% of the total time, that is, the duration of the first driving voltage may account for approximately 20% of the total time.

[0082] For example, the second applying duration may account for 70% of the total time, that is, the duration of the second driving voltage may account for approximately 70% of the total time.

[0083] For example, the third applying duration may account for 10% of the total time, that is, the duration of the third driving voltage may account for approximately 10% of the total time.

[0084] In practice, according to the requirements of steering control, the durations of different driving voltages can be assigned more reasonably by setting the duration corresponding to different driving voltages. In this way, the temperature rise of the rotating electromagnet can be effectively reduced, thereby improving stability, safety, and reliability of the rotating electromagnet during steering control.

[0085] In some embodiments, whether moving to the designated positions may be determined by performing detections using sensors.

[0086] In some embodiments, determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail, includes: a first sensing signal is acquired from a first sensor, and it is determined whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail according to the first sensing signal. The first sensor is configured to detect a moving position of the guide wheel on the sliding rail.

[0087] In practice, the first sensor may be arranged at different positions for detection according to actual application needs, and the arrangement positions will not be described in detail here.

[0088] For example, the first sensor is arranged on a lateral surface of the sliding rail, and when the guide wheel passes the arrangement position of the first sensor, the first sensor is triggered to output a result of detection.

[0089] For example, the first sensor is arranged in the vicinity of the lever and configured to detect a moving position of the lever, and the first sensor may be triggered to output a result of detection by detecting the moving positions of the lever.

[0090] In practice, the first sensor may be selected according to actual application needs, and the model of the first sensor will not be described in detail here.

[0091] For example, the first sensor may be a photoelectric sensor, such as a sensor that can emit and receive infrared light. When the object to be detected (such as the guide wheel, the lever, or the like) blocks the detection signal of the photoelectric sensor, the sensor outputs a result of detection.

[0092] For example, the first sensor may be a reader for reading identification, such as a barcode reader. When the object to be detected (such as the guide wheel, the lever, or the like) passes the arrangement position of the reader, the reader reads the corresponding barcode identification, and then outputs a result of detection.

[0093] In some embodiments, determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail, includes: a second sensing signal is acquired from a second sensor, and it is determined whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail according to the second sensing signal. The second sensor is configured to detect another moving position of the guide wheel on the sliding rail.

[0094] Correspondingly, similar to the above example of the first sensor, the arrangement, model, or the like of the second sensor may be determined according to actual application needs, and will not be described in detail here.

[0095] Based on the same invention concept, the present disclosure further provides a system for controlling steering of an overhead hoist vehicle, applicable to the overhead hoist vehicle in a semiconductor automation plant. The system for controlling steering is configured to perform the operations of the method for controlling steering described in any of the above embodiments. In this way, when the overhead hoist vehicle needs steering control, efficient and orderly steering can be implemented.

[0096] As shown in FIG. 8, the system 2000 for controlling steering of the overhead hoist vehicle may include: an activating module 2020 and a switching module 2040.

[0097] In some embodiments, the activating module 2020 is configured to: apply a first driving voltage to an electromagnet in response to receiving a steering control signal. The first driving voltage is configured to control the electromagnet to drive a guide wheel to move on a sliding rail, and a difference between the first driving voltage and a target voltage is not less than a first threshold. The target voltage refers to a driving voltage configured to overcome a

maximum static friction force during controlling the electromagnet to drive the guide wheel to move on the sliding rail.

[0098] The switching module 2040 is configured to:

[0099] determine whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to a first designated position on the sliding rail, and apply a second driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the first designated position, where the second driving voltage refers to another driving voltage configured to control the electromagnet to drive the guide wheel to move on the sliding rail at a first preset velocity, and the second driving voltage is not equal to the first driving voltage;

[0100] determine whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to a second designated position on the sliding rail, and apply a third driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the second designated position, where the second designated position refers to a preset dwelling position, under driving of the electromagnet, of the guide wheel on the sliding rail, and the third driving voltage is greater than the target voltage; and

[0101] determine whether applying of the third driving voltage meets a preset condition, and power off the electromagnet in response to the applying of the third driving voltage meeting the preset condition.

[0102] By providing the activating module and the switching module in control system, operation of the rotating electromagnet can be rapidly and accurately controlled when steering control is needed, and the rotating electromagnet drives the lever, the lever in turn drives the guide wheel to move on the sliding rail, such that the guide wheel cooperates with overhead steering track to guide steering of the overhead hoist vehicle during travelling at bends. By applying different driving voltages to the electromagnet in different moving sections of the guide wheel, not only rapid and high temperature rise of the electromagnet due to prolonged application of driving voltage, but also collision between the guide wheel and the steering guide track or even jamming of the guide wheel due to rebounding after powering off the electromagnet can be prevented. In this way, the operation stability, safety, and reliability of the overhead hoist vehicle during steering can be improved, thereby improving the handling efficiency of wafer pods, and improving the automatic production efficiency of the semiconductor.

[0103] In some embodiments, the system for controlling steering of the overhead hoist vehicle further includes a voltage regulator (not shown) configured to regulate a system voltage to obtain one or more of the first driving voltage, the second driving voltage, and the third driving voltage.

[0104] In some embodiments, the system for controlling steering of the overhead hoist vehicle further includes one or more solid-state relays (not shown) configured to switch and apply one or more driving voltages obtained by regulation of the system voltage by the voltage regulator to the electromagnet.

[0105] In some embodiments, the system for controlling steering of the overhead hoist vehicle further includes a timer (not shown) configured to acquire one or more of a first preset duration, a second preset duration, and a third preset duration. The first preset duration refers to an applying duration of the first driving voltage, the second preset duration refers to an applying duration of the second driving voltage, and the third preset duration refers to an applying duration of the third driving voltage.

[0106] In some embodiments, the system for controlling steering of the overhead hoist vehicle further includes a first sensor and/or a second sensor. The first sensor is configured to detect a moving position of the guide wheel on the sliding rail, and the second sensor is configured to detect another moving position of the guide wheel on the sliding rail.

[0107] In some embodiments, the switching module includes a PLC (not shown). In practice, the PLC may be disposed in the overhead hoist vehicle, in order to simplify overall structure of the system.

[0108] The embodiments of the present disclosure are described in a progressive manner, and the same and similar parts between each embodiment may be referred to each other. Each embodiment focuses on describing the differences from other embodiments. Especially for the method embodiments described later, as they correspond to the system, the description is relatively simple, and reference may be made to the description of the system embodiments for relevant details.

[0109] The above are only the specific embodiments of the present disclosure, but the scope of protection of the present disclosure is not limited to this. Any changes or replacements that are easily conceivable to those skilled in the art within the scope of disclosure of the present disclosure shall fall within the scope of protection of the present disclosure. Therefore, the

protection scope of the present disclosure should be determined by the protection scope of the claims.

CLAIMS

1. A method for controlling steering of an overhead hoist vehicle, comprising:

applying a first driving voltage to an electromagnet in response to receiving a steering control signal, wherein the first driving voltage is configured to control the electromagnet to drive a guide wheel to move on a sliding rail, and a difference between the first driving voltage and a target voltage is not less than a first threshold, and wherein the target voltage refers to a driving voltage configured to overcome a maximum static friction force during controlling the electromagnet to drive the guide wheel to move on the sliding rail;

determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to a first designated position on the sliding rail, and applying a second driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the first designated position, wherein the second driving voltage refers to another driving voltage configured to control the electromagnet to drive the guide wheel to move on the sliding rail, and the second driving voltage is not equal to the first driving voltage;

determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to a second designated position on the sliding rail, and applying a third driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the second designated position, wherein the second designated position refers to a preset dwelling position, under driving of the electromagnet, of the guide wheel on the sliding rail, and the third driving voltage is greater than the target voltage; and

determining whether applying of the third driving voltage meets a preset condition, and powering off the electromagnet in response to the applying of the third driving voltage meeting the preset condition.

2. The method according to claim 1, wherein the second driving voltage is less than the first driving voltage; and/or

wherein the third driving voltage is equal to the second driving voltage.

3. The method according to claim 1, wherein determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail, includes:

acquiring a first applying duration of the first driving voltage; and

determining whether the first applying duration is greater than or equal to a first preset duration, and determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail.

4. The method according to claim 1, wherein determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail, includes:

acquiring a second applying duration of the second driving voltage; and

determining whether the second applying duration is greater than or equal to a second preset duration, and determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail.

5. The method according to claim 1, wherein determining whether applying of the third driving voltage meets the preset condition, includes:

acquiring a third applying duration of the third driving voltage; and

determining whether the third applying duration is greater than or equal to a third preset duration, and determining whether applying of the third driving voltage meets the preset condition.

6. The method according to claim 1, further including:

regulating a system voltage using a voltage regulator to obtain one or more of the first driving voltage, the second driving voltage, and the third driving voltage.

7. The method according to claim 1, wherein determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail, includes:

acquiring a first sensing signal from a first sensor; and

determining whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail according to the first sensing signal, wherein the first sensor is configured to detect a moving position of the guide wheel on the sliding rail; and/or

determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail, includes:

acquiring a second sensing signal from a second sensor; and

determining whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail according to the second sensing signal, wherein the second sensor is configured to detect another moving position of the guide wheel on the sliding rail.

8. The method according to any one of claims 1 to 7, wherein applying the first driving voltage to the electromagnet, includes: applying the first driving voltage to the electromagnet using a first solid-state relay; and/or

applying the second driving voltage to the electromagnet, includes: applying the second driving voltage to the electromagnet using a second solid-state relay; and/or

applying the third driving voltage to the electromagnet, includes: applying the third driving voltage to the electromagnet using a third solid-state relay.

9. A system for controlling steering of an overhead hoist vehicle, comprising: an activating module and a switching module;

wherein the activating module is configured to: apply a first driving voltage to an electromagnet in response to receiving a steering control signal, wherein the first driving voltage is configured to control the electromagnet to drive a guide wheel to move on a sliding rail, and a difference between the first driving voltage and a target voltage is not less than a first threshold, and wherein the target voltage refers to a driving voltage configured to overcome a maximum static friction force during controlling the electromagnet to drive the guide wheel to move on the sliding rail; and

wherein the switching module is configured to:

determine whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to a first designated position on the sliding rail, and apply a second driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the first designated position, wherein the second driving voltage refers to another driving voltage configured to control the electromagnet to drive the guide wheel to move on the sliding rail at a first preset velocity, and the second driving voltage is not equal to the first driving voltage;

determine whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to a second designated position on the sliding rail, and apply a third driving voltage to the electromagnet in response to the electromagnet driving the guide wheel to the second designated position, wherein the second designated position refers to a preset

dwelling position, under driving of the electromagnet, of the guide wheel on the sliding rail, and the third driving voltage is greater than the target voltage; and

determine whether applying of the third driving voltage meets a preset condition, and power off the electromagnet in response to the applying of the third driving voltage meeting the preset condition.

10. The system according to claim 9, further including a voltage regulator configured to regulate a system voltage to obtain one or more of the first driving voltage, the second driving voltage, and the third driving voltage.

11. The system according to claim 10, further including one or more solid-state relays configured to switch and apply one or more driving voltages obtained by regulation of the system voltage by the voltage regulator to the electromagnet.

12. The system according to claim 9, further including a timer configured to acquire one or more of a first preset duration, a second preset duration, and a third preset duration;

wherein the first preset duration refers to an applying duration of the first driving voltage, the second preset duration refers to an applying duration of the second driving voltage, and the third preset duration refers to an applying duration of the third driving voltage.

13. The system according to claim 9, further including a first sensor and/or a second sensor;

wherein the first sensor is configured to detect a moving position of the guide wheel on the sliding rail, and the second sensor is configured to detect another moving position of the guide wheel on the sliding rail.

14. The system according to any one of claims 9 to 13, wherein the switching module includes a programmable logic controller.

15. The system according to any one of claims 9 to 14, wherein the second driving voltage is less than the first driving voltage; and/or

wherein the third driving voltage is equal to the second driving voltage.

16. The system according to claim 13, wherein the switching module is further configured to:

acquire a first sensing signal from the first sensor; and

determine whether the electromagnet drives, under controlling of the first driving voltage, the guide wheel to the first designated position on the sliding rail according to the first sensing signal; and/or

acquire a second sensing signal from the second sensor; and

determine whether the electromagnet drives, under controlling of the second driving voltage, the guide wheel to the second designated position on the sliding rail according to the second sensing signal.

17. The system according to claim 11, wherein the activating module is configured to apply the first driving voltage to the electromagnet using a first solid-state relay; and

wherein the switching module is further configured to:

apply the second driving voltage to the electromagnet using a second solid-state relay; and/or

apply the third driving voltage to the electromagnet using a third solid-state relay.

ABSTRACT OF THE DISCLOSURE

The present disclosure provides a method and a system for controlling steering of an overhead hoist vehicle, applicable to the field of manufacturing equipment for semiconductor wafers. The method for controlling steering of the overhead hoist vehicle includes: when steering control is needed, a first driving voltage is applied to an electromagnet configured for controlling and guiding of steering, and the electromagnet drives a guide wheel to move on a sliding rail, in order to cooperate with an overhead guide track to guide steering; when the guide wheel moves to a first designated position on the sliding rail, a second driving voltage is applied to the electromagnet, and when the guide wheel moves to a second designated position on the sliding rail, a third driving voltage is applied to the electromagnet, and then the electromagnet is powered off. By applying different driving voltages to the rotating electromagnet, the rotating electromagnet can be in different working states during steering control, thereby effectively improving control of the temperature rise of the electromagnet and preventing the coordination between the guide wheel and the overhead guide track from being affected by rebounding of the electromagnet due to power outage.

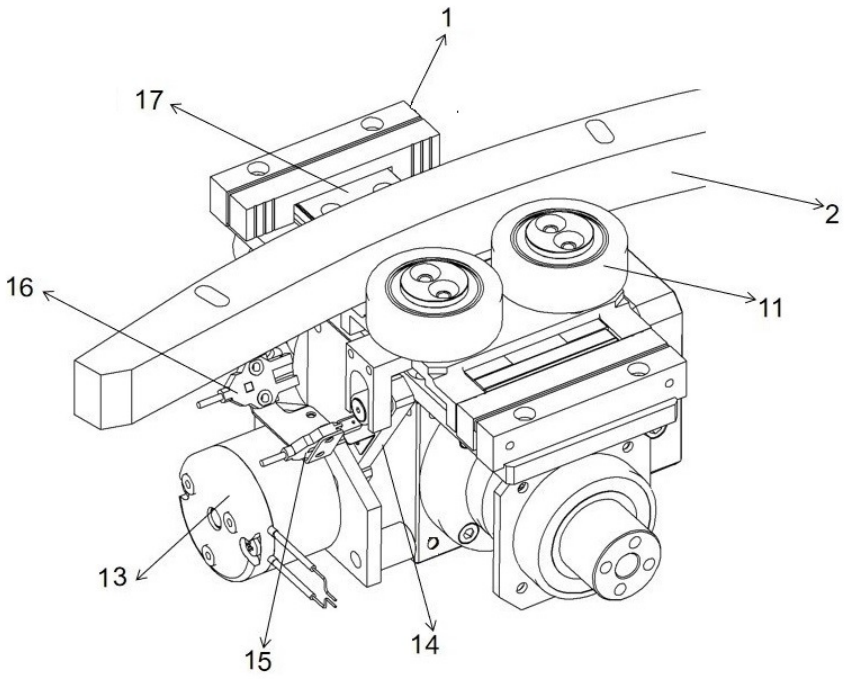


FIG. 1

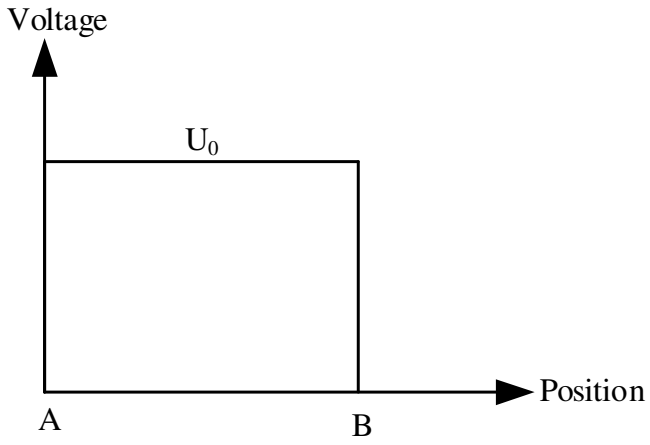


FIG. 2

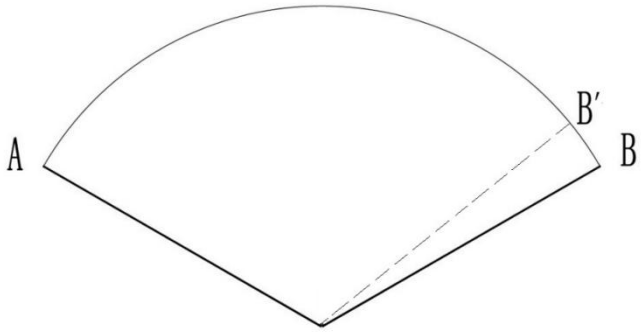


FIG. 3

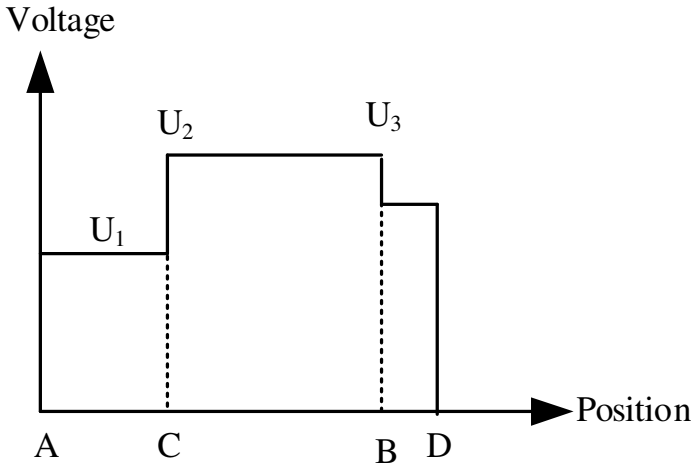


FIG. 4

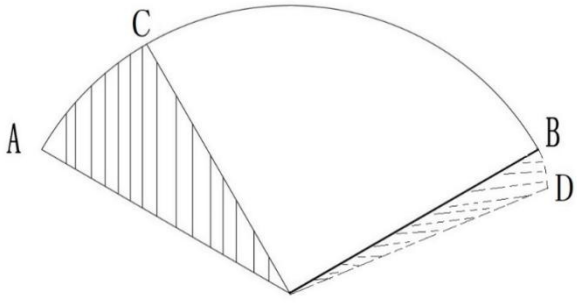


FIG. 5

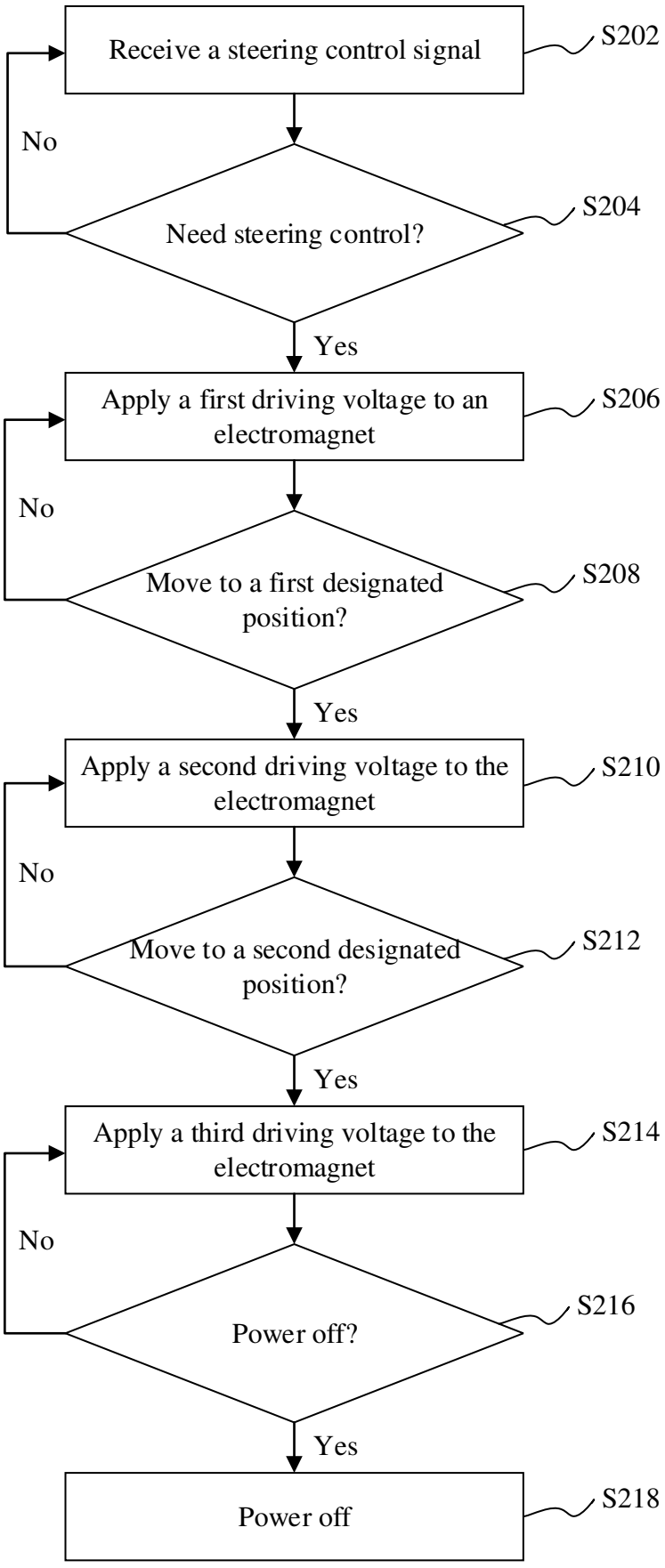

Receive a steering control signal
S202
No
Need steering control?
S204
Yes
Apply a first driving voltage to an electromagnet
S206
No
Move to a first designated position?
S208
Yes
Apply a second driving voltage to the electromagnet
S210
No
Move to a second designated position?
S212
Yes
Apply a third driving voltage to the electromagnet
S214
No
Power off?
S216
Yes
Power off
S218

FIG. 6

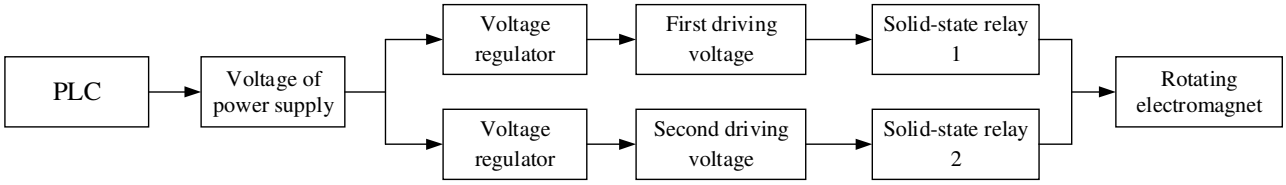

PLC
Voltage of power supply
Voltage regulator
First driving voltage
Solid-state relay 1
Voltage regulator
Second driving voltage
Solid-state relay 2
Rotating electromagnet

FIG. 7

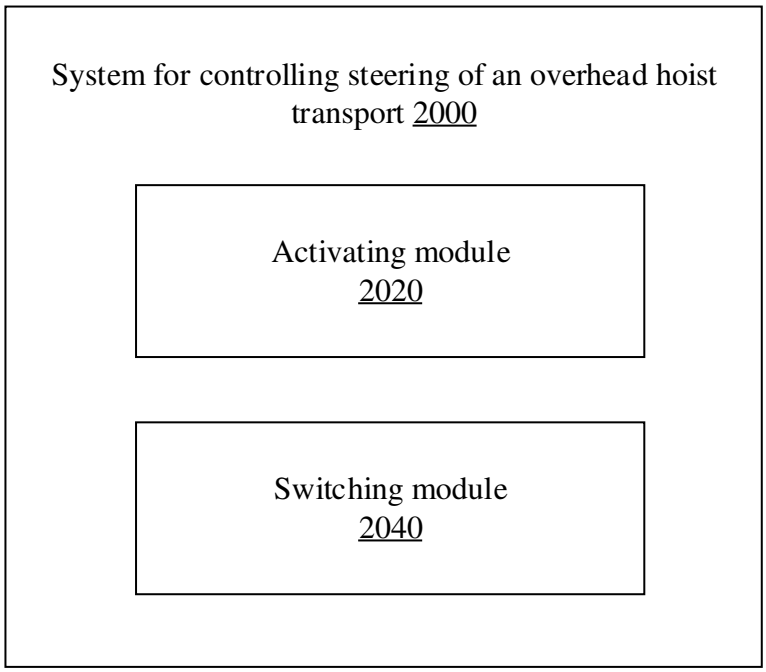

System for controlling steering of an overhead hoist transport 2000
Activating module 2020
Switching module 2040

FIG. 8