

{DESCRIPTION}

{Title of Invention}

MECHANICAL PARKING APPARATUS AND POWER SUPPLYING METHOD FOR
MECHANICAL PARKING APPARATUS

{Technical Field}

{0001}

The present invention relates to a mechanical parking apparatus and a power supplying method for a mechanical parking apparatus.

{Background Art}

{0002}

In the related art, mechanical parking apparatuses (so-called multistory parking apparatuses) in which vehicles are moved in the up/down direction when storing/removing them in/from parking lots have been developed. Such mechanical parking apparatuses include ones in which electrical power generated by using solar cells is utilized to drive various motors and so forth.

For example, Patent Literature 1 discloses a mechanical parking apparatus in which solar cells that convert solar-light energy to electrical energy are provided on the external walls of a parking tower that stores vehicles, a charging device that stores the converted electrical energy is connected to a controller and driving motors, and the controller and the driving motors are driven and controlled by

means of that electrical energy.

{0003}

In addition, Patent Literature 2 discloses a mechanical parking apparatus in which a solar power unit that converts solar-light energy to electrical energy is provided on the external wall of a parking tower provided with a plurality of parking portions that store vehicles, a power storage device is connected to the solar power unit, the power storage device is connected to a controller and driving motors, and the controller and the driving motors are driven and controlled by means of that electrical energy.

{Citation List}

{Patent Literature}

{0004}

{PTL 1} Publication of Japanese Examined Utility Model
Registration No. 2565941

{PTL 2} Japanese Unexamined Utility Model Application,
Publication No. Hei 5-62667

{Summary of Invention}

{Technical Problem}

{0005}

In general, because solar cells provided in mechanical parking apparatuses are interconnected with a power grid, DC power is converted to AC power. Because of this, DC power generated by solar cells is utilized to drive electric power

loads such as motors and so forth provided in mechanical parking apparatuses after being converted to AC power and converted again to DC power.

Utilizing DC power generated by solar cells by converting it to AC power and subsequently converting it again to DC power in this way involves conversion loss each time conversion is performed, and therefore, the overall efficiency is decreased, and it is not economical.

{0006}

In addition, in the case in which a mechanical parking apparatus can transmit electrical power generated by solar cells to the power grid as AC power and can supply this generated power to electric power loads as DC power, when the DC power is supplied to the electric power load, voltage fluctuations caused by doing so may affect the power grid.

For example, in the case in which a DC line of a power conditioner is connected to a power-source line of an inverter and the DC power from the power conditioner is supplied to the electric power loads via the inverter, voltage fluctuations caused by noise or the like generated by the inverter and the electric power loads (motors and so forth) may affect the power grid via the DC line and the power conditioner. In addition, it may not be possible to operate an IGBT for power generation due to such voltage fluctuations.

{0007}

The present invention has been made in light of the above-described circumstances, and an object thereof is to provide a mechanical parking apparatus and a power supplying method for a mechanical parking apparatus with which electrical power generated by solar cells can efficiently be utilized.

{Solution to Problem}

{0008}

In order to solve the problems described above, a mechanical parking apparatus and a power supplying method for a mechanical parking apparatus of the present invention employ the following solutions.

{0009}

A mechanical parking apparatus according to a first aspect of the present invention includes a solar cell that converts solar light to electrical power; an electric power load that utilizes DC power; and a power conditioner that outputs electrical power generated by the solar cell as AC power and DC power, wherein the DC power output from the power conditioner is supplied to the electric power load, and the AC power output from the power conditioner is transmitted to a power grid.

{0010}

With this configuration, the mechanical parking apparatus is provided with the solar cell that converts solar light to

electrical power, the electric power load that utilizes DC power, and the power conditioner that outputs the electrical power generated by the solar cell as AC power and DC power. The electric power load that utilizes the DC power is, for example, a raising/lowering motor for raising/lowering a pallet, on which a vehicle is placed, between an entry level and a storage level, a turning motor for turning the pallet, or the like.

{0011}

In the related art, electrical power generated by a solar cell is converted from DC power to AC power temporarily, it is subsequently converted again to DC power, and then, the electrical power is supplied to an electric power load that utilizes DC power. However, because such a method involves conversion loss each time conversion is performed, the overall efficiency is decreased, and it is not economical.

{0012}

Therefore, the power conditioner outputs the electrical power generated by the solar cell as AC power and DC power. Then, this DC power is directly supplied to the electric power load that utilizes the DC power.

Specifically, the DC power is output from the power conditioner to be directly supplied to the electric power load, and thus, the electrical power generated by the solar cell is supplied to the electric power load without causing

conversion loss. In addition, because it is also possible to output AC power from the power conditioner, electrical power generated by the solar cell that is not consumed at the electric power load can also be transmitted to the power grid (to be sold). Therefore, with this configuration, it is possible to efficiently utilize electrical power generated by the solar cell.

{0013}

In the first aspect described above, it is preferable that a voltage of the DC power output from the power conditioner be set to be equal to a predetermined value, and that the AC power output from the power conditioner be set to be equal to a difference between the DC power output from the power conditioner and electrical power generated by the solar cell.

{0014}

With this configuration, the voltage of the DC power output from the power conditioner is set to be equal to the predetermined value. This predetermined value is set in advance in accordance with DC power to be utilized by the electric power load; in other words, the power conditioner does not output DC power whose voltage exceeds this predetermined value. On the other hand, AC power output from the power conditioner is set to be equal to the difference between the DC power output from the power conditioner and the

electrical power generated by the solar cell. Specifically, when electrical power consumed at the electric power load is equal to or greater than the electrical power generated by the solar cell, the electrical power generated by the solar cell is not transmitted to the power grid. On the other hand, when the electrical power consumed at the electric power load is less than the electrical power generated by the solar cell, AC power in accordance with the above-described difference is transmitted to the power grid.

With this configuration, because the power conditioner preferentially outputs DC power rather than AC power in this way, it is possible to make the electric power load preferentially consume the electrical power generated by the solar cell.

{0015}

In the first aspect described above, it is preferable that the predetermined value be greater than a voltage of DC power that is converted from the power grid and that is supplied to the electric power load.

{0016}

With this configuration, because the voltage of DC power output from the power conditioner is greater than the voltage of DC power converted from the power grid, the electric power load preferentially consumes the electrical power generated by the solar cell rather than the electrical power supplied from

the power grid.

Note that, when the electrical power generated by the solar cell drops below that electrical power consumed at the electric power load, because the voltage of the DC power output from the power conditioner becomes lower than the voltage of the DC power that is converted and supplied from the power grid, the electric power load also utilizes the electrical power supplied from the power grid.

{0017}

It is preferable that the first aspect described above be provided with a secondary battery into which the DC power output from the power conditioner is charged, and that the electric power load utilize electrical power discharged from the secondary battery.

{0018}

With this configuration, the DC power output from the power conditioner is charged into the secondary battery. With the solar cell, generated power fluctuates depending on the weather and time of day. In addition, if the secondary battery is not provided, because the electrical power generated by the solar cell must be utilized at the same time as electrical power is generated, this electrical power can be utilized only to assist the motor-running operation of the electric power load, and it is not possible to effectively utilize the electrical power for cutting peak electricity

demand or the like with respect to the electrical power supplied from the power grid. Accordingly, with this configuration, because the electrical power generated by the solar cell is not converted to AC power, this electrical power is directly charged into the secondary battery as DC power, and electrical power discharged from the secondary battery is utilized in the motor-running operation of the electric power load, it is possible to effectively reduce the electrical power supplied from the power grid.

{0019}

It is preferable that the first aspect described above be provided with an estimating means for estimating electrical power generated by the solar cell and a secondary-battery controlling means for charging the secondary battery within a range of the generated electrical power estimated by the estimating means.

{0020}

With this configuration, because the secondary battery is charged within the range of electrical power generated by the solar cell, it is possible to prevent the secondary battery from being charged by the electrical power supplied from the power grid.

{0021}

It is preferable that the first aspect described above be provided with a converting means for converting DC power to AC

power, and that, in the case in which power supply from the power grid is stopped, the DC power output from at least one of the solar cell and the secondary battery be supplied to the electric power load that utilizes DC power, and the AC power converted by the converting means be supplied to the electric power load that utilizes AC power.

{0022}

With this configuration, DC power is converted to AC power by the converting means. This DC power includes DC power output from the solar cell and the secondary battery, as well as regenerated power. Then, in the case in which the power supply from the power grid is stopped, that is, in the case in which a power outage or the like occurs, DC power that is output from at least one of the solar cell and the secondary battery is supplied to the electric power load that utilizes the DC power, and AC power converted by the converting means is supplied to the electric power load that utilizes the AC power. Therefore, with this configuration, it is possible to operate the electric power load that utilizes AC power even if power supply from the power grid is stopped.

{0023}

In the first aspect described above, it is preferable that the secondary-battery controlling means make the secondary battery discharge electrical power equal to the difference between the electrical power generated by the solar

cell and the electrical power utilized by the electric power load.

{0024}

With this configuration, because the electrical power discharged from the secondary battery by means of the secondary-battery controlling means is equal to the difference between the electrical power generated by the solar cell and the electrical power utilized by the electric power load, it is possible to stably supply electrical power to the electric power load even if the electrical power generated by the solar cell fluctuates due to the weather and time of day.

{0025}

In the first aspect described above, it is preferable that the electric power load that utilizes AC power include a charging device for charging a secondary battery provided in an electric vehicle.

{0026}

With this configuration, it is possible to charge an electric vehicle even if the power supply from the power grid is stopped.

{0027}

A mechanical parking apparatus according to a second aspect of the present invention includes a solar cell that converts solar light to electrical power; an electric power load that utilizes DC power; and a power conditioner that

transmits electrical power generated by the solar cell to a power grid as AC power and that supplies this generated electrical power to the electric power load as DC power, wherein the transmission of the AC power from the power conditioner to the power grid is interrupted while the DC power is being supplied to the electric power load from the power conditioner.

{0028}

With this configuration, the mechanical parking apparatus is provided with the solar cell that converts solar light to electrical power, the electric power load that utilizes DC power, and the power conditioner that transmits the electrical power generated by the solar cell to the power grid as AC power and that supplies this generated power to the electric power load as DC power.

Also, AC power is not transmitted to the power grid from the power conditioner while the DC power is being supplied to the electric power load from the power conditioner. Note that, in order not to transmit the AC power to the power grid from the power conditioner, for example, the connection between the power conditioner and the power grid is cut.

By doing so, even in the case in which the electrical power generated by the solar cell can be transmitted to the power grid as AC power and this generated power can be supplied to the electric power load as DC power, it is

possible to prevent the influence of supplying DC power to the electric power load from spreading to the power grid.

{0029}

As described above, with this configuration, even in the case in which the electrical power generated by the solar cell can be transmitted to the power grid as AC power and this generated power can be supplied to the electric power load as DC power, it is possible to prevent the influence of supplying DC power to the electric power load from spreading to the power grid. Therefore, with this configuration, it is possible to efficiently utilize the electrical power generated by the solar cell.

{0030}

In the second aspect described above, it is preferable that the DC power be supplied to the electric power load from the power conditioner in the case in which the electric power load consumes electrical power, and that the AC power be transmitted to the power grid from the power conditioner in the case in which the electric power load does not consume electrical power.

{0031}

With this configuration, because the electrical power generated by the solar cell is consumed at the electric power load but the generated power is transmitted to the power grid when the generated power is not consumed at the electric power

load, it is possible to efficiently utilize the electrical power generated by the solar cell.

{0032}

In the second aspect described above, it is preferable that, in the case in which the electric power load is regenerating electrical power, the AC power be transmitted to the power grid from the power conditioner, and the electrical power regenerated by the electric power load be also transmitted to the power grid.

{0033}

With this configuration, because it is not necessary to consume the regenerated power by means of a resistance, it is possible to utilize the regenerated power together with the electrical power generated by the solar cell.

{0034}

It is preferable that the second aspect described above be provided with a secondary battery into which at least one of the DC power output from the power conditioner and the electrical power regenerated by the electric power load is charged, and that the electrical power charged into the secondary battery be utilized for power consumption at the electric power load.

{0035}

With this configuration, DC power output from the power conditioner is charged into the secondary battery. With the

solar cell, generated power fluctuates depending on the weather and time of day. In addition, if the secondary battery is not provided, because the electrical power generated by the solar cell must be utilized at the same time as electrical power is generated, this electrical power can be utilized only to assist the motor-running operation of the electric power load, and it is not possible to effectively utilize the electrical power for cutting peak electricity demand or the like with respect to the electrical power supplied from the power grid. Accordingly, with this configuration, the electrical power generated by the solar cell is not converted to AC power and is directly charged into the secondary battery as DC power, and thus, it is possible to more effectively utilize the electrical power generated by the solar cell.

{0036}

In the second aspect described above, it is preferable that, in the case in which the electric power load consumes electrical power, the electrical power charged into the secondary battery be supplied to the electric power load and, also, that the electrical power generated by the solar cell be transmitted to the power grid.

{0037}

With this configuration, it is possible to achieve utilization of the electrical power charged into the secondary

battery and utilization of the electrical power generated by the solar cell at the same time.

{0038}

In the second aspect described above, it is preferable that, in the case in which the electric power load regenerates electrical power, the regenerated power be charged into the secondary battery and, also, that the electrical power generated by the solar cell be transmitted to the power grid.

{0039}

With this configuration, it is possible to achieve charging of the secondary battery with the regenerated power and utilization of the electrical power generated by the solar cell at the same time.

{0040}

In the second aspect described above, it is preferable that the electrical power charged into the secondary battery can be transmitted to the power grid via the power conditioner.

{0041}

With this configuration, because the electrical power charged into the secondary battery is not only utilized by the electric power load is but also transmitted to the power grid, it is possible to more effectively utilize the electrical power charged into the secondary battery.

{0042}

In the second aspect described above, it is preferable that a capacity that is set in advance and to which the secondary battery is charged by performing regenerative operation once or more be set for the secondary battery as a reserve capacity, and that the electrical power generated by the solar cell not be charged into the reserve capacity.

{0043}

With this configuration, because a capacity that makes it possible to charge electrical power regenerated by performing regenerative operation at least once is set for the secondary battery as a reserve capacity, it is possible to charge the regenerated power to the secondary battery at least in the amount corresponding to the reserve capacity. Specifically, when the secondary battery is in a fully charged state, the regenerated power is consumed at, for example, a resistor, and is not effectively utilized in some cases. Because of this, in the case in which the charge percentage of the secondary battery exceeds the reserve capacity, the electrical power generated by the solar cell is transmitted to the power grid. Alternatively, electrical power charged in excess of the reserve capacity is transmitted to the power grid.

By doing so, with this configuration, it is possible to more effectively utilize the regenerated power.

{0044}

A power supplying method for a mechanical parking

apparatus according to a third aspect of the present invention is a power supplying method for a mechanical parking apparatus that includes a solar cell that converts solar light to electrical power, an electric power load that utilizes DC power, and a power conditioner that outputs the electrical power generated by the solar cell as AC power and DC power, the power supplying method including supplying the DC power output from the power conditioner to the electric power load and transmitting the AC power output from the power conditioner to a power grid.

{0045}

A power supplying method for a mechanical parking apparatus according to a fourth aspect of the present invention is a power supplying method for a mechanical parking apparatus that includes a solar cell that converts solar light to electrical power, an electric power load that utilizes DC power, and a power conditioner that transmits electrical power generated by the solar cell to a power grid as AC power and that supplies this generated electrical power to the electric power load as DC power, the power supplying method including interrupting the transmission of the AC power from the power conditioner to the power grid while the DC power is being supplied to the electric power load from the power conditioner.

{Advantageous Effects of Invention}

{0046}

With the present invention, an excellent advantage is afforded in that electrical power generated by solar cells can efficiently be utilized.

{Brief Description of Drawings}

{0047}

{Fig. 1} Fig. 1 is a diagram showing the external appearance of a mechanical parking apparatus according to a first embodiment of the present invention.

{Fig. 2} Fig. 2 is a block diagram showing the electrical configuration of the mechanical parking apparatus according to the first embodiment of the present invention.

{Fig. 3} Fig. 3 is a block diagram showing the configuration of a power conditioner according to the first embodiment of the present invention.

{Fig. 4} Fig. 4 is an electric circuit diagram partially showing the configuration of a motive-power power source unit according to the first embodiment of the present invention.

{Fig. 5} Fig. 5 is a block diagram showing the flow of electrical power in the case in which motor-running operation is performed by a raising/lowering motor of the mechanical parking apparatus according to the first embodiment of the present invention.

{Fig. 6} Fig. 6 is a block diagram showing the flow of electrical power in the case in which regenerative operation

is performed by the raising/lowering motor of the mechanical parking apparatus according to the first embodiment of the present invention.

{Fig. 7} Fig. 7 is a block diagram showing the flow of electrical power in the case in which the raising/lowering motor and a turning motor of the mechanical parking apparatus according to the first embodiment of the present invention have been stopped.

{Fig. 8} Fig. 8 is a block diagram showing the electrical configuration of a mechanical parking apparatus according to a second embodiment of the present invention.

{Fig. 9} Fig. 9 is a block diagram showing the flow of electrical power in the case in which motor-running operation is performed by a raising/lowering motor of the mechanical parking apparatus according to the second embodiment of the present invention.

{Fig. 10} Fig. 10 is a block diagram showing the flow of electrical power in the case in which regenerative operation is performed by the raising/lowering motor of the mechanical parking apparatus according to the second embodiment of the present invention.

{Fig. 11} Fig. 11 is a block diagram showing the flow of electrical power in the case in which the raising/lowering motor and a turning motor of the mechanical parking apparatus according to the second embodiment of the present invention

have been stopped.

{Fig. 12} Fig. 12 is a block diagram showing the flow of electrical power in the case in which the raising/lowering motor and the turning motor of the mechanical parking apparatus according to the second embodiment of the present invention have been stopped and a secondary battery is fully charged.

{Fig. 13} Fig. 13 is a graph showing the state-of-charge percentage of the secondary battery according to the second embodiment of the present invention.

{Fig. 14} Fig. 14 is a block diagram showing the electrical configuration of a mechanical parking apparatus according to a third embodiment of the present invention.

{Fig. 15} Fig. 15 is a block diagram showing the flow of electrical power in the case in which motor-running operation is performed by a raising/lowering motor of the mechanical parking apparatus according to the third embodiment of the present invention during a power outage.

{Fig. 16} Fig. 16 is a block diagram showing the flow of electrical power in the case in which regenerative operation is performed by the raising/lowering motor of the mechanical parking apparatus according to the third embodiment of the present invention during a power outage.

{Fig. 17} Fig. 17 is a block diagram showing the flow of electrical power in the case in which the raising/lowering

motor and a turning motor of the mechanical parking apparatus according to the third embodiment of the present invention have been stopped during a power outage.

{Fig. 18} Fig. 18 is a block diagram showing the flow of electrical power in the case in which the raising/lowering motor and the turning motor of the mechanical parking apparatus according to the third embodiment of the present invention have been stopped and an electric vehicle is charged during a power outage.

{Fig. 19} Fig. 19 is a block diagram showing the flow of electrical power in the case in which the raising/lowering motor and the turning motor of the mechanical parking apparatus according to the third embodiment of the present invention have been stopped and an emergency power source is used during a power outage.

{Fig. 20} Fig. 20 is a block diagram showing another example of the electrical configuration of the mechanical parking apparatuses according to the second embodiment and the third embodiment of the present invention.

{Fig. 21} Fig. 21 is a block diagram showing the electrical configuration of a mechanical parking apparatus according to a fourth embodiment of the present invention.

{Fig. 22} Fig. 22 is a diagram showing ON/OFF states of individual switches and the flow of electrical power in the case in which motor-running operation is performed in a DC

power source mode according to the fourth embodiment of the present invention.

{Fig. 23} Fig. 23 is a diagram showing ON/OFF states of the individual switches and the flow of electrical power in the case in which regenerative operation is performed in the DC power source mode according to the fourth embodiment of the present invention.

{Fig. 24} Fig. 24 is a diagram showing ON/OFF states of the individual switches and the flow of electrical power in the case in which regenerative operation is performed in the grid interconnected mode according to the fourth embodiment of the present invention.

{Fig. 25} Fig. 25 is a diagram showing ON/OFF states of the individual switches and the flow of electrical power in the case in which the mechanical parking apparatus according to the fourth embodiment of the present invention is provided with a motive-power power source unit including a regenerative function and in which regenerative operation is performed in the grid interconnected mode.

{Fig. 26} Fig. 26 is a schematic diagram showing the relationship between the DC power source mode and the grid interconnected mode according to the fourth embodiment of the present invention.

{Fig. 27} Fig. 27 is a block diagram showing the electrical configuration of a mechanical parking apparatus according to a

fifth embodiment of the present invention.

{Fig. 28} Fig. 28 is a diagram showing ON/OFF states of individual switches and the flow of electrical power in the case in which a secondary battery is charged in the DC power source mode according to the fifth embodiment of the present invention.

{Fig. 29} Fig. 29 is a diagram showing ON/OFF states of the individual switches and the flow of electrical power in the grid interconnected mode according to the fifth embodiment of the present invention.

{Fig. 30} Fig. 30 is a diagram showing ON/OFF states of the individual switches and the flow of electrical power in the DC power-source power generation mode according to the fifth embodiment of the present invention.

{Fig. 31} Fig. 31 is a schematic diagram showing the charging capacity of the secondary battery according to the fifth embodiment of the present invention.

{Fig. 32} Fig. 32 is a schematic diagram showing a minimum-required charging capacity of the secondary battery according to the fifth embodiment of the present invention.

{Fig. 33} Fig. 33 is a schematic diagram showing the relationship among the DC power source mode, the grid interconnected mode, and the DC power-source power generation mode according to the fifth embodiment of the present invention.

{Description of Embodiments}

{0048}

Embodiments of a mechanical parking apparatus and a power supplying method for a mechanical parking apparatus according to the present invention will be described below with reference to the drawings.

{0049}

[First Embodiment]

A first embodiment of the present invention will be described below.

{0050}

Fig. 1 shows a diagram showing the external appearance of a mechanical parking apparatus 10 according to the first embodiment.

The mechanical parking apparatus 10 allows vehicles 12 to be stored/removed via an entry level and raises/lowers pallets, on which the vehicles 12 are placed, between the entry level and storage levels where the vehicles 12 are stored. Furthermore, the roof of the mechanical parking apparatus 10 is provided with solar cells 14 that convert solar light to electrical power. The configuration of the mechanical parking apparatus 10 according to the first embodiment is merely an example, other configurations in which the entry level is located at a level above the storage levels, and so forth may be employed, and the location where

the solar cells 14 are provided may also be locations other than the roof. In addition, in the following descriptions, motor-running operation refers to operation performed when storing the vehicles 12 in the mechanical parking apparatus 10, and regenerative operation refers to operation performed when removing the vehicles 12 from the mechanical parking apparatus 10.

{0051}

Fig. 2 is a block diagram showing the electrical configuration of the mechanical parking apparatus 10 according to the first embodiment.

The mechanical parking apparatus 10 is connected to a power grid 22 via a transformer 20, and AC power is supplied thereto from the power grid 22. Also, the mechanical parking apparatus 10 is provided with a power conditioner (hereinafter referred to as "powercon") 24 and a control board 26. In addition, in the following descriptions, transmission lines for DC power are referred to as DC lines 28 (single solid lines in Fig. 2), and transmission lines for AC power are referred to as AC lines 30 (double solid lines in Fig. 2). The solar cells 14 are interconnected with the power grid via the powercon 24 and the AC lines 30.

{0052}

The powercon 24 according to the first embodiment outputs electrical power generated by the solar cells 14 (hereinafter

referred to as "solar-generated power") as AC power and DC power.

Fig. 3 is a block diagram showing the configuration of the powercon 24.

The powercon 24 is provided with a DC/DC converter 24A that converts DC power generated by the solar cells 14 so as to achieve a voltage of a predetermined magnitude and a DC/AC converter 24B that converts the DC power output from the DC/DC converter 24A to AC power.

{0053}

Then, the DC power output from the DC/DC converter 24A is supplied to electric power loads that utilize the DC power via the DC lines 28. On the other hand, the AC power output from the DC/AC converter 24B is transmitted to the power grid 22 via the DC lines 28, making it possible to sell the electrical power. In the first embodiment, the voltage of the DC power output from the powercon 24 is assumed to be 315 V as an example, and the voltage of the AC power output from the powercon 24 is assumed to be 200 V as an example.

{0054}

In the case of the related art, DC power output from solar cells 14 is converted to AC power temporarily, is subsequently converted again to DC power, and is then supplied to the electric power loads that utilize the DC power. However, because such a method involves conversion loss each

time the conversion is performed, the overall efficiency is decreased, and it is not economical.

{0055}

Therefore, as described above, the powercon 24 outputs the solar-generated power as AC power and DC power, and this DC power is directly supplied to the electric power loads that utilize the DC power.

Specifically, the DC power is output from the powercon 24 to be directly supplied to the electric power loads, and thus, the solar-generated power is supplied to the electric power loads without causing conversion loss. In addition, because it is also possible to output AC power from the powercon 24, solar-generated power that is not consumed at the electric power loads can also be transmitted to the power grid 22 (to be sold). Therefore, with the mechanical parking apparatus 10 according to the first embodiment, it is possible to efficiently utilize the solar-generated power.

{0056}

Note that the electric power loads that utilize DC power refer to a raising/lowering motor 32 for raising/lowering the pallets between the entry level and the storage levels, a turning motor 34 for turning the pallets at the entry level, and so forth. The DC power is converted to, for example, three-phase AC power by motive-power units 36A and 36B having a so-called inverter function and is utilized by the

raising/lowering motor 32 and the turning motor 34. The raising/lowering motor 32 and the turning motor 34 can perform regenerative operation to generate regenerated power during regenerative operation.

{0057}

The control board 26 is provided with a motive-power power source unit 40 that converts the AC power supplied from the power grid 22 to DC power and a control device 42 that handles the overall control of the mechanical parking apparatus 10. The DC power converted by the motive-power power source unit 40 serves as motor-running power and is supplied to the electric power loads that utilize the DC power.

{0058}

In addition, as shown in Fig. 4, the motive-power power source unit 40 according to the first embodiment is provided with a diode bridge circuit 40A that is compatible with three-phase AC current, thus preventing a reverse flow in which the electrical power regenerated by the raising/lowering motor 32 and the turning motor 34 flows into the power grid 22. With the mechanical parking apparatus 10 according to the first embodiment, the electrical power regenerated by the raising/lowering motor 32 and the turning motor 34 are consumed at a resistor 44 provided in the DC lines 28. By doing so, only the electrical power generated by the solar

cells 14 is transmitted to the power grid 22. Furthermore, a diode 46 is provided in the DC lines 28 so that the regenerated power does not flow into the powercon 24.

{0059}

Note that the motive-power power source unit 40 is not limited to the configuration provided with the diode bridge circuit 40A such as that shown in Fig. 4, and a PWM converter may be provided, thereby controlling the power supply from the power grid 22 and transmission to (power regeneration for) the power grid 22. In addition, in the case of a mechanical parking apparatus provided in an apartment building or the like, the configuration thereof may be such that regenerated power can be utilized by other apartment building equipment.

{0060}

The electric power loads that utilize AC power utilize the AC power supplied from the power grid 22. The electric power loads that utilize AC power refer to, for example, a control device 42 provided in the control board 26 and an electric-vehicle charging device 48 for charging a secondary battery provided in an electric vehicle.

{0061}

In addition, with the mechanical parking apparatus 10 according to the first embodiment, the voltage of the DC power output from the powercon 24 is set to be equal to a predetermined value (315 V, described above as an example).

This predetermined value is set in advance in accordance with the DC power to be utilized by the electric power loads, in other words, the powercon 24 does not output DC power whose voltage exceeds this predetermined value. On the other hand, when the mechanical parking apparatus 10 performs motor-running operation, the AC power output from the powercon 24 is set to be equal to a difference between the DC power output from the powercon 24 and the solar-generated power.

Specifically, when electrical power consumed at the electric power loads is equal to or greater than the solar-generated power, the solar-generated power is not transmitted to the power grid 22. On the other hand, when the electrical power consumed at the electric power loads is less than the solar-generated power, the solar-generated power is transmitted to the power grid 22 as AC power in accordance with the above-described difference.

{0062}

With the mechanical parking apparatus 10 according to the first embodiment, because the powercon 24 preferentially outputs DC power rather than AC power in this way, it is possible to make the electric power loads preferentially consume the solar-generated power.

{0063}

Furthermore, the voltage of the DC power output from the powercon 24 is made greater than the voltage of the DC power

that is converted by the motive-power power source unit 40 and supplied to the electric power loads. For example, as compared with the DC power of 315 V output from the powercon 24, DC power of 300 V is output from the motive-power power source unit 40. By doing so, with the mechanical parking apparatus 10 according to the first embodiment, the electric power loads preferentially consume the solar-generated power rather than the electrical power supplied from the power grid 22.

{0064}

Note that, when the electrical power consumed at the electric power loads is greater than the solar-generated power, the voltage of the DC power output from the powercon 24 becomes less than the voltage of the DC power supplied from the power grid 22. Because of this, in the case in which the voltage of the DC power output from the powercon 24 becomes less than 300 V, the electric power loads also utilize the electrical power supplied from the power grid 22 via the motive-power power source unit 40.

{0065}

Next, the operation of the mechanical parking apparatus 10 according to the first embodiment will be described.

{0066}

Fig. 5 shows the flow of electrical power in the case in which motor-running operation is performed by the

raising/lowering motor 32 of the mechanical parking apparatus 10. As shown in Fig. 5, the raising/lowering motor 32 receives a supply of DC power (solar-generated power) output from the powercon 24 and DC power (motor-running power) that is the electrical power supplied from the power grid 22 and that is converted by the motive-power power source unit 40. Note that, in the case in which the solar-generated power is sufficient as driving power for the raising/lowering motor 32, the motor-running power is not supplied to the raising/lowering motor 32.

{0067}

Fig. 6 shows the flow of electrical power in the case in which regenerative operation is performed by the raising/lowering motor 32 of the mechanical parking apparatus 10. As shown in Fig. 6, the raising/lowering motor 32 outputs regenerated power. This regenerated power is consumed at the resistor 44. The powercon 24 outputs the solar-generated power as AC power and transmits it to the power grid 22.

{0068}

Fig. 7 shows the flow of electrical power in the case in which the raising/lowering motor 32 and the turning motor 34 of the mechanical parking apparatus 10 have been stopped. As shown in Fig. 7, the powercon 24 outputs the solar-generated power as AC power and transmits it to the power grid 22.

{0069}

As has been described above, the mechanical parking apparatus 10 according to the first embodiment is provided with the solar cells 14 that convert solar light to electrical power, the raising/lowering motor 32 and the turning motor 34, which are the electric power loads that utilize DC power, and the powercon 24 that outputs the solar-generated power as AC power and DC power. Also, the mechanical parking apparatus 10 supplies the DC power output from the powercon 24 to the electric power loads and transmits the AC power output from the powercon 24 to the power grid 22.

{0070}

As described above, with the mechanical parking apparatus 10 according to the first embodiment, the DC power is output from the powercon 24 to be directly supplied to the electric power loads, and thus, the solar-generated power is supplied to the electric power loads without causing conversion loss. In addition, because it is also possible to output the AC power from the powercon 24, solar-generated power that is not consumed at the electric power loads can also be transmitted to the power grid 22 (to be sold).

Therefore, with the mechanical parking apparatus 10 according to the first embodiment, it is possible to efficiently utilize the solar-generated power.

{0071}

In addition, with the mechanical parking apparatus 10

according to the first embodiment, because the voltage of the DC power output from the powercon 24 is set to be equal to the predetermined value and the AC power output from the powercon 24 is set to be equal to the difference between the DC power output from the powercon 24 and the solar-generated power, it is possible to make the electric power loads preferentially consume the solar-generated power.

{0072}

In addition, with the mechanical parking apparatus 10 according to the first embodiment, because the voltage of the DC power output from the powercon 24 is made greater than the voltage of the DC power converted from the AC power supplied from the power grid 22, the electric power loads preferentially consume the electrical power generated by the solar cells 14 rather than the electrical power supplied from the power grid 22.

{0073}

[Second Embodiment]

A second embodiment of the present invention will be described below.

{0074}

Fig. 8 is a block diagram showing the electrical configuration of a mechanical parking apparatus 10 according to the second embodiment. Note that components in Fig. 8 that are the same as those shown in Fig. 2 are given the same

reference signs as those in Fig. 2, and descriptions thereof will be omitted.

{0075}

The mechanical parking apparatus 10 according to the second embodiment is provided with a secondary battery 60 to which DC power output from the powercon 24 and DC power regenerated from the electric power loads are charged. Control related to charging/discharging of the secondary battery 60 is performed by a secondary-battery control device 62 having a DC/DC converter function. Also, electrical power discharged from the secondary battery 60 is utilized by the electric power loads.

{0076}

With the solar cells 14, the solar-generated power fluctuates depending on the weather and time of day. In addition, if the secondary battery 60 is not provided, because the solar-generated power must be utilized at the same time as electrical power is generated, this electrical power can be utilized only to assist the motor-running operation of the electric power loads, and it is not possible to effectively utilize the electrical power for cutting peak electricity demand or the like with respect to the electrical power supplied from the power grid 22. For example, in the case in which the solar-generated power generated by the solar cells 14 is about 2 kW, as opposed to 18.5 kW for the electrical

power consumed by the motors, the solar-generated power accounts for about 10 % of the electrical power consumed by the motors. However, by setting the fully charged capacity of the secondary battery 60 to be a capacity that can cover the electrical power consumed to perform motor-running operation of the raising/lowering motor 32 and the turning motor 34 at least once, the mechanical parking apparatus 10 can perform motor-running operation of the raising/lowering motor 32 and the turning motor 34 without using the electrical power supplied from the power grid 22.

As described above, with the mechanical parking apparatus 10 according to the second embodiment, because the solar-generated power is not converted to AC power, this electrical power is directly charged into the secondary battery 60 as DC power, and the electrical power is utilized in the motor-running operation of the electric power loads, it is possible to effectively reduce the electrical power supplied from the power grid 22.

{0077}

In addition, the control device 42 provided in the control board 26 receives inputs of measurement signals from a light meter 64 that measures the illuminance at the solar cells 14. The control device 42 estimates the solar-generated power based on the measurement signals output from the light meter 64 and outputs the estimation information indicating the

estimation result to the secondary-battery control device 62. Note that the illuminance and the solar-generated power generated by the solar cells 14 are in a substantially proportional relationship.

{0078}

The secondary-battery control device 62 estimates the current of the DC power output from the solar cells 14 based on the estimation information that has been input thereto, and the solar-generated power is charged into the secondary battery 60 by means of the secondary-battery control device 62 in accordance with the charge percentage of the secondary battery 60, within the range of the estimated solar-generated power. In other words, the secondary-battery control device 62 controls the electrical power that flows in the DC lines 28 by charging the secondary battery 60.

DC lines 28 can also transmit the DC power that is converted and supplied from the power grid 22. Because of this, DC lines 28 may carry the DC power that is converted and supplied from the power grid 22 and the DC power from the solar cells 14 in a mixed state. Therefore, by estimating the solar-generated power and by charging the secondary battery 60 within the range of the estimated solar-generated power, the mechanical parking apparatus 10 according to the second embodiment can prevent the DC power that is converted and supplied from the power grid 22 from being charged into the

secondary battery 60. In addition, with the mechanical parking apparatus 10, it is possible to prevent a situation in which the secondary battery 60 is not charged even though the solar cells 14 are generating electrical power and the secondary battery 60 is not fully charged.

{0079}

Furthermore, an ammeter 66 that measures current values of the DC power output from the powercon 24 is provided in the DC lines 28. While the secondary battery 60 is being charged, the secondary-battery control device 62 performs control thereof with reference to the measurement result of the ammeter 66 so that currents flow in the DC lines 28 within the range of the solar-generated power estimated based on the measurement result of the light meter 64. In addition, a voltmeter may be provided instead of the ammeter 66.

{0080}

Next, the operation of the mechanical parking apparatus 10 according to the second embodiment will be described.

{0081}

Fig. 9 shows the flow of electrical power in the case in which motor-running operation is performed by the raising/lowering motor 32 of the mechanical parking apparatus 10. As shown in Fig. 9, the raising/lowering motor 32 utilizes, as motor-running power, the DC power output from the secondary battery 60 due to discharge from the secondary

battery 60. On the other hand, the solar-generated power is supplied to the power grid 22 (to be sold) by the powercon 24 as AC power.

{0082}

Fig. 10 shows the flow of electrical power in the case in which regenerative operation is performed by the raising/lowering motor 32 of the mechanical parking apparatus 10. As shown in Fig. 10, regenerated power output from the raising/lowering motor 32 is charged into the secondary battery 60. On the other hand, the solar-generated power is supplied to the power grid 22 (to be sold) by the powercon 24 as AC power. Note that, in the case in which the secondary battery 60 is fully charged, the regenerated power is consumed at the resistor 44.

{0083}

Fig. 11 shows the flow of electrical power in the case in which the raising/lowering motor 32 and the turning motor 34 of the mechanical parking apparatus 10 have been stopped. As shown in Fig. 11, the powercon 24 outputs the solar-generated power as DC power, and this DC power is charged into the secondary battery 60 by means of the secondary-battery control device 62.

{0084}

Fig. 12 shows the flow of electrical power in the case in which the raising/lowering motor 32 and the turning motor 34

of the mechanical parking apparatus 10 have been stopped and the secondary battery 60 is fully charged. As shown in Fig. 12, the solar-generated power is supplied to the power grid 22 (to be sold) by the powercon 24 as AC power.

{0085}

Fig. 13 is a graph showing the state of energy (voltage) possessed by the secondary battery 60. Region I in the Fig. 13 corresponds to the case in which the raising/lowering motor 32 and so forth are performing motor-running operation and in which electrical power is being discharged, as shown in Fig. 9. Region II in Fig. 13 corresponds to the case in which the raising/lowering motor 32 and so forth are performing regenerative operation and the secondary battery 60 is being charged, as shown in Fig. 10. Region III in Fig. 13 corresponds to the case in which the raising/lowering motor 32 and so forth have been stopped and the secondary battery 60 is being charged, as shown in Fig. 11. Region IV in Fig. 13 corresponds to the case in which the raising/lowering motor 32 and so forth have been stopped and the secondary battery 60 is fully charged, as shown in Fig. 12.

As shown in Fig. 13, the secondary battery 60 is charged by electrical power regenerated by the raising/lowering motor 32 and so forth and by power generation by the solar cells 14, and the charged power is utilized when the raising/lowering motor 32 and so forth perform motor-running operation. By

repeating such a cycle, the mechanical parking apparatus 10 can effectively reduce the electrical power supplied from the power grid 22.

{0086}

[Third Embodiment]

A third embodiment of the present invention will be described below.

{0087}

Fig. 14 shows the configuration of a mechanical parking apparatus 10 according to the third embodiment. Note that components in Fig. 14 that are the same as those in Fig. 8 are given the same reference signs as those in Fig. 8, and descriptions thereof will be omitted.

{0088}

The mechanical parking apparatus 10 according to the third embodiment is provided with an AC power control device 70 having a DC/AC converter that converts DC power to AC power. This DC power includes the DC power output from the solar cells 14 and the secondary battery 60, as well as regenerated power.

{0089}

With the mechanical parking apparatus 10 according to the third embodiment, in the case in which power supply from the power grid 22 is stopped, that is to say, in the case in which autonomous operation is performed due to a power outage

occurring, DC power output from at least one of the secondary battery 60 and the solar cells 14 is supplied to the electric power loads that utilize DC power, and AC power converted by the AC power control device 70 is supplied to the electric power loads that utilize AC power. Therefore, with the mechanical parking apparatus 10 according to the third embodiment, the electric power loads that utilize AC power can be operated even if power supply from the power grid 22 is stopped.

{0090}

In addition, the mechanical parking apparatus 10 according to the third embodiment is provided with an emergency power source 72 that can be used during a power outage. The emergency power source 72 is electrically connected to an information processing device, a communication device, and so forth and supplies electrical power to these devices.

{0091}

Between the AC power control device 70 and a DC line 28, a switch 74A that switches an electrical connection between the AC power control device 70 and the DC line 28 is provided. The switch 74A is set to the OPEN state when a power outage is not occurring, thus cutting the electrical connection between the AC power control device 70 and the DC line 28; however, when a power outage occurs, the switch 74A is set to the

CLOSED state to establish an electrical connection.

Similarly, switches 74B, 74C, and 74D that switch electrical connections are also provided between the AC power control device 70 and the control device 42, between the AC power control device 70 and the electric-vehicle charging device 48, and between the AC power control device 70 and the emergency power source 72, which are the electric power loads that utilize AC power.

Furthermore, switches 74E and 74F that switch electrical connections are also provided between the power grid 22 and the control device 42 and between the power grid 22 and the electric-vehicle charging device 48.

The switches 74A to 74F are switched based on control signals from the control device 42.

{0092}

Note that, with the mechanical parking apparatus 10 according to the third embodiment, because the electrical connections with the power grid 22 are cut during a power outage, AC power is not output from the powercon 24, and only DC power is output therefrom. Accordingly, the secondary battery 60 is charged by means of the secondary-battery control device 62 based on the measurement result of the ammeter 66 or the voltmeter.

{0093}

Next, the operation of the mechanical parking apparatus

10 according to the third embodiment will be described.

{0094}

Fig. 15 shows the flow of electrical power in the case in which the raising/lowering motor 32 of the mechanical parking apparatus 10 performs motor-running operation during a power outage.

As shown in Fig. 15, because the switches 74A and 74B are closed, the AC power control device 70 and the DC line 28, as well as the AC power control device 70 and the control device 42 are electrically connected. On the other hand, the switches 74E and 74F are open. The raising/lowering motor 32 utilizes, as motor-running power, the DC power output from the secondary battery 60 due to discharge from the secondary battery 60 (hereinafter referred to as "discharged secondary-battery power"). On the other hand, the control device 42 utilizes AC power that is converted by the AC power control device 70 from the discharged secondary-battery power and the solar-generated power.

{0095}

Fig. 16 shows the flow of electrical power in the case in which the raising/lowering motor 32 of the mechanical parking apparatus 10 performs regenerative operation during a power outage. The OPEN/CLOSED states of the switches 74A to 74F are the same as those shown in Fig. 15.

As shown in Fig. 16, regenerated power output from the

raising/lowering motor 32 is charged into the secondary battery 60 and is also output to the AC power control device 70. The control device 42 utilizes AC power converted by the AC power control device 70 from the regenerated power and the solar-generated power.

{0096}

Fig. 17 shows the flow of electrical power in the case in which the raising/lowering motor 32 and the turning motor 34 of the mechanical parking apparatus 10 have been stopped during a power outage. The OPEN/CLOSED states of the switches 74A to 74F are the same as those shown in Fig. 15.

As shown in Fig. 17, the solar-generated power is charged into the secondary battery 60 by means of the secondary-battery control device 62. The control device 42 utilizes AC power that is converted by the AC power control device 70 from the solar-generated power.

{0097}

Note that, when the secondary battery 60 is fully charged, the solar-generated power is consumed at the resistor 44.

{0098}

Fig. 18 shows the flow of electrical power in the case in which the raising/lowering motor 32 and the turning motor 34 of the mechanical parking apparatus 10 have been stopped and an electric vehicle is charged during a power outage.

As shown in Fig. 18, the switches 74A to 74C are closed. The control device 42 and the electric-vehicle charging device 48 utilize the AC power converted by the AC power control device 70 from the solar-generated power and the discharged secondary-battery power.

{0099}

Here, the secondary-battery control device 62 makes the secondary battery 60 discharge by an amount equal to a difference between the solar-generated power and electrical power utilized by the control device 42 and the electric-vehicle charging device 48. Because the electric-vehicle charging device 48 charges the electric vehicle, the power usage thereof is particularly high. However, the solar-generated power fluctuates due to the influences of the weather and time of day. Because of this, the secondary-battery control device 62 makes the secondary battery 60 discharge electrical power in accordance with the difference between the solar-generated power estimated based on the measurement results of the ammeter 66 and the light meter 64 and the electrical power utilized by the electric-vehicle charging device 48 and so forth. Therefore, with the mechanical parking apparatus 10, it is possible to stably supply electrical power to the electric-vehicle charging device 48.

{0100}

Fig. 19 shows the flow of electrical power in the case in which the raising/lowering motor 32 and the turning motor 34 of the mechanical parking apparatus 10 have been stopped and the emergency power source 72 is used during a power outage.

As shown in Fig. 19, the switches 74A, 74B, and 74D are closed. The control device 42 and the emergency power source 72 utilize AC power converted by the AC power control device 70 from the solar-generated power and the discharged secondary-battery power.

Note that, in some cases, the emergency power source 72 is connected to devices used during an emergency, such as an information processing device, a communication device, and so forth, and supplies electrical power thereto. If only the solar-generated power is supplied to the emergency power source 72 in the case in which such devices are connected thereto, it may not be possible to cover the power usage of these devices. Therefore, as with the case shown in Fig. 18, the secondary-battery control device 62 makes the secondary battery 60 discharge in accordance with the difference between the solar-generated power estimated based on the measurement results of the ammeter 66 and the light meter 64 and the electrical power utilized by the emergency power source 72 and so forth.

{0101}

As above, although the present invention has been described in terms of the above-described first to third embodiments, the technical scope of the present invention is not limited to the scope of the descriptions of the first to third embodiments described above. Within a range that does not depart from the scope of the invention, it is possible to incorporate various alterations or improvements into the first to third embodiments described above, and forms into which such alterations or improvements are incorporated are also encompassed by the technical scope of the present invention.

{0102}

For example, in the second and third embodiments described above, although forms in which the solar-generated power is estimated by using the light meter 64 and charging of the secondary battery 60 is controlled based on the estimation result have been described, the present invention is not limited thereto, and, as shown in Fig. 20, a form in which an ammeter 80 that measures electrical power flowing into the power grid 22 is provided and charging of the secondary battery 60 is controlled based on the measurement result of the ammeter 80 may be employed. The case in which current is measured at the ammeter 80 corresponds to a case in which the powercon 24 outputs the solar-generated power as AC power. In this case, although the secondary battery 60 needs to be charged if the secondary battery 60 is not fully charged,

charging is not performed. Therefore, in the case in which the secondary battery 60 is not fully charged, the powercon 24 outputs DC power so that current does not flow into the ammeter 80, thus charging the secondary battery 60.

{0103}

In addition, in the first to third embodiments described above, although a form in which one powercon 24 is provided in one mechanical parking apparatus 10 has been described, the present invention is not limited thereto, and a form in which a plurality of mechanical parking apparatuses 10 are connected to one powercon 24 may be employed.

{0104}

[Fourth Embodiment]

A fourth embodiment of the present invention will be described below.

{0105}

Note that, the external appearance of a mechanical parking apparatus 10 according to the fourth embodiment is the same as the external appearance of the mechanical parking apparatus 10 according to the first embodiment shown in Fig. 1, and therefore, descriptions thereof will be omitted.

{0106}

Fig. 21 is a block diagram showing the electrical configuration of the mechanical parking apparatus 10 according to the fourth embodiment.

The mechanical parking apparatus 10 is connected to a power grid 122 via a transformer 120, and AC power is supplied thereto from the power grid 122. Also, the mechanical parking apparatus 10 is provided with a power conditioner (hereinafter referred to as "powercon") 124 and a control board 126. In addition, in the following descriptions, transmission lines for DC power are referred to as DC lines 128 (single solid lines in Fig. 21), and transmission lines for AC power are referred to as AC lines 130 (double solid lines in Fig. 21). Solar cells 114 are interconnected with the power grid via the powercon 124 and the AC lines 130.

{0107}

The powercon 124 according to the fourth embodiment outputs electrical power generated by the solar cells 114 (hereinafter referred to as "solar-generated power") as AC power and DC power. Note that the configuration of the powercon 124 is the same as the configuration shown in Fig. 3.

{0108}

Thus, the powercon 124 outputs the solar-generated power as AC power and DC power, and this DC power is directly supplied to electric power loads that utilize DC power.

By doing so, the DC power is output from the powercon 124 to be directly supplied to the electric power loads, and thus, the solar-generated power is supplied to the electric power loads without causing conversion loss. In addition, because

it is also possible to output AC power from the powercon 124, solar-generated power that is not consumed at the electric power loads can also be transmitted to the power grid 122 (to be sold). Therefore, with the mechanical parking apparatus 10 according to the fourth embodiment, it is possible to efficiently utilize the solar-generated power.

{0109}

Note that the electric power loads that utilize DC power refer to, for example, a raising/lowering motor 132 for raising/lowering the pallets between the entry level and the storage levels, a turning motor 134 for turning the pallets at the entry level, and so forth. The DC power is converted to, for example, three-phase AC power by motive-power power source units 136A and 136B having a so-called inverter function and is utilized by the raising/lowering motor 132 and the turning motor 134. The raising/lowering motor 132 and the turning motor 134 can perform regenerative operation and generate regenerated power during regenerative operation. Note that, in addition to the raising/lowering motor 132 and the turning motor 134 to which electrical power is supplied via the motive-power power source units 136A and 136B having the inverter function, the electric power loads that utilize DC power include other electric power loads such as an electric power load to which DC power is supplied without using an inverter and so forth.

{0110}

Furthermore, the powercon 124 can supply AC power to an outlet 138 via the AC lines 130. By doing so, minimum-required autonomous operation is made possible by using the solar-generated power, even if the power supply from the power grid 122 is completely stopped.

{0111}

The control board 126 is provided with a motive-power power source unit 140 that converts AC power supplied from the power grid 122 to DC power and a control device 142 that handles the overall control of the mechanical parking apparatus 10. The DC power converted by the motive-power power source unit 140 serves as motor-running power and is supplied to the electric power loads that utilize the DC power. Note that the configuration of the motive-power power source unit 140 is the same as the configuration shown in Fig. 4.

{0112}

Furthermore, the mechanical parking apparatus 10 according to the fourth embodiment is provided with a switch 150A in the DC lines 128, a switch 150B in the AC lines 130, and a switch 150C in the AC lines 130. Note that the position at which the switch 150A is provided is closer to the powercon 124 than a resistor 144 and a diode 146 are.

{0113}

Next, the operation of the mechanical parking apparatus 10 according to the fourth embodiment will be described.

{0114}

By switching the switches 150A, 150B, and 150C ON and OFF by means of the control device 142, the mechanical parking apparatus 10 performs control such that the AC power is not transmitted to the power grid 122 from the powercon 124 while the DC power is supplied to the electric power loads from the powercon 124 (hereinafter referred to as "DC power source mode").

{0115}

Note that the switch 150C is appropriately switched ON and OFF by means of the control device 142 in the case in which power transmission from the power grid 122 is stopped or the like.

{0116}

Fig. 22 is a diagram showing ON/OFF states of the switches 150A and 150B and the flow of electrical power in the case in which motor-running operation is performed in the DC power source mode.

As shown in Fig. 22, in the DC power source mode, the switch 150A is turned ON whereas the switch 150B is turned OFF. By doing so, the connection between the powercon 124 and the power grid 122 is cut while the DC power (solar-generated power) is being supplied to the electric power loads from the

powercon 124 via the motive-power power source unit 140.

Therefore, with the mechanical parking apparatus 10 according to the fourth embodiment, it is possible to prevent the influence of supplying the DC power to the electric power loads from spreading to the power grid 122. Note that the voltage of the DC power output from the powercon 124 in the DC power source mode is set within the range of voltages that allows the operation of the motive-power power source unit 140.

{0117}

Fig. 23 is a diagram showing ON/OFF states of the switches 150A and 150B and the flow of electrical power in the case in which regenerative operation is performed in the DC power source mode. Note that Fig. 23 shows, as an example, a case in which regenerated power is generated by the raising/lowering motor 132.

When the regenerative operation is performed in the DC power source mode, because the voltages of the DC lines 128 increase due to the regenerated power, the DC power from the powercon 124 does not reach the motive-power power source unit 140. On the other hand, the regenerated power is consumed at the resistor 144 (damping resistance). When the regenerative operation is performed in the DC power source mode, as shown in Fig. 23, because the solar-generated power, which is the DC power from the powercon 124, is neither consumed at the

electric power loads nor transmitted to the power grid 122, this electrical power is wasted.

{0118}

Therefore, in the case in which regenerative operation is performed or in the case in which operation is stopped (operation of the raising/lowering motor 132 and the turning motor 134 is stopped), the mechanical parking apparatus 10 performs control so that the solar-generated power is transmitted to the power grid 122 (hereinafter referred to as "grid interconnected mode").

{0119}

Fig. 24 is a diagram showing ON/OFF states of the switches 150A and 150B and the flow of electrical power in the case in which regenerative operation is performed in the grid interconnected mode.

As shown in Fig. 24, in the grid interconnected mode, the switch 150A is turned OFF, whereas the switch 150B is turned ON. By doing so, the connection between the powercon 124 and the electric power loads is cut while AC power (solar-generated power) is being transmitted to the power grid 122 from the powercon 124. In this way, with the mechanical parking apparatus 10 according to the fourth embodiment, it is possible to transmit the solar-generated power to the power grid 122 as AC power while regenerative operation is being performed. Note that the regenerated power is consumed at the

resistor 144.

{0120}

In addition, in general, the solar-generated power transmitted to the power grid 122 from the powercon 124 as AC power has a higher voltage than the operating voltage of the motive-power power source unit 140. Because of this, if the voltages of the DC lines 128 become equal to or greater than the operating voltage of the motive-power power source unit 140 due to the influence of the powercon 124, this causes a voltage abnormality, and the output voltage of the motive-power power source unit 140 becomes 0 V (Over Voltage: excess voltage), which triggers a protection circuit, and the function of the motive-power unit is stopped. However, by cutting the connection between the powercon 124 and the motive-power power source unit 140 by means of the switch 150A while AC power is being transmitted to the power grid 122 from the powercon 124, as in the grid interconnected mode, it is possible to prevent the function of the motive-power power source unit 140 from being stopped due to the influence of the powercon 124.

{0121}

In addition, in the case in which the operation of the mechanical parking apparatus 10 is stopped, whether or not the regenerated power is generated is the only difference as compared with the example shown in Fig. 24, and ON/OFF states

of the switches 150A and 150B are set to be the same as those shown in Fig. 24.

{0122}

Here, in the example shown in Fig. 24, because the regenerated power is consumed at the resistor 144, it is not possible to effectively utilize the regenerated power.

Accordingly, the motive-power power source unit 140 may be provided with a regenerative function, which makes it possible to convert electrical power regenerated by the electric power loads to AC power and to transmit the AC power to the power grid 122, thus effectively utilizing the regenerated power.

{0123}

Fig. 25 is a diagram showing ON/OFF states of the switches 150A and 150B and the flow of electrical power in the case in which the mechanical parking apparatus 10 is provided with a motive-power power source unit 140A having the regenerative function and in which regenerative operation is performed in the grid interconnected mode.

As shown in Fig. 25, because AC power is transmitted to the power grid 122 from the powercon 124 and the motive-power power source unit 140A transmits electrical power regenerated by the electric power loads to the power grid 122, it is not necessary to consume the regenerated power at the resistor 144, and thus, it is possible to utilize the regenerated

power.

{0124}

Fig. 26 is a schematic diagram showing the relationship between the DC power source mode and the grid interconnected mode.

As described above, the DC power source mode is used in the case in which motor-running operation is performed. On the other hand, the grid interconnected mode is used in the case in which the regenerative operation is performed or the operation is stopped, as described above.

By switching between the DC power source mode and the grid interconnected mode depending on whether motor-running operation is performed, regenerative operation is performed, or operation is stopped, as described above, DC power is supplied to the electric power loads from the powercon 124 in the case in which motor-running operation is performed; AC power is transmitted to the power grid 122 from the powercon 124 and electrical power regenerated by the electric power loads is also supplied to the power grid 122 in the case in which regenerative operation is performed; and AC power is transmitted to the power grid 122 from the powercon 124 in the case in which the operation is stopped.

{0125}

As has been described above, the mechanical parking apparatus 10 according to the fourth embodiment is provided

with the solar cells 114 that convert solar light to electrical power, the electric power loads that utilize DC power, and the powercon 124 that transmits electrical power generated by the solar cells 114 to the power grid 122 as AC power and that supplies this generated power to the electric power loads as DC power. Also, because the mechanical parking apparatus 10 does not transmit AC power to the power grid 122 from the powercon 124 while DC power is being supplied to the electric power loads from the powercon 124, it is possible to prevent the influence of supplying the DC power to the electric power loads from spreading to the power grid 122. Therefore, with the mechanical parking apparatus 10 according to the fourth embodiment, it is possible to efficiently utilize the electrical power generated by the solar cells 114.

{0126}

In addition, the mechanical parking apparatus 10 according to the fourth embodiment supplies the DC power to the electric power loads from the powercon 124 in the case in which motor-running operation is performed and transmits the AC power to the power grid 122 from the powercon 124 in the case in which the electric power loads do not consume electrical power, and therefore, it is possible to efficiently utilize the solar-generated power.

{0127}

In addition, because the mechanical parking apparatus 10

according to the fourth embodiment transmits the AC power to the power grid 122 from the powercon 124 in the case in which regenerative operation is performed and also transmits regenerated power to the power grid 122, it is not necessary to consume the regenerated power at the resistor 144, and it is possible to utilize the regenerated power together with the solar-generated power.

{0128}

[Fifth Embodiment]

A fifth embodiment of the present invention will be described below.

{0129}

Note that, the external appearance of a mechanical parking apparatus 10 according to the fifth embodiment is the same as the external appearance of the mechanical parking apparatus 10 according to the first embodiment shown in Fig. 1, and therefore, descriptions thereof will be omitted.

{0130}

Fig. 27 is a block diagram showing the electrical configuration of the mechanical parking apparatus 10 according to the fifth embodiment. Note that components in Fig. 27 that are the same as those in Fig. 21 are given the same reference signs as those in Fig. 21, and descriptions thereof will be omitted.

As shown in Fig. 27, the mechanical parking apparatus 10

according to the fifth embodiment is provided with a secondary battery 160 and a secondary-battery control device 162 as a charge/discharge system.

DC power output from the powercon 124 and DC power regenerated by the electric power loads are charged into the secondary battery 160. The secondary-battery control device 162 has a DC/DC converter function and performs control related to charging/discharging of the secondary battery 160.

{0131}

With the solar cells 114, the solar-generated power fluctuates depending on the weather and time of day. In addition, if the secondary battery 160 is not provided, because the solar-generated power must be utilized at the same time as electrical power is generated, this electrical power can be utilized only to assist the motor-running operation of the electric power loads, and it is not possible to effectively utilize the electrical power for cutting peak electricity demand or the like with respect to the electrical power supplied from the power grid 122. With the mechanical parking apparatus 10 according to the fifth embodiment, the solar-generated power is not converted to AC power and is directly charged into the secondary battery 160 as DC power, and thus, it is possible to effectively utilize the solar-generated power.

{0132}

Fig. 28 is a diagram showing ON/OFF states of the switches 150A and 150B and the flow of electrical power in the case in which the secondary battery 160 is charged in the DC power source mode according to the fifth embodiment.

As shown in Fig. 28, in the DC power source mode according to the fifth embodiment, the switch 150A is turned ON, whereas the switch 150B is turned OFF.

{0133}

In the case in which the operation of the mechanical parking apparatus 10 is stopped in the DC power source mode, DC power is charged into the secondary battery 160 from the powercon 124, as shown in Fig. 28. In the DC power source mode according to the fifth embodiment, the mechanical parking apparatus 10 is in a state in which the operation is stopped where neither motor-running operation nor regenerative operation is performed.

{0134}

Fig. 29 is a diagram showing ON/OFF states of the switches 150A and 150B and the flow of electrical power in the grid interconnected mode according to the fifth embodiment.

As shown in Fig. 29, in the grid interconnected mode, the switch 150A is turned OFF, whereas the switch 150B is turned ON.

{0135}

Thus, in the grid interconnected mode, AC power (solar-

generated power) is transmitted to the power grid 122 from the powercon 124. In addition, in the case in which regenerative operation is performed, electrical power regenerated by an electric power load (the raising/lowering motor 132 in the example shown in Fig. 29) is charged into the secondary battery 160. On the other hand, in the case in which motor-running operation is performed, electrical power charged into the secondary battery 160 (hereinafter referred to as "charged power") is discharged, and this discharged electrical power is supplied to the electric power loads.

In the grid interconnected mode according to the fifth embodiment, because the charged power in the secondary battery 160 is supplied to the electric power loads in the motor-running operation and the solar-generated power is transmitted to the power grid 122, it is possible to achieve utilization of the charged power in the secondary battery 160 and utilization of the solar-generated power at the same time.

{0136}

In addition, in the grid interconnected mode according to the fifth embodiment, because the regenerated power is charged into the secondary battery 160 and the solar-generated power is transmitted to the power grid 122, it is possible to achieve charging of the secondary battery 160 with the regenerated power and utilization of the solar-generated power at the same time.

{0137}

In addition, the mechanical parking apparatus 10 according to the fifth embodiment performs control so that the charged power is transmitted to the power grid 122 (hereinafter referred to as "DC power-source power generation mode").

Fig. 30 is a diagram showing ON/OFF states of the switches 150A (switches 150AA and 150AB in the case of the fifth embodiment) and 50B and the flow of electrical power in the DC power-source power generation mode. Note that, in the example shown in Fig. 30, two DC lines 128A and 128B, in which the directions of electrical power flow are individually restricted by diodes 146A and 146B and in which the switches 150AA and 150AB are provided, are provided between the powercon 124 and the secondary battery 160 and between the powercon 124 and the electric power loads. Although the diodes 146A and 146B allow electrical power to flow in opposite directions from each other, in practice, the DC lines 128A and 128B allow the electrical power to flow in both directions. Specifically, the DC line 128A allows the electrical power to flow from the powercon 124 to the secondary battery 160 and the electric power loads, and the DC line 128B allows the electrical power to flow from the secondary battery 160 to the powercon 124.

{0138}

Note that, although the switch 150A may be provided alone in the case in which the diodes 146A and 146B are not provided, this will make it impossible to easily prevent an unintended reverse flow of electrical power.

{0139}

Furthermore, a switch 150D is provided between the solar cells 114 and the powercon 124.

{0140}

Also, in the DC power-source power generation mode, the switch 150AA is turned OFF, whereas the switch 150AB is turned ON, and the switch 150B is also turned ON. By doing so, electrical power flows only to the powercon 124 from the secondary battery 160, and the electrical power can also be supplied to the power grid 122 from the powercon 124. Thus, by discharging the charged power in the secondary battery 160, the charged power is converted to AC power via the powercon 124 and is transmitted to the power grid 122.

Note that, in the DC power-source power generation mode, by turning OFF the switch 150D, the connection between the solar cells 114 and the powercon 124 is cut, and electrical power is prevented from flowing in reverse from the powercon 124 to the solar cells 114.

{0141}

As described above, in the DC power-source power generation mode, it is possible to transmit the charged power

in the secondary battery 160 to the power grid 122 via the powercon 124. Therefore, because the charged power in the secondary battery 160 is not only utilized by the electric power loads but also utilized for power transmission to the power grid 122, it is possible to more effectively utilize the charged power in the secondary battery 160.

{0142}

Here, with secondary battery 160 according to the fifth embodiment, a capacity that is set in advance and to which the secondary battery 160 is charged by performing regenerative operation once or more is set to be a reserve capacity (hereinafter referred to as "reserve charging capacity"), and the solar-generated power is not charged into the reserve charging capacity.

{0143}

Fig. 31 is a schematic diagram showing the charging capacity of the secondary battery 160.

The secondary battery 160 has the minimum charging capacity and the reserve charging capacity, which are set in advance.

Electrical power charged into the minimum charging capacity corresponds to electrical power consumed by performing motor-running operation at least once or more.

{0144}

The capacity of the secondary battery 160 can be charged

with the solar-generated power and the regenerated power until reaching the reserve charging capacity, whereas the reserve charging capacity cannot be charged with the solar-generated power, as described above. In other words, the reserve charging capacity can be charged only with the regenerated power. The reason for doing so is that, when the secondary battery 160 is in a fully charged state, the regenerated power is consumed at, for example, the resistor 144, and the regenerated power cannot be effectively utilized in some cases; in particular, a greater amount of regenerated power is wasted when removing operation is consecutively repeated. Therefore, the reserve charging capacity that can be charged only with the regenerated power is set for the secondary battery 160.

{0145}

Because of this, when the charge percentage of the secondary battery 160 exceeds the reserve charging capacity, the solar-generated power is transmitted to the power grid 122. Alternatively, the electrical power charged in excess of the reserve charging capacity is transmitted to the power grid 122 while the operation of the mechanical parking apparatus 10 is stopped in a DC power-source power generation mode.

Note that the minimum charging capacity and the reserve charging capacity are set in advance, and the charge percentage of the secondary battery 160 is managed by the

secondary-battery control device 162.

{0146}

By doing so, with the mechanical parking apparatus 10 according to the fifth embodiment, it is possible to more effectively utilize the regenerated power. In addition, because some capacity to be charged with the regenerated power always remains, the regenerated power can also be charged into the secondary battery 160 during nighttime or the like when the solar cells 114 are not generating electrical power.

{0147}

In addition, because electrical power corresponding to the electrical power consumed by performing motor-running operation at least once or more is charged into the secondary battery 160 as the minimum charging capacity, it is possible to suppress the use of electrical power supplied from the power grid 122 in the motor-running operation.

{0148}

Furthermore, as shown in Fig. 32, it suffices that the secondary battery 160 has a capacity corresponding to at least the minimum charging capacity and the reserve charging capacity, in other words, a capacity corresponding to the electrical power required to perform the regenerative operation or the motor-running operation at least twice. Accordingly, a small secondary battery having a low capacity may be employed as the secondary battery 160.

{0149}

Fig. 33 is a schematic diagram showing the relationship among the DC power source mode, the grid interconnected mode, and the DC power-source power generation mode.

As described above, the DC power source mode is used in the case in which the operation is stopped, wherein the state thereof is such that the solar-generated power can be charged into the secondary battery 160, in other words, a case in which the charge percentage of the secondary battery 160 has not exceeded the reserve charging capacity.

As described above, the grid interconnected mode is used in the case in which the regenerative operation or the motor-running operation is performed or the operation is stopped, wherein the state thereof is such that the solar-generated power cannot be charged into the secondary battery 160.

The DC power-source power generation mode is used in the case in which the operation is stopped and the charged voltage of the secondary battery 160 is discharged into be supplied to the power grid 122, in other words, in the case in which the secondary battery 160 is charged in excess of the reserve charging capacity.

{0150}

As above, although the present invention has been described by using the fourth and fifth embodiments described above, the technical scope of the present invention is not

limited to the scope of the descriptions of the fourth and fifth embodiments described above. Within a range that does not depart from the scope of the invention, it is possible to incorporate various alterations or improvements into the fourth and fifth embodiments described above, and forms into which such alterations or improvements are incorporated are also encompassed by the technical scope of the present invention.

{0151}

For example, although forms in which the mechanical parking apparatus 10 is a multistory parking apparatus have been described in the fourth and fifth embodiments described above, the present invention is not limited thereto, and the mechanical parking apparatus 10 may take a form in which the pallets are moved not only up and down but also moved in a plane, as in a planar circulating system or a multistory circulating system.

{Reference Signs List}

{0152}

10 mechanical parking apparatus

14 solar cells

22 power grid

24 power conditioner

32 raising/lowering motor

34 turning motor

42 control device
48 electric-vehicle charging device
60 secondary battery
62 secondary-battery control device
70 AC power control device
114 solar cells
122 power grid
124 power conditioner
132 raising/lowering motor
134 turning motor
142 control device
160 secondary battery
162 secondary-battery control device

{CLAIMS}

{Claim 1}

A mechanical parking apparatus comprising:

 a solar cell that converts solar light to electrical power;

 an electric power load that utilizes DC power; and

 a power conditioner that outputs electrical power generated by the solar cell as AC power and DC power,

 wherein the DC power output from the power conditioner is supplied to the electric power load, and the AC power output from the power conditioner is transmitted to a power grid.

{Claim 2}

A mechanical parking apparatus according to Claim 1,

 wherein a voltage of the DC power output from the power conditioner is set to be equal to a predetermined value, and

 the AC power output from the power conditioner is set to be equal to a difference between the DC power output from the power conditioner and electrical power generated by the solar cell.

{Claim 3}

A mechanical parking apparatus according to Claim 2, wherein the predetermined value is greater than a voltage of DC power

that is converted from the power grid and that is supplied to the electric power load.

{Claim 4}

A mechanical parking apparatus according to any one of Claims 1 to 3, further comprising:

a secondary battery into which the DC power output from the power conditioner is charged,

wherein the electric power load utilizes electrical power discharged from the secondary battery.

{Claim 5}

A mechanical parking apparatus according to Claim 4, further comprising:

an estimating means for estimating electrical power generated by the solar cell; and

a secondary-battery controlling means for charging the secondary battery within a range of the generated electrical power estimated by the estimating means.

{Claim 6}

A mechanical parking apparatus according to Claim 4 or 5, further comprising:

a converting means for converting DC power to AC power,

wherein, in the case in which power supply from the power

grid is stopped, the DC power output from at least one of the solar cell and the secondary battery is supplied to the electric power load that utilizes DC power, and the AC power converted by the converting means is supplied to the electric power load that utilizes AC power.

{Claim 7}

A mechanical parking apparatus according to Claim 6, wherein the secondary-battery controlling means makes the secondary battery discharge electrical power equal to the difference between the electrical power generated by the solar cell and the electrical power utilized by the electric power load.

{Claim 8}

A mechanical parking apparatus according to Claim 6 or 7, wherein the electric power load that utilizes AC power includes a charging device for charging a secondary battery provided in an electric vehicle.

{Claim 9}

A mechanical parking apparatus comprising:

- a solar cell that converts solar light to electrical power;

- an electric power load that utilizes DC power; and

- a power conditioner that transmits electrical power

generated by the solar cell to a power grid as AC power and that supplies this generated electrical power to the electric power load as DC power,

wherein the transmission of the AC power from the power conditioner to the power grid is interrupted while the DC power is being supplied to the electric power load from the power conditioner.

{Claim 10}

A mechanical parking apparatus according to Claim 9, wherein the DC power is supplied to the electric power load from the power conditioner in the case in which the electric power load consumes electrical power, and the AC power is transmitted to the power grid from the power conditioner in the case in which the electric power load does not consume electrical power.

{Claim 11}

A mechanical parking apparatus according to Claim 9 or 10, wherein, in the case in which the electric power load is regenerating electrical power, the AC power is transmitted to the power grid from the power conditioner, and the electrical power regenerated by the electric power load is also transmitted to the power grid.

{Claim 12}

A mechanical parking apparatus according to any one of Claims 9 to 11, further comprising:

a secondary battery into which at least one of the DC power output from the power conditioner and the electrical power regenerated by the electric power load is charged,

wherein the electrical power charged into the secondary battery is utilized for power consumption at the electric power load.

{Claim 13}

A mechanical parking apparatus according to Claim 12, wherein, in the case in which the electric power load consumes electrical power, the electrical power charged into the secondary battery is supplied to the electric power load and, also, the electrical power generated by the solar cell is transmitted to the power grid.

{Claim 14}

A mechanical parking apparatus according to Claim 12 or 13, wherein, in the case in which the electric power load regenerates electrical power, the regenerated power is charged into the secondary battery and, also, the electrical power generated by the solar cell is transmitted to the power grid.

{Claim 15}

A mechanical parking apparatus according to any one of Claims 12 to 14, wherein the electrical power charged into the secondary battery can be transmitted to the power grid via the power conditioner.

{Claim 16}

A mechanical parking apparatus according to any one of Claims 12 to 15, wherein a capacity that is set in advance and to which the secondary battery is charged by performing regenerative operation once or more is set for the secondary battery as a reserve capacity, and the electrical power generated by the solar cell is not charged into the reserve capacity.

{Claim 17}

A power supplying method for a mechanical parking apparatus provided with a solar cell that converts solar light to electrical power, an electric power load that utilizes DC power, and a power conditioner that outputs the electrical power generated by the solar cell as AC power and DC power, the power supplying method comprising:

supplying the DC power output from the power conditioner to the electric power load; and

transmitting the AC power output from the power conditioner to a power grid.

{Claim 18}

A power supplying method for a mechanical parking apparatus provided with a solar cell that converts solar light to electrical power, an electric power load that utilizes DC power, and a power conditioner that transmits electrical power generated by the solar cell to a power grid as AC power and that supplies this generated electrical power to the electric power load as DC power, the power supplying method comprising:

interrupting the transmission of the AC power from the power conditioner to the power grid while the DC power is being supplied to the electric power load from the power conditioner.