

{DESCRIPTION}

{Title of Invention}

CHARGING SYSTEM FOR AUTOMATED PARKING GARAGE AND AUTOMATED
PARKING GARAGE INCLUDING THE SAME

{Technical Field}

{0001}

The present invention relates to charging systems for automated parking garages that can charge vehicle batteries in motor-driven vehicles while they are parked, and particularly, to a charging system for automated parking garages that prevents interrupted charging when a motor-driven vehicle being charged is transported in an automated parking garage of the multistory circulating type, the plane reciprocating type, or the horizontal circulating type, and to an automated parking system including such a charging system.

{Background Art}

{0002}

With the growing global awareness of environmental protection in recent years, environmentally friendly vehicles such as hybrid vehicles and electric vehicles (hereinafter referred to as "motor-driven vehicles") are becoming considerably widespread. Such motor-driven vehicles incorporate a large-capacity vehicle battery and are driven by an electric motor powered by electricity stored in the vehicle battery. The vehicle battery is charged by connecting a

charging connection unit disposed on the exterior of the motor-driven vehicle to an outlet of a power supply such as a household power supply (commercial power supply) with a charging cable.

{0003}

Accordingly, automated parking garages built beside buildings such as condominiums and office buildings and hourly pay automated parking garages operating in places such as urban areas have increasingly been equipped with charging equipment for enabling charging of vehicle batteries in motor-driven vehicles. For example, an automated parking garage as disclosed in PTL (Patent Literature) 1 is proposed in the related art.

{0004}

This automated parking garage includes a plurality of parking racks arranged vertically on the inner surfaces of opposing sidewalls in a parking structure and an elevator-type raising/lowering platform disposed between the opposing columns of the parking racks so as to be raised and lowered vertically. A vehicle to be parked is parked on an empty pallet placed on the raising/lowering platform at the ground floor, and the pallet is raised by the raising/lowering platform. When the raising/lowering platform is stopped beside an empty parking rack, the pallet, with the vehicle parked thereon, is slid horizontally from the raising/lowering

platform onto the parking rack.

{0005}

This automated parking garage is equipped with charging systems. Each charging system includes a power-supplying connection unit disposed on a parking rack, a power-receiving connection unit disposed on the bottom surface of a pallet, and an outlet unit that is disposed on the top surface of the pallet and that is connected to a motor-driven vehicle. The outlet unit is electrically connected to the power-receiving connection unit. When a motor-driven vehicle in need of charging is parked on the pallet at the ground floor, a charging cable connection port on the body of the vehicle is connected to the outlet unit on the pallet with a charging cable, and the vehicle is transported onto the parking rack in the connected state. When the pallet carrying the motor-driven vehicle is stored in position on the parking rack, the power-receiving connection unit comes into contact with the power-supplying connection unit so that the motor-driven vehicle is supplied with power, thus charging the motor-driven vehicle.

{0006}

Because the parking racks of the automated parking garage disclosed in PTL 1 are one pallet wide, the pallets are not moved horizontally over a distance of more than the width thereof. However, for example, in an automated parking garage

of the multistory circulating type or the plane reciprocating type, as disclosed in PTL 2, which includes parking racks wide enough to accommodate several pallets side-by-side, the pallets are moved across the parking racks by a distance of several meters to several tens of meters. In such an automated parking garage of the multistory circulating type, pallets carrying parked vehicles are frequently moved and interchanged during storage and retrieval of vehicles.

{0007}

If such an automated parking garage of the plane reciprocating type is equipped with the charging systems disclosed in PTL 1, the power-receiving connection units disposed on the pallet side repeatedly come into and out of contact with the power-supplying connection units on the power supply side, which are disposed on the parking racks, as the pallets are moved across the parking racks (transport path). If this occurs while the motor-driven vehicles are being charged (supplied with power), sparking (sparks) occurs between the power-supplying connection units and the power-receiving connection units, thus leading to burning of contacts and incidents such as an abnormal smell and fire. Also, interrupted charging due to frequent disconnection from the charging power supply during charging of the motor-driven vehicles is undesirable because it leads to failures in and shortened lives of the charging-related equipment and the

batteries in the motor-driven vehicles.

{0008}

Accordingly, the automated parking garage of the multistory circulating type disclosed in PTL 2 includes a power transmission line (trolley line) installed on the top surfaces of parking racks in the moving direction of pallets and current collectors disposed on the bottom surfaces of the pallets and configured to come into contact with the power transmission line to supply power. This allows the current collectors to remain in contact with the power transmission line while the pallets are being moved across the parking racks so that the current collectors do not repeatedly come into and out of contact with the power transmission line, thus preventing sparking and interrupted charging.

{Citation List}

{Patent Literature}

{0009}

{PTL 1}

Japanese Unexamined Patent Application, Publication No.
2010-222793

{PTL 2}

Japanese Unexamined Patent Application, Publication No.
2010-070985

{Summary of Invention}

{Technical Problem}

{0010}

However, the installation of the power transmission line on the top surfaces of the parking racks (transport path) in the moving direction of the pallets, as described above, requires the power transmission line to be rail-shaped with high linearity and thus involves a difficult installation procedure. This makes it difficult to perform a retrofitting procedure for installing charging systems in an existing multistory parking garage equipped with no charging system. In addition, because such a rail-shaped power transmission line is uncovered, it may suffer detrimental effects due to deposition of contaminants such as water, oil, and dust on the power transmission line. Another problem is that the operator or any device is likely to come into contact with the power transmission line, for example, during maintenance. A further problem is that the motor-driven vehicles cannot be charged on a circulating raising/lowering platform path.

{0011}

In light of the above problems, an object of the present invention is to provide a charging system for automated parking garages that prevents interrupted charging during the movement of a pallet along a transport path with a simple, low-cost, and safe structure to keep devices, such as electrical contacts on the power supply side, electrical contacts on the pallet side, charging-related equipment, and

batteries in motor-driven vehicles, in good condition for stable charging and that facilitates a retrofitting procedure for installing the charging system in an existing automated parking garage equipped with no charging system, and also to provide an automated parking garage including such a charging system.

{Solution to Problem}

{0012}

To solve the above problems, the present invention employs the following solutions.

Specifically, a first aspect of a charging system for an automated parking garage according to the present invention is a charging system for an automated parking garage equipped with a pallet on which a vehicle is placed and a transport path along which the pallet is transported in a predetermined direction, and the charging system is provided in the automated parking garage to charge a vehicle battery in a motor-driven vehicle parked on the pallet. The charging system includes a plurality of power-supplying connection units arranged at predetermined intervals on the transport path in the transport direction and connected to a power supply means; a power-receiving connection unit that is disposed on the pallet and that comes into contact with the power-supplying connection units at predetermined positions during transportation of the pallet; and an outlet unit that

is disposed on the pallet, that is electrically connected to the power-receiving connection unit, and that relays power supplied from the power-supplying connection units to the motor-driven vehicle. The power-receiving connection unit is shaped to extend over a predetermined length in the moving direction of the pallet, and the plurality of power-supplying connection units are positioned such that the power-receiving connection unit remains in contact with a contact of at least one of the power-supplying connection units irrespective of the position of the pallet on the transport path.

{0013}

The above structure requires no power transmission line (trolley line) to be installed in a straight line on the top surface of the transport path; instead, the power-supplying connection units may be sparsely arranged on the transport path and may be connected to the power supply means, such as a commercial power supply, and the power-receiving connection unit and the outlet unit may be mounted on the pallet, which allows the charging system to have a simple and low-cost structure and facilitates a retrofitting procedure for installing the charging system in an existing automated parking garage equipped with no charging system.

{0014}

In addition, the power-receiving connection unit on the pallet remains in contact with at least one of the contacts

irrespective of the position of the pallet on the transport path. Thus, the power-receiving connection unit on the pallet remains electrically connected to the power-supplying connection units on the transport path irrespective of the position through which the pallet is being moved along the transport path. This prevents sparking (sparks) between the power-supplying connection units (contacts) and the power-receiving connection unit and thus prevents incidents such as burning of the electrical contacts. In addition, the frequency of interrupted charging due to disconnection from the power supply during charging of the motor-driven vehicle is reduced. This avoids failures in and shortened lives of the charging-related equipment and the battery in the motor-driven vehicle and keeps these devices in good condition for stable charging.

{0015}

According to a second aspect of the charging system for an automated parking garage according to the present invention, the power-receiving connection unit in the first aspect has a sliding groove whose perpendicular cross-section is shaped to surround the contacts of the power-supplying connection units from thereabove, and the contacts are configured to be biased from therebelow so as to be pressed into sliding contact with an inner top surface of the sliding groove. Entry guides are disposed at both ends of the sliding

groove, and the entry guides are widened in a funnel shape such that the contacts are easily guided into the sliding groove through both ends thereof.

{0016}

The above structure, in which the cross-section of the sliding groove of the power-receiving connection unit is shaped to surround the contacts of the power-supplying connection units from thereabove when the contacts are in contact with the sliding groove, can reduce detrimental effects due to deposition of contaminants such as water, oil, and dust on the contacts. Because the contacts are biased from therebelow so as to be pressed into sliding contact with the inner top surface of the sliding groove of the power-receiving connection unit, a good electrical contact can be made between the contacts and the power-receiving connection unit.

{0017}

In addition, because the entry guides, which are widened in a funnel shape, are disposed at both ends of the sliding groove, the contacts of the power-supplying connection units are easily guided into the sliding groove, thus making a good contact between the contacts and the sliding groove to achieve electrical conduction, even if the relative positional accuracy between the power-supplying connection units and the power-receiving connection unit is relatively low.

{0018}

According to a third aspect of the charging system for an automated parking garage according to the present invention, the contacts of the power-supplying connection units in the second aspect are disposed so as to be movable relative to the position of the transport path in a vertical direction and in a forward and backward direction by predetermined amounts of positional adjustment, and at a free position where the contacts are not guided in the sliding groove, the contacts are positioned within the openings of the entry guides as viewed in the transport direction of the transport path.

{0019}

In the above structure, the contacts of the power-supplying connection units are movable relative to the position of the transport path in the vertical direction and in the forward and backward direction by the predetermined amounts of positional adjustment, and at the free position, the contacts are positioned within the openings of the entry guides, which are widened in a funnel shape, as viewed in the transport direction of the transport path; therefore, the contacts are easily guided into the sliding groove of the power-receiving connection unit. This ensures a good contact between the power-supplying connection units and the power-receiving connection unit for stable charging, even if the relative positional accuracy between the power-supplying

connection units (contacts) and the power-receiving connection unit (sliding groove) is relatively low. Furthermore, a retrofitting procedure can be easily performed to install the charging system in an existing automated parking garage that does not have high relative positional accuracy between the pallet and the transport path.

{0020}

According to a fourth aspect of the charging system for an automated parking garage according to the present invention, the transport path in any one of the first to third aspects is provided at each of a plurality of levels, and the charging system further includes an elevator-type raising/lowering platform that is positioned at an end of the transport paths and that circulates the pallet on the transport paths; and a raising/lowering platform connection unit that is disposed on the raising/lowering platform, that is connected to the power supply means, and that comes into contact with the power-receiving connection unit. The raising/lowering platform connection unit is positioned such that, when the pallet is moved between the transport paths and the raising/lowering platform, the power-receiving connection unit remains in contact with at least one of: the contacts of the power-supplying connection units and a contact of the raising/lowering platform connection unit.

{0021}

In the above structure, not only are the plurality of power-supplying connection units disposed on the transport paths, but also the raising/lowering platform connection unit is disposed on the raising/lowering platform, and when the pallet is moved between the transport paths and the raising/lowering platform, the power-receiving connection unit on the pallet remains in contact with at least one of: the contacts of the power-supplying connection units and the contact of the raising/lowering platform connection unit; therefore, the pallet continues to be supplied with power while being moved between the transport paths and the raising/lowering platform. Thus, the pallet continues to be supplied with power irrespective of the position of the pallet. This prevents sparking between the connection units, thus reducing incidents such as burning of the electrical contacts, and at the same time, prevents interrupted charging due to disconnection from the power supply during charging of the motor-driven vehicle, thus keeping the devices such as the charging-related equipment and the battery in the motor-driven vehicle in good condition for stable charging.

{0022}

According to a fifth aspect of the charging system for an automated parking garage according to the present invention, the charging system in any one of the first to fourth aspects further includes a power-indicating means for indicating that

the pallet is being supplied with power.

{0023}

The above structure, in which the power-indicating means indicates that the pallet is being supplied with power, prevents accidents such as electric shocks during maintenance and also facilitates detection of any failure in the power supply system to keep the charging system in good condition for stable charging.

{0024}

An automated parking garage according to the present invention includes the charging system according to any one of the first to fifth aspects.

{0025}

The above structure facilitates mounting of the power-supplying connection units on the transport path and mounting of the power-receiving connection unit and the outlet unit on the pallet, thus allowing the charging system to have a simple and low-cost structure. In addition, the above structure prevents sparking between the power-supplying connection units and the power-receiving connection unit, thus preventing incidents such as burning of the electrical contacts, and also reduces the frequency of or completely prevents interrupted charging due to disconnection from the power supply during charging of the motor-driven vehicle. This avoids failures in and shortened lives of the charging-related equipment and the

battery in the motor-driven vehicle and keeps these devices in good condition for stable charging.

{Advantageous Effects of Invention}

{0026}

As described above, the charging system for an automated parking garage and the automated parking garage including the charging system according to the present invention prevent interrupted charging during the movement of the pallet with a simple, low-cost, and safe structure to keep the devices, such as the electrical contacts on the pallet and the parking racks, the charging-related equipment, and the battery in the motor-driven vehicle in good condition for stable charging, and also facilitate a retrofitting procedure for installing the charging system in an existing automated parking garage equipped with no charging system.

{Brief Description of Drawings}

{0027}

{Fig. 1}

Fig. 1 is a schematic longitudinal sectional view of an automated parking garage to which charging systems according to a first embodiment of the present invention are applied.

{Fig. 2}

Fig. 2 is a plan view of a pallet shown in Fig. 1.

{Fig. 3}

Fig. 3 is an enlarged view showing a pallet and a

charging system for each parking space shown in Fig. 1.

{Fig. 4}

Fig. 4 is a perpendicular sectional view taken along line IV-IV in Fig. 3.

{Fig. 5}

Fig. 5 is a perpendicular sectional view taken along line V-V in Fig. 3.

{Fig. 6}

Figs. 6(a) to 6(c) are diagrams showing the operation of the automated parking garage including the charging systems according to the first embodiment at the time of storage.

{Fig. 7}

Figs. 7(a) to 7(c) are diagrams showing the operation of the automated parking garage including the charging systems according to the first embodiment at the time of retrieval.

{Fig. 8}

Fig. 8 is a schematic longitudinal sectional view of an automated parking garage to which charging systems according to a second embodiment of the present invention are applied.

{Fig. 9}

Figs. 9(a) to 9(c) are diagrams showing the operation of the automated parking garage including the charging systems according to the second embodiment at the time of storage.

{Fig. 10}

Figs. 10(a) to 10(c) are diagrams showing the operation

of the automated parking garage including the charging systems according to the second embodiment at the time of retrieval.

{Description of Embodiments}

{0028}

First Embodiment

A first embodiment of the present invention will be described below with reference to Figs. 1 to 7. The present invention is applicable to a wide variety of automated parking garages that transport a vehicle-to-be-parked on a pallet inside a parking structure and is not limited to automated parking garages of the multistory circulating type described below.

{0029}

Fig. 1 is a schematic longitudinal sectional view of an automated parking garage to which charging systems according to the first embodiment of the present invention are applied. This automated parking garage 1 is of the multistory circulating type and includes, for example, an underground storage room 2 in which an upper transport path 3 and a lower transport path 4 are arranged vertically so as to be aligned with each other. Although the upper and lower transport paths 3 and 4 in Fig. 1 are long enough to park three vehicles 5 side-by-side, the number of vehicles parked in each transport path may be four or more, or may be less than three. The number of upper and lower transport paths 3 and 4 is not

limited to two, but may be more than two.

{0030}

The vehicles 5 to be parked are placed on steel pallets 6, and the pallets 6 are placed on the upper and lower transport paths 3 and 4 and are transported along the upper and lower transport paths 3 and 4 by sliding in the transverse direction. The upper transport path 3 and the lower transport path 4 are composed of, for example, a plurality of transverse rail members 7 passing under the pallets 6 around the front end, the rear end, and the middle thereof. As also shown in Fig. 2, wheel trains 8 extending along the width of the vehicles 5 are attached to the bottoms of the pallets 6 around the front and rear ends in the longitudinal direction thereof, and these wheel trains 8 roll over the top surfaces of the transverse rail members 7 so that the pallets 6 are smoothly slidable. Also disposed on the transverse rail members 7 are limiting wheels (not shown) that limit the movement of the pallets 6 in the longitudinal direction thereof (forward and backward direction). The wheel trains are not necessarily disposed on the pallets 6, but may be disposed on the transverse rail members 7.

{0031}

An entry/exit elevator 11 is disposed at one end of the upper and lower transport paths 3 and 4, and a circulating elevator 12 is disposed at the other end thereof. The

entry/exit elevator 11 includes an entry/exit 13 provided at the ground floor and an elevator-type raising/lowering platform 14 that vertically connects one end of the upper transport path 3 to one end of the lower transport path 4, which are provided underground, and that is raised and lowered. The circulating elevator 12 includes an elevator-type raising/lowering platform 15 that vertically connects the other end of the upper transport path 3 to the other end of the lower transport path 4 and that is raised and lowered. The raising/lowering platforms 14 and 15 are raised and lowered by motors (not shown).

{0032}

When a vehicle 5 is to be stored, an empty pallet 6 is called to the entry/exit 13, and the vehicle 5 to be stored drives onto the pallet 6. The pallet 6 carrying the vehicle 5 is lowered by the raising/lowering platform 14, and when the height of the raising/lowering platform 14 matches the height of the upper transport path 3 or the lower transport path 4 (transverse rail members 7), the pallet 6 is transported from the raising/lowering platform 14 along the upper transport path 3 or the lower transport path 4 (transverse rail members 7) to an empty parking space by being slid horizontally by means of a sliding mechanism (not shown). Conversely, when a vehicle 5 stored on the upper transport path 3 or the lower transport path 4 is to be retrieved, the entry/exit elevator

11 and the circulating elevator 12 are operated to circulate the pallets 6 until the pallet 6 carrying the vehicle 5 to be retrieved arrives next to the entry/exit elevator 11, and the pallet 6 carrying the vehicle to be retrieved is transported to the entry/exit 13 by the entry/exit elevator 11 to retrieve the vehicle 5.

{0033}

The automated parking garage 1 can accommodate motor-driven vehicles powered by electric motors as well as normal vehicles powered by internal combustion engines. As also shown in Figs. 2 and 3, the automated parking garage 1 is equipped with charging systems 21 for charging vehicle batteries in motor-driven vehicles while they are parked. For illustration purposes, all pallets 6 in Fig. 1 are shown as having power-receiving connection units 23 and outlet units 24, described below, which constitute the charging systems 21, and all vehicles 5 shown in the figure are assumed to be motor-driven vehicles; however, the charging systems 21 may be provided only for some pallets 6, and both motor-driven vehicles and normal vehicles may be parked. The charging systems 21 are composed of, for example, four power-supplying connection units 22A to 22D provided for each of the upper transport path 3 and the lower transport path 4, power-receiving connection units 23, outlet units 24, and power indicator lamps 25 (power-indicating means).

{0034}

The power-supplying connection units 22A to 22D are arranged at predetermined intervals in the transport direction of the upper transport path 3 and the lower transport path 4. As shown in Figs. 3 and 4, the power-supplying connection units 22A to 22D each include a contact support 28. The contact support 28 includes, for example, a pair of horizontal support bars 29 protruding from the front surface of the transverse rail member 7 and a trapezoidal leaf spring 30 bent upward in a front view and bridging the pair of horizontal support bars 29 such that the leaf spring 30 is slidable in the axial direction. As shown in Fig. 4, each horizontal support bar 29 is fitted with two coil springs 31 such that the leaf spring 30 is held therebetween. In a front view (see Fig. 3), a contact holder 32 formed of an insulating material such as resin or ceramic is fixed to the middle of the leaf spring 30 in the longitudinal direction, and rotatable rollers 33 are disposed at both ends thereof.

{0035}

Contacts 35 are disposed on the top surface of the contact holder 32. For example, three contacts 35 are provided for plus current, minus current, and earth current (see Fig. 4), and these contacts 35 are formed as flat plates, which are parallel and separated from each other in the forward and backward direction, and can be extended from the

top surface of the contact holder 32 as they are biased upward by a biasing member (not shown). A power connection box 36 is also disposed on the bottom of the leaf spring 30, and a power cable 38 (power supply means, see Fig. 1) disposed along the transverse rail member 7 is connected to the power connection box 36 so that power is supplied from an external power supply (such as a commercial power supply) through the power cable 38 to the contacts 35. As shown in Fig. 4, the contacts 35 are movable in the forward and backward direction and in the vertical direction by predetermined amounts of positional adjustment X and Y, respectively, because the coil springs 31 are compressible in the forward and backward direction and the leaf spring 30 is bendable in the vertical direction.

{0036}

The power-receiving connection units 23 are members that come into contact with the power-supplying connection units 22A to 22D (contacts 35) at predetermined positions when the pallets 6 are transported along the upper transport path 3 or the lower transport path 4. The power-receiving connection units 23 extend over a predetermined length in the transport direction of the pallets 6 and are fixed to the bottoms of the pallets 6 with two securing units 41 therebetween. As shown in Figs. 4 and 5, the perpendicular cross-section of each power-receiving connection unit 23 is channel-shaped (gutter-shaped) so as to be open downward, with longitudinal guide

plates 23a formed integrally with the open end thereof so as to extend downward. The space inside the power-receiving connection unit 23 is formed as a sliding groove 42, and conduction plates 43 formed of a good conductor are bonded to the inner top surface thereof. Although not shown, three conduction plates 43 are parallel and provided for plus current, minus current, and earth current so as to be electrically insulated from each other and from the power-receiving connection unit 23 and so as to come into contact with different contacts 35.

{0037}

When the pallets 6 are moved along the upper transport path 3 or the lower transport path 4, the contact holders 32 and the contacts 35 of the power-supplying connection units 22A to 22D are guided in a sliding manner into the sliding grooves 42 of the power-receiving connection units 23. The cross-section of the sliding grooves 42 is shaped to surround the contacts 35 from thereabove when the contacts 35 are guided into the sliding grooves 42. When the contact holders 32 and the contacts 35 are guided into the sliding grooves 42, the rollers 33 disposed on the contact holders 32 roll on the bottom surfaces 23b of the power-receiving connection units 23. Because the contacts 35 are biased upward by the biasing member (not shown) so as to be extended from the top surfaces of the contact holders 32, as described above, the contacts 35

are pressed into sliding contact with the conduction plates 43 disposed on the inner top surfaces of the sliding grooves 42. Accordingly, the contacts 35 pressed against the conduction plates 43 exert a reaction force on the rollers 33.

{0038}

As shown in Figs. 2, 3, and 5, entry guides 45 are disposed at both ends of the power-receiving connection unit 23 (sliding groove 42). The entry guides 45 have a perpendicular cross-section that is similar to that of the sliding grooves 42 and whose height dimension H and front-to-rear dimension W increase outward, i.e., widened in a funnel shape. The bottom surfaces 45a of the entry guides 45 increase in height toward the center of the power-receiving connection unit 23 in the longitudinal direction, i.e., sloped upward, and the side surfaces 45b of the entry guides 45 decrease in vertical extent and spacing toward the center. These entry guides 45 allow the contact holders 32 and the contacts 35 of the power-supplying connection units 22A to 22D to be easily guided into both ends of the sliding grooves 42.

{0039}

When the contact holders 32 and the contacts 35 of the power-supplying connection units 22A to 22D are located at a free position, where they are not guided in the sliding grooves 42 of the power-receiving connection units 23, the contact holders 32 and the contacts 35 are positioned within

the openings of the entry guides 45, i.e., within the height dimension H and front-to-rear dimension W of the entry guides 45, as viewed in the transport direction of the upper and lower transport paths 3 and 4 (see Fig. 5). At the free position, the upper ends of the contacts 35 are lower than the conduction plates 43 of the power-receiving connection units 23 (sliding grooves 42). As the contact holders 32 and the contacts 35 are guided into the openings of the entry guides 45 and advance through the entry guides 45, the rollers 33 disposed on the contact holders 32 come into contact with the bottom surfaces 45a of the entry guides 45. Because the contacts 35 are movable over the range of the amount of positional adjustment Y as the leaf springs 30 are bent, the contact holders 32 are raised upward by the upward slopes of the bottom surfaces 45a. Then, the contacts 35 come into contact with the conduction plates 43. Also, because the contacts 35 are movable over the range of the amount of positional adjustment X as the coil springs 31 are compressed, even if the center positions of the contacts 35 deviate from those of the power-receiving connection units 23 (sliding grooves 42), the contacts 35 are positioned as they are moved along the slopes of the side surfaces 45b of the entry guides 45 in the forward and backward direction (direction along the dimension W).

{0040}

For example, the outlet units 24 are disposed on the top surface of one of curbs 6a formed at both ends of the pallets 6 so as not to interfere with the vehicles parked on the pallets 6. As shown in Fig. 2, the outlet units 24 are electrically connected to the power-receiving connection units 23 (conduction plates 43) via connection cables 47 disposed under the pallets 6. Charging cables 48 extending from the motor-driven vehicles 2 are connected to the outlet units 24. The outlet units 24 relay the power supplied from the power-supplying connection units 22A to 22D through the power-receiving connection units 23 to the motor-driven vehicles 2. The outlet units may be disposed anywhere on the top surfaces of the pallets 6.

{0041}

As shown in Figs. 1 and 3, for example, the power indicator lamps 25 are disposed on the transverse rail members 7, which form the upper transport path 3 and the lower transport path 4, so as to be located at the front centers of the pallets 6 when the pallets 6 are stopped in position. The power indicator lamps 25 are on while the motor-driven vehicles 2 parked on the pallets 6 are being charged, indicating that the pallets 6 are being supplied with power. In Fig. 1, for example, the power indicator lamps 25 under the vehicles 2 not being supplied with power (or non-motor-driven vehicles) are off, and the power indicator lamps 25 under the

vehicles 2 being supplied with power are on. Alternatively, the power indicator lamps 25 may be directly disposed on the pallets 6.

{0042}

The plurality of power-supplying connection units 22A to 22D are positioned on the upper transport path 3 and the lower transport path 4 such that the power-receiving connection units 23 on the pallets 6 remain in contact with the contacts 35 of at least one of the power-supplying connection units 22A to 22D irrespective of the positions of the pallets 6 on the upper transport path 3 and the lower transport path 4. In Fig. 1, for example, among the four power-supplying connection units 22A to 22D, the two outer power-supplying connection units 22A and 22D are positioned to come into contact with the portions of the power-receiving connection units 23 near the inner ends thereof on the pallets 6 placed on both sides of the three-vehicle-long parking space. The two inner power-supplying connection units 22B and 22C are disposed at a distance shorter than the length of the power-receiving connection units 23 from the two outer power-supplying connection units 22A and 22D. The distance between the power-supplying connection units 22B and 22C is also set to be shorter than the length of the power-receiving connection units 23, and the power-supplying connection units 22B and 22C are positioned to come into contact with the power-receiving

connection unit 23 on the pallet 6 placed in the center of the three-vehicle-long parking space near both ends of the power-receiving connection unit 23.

{0043}

The thus-configured automated parking garage 1 and the charging systems 21 operate as follows.

{0044}

Figs. 6(a) to 6(c) are diagrams showing the operation of the automated parking garage 1 at the time of storage. As shown, for example, when the circulating elevator 12 transports a pallet 6A carrying a motor-driven vehicle 5A onto the upper transport path 3 (or the lower transport path 4), the pallet 6A is transported from the raising/lowering platform 15 of the circulating elevator 12 onto the upper transport path 3, and at the same time, a pallet 6B, carrying a motor-driven vehicle 5B, that has already been placed at the end of the upper transport path 3 near the circulating elevator 12 is shifted toward the center (to the left in the drawings) by the width of one vehicle. The power-receiving connection unit 23B on the pallet 6B at the position in Fig. 6(a) is in contact with the power-supplying connection unit 22A. The power-supplying connection unit 22A, as described above, is in contact with the portion of the power-receiving connection unit 23B near the inner end thereof.

{0045}

As shown in Figs. 6(b) and 6(c), as the pallet 6B is shifted toward the center of the upper transport path 3, the power-receiving connection unit 23B comes into contact with the power-supplying connection unit 22B before being disconnected from the power-supplying connection unit 22A and then comes into contact with the power-supplying connection unit 22C so that the pallet 6B continues to be supplied with power. Thus, the power-receiving connection unit 23B on the pallet 6B remains electrically connected irrespective of the position through which the pallet 6B is being moved along the transport path 3. At the same time, the power-receiving connection unit 23A on the incoming pallet 6A comes into contact with the power-supplying connection unit 22A so that the pallet 6A is supplied with power, thereby starting to supply power to the motor-driven vehicle 5A. During this process, control is preferably performed so as to start supplying power after the power-receiving connection unit 23A completely comes into contact with the power-supplying connection unit 22A.

{0046}

Figs. 7(a) to 7(c) are diagrams showing the operation at the time of retrieval. For example, to retrieve the motor-driven vehicle 5A on the pallet 6A placed at the end of the upper transport path 3 (or the lower transport path 4) near the circulating elevator 12 and being supplied with power from

the power-supplying connection unit 22A in contact therewith, the pallet 6A is transferred from the upper transport path 3 to the raising/lowering platform 15 of the circulating elevator 12, and accordingly the pallet 6A is disconnected from the power-supplying connection unit A and is no longer supplied with power therefrom. At the same time, the pallet 6B placed at the central position of the upper transport path 3 is shifted to the end of the upper transport path 3 (to the right in the drawings). As shown in Figs. 7(b) to (c), as the pallet 6B at the position in Fig. 7(a), in which the power-receiving connection unit 23B is being supplied with power from the power-supplying connection units 22B and 22C in contact therewith, is shifted toward the end of the upper transport path 3, the pallet 6B is first disconnected from the power-supplying connection unit 22C and then from the power-supplying connection unit 22B. The power-receiving connection unit 23B, however, comes into contact with the power-supplying connection unit 22A before being disconnected from the power-supplying connection unit 22B so that the pallet 6B continues to be supplied with power.

{0047}

Thus, the power-receiving connection units 23 on the pallets 6 remain in contact with the contacts 35 of at least one of the power-supplying connection units 22A to 22D irrespective of the positions of the pallets 6 on the upper

transport path 3 and the lower transport path 4 so that the pallets 6 remain electrically connected, which prevents sparking (sparks) between the power-supplying connection units 22A to 22D (contacts 35) and the power-receiving connection units 23 (conduction plates 43) and thus prevents incidents such as burning of the electrical contacts. In addition, the frequency of interrupted charging due to disconnection from the power supply during charging of the motor-driven vehicles 5 is significantly reduced. This avoids failures in and shortened lives of the charging-related equipment and the batteries in the motor-driven vehicles 5 and keeps these devices in good condition for stable charging. These advantageous effects are also provided when the pallets 6 are transported by the raising/lowering platform 14 of the entry/exit elevator 11.

{0048}

In addition, this structure requires no power transmission lines (trolley lines) to be installed in a straight line on the top surfaces of the upper transport path 3 and the lower transport path 4 (transverse rail members 7); instead, the power-supplying connection units 22A to 22D may be sparsely arranged on the upper and lower transport paths 3 and 4 and may be connected to the power cables 38 disposed along the transverse rail members 7 of the upper and lower transport paths 3 and 4, and the power-receiving connection

units 23 and the outlet units 24 may be mounted on the pallets 6, which allows the charging systems 21 to have a simple and low-cost structure and facilitates a retrofitting procedure for installing the charging systems 21 in an existing automated parking garage equipped with no charging system.

{0049}

In addition, the power-receiving connection units 23 on the pallets 6 have the sliding grooves 42, whose perpendicular cross-section is shaped to surround the contacts 35 of the power-supplying connection units 22A to 22D from thereabove, and the contacts 35 are configured to be biased from therebelow so as to be pressed into sliding contact with the conduction plates 43 disposed on the inner top surfaces of the sliding grooves 42; therefore, it is possible to reduce detrimental effects due to deposition of contaminants such as water, oil, and dust on the contacts 35 by the sliding grooves 42 when the contacts 35 are in contact with the sliding grooves 42. Because the contacts 35 are biased from therebelow so as to be pressed into sliding contact with the conduction plates 43 of the power-receiving connection units 23, a good electrical contact can be made between the contacts 35 and the power-receiving connection units 23.

{0050}

In addition, because the entry guides 45, which are widened in a funnel shape, are disposed at both ends of the

sliding grooves 42, the contacts 35 are easily guided into the sliding grooves 42, thus making a good contact between the contacts 35 and the sliding grooves 42 to achieve electrical conduction, even if the relative positional accuracy between the power-supplying connection units 22A to 22D and the power-receiving connection units 23 is relatively low. This also facilitates a retrofitting procedure for installing the charging systems 21 in an existing automated parking garage equipped with no charging system.

{0051}

In addition, the contacts 35 of the power-supplying connection units 22A to 22D are movable relative to the positions of the upper and lower transport paths 3 and 4 (transverse rail members 7) in the forward and backward direction and in the vertical direction by the predetermined amounts of positional adjustment X and Y, respectively, and at the free position, where the contacts 35 are not guided in the sliding grooves 42, the contacts 35 are positioned within the openings of the entry guides 45 (height dimension $H \times$ front-to-rear dimension W) as viewed in the transport direction of the upper and lower transport paths 3 and 4 (transverse rail members 7); therefore, the contacts 35 are easily guided into the sliding grooves 42. This ensures a good contact between the power-supplying connection units 22A to 22D and the power-receiving connection units 23 for stable charging, even if the

relative positional accuracy between the power-supplying connection units 22A to 22D (contacts 35) and the power-receiving connection units 23 (sliding grooves 42) is relatively low. Furthermore, a retrofitting procedure can be easily performed to install the charging systems 21 in an existing automated parking garage that does not have high relative positional accuracy between the pallets 6 and the upper and lower transport paths 3 and 4.

{0052}

In addition, because the power indicator lamps 25 are provided to indicate that the pallets 6 are being supplied with power, the pallets 6 being supplied with power are clearly indicated. This prevents accidents such as electric shocks during maintenance and also facilitates detection of any failure in the power supply system to keep the charging systems 21 in good condition for stable charging. For a parking garage of the plane reciprocating type, the raising/lowering platform 15 may be replaced by a dolly that travels perpendicular to the storage direction of the pallets 6.

{0053}

Second Embodiment

Next, a second embodiment of the present invention will be described with reference to Figs. 8 to 10. Fig. 8 is a schematic longitudinal sectional view of an automated parking

garage 101 to which charging systems 51 according to the second embodiment of the present invention are applied. The charging systems 51 have the same structure as the automated parking garage 1 and the charging systems 21 of the first embodiment except that power-supplying connection units 22E and 22F, in addition to the power-supplying connection units 22A to 22D, are disposed on the upper and lower transport paths 3 and 4 and that raising/lowering platform connection units 22G and 22H are disposed on the raising/lowering platform 15 of the circulating elevator 12 and the raising/lowering platform 14 of the entry/exit elevator 11, respectively; therefore, the same components are labeled with the same reference signs, and a description thereof is omitted. In addition, the power-supplying connection units 22E and 22F and the raising/lowering platform connection units 22G and 22H have the same structure as the power-supplying connection units 22A to 22D described in the first embodiment; therefore, the reference signs of the components of the detailed structure are omitted.

{0054}

The power-supplying connection units 22E and 22F are mounted near the outer ends of the upper and lower transport paths 3 and 4 and are positioned so as to come into contact with the power-receiving connection units 23 on the pallets 6 stopped thereon near the outer ends thereof. The power-

supplying connection units 22E and 22F are supplied with power from power cables 38 similar to those of the first embodiment. The raising/lowering platform connection units 22G and 22H are supplied with power from, for example, flexible power cables 53 (power supply means) capable of following the rising and falling motion of the raising/lowering platforms 14 and 15. When the pallets 6 are placed on the raising/lowering platforms 14 and 15, the raising/lowering platform connection units 22G and 22H come into contact with the power-receiving connection units 23 on the pallets 6 to supply power to the pallets 6.

{0055}

The raising/lowering platform connection units 22G and 22H are positioned such that, when the pallets 6 are moved between the upper transport path 3 or the lower transport path 4 and the raising/lowering platforms 14 and 15, the power-receiving connection units 23 on the pallets 6 being moved remain in contact with at least one of: the contacts 35 of the power-supplying connection units 22E and 22F and the contacts 35 of the raising/lowering platform connection units 22G and 22H. For example, the raising/lowering platform connection units 22G and 22H are positioned on the raising/lowering platforms 14 and 15, respectively, near the upper and lower transport paths 3 and 4, and the distance between the raising/lowering platform connection unit 22G and

the power-supplying connection unit 22E and the distance between the raising/lowering platform connection unit 22H and the power-supplying connection unit 22F are set to be shorter than the length of the power-receiving connection units 23.

{0056}

The thus-configured automated parking garage and the charging systems 51 operate as follows.

{0057}

Figs. 9(a) to 9(c) are diagrams showing the operation of the automated parking garage 101 equipped with the charging systems 51 at the time of storage. As shown, for example, when the raising/lowering platform 15 of the circulating elevator 12 transports the pallet 6A carrying the motor-driven vehicle 5A onto the upper transport path 3 (or the lower transport path 4), the pallet 6A is transported from the raising/lowering platform 15 of the circulating elevator 12 onto the upper transport path 3, and at the same time, the pallet 6B, carrying the motor-driven vehicle 5B, that has already been placed at the end of the upper transport path 3 near the circulating elevator 12 is shifted toward the center (to the left in the drawings) by the width of one vehicle. Thus, as in the case of the charging systems 21 of the first embodiment, when the pallet 6B is moved along the upper transport path 3, the power-receiving connection unit 23B is in contact with any of the six power-supplying connection

units 22A to 22F irrespective of the position through which the pallet 6B is being moved along the upper transport path 3 so that the pallet 6B continues to be supplied with power.

{0058}

As shown in Fig. 9(a), the pallet 6A placed on the raising/lowering platform 15 is supplied with power from the raising/lowering platform connection unit 22G in contact with the power-receiving connection unit 23A. As shown in Figs. 9(b) and 9(c), as the pallet 6A is moved from the raising/lowering platform 15 onto the upper transport path 3, the power-receiving connection unit 23A comes into contact with the power-supplying connection unit 22E before being disconnected from the raising/lowering platform connection unit 22G. Thus, the pallet 6A continues to be supplied with power while being moved from the raising/lowering platform 15 onto the upper transport path 3.

{0059}

Figs. 10(a) to 10(c) are diagrams showing the operation at the time of retrieval. For example, to retrieve the motor-driven vehicle A on the pallet 6A placed at the end of the upper transport path 3 (or the lower transport path 4) near the circulating elevator 12 and being supplied with power from the power-supplying connection units 22A and 22E in contact therewith, the pallet 6A is transferred from the upper transport path 3 to the raising/lowering platform 15 of the

circulating elevator 12, and accordingly the power-receiving connection unit 23A on the pallet 6A is disconnected from the power-supplying connection units 22A and 22E, although the power-receiving connection unit 23A comes into contact with the raising/lowering platform connection unit 22G before being disconnected from the power-supplying connection unit 22E. Thus, the pallet 6A continues to be supplied with power while being moved from the upper transport path 3 onto the raising/lowering platform 15.

{0060}

Thus, not only are the plurality of power-supplying connection units 22A to 22F disposed on the upper and lower transport paths 3 and 4, but also the raising/lowering platform connection units 22G and 22H are disposed on the raising/lowering platforms 14 and 15, respectively, and when the pallets 6 are moved between the upper and lower transport paths 3 and 4 and the raising/lowering platforms 14 and 15, the power-receiving connection units 23 on the pallets 6 remain in contact with at least one of: the contacts 35 of the power-supplying connection units 22E and 22F and the contacts 35 of the raising/lowering platform connection units 22G and 22H; therefore, the pallets 6 continue to be supplied with power while being moved between the upper and lower transport paths 3 and 4 and the raising/lowering platforms 14 and 15.

{0061}

Thus, the pallets 6 continue to be supplied with power irrespective of the positions of the pallets 6. This prevents sparking (sparks) between the contacts, thus reducing incidents such as burning of the electrical contacts, and at the same time, completely prevents interrupted charging due to disconnection from the power supply during charging of the motor-driven vehicles 5, thus keeping the devices such as the charging-related equipment and the batteries in the motor-driven vehicles 5 in good condition for stable charging. These advantageous effects are also provided when the pallets 6 are transported by the raising/lowering platform 14 of the entry/exit elevator 11.

{0062}

As described above, the automated parking garages 1 and 101 equipped with the charging systems 21 and 51 prevent interrupted charging during the movement of the pallets 6 and thereby prevent sparking between the electrical contacts on the power supply side and the electrical contacts on the pallet 6 side, thus keeping these electrical contacts in good condition, and also reduces the frequency of or completely prevents interrupted charging due to disconnection from the power supply during charging of the motor-driven vehicles 5. This avoids failures in and shortened lives of the charging-related equipment and the batteries in the motor-driven

vehicles 5 and keeps these devices in good condition for stable charging.

{0063}

The present invention is not limited to the above embodiments; modifications can be optionally made without departing from the scope of the present invention. For example, although the above embodiments illustrate the case where the charging systems 21 and 51 according to the present invention are applied to underground multistory parking garages in which the entry/exit 13 is provided at the ground floor and the upper transport path 3 and the lower transport path 4 are built underground, the charging systems according to the present invention may be applied to, for example, above-ground multistory parking garages.

{Reference Signs List}

{0064}

- 1, 101 automated parking garage
- 3 upper transport path (transport path)
- 4 lower transport path (transport path)
- 5 motor-driven vehicle
- 6 pallet
- 7 transverse rail member
- 11 entry/exit elevator
- 12 circulating elevator
- 13 entry/exit

14, 15 raising/lowering platform

21, 51 charging system

22A to 22F power-supplying connection unit

22G, 22H raising/lowering platform connection unit

23 power-receiving connection unit

24 outlet unit

25 power indicator lamps (power-indicating means)

35 contact

38, 53 power cable (power supply means)

42 sliding groove

45 entry guide

48 charging cable

H, W height dimension and front-to-rear dimension defining
opening of entry guide

X, Y amount of positional adjustment of contact

{CLAIMS}

{Claim 1}

A charging system for an automated parking garage equipped with

a pallet on which a vehicle is placed; and

a transport path along which the pallet is transported in a predetermined direction, the charging system being provided in the automated parking garage to charge a vehicle battery in a motor-driven vehicle parked on the pallet,

the charging system comprising:

a plurality of power-supplying connection units arranged at predetermined intervals on the transport path in the transport direction and connected to a power supply means;

a power-receiving connection unit that is disposed on the pallet and that comes into contact with the power-supplying connection units at predetermined positions during transportation of the pallet; and

an outlet unit that is disposed on the pallet, that is electrically connected to the power-receiving connection unit, and that relays power supplied from the power-supplying connection units to the motor-driven vehicle,

wherein the power-receiving connection unit is shaped to extend over a predetermined length in a moving direction of the pallet, and

wherein the plurality of power-supplying connection units

are positioned such that the power-receiving connection unit remains in contact with a contact of at least one of the power-supplying connection units irrespective of the position of the pallet on the transport path.

{Claim 2}

The charging system for an automated parking garage according to Claim 1,

wherein the power-receiving connection unit has a sliding groove whose perpendicular cross-section is shaped to surround the contacts of the power-supplying connection units from thereabove,

wherein the contacts are configured to be biased from therebelow so as to be pressed into sliding contact with an inner top surface of the sliding groove, and

wherein entry guides are disposed at both ends of the sliding groove, the entry guides being widened in a funnel shape such that the contacts are easily guided into the sliding groove through both ends thereof.

{Claim 3}

The charging system for an automated parking garage according to Claim 2, wherein the contacts of the power-supplying connection units are disposed so as to be movable relative to the position of the transport path in a vertical

direction and in a forward and backward direction by predetermined amounts of positional adjustment, and at a free position where the contacts are not guided in the sliding groove, the contacts are positioned within the openings of the entry guides as viewed in the transport direction of the transport path.

{Claim 4}

The charging system for an automated parking garage according to any one of Claims 1 to 3,

wherein the transport path is provided at each of a plurality of levels,

the charging system further comprising:

an elevator-type raising/lowering platform that is positioned at an end of the transport paths and that circulates the pallet on the transport paths; and

a raising/lowering platform connection unit that is disposed on the raising/lowering platform, that is connected to the power supply means, and that comes into contact with the power-receiving connection unit,

wherein the raising/lowering platform connection unit is positioned such that, when the pallet is moved between the transport paths and the raising/lowering platform, the power-receiving connection unit remains in contact with at least one of: the contacts of the power-supplying connection units and

a contact of the raising/lowering platform connection unit.

{Claim 5}

The charging system for an automated parking garage according to any one of Claims 1 to 4, wherein the charging system further comprises a power-indicating means for indicating that the pallet is being supplied with power.

{Claim 6}

An automated parking garage comprising the charging system according to any one of Claims 1 to 5.