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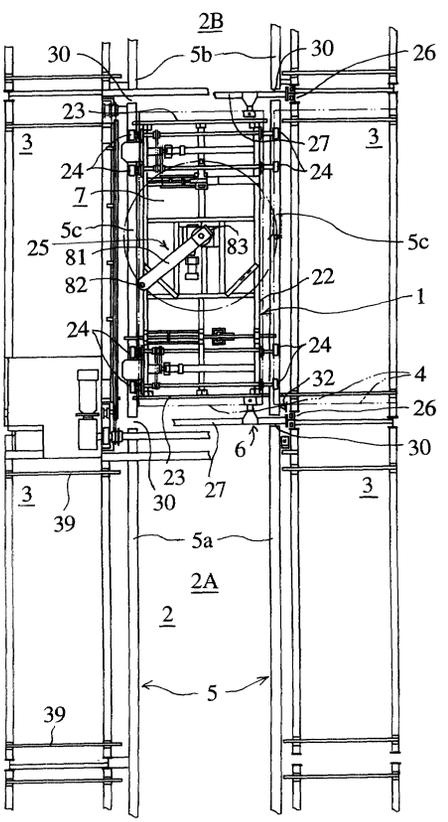
(54) A planar reciprocating type parking system

(57) In a planar reciprocating type parking system a carrier cart is adapted to travel reciprocally on a pair of rails laid on a transport aisle and carry a car-mounting tray. A plurality of car storage compartments are arranged in a row on each side of the transport aisle and each accommodates a tray. A tray transfer device is mounted on the carrier cart and is adapted to transfer the tray between the carrier cart and the car storage compartments. In a lift passage shaft communicating a car entry/exit floor with car parking floors a lift is installed which is adapted to raise or lower the tray. The lift is located at an arbitrary position on the transport aisle corresponding to one of the car storage compartments. At corners of the lift passage shaft guide rails are erected that vertically guide the lift. Lifting members move up or down the guide rails and are provided with support members that project inwardly of the lift passage shaft to support the tray. The pair of rails on the transport aisle are divided by the lifting members at locations where the lifting members pass through the rails. The divided portions are used as passage portions for the lifting members. The tray can be transferred between the lift and the carrier cart as the lifting members of the lift move up or down the guide rails. With such an arrangement the overall construction of the parking system is simplified and costs are reduced.

FIG. 9



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a multifloor, planar reciprocating type parking system, in which a row of car compartments is provided on each side of a transport aisle on which a carrier cart reciprocates, thus efficiently utilizing a plane, elongate in a lateral or longitudinal direction.

Prior Art

[0002] Figure 1 shows the configuration of a conventional planar reciprocating type parking system. In the figure, reference numeral 2 represents a transport aisle 2, on which a pair of rails 5 for a carrier cart are laid. Denoted 50 is a carrier cart which carries a tray and has a total of four wheels 51, two each at the front and rear on both sides, rolling on the paired rails 5 on the transport aisle 2. On the carrier cart 50 is a laid transverse rail, on which is mounted an automobile carrying tray 4. Car compartments 3 for storing automobiles are arranged on either side of the transport aisle 2 and each have a pair of transverse rails 39, on which a tray 4 is mounted. A lift 6 is installed between car storage floors and a car entry/exit floor to communicate the floors and the car entry/exit. Designated 60 is a drive unit for transferring the tray 4 between the carrier cart 50 and the lift 6.

[0003] The carrier cart 50 has a tray transfer device 80 mounted thereon, which is disclosed in Japan Patent Publication No. 33734/1995 previously filed by the inventor of this invention. As shown in detail in Figure 2, the tray transfer device 80 has a horizontally rotatable arm 81 whose rotating center is located at the center of the width of the carrier cart 50 and whose front end projects into the car compartment 3 by a predetermined dimension; an engagement member 82 erected upwardly at the free end of the rotary arm 81; and a drive motor 83 having a reduction gear and serving as a rotary drive unit for driving the rotary arm 81. The rotary arm 81 is rotated to bring the engagement member 82 into or out of engagement with an angle guide member 10 mounted on the underside of the tray 4 along the longitudinal direction to transfer the tray 4 between the carrier cart 50 and the associated car compartment 3.

[0004] In the conventional planar reciprocating type parking system mentioned above, however, because of the operation mechanism of the tray transfer device, a tray that was drawn in from a car compartment in one row cannot be transferred to a compartment in the opposite row. This necessitates the lift to be located in the carrier cart transport aisle, making it impossible to efficiently set the car entry floor at one corner of a building or causing a dead space to be formed on the car entry floor in a building. The conventional parking system therefore has a problem of being unable to make efficient utilization of the installation space. It also requires one drive unit for transfer of a tray between the carrier cart and the lift and another for transfer between the lift and the car compartments on each side of the lift, thus making the parking system as a whole complex in construction and costly.

[0005] Further, in the conventional planar reciprocating type parking system, because the tray transfer device cannot feed the tray in the direction of travel of the carrier cart, when the lift is installed at the end of the transport aisle according to the installation requirements of a parking lot, it is necessary to provide additional drive unit for transferring the tray between the carrier cart and the lift. When the lift is installed in an intermediate part of the transport aisle, the transport aisle and its paired rails are divided by the lift passage shaft, so that the divided transport aisles must each be provided with a dedicated carrier cart and a tray transfer device mounted on each carrier cart and also with a drive unit for transferring the tray between each carrier cart and the lift, thus rendering the construction of the parking system as a whole complicated and costly.

[0006] Further, in the conventional planar reciprocating type parking system, because the tray is transferred directly between the carrier cart and the lift, when cars are taken out of the same parking floor successively, it is necessary, at each exit of a car, to transfer the vacant tray, which was used to carry a car to the exit, from the lift onto the carrier cart and return it into the car storage compartment. Hence, the operation of moving the next car to the exit cannot be started while the first car exiting operation is under way, making it impossible to perform successive exiting operations swiftly. Likewise, when two or more cars are moved into the same parking floor, the operation of entering the next car cannot be started while the first car entry operation is under way, rendering the successive car entering operations slow.

OBJECT OF THE INVENTION

[0007] The present invention has been accomplished to solve the above-mentioned problems experienced with the prior art and its primary objective is to provide a planar reciprocating type parking system in which if the lift is located at an arbitrary position on the transport aisle, the carrier cart can travel reciprocally over the entire transport aisle and the tray can be transferred between the carrier cart and the lift without requiring any additional drive unit, thus realizing a simple construction of the parking system as a whole and reduction in cost.

[0008] A second objective of this invention is to provide a planar reciprocating type parking system, in which, when a plurality of cars are successively moved into or out of the same parking floor, the preparation for moving the next car into or out of the parking floor can be made while the entry or exit operation of the first car is under way, thus allowing swift continuous entry or exit

of cars.

SUMMARY OF THE INVENTION

[0009] To achieve the above objectives, the planar reciprocating type parking system of this invention is characterized in that the lift is located at an arbitrary position on the transport aisle corresponding to one of the car storage compartments; that at four corners of a lift passage shaft are erected guide rails that vertically guide the lift, and lifting members move up or down the guide rails and are provided with support members that project inwardly of the lift passage shaft to support the tray at four points; that the pair of rails on the transport aisle are divided by the lifting members at locations where the lifting members pass through the rails, and the divided portions are used as passage portions for the lifting members; and that the tray can be transferred between the lift and the carrier cart as the lifting members of the lift move up or down the guide rails.

[0010] With this arrangement, if the lift is located at an arbitrary position on the transport aisle, the carrier cart can travel reciprocally over the entire transport aisle and the tray can be transferred between the carrier cart and the lift without requiring any additional drive unit, thus realizing a simple construction of the parking system as a whole and reduction in cost. This offers a significant practical advantage.

[0011] Further, the planar reciprocating type parking system of this invention is characterized in that the lift is located at one end of the transport aisle; that the parking system includes a first tray transfer device mounted on the carrier cart to transfer the tray between the carrier cart and the car storage compartments on both sides of the transport aisle, second tray transfer devices installed between the car storage compartments on both sides of the lift and the car storage compartments adjoining these lift-side car storage compartments to transfer the tray between these compartments, and third tray transfer devices installed in the car storage compartments on both sides of the lift to transfer the tray between the car storage compartments on both sides of the lift and the lift; and that one of the car storage compartments on each floor is set as a dead space with no tray installed to allow the trays to be moved in circulation.

[0012] With this arrangement, when a plurality of cars are to be moved into or out of the same parking floor successively, it is possible to transfer the trays from the car storage compartments onto the carrier cart and forward them from the carrier cart to the lift successively through second and third tray transfer devices arranged on one side of the aisle and, at the same time, to transfer the trays returned from the lift onto the carrier cart through second and third tray transfer devices arranged on the other side of the aisle and forward them to the car storage compartments successively. The trays can thus be moved in circulation on each parking floor, allowing the preparation for the next car entry or exit operation to be made while the first car entry or exit operation is being performed. The entry or exit of two or more cars therefore can be made swiftly and continuously.

[0013] The present invention will be described in greater detail in conjunction with preferred embodiments by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

[0014]

Figure 1 is a plan view of an example of a conventional planar reciprocating type parking system;
Figure 2 is a plan view of a tray transfer device used in the conventional parking system;
Figure 3 is a plan view of a planar reciprocating type parking system ;
Figure 4 is a side view of a tray transfer device mounted on a carrier cart ;
Figure 5 is a plan view showing a part of the tray pulling operation performed by the tray transfer device
Figure 6 is plan views showing a series of steps for switching engagement of an engagement member of the tray transfer device from a first guide member to a second guide member as the carrier cart ; in which
Figure 6(a) shows a state, in which one of the trays in the left row of car storage compartments is pulled out from the compartment onto the carrier cart and locked there and the carrier cart is about to move;
Figure 6(b) shows a state, in which as the carrier cart 1 travels, a rotary arm is driven by a servo motor to rotate in a direction opposite to the direction in which it was rotated to pull out the tray;
Figure 6(c) shows a state, in which as the carrier cart travels, the rotary arm is stopped when a roller is aligned with a second guide member lOb; and
Figure 6(d) shows a state, in which as the carrier cart travels, the engagement member engages with the second guide member and remains engaged until the carrier cart traveling on the transport aisle reaches the lift;
Figure 7 is a plan view showing the process of pushing out the tray as performed by the tray transfer device, following the operation of Figure 5, in the parking system of the first embodiment;
Figure 8 is a plan view showing another process of transferring the tray as performed by the tray transfer device in the parking system of the embodiment according to Fig.3-7;
Figure 9 is a partial plan view showing one parking floor of a first embodiment of the planar reciprocating type parking system;
Figure 10 is an enlarged plan view of the carrier cart, the lift passage shaft and the lift in the first embod-

iment of the parking system;

Figure 11 is an enlarged front view of the lift passage shaft and the lift, as seen from the car compartment side, in the first embodiment of the parking system;

Figure 12 is an enlarged side view of the lift passage shaft, the car compartment and the lift in the first embodiment of the parking system;

Figure 13(a) is a side view showing an example operation of transferring the tray between the lift and the carrier cart in the first embodiment of the parking system;

Figure 13(b) is a side view showing another operation of transferring the tray between the lift and the carrier cart in the first embodiment of the parking system;

Figure 14 is a plan view of the planar reciprocating type parking system as a second embodiment of this invention;

Figure 15(a) is a partial side view showing the second and third tray transfer devices in the second embodiment of the parking system; and

Figure 15(b) is a partial side view showing the carrier cart on the transport aisle and the car compartment in the second embodiment of the parking system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Figure 3 shows the construction of the planar reciprocating type parking system . In the figure, reference number 1 represents a self-propelled carrier cart that carries a tray 4 on which a car is mounted. Denoted 2 is a transport aisle, on which is laid a pair of rails 5 on which the carrier cart 1 can travel reciprocally. On each side of the transport aisle 2 is arranged a row of car storage compartments 3, each of which accommodates a tray 4 therein. A lift 6 extends through its lift passage shaft 7 and communicates with a car entry/exit floor. The lift 6 is located at one end of one of the car storage compartment rows (on the right side in Figure 3).

[0016] In this parking system, mounted on the carrier cart 1 is a tray transfer device 11 that transfers the tray 4 between the carrier cart 1 and respective car storage compartments 3 and between the carrier cart 1 and the lift 6, and which includes a rotary arm 12, an engagement member 13 of the rotary arm 12, a rotary drive unit 14 for the rotary arm 12, and a vertical drive unit 16 for the engagement member 13.

[0017] The rotary arm 12 has its rotating center set at a predetermined position at a center of the width of the carrier cart 1 and is disposed horizontally rotatable. The rotary arm 12 has a length such that when it is rotated, its front end projects into the car storage compartment 3 by a predetermined dimension.

[0018] The engagement member 13 of the rotary arm 12, as shown in Figure 4, comprises a roller 8 and its support shaft 9, with the support shaft 9 inserted from above through an insert hole 12a at the free end of the rotary arm 12 and connected, vertically movable, to the vertical drive unit 16. The roller 8 is tapered so that its diameter is progressively reduced from the bottom toward the top and is shaped as a whole like a truncated cone.

[0019] The rotary drive unit 14 for the rotary arm 12 includes a servo motor whose rotating shaft 15, as shown in Figure 4, is mounted with the rotary arm 12. In the rotating operation of the rotary arm 12, its rotation stop position is controlled by a pulse signal.

[0020] The vertical drive unit 16 for the engagement member 13, as shown in Figure 4, has a drive motor 20, such as a linear head motor, and a drive shaft 21 linearly driven by the drive motor 20, and is mounted on the underside of the free end of the rotary arm 12 below the engagement member 13, with the support shaft 9 of the engagement member 13 and the drive shaft 21 coupled. In the figure, designated 17 is a power cord connected at one end to the drive motor 20 and at the other end through the rotary arm 12 to a collector 18 that projects on the pivotably supported side of the rotary arm 12. The collector 18 is connected to a power supply through an output terminal 19 of the servo motor 14 of the rotary drive unit. This connection structure of the collector 18 and the feeder 19 does not block the rotation of the rotary arm 12. The vertical drive unit 16 for the engagement member 13 may be constructed of a motor-driven cylinder and a solenoid instead of the linear head motor.

[0021] The vertical drive unit 16 may also be made as a means for vertically moving the entire rotary arm 12, not just the engagement member 13, and may be provided on the rotary drive unit 14 side. In this case, the support shaft 9 of the engagement member 13 is fixed, and the drive motor 20 for vertically moving the engagement member 13 and the cord 17 for connecting the drive motor to the power supply through the collector 18 are obviated.

[0022] The tray transfer device 11 of the above construction is mounted on the carrier cart 1. The car mounting tray 4 has on its underside a pair of angle guide members 10 separated in a tray width direction and arranged at both sides of the tray in such a way that the angle guide members 10 can be engaged by the engagement member 13 of the tray transfer device 11. The both ends of these angle guide members 10 are open and expanded outwardly, as shown in Figure 2 of the prior art, to ensure that the circling engagement member 13 can reliably fit into the guide member. In the description that follows, at the underside of the tray 4, the angle guide member 10 located on the inner side, which is closer to the transport aisle 2, is referred to as a first guide member 10a and the angle guide member 10 on the opposite outer side as a second guide member 10b.

[0023] Next, the operation of the planar reciprocating type parking system will be explained by referring to Figure 3 to Figure 9. In moving cars into or out of the parking

system, let us first explain briefly about a series of tray transfer steps, ranging from taking out a tray 4 from a car storage compartment 3 situated at the far end on the right side in Figure 3 (top of Figure 3) to placing the tray 4 on the lift 6 situated in the same row as the car storage compartment 3 from which the tray 4 was taken out. In the following description, a series of operation steps for forwarding the tray 4 to the same side as the compartment from which the tray was taken is called a first tray transfer operation. In this operation, the carrier cart 1 is moved to a position on the transport aisle 2 in front of the compartment at the far end on the right side, after which the rotary arm 12 is rotated toward the compartment 3 (counterclockwise in Figure 3) to cause the engagement member 13 to engage the first guide member 10a on the underside of the tray 4. The engagement member 13, as it circles together with the rotary arm 12 along the first guide member 10a, pulls out the tray 4 from the compartment onto the carrier cart 1. When the tray 4 is transferred completely onto the carrier cart 1, it is locked by a tray lock device not shown. Then, with the engagement member 13 and the first guide member 10a kept engaged, the carrier cart 1 travels to a position in front of the lift 6. Then the rotary arm 12 is pivoted backward (clockwise in Figure 3) to push out the tray 4 onto the lift 6. A series of steps for transferring the tray 4 from the lift 6 onto the carrier cart 1 and forwarding it to a desired compartment 3 in the same row as the lift is performed in the similar way to the above-mentioned first tray transfer operation. Further, the tray forwarding between the car storage compartments 3 in the same row, rather than between the lift 6 and the compartment, is carried out in the same way as the first tray transfer operation.

[0024] Next, a series of tray transfer operation steps for taking out a tray 4 from the car storage compartment 3 situated at the far end on the left side in Figure 3 and forwarding it onto the lift 6 situated at a row opposite the row of the compartment from which the tray 4 was taken out, will be explained in detail. In the following description, a series of steps for forwarding a tray to a side opposite the side of the source compartment from which the tray was taken out is called a second tray transfer operation.

[0025] In Figure 3, the carrier cart 1 travels by its own power on the transport aisle 2 and stops at the far end (in Figure 3, at the top). Next, in the tray transfer device 11 of the carrier cart 1, the servo motor 14 is activated to rotate its shaft 15, causing the rotary arm 12 to turn (clockwise in Figure 3) from the initial home position where it is parallel to the transport aisle 2 toward the car storage compartment 3 on the left. When front end of the pivoting rotary arm 12 enters into the car storage compartment 3 and the rotary arm 12 as a whole becomes perpendicular to the row of the compartments, the engagement member 13 fits into one end of the first guide member 10a on the underside of the tray 4 accommodated in the car storage compartment 3. As shown in Figure 5, as the rotary arm 12 continues pivoting, the engagement member 13 moves along the first guide member 10a pulling out the tray 4 toward the carrier cart 1. When the rotary arm 12 rotates to a position where it is parallel to the longitudinal direction of the tray 4, the engagement member 13 comes close to the end of the first guide member 10a of the tray 4. As the rotary arm 12 further pivots, the engagement member 13 moves along the first guide member 10a in the opposite direction. The rotary arm 12 is pivoted in this way until the tray 4 is completely transferred onto the carrier cart 1, at which time it stops pivoting. Then, the tray 4 is locked by the tray lock means (not shown) and held in this state.

[0026] When the tray 4 is placed on the carrier cart 1, the carrier cart 1 moves by its own power on the transport aisle 2 toward the lift 6, as shown by the arrows in Figure 6(a) to 6(d). Figure 6(a) shows a state, in which one of the trays in the car storage compartments on the left side is pulled out onto the carrier cart 1 and locked there and the carrier cart 1 is about to move. While the carrier cart 1 is moving, the vertical drive unit 16 for the engagement member 13 in the tray transfer device 11 is activated. That is, the drive motor 20 drives the drive shaft 21 downwardly, causing the support shaft 9 of the engagement member 13 connected to the drive shaft 21 to move down toward the underside of the rotary arm 12. With the lowering movement of the support shaft 9, the roller 8 moves down to a position where it contacts the upper surface of the rotary arm 12 (the position indicated by a two-dot line in Figure 4) and disengages from the first guide member 10a, at which time the drive motor 20 is stopped. When the engagement member 13 disengages from the tray 4, the servo motor 14 is activated to pivot the rotary arm 12 in a direction as shown in Figure 6(b) (counterclockwise in Figure 3), opposite to the direction in which it was pivoted when the tray 4 was pulled out. Then, the rotary arm 12 is stopped when the roller 8 is aligned with another guide member, or second guide member lOb, as shown in Figure 6(c). The drive motor 20 of the vertical drive unit 16 is operated again to drive the drive shaft 21 upward, causing the support shaft 9 and roller 8 of the engagement member 13 to move above the upper surface of the rotary arm 12 (indicated by a solid line in Figure 4) to insert the roller 8 into the second guide member 10b from blow for engagement. Because the roller 8 is shaped like a truncated cone, i.e., tapered so that its diameter progressively decreases from the bottom toward the top, if there is some deviation between the stop position of the rotary arm 12 and a position immediately below the second guide member 10b, a smooth engagement can be obtained between the engagement member 13 and the second guide member 10b. Once the engagement member 13 and the second guide member 10b engage, they are held in that state until the carrier cart 1 traveling on the transport aisle 2 reaches the lift 6, as shown in Figure 6(d).

[0027] While the carrier cart 1 is traveling, the engagement of the engagement member 13 is switched from the first guide member 10a to the second guide member 10b. When the carrier cart 1 comes in front of the lift 6, it is stopped and the tray 4 is unlocked. In the tray transfer device 11, the servo motor 14 is started to pivot the rotary arm 12 toward the lift 6 (clockwise in Figure 3), causing the engagement member 13 to move along the second guide member 10b, pushing out the tray 4 from the carrier cart 1 toward the lift 6. When the rotary arm 12 pivots to a position where it is parallel to the longitudinal direction of the tray 4, the engagement member 13 comes close to the end of the second guide member 10b and the tray 4 projects from the carrier cart 1 into the lift 6 by a distance equal to about half the width of the tray 4. As the rotary arm 12 continues to pivot, the engagement member 13 moves along the second guide member 10b in the opposite direction. When the rotary arm 12, which is pushing the tray 4 as shown in Figure 7, reaches a predetermined rotating angle, the tray 4 is completely transferred onto the lift 6. At the same time, the engagement member 13 comes off the second guide member 10b of the tray 4 and the rotary arm 12 is pivoted to the initial home position on the carrier cart 1 where it is stopped. The tray 4 that was moved from the left row to the right row in Figure 3 has the positional relation of the first and second guide members 10a, 10b reversed. That is, after the tray 4 has been transferred from one side to the other, the guide member on the inner side closer to the transport aisle 2 is the first guide member 10a and the one on the outer side is the second guide member 10b, so that the positions of the guide members are opposite to those before the transfer.

[0028] Figure 8 shows an example forwarding operation, in which a tray 4 is transferred from a car storage compartment 3 at the far end of the left-hand side row to a compartment 3 at the near end of the right-hand side row. In this series of steps, too, the components of the system perform the similar tray transfer operation to the one described above.

[0029] In the configuration of Figure 3, the similar operation is also performed when transferring the tray 4 from the lift 6 to the carrier cart 1 and forwarding it to a compartment 3 in a different row than that of the lift 6, or when transferring the tray 4 between the compartments 3 of different rows.

[0030] As explained above, this embodiment is constructed to be able to perform the first tray transfer operation and the second tray transfer operation. With the lift 6 installed at an arbitrary location in a row of car storage compartments 3 and with the tray transfer device 11 mounted on the carrier cart 1 that travels back and forth on the transport aisle 2, the first tray transfer operation involves pulling out a tray 4 from a car storage compartment 3 or the lift 6 onto the carrier cart 1 by the pivoting action of the rotary arm 12 whose engagement member 13 slides along the first guide member 10a, and then pivoting the rotary arm 12 toward the lift 6 or compartment 3 in the same row as the source compartment from which the tray 4 was pulled out, with the engagement member 13 and the first guide member 10a kept engaged, to forward the tray 4 to the lift 6 or compartment 3 in the same row of the source compartment. The second tray transfer operation involves switching the engagement of the engagement member 13 from the first guide member 10a to the second guide member 10b and pivoting the rotary arm 12 toward the lift 6 or compartment 3 in a row opposite the row of the source compartment from which the tray 4 was pulled out, to forward the tray 4 to the lift 6 or compartment 3 in the opposite row. This arrangement makes it possible to forward the tray 4 between car storage compartments 3 in the same row or between compartments 3 in different rows, or between the compartment 3 and the lift 6 by operating only the tray transfer device 11 on the carrier cart 1, allowing swift and smooth car entry or exiting to or from the parking system.

[0031] With this configuration of the parking system, because the lift 6 can be located at any arbitrary position in a row of car storage compartments 3, the car entry floor can be set at a corner of a building, thus permitting efficient use of space in the building. The parking system therefore can be installed efficiently in a confined space. Furthermore, because no additional drive unit is required for transferring the tray between the lift 6 and the carrier cart 1, the parking system as a whole has a simple construction and reduced cost.

(Embodiment 1)

[0032] Figure 9 to Figure 12 show constitutional elements of a multifloor planar reciprocating type parking system as a first embodiment of this invention. Figure 9 is a partial plan view of one parking floor of this parking system. Figure 10 is an enlarged plan view of the carrier cart, lift passage shaft and lift of Figure 9. Figure 11 is an enlarged side view, as seen from the compartment side, showing the lift passage shaft and the lift. Figure 12 is an enlarged end view, as seen from the lift passage shaft side, showing the lift passage shaft and the lift.

[0033] In Figures 9 to 12, components identical with those of the embodiment according to Figures 3 to 8 are given like reference numbers. In Figure 9, reference number 2 represents a transport aisle, and reference number 1 denotes a self-propelled carrier cart traveling back and forth on the transport aisle 2. Denoted 25 is a tray transfer device mounted on the carrier cart 1. Car storage compartments 3 are arranged in two rows, one on each side of the transport aisle 2 and each of these compartments accommodates a tray 4. Designated 7 is a lift passage shaft that is located at an arbitrary position on the transport aisle 2 corresponding to a specified car storage compartment 3 and communicates the car entry/exit floor E (see Figure 11 and 12) with each parking floor. Denoted 6 is a lift installed in the lift passage shaft 7.

[0034] A pair of rails 5 for the carrier cart are laid on both sides of the transport aisle 2 and are divided by the lift passage shaft 7 into two pairs of rail portions 5a and 5b-arranged on transport aisles 2A and 2B, respectively, both making up the transport aisle 2 divided by the lift passage shaft 7-and also into a pair of rail portions 5c arranged on the lift passage shaft 7. Between the rail portions 5c on the lift passage shaft 7 and the rail portions 5a, 5b on the divided transport aisles on both sides of the lift passage shaft 7 are formed passage portions 30 of a predetermined gap that allow the lift 6 to pass through the rails 5.

[0035] The carrier cart 1, as shown in Figure 10, includes a cart frame 22 as a structural skeleton and a pair of transverse rails 23 for the tray 4 that are laid in width direction at the longitudinal ends of the cart frame 22. The cart frame 22 has a total of eight rotatably supported wheels 24, four on each of the widthwise-separated sides, two each at the front and rear, assuming positions corresponding to the paired rails 5 on the transport aisle 2.

[0036] In this first embodiment, the tray transfer device 25 mounted on the carrier cart 1 has the same construction as the tray transfer device 80 of the prior art. The identical components with those of the prior art are assigned like reference numbers and their explanations are omitted. The trays 4 are each provided at its underside with angle guide members 10 which an engagement member 82 of the tray transfer device 25 is adapted to engage. In this embodiment, the tray transfer device may use the same type of device as the tray transfer device 11 of the embodiment according to Figures 3 to 8.

[0037] In Figure 9, the lift 6 includes a total of four guide rails 26 erected at four corners of the lift passage shaft 7; a pair of lifting members 27 arranged in the lift passage shaft 7 in the width direction of the transport aisle 2 at the front and rear sides of the carrier cart 1 and guided vertically along the guide rails 26; support members 28 projecting inwardly of the lift passage shaft 7 from the ends of the lifting members 27 to support the trays 4 at four points; and a vertical drive unit 29 to drive the paired lifting members 27 vertically (refer to Figure 13 and 14). These components will be explained with reference to Figure 11 and 12.

[0038] The four guide rails 26 are each made of a column member, H-shaped or U-shaped in cross section and erected outside the paired rails 5 with their open faces directed perpendicularly to the longitudinal direction of the transport aisle 2.

[0039] The pair of lifting members 27 are each disposed between the opposing guide rails 26 located at the widthwise-separated sides of the lift passage shaft 7 so that they can pass through the passage portions 30 of the paired rails 5. The ends of the paired lifting members 27 are connected to slidable lifting rods 32 through guide rollers 31 on the guide rails 26. The support members 28 mounted to the lifting members 27 are situated inside the paired rails 5 and have upwardly protruding engagement projections 33 at their front ends.

[0040] The vertical drive unit 29 includes a drive motor 34 with a reduction gear, a sprocket 35, a counter weight 36 and a drive chain 37. The drive chain 37 is connected to the lifting rods 32 to vertically drive the lifting rods 32 and therefore the paired lifting members 27.

[0041] In this construction of the lift 6, the tray 4 has formed on the longitudinal sides of its undersurface engagement recesses 38 that can accept the engagement projections 33 of the support members 28, as shown in Figure 11 and 12.

[0042] In Figure 9, in each car storage compartment 3 are laid a pair of transverse rails 39 corresponding to the transverse rails 23 of the carrier cart 1 so that, as shown in Figure 11, the tray 4 can be moved on the transverse rails 39 through rollers 40.

[0043] Next, the operation of this planar reciprocating type parking system will be explained by referring to Figure 9 and Figure 13. Figure 13 shows a part of the tray transfer operation between the lift 6 and the carrier cart 1.

[0044] In the process of moving a car into or out of the parking system, let us first explain about a series of steps, from taking the tray 4 out of a car storage compartment 3 other than the compartments adjoining the lift passage shaft 7 on both sides (this compartment is called a source compartment 3) to putting the tray 4 on the lift 6.

[0045] In Figure 9, at first the carrier cart 1 is moved on the paired rails 5 on the transport aisle 2 to a position in front of the source compartment 3. Then, in front of the source compartment 3, the tray transfer device 25 is operated to pivot the rotary arm 81 to pull out the tray 4 onto the carrier cart 1. The tray 4, after it was completely transferred onto the carrier cart 1, is locked by a tray lock device not shown. With the engagement member 82 and the angle guide member 10 engaged, the carrier cart 1 travels on the transport aisle 2 toward the lift passage shaft 7

[0046] As the carrier cart 1 enters into the lift passage shaft 7, the front wheels 24 on both sides of the carrier cart 1 reach the passage portions 30 between the rail portions 5a or 5b and the rail portions 5c and pass over the passage portions 30 without falling, with the succeeding six wheels 24, three on each side, supporting the carrier cart 1 on the rails 5. The next pair of wheels 24 that have reached the passage portions 30 similarly pass over the passage portions 30, supported by other wheels running on the rails 5. After all the wheels 24 have passed onto the rail portions 5c in the lift passage shaft 7, the carrier cart 1 is stopped. Then, as shown in Figure 13(a), the lift 6 moves up the lift passage shaft 7 from below the carrier cart 1. That is, the paired lifting members 27 move up the lift passage shaft 7 and when the support members 28 contact the underside of the tray 4 on the carrier cart 1, the engagement projections 33 and the engagement recesses 38 engage, securely supporting the tray 4 and lifting it upward from the carrier

cart 1. As the tray 4 is lifted, the engagement member 82 of the tray transfer device 25 disengages from the angle guide member 10 on the underside of the tray 4. Then, the lift 6 moves up the lift passage shaft 7 to the car entry/exit floor E where the car is moved into or out of the parking system.

[0047] When the tray 4 is to be transferred from a compartment 3 on either side of the lift passage shaft 7 onto the lift 6, the carrier cart 1 is first moved into the lift passage shaft 7 and then the tray transfer device 25 is operated to pull out the tray 4 from the compartment 3 onto the carrier cart 1. Next, the lift 6 is moved up from below the carrier cart 1 to lift the tray 4 from the carrier cart 1, thus achieving the transfer of the tray.

[0048] Next, in the process of moving a car into or out of the parking system, we will explain about a series of steps, from transferring the tray 4 from the lift 6 onto the carrier cart 1 to forwarding it into a desired compartment 3 (this compartment is called a destination compartment 3).

[0049] In Figure 9, the lift 6 carrying the tray 4 is moved up or down the lift passage shaft 7 to the desired floor and is stopped at a predetermined position higher than the destination floor. Next, the carrier cart 1 is moved on the paired rails 5 passing over the passage portions 30 and entering into the lift passage shaft 7. Then, as shown in Figure 13(b), the lift 6 is lowered in the lift passage shaft 7 from above the carrier cart 1. That is, the paired lifting members 27 move down the lift passage shaft 7, lowering the tray 4-which is supported and locked on the support members 28-onto the carrier cart 1. At the same time, the engagement member 82 is inserted from below into the angle guide member 10 on the underside of the tray 4. During this process, the lifting members 27 pass the sides of the carrier cart 1, causing the support members 28 to part from the tray 4, and the lift 6 is lowered below the carrier cart 1.

[0050] Next, the carrier cart 1 travels on the paired rails 5 on the transport aisle 2 to the front of the destination compartment.3. At the front of the destination compartment 3, the tray transfer device 25 is operated to pivot the rotary arm 81 toward the compartment 3, pushing the tray 4 from the carrier cart 1 into the destination compartment 3 so that the tray 4 is placed on the transverse rails 39.

[0051] When the tray 4 is to be transferred from the lift 6 to a compartment on either side of the lift passage shaft 7, the process involves transferring the tray 4 from the lift 6 onto the carrier cart 1 and then operating the tray transfer device 25 to cause the tray 4 to move from the carrier cart 1 into the car storage compartment 3.

[0052] As described above, in this embodiment, the lift 6 includes a total of four guide rails 26 erected at four corners of the lift passage shaft 7; a pair of lifting members 27 arranged in the lift passage shaft 7 in the width direction of the transport aisle 2 at the front and rear sides of the carrier cart 1 and guided vertically along the guide rails 26; support members 28 projecting inwardly of the lift passage shaft 7 from the ends of the lifting members 27 to support the trays 4 at four points; and a vertical drive unit 29 to drive the paired lifting members 27 vertically. The pair of rails 5 on the transport aisle 2 are divided by the pair of lifting members 27 and the passage portions 30 are provided at the divided points. The carrier cart 1 are supported on the rails 5 by a total of eight wheels 24, four on each side at the front and rear. Because of this construction, if the lift passage shaft 7 is located at an intermediate position of the transport aisle 2 in front of an arbitrary car storage compartment 3, the carrier cart 1 can move back and forth over the entire transport aisle 2 by passing through the lift passage shaft 7, making it possible to transfer the tray 4 between the carrier cart 1 and the lift 6 without using any additional drive unit. Further, because the support members 28 of the lift 6 are each provided with an engagement projection 33 for engagement with the engagement recess 38, the tray 4 can be reliably supported on the lift 6 without being dislocated.

[0053] If the lift passage shaft 7 is set at an intermediate part of the transport aisle 2, therefore, there is no need to add another carrier cart 1 or tray transfer device 25 or to install a dedicated tray transfer device between the carrier cart 1 and the lift 6, thus simplifying the overall construction of the parking system and reducing the cost.

[0054] While in this embodiment the lift passage shaft 7 for the lift 6 is set at an intermediate location on the transport aisle 2, it is also possible to locate it at an end of the aisle. In this case, too, the tray 4 can be transferred directly between the carrier cart 1 and the lift 6, requiring no additional drive unit and realizing a simplified structure and reduced cost of the parking system as a whole.

(Embodiment 2)

[0055] Figure 14 shows the construction of the planar reciprocating type parking system as a second embodiment of this invention. This parking system consists of a plurality of parking floors, each of which has the construction of Figure 14, except for the car entry/exit floor.

[0056] In Figure 14, designated 2 is a transport aisle, which is arranged at a central-when viewed widthwise-part of each of elongate parking floors and extends in the longitudinal direction. On the transport aisle 2 are laid a pair of rails 5, which are provided with a feeder (not shown) for the carrier cart. A self-propelled carrier cart 1 for carrying a car-mounting tray 4 is put on the rails 5 on the transport aisle 2 and supplied with electricity through a collector (not shown) on the carrier cart 1 and a feeder on the rails 5, and runs reciprocally on the rails 5. On either side of the transport aisle 2 there is arranged a row of car storage compartments 3, each of which has a pair of transverse rails 39, on which the tray 4 can be placed as shown in Figure 15(b). The right-hand side of the transport aisle 2 is referred to as an R

side and the left-hand side as an L side for distinction. Each of the trays 4 is mounted on its undersurface with a pair of angle guide members 10 at widthwise separated sides. The both ends of these angle guide members 10 are open and expanded outwardly, as shown in Figure 2, so that pivoting engagement members 13, 48 of the tray transfer devices 11, 46R, 46L to be described later can reliably fit into the angle guide members 10. In the following explanation, the angle guide member 10 on the underside of the tray 4 situated at a side closer to the transport aisle 2 is referred to as a first guide member 10a and the angle guide member 10 at the opposite side as a second guide member 10b. A lift 6 communicates the car entry/exit floor with each of the parking floors. A lift passage shaft 7 is installed at one end of the transport aisle 2. The car storage compartments 3 on both sides of the lift 6 are set as lift connecting compartments 3aR, 3aL; and the car storage compartments 3 adjoining the lift connecting compartments 3aR, 3aL are set as tray longitudinal forwarding compartments 3bR, 3bL. In this parking system, the lift connecting compartment 3aR and tray longitudinal forwarding compartment 3bR on the R side are used as car exiting compartments; and the lift connecting compartment 3aL and tray longitudinal forwarding compartment 3bL on the L side are used as car entry compartments.

[0057] The carrier cart 1 has mounted thereon a first tray transfer device 11 that transfers the tray 4 between the carrier cart 1 and the compartments 3 on the R and L sides. The first tray transfer device 11 includes a rotary arm 12, an engagement member 13 at the free end of the rotary arm 12, a rotary drive unit (servo motor) 14 for the rotary arm 12, and a vertical drive unit 16 for the engagement member 13. Denoted 41 is a tray lock device for locking the tray 4 mounted on the carrier cart 1. The first tray transfer device 11 is of the same type as the one used in the embodiment according to Figures 3 to 8, and thus the construction and the working will be explained by referring to Figure 4 to 7 as required.

[0058] The rotary arm 12 has its rotating center set at a predetermined position at a center of the width of the carrier cart 1 and is disposed horizontally rotatable. The rotary arm 12 has a length such that when it is rotated, its front end projects into the car storage compartment 3 by a predetermined dimension.

[0059] The engagement member 13 of the rotary arm 12, as shown in Figure 4, comprises a roller 8 and its support shaft 9, with the support shaft 9 inserted from above through an insert hole 12a at the free end of the rotary arm 12 and connected, vertically movable, to the vertical drive unit 16. The roller 8 is tapered so that its diameter is progressively reduced from the bottom toward the top and is shaped as a whole like a truncated cone.

[0060] The rotary drive unit 14 for the rotary arm 12 is a direct-coupled servo motor whose rotating shaft 15, as shown in Figure 4, is mounted with the rotary arm 12. In the rotating operation of the rotary arm 12, its rotation stop position is controlled by a pulse signal.

[0061] The vertical drive unit 16 for the engagement member 13, as shown in Figure 4, has a drive motor 20, such as a linear head motor, and a drive shaft 21 linearly driven by the drive motor 20, and is mounted on the underside of the free end of the rotary arm 12 below the engagement member 13, with the'support shaft 9 of the engagement member 13 and the drive shaft 21 coupled. In the figure, designated 17 is a power cord connected at one end to the drive motor 20 and at the other end through the rotary arm 12 to a collector 18 that is mounted on the pivotably supported side of the rotary arm 12. The collector 18 is connected to a power supply through a feeder 19 at the top of the direct-coupled servo motor 14 of the rotary drive unit. This connection structure of the collector 18 and the feeder 19 does not block the rotation of the rotary arm 12. The vertical drive unit 16 for the engagement member 13 may be constructed of a motor-driven cylinder and a solenoid instead of the linear head motor.

[0062] The vertical drive unit 16 may also be formed as a means for vertically moving the entire rotary arm 12, not just the engagement member 13, and may be provided on the rotary drive unit 14 side, as shown by an imaginary line in Figure 4. In this case, the support shaft 9 of the engagement member 13 is fixed, and the drive motor 20 for vertically moving the engagement member 13 and the cord 17 for connecting the drive motor to the power supply through the collector 18 are obviated.

[0063] Between the lift connecting compartments 3aR, 3aL and the tray longitudinal forwarding compartments 3bR, 3bL are provided second tray transfer devices 42R, 42L for transferring the tray 4 between these compartments. The second tray transfer devices 42R, 42L, as shown in Figure 15(a), comprise a chain conveyor 43 straddling the compartments 3aR and 3bR and compartments 3aL and 3bL and a tray support frame 44 mounted on the chain conveyor 43 to support the tray 4. Denoted 45 is a chain guide that guides the circling motion of the chain conveyor 43 to prevent its loosening.

[0064] Fixedly installed in the lift connecting compartments 3aR, 3aL are third tray transfer devices 46R, 46L that transfer the tray 4 between the lift 6 and the lift connecting compartments 3aR, 3aL. The third tray transfer device 46R on the R side is for exiting of a car, and the third tray transfer device 46L on the L side is for entry of a car. These third tray transfer devices 46R, 46L use the same conventional type of device as those of Figure 2, and have a rotary arm 47, an engagement member 48 at the free end of the rotary arm 47, and a rotary drive unit 49 for the rotary arm 47. That is, the rotary arm 47 has its rotating center set at a predetermined position at a center of the width of the lift connecting compartment 3aR and is disposed horizontally rotatable. The rotary arm 47 has a length such that when it is rotated, its front end projects into the lift passage shaft 7 by a predetermined dimension. The engagement member 48 of the

rotary arm 47 comprises, though not shown, a truncated cone-shaped roller and its support shaft. Unlike the first tray transfer device 11, the third tray transfer device has the support shaft secured to the front end of the rotary arm 47. The rotary drive unit 49 for the rotary arm 47 uses a drive motor with a reduction gear.

[0065] In this parking system, for the operation of the tray transfer devices 11, 42R, 42L, 46R, 46L, at least one of the compartments on both sides R, L of the transport aisle 2 on each floor is set as a dead space with no tray installed therein.

[0066] Next, the basic operation of the first, second and third tray transfer devices 11, 42R, 42L, 46R, 46L in this planar reciprocating type parking system will be described by referring mainly to Figure 14 and, as required, to Figure 4 to 7.

[0067] The first tray transfer device 11 can take either a first tray transfer operation or a second tray transfer operation. The first tray transfer operation involves pulling out the tray 4 from a car storage compartment 3 or source compartment on the R side or L side of the transport aisle 2 onto the carrier cart 1 and forwarding the tray 4 into a destination compartment in the same row as the source compartment. The second tray transfer operation involves forwarding the tray 4 into a destination compartment 3 in a row opposite the row from which the tray 4 was pulled out. That is, the transfer process works as follows. First, the servo motor 14 rotates the shaft 15, which in turn causes the rotary arm 12 to pivot from the initial home position, where it is parallel to the longitudinal direction of the transport aisle 2, toward a car storage compartment 3 on the R side or L side. When, as the result of the pivoting motion of the rotary arm 12, the rotary arm's front end enters into the compartment and the rotary arm as a whole is perpendicular to the row of the compartments, the engagement member 13 enters into one end of the first guide member 10a attached to the underside of the tray 4 in the compartment 3. As shown in Figure 5, as the rotary arm 12 continues to pivot, the engagement member 13 moves along the first guide member 10a, pulling out the tray 4 toward the carrier cart 1. When the rotary arm 12 rotates to a position where it is parallel to the longitudinal direction of the tray 4, the engagement member 13 comes close to the end of the first guide member 10a of the tray 4. As the rotary arm 12 is further pivoted, the engagement member 13 moves in the opposite direction along the first guide member 10a. When the rotary arm 12 is pivoted through a predetermined angle, it is stopped. Now, the tray 4 is completely transferred onto the carrier cart 1. The tray 4 is then locked in this state by a tray lock device 41. With the tray 4 moved to the front of the destination compartment, the following tray forwarding operation is performed.

[0068] When the destination compartment is on the same side as the source compartment from which the tray 4 was pulled out, the rotary arm 12 is pivoted in the backward direction to push the tray 4 into the destination compartment 3. In the following description, a series of operation steps to forward the tray 4 into the destination compartment on the same side of the source compartment is referred to as a first tray transfer operation.

[0069] When the destination compartment is on the side opposite the source compartment from which the tray 4 was pulled out, the forwarding operation involves putting the tray 4 onto the carrier cart 1 as described above and operating the vertical drive unit 16 for the engagement member 13 in the first tray transfer device 11. That is, as shown in Figure 4, the drive motor 20 drives the drive shaft 21 downwardly to lower the support shaft 9 of the engagement member 13 connected to the drive shaft 21 toward the underside of the rotary arm 12. The lowering motion of the support shaft 9 causes the roller 8 to move down to the upper surface of the rotary arm 12 and disengage from the first guide member 10a, at which time the drive motor 20 is stopped. When the engagement member 13 disengages from the tray 4, the servo motor 14 is operated to pivot the rotary arm 12 in a direction opposite the direction in which it was pivoted when the tray 4 was pulled out. When the roller 8 and the second guide member 10b are aligned, the rotary arm 12 is stopped. Then, the drive motor 20 for the vertical drive unit 16 is started again to move the drive shaft 21 upward until the support shaft 9 of the engagement member 13 rises above the upper surface of the rotary arm 12, causing the roller 8 to fit from below into the second guide member 10b for engagement. At this time, because the roller 8 is shaped like a truncated cone with its diameter progressively decreasing from the bottom toward the top, if there is some deviation between a stop position of the rotary arm 12 and a position directly below the second guide member 10b, a smooth engagement can be obtained between the engagement member 13 and the second guide member 10b.

[0070] After the engagement member 13 is switched from the first guide member 10a to the second guide member 10b, the tray 4 is unlocked and the servo motor 14 in the first tray transfer device 11 is operated to pivot the rotary arm 12 toward the destination compartment 3. As the rotary arm 12 is pivoted, the engagement member 13 moves along the second guide member 10b, pushing the tray 4 from the carrier cart 1 toward the destination compartment 3. When the rotary arm 12 rotates to a position where it is parallel to the longitudinal direction of the tray 4, the engagement member 13 comes close to the end of the second guide member 10b of the tray 4. As the rotary arm 12 is further pivoted, the engagement member 13 moves in the opposite direction along the second guide member 10b. As shown in Figure 7, when the rotary arm 12 is pivoted through a predetermined angle, the tray 4 is completely transferred into the destination compartment 3. At the same time, the engagement member 13 disengages from the second guide member 10b and the rotary arm 12 is pivoted to the initial home position on the carrier cart 1 and stopped there.

[0071] The second tray transfer devices 42R, 42L can perform the longitudinal tray forwarding operation between the lift connecting compartments 3aR, 3aL and the tray longitudinal forwarding compartments 3bR, 3bL. The second tray transfer device 42R on the R side is used mainly for moving a car out of the parking system and performs the steps of circulating the chain conveyor 43 to turn the tray support frame 44 in a direction from the tray longitudinal forwarding compartment 3bR toward the lift connecting compartment 3aR and then longitudinally forwarding the tray 4 mounted on the tray support frame 44 from the tray longitudinal forwarding compartment 3bR to the lift connecting compartment 3aR. The second tray transfer device 42L on the L side is used mainly for moving a car into the parking system and performs the steps reverse to the ones described above to longitudinally forward the tray 4 from the lift connecting compartment 3aL to the tray longitudinal forwarding compartment 3bL.

[0072] The third tray transfer devices 46R, 46L can perform the first tray transfer operation between the lift 6 and the lift connecting compartments 3aR, 3aL. The third tray transfer device 46R on the R side is used mainly for moving a car out of the parking system and performs the first tray transfer operation to push out the tray 4 from the lift connecting compartment 3aR onto the lift 6. That is, in the lift connecting compartment 3aR, the engagement member 48 engages the second guide member 10b of the tray 4 and the operation of the rotary drive unit 49 pivots the rotary arm 47 toward the lift passage shaft 7. When the rotary arm 47 comes to a position where it is perpendicular to the longitudinal direction of the lift passage shaft 7, the tray 4 is completely transferred onto the lift 6, immediately after which the engagement member 48 disengages from the second guide member 10b. The third tray transfer device 46L on the L-side is used mainly to move a car into the parking system and performs the first tray transfer operation to pull the tray 4 from the lift 6 into the lift connecting compartment 3aL. The first tray transfer operation on the L side is reverse to that performed on the R side.

[0073] Next, the overall operation of the planar reciprocating type parking system based on the basic operations of the tray transfer devices 11, 42R, 42L, 46R, 46L will be explained by referring mainly to Figure 14 and also, as required, to other figures.

[0074] Here, let us first explain about the operation for moving cars-stored one in each of three compartments in a row on the same floor, for example, on the R side of the lift-out of the parking system successively.

[0075] In Figure 14, the carrier cart 1 travels on the transport aisle 2 toward the first compartment 3 (the first refers to the order in which the car is to be taken out of the compartment) and stops in front of the first compartment 3. The first tray transfer device 11 on the carrier cart 1 performs the first tray transfer operation to pull out the tray 4 onto the carrier cart 1. Then, the tray 4 is locked in this state by the tray lock device 41. With the tray 4 and the first tray transfer device 11 engaged, the carrier cart 1 moves to the front of the tray longitudinal forwarding compartments 3bR, 3bL, after which the first tray transfer device 11 performs the first tray transfer operation to transfer the tray 4 from the carrier cart 1 onto the tray longitudinal forwarding compartment 3bR on the R side.

[0076] The vacant carrier cart 1 travels toward the second compartment 3 (the second refers to the order in which the car is to be taken out of the compartment). In front of the second compartment 3, the similar tray transfer operation is performed. The first tray 4 that was transferred to the tray longitudinal forwarding compartment 3bR on the R side is forwarded from the tray longitudinal forwarding compartment 3bR to the lift connecting compartment 3aR by the longitudinal forwarding operation of the second tray transfer device 42R.

[0077] Next, the second tray 4 that was carried by the carrier cart 1 to the front of the tray longitudinal forwarding compartments 3bR, 3bL is transferred from the carrier cart 1 onto the tray longitudinal forwarding compartment 3bR on the R side by the first tray transfer operation of the first tray transfer device 11.

[0078] In parallel with this operation, the lift 6 is raised or lowered to this parking floor. In the lift connecting compartment 3aR on the R side, the third tray transfer device 46R performs the first tray transfer operation to transfer the first tray 4 onto the lift 6. The lift 6 moves up or down to the car entry/exit floor, where the car on the first tray 4 is moved out.

[0079] The carrier cart 1, which is now vacant again, moves toward the third compartment (the third refers to the order in which the car is to be taken out of the compartment). In front of the third compartment, the similar tray transfer operation is performed. The second tray 4, which was forwarded to the tray longitudinal forwarding compartment 3bR on the R side, is transferred from the tray longitudinal forwarding compartment 3bR to the lift connecting compartment 3aR by the longitudinal transfer operation of the second tray transfer device 42R.

[0080] Next, the third tray 4, which was forwarded to the front of the tray longitudinal forwarding compartments 3bR, 3bL by the carrier cart 1, is transferred from the carrier cart 1 onto the tray longitudinal forwarding compartment 3bR on the R side by the first tray transfer operation of the first tray transfer device 11.

[0081] In parallel with this operation, the lift 6 is raised or lowered to this parking floor. In the lift connecting compartment 3aL on the L side, the third tray transfer device 46L performs the first tray transfer operation to pull the first tray 4, which is vacant, from the lift 6 onto the lift connecting compartment 3aL. The lift 6 is now vacant and, in the lift connecting compartment 3aR on the R side, the third tray transfer device 46R performs the first tray transfer operation to push the second tray 4 onto the lift 6. The lift 6 is raised or lowered to the entry/exit floor, where the car on the second tray 4 is moved out.

[0082] The carrier cart 1, which is vacant again, waits for the next car entry/exit operation. At the same time, the third tray 4 that was transferred onto the tray longitudinal forwarding compartment 3bR on the R side is similarly transferred from the tray longitudinal forwarding compartment 3bR to the lift connecting compartment 3aR by the longitudinal forwarding operation of the second tray transfer device 42R on the R side. The lift 6 is raised or lowered to this parking floor and, in the lift connecting compartment 3aL on the L side, the third tray transfer device 46L performs the first tray transfer operation to pull the second vacant tray 4 onto the lift connecting compartment 3aL. The lift 6 is now vacant. In the lift connecting compartment 3aR on the R side, the third tray transfer device 46R performs the first tray transfer operation to push the third tray 4 onto the lift 6. The lift 6 is raised or lowered to the entry/exit floor, where the car on the third tray 4 is moved out.

[0083] In this car exit process, when cars stored in, for example, three compartments 3 in a row on the L side of the lift on the same floor are to be taken out successively, the first tray transfer device 11 on the carrier cart 1 performs the second tray transfer operation. That is, the carrier cart 1 stops at the front of the source compartment 3 and the first tray transfer device 11 on the carrier cart 1 pulls out the tray 4 onto the carrier cart 1. Then, the tray 4 is locked in this state by the tray lock device 41. While the carrier cart 1 is traveling, the engagement member 13 is switched from the first guide member 10a to the second guide member lOb according to the second tray transfer operation of the first tray transfer device 11. Next, when the carrier cart 1 comes to the front of the tray longitudinal forwarding compartments 3bR, 3bL, the first tray transfer device 11 performs the second tray transfer operation to push the tray 4 from the carrier cart 1 onto the tray longitudinal forwarding compartment 3bR on the R side. The subsequent operation steps are the same as those described above.

[0084] Next, the process of entering, for example, three cars into three compartments on the R side on the same floor successively will be described.

[0085] In Figure 14, after a tray 4 carrying a first car is raised or lowered to the destination floor by the lift 6 (the first refers to the order in which the car is entered into the parking system), the third tray transfer device 46L in the lift connecting compartment 3aL on the L side performs the first tray transfer operation to pull the tray 4 from the lift 6 onto the lift connecting compartment 3aL.

[0086] The operation similar to the one already explained in the process of moving the car out of the parking system is performed beforehand to move a vacant tray 4 to the lift connecting compartment 3aR on the R side. The first tray transfer operation of the third tray transfer device 46R causes the vacant tray 4 to be moved onto the lift 6, which is then raised or lowered to the entry/exit floor, where it receives a second car (the second refers to the order in which the car is entered). The tray 4 carrying the first incoming car, which was already transferred to the lift connecting compartment 3aL on the L side, is moved into the tray longitudinal forwarding compartment 3bL by the longitudinal transfer operation of the second tray transfer device 42L.

[0087] In parallel with this operation, the carrier cart 1 transfers the vacant tray 4 for the incoming car to the tray longitudinal forwarding compartment 3bR on the R side. With the carrier cart 1 held in front of the tray longitudinal forwarding compartments 3bR, 3bL on the R and L sides, the first tray transfer device 11 on the carrier cart 1 performs the second tray transfer operation to pull the first tray 4 carrying the incoming car from the tray longitudinal forwarding compartment 3bL on the L side onto the carrier cart 1. The carrier cart 1 travels on the transport aisle 2 and, by the second tray transfer operation of the first tray transfer device 11, pushes the first car-mounting tray into the predetermined compartment 3 on the R side. After the first car parking operation is finished, the first tray transfer device 11 pulls a vacant tray 4 from other compartment on the R or L side onto the carrier cart 1 and carries and transfers it to the tray longitudinal forwarding compartment 3bR.

[0088] In the meant time, the tray 4 carrying the second car is raised or lowered from the entry/exit floor by the lift 6. The third tray transfer device 46L pulls, by its first tray transfer operation, the second car-loaded tray 4 from the lift 6 onto the lift connecting compartment 3aL. Likewise, the vacant tray 4 waiting in the lift connecting compartment 3aR on the R side is transferred onto the lift 6 by the first tray transfer operation of the third tray transfer device 46R. The lift 6 is then raised or lowered to the entry/exit floor, where it accepts the third car (the third refers to the order in which the car is entered). On the other hand, the tray 4 carrying the second incoming car, which was pulled into the lift connecting compartment 3aL, is transferred to the tray longitudinal forwarding compartment 3bL by the longitudinal transfer operation of the second tray transfer device 42L. The carrier cart 1 is held standing by in front of the tray longitudinal forwarding compartments 3bR, 3bL on the R and L sides and the first tray transfer device 11 on the carrier cart 1 performs the second tray transfer operation to pull the second car-loaded tray 4 from the tray longitudinal forwarding compartment 3bL onto the carrier cart 1. The carrier cart 1 travels on the transport aisle 2 and, by the second tray transfer operation of the first tray transfer device 11, transfers the second car-loaded tray 4 to a predetermined compartment 3 on the R side. With the second car parking operation completed, the carrier cart 1 prepares for the next car entry/exit operation and returns to the front of the tray longitudinal forwarding compartments 3bR, 3bL where it stands by.

[0089] Next, the tray 4 carrying the third car is raised or lowered from the entry/exit floor by the lift 6 and is pulled from the lift 6 into the lift connecting compartment 3aL on the L side by the first tray transfer operation of the third tray transfer device 46L. The tray 4 is then lon-

gitudinally transferred by the second tray transfer device 42L to the tray longitudinal forwarding compartment 3bL, from which it is further transferred onto the carrier cart 1. The carrier cart 1 travels on the transport aisle 2 to the front of the destination compartment on the R side, where the first tray transfer device 11 performs the second tray transfer operation to push the third car-loaded tray 4 into the compartment, thus completing the third car parking operation.

[0090] In this car entry process, when, for example, three cars are to be successively moved into three compartments on the L side on the same floor, the operation steps are similar to the above process, except that the first tray transfer device 11 on the carrier cart 1 performs the first tray transfer operation.

[0091] In summary, this embodiment has the construction in which the lift 6 is installed at one end of the transport aisle 2; in which the car storage compartments 3 on either side of the lift 6 are set as the lift connecting compartments 3aR, 3aL and the compartments adjoining the lift connecting compartments 3aR, 3aL are set as the tray longitudinal forwarding compartments 3bR, 3bL; in which the first tray transfer device 11 is mounted on the carrier cart 1, the second tray transfer devices 42R, 42L are installed between the lift connecting compartments 3aR, 3aL and the tray longitudinal forwarding compartments 3bR, 3bL, and the third tray transfer devices 46R, 46L are installed in the lift connecting compartments 3aR, 3aL; and in which a dead space without a tray is provided in at least one of a plurality of compartments 3 on both the R and L sides of the transport aisle 2. Because of this construction, the trays 4 can be circulated on the same parking floor so that when a plurality of cars stored on the same parking floor are to be moved out successively or when a plurality of cars are to be moved successively into the same parking floor, it is possible to prepare for the next car exit/entry operation while the first car exit/entry operation is being performed, significantly reducing the time required for the successive car exit or entry operation.

Claims

1. In a planar reciprocating type parking system, having

   a carrier cart (50), adapted to travel reciprocally on a pair of rails (5) laid on a transport aisle (2) and carry a car-mounting tray (4);
   a plurality of car storage compartments (3) arranged in a row on each side of the transport aisle (2) and each accomodating a tray (4);
   a tray transfer device (11) mounted on the carrier cart (50) and adapted to transfer the tray between the carrier cart and the car storage compartments; and
   a lift (6) installed in a lift passage shaft (7) communicating a car entry/exit floor with car parking floors and adapted to raise or lower the tray;
   the planar reciprocating type parking system characterized in that:

   said lift (6) is located at an arbitrary position on the transport aisle (2) corresponding to one of the car storage compartments (3);
   wherein at corners of the lift passage shaft are erected guide rails (26) that vertically guide the lift, and lifting members (27) move up or down the guide rails (26) and are provided with support members (28) that project inwardly of the lift passage shaft (7) to support the tray (4);
   wherein the pair of rails (5) on the transport aisle (2) are divided by the lifting members (27) at locations where the lifting members pass through the rails, and the divided portions are used as passage portions (30) for the lifting members (27); and
   wherein the tray (4) can be transfered between the lift (6) and the carrier cart (1) as the lifting members (27) of the lift move up or down the guide rails (26).

2. The planar reciprocating type parking system according to claim 1, wherein the support members (28) of the lift (6) have upwardly protruding engagement projections (33) and the trays (4) have at the underside thereof engagement recesses (38) that can receive the engagement projections (33).

3. In a planar reciprocating type parking system, having

   a plurality of car parking floors;
   a transport aisle (2) provided on each of the car parking floors and on which a carrier cart (1) travels reciprocally to transport a car-mounting tray; (4)
   a plurality of car storage compartments (3) arranged in a row on each side of the transport aisle (2) and each accomodating a tray (4);
   the planar reciprocating type parking system further comprising:

   a lift installed between a car entry/exit floor and the car parking floors and located at one end of the transport aisle (2);
   a first tray transfer device (11) mounted on the carrier cart (1) to transfer the tray between the carrier cart and the car storage compartments (3) on both sides of the transport aisle (2);
   second tray transfer devices (42R,42L), installed between the car storage compartments (3), on both sides of the lift (6) and

the car storage compartments (3) adjoining these lift-side car storage compartments to transfer the tray (4) between these compartments; and

third tray transfer devices (46R, 46L) installed in the car storage compartments (3aR,3aL) on both sides of the lift (6) to transfer the tray between the car storage compartments on both sides of the lift and the lift;

wherein one of the car storage compartments (3) on each floor is set as a dead space with no tray installed to allow the trays to be moved in circulation.

4. The planar reciprocating type parking system according to claim 3, wherein the first tray transfer device (11) comprises a rotary arm, (12) which has a pivoting center thereof set at a center of the width of the carrier cart(1) and is disposed horizontally rotatable and which has a length such that the front end of the rotary arm projects into the car storage compartment (3) side by a predetermined distance; an engagement member (13) provided at the front end of the rotary arm (12) and adapted to engage with one of a pair of guide members provided on both sides of the underside of each tray; a rotary drive unit (14) to pivot the rotary arm (12); and a vertical drive unit (16) to displace the engagement member (13) or the rotary arm (12) vertically; and wherein the first tray transfer device (11) can transfer the tray (4) between the carrier cart (1) and the car storage compartments (3) on both sides (R,L) of the transport aisle.

5. The planar reciprocating type parking system according to claim 3 or 4, wherein the second tray transfer device (42R,42L) each comprise a chain conveyor (43) and a tray support member (44) mounted on the chain conveyor to support the tray, and can transfer the tray (4) between the car storage compartments (3aR,3bR) on both sides of the lift and the car storage compartments adjoining the lift-side car storage compartments.

6. The planar reciprocating type parking system according to claim 3, 4 or 5, wherein the third tray transfer devices (46R,46L) each have a rotating center thereof set at a center of the width of the car storage compartments (30R,30L) on both sides of the lift and are disposed horizontally rotatable; the third tray transfer devices each comprise a rotary arm (47) having a length such that a front end of the rotary arm projects into the lift side by a predetermined distance, an engagement member (48) provided at the front end of the rotary arm (47) and adapted to engage with one of a pair of guide members provided on both sides of the underside of each tray, and a rotary drive unit (49) to pivot the rotary arm (47); the third tray transfer devices can transfer the tray between the car storage compartments on both sides (R,L) of the lift and the lift.

FIG. 1

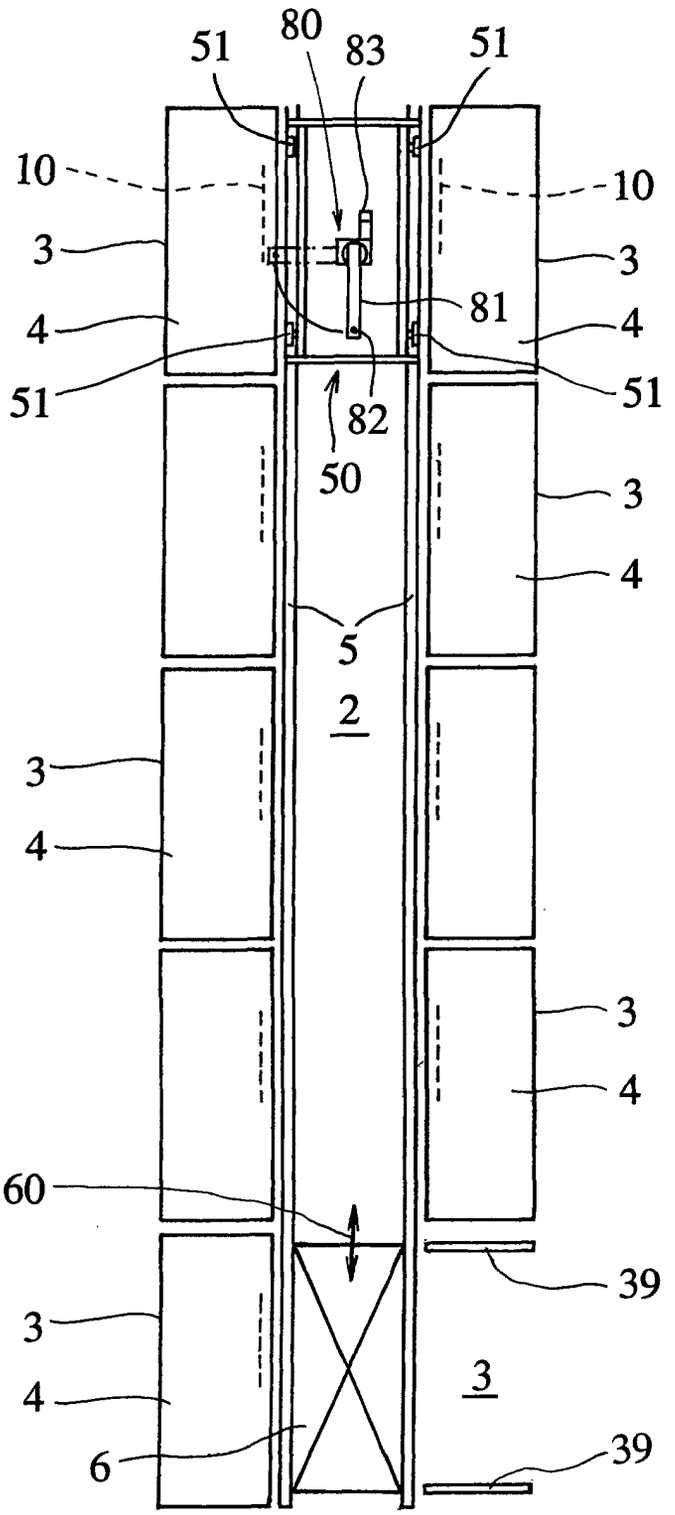


FIG. 2

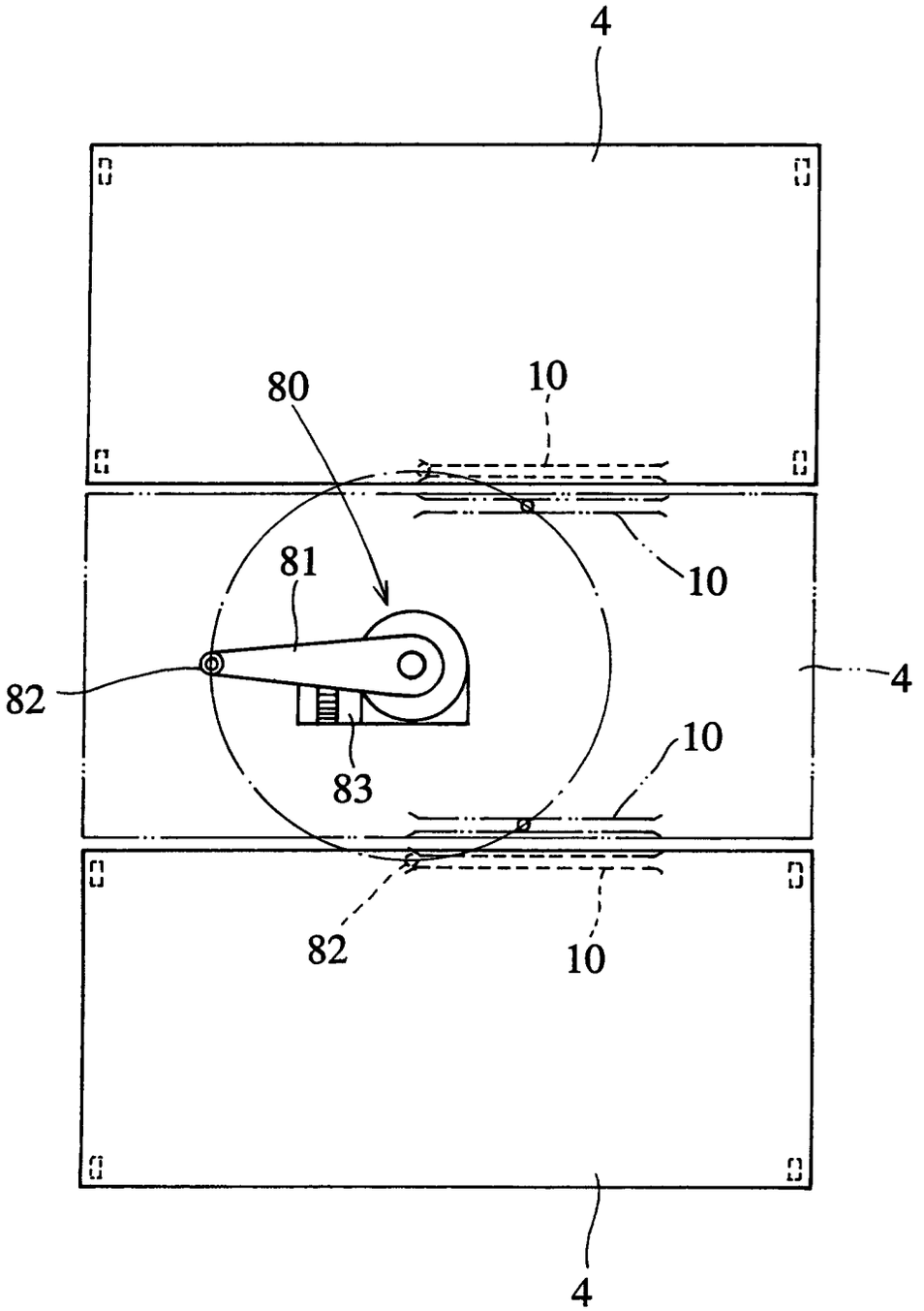


FIG. 3

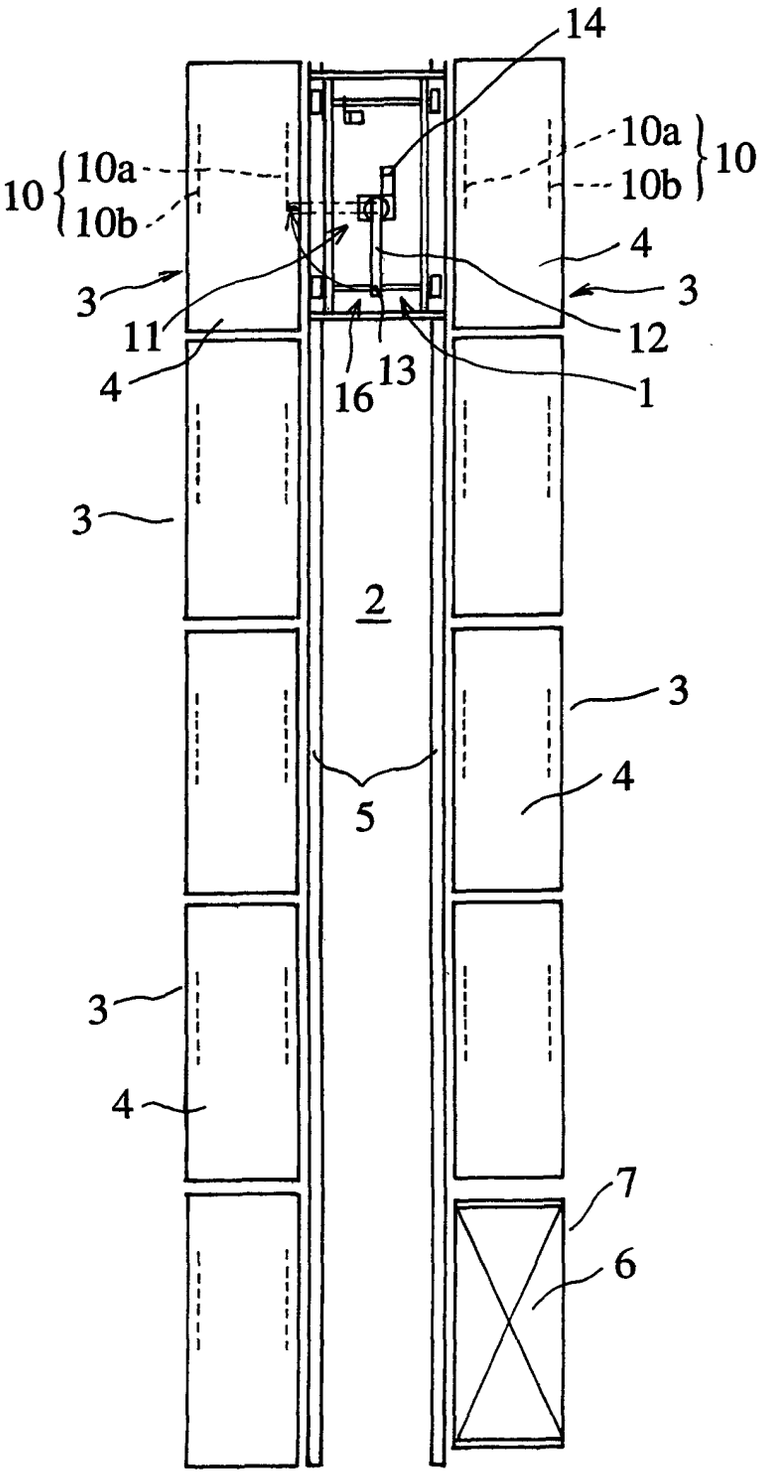


FIG. 4

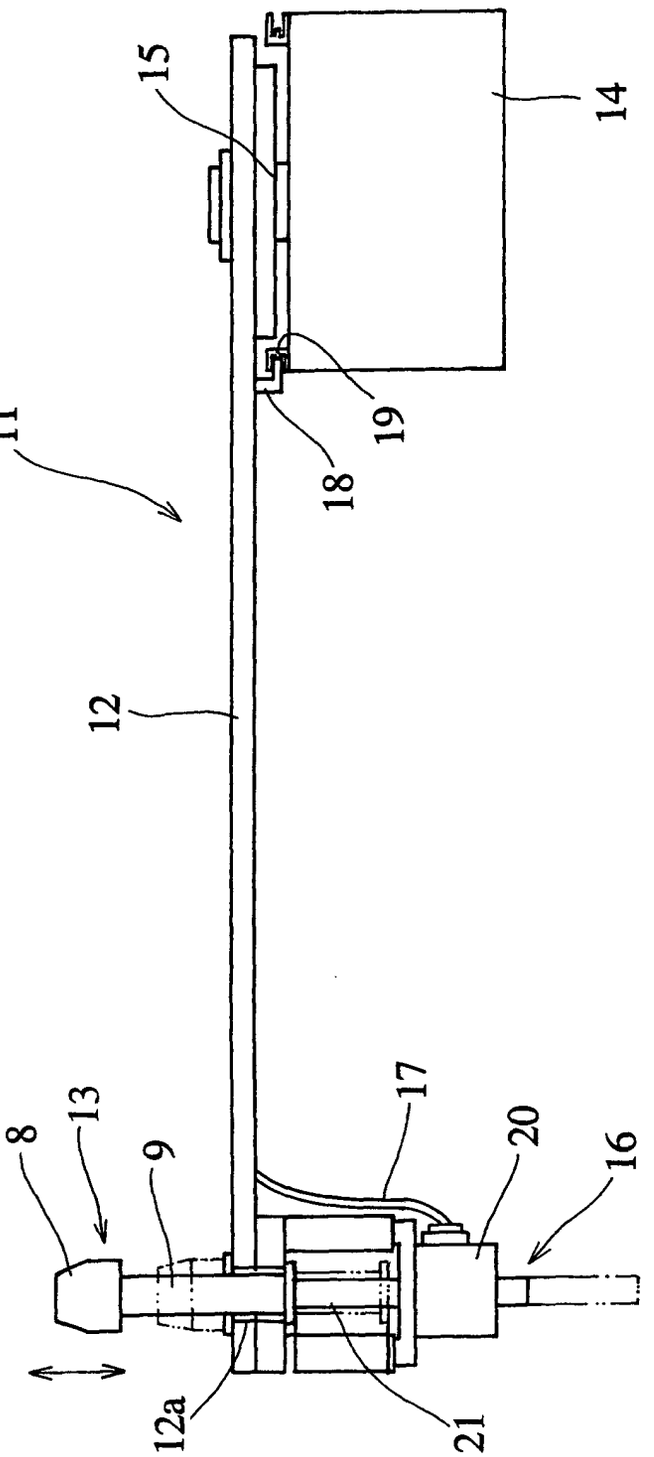
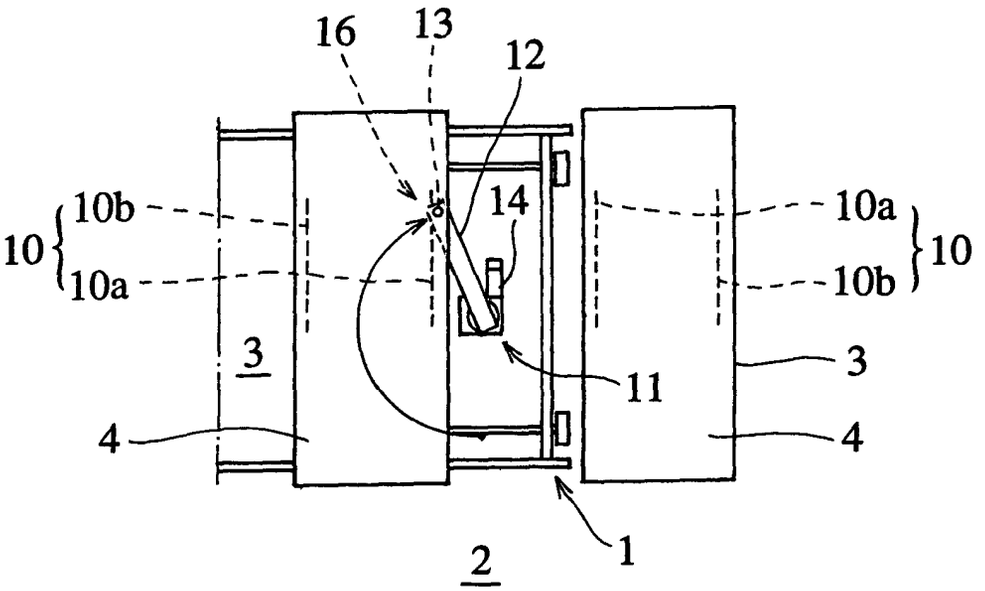


FIG. 5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13
12
14
10
10b
10a
10a
10b
10
3
3
11
4
4
2
1

FIG. 7

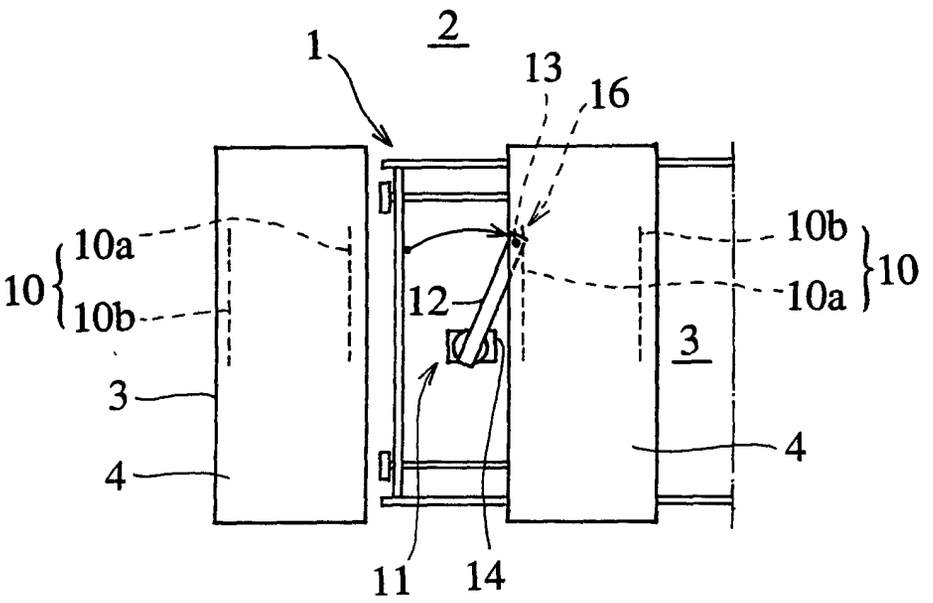

2
1
13
16
10
10a
10b
10b
10a
10
12
3
3
4
4
11
14

FIG. 6

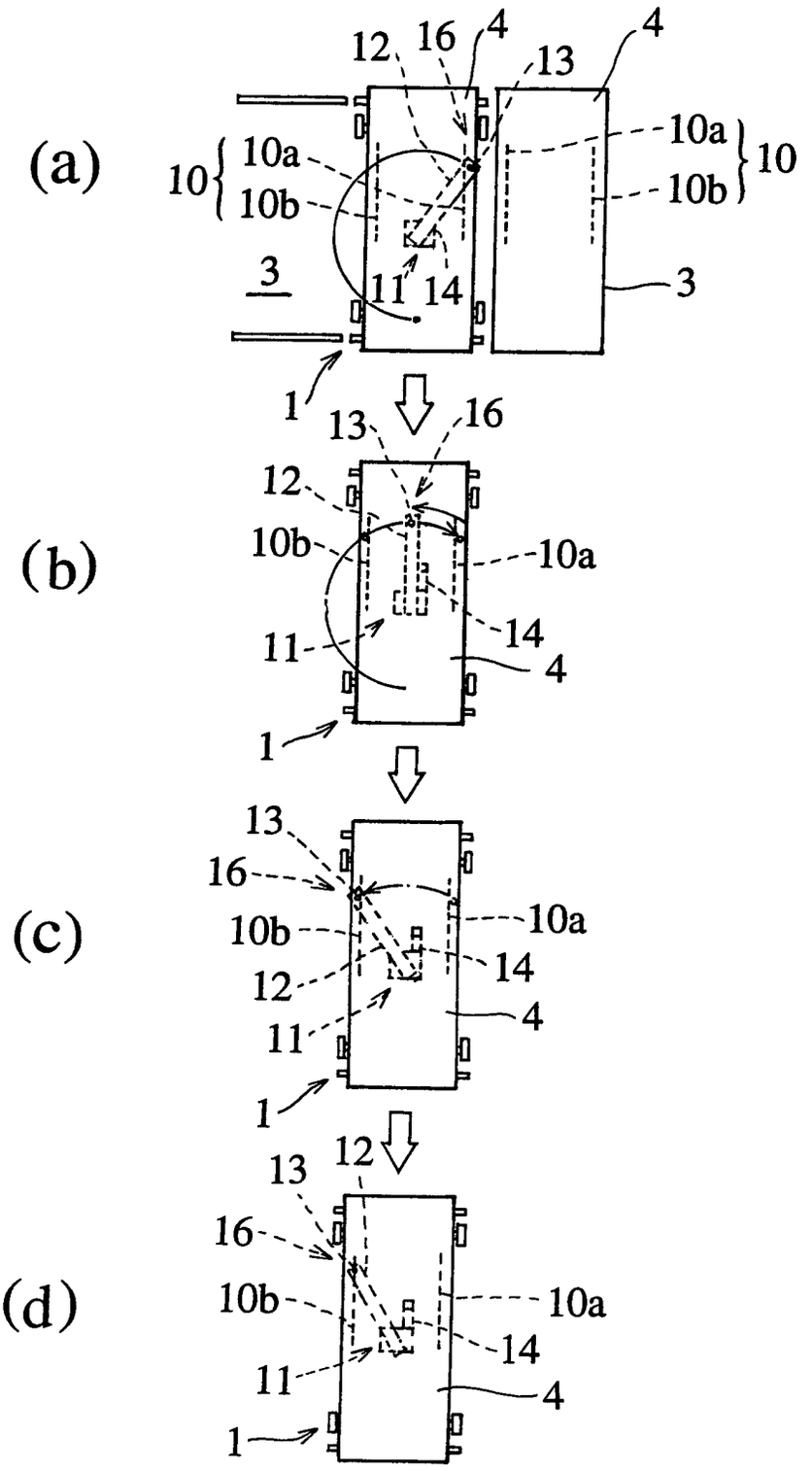

(a)
12
16
4
13
4
10a
10
10b
10
10a
10b
3
11
14
3
1
(b)
13
16
12
10b
10a
14
11
4
1
(c)
13
16
10b
10a
14
12
11
4
1
(d)
12
13
16
10b
10a
14
11
4
1

FIG. 8

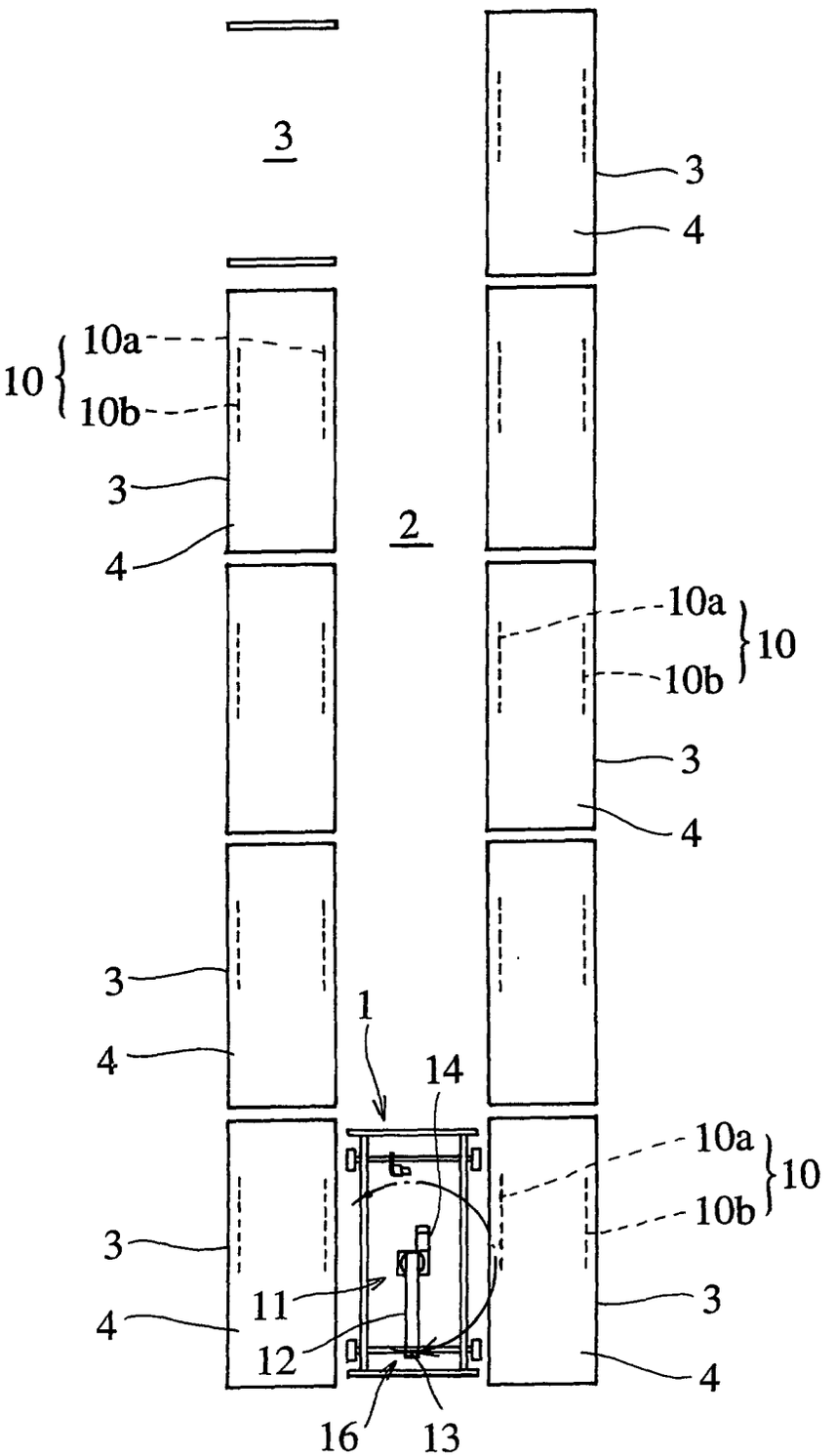
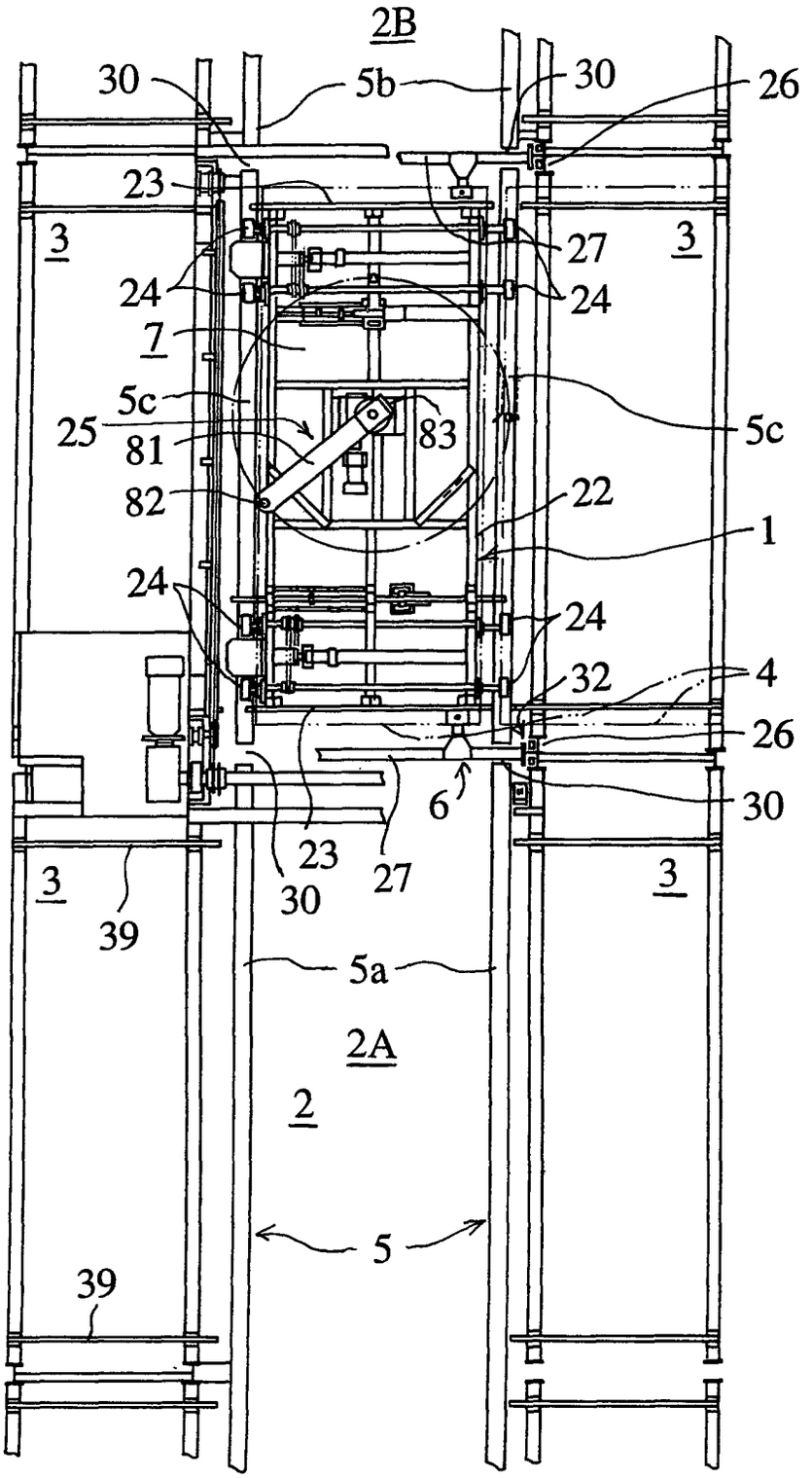


FIG. 9


2B
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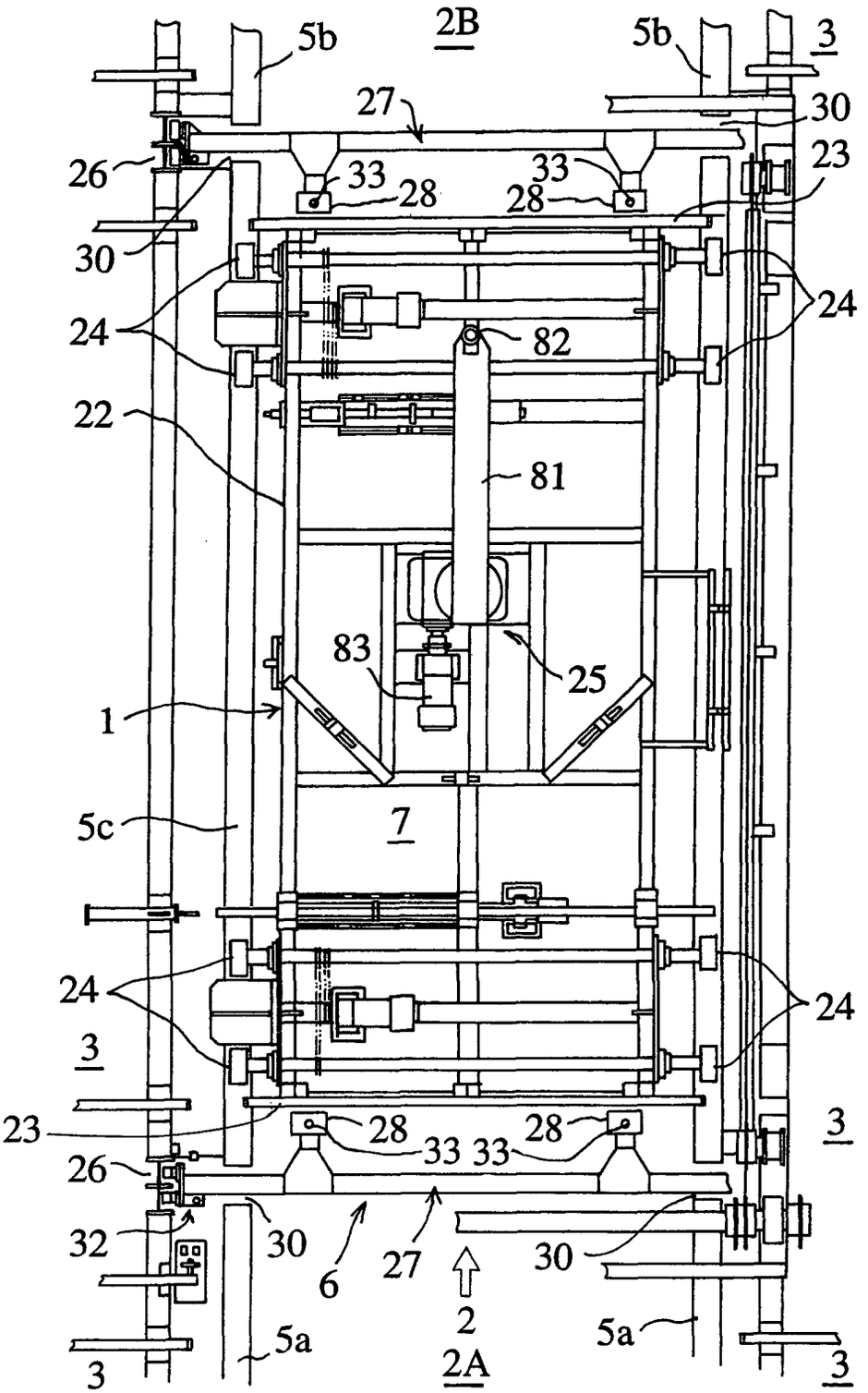
23
3
27
3
24
24
7
5c
25
81
83
5c
82
22
1
24
24
32
4
26
6
30
23
27
30
3
3
39
5a
2A
2
5
39

FIG. 10


2B
5b
5b
3
27
30
23
26
33
28
33
28
30
24
24
82
22
81
83
25
1
5c
7
24
24
3
23
28
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33
26
32
30
6
27
30
2
2A
5a
5a
3
3

FIG. 11

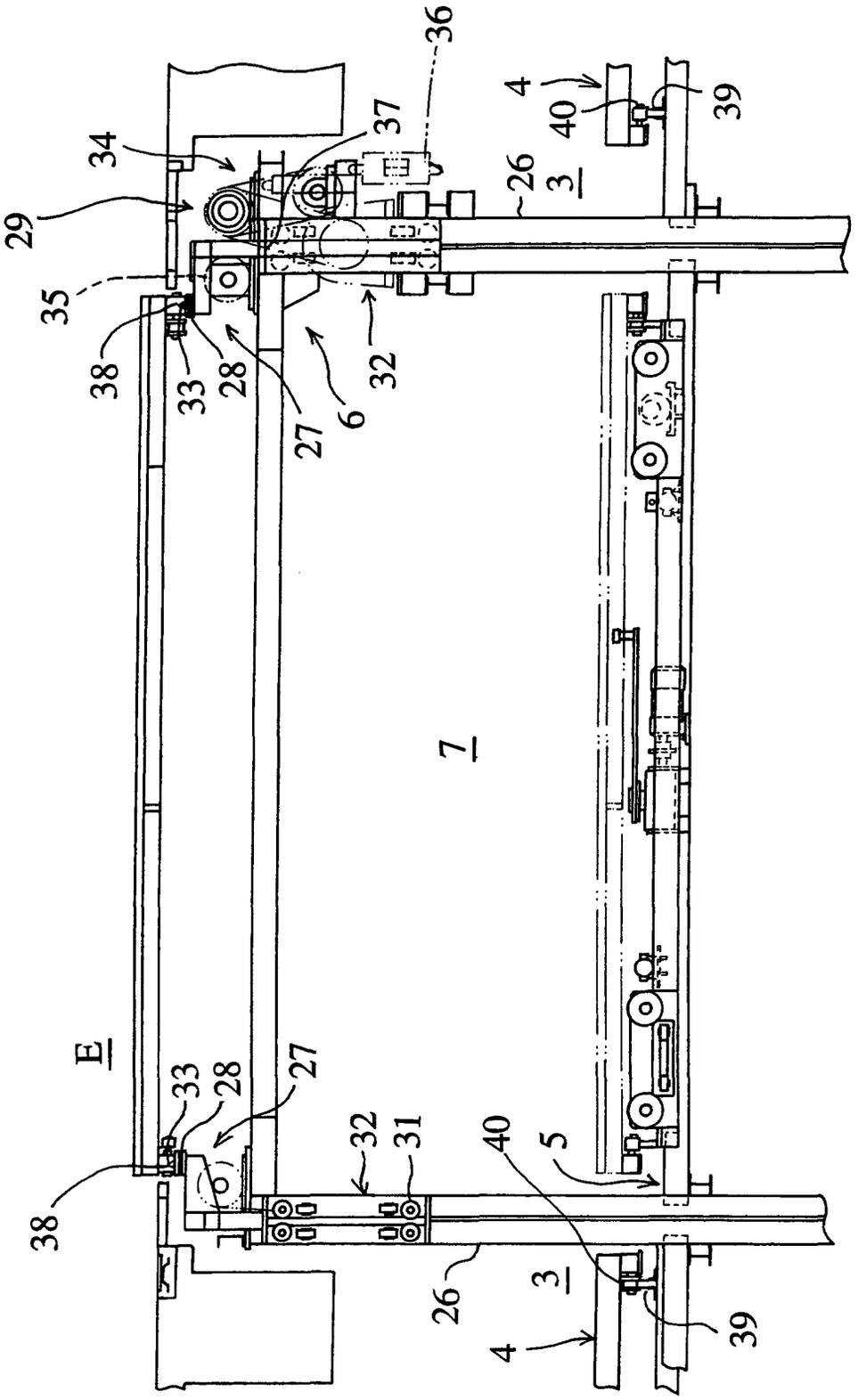


FIG. 12

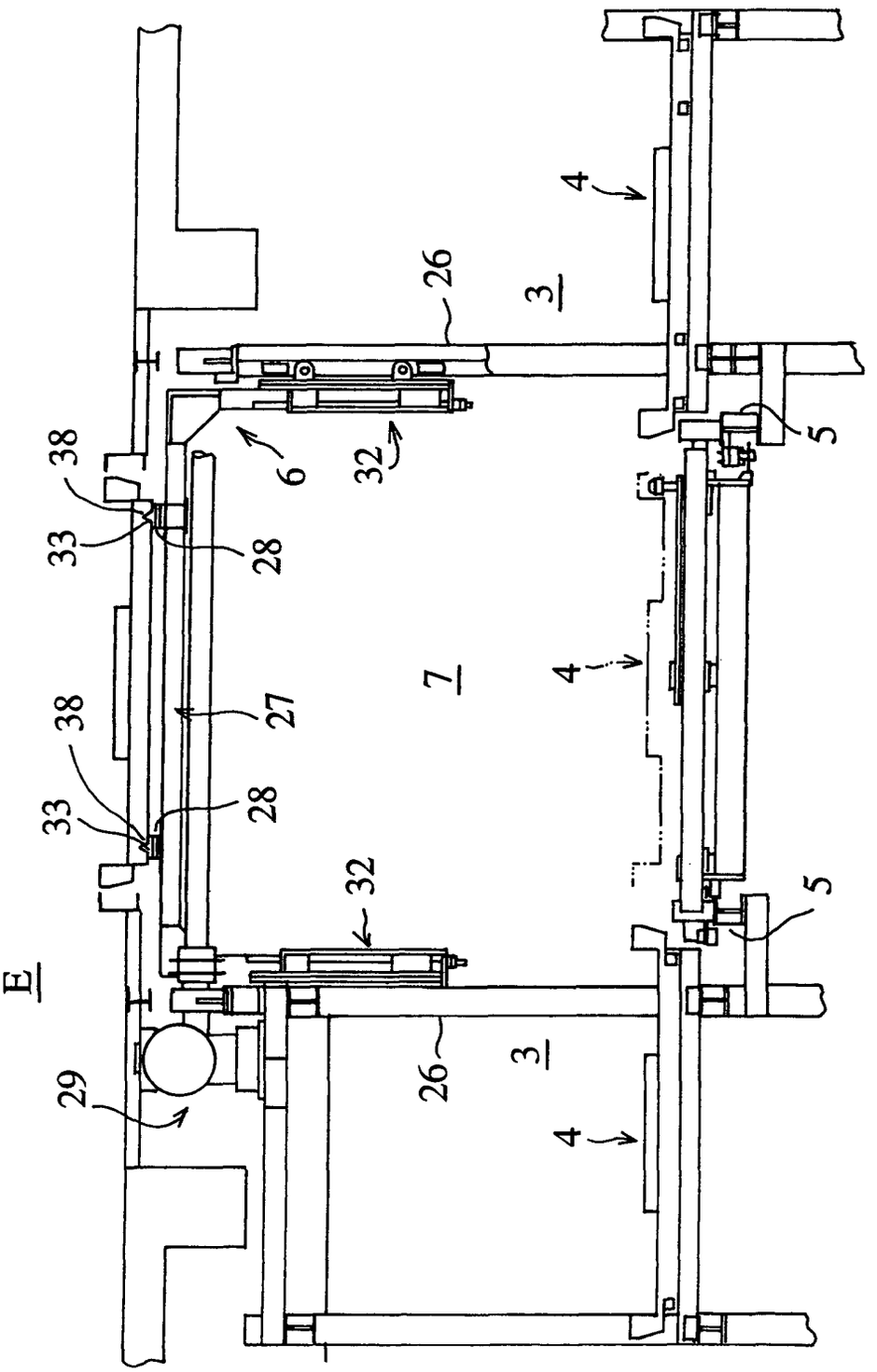


FIG. 13

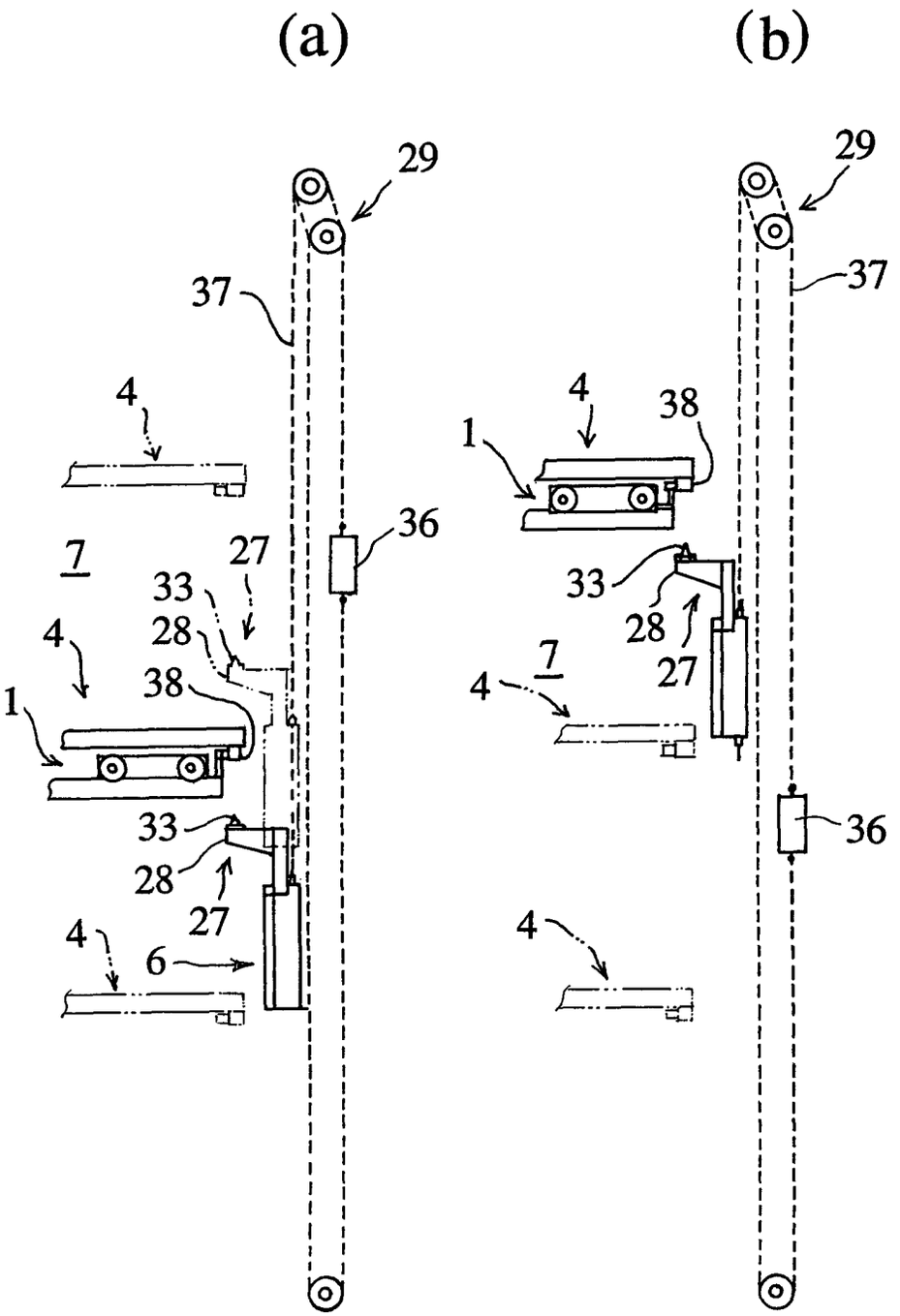
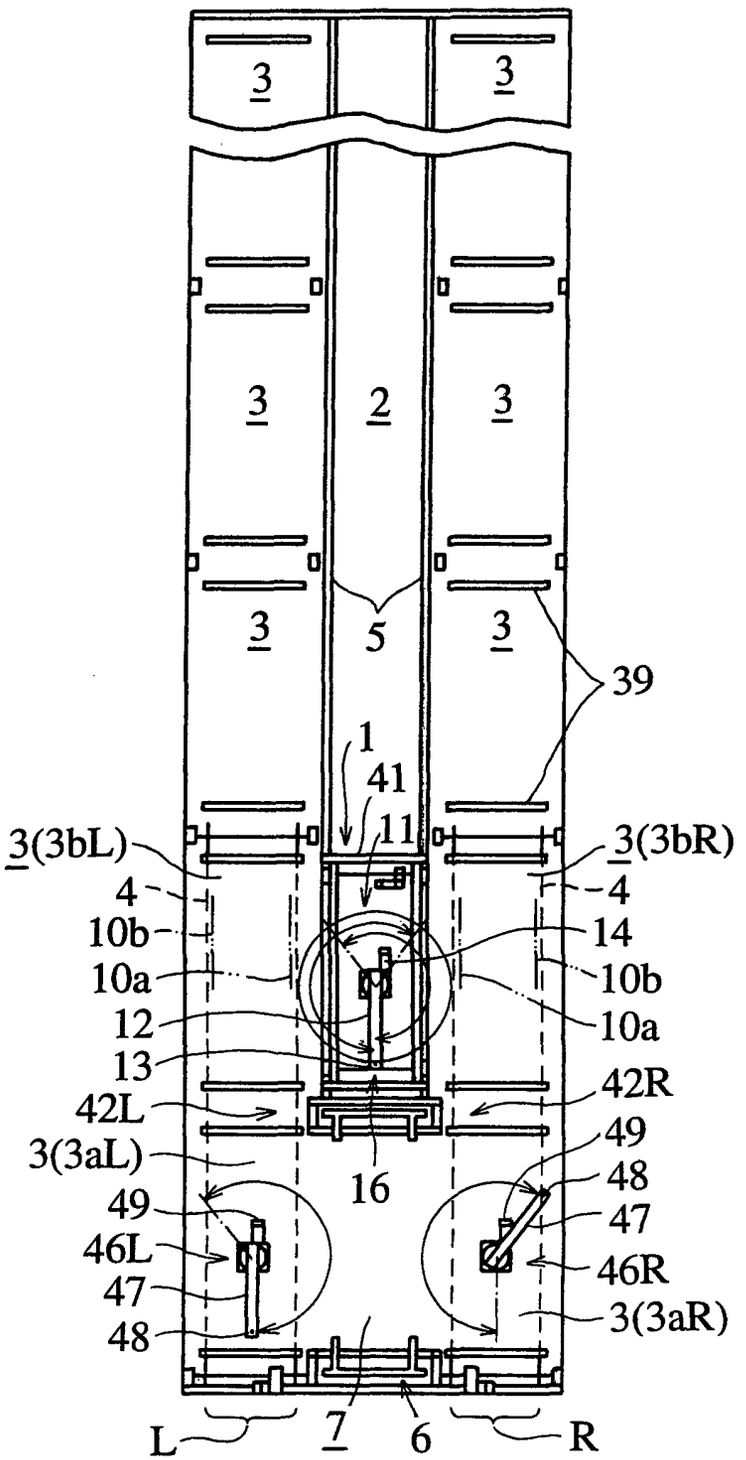


FIG. 14


3
3
3
2
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3
5
3
39
1
41
11
3(3bL)
3(3bR)
4
4
10b
14
10a
10b
12
10a
13
42L
42R
49
3(3aL)
48
16
49
47
46L
46R
47
3(3aR)
48
L
7
6
R

FIG. 15
(a)

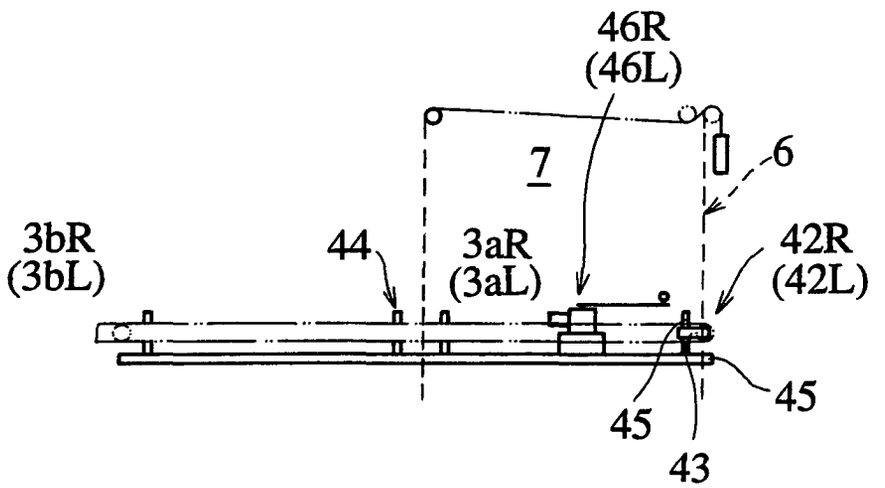
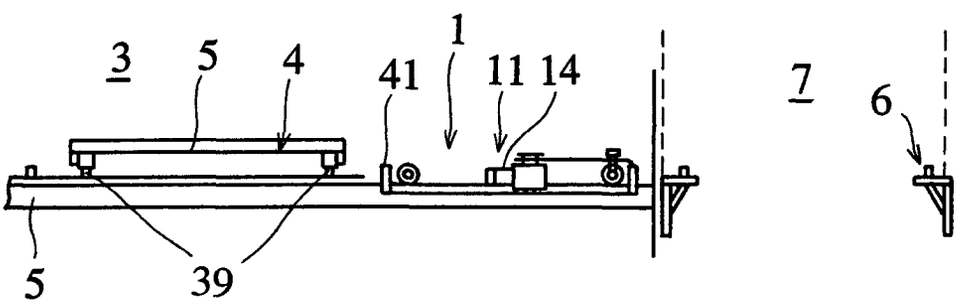


FIG. 15
(b)



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 11 0331

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	WO 89 09866 A (SKY PARK AB) 19 October 1989 (1989-10-19) * the whole document *	1	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			E04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 May 2001	Delzor, F

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