



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.12.2012 Bulletin 2012/52

(51) Int Cl.:
E04H 6/22 (2006.01) **E04H 6/34** (2006.01)
E04H 6/24 (2006.01) **E04H 6/36** (2006.01)
E04H 6/28 (2006.01) **E04H 6/40** (2006.01)

(21) Application number: **12172543.6**

(22) Date of filing: **19.06.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **21.06.2011 IT MI20111123**

(54) **Automated parking with mobile platforms**

(57) An automated car park for housing in an orderly manner a plurality of motor vehicles comprises mobile platforms (12) for housing the motor vehicles. The platforms are movable between a storage area (13, 113) and at least one zone (14, 114) for entry/exit of the motor vehicles. The storage area is a horizontal area housing the platforms (23) arranged alongside each other in a

group in two perpendicular directions, and motorized means (17, 25) for the guided movement of the platforms in said two perpendicular directions are provided in order to be able to perform, when operated, coordinated translatory movements of the platforms so as to displace a selected platform between a rest position in the storage area (13, 113) and the entry/exit zone (14, 114).

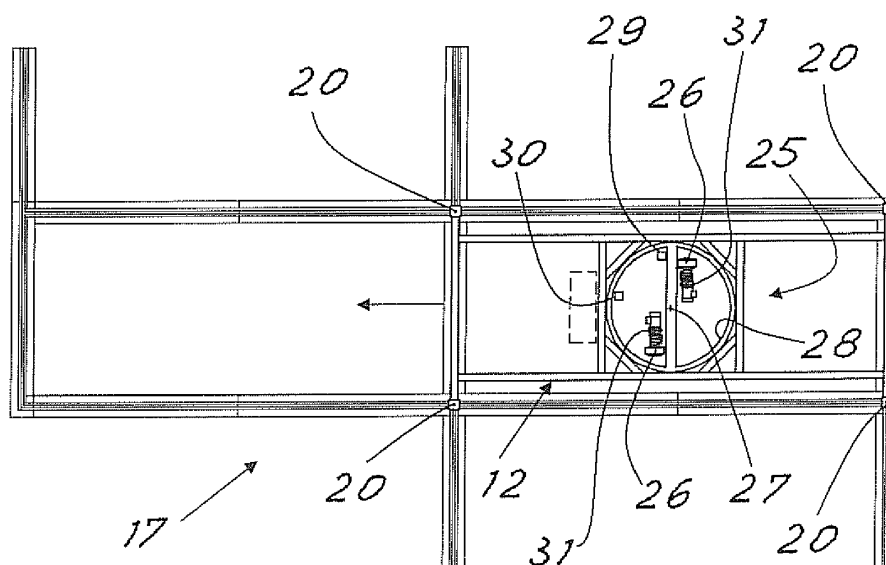


Fig.5

Description

[0001] The present invention relates to an innovative automated car park for housing motor vehicles with minimum wastage of space.

[0002] The problem of managing to optimize use of the space available for parking motor vehicles is known.

[0003] In the prior art various solutions for automated car parks which attempt to solve this problem are known. For example, vertical automated car parks which manage to arrange motor vehicles on top of each other in several storeys, so as to reduce the plan volume of the car park, are known. These systems, however, are somewhat costly and complex owing to the need to have to provide underground vertical-movement structures for relatively heavy loads. Automated car parks with a rotating carousel have also been proposed, these allowing the motor vehicles to be introduced into loading structures which rotate about a vertical axis so as to move the compartments of the carousel opposite a motor vehicle entry and exit zone. The movement operation is simplified compared to that of vertical car parks, but the overall volume is considerable and the rotating movement is seldom optimal with regard to said use of the space.

[0004] There also exist car parks where platforms or shuttles each house a vehicle and are moved so as to reach the storage zone from a loading/unloading zone. The movements are, however, generally complicated and the spaces required are in any case considerable in order to allow manoeuvring of the shuttles along transfer corridors.

[0005] The general object of the present invention is to provide an automated car park which is able to ensure improved use of the horizontal space, can be easily adapted to various spaces and is simple and relatively inexpensive to realize. A further object is to provide a method for constructing and managing such a car park.

[0006] In view of these objects the idea which has occurred is to provide, according to the invention an automated car park according to Claim 1.

[0007] Also according to the invention the idea which has occurred is to provide a method for constructing and managing an automated car park, comprising the steps of providing a storage area housing a plurality of platforms in a grid arrangement of parking zones situated alongside each other in two perpendicular horizontal directions, each parking zone being able to house one of the said platforms and each platform being able to house a motor vehicle; providing motorized means for displacement of the platforms in said two directions, forming or leaving an empty parking zone in the storage area, performing coordinated sequential movements of the platforms in the storage area making use of the free parking zone, so as to displace with successive movements a desired platform between a parking zone in the storage area and a motor vehicle entry/exit zone.

[0008] In order to illustrate more clearly the innovative principles of the present invention and its advantages

compared to the prior art, an example of embodiment applying these principles will be described below, with the aid of the accompanying drawings. In the drawings:

- 5 - Figure 1 shows a schematic plan view of a first embodiment of a car park according to the invention;
- Figure 2 shows a schematic plan view of a second embodiment of a car park according to the invention;
- 10 - Figure 3 shows a schematic perspective view of an example of embodiment of a mobile platform in a car park according to the invention;
- Figure 4 is a partial schematic side view of a part for supporting and allowing sliding travel of the platform shown in Figure 3;
- 15 - Figure 5 shows a schematic plan view of a platform in a first sliding travel condition;
- Figure 6 shows a schematic plan view of the platform according to Figure 5 in a second sliding travel condition;
- 20 - Figure 7 shows block diagram of a control system with which a car park according to the invention may be provided;
- Figure 8 shows schematically an example of a possible movement sequence inside a car park according to the invention for extraction of a predetermined vehicle.
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[0009] With reference to the Figures, Figure 1 shows a first example of an automated car park - denoted generally by 10 - which is provided in accordance with the invention so as to house in an orderly manner a plurality of motor vehicles 11 (shown in broken lines for greater clarity).

[0010] The car park 10 comprises a plurality of platforms 12 which each house a motor vehicle and are movable between a storage area 13 and at least one motor vehicle entry/exit zone 14.

[0011] The storage area is a horizontal area housing the platforms arranged alongside each other in a group in two perpendicular directions (one vertical and the other horizontal in the plane of the drawing according to Figure 1). This area may be rectangular, as can be seen in the figure, or also formed by a composition of rectangular areas, as will become clear below, depending on the space available.

[0012] In the car park there are also present suitable means for the guided movement of the platforms in said two perpendicular directions so as to be able to perform, when operated, coordinated translatory movements of the platforms so as to displace a selected platform between a rest position in the storage area and the entry/exit zone. In the example according to Figure 1, the entry/exit zone comprises a one-way lane 18 with an entrance for the vehicles at one end and an exit at the other end.

[0013] Advantageously, the platforms are displaced only in the two perpendicular directions which coincide with a longitudinal extension and a transverse extension of the platforms, being suitably formed with a rectangular

shape in plan view for each housing a motor vehicle with a minimum lateral space.

[0014] As can be clearly seen for example in Figure 3, each platform may be formed with a metal-beam framework structure having an upper vehicle loading surface (not shown in Figure 3). To ensure better stability of the load, two grooved rails 15 for guiding the vehicle wheels may be provided on the platform. These rails thus form the upper loading surface.

[0015] As is clearly shown in Figure 1, the storage zone 13 advantageously comprises a grid arrangement of parking zones situated closely alongside each other in the said two perpendicular directions, each parking zone, or compartment, being able to house a platform.

[0016] For the objects which will become clear below, the grid arrangement of parking zones (advantageously rectangular) comprises one parking zone which is kept empty or can be emptied by means of extraction of a platform from the storage area towards an external area. As will be seen, this allows the displacement of a selected platform between the storage area and the entry/exit zone by means of repeated movements of single platforms in the storage area. The parking zones may therefore be situated very close together leaving only a minimum space for movement without lateral contact between the platforms.

[0017] In the example shown in Figure 1, the number of platforms corresponds to the number of the parking zones or compartments of the grid in the storage area and a further auxiliary parking zone 16 is envisaged so as to enable a parking zone to be freed in the storage area for movement of the platforms during normal operation. Alternatively, it is possible to envisage one less platform than the number of compartments in the grid so as to have always a free parking zone in the storage area.

[0018] As can be seen again in Figure 1, a grid arrangement of guide rails 17 is advantageously present in the storage area, said rails being arranged in the said two directions between two parking zones for the displacement of each platform.

[0019] The intersection points of rails arranged in the two directions constitute switch-over points for allowing the direction of the platform to be changed between the two perpendicular directions.

[0020] Already from the structure described it is clear how, by means of a coordinated movement of the various platforms, it is possible to move any platform from a parking zone in the storage area grid to the entry/exit zone so that a vehicle moving independently along the lane 18 may be loaded/unloaded onto/from it. Advantageously, a suitable ramp between the platform and the road surface or suitable runways will allow the vehicles to drive up and down.

[0021] Figure 2 shows a possible constructional variant of the car park (denoted generally by 100) where the storage area 113 houses the platforms 12 which move in the two perpendicular directions along the grid arrangement of mutually perpendicular rails 17. The entry

and exit zone 114 is formed as a simple passageway for allowing a vehicle to pass inside the compartment which faces it from the storage area. This compartment does not have an outer side wall or is provided with a door (not shown) for allowing the driver to get out of or into the vehicle (shown in broken lines in Figure 2) present on the platform in this position. Alternatively, the rails may extend through the opening 114 (as shown in broken lines) so as to allow the platform to move out of the storage area. This latter solution is useful in particular if the entry/exit compartment is not situated on a side edge of the storage area.

[0022] Figure 4 shows a platform according to the invention provided with four sliding support units situated on the ground at the vertices of a rectangle, as indicated by 20. The interval between the support points in the two directions corresponds to the interval between the pairs of rails in these directions. Advantageously, each platform has four ball supports arranged at the vertices of a rectangle which may coincide approximately with the plan volume of the platform, so as to travel along parallel pairs of rails which are suitably spaced.

[0023] Advantageously, the rails 17 form sliding grooves 21 projecting at a low height from the surface of the storage area and the platforms slide on the rails of the grid by means of ball supports 22 which project at the bottom from the units 20, as can be seen in greater detail in Figure 4. As can be seen in this figure, the grooved rails may be advantageously formed by means of a first metal base plate or strip 23 which is fixed to the ground and onto which lateral metal bands 24 which form the channel 21 are fixed (for example welded). The bands 24 are interrupted at the rail intersections such that the balls may change direction at these points and the platform may move in the two mutually perpendicular directions along the rail grid.

[0024] Owing to the ball supports the platforms may easily change direction at the rail intersections without the need for steering guide means. The positioning of the balls at the intersections corresponds to the position of the platform completely housed inside a parking compartment. In this way, each platform may move easily from one compartment to an adjacent free compartment by means of simple displacement in the appropriate direction.

[0025] As can be seen more clearly in Figures 3, 5 and 6, the motorized means for guided movement of the platforms comprise advantageously in each platform a substantially central carriage 25 which is provided with motorized drive wheels 26 and which rotates, when operated, about a vertical axis 27 so as to direct these wheels in either one of the two perpendicular directions. In this way orthogonal displacement of the platform may be easily performed in both directions along the rails.

[0026] In order to facilitate rotation, the carriage has a circular swivel ring 28 with an end-of-travel stop 29, 30 and the carriage is provided with two wheels arranged with their axes of rotation parallel to each other and sym-

metrically arranged with respect to the vertical axis 27 of rotation of the swivel ring. The swivel ring may be simply laterally guided by suitable known means sliding on the frame, without the need for a physical axis of rotation supported on the frame of the platform.

[0027] Each wheel is advantageously equipped with its own electric rotary motor 31. In this way, the carriage displaces the platform by means of rotation of the two wheels in the same direction, while it rotates about the vertical axis 27 in either direction as far as the corresponding end-of-travel stop 20 or 30 by means of opposite rotation of the wheels with respect to each other. Orientation of the wheels in the two perpendicular directions of sliding travel of the platform is thus facilitated. Figure 5 shows the orientation of the carriage for a movement of the platform in the direction of its longitudinal extension (horizontal in the figure), while Figure 6 (where, for greater clarity, the rails are shown only in broken lines) shows orientation of the carriage at right angles with respect to the first orientation for movement of the platform in the direction of its transverse extension (vertical in the figure).

[0028] Powering of the platform motors may be performed by means of suitable electrified contact rails or by means of rechargeable batteries which are arranged on each platform. In this second case, recharging may be performed by means of automatic connection, using known electrical contact means (not shown), to an external electric power source when the platform is at a standstill in one of the parking compartments of the grid. Since the displacements are short and the recharging intervals frequent, the batteries may have a suitably reduced capacity, thereby favouring the cost, weight and overall dimensions. Advantageously, the car park according to the invention comprises an electronic system for controlling the guided movement means which avoids having to perform manually displacement of each platform into the correct position of a desired platform for loading or unloading a specific vehicle. The control system may advantageously dialog with each platform by means of known wireless communication means (for example a short-range radio wave transmission system).

[0029] Figure 7 shows schematically an electronic system, denoted generally by 50, for automated control of the car park. This system 50 comprises means (for example a keyboard 51 with display 52) for inputting a request for displacement of a selected platform between entry/exit zone and car park parking area. Moreover, the system is advantageously equipped with a memory 53 which memorizes the position of the platforms in the car park and with calculation means 54 for calculating the displacements, able to calculate the combination of coordinated movements of the platforms necessary for being able to move efficiently the selected platform between entry/exit zone and parking area. Finally, actuator means 55 are present for performing in sequence the combination of coordinated movements. The actuator means send control signals 56 to the platforms and may advantageously receive feedback signals 57.

tageously receive feedback signals 57.

[0030] Advantageously, the control system is formed by a microcontroller system which is suitably programmed with a path and movement optimization algorithm, as can be easily imagined by the person skilled in the art on the basis of the description provided here.

[0031] The actuator system also comprises advantageously known sensor devices (not shown) for correct movement and positioning of the platforms. For example known proximity sensors may be used for precise stoppage of the platforms in the parking zones, while identification sensors, such as RFID transponders or the like, may be used to identify the specific platforms.

[0032] When it is desired to deposit a motor vehicle in the car park, it is merely required to activate, via the input means, a loading procedure whereby a free platform is displaced by the control system into the entry/exit zone. Once the platform has reached this zone, it is possible to drive the motor vehicle onto the platform (using for example special ramps in the entry/exit zone). Once the vehicle is positioned on the platform, it is merely required to get out of the vehicle and start a storage procedure, again via command input means, during which the control system will move the platform inside the storage area. The operation may be repeated until all the platforms are occupied. The system will calculate in each case the path and the sum of coordinated movements which must be performed by the platforms.

[0033] Advantageously, the system will be instructed using or will generate reference information for each specific vehicle introduced, in order to facilitate subsequent retrieval performed externally. For example, when the system conveys an empty platform into the loading zone a reference number to be memorized may be shown on the display.

[0034] When it is required to retrieve a vehicle, it is therefore sufficient to enter the request with the reference number via the input means. The control system will calculate the movements of the platforms which are needed to move the platform with that vehicle from its existing internal parking zone into the entry and exit zone. The movements will be carried out and the platform with the desired vehicle will be brought into the entry and exit zone. It is thus possible to get into the vehicle and get out of it from the platform and then leave the car park zone.

[0035] Figure 8 shows by way of example steps a) to e) for moving the platforms so as to bring a platform (indicated by B) from the internal storage position into the zone for unloading the vehicle present on it.

[0036] The method for constructing and managing an automated car park according to the invention comprises simple and flexible operating steps.

[0037] In fact it is sufficient to provide a storage area housing a plurality of platforms in a grid arrangement of parking zones situated alongside each other in two perpendicular horizontal directions. Each parking zone may thus house one of the said platforms and each platform

may in turn house a motor vehicle. By providing motorized means for displacement of the platforms in said two directions, it is merely required to create or leave an empty parking zone in the storage area and perform coordinated sequential movements of the platforms in the storage area making use of the free parking zone, so as to displace with successive movements a desired platform between a parking zone in the storage area and a motor vehicle entry/exit zone. Also in accordance with the principles of the invention advantageously a computerized unit is used to control the coordinated sequential movements, which unit, based on the knowledge of the positions of the platforms in the storage area and the position of a free storage zone, calculates and performs the sequence of coordinated sequential movements for obtaining displacement of a desired platform between a parking zone in the storage area and a motor vehicle entry/exit zone. The movement is thus rapid and without difficulty.

[0038] At this point it is clear how the predefined objects have been achieved.

[0039] With an automated car park designed in accordance with the invention it is possible for example to use effectively generally rectangular areas also in existing buildings with a not particularly high ceiling height. The time required for construction of the car park is not long and the work for adaptation of existing areas is minimal. The costs are relatively limited since the structure is simple to construct and install. Moreover, the system may be easily expanded to meet growing requirements. The simplicity of the structure guarantees a low level of maintenance and low percentage of faults.

[0040] Owing to the structure which may be completely closed in a stable manner, except for the entry and exit zone (where there may be barriers and automatic or manual moving doors), the car park may be easily fitted out with security closing systems in order to prevent the entry of unauthorized persons into the storage area. This storage area usually does not require access by persons during normal operation of the car park.

[0041] Obviously, the above description of an embodiment applying the innovative principles of the present invention is provided by way of example of these innovative principles and must therefore not be regarded as limiting the scope of the rights claimed herein. For example, the arrangement of the compartments alongside each other in a storey may vary, also so as to adapt to obstacles (such as pillars or the like) which are present in the area to be equipped with the car park and/or to provide the vehicle entry and exit zones at points already provided with suitable accesses. The rail structure and the motorized movement means may vary depending on the practical requirements.

[0042] It can be readily understood on the basis of the description provided above how easy it is to obtain different car park configurations by simply lengthening some of the rails in the various directions, thus adapting the car park to the specific requirements with minimum costs and always making optimum use of the space.

[0043] The entry and exit zones may be more than one or be separate (one entrance zone and one exit zone) also depending on the specific structure of the building which must house the car park and the desired or already existing entrance/exit accessways for the motor vehicles.

Claims

1. An automated car park for housing in an orderly manner a plurality of motor vehicles, comprising mobile platforms (12) housing the motor vehicles, the platforms being movable between a storage area (13, 113) and at least one zone (14, 114) for entry/exit of the motor vehicles; the storage area is a horizontal area housing the platforms (12) arranged alongside each other in a group in two perpendicular directions, motorized means (17, 25) for the guided movement of the platforms along said two perpendicular directions being present in order to be able to perform, when operated, coordinated translatory movements of the platforms so as to displace a selected platform between a rest position in the storage area (13, 113) and the entry/exit zone (14, 114), **characterized in that** the storage area comprises a grid arrangement of grooved guide rails (17) which are arranged in the said two perpendicular directions and along which the platforms (12) travel by means of ball supports (20), the motorized means comprising in each platform a carriage (25) which is provided with motorized drive wheels (26) and which rotates, when operated, about a vertical axis (27) so as to direct said wheels in either one of the said two directions.
2. Car park according to Claim 1, **characterized in that** the said two perpendicular directions coincide with a longitudinal extension and a transverse extension of the platforms (12).
3. Car park according to Claim 1, **characterized in that** the storage area contains a grid arrangement of parking zones which are situated alongside each other in the said two perpendicular directions, each parking zone being able to house one of the said platforms (12).
4. Car park according to Claim 3, **characterized in that** a parking zone in the grid arrangement is kept empty or can be emptied by means of extraction of a platform (12) from the storage area, so as to allow displacement of a selected platform between storage area and entry and exit zone by means of repeated movements of individual platforms in the storage area.
5. Car park according to Claim 3, **characterized in that** the storage area contains the grid arrangement of guide rails (17) for displacing each platform (12) in

the said two directions between the parking zones (12), the rail intersection points arranged in the two directions being switch-over points allowing the direction of the platforms to be changed.

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6. Car park according to Claim 1, **characterized in that** each platform is provided with four ball supports (20) arranged at the vertices of a rectangle for sliding travel along parallel pairs of rails.

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7. Car park according to Claim 1, **characterized in that** the carriage (25) has a circular swivel ring (28) with an end-of-travel stop and the carriage has two wheels which are arranged with their axis of rotation parallel to each other and symmetrical with respect to the said vertical axis (27), each wheel being provided with its own rotary motor (31) so that the carriage moves the platform by means of rotation of the wheels in the same direction and rotates about the said vertical axis (27) in one direction or the other as far as the end-of-travel stop by means of opposite rotation of the wheels with respect to each other so as to orient the wheels in either perpendicular direction.

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8. Car park according to Claim 1, **characterized in that** it comprises an electronic system (50) for controlling the guided movement means, the electronic system being provided with means (51, 52) for inputting a request for displacement of a selected platform between entry/exit zone and storage area, a memory (53) for storing the position of the platforms, displacement calculation means (54) for calculating the combination of coordinated movements of the platforms necessary for being able to move the selected platform between entry/exit zone and storage area and actuator means (55) for performing in sequence the combination of coordinated movements by sending commands (56) to the motorized movement means.

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9. Car park according to Claim 1, **characterized in that** the guide rails are formed by means of a first metal base strip (23) which is fixed to the ground and provided with lateral metal bands (24) which form a channel (21) for sliding travel of the ball supports, the bands (24) being interrupted at the rail intersections such that the ball supports may change direction at these points.

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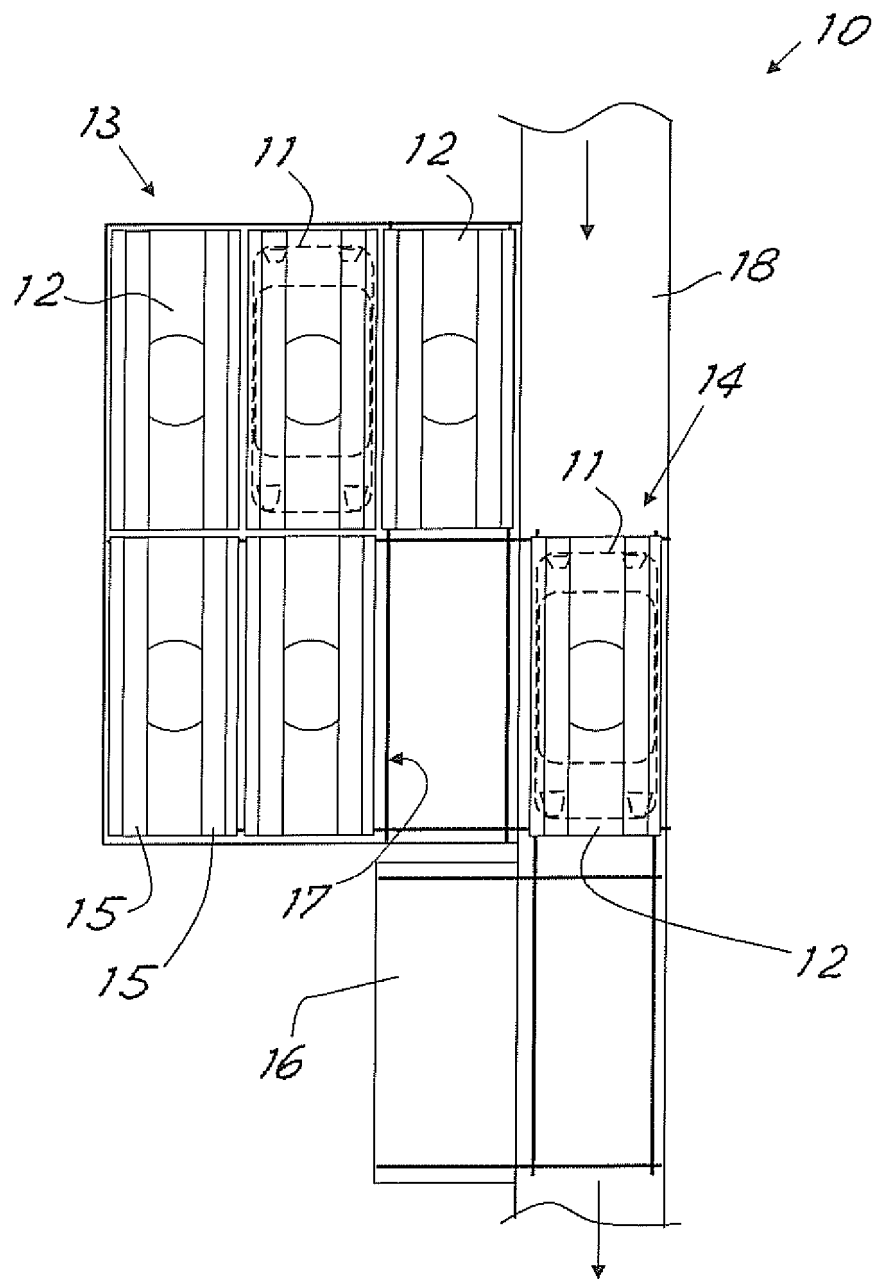


Fig.1

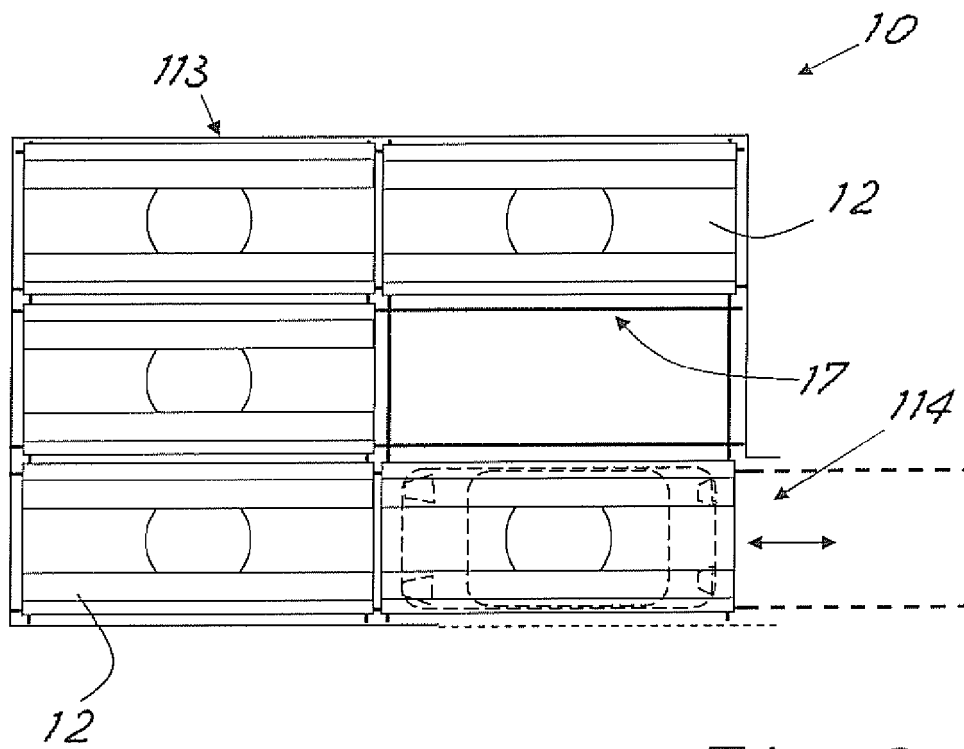


Fig. 2

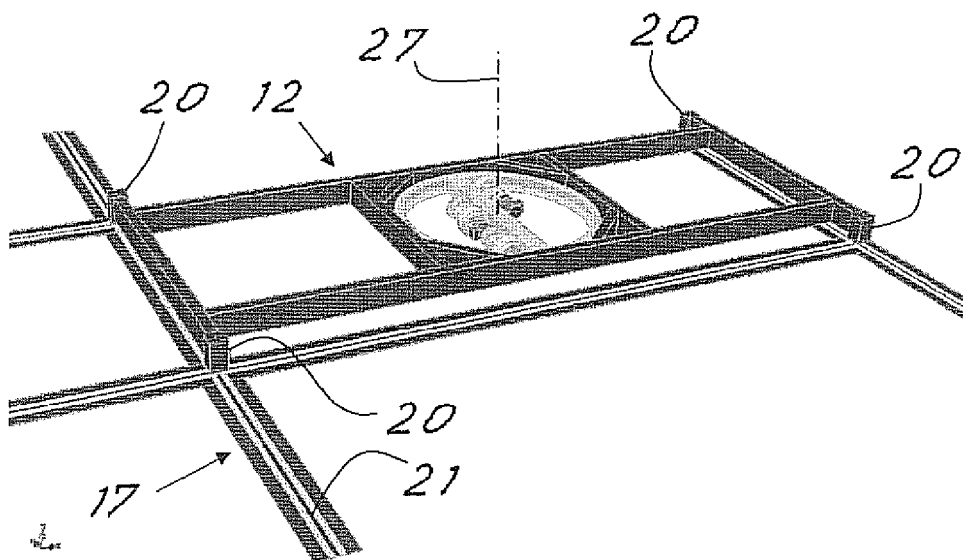
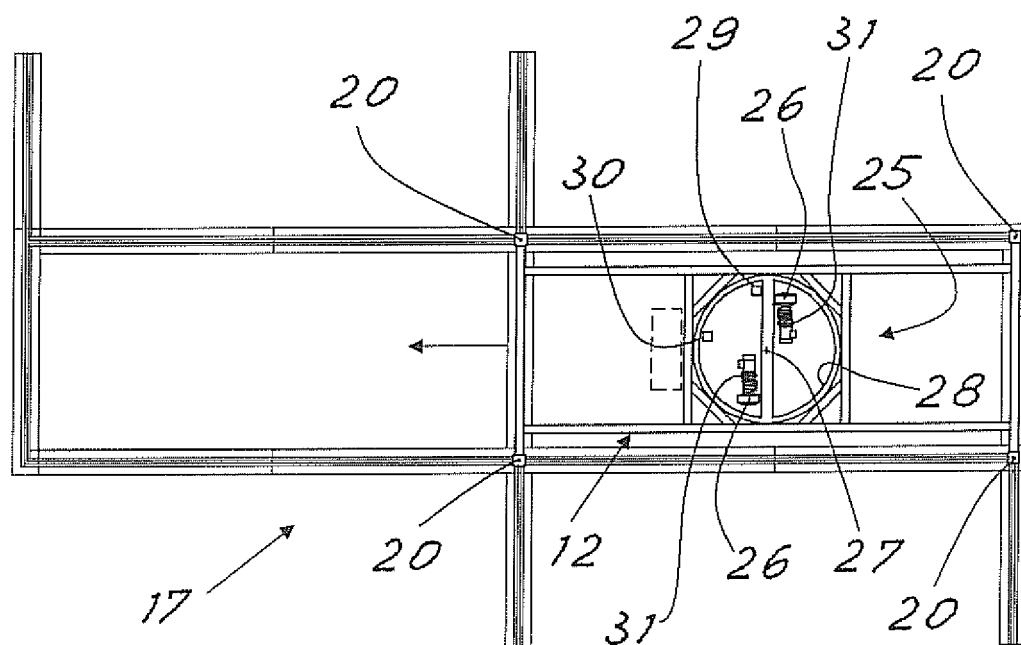
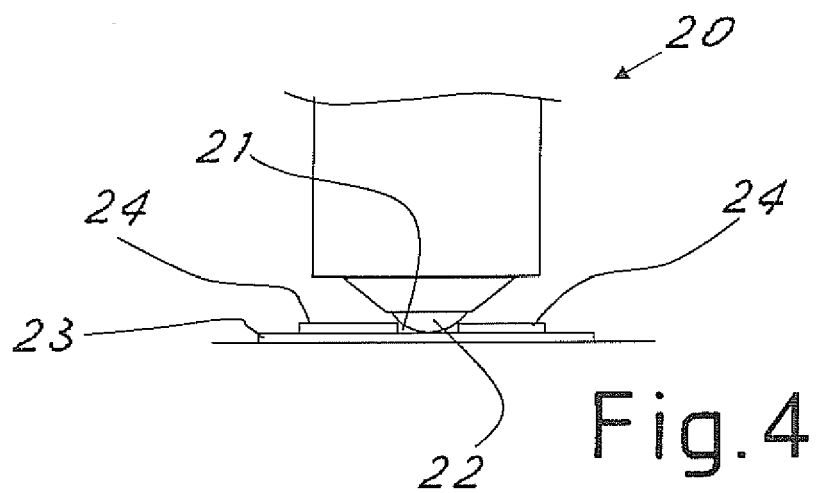


Fig. 3



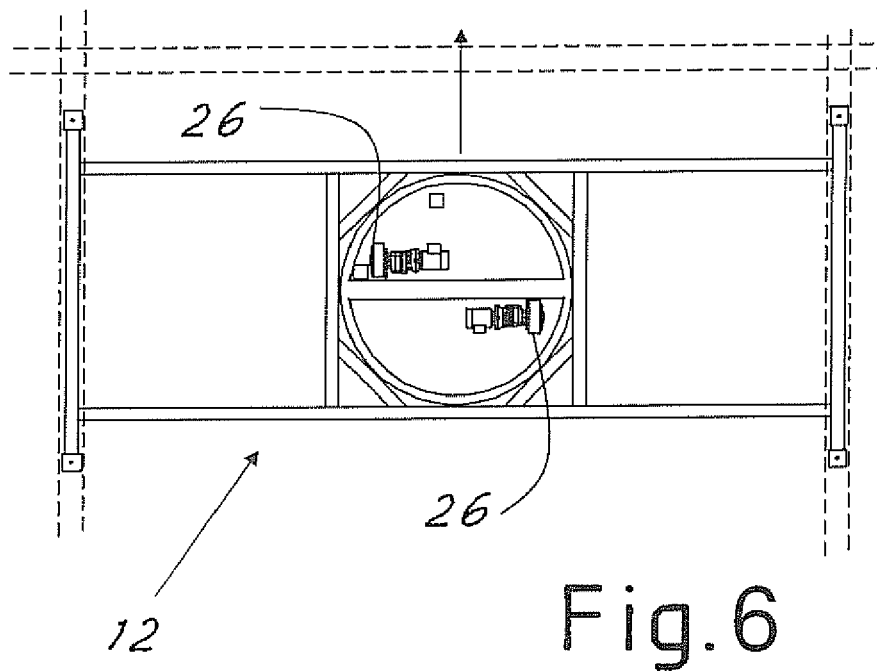


Fig. 6

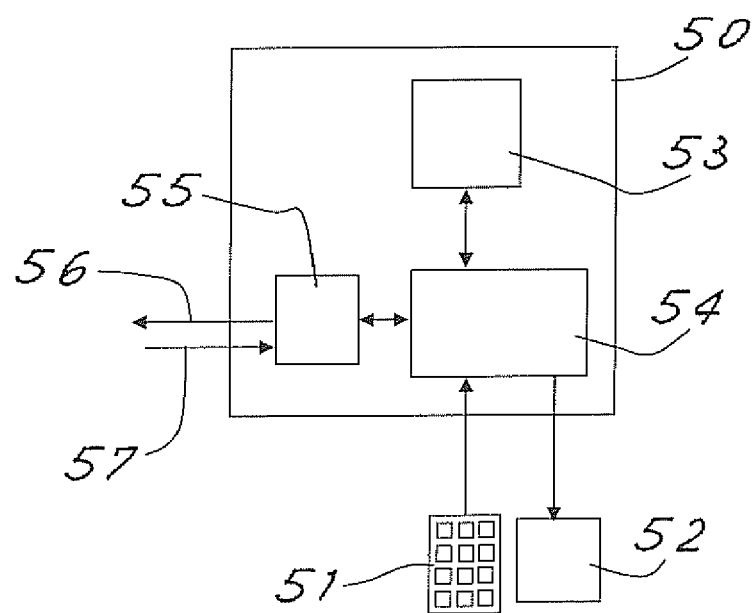
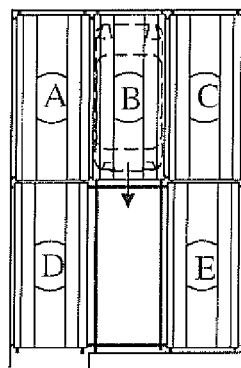
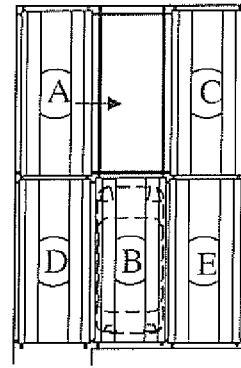


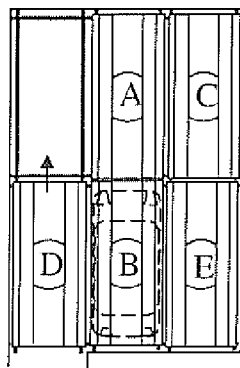
Fig. 7



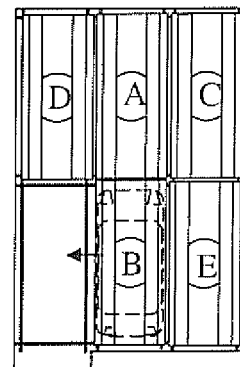
a)



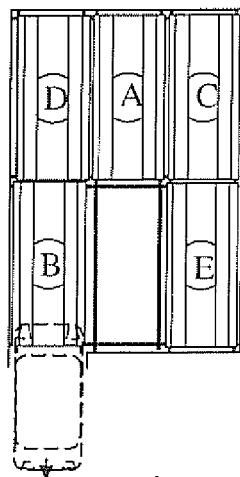
b)



c)



d)



e)

Fig.8



EUROPEAN SEARCH REPORT

Application Number
EP 12 17 2543

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2005/207876 A1 (SPRINGWATER RICHARD [US]) 22 September 2005 (2005-09-22) * paragraph [0068] - paragraph [0081]; figure 4c *	1-9	INV. E04H6/22 E04H6/34 E04H6/24 E04H6/36 E04H6/28 E04H6/40
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 August 2012	Examiner Topcuoglu, Sadik Cem
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 17 2543

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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30-08-2012

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