March 7, 1967 R. F. WITTENMYER ET AL 3,307,307

HELICAL BUILDING

Filed March 2, 1964 3 Sheets-Sheet 1

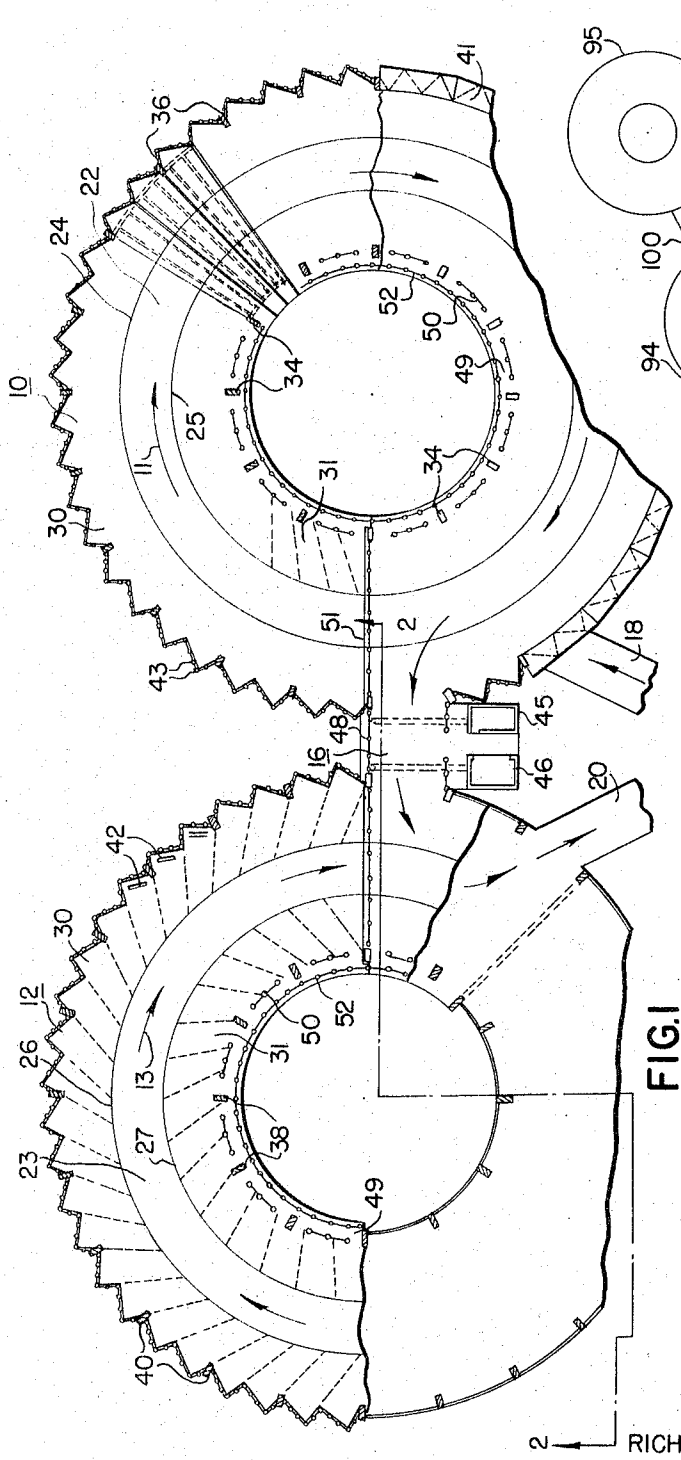


FIG.1

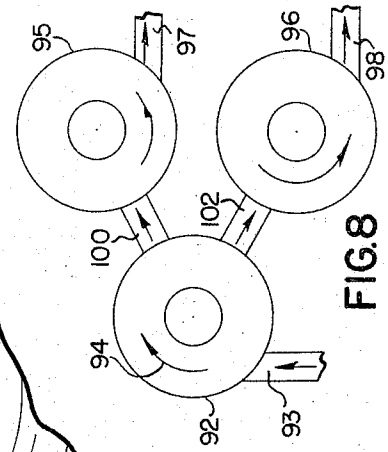


FIG.8

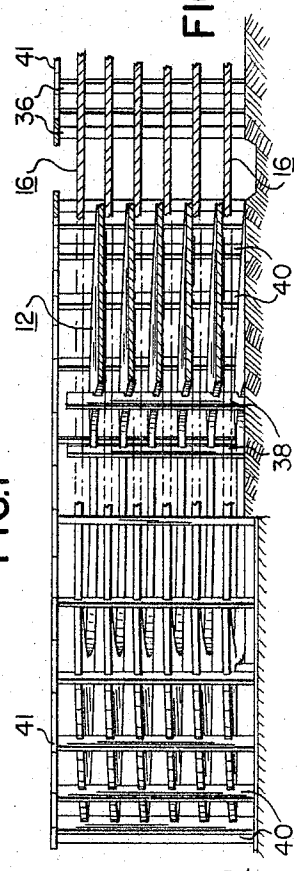


FIG.2

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HELICAL BUILDING

Filed March 2, 1964 3 Sheets-Sheet 2

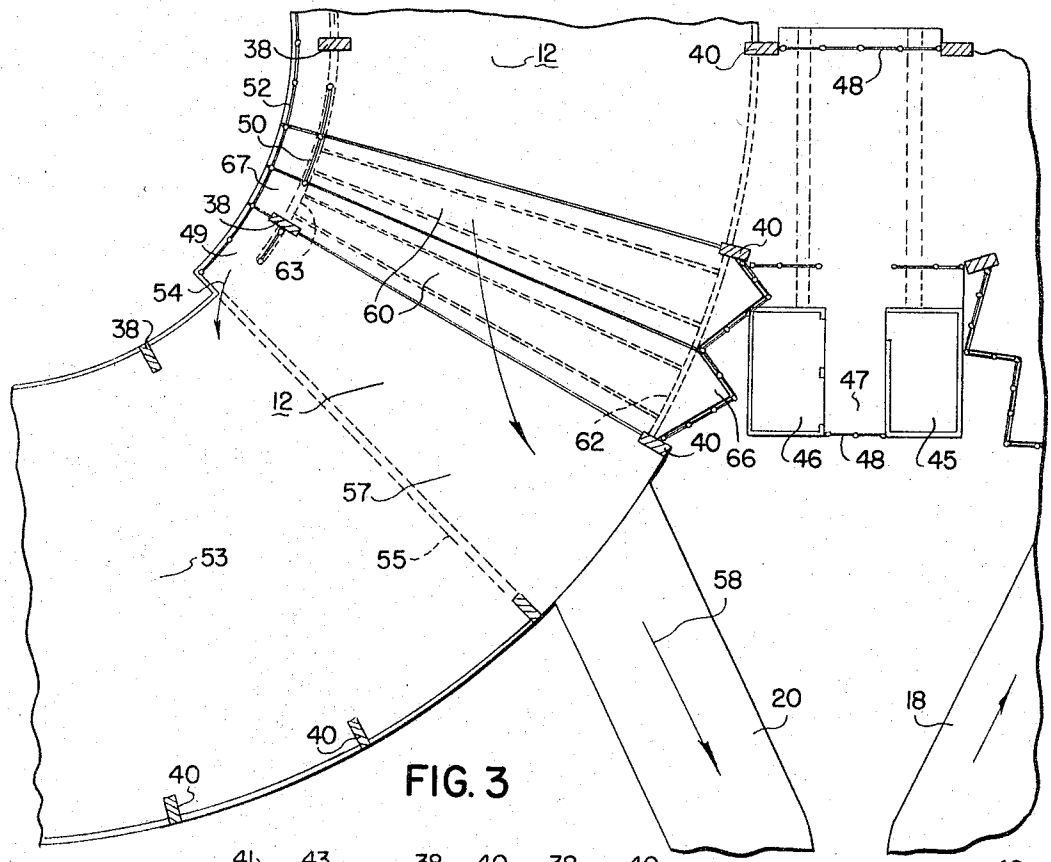


FIG. 3

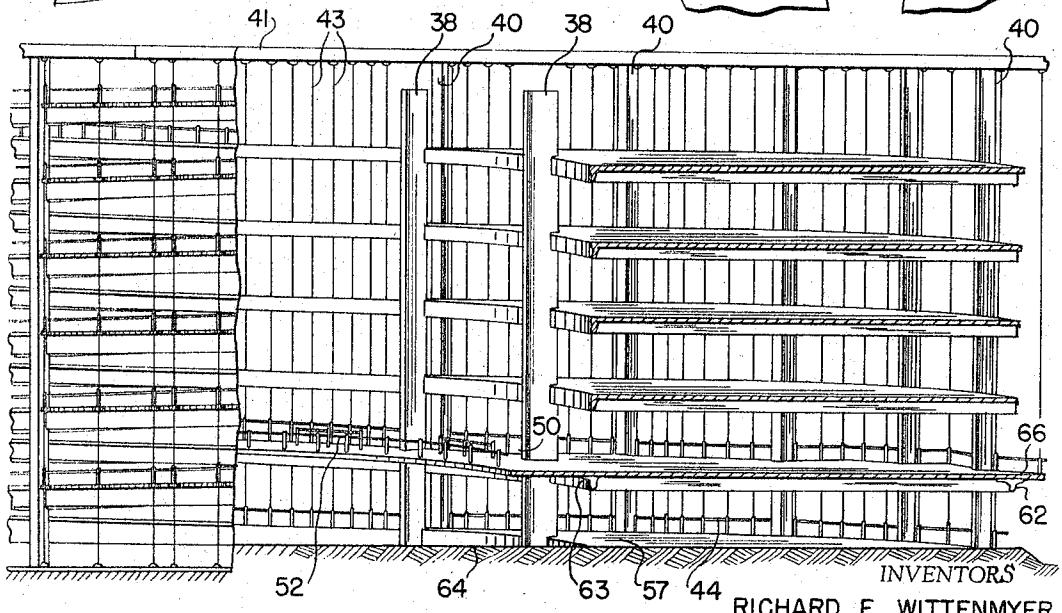


FIG. 4

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HELICAL BUILDING

Filed March 2, 1964 3 Sheets-Sheet 3

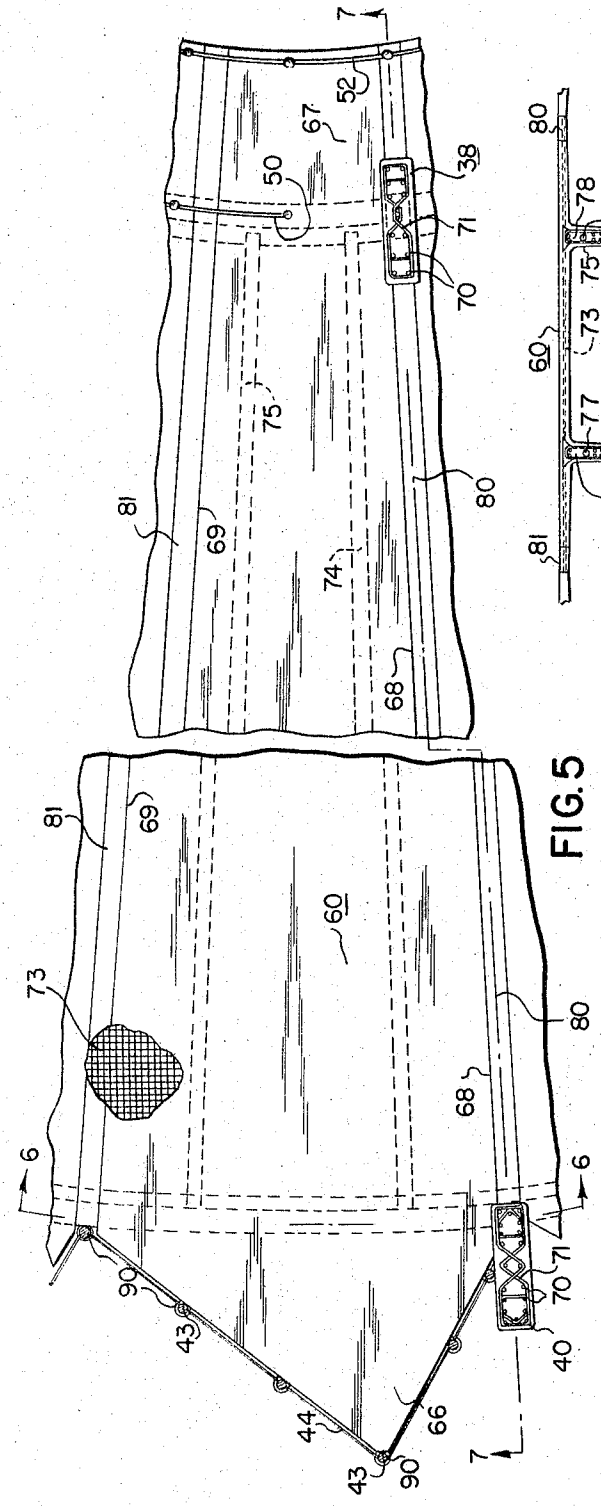


FIG. 5

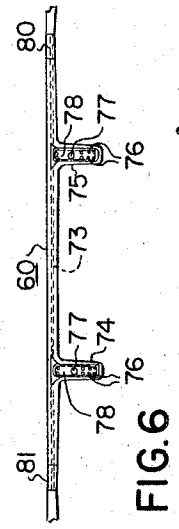


FIG. 6

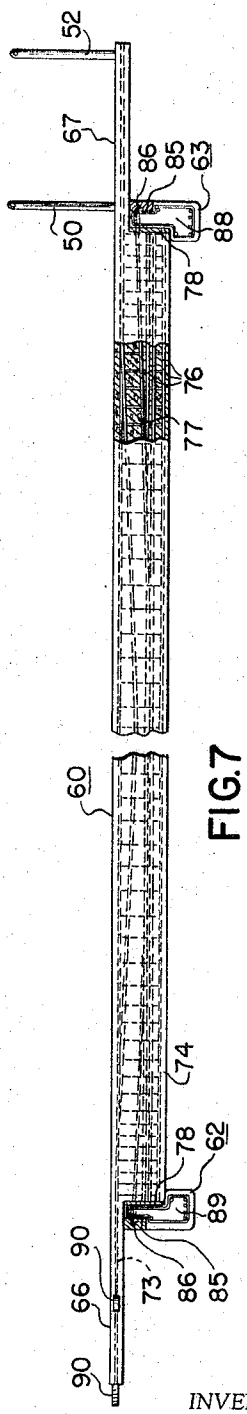


FIG. 7

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HELICAL BUILDING

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Filed Mar. 2, 1964, Ser. No. 348,506
8 Claims. (Cl. 52—175)

This invention relates to parking garages and, more particularly, to an improved vehicle parking garage.

Priorly, numerous attempts have been made to provide multi-story parking garages with ramps between floors and with provision for parking on the various floors. These garages, however, exhibit numerous disadvantages. For example, they employ a large amount of floor space to provide the necessary ramps, which ramps limit available parking area. Also, because of the complex network of roadways and the difficulty of maneuvering vehicles through these roadways, these structures require attendants to park and retrieve the cars. Still other disadvantages of these known types of garages are the short turns and intersections which define traffic hazards when vehicles are coming from different directions to enter a common ramp. Further, although attempts have been made to provide all-ramp type garages, these attempts have resulted in uneconomical structures having separate entrances and exits for each of two-ramp type structures with no provision for driving from one structure to another. Thus, these structures prevent maximum utilization of the parking area.

Accordingly, it is an object of this invention to provide a garage which obviates the above-mentioned disadvantages.

It is another object of this invention to provide an improved all-ramp type garage which makes maximum utilization of the garage structure to provide a maximum amount of parking area.

Still another object of this invention is to provide an improved parking garage in which the driveways are uniform, free form sharp turns, hazardous intersections and oncoming traffic so that the customers may park and retrieve their own vehicles without creating traffic hazards.

It is a further object of this invention to provide an improved parking garage which can be quickly, easily and economically constructed.

It is a still further object of this invention to provide an improved, all-ramp type parking garage which provides a maximum ratio of parking area to driveway area and which provides for easy ingress and egress of the vehicles and predestrians without introducing traffic problems.

Another object of this invention is to provide an improved parking garage in which a large number of identical pre-cast, pre-stressed concrete sections are employed which may advantageously include means for post-stressing.

It is a still further object of this invention to provide a parking garage with a pair of spiral, all-ramp structures, each including parking areas on each side of a radially centered, single lane driveway in which the parking stalls are angularly disposed relative to the driveway to facilitate the entrance and exit of the vehicles from the stalls. Advantageously, this arrangement provides for the maximum utilization of the space because it provides a maximum parking area to driveway ratio.

Yet another object of this invention is to provide an improved parking garage with a plurality of spiral all-ramp structures inter-connected by crossovers, or bridges, to facilitate the ingress and egress of vehicles.

A still further object of this invention is to provide an improved parking garage with a plurality of helical, all-ramp structures with crossovers inter-connecting corresponding levels on the respective ramps, one of the structures spiraling in one direction and at least one other structure spiraling in the opposite direction, entrance means connected to one of the helical structures and exit means connected to at least one of the other helical structures, each structure having a single lane driveway positioned between two series of radially spaced parking stalls.

Another object of this invention is to provide in a garage a plurality of helical, all-ramp structures, one spiraling in one direction and another spiraling in the opposite direction with pedestrian ramp means along the inner edges of the helices to provide safe pedestrian paths so that the pedestrians may quickly and safety ascend and descend the structures.

Briefly, in acordance with aspects of this invention, at least two spiral, or helical, structures are positioned in side-by-side relationship with either the two structures or the direction of travel thereon, but not both, being of opposite hand, one clockwise and the other counterclockwise. These structures are inter-connected at corresponding levels so that an entranceway may be provided for only one of the structures and an exitway provided for the other structure and the traffic will always progress in one pattern throughout the respective structures. Advantageously, each spiral structure is provided with a radially positioned, single lane drive intermediate the spiral structure to provide parking areas in the form of a series of stalls on each side of the drive.

According to other aspects of this invention, the parking stalls are positioned at acute angles relative to the drive to permit the vehicles to enter and leave the stalls with a minimum of turning of the steering wheel.

In accordance with further aspects of this invehtion, a pedestrian ramp is provided along the inner edge of each helix so that the pedestrians have a safe walking area remote from the traffic.

Advantageously, the parking garage may be formed from a plurality of identically shaped interior and exterior edge beams and a plurality of identically shaped, pre-cast, radially tapered floor units which incorporate their own longitudinal beams so that the major portion of the construction of a number of buildings can be accomplished at a single site and the assembly accomplished on the garage site with the addition of columns which are conveniently pre-cast or cast in place. Also advantageously, these tapered floor units include cables which can be post-tensioned to provide additional support for the concrete floor units. The pre-cast floor units may be formed with a triangular shaped outer edge to define corners for the vehicle stalls along the outer periphery of the spiral, or helical, ramp and the inner edge of the pre-cast floor units may be provided with a segmented circular pedestrian ramp. The parking garage can be quickly and easily constructed by casting in place a predetermined number of reinforced inner columns and a plurality of reinforced outer columns. These outer columns are inter-connected with pre-formed reinforced beams which connect the respective outer columns to define an outer circle. A group of identical pre-cast beams connects the respective inner columns to define an inner circle. The radially tapered pre-cast floor units are then placed to bridge the inner and outer beams in a continuous all-ramp structure. Bridges are then cast between corresponding levels of the structures.

In one embodiment, at least three helical structures are constructed with their axes parallel and with their peripheries adjacent each other, one helix for upward traffic flow and two helices for downward traffic flow, or vice versa, with bridges interconnecting the first helix with each of the others. The upward helix or helices serve

as entrance ramps while the downward helix or helices serve as exit ramps. Each of the ramps has parking space on both peripheries of a centrally located, single lane driveway, which arrangement facilitates the exit of traffic.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a partial plan view of one illustrative embodiment of parking garage according to this invention;

FIGURE 2 is a partial sectional view, in elevation, taken along the lines 2—2 of FIGURE 1 with the pedestrian ramp and outer railings removed;

FIGURE 3 is a partial view, to an enlarged scale, of the first floor of the sector cut out of FIGURE 1 by the lines 2—2;

FIGURE 4 is a view in elevation, partly in section, of the left hand helix of FIGURE 1 to the same scale as FIGURE 3;

FIGURE 5 is a plan view, partly broken away, of a double cantilever T beam floor unit to an enlarged scale relative to FIGURE 3;

FIGURE 6 is a sectional view of the T beam floor unit shown in FIGURE 5, taken along the line 6—6;

FIGURE 7 is a view in elevation of the T beam floor unit shown in FIGURES 5 and 6 taken along the lines 7—7 of FIGURE 5; and,

FIGURE 8 is a plan view to a greatly reduced scale of another illustrative embodiment of this invention.

FIGURE 1 shows a plan view, partially broken away, of one illustrative parking garage according to this invention and FIGURE 2 is a view in elvation and in section of the left hand structure of FIGURE 1, taken along the lines 2—2 of FIGURE 1 and including a portion of the right hand structure of FIGURE 1. FIGURE 2 does not show the pedestrian ramp and the safety devices which will be subsequently shown and described. FIGURE 1 includes a first spiral, or helical, structure 10 which, in this particular instance, spirals upwardly in a clockwise direction as indicated by arrow 11 and a second spiral, or helical, structure 12 which spirals downwardly in a clockwise direction as indicated by arrow 13. Stated in another manner, the structures 10, 12 spiral in opposite directions with respect to ascending elevations. The structure are interconnected at corresponding elevations by a plurality of substantially horizontal bridges 16. The parking garage includes a single entrance 18 and a single exit 20. Each of the helical structures 10, 12 includes a single lane driveway 22, 23, respectively, radially positioned intermediate the helix as outlined by the concentric helical lines 24, 25 and 26, 27. The structures 10, 12 are each provided with two series of parking stalls 30, 31 on opposite sides of the respective concentric helical lines 24, 25 and 26, 27.

Each of the structures is formed by casting vertical columns in a pair of concentric circles on the garage site and these columns are cast on suitable foundations not shown or described. For example, structure 10 is formed with a plurality of interior columns 34, positioned in a circle, and a plurality of exterior columns 36, also positioned in a circle concentric with the circle defined by columns 34. After these columns are formed in position, they are interconnected by beams which are placed on cast-in-place reinforced concrete wedges, or supports, not shown, on the respective columns so that a plurality of exterior edge beams connect the columns 36 while a plurality of substantially identical interior edge beams connect the interior columns 34, which beams will be subsequently shown and described. Similarly, the structure 12 is formed by casting a plurality of interior columns 38 and a plurality of exterior columns 40, concentric with the circle defined by the interior columns 38. The exterior columns 40 are connected with exterior edge beams and the interior columns 38 are connected by interior edge beams. The tops of the exterior columns 40 are interconnected by a series of top edge beams 41 to improve the esthetic appeal of the structure and to give the columns increased stability. Similarly, the exterior columns 36 are interconnected by a series of top edge beams 41.

As a safety precaution, each stall may be provided with a vehicle stop member, or bumper, 42 shown on certain of the stalls 30 of the structure 12. As a further safety measure, each structure is provided with a series of spring tensioned vertical cables 43 which are connected around the periphery of the helices and are interconnected by generally horizontal cables to define an outer safety railing 44. Preferably, these cables 43 are connected between the top edge beams 41 and the foundations of the structures by means of springs, not shown, so that they will yield without snapping if struck by a vehicle.

Several provisions are made for the ingress and egress of pedestrians. For example, each of the structures may be provided with an elevator, such as an elevator 45 for the structure 10 and an elevator 46 for the structure 12, or a single elevator may be provided for both of the structures. These elevators are connected with each of the bridges 16 by means of a walk 47 which is protected by a railing 48. A pedestrian helical ramp 49 is also provided around the inner periphery of each of the structures 10, 12, and each ramp includes an inner railing 50 and an outer railing 52. The inner railing 50 is defined by a number of relatively short sections spaced from the interior columns to permit the ingress and egress of pedestrians between the railing sections and the interior columns. The top floor of each of structures 10, 12 terminates in a radially aligned fence 51 which extends over the top bridge 16.

FIGURE 3 shows, to an enlarged scale with respect to FIGURE 1, the first floor of the sector cut off by the lines 2—2 of FIGURE 1. This view includes the ground level portion 53 of the foundation which may be horizontal or a spiral below grade. The pedestrians may pass from the end of ramp 49 onto the ground in the direction of arrow 54. The junction between the inclined portion of helix 12 and ground portion 53 is defined by a dotted line 55. This view also shows the inclined portion 57 of the foundation which defines a passage to the exit 20 as indicated by arrow 58 and meets the edge of a first of a series of floor T beams 60. The flooring for the above-ground portion of each of the helices is provided by this series or substantially identical tapered, pre-cast and pre-stressed T beams 60, which will be subsequently described in detail.

FIGURE 4 is a view in elevation, partly in section, of the helix 12 to the same scale as FIGURE 3. The T beams 60 have their longitudinal dimension on radii of the respective structures 10, 12 and are each supported by an exterior and an interior edge beam, 62, 63, respectively. The line 64 indicates the ground level from which the inclined portion 57 of the foundation defines the beginning of the helix 12. A triangular portion 66 of beam 60 extends beyond exterior edge beam 62 to define a cantilever portion. Although only portions of the pedestrian railings 52, 50 are shown, it is apparent that the portions of the floor beams 60 defining pedestrian ramp 49 are, in fact, each a cantilever 67 which extends beyond the interior edge beam 63. These cantilever portions will be described in detail with respect to FIGURES 5 and 7.

FIGURE 5 shows a plan view, partly broken away, and to an enlarged scale relative to FIGURE 3, of the double cantilever floor T beam 60 used to form all the floor of the parking garage which is above the inclined portion of the foundation. Each of the beams 60 is tapered and terminates in an outer triangular cantilever section 66. The end of the beam 60 opposite from the triangular section 66 is the second cantilever section 67 which is a section of a circle defining a short length of the pedestrian spiral ramp 49. The T beam 60 has a

pair of longitudinal edges **68**, **69**, each of which lies on radii of the respective helix when the beam is installed in the building. The beam **60** is preferably pre-cast concrete in which a mesh screen **73**, shown to an enlarged scale, is imbedded in the floor surface as one reinforcing means and this screen may be of the order of two-inch meshes of No. 12 wire. FIGURE 5 also shows the vertical columns **38**, **40**, each with a group of reinforcing rods **70**, each group having an interlacing wire **71**. Similar reinforcing is employed in columns **34**, **36**.

The T portions of T beams **60** are also provided with pre-stressing and post-tensioning means which will be subsequently described. The second cantilever section **67** of T beam **60** extends beyond the interior edge beam **63**, as viewed in FIGURES 5 and 7, and has pipe railings **50**, **52** along the inner and outer edges, respectively. The inner railing **50** is in short sections spaced from each interior column **34** or **38** to permit pedestrians to enter and leave the spiral ramp **49**.

FIGURE 6 is a view in section, of the beam of FIGURE 5, taken along the lines **6—6** thereof. The T beam **60** has a pair of longitudinal T-shaped reinforcing sections **74**, **75**, each of which has a plurality of steel rods **76** of a first diameter and at least one rod **77** of a larger diameter. The T sections **74**, **75** are each provided with a pair of end plates **78** on opposite ends thereof and the rods **76** are preferably pre-stressed and secured to these end plates **78**. Advantageously, the rods **77** extend through the end plates **78** and are post-stressed to provide additional reinforcing for the T beams in a manner which will be subsequently described.

In FIGURE 6 a pair of joints **80**, **81** between the next adjacent, partially shown, T beams **60** completes the floor surface and these joints are cast in place after the beams **60** are positioned on the beams **62**, **63**. The screen **73** is held near the surface of the beam **60** at the T-shaped sections **74**, **75**. Between the T sections **74**, **75** the screen bows downwardly near the lower surface of the beam and after the beam is set this bowed portion of the screen **73** provides transverse reinforcement of the beams **60**.

Referring now to FIGURE 7, there is depicted a longitudinal view, in elevation, of the beam **60** taken along the lines **7—7** of FIGURE 5. As therein shown, the longitudinal T sections **74**, **75** fit between the interior and exterior beams **62**, **63** and the rods **77** extend through suitable notches, not shown, in the edge beams. A plate **85** is attached to the outer end of the rod **77** and on the outer surface of beam **62** by means of a nut **86**. Another plate **85** is connected to the inner end of the rod **77** and on the inner surface of beam **63** by means of another nut **86** and the nuts **86** are tightened to provide post-tensioning of the beam **60**.

The edge beams **62**, **63** are preferably L-shaped in cross-section as shown in FIGURE 7. Interior L-shaped edge beam **63** has a lower portion **88** which projects to the left and engages the interior ends of the T sections **74**, **75**. Similarly, on the opposite ends of the beam **60**, the exterior edge beam **62** has an L-shaped cross-section including a lower portion **89** which projects inwardly and engages the ends of T sections **74**, **75**.

When the beams **60** are being cast a plurality of eye bolts **90** are positioned to project from the edges of the triangular section **66** to receive the vertical cables **43**. In cutting the screen **73** before it is placed in the concrete, it is measured and cut to provide an overlap on each side of the beam which is preferably equal to the width of the floor joints **80**, **81** to thus provide reinforcement for these joints.

FIGURE 8 shows a plan view to a greatly reduced scale relative to FIGURE 1, of another embodiment of this invention. In this embodiment a first helical structure **92** is a structure similar to the structure **10** of FIGURE 1 in that it is provided with an entrance **93** and spirals upwardly in a clockwise direction as indicated by an arrow **94**. A pair of structures **95**, **96**, each corresponding with the construction of helix **12** of FIGURE 1, is also provided. These structures each have an exit ramp **97**, **98**, respectively, and are each connected to the helix **92** at corresponding levels by means of one of a pair of bridges **100**, **102**. This arrangement greatly facilitates the egress of the vehicles, especially where a parking garage has a utilization pattern of gradually filling in the morning but quickly emptying in the evening rush hour.

In use, the helical structures **10** and **12** have decided advantages as a parking garage. A person will drive his automobile in the entrance **18** and will spiral clockwise upwardly until he finds an empty parking stall in which he will park his automobile. If an empty stall cannot be found in the first complete revolution, he may continue on up for as many revolutions as necessary to reach an empty stall. The fact that the two helical structures **10** and **12** are open on the sides and with the view obstructed only by the vertical cables **43**, permits the driver of the vehicle to easily look over to the other helical structure **12** to see if there are vacant parking stalls in that structure. If there are, he may cross over at any one of the connecting bridges **16** and start a downward spiral in a clockwise direction to reach such unoccupied parking stall. Upon parking his vehicle, the driver may then walk up or down the spiral pedestrian ramp **49** to reach the exit or to reach one of the elevators **45**, **46**. Since these spiral pedestrian ramps **49** are on the inside of the helix, they are in a safe position for the pedestrians and also provide a short path for the pedestrians.

The fact that the driveways **22** and **23** are single lane provides safety in that a driver will not be surprised by a vehicle coming in the opposite direction. Further, since the parking stalls are at an angle rather than perpendicular to the driveways, this promotes ease of entry and exit from the parking stalls and also assures that a driver will not turn his vehicle around to go back down an up ramp. The fact that there are parking stalls on each side of a driveway which is a single lane driveway, assures a maximum utilization of the building structure for parking and since the entire building structure is a helical ramp all of the ramp surfaces are used for parking and not used merely for travel from one floor level to another as in many of the prior art parking garages.

The connecting bridges **16** may provide one direction or two directions of traffic movement. The first and second helical structures **10** and **12** have been shown as being structurally of opposite hand, one spiraling clockwise upwardly and the other spiraling counterclockwise upwardly. With one direction of traffic flow on a bridge **16**, for safety, either the structures may be of opposite hand or the traffic flow thereon may be of opposite hand, but not both. As illustrated in FIGURE 1, a vehicle will spiral clockwise upwardly in the first helical structure **10** and then cross over on one of the several bridges **16** and spiral clockwise downwardly in the second helical structure **12**. If this second helical structure **12** were constructed the same as the first helical structure **10**, namely spiraling clockwise upwardly, then the traffic flow on this second helical structure would be a counterclockwise direction in order to spiral downwardly.

The bridges **16** may also be made wider to permit two-way traffic flow so that traffic may flow from the up helical ramp to the down helical ramp or vice versa, in order to best find an available parking stall. In this case of two direction traffic flow on bridges **16**, it is preferred, for safety purposes, that the structures **10** and **12** be made structurally of opposite hand, so that the traffic flow on the bridges from up to down or down to up will not cross each other. In this way, curbs or baffles may be built into the bridges **16** in order to safely direct the traffic flow. It will be noted that in FIGURE 1 in the helical structure **10**, upward traffic flow spirals clockwise according to the arrow **11**. In crossing the bridge **16**

and going to a downward clockwise spiral, approximately a 180 degree turn to the left is made from the driveway **22** onto the bridge **16** and then onto the driveway **23**. Accordingly, with a slightly wider bridge **16**, it will be easy to provide a down to up traffic flow pattern by a 180 degree turn to the left off the driveway **23** across the bridge **16** and onto the driveway **22**.

While certain illustrative embodiments of the invention have been shown, it is understood that the concepts thereof may be employed in other embodiments without departing from the spirit and scope of this invention. For example, either or both of the helices **10**, **12** may be provided with double lead screw surfaces or helical surfaces. Further, more than three helical structures may be provided with interconnecting bridges and with surfaces which spiral in opposite directions. Still further, any of these embodiments may be provided with underground parking ramp portions of all-ramp construction and with the entrances and exits at the ground, or street level.

What is claimed is:

1. A vehicle parking building comprising a pair of substantially circularly helical, all-ramp structures positioned with their axes substantially vertical,

a helical, single lane driveway radially positioned intermediate each structure,

a plurality of vehicle stalls on each side of each driveway,

a plurality of columns arranged in an exterior circle and in an interior circle,

a plurality of exterior edge beams connecting adjacent exterior columns,

a plurality of interior edge beams connecting adjacent interior columns,

a plurality of wedge-shaped floor beam sections positioned with their long dimension bridging the interior and exterior edge beams and forming said driveway,

said columns and edge beams providing substantially entirely the support for said floor beam sections,

means cooperating with said edge beams to post-tension portions of said floor beam sections,

and crossover means connecting at least the upper ends of said structures.

2. The combination according to claim **1** wherein said floor beam sections are substantially identical,

said post-tensioning means includes at least one radial reinforcing rod and means engaging the outer ends of said reinforcing rod and said edge beams.

3. The combination according to claim **1** including means establishing only one-way traffic on said crossover means.

4. The combination according to claim **1** wherein said floor beam sections extend over each of said outer and inner edge beams,

said extensions over said inner edge beams forming a helical pedestrian ramp,

and said extensions over said outer edge beams being triangular in shape forming an end portion of said vehicle stalls.

5. A parking garage comprising a pair of substantially circularly helical, all-ramp structures positioned adjacent each other and spiraling in opposite directions, each of said structures including a plurality of exterior columns positioned in a first circle,

a plurality of interior columns positioned in a second circle concentric with said first circle,

a plurality of exterior edge beams connecting adjacent exterior columns,

a plurality of interior edge beams connecting adjacent interior columns,

a plurality of pre-cast, wedge-shaped floor beams positioned with their long dimension bridging the interior and exterior edge beams and extending thereover, said floor beams including at least one T-shaped section having reinforcing rods therein, certain of said reinforcing rods being prestressed and means on said edge beams for post-tensioning at least one of said rods,

and drive means interconnecting said structures.

6. A vehicle parking garage comprising a pair of helical structures of all-ramp construction spiraling upwardly in opposite directions, each of said helical structures including a plurality of exterior columns positioned in a first circle, a plurality of interior columns positioned in a second circle concentric with said first circle, exterior edge beams connecting said exterior columns and interior edge beams connecting said interior columns and tapered floor beams interconnecting said exterior and interior edge beams,

said columns and edge beams substantially entirely supporting said floor beams,

entrance means at one end of one of said helical structures,

exit means at a corresponding end of the other of said structures,

and means interconnecting said structures remote from said entrance means and said exit means.

7. The combination according to claim **6** wherein each of said exterior edge beams is L-shaped in cross section with the projecting portion of the L directed toward said interior edge beams, each of said interior edge beams being L-shaped in cross section with the projecting portion extending toward said exterior edge beams, said floor beams including T-shaped sections resting upon the projecting portions of said edge beams.

8. The combination according to claim **6** wherein said floor beams project interiorly from said interior edge beams to define a spiral pedestrian ramp and wherein said garage includes railing means around said pedestrian spiral ramp.

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