Dec. 31, 1968 C. H. HAGEL 3,419,161

ELEVATOR AND BUILDING ARRANGEMENT

Filed March 25, 1965 Sheet 1 of 4

Fig. 1

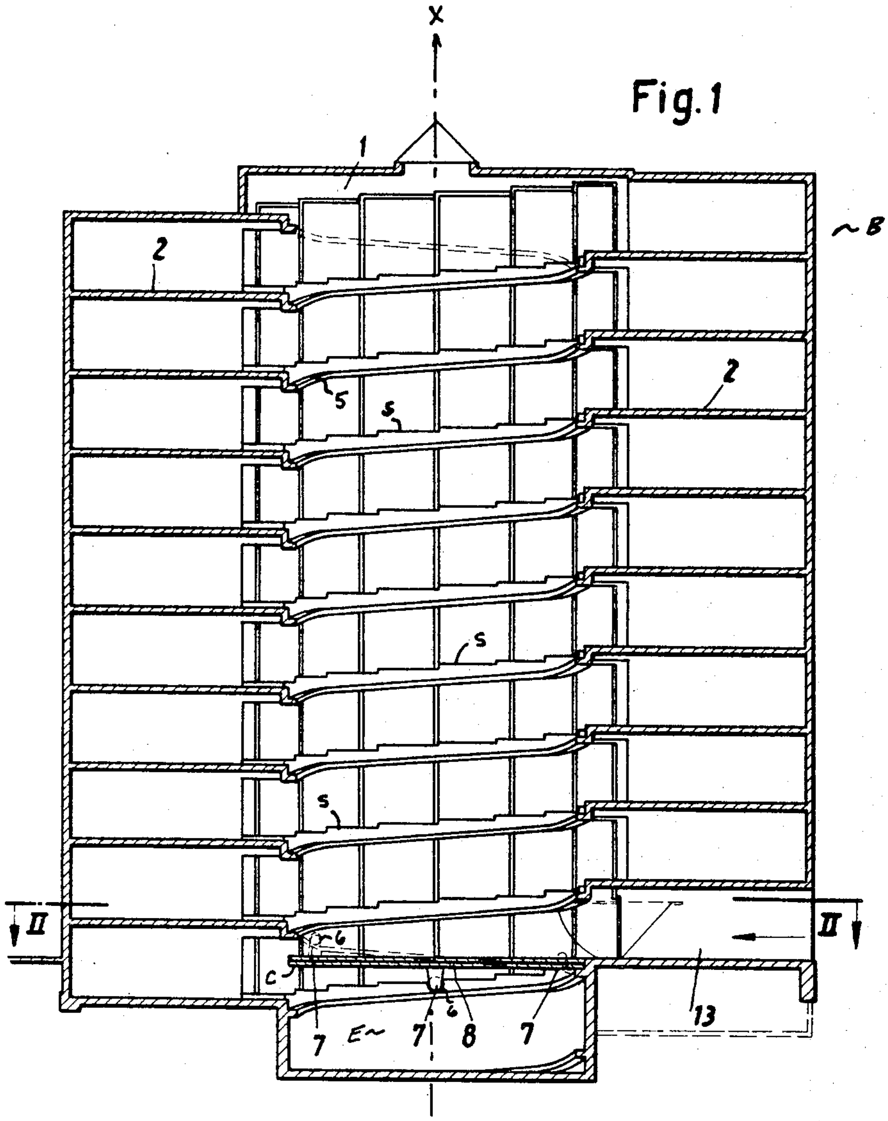

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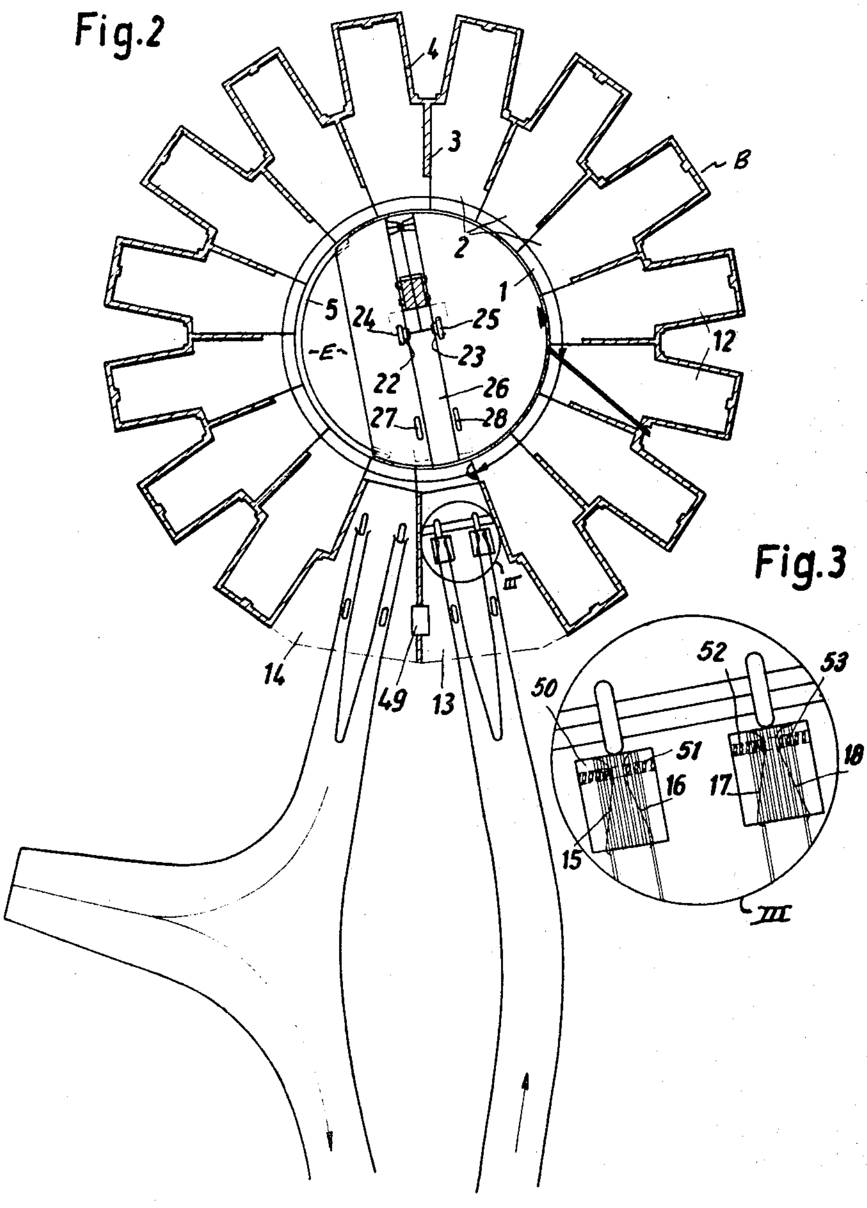
Fig.2



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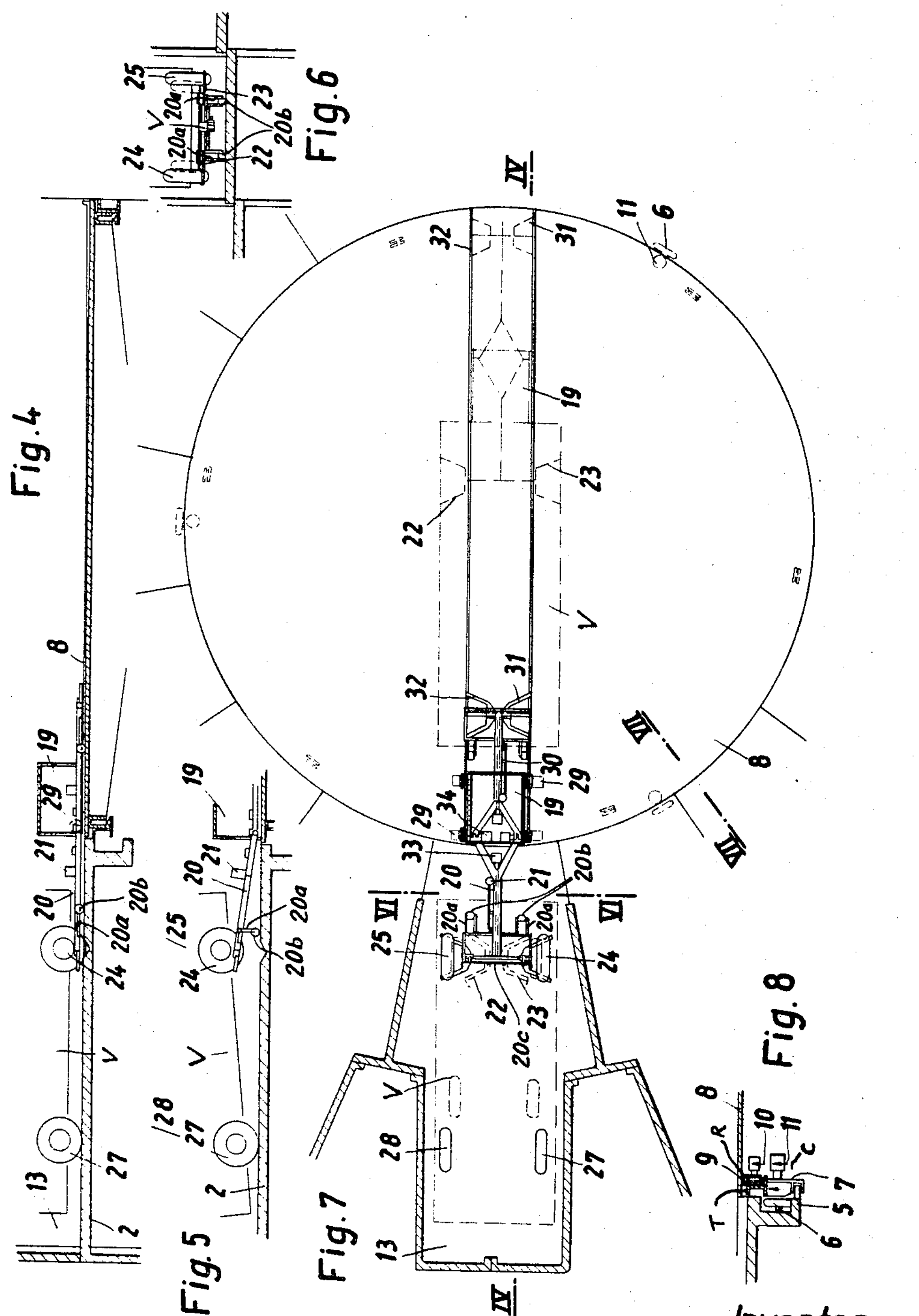

Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8

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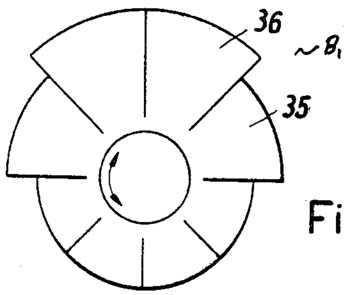

Fig.9

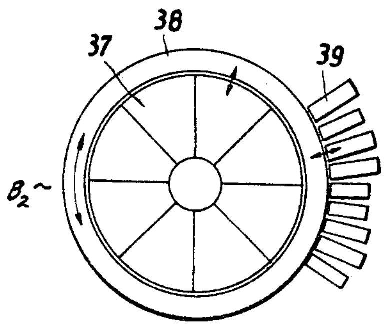

Fig.10

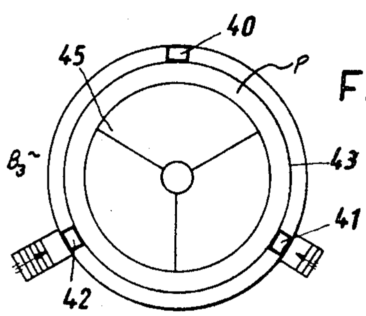

Fig.11

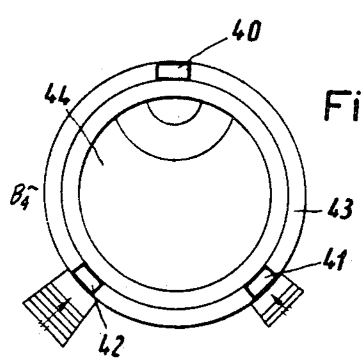

Fig.12

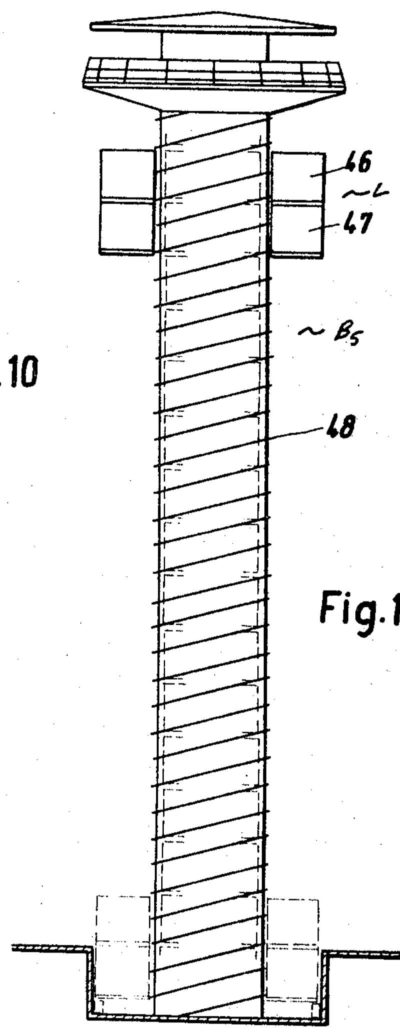

Fig.13

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United States Patent Office 3,419,161
Patented Dec. 31, 1968

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3,419,161
ELEVATOR AND BUILDING ARRANGEMENT
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Filed Mar. 25, 1965, Ser. No. 442,645
Claims priority, application Austria, Apr. 13, 1964, A 3,186/64
2 Claims. (Cl. 214—16.1)

ABSTRACT OF THE DISCLOSURE

An elevator structure wherein a rotatably driven carriage is guided on a stationary, vertical helical track for movement along the axis thereof to position a load carrier at a selected elevation, the load carrier being independently rotatable relative to the carriage to assume a given angular orientation upon arrival at such elevation and to reduce centrifugal forces due to carriage rotation and acting upon objects carried by the load carrier.

This invention relates in general to elevators and building structures which are arranged to accommodate elevators, and more particularly to an elevator and building structure arrangement having a helical track upon which an elevator load carrier is guided and move up and down for conveying load items, such as vehicles, betwen various levels of the building.

For the purpose of illustration and example, the description of the invention herein is centered around a particular application, specifically, the use of an elevator and building arrangement according to the invention which is particularly adapted for the storage of vehicles, such as automobiles. However, as will be appreciated by those skilled in the art, the elevator and building arrangement according to the instant invention can be used for numerous other purposes, and readily adapted for such other uses in an obvious manner. Furthermore, the elevator construction according to the invention is suitable for general use by itself, such as for example, where it is desired merely to transport persons to an elevated observation position.

In the construction of multi-story garage buildings, it is known to arrange the storage spaces or chambers for accommodating vehicles in an annular ring around an elevator shaft which serves for the guidance of a vehicle carrier or lift having a rotatable vehicle support platform. By using a rotatable vehicle support platform in such a prior art arrangement, a vehicle can be brought into the building along a selected path leading to the elevator shaft, transferred onto the vehicle carrier, raised or lowered to a selected storage level, and transferred thereat to an unoccupied storage area, with the support platform being rotated so that the vehicle can be moved in a straight line from the carrier into the intended storage area. To remove vehicles from their storage areas in the building, this procedure is reversed.

One of the disadvantages of such prior art garage elevator arrangements which is eliminated by the elevator arrangement of the instant invention is the need for frequent inspection, maintenance and replacement of the wire ropes used for operating certain prior art elevators. By using a load carrying member such as a vehicle carrier which is supported by a vertically disposed helical guide track and suitable drive means for moving the vehicle carrier relative to the guide track, vehicles and other load items can be conveyed between different positions and levels along the guide track without the need for any wire rope and pulley drive arrangement as used in those prior art elevator systems.

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The use of wire rope and pulley driving arrangements in prior art elevators presented a severe maintenance and safety problem, since wire ropes are subjected to wear and fatigue failure when continually driven around pulleys. Although by using pulleys having a large diameter relative to that of the rope, it is possible to reduce bending stresses and fatigue failure in the rope, the use of large pulleys does not alleviate the wear problem. In many garage elevator applications, the size of the pulleys which can be used is limited by the available space, and thus, the extent to which bending stresses in the ropes can be reduced is somewhat restricted.

Another advantage of the elevator construction according to the invention lies in the feature that the drive means used for moving the load carrier can be supported directly by the load carrier itself. For example, the load carrier can be driven up and down along the helical track by means of one or more drive wheels attached to the carrier which engage the track. In contrast to the prior art elevators which required a space at the top of the elevator shaft for housing the drive pulleys, which the height of this space being frequently equal to that of one story of the building in which the elevator is installed, the elevator according to the instant invention requires no such extra space for its drive mechanism, and its load carrier can in general be driven between the lowermost and uppermost extremities of the track.

Furthermore, the load carrier driving arrangement of the instant invention eliminates the need for periodic adjustment of load carrier stopping station positions in cases where automatic position control is provided. In prior art elevators using wire rope drive systems, variations in rope length due to stretching and load variations made it necessary to make frequent compensating adjustments in the stopping station positions.

In essence, the concept of the elevator and building arrangement according to the invention is quite simple, and is based upon the same principles as the motion of a nut upon a screw, with the nut corresponding to the load carrier and the screw corresponding to the helical guide track.

Accordingly, the invention is susceptible of several alternative emodiments and variations thereof. For example, the helical track can be of open construction like a coil spring with spaced-apart turns, and mounted within a cylindrical well passage provided in a building, with the load carrier being mounted inside of the track and movably supported thereby so that the load carrier can be displaced along the direction of the track longitudinal axis by rotating it relative thereto. In this embodiment the load carrier moves along the track axis in the manner of a male threaded nut in a female threaded hollow shaft.

Alternatively, the load carrier can be constructed in a completely annular, or segmental annular form and supported on the outside of the guide track so as to be axially movable in the manner of a femal threaded nut on a male threaded screw. In this case, the helical track can be mounted to the outside of a cylindrical multi-story structure which is preferably of open construction so that vehicles can be transferred from the load carrier into storage areas provided at the various levels inside the structure.

If desired, an elevator arrangement according to the invention can be provided which has an annular load carrier that is movable up and down within an annular well provided inside of a building. Such an arrangement will permit the transfer of vehicles between the load carrier and storage areas bordering on both the outer and inner boundaries of the annular well.

While the operation of the elevator according to the invention has been described in terms of the motion of a nut upon a screw, this by no means implies that a threaded engagement is necessary between the load carrier and the guide track, or that the load carrier itself must necessarily rotate in the manner of a nut as it advances axially along the guide track.

Although a mating threaded engagement between the load carrier and the guide track can be used, it is preferable to use an undercarriage which is connected to the load carrier, and which has wheels that engage the track for supporting and driving the load carrier. In such a case, the wheels are journaled to arms which extend from the undercarriage, with said arms having lengths which enable the load carrier to be supported by the undercarriage in a horizontally level attitude. The wheels are driven so as to rotate the undercariage about the guide track axis, thereby causing said undercarriage to advance axially in the manner of a nut rotatably driven along a screw. By pivotally connecting the load carrier to the undercarriage and providing means for counterrotating the load carrier with respect to the undercarriage, such as for example, counterrotation means responsive to the undercarriage wheel drive means, the angular position of the load carrier about the guide track axis can be made independent of the angular position of the undercarriage.

The elevator arrangement of the prevent invention also features an opposition load transfer mechanism which can be operated either under manual or automatic control to transfer vehicles and other load items between the load carrier and adjacent storage and receiving areas. The load transfer mechanism is supported by the load carrier so as to be capable of operation at each of the various storage levels services by the load carrier, and includes means for grasping and drawing a vehicle from an adjacent delivery platform onto the load carrier in a selected direction of alignment, and discharging said vehicle from the load carrier onto an adjacent receiving platform. Thus, where it is desired to place a vehicle in a selected elevated storage area in a garage building, the vehicle can be driven under its own power up to a delivery platform on a lower story of the building, drawn onto the load carrier by the transfer mechanism, and brought up on the load carrier to the level of the intended storage area. At this level, the load carrier is rotated by the counterrotation means to align the transfer mechanism in the direction of the intended storage area so that when the vehicle is transferred to the receiving platform it will be oriented in a direction that will permit it to be driven in a straight line into the selected storage area. To remove a vehicle in such an elevated storage area, it is only necessary to reverse the aforesaid procedure.

Since in the axial motion of the load carrier and its undercarriage, the undercarriage following the helical guide track undergoes simultaneous rotation about the helical axis, this rotation can be utilized to align the load carrier transfer mechanism in a given radial direction as it arrives at a selected level within the building. This can be accomplished according to the invention by an automatic control means responsive to the angular position of the undercarriage relative to the guide track axis, and respective to the angular position of the load carrier relative to the undercarriage. For example, the radial position and elevation differential of the intended storage area can be programmed into the automatic control means to cause said control means to adjust the counterrotation rate of the load carrier relative to the undercarriage so that when the load carrier arrives at the selected storage area level, the transfer mechanism is aligned radially with the storage area, so that no further rotation at that level is required. Such an arrangement would permit immediate operation of the transfer mechanism upon arrival at the storage area and would speed up the storage and delivery of the vehicles from the building.

This type of automatically controlled elevator operation can be provided in each of the several embodiments of the invention, regardless of whether an annulus or circular load carrier is used, or whether in the case of an annular load carrier it rides on an inside or an outside helical track.

As will be appreciated by those skilled in the art, the uses of a helical track for guiding and lifting the load carrier offers a substantially inherent mechanical advantage. For example, the pitch of the helical track, preferably made equal to the height of a story in the building, or slightly greater for sufficient height clearance in transferring vehicles between the load carrier and storage areas in those embodiments of the invention wherein load transfer necessarily occurs through the spacing between adjacent turns of the track. By using a guide track helix of sufficient diameter in relation to its pitch, a selected mechanical advantage in lifting the load carrier and load items supported thereby can be obtained.

However, a high mechanical lifting advantage can only be achieved at the sacrifice of lifting rate for a given undercarriage rotation speed. Accordingly, the selection of the guide track helix diameter will depend upon the desired lifting rate and permissible undercarriage rotation speed in a given application, as well as other considerations such as available space and cost.

It is therefore, an object of the invention to provide an elevator arrangement that is suitable for transferring vehicles and other load items between various storage area levels in a building.

Another object of the invention is to provide an elevator arrangement as aforesaid which is relatively free from excessive wear on its movable parts, so as to require a minimum amount of inspection and maintenance.

Another and further object of the invention is to provide an elevator arrangement as aforesaid which is automatically controlled.

Still another and further object of the invention is to provide an elevator arrangement in combination with a building having storage areas which are radially aligned with respect to the elevator so as to permit vehicles to be transferred between the elevator and such storage areas along straight radial paths.

Another object of the invention is to provide an elevator having means for transferring vehicles and other load items between a load carrier and adjacent areas of various levels in a storage building.

Other and further objects of the invention will become apparent from the following detailed description and accompanying drawings in which:

FIG. 1 is an elevation view, partly in section, of a storage building adapted for use in combination with the elevator according to a preferred embodiment of the invention, and showing a typical installation of the helical guide track therefor.

FIG. 2 is a horizontal transverse sectional view of the building of FIG. 1 taken along line II—II therein.

FIG. 3 is an enlarged view of a portion of FIG. 2, showing the details within the circle III therein.

FIG. 4 is an axial elevation sectional view through a load carrying platform and load transfer mechanism of an elevator according to another embodiment of the invention, showing a vehicle in a typical position prior to its transfer onto the platform and showing adjacent portions of a surrounding building.

FIG. 5 is a portion of the axial elevation section view of FIG. 4 showing a typical position assumed by the vehicle and load transfer mechanism when the front wheels of the vehicle are lifted thereby.

FIG. 6 is a side elevation view, partly in section, of a portion of the arrangement of FIG. 5.

FIG. 7 is a top plan view of the arrangement shown in FIG. 4.

FIG. 8 is an elevational sectional view of a portion of a typical load carrying member suitable for use in the arrangement of FIGS. 4 and 7, together with its undercarriage and drive means.

FIG. 9 is a top plan view of a horizontal section through an alternative building structure which can be used in combination with the elevator arrangement of the invention.

FIG. 10 is a top plan view of a horizontal section through another building structure which can be used in combination with the elevator arrangement according to another embodiment of the invention.

FIG. 11 is a top plan view of a horizontal section through another building structure which can be used in combination with the elevator arrangement according to another alternative embodiment of the invention.

FIG. 12 is a top plan view of a horizontal section through still another building structure which can be used in combination with the elevator arrangement of FIG. 11.

FIG. 13 is an elevation view, partly in section, of a building structure and elevator arrangement according to another embodiment of the invention.

Referring now to FIGS. 1 and 2, wherein some of the details have been omitted for purposes of clarity, the building B accommodates an elevator E which travels up and down within a hollow cylindrical well **1** provided therein, said well being bordered by a helically wrapped floor **2**, in an arrangement similar to that of a spiral ramp or staircase. The floor **2** is preferably provided with horizontal flat stepped portions S arranged in radial symmetry with respect to the longitudinal axis X of the cylindrical well **1**. These stepped sections S together with radial walls **3** and **4**, define a plurality of storage area chambers **12**, such as can be used for storing vehicles and other load items.

At the inner boundary of the floor **2** is affixed a guide track **5** which is part of the elevator E, said track **5** being likewise helical and concentric with the axis X and also preferably vertical. The track **5** serves to guide a load carrying member in the form of a circular platform **8** which is also part of the elevator E, and which is driven up and down within the well **1** and is supported by said track **5** via roller wheels **6** which are journaled to frame arms **7** of an undercarriage C.

The load carrying platform **8** is connected to and supported by the undercarriage C by means of rollers or wheels **9** which are guided in a circular track T fixedly mounted to the undercarriage C. As shown in more detail in FIG. 8, the wheels **6** are in guiding engagement with the helical track **5**, with at least one wheel **6** being rotatably driven by a motor **11** which is also supported by the undercarriage C, preferably at a frame arm **7** thereof. For simplicity, it is preferable that only one wheel **6** be motor-driven, to avoid the need for synchronization between a plurality of motor-driven wheels **6**. However, if desired, a plurality of wheels **6** can be power driven, in which case synchronization means (not shown) are provided to maintain all drive wheels **6** at the same peripheral speed.

Since it is ordinarily desired to maintain the undercarriage C and load carrier platform **8** in a horizontally level attitude, the frame arms **7** which extend from said undercarriage C at various stations around its periphery, are made of such individual lengths that when their respectively journaled wheels **6** are in contact with the guide track **5**, the undercarriage C is level. These lengths can be simply determined by the application of merely routine engineering calculations for a given helical track **5**.

To maintain a stable undercarriage C and platform **8** attitude, at least three frame arms **7** and wheel **6** supports must be used. Ordinarily, it will be desirable to provide more than three frame arms **7** and wheel **6** supports for the undercarriage C, preferably in a symmetrically disposed arrangement with respect to the center of the undercarriage C.

The motor **10**, as in the case of the motor **11** which serves to rotate the undercarriage C about the axis X, is for simplicity, preferably connected to drive only one of the wheels **9**, so as to provide means for independently rotating the platform **8** with respect to the undercarriage C. However, if desired, and with the inclusion of suitable synchronizing means (not shown) a plurality of wheels **9** can be power driven, either by individual motors **10**, or by one or more motors **10** via an appropriate transmission (not shown). Likewise, a minimum of three wheels **9** are required for stably supporting the platform **8** upon the undercarriage C.

Since the circular track T will be horizontally level with the undercarriage C, the wheels **9** are journaled at equal distances from the bottom of the platform **8** to support members extending downward therefrom. For convenience, the wheels **9** can be journaled to a common circular ring or channel R which is fastened to the bottom of the platform **8** so as to be concentric with the axis X which is the center of rotation of said platform **8**.

When the wheels **6** are rotated by the motor **11**, the undercarriage C is rotated about the axis X of the helical track **5** and is simultaneously advanced either up or down along said axis X, in the manner of a nut rotating upon a screw, with the direction of advancement depending upon the direction in which the wheels **6** are rotated.

By rotating the wheels **9** via the motor **10**, so as to produce a counterrotation of the platform **8** about axis X relative to the undercarriage C, the angular position of said platform **8** can be controlled independently with respect to the rotation of the undercarriage C. For example, by driving the wheels **9** to rotate the platform **8** at an angular velocity equal, but opposite to that of the undercarriage C, the platform **8** can be maintained at a constant angular orientation with respect to the building B and chambers **12** therein as said platform **8** is moved along the axis X with the undercarriage C. By rotating the platform **8** at an angular velocity either slightly greater or slightly less than the undercarriage C, but opposite thereto, the platform **8** can be imparted with a relatively low angular velocity with respect to the building B, said angular velocity being equal to the differential between the absolute angular velocity of the undercarriage C with respect to the axis X, and the angular velocity of the platform **8** relative to the undercarriage C.

This type of operation enables the platform **8** to be oriented at a comfortably low angular velocity as it is moved up or down by the undercarriage C, so that when it arrives at a given elevation within the building B, a given radial line on the platform **8** will be directed at a given compartment **12** at that elevation. Such an arrangement permits a vehicle V to be driven along any arbitrary radial line onto the platform **8** and to be conveyed thereby to a selected compartment **12** level, and to be transferred thereto with only simple, straight line motion.

While in the case of the spiral arrangement of the compartments **12** illustrated in FIG. 1, the undercarriage C and platform **8** could be locked to rotate together, and in such case, the independent platform **8** rotation wheels **9** and motor **10** could be eliminated, because the helical track **5** and adjacent spiral floor **2** have the same pitch, the elimination of the independent rotation capability in platform **8** would impose a speed limit on the operation of the elevator E.

For example, in the case of a co-rotating platform **8** and undercarriage C, the angular velocity of both is directly dependent upon their axial velocity, and is given by the formula:

$$V_x = p\omega/2\pi$$

wherein V_x is the axial velocity of platform **8** and undercarriage C in feet per second, p is the pitch of the helical track **5** in feet, and ω is the common angular velocity of the platform **8** and undercarriage C in radians per second about axis X.

Thus, it can readily be seen that for such an elevator E wherein high rates of load carrier **8** ascent and descent are desired, a load carrier 8 locked to its associated undercarriage C must necessarily be subjected to a high angular velocity. In general, high load carrier 8 angular velocities are undesirable, especially if human operators are to accompany the vehicles transported thereupon. Furthermore, such high angular velocities produce centrifugal forces which tend to drive vehicles against the outer peripheral boundary of the load carrier 8, thereby creating unbalanced load forces.

By providing a load carrier 8 and undercarriage C arrangement according to the invention which includes means such as the wheels 9 and motor 10 for independently counter rotating the load carrier 8 relative to the undercarriage C, the aforementioned undesirable affects of load carrier 8 angular velocity are eliminated. For example, where a vehicle is driven onto the load carrier platform 8 along a radial line which is displaced 180° behind the angular position of the storage chamber 12 into which said vehicle is to be delivered with a single straight line transfer path, and the elevation differential between said chamber 12 and the initial load carrier 8 position is equivalent to ten turns of the helical track 5, the load carrier 8 is advanced 180° during the course of ten revolutions of the undercarriage C., i.e., 18° of load carrier 8 rotation per revolution of the undercarriage C. This can be simply accomplished by controlling the speed of the motor 10 so as to counter rotate the load carrier 8 at a rate which is 18° per revolution less than that of the undercarriage C.

For purposes of simplification, the means for delivering power to the motors 10 and 11 which are preferably electric motors, are not shown. However, as will be obvious to those skilled in the art, the electrical power for driving the motors 10 and 11 can be conveniently transmitted by means of an additional helical rail (not shown) which is supported by the guide rail 5, and is insulated therefrom in a manner similar to "third rail" electric transit systems. By providing suitable brush contacters (not shown) which engage the electric rail (not shown), said brush contacters being supported preferably by the undercarriage C, electrical power can be transferred from the electric rail onto the undercarriage C via said brush contacters, and thence to the motor 11 by conventional conductive means (not shown) for operating said motor 11.

To transfer electric power from the undercarriage C to the load carrier 8 for operating the motor 10, slip rings (not shown) mounted on the undercarriage C and electrically connected to the brushes thereon can be used in combination without a second set of brush contactors (not shown) mounted to the bottom of the load carrier 8 for engagement with the slip rings, with the motor 10 being electrically connected for operation by electric power transmitted via slip rings and second set of bruhes. Thus, with such electrical power transmission arrangement, there is no interference with the independent rotation of the load carrier 8 with respect to the undercarriage C, and electric power is available for operating the motors 10 and 11 over the full extent of the helical track 5.

As is shown in FIG. 2, the accommodating chambers 12 for motor vehicles conveyed by the elevator E are of substantially similar geometry, and are arranged in substantial radial symmetry with respect to the axis X. FIG. 2, which is a section taken through the entrance and exit level of the building B, also shows a vehicle entrance area 13 and a vehicle exit area 14, which are peculiar to that particular level of the building B and are not repeated in the upper levels thereof.

The entrance area 13 is provided with means for enforcing an exactly centered orientation of incoming vehicles. As is shown on an enlarged scale in FIG. 3, these means comprise two pairs of spring-cushioned cheek members 15, 16 and 17, 18, with the cheek members 15 and 16 being urged together by springs 50 and 51 respectively, and the cheek members 17 and 18 being similarly urged together by springs 52 and 53 respectively. The cheek members 15–18 define reeciving space which are tapered like wedges so that the successively incoming front and rear wheels of a vehicle are positioned until the spring forces are balanced when the center line of such vehicle is aligned with the center line of the entrance area 13.

In FIGS. 4–7, 19 is a transfer wagon which is moveable in a radial direction on the load carrier 8, to which transfer wagon an arm 20 is pivotally connected. To the arm 20 is pivotally connected a support 20*a*, which is provided with rollers 20*b*. When the support 20*a* is swung downward, as in FIG. 5, with the aid of a motor 21, the arm 20 is raised from the horizontal position shown in FIG. 4.

At the front end of arm 20 is a transverse arm 20*c* on which two transversely displaceable wheel gripper forks 22 and 23 are mounted. The transverse movement of forks 22 and 23 is effected by means of a motor 33, which like motor 21 can be an electric motor.

The transfer wagon 19 is equipped with a motor 29, which moves it back and forth on the load carrier 8.

In FIG. 4, a vehicle V, such as an automobile stands in a parking area 13, with its front wheels 24 and 25 and its rear wheels 27 and 28 resting on the floor 2 thereof, the front wheels 24 and 25 being aligned with the direction of transfer wagon 19 movement. With the arm 20 is in its lowest position, i.e. horizontal, and with the support 20*a* swung against it, and the gripper folks 22 and 23 brought together as shown in dashed outline in FIG. 7, transfer wagon 19 is driven forward to position arm 20 and gripper forks 22 and 23 underneath the vehicle V and between its front wheels 24 and 25. The gripper forks 22 and 23 are then spread apart to grip the wheels 24 and 25, the support 20*a* is swung downward to raise the arm 20 and thereby lift the wheels 24 and 25 as shown in FIG. 5. The vehicle V can then be drawn onto load carrier 8 by operating motor 29 to drive transfer wagon 19 in the reverse direction.

On the side of the platform 8 which is opposite to the arm 20, as shown in FIGS. 4 and 7, the transfer wagon 19 is provided with another arm 30 having gripper forks 31 and 32 so that the transfer wagon 19 can be moved across the platform 8 throughout its diameter, and the platform 8 can be rotated through 180° for functionally substituting the gripper forks 31 and 32 for those borne by arm 20.

A motor 33 effects the spreading of the forks 22 and 23, which serve for gripping the front wheels of the vehicle V. The motor 34 affects the traverse of the arm 20 associated with transfer wagon 19, as may be required for matching the dimensions of the building B to those of the vehicle V, or for a change to a different direction of operation of the arm 20. If desired, a second drive means (not shown) can be provided, said second drive means being movable on wheels across the platform 8 in the direction of the same diameter on which the transfer wagon 19 is movable. The direction of movement of the transfer wagon 19 need not be exactly aligned with a diameter. Different drive means (not shown) may be arranged to be moved on wheels one behind the other in directions which extend parallel to a diameter of the platform 8.

As soon as the vehicle V has been moved in the previously described manner onto the load carrier 8, the motors 11 and 10 are started to move said load carrier 8 through the well 1 until the vehicle V is on the level of a preselected unoccupied chamber 12. Immediately thereafter, the motor 29 effects the traverse of the transfer wagon 19 so that the vehicle V is moved into the accommodating chamber 12. Then the motor 21 lowers the arm 20. The motors 29 are subsequently started again to retract the transfer wagon 19 onto the load carrier 8. The motor or motors 11 which drive the undercarriage

C are then started to lower the load carrier into the position shown in FIG. 1, in which a new vehicle (not shown) can be received.

If desired, the load carrier **8** can be moved to a different level of the building B to receive another vehicle (not shown) to be removed from the building B.

The operation of the elevator E is by no means confined to the transfer of vehicles between storage chambers **12** and the entrance and exit areas **13** and **14** respectively, but can also be operated for transferring vehicles between various chambers **12** in the building B, in an obvious manner.

FIG. 9 illustrates that the cross sectional shape of the building B_1 need not be circular as in the case of the building B, but can be provided with radially arranged accommodating storage chambers **35** and **36** of different radial depths.

FIG. 10 shows another embodiment of the invention wherein the building B_2 is provided with a plurality of radially arranged storage compartments **37** and an elevator arrangement having an annular load carrier **38**, which travels up and down along the outside of the core compartments **37** so as to permit vehicles to be conveyed between various compartments **37** located at various levels in the building B_2. If desired, additional vehicle compartments **39** can be arranged around the outer periphery of the load carrier **38** so that said load carrier **38** can be used for transferring the vehicles and other load items between the compartments **37** and **39**.

FIG. 11 shows an elevator arrangement which is provided with load carriers **40, 41** and **42** which are movable along a common helical guide track **43**. At typical levels throughout the building B_3, radially arranged storage compartments **45** are provided together with an adjoining platform extension P which supports the helical track **43** so that the vehicles and other load items can be transferred from the load carriers **40, 41** and **42** across the platform P and into and out of the chambers **45**.

A somewhat similar arrangement according to the invention is embodied in the building B_4 shown in FIG. 12, with the difference being in the partitioning of the storage area **44** which is relatively open rather than divided into radial compartments, such as the compartments **45** of FIG. 11.

FIG. 13 shows a building B_5 in which an annular load carrier L having two annular deck compartments **46** and **47** is provided. The load carrier L is guided by a helical track **48** which surrounds the exterior of the building B_5 and is fixedly supported thereby.

The operation of the elevators according to the various embodiments of the invention can be performed automatically by a suitable conventional control means, if desired. Limit switches (not shown) responsive to the various positions of the load carriers, and/or their associated undercarriages C, can be provided to de-energize the drive motors **10** and **11** when the desired stopping station positions have been reached by the load carriers, and to energize said motors **10** and **11** for driving said load carriers to designated subsequent positions. Such automatically controlled operation is advantageous in that fewer and possibly no operating personnel will be required within the storage buildings, but rather can be placed at the entrance and exit areas **13** and **14** respectively for control of the conveyance of the vehicles into, out of and within the building.

For example, an automatic elevator control programmer **49** can be provided as shown in FIG. 2 in a position between the entrance and exit areas **13** and **14**, so as to be operatively accessible from either of said areas **13** and **14**. In the typical operation of such a programmer **49**, a plurality of keyholes (not shown) or revolving plugs (not shown) representing the parking places or chambers **12** in the building can be provided. With such an arrangement, a self-service garage building can be maintained, since the vehicles can be parked by their drivers. In parking such vehicles, a key (not shown) can be provided in each keyhole corresponding to an unoccupied parking chamber **12**, so that the driver drives his vehicle up onto the entrance area **13** and rotates one of these keys to a stop and removes it to effect automatic parking of the vehicle in the corresponding chamber **12**.

An electronic control device (not shown) can be provided for controlling the operation of the load carriers so as to selectively cause said load carriers to be returned to an intermediate waiting position or to move to a selected chamber **12**, or to the entrance and exit level, as desired.

When the driver of a vehicle parked in one of the storage chambers **12** desires to have his vehicle returned it is only necessary for him to insert the key into the corresponding keyhole on the programmer **49** and thereby initiate an automatic sequence of operations wherein the load carrier will be driven to the level of the storage chamber **12** which contains the vehicle, and at that level said vehicle will be pulled onto the load carrier by its associated load transfer mechanism comprising the gripper **20** and drive means **19**, and thence brought to the level of the exit area **14** and removed from the load carrier thereat by the action of said transfer mechanism, thereby enabling the driver to enter his vehicle and drive same away from the exit area **14**.

In the construtcion of the elevator and building arrangement according to the invention, the helical guide track **5** and structural elements of the load carrier **8** and undercarriage C are advantageously made of steel, or any other suitable structural material. The various building structures previously described herein can be advantageously constructed from prefabricated modular elements, such as those made from steel, sheet metal, reinforced or pre-stressed concrete, etc., because each of said buildings comprises a plurality of similar structural modules.

One of the typical advantages of the elevator and building arrangement according to the invention is that the helical guide track **5** may be assembled in sections as the construction of the building progresses with the addition of successive stories. Once the lowermost story has been completed, the load carrier **8** and its undercarriage C can be installed on the track **5**, so as to provide an elevator E that can be used for transporting the prefabricated parts and materials necessary for the assembly of the upper story levels of the building. Thus, buildings which incorporate the elevator arrangement of the instant invention can be erected without the assistance or heavy cranes with extensive swing ranges.

If desired, a lifting device (not shown), or crane can be mounted to the load carrier **8** to aid in the placing of the heavier prefabricated parts at various exposed unfinished portions of the building. For example, such a lifting device can be provided in the form of a tripod (not shown) fixedly mounted to the load carrier **8**, and a movable jib arm (not shown) supported by said tripod.

In its basic form, the application of the elevator and building arrangement of the instant invention can be extended to the art of mine shaft construction simply by reversing the vehicle arrangement of the undercarriage C and load carrier **8** so that the undercarriage C rides above the load carrier **8** and is guided by a downwardly extending helical track (not shown) similar to the track **5**. This track (not shown) can likewise be assembled in successively adjoining circular mine shaft wall (not shown) as it is extended downward during the progress of construction. In such mine shaft construction application, the load carrier **8** can serve as a working platform, and can be provided with extendable hydraulically operated propping members (not shown) which have bracing claws (not shown) for engaging the shaft wall in the excavation region to prevent caveins.

If desired, digging machines and implements (not shown) can be mounted to the bottom of the load carrier **8**.

As the plan outline of the load carrier can be made to correspond to the necessarily circular cross sectional shape of the mine shaft, it ordinarily will not be necessary to provide a space between the lateral boundry of the load carrier and the shaft wall for guide rods (not shown) and safety catch rails (not shown). Consequently, the mine shaft may be smaller in diameter so as to reduce the cost thereof. Also, the application of the elevator arrangement of the instant invention to mine shaft construction is advantageous because the need for pithead frames is eliminated. Another advantage resides in the fact that the pithead building may be mounted directly over the mine shaft. The danger of the load carrier falling is also greatly reduced, however emergency cages (not shown) similar in construction to the load carrier can be kept in readiness so as to be moved quickly into the shaft and installed on the guide track for underground rescue operations should the need therefor arise.

If desired, a plurality of load carrier cages (not shown) smaller in size than the inside diameter of the guide track, and which travel simultaneously in parallel vertical directions can be provided.

This mode of operation, which is analogous to the rapid sequence operation of railway trains, can be provided in accordance with the invention with an advantageous reduction in costs and improved performance.

The application of the elevator arrangement of the instant invention is not necessarily limited to the case of a vertically travelling load carrier, but may be applied in a manner which will be apparent to those skilled in the art upon reading the foregoing description of the invention herein, to applications involving the construction of inclined ducts and in tunneling.

It should be noted that the basic invention described herein by way of example is susceptible of numerous variations, as will be apparent to those skilled in the art, and is intended to be limited only by the following claims.

I claim:

1. An elevator which comprises:

(a) a stationary, vertically disposed helical guide track having a plurality of spaced-apart turns to accommodate the transfer of objects through open spaces between adjacent turns;

(b) a carriage means disposed in guided engagement with said guide track for support thereby, said carriage means being disposed for rotation relative to said guide track about the longitudinal axis thereof and for movement along said axis when rotated;

(c) a first means supported by said carriage means to rotate same relative to the guide track and about said axis;

(d) a load carrier means supported by said carriage means for movement therewith along said axis, said load carrier means being disposed for independent rotation relative to said carriage means about said axis; and

(e) a second drive means supported by said load carrier means adapted to rotate the same in a direction opposite to that of the carriage means rotation, whereby to reduce centrifugal forces upon said load carrier and upon objects carried by said load carrier, due to said carriage means rotation, which second drive means is further adapted to angularly orient said load carrier upon arrival thereof at a selected elevation whereby objects can be transferred to and from said load carrier means through said adjacent guide track turn spaces upon arrival of the load carrier means at such elevation.

2. Elevator as claimed in claim **1**, wherein said second drive means is adapted to rotate said load carrier at such a rate as to maintain said load carrier at substantially zero angular velocity with respect to said guide track.

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U.S. Cl. X.R.

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