June 9, 1964 C. R. COLBERT 3,136,431

URBAN PARKING SYSTEM

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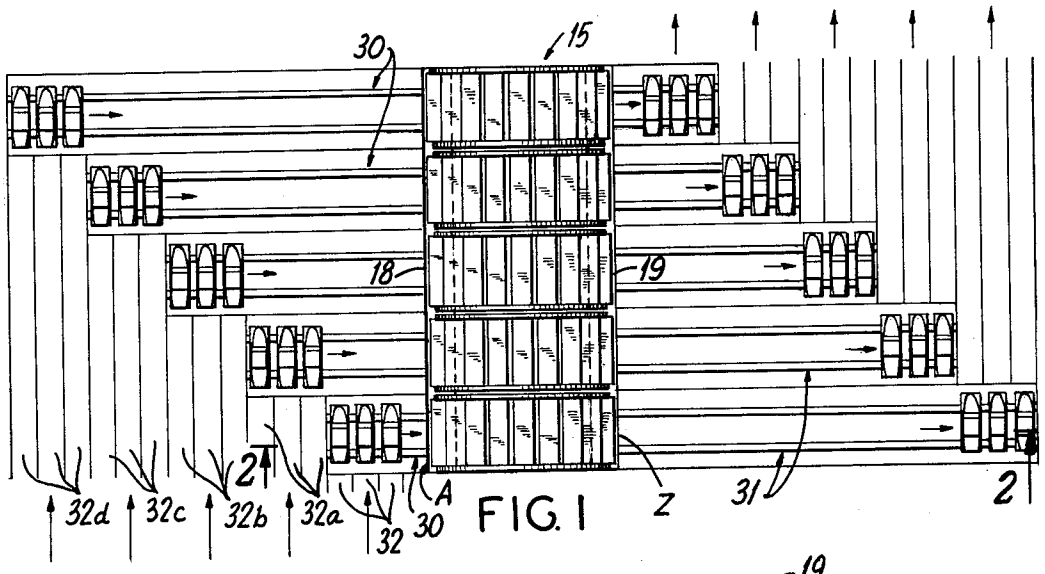

FIG. 1

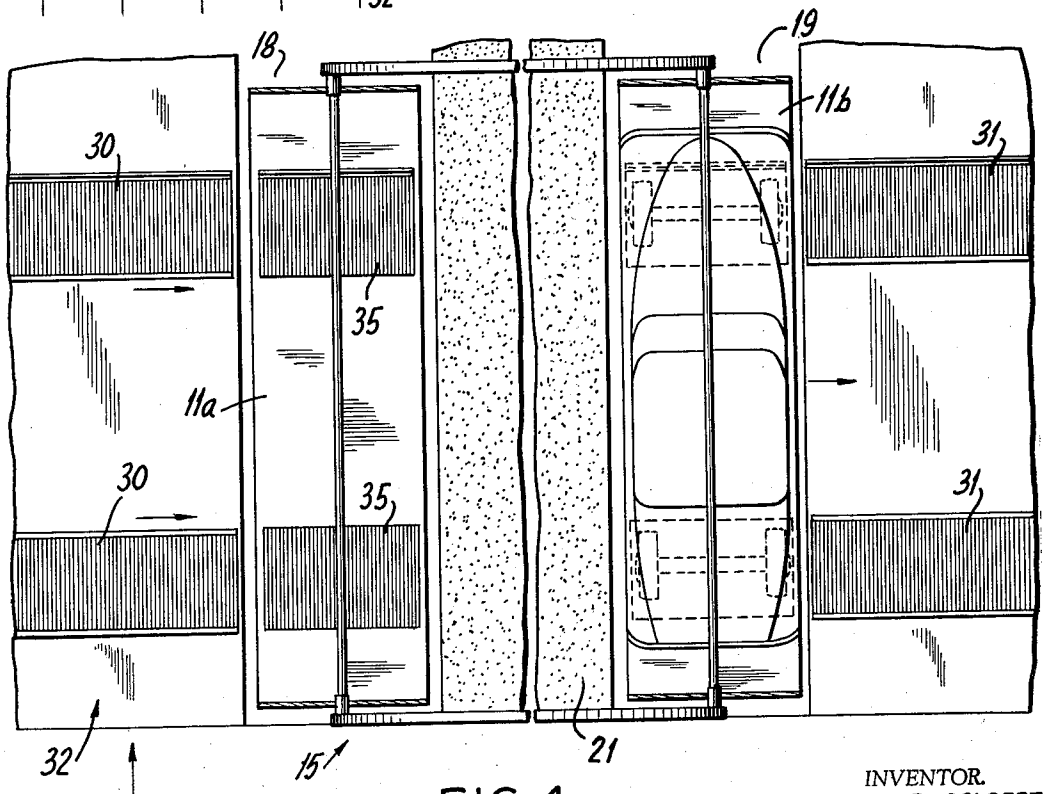

FIG. 4

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Filed Sept. 25, 1961 2 Sheets-Sheet 2

FIG. 2

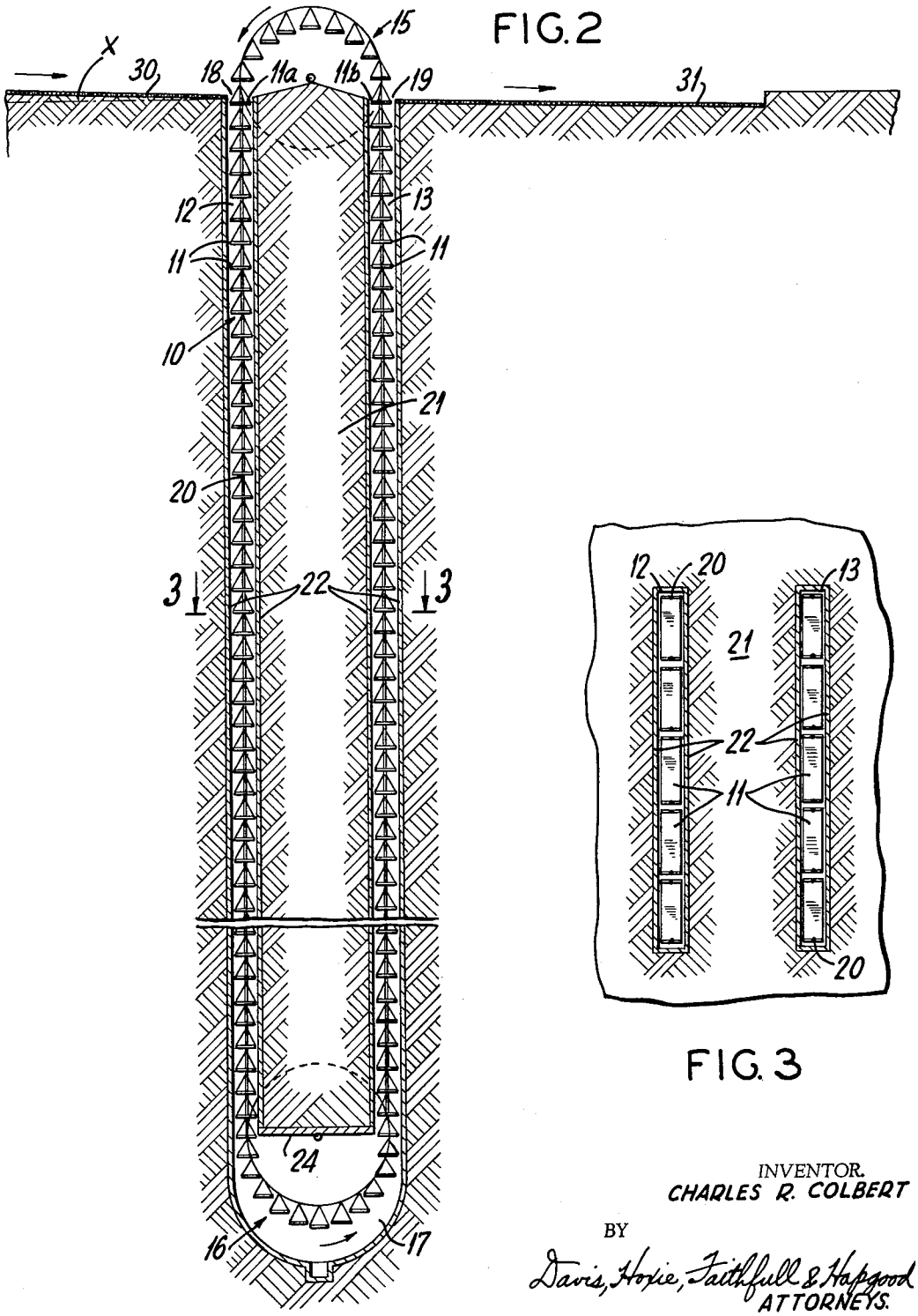

FIG. 3

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URBAN PARKING SYSTEM

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This invention is in a motor car parking or temporary storage system for congested urban areas where three imposed conditions create a problem that has not yet been solved satisfactorily. The three conditions are the demand for ever larger parking capacity, the demand for close proximity to business establishments, and the limited availability of land even at high cost.

Urban renewal projects, for example, commonly call for optimum usage of a given land area to provide structures such as stores, offices, and theatres for a given user and visitor population, while attaining an optimum combination of free surface area and occupied surface area and while also providing a self-contained car storage capacity to meet the different needs of the regular and the transient population of the area.

Within limits, increased height of the structures built on the given area permits a better ratio of occupied to free area, but the attainment of an optimum ratio is commonly prevented by the land area requirement for car storage using conventional systems. The excessive land area requirement of surface storage has been lessened to a considerable extent by the use of basement or lower-floor space within the buildings; but considerations of cost and competing demands for the same space impose a limit on this reduction of the land area requirement, and commonly result either in the provision of inadequate storage capacity, with a consequent loss of convenience and a detrimental burden on neighboring areas, or in an undesirably low ratio of free to occupied surface area, or both.

The land area required for good parking service is dependent not only upon the total number of cars to be stored but also upon two variables which make it necessary to provide extra space at the reception and delivery points, viz., the variation in parking time and in the densities of arrivals and departures.

The present invention solves or greatly relieves this problem by a combination of endless conveyors, or so-called circuitous elevators, traveling for the most part in vertical underground shafts of uncommon depth, with a loading and unloading station at the surface which in a minimum space provides both for ready loading-unloading and for the temporary accumulation of cars awaiting loading or awaiting drive-away after being unloaded. Preferably there are several conveyor units having different cycle times to accommodate the different parking times of different classes of user. The invention includes also a novel arrangement of two subsurface vertical shafts for such a system which through circumferential friction and end bearing may also be used as foundations for buildings located above.

A preferred form of this system is described below with reference to the accompanying drawings, in which:

FIGURE 1 is a plan view of the loading-unloading station at the ground surface, and of the tops of several endless conveyors working in two sub-surface vertical shafts;

FIGURE 2 is a vertical section on the line 2—2 of FIGURE 1, showing the vertical shafts, the connecting tunnel for a reversing turn at the bottom and the reversing turn above ground at the top;

FIGURE 3 is a sub-surface section on line 3—3 of FIGURE 2; and

FIGURE 4 is an enlarged plan view of a portion of a horizontal roller conveyor at the surface for loading and unloading.

Mechanical details of the endless conveyors, with their individually suspended car carriages and their driving and control means, together with auxiliaries such as anti-sway devices, car stops, and details of feed and delivery conveyors, are not shown because numerous constructions of these units of the system are known per se in connection with former proposals for their use for car storage, chiefly above ground. These include both the parallel, vertical-run type of conveyor used in the present system, and also the Ferris-wheel type, some mechanical details of which are useful also in the present type of conveyor.

FIGURE 2 best shows the way in which an endless, storage conveyor **10**, having a series of suspended or pendulous individual car carriages **11**, is arranged to travel in two spaced vertical shafts **12, 13** in the earth, with a semi-circular reversing turn **15** above ground and a like reversing turn **16** in a bottom cavity or tunnel **17** connecting the two vertical shafts **12, 13**. The upper reversing turn is above grade so that cars can be loaded and unloaded at the surface at the mouths **18, 19** of the vertical shafts.

To simplify, the conventional suspension of the carriages on the endless belt, chain or cable is shown only schematically, and only in the instances of the carriages **11***a* and **11***b* at the loading and unloading station. The endless belt or the like is indicated by the line **20**, and the several cross-lines indicate the suspended carriages.

The two vertical shafts **12, 13**, made separately for a purpose to be described, are spaced apart by a distance sufficient to permit a generally semi-circular reversing turn at the top and bottom. This makes it needless to employ the special mechanical devices, designed for closely spaced shafts (e.g., Rugg 1,813,203), for keeping the several carriages clear of one another during the turn. The conveyor unit thus can be simplified in that respect if desired. The above-surface space under the arch of the upper turn can be used in large part or in whole as a transverse passageway, or for an office or for operating equipment.

The major purpose in having separate, spaced shafts in this underground system is to leave the central column of earth **21** as a measure by which to resist any hydraulic lifting forces of subterranean water. Each vertical shaft has liner walls **22**, preferably of metal plate, precast concrete or monolithic reinforced concrete cast in place as in a caisson or a cased well; and when formed in water-bearing earth, the bottom cavity **17** connecting the shafts is similarly lined and is made sufficiently water-tight either to prevent inflow of liquid entirely or to limit inflow to a minimum that can be dealt with feasibly by sump pumps. With such sealing, the two interconnected shafts constitute a large U-tube which can also be utilized for end bearing and for sidewall frictional resistant caisson or hollow pile building foundations for structures located above. Any such subterranean structure may at times be subjected to a lifting force by subterranean liquid. This is resisted by the friction at the interfaces between the shafts and the surrounding earth or any exterior sealing cement. This resistance is supplemented in the present arrangement by the downwardly acting force of the weight of the column of earth **21** between the shafts and above the structural members **24** which form the ceiling of the bottom cavity **17**, and which are joined to the inner walls of the shaft liners **22**.

In horizontal cross-section, the vertical shafts are generally rectangular, as shown in FIGURES 1 and 3, and may have reinforced or rounded corners at sidewall intersections. In the direction of a horizontal line from one shaft to the other, each shaft is wide enough to accom-

modate a car carriage in its narrower dimension (FIG. 4), together with any guide means that may be used. In the horizontal direction normal to this, as shown in FIGURE 3, the shaft is wide enough to accommodate one or more conveyors in tandem alignment, five being indicated schematically. It will be seen from FIGURE 3 that the intervening column of earth 21 is integral with the surrounding earth at two ends, and is not isolated, so that it is in communication with the surrounding earth with respect to subterranean water. Hence, there is no material imbalance or differential of hydraulic forces as between the central column 23 and the surrounding earth. Under some subterranean conditions heavy load-bearing vertical concrete slabs or elongated columns will be located between the vertical conveyor shafts and when extended upward serve to support buildings or other structures above.

With this system, I contemplate carrying the shafts to a depth down to several hundred feet to obtain sufficient storage and bearing capacity without undue enlargement of the surface area required for the loading and unloading operations. For these operations, I provide the special arrangement of feed-lanes and horizontal conveyors schematically shown in FIGURE 1. Speaking generally, cars are loaded and unloaded sidewise by gravity-feed roller conveyors running substantially horizontally at a right angle to the long axes of the car carriages 11. For the system shown, having five car storage conveyors running in the vertical shafts, I provide five horizontal loading conveyors 30, and five similar unloading conveyors 31 directly opposite.

The five vertical conveyors are designed to have different times for a complete cycle of movement so that different "modules" of storage time can be provided to meet the needs of different users. The different cycle times can be provided either by running the different conveyors at different speeds or by making them of different lengths, with correspondingly different depths of their vertical shafts below ground. To obtain maximum storage capacity, for a given usage of surface area, I prefer to employ different rates of operation of the several vertical conveyors, and to make them all of equal length.

With this system of several conveyors having different cycle times, I use the FIGURE 1 system of feed-lanes and horizontal conveyors so that by entering the appropriate feed-lane a car can be driven aboard the horizontal loading conveyor which feeds the vertical conveyor having a cycle time corresponding to the desired storage time.

Thus, in FIGURE 1, the vertical storage conveyor Z has the shortest cycle time, and is fed by a horizontal conveyor 30 running from left to right and consisting of small rollers extending in the fore and aft direction of the cars, and arranged in two series of such width and spacing as to take the front and rear wheels of a variety of cars. This conveyor extends far enough to the left of the mouth 18 of vertical shaft 12 to accommodate several, e.g., three, cars which are driven aboard in parallel feed-lanes 32 at a right angle to the direction of motion on the conveyor 30, or parallel to the long axis of the car carriages. The several feed-lanes permit several cars to be driven aboard at close intervals of time, or even at once, without requiring each to await loading of a predecessor onto the vertical storage conveyor. The loading onto the storage conveyor Z can then be done later by pushing the cars or by releasing stops to let them roll aboard by gravity.

As shown in FIGURE 2, the horizontal loading conveyor is inclined downwardly from left to right at an angle X to permit gravity feed of cars onto a car carriage of the storage conveyor. The car carriage floor has similar rollers 35 (see FIGURE 4), and can be tilted slightly to continue the gravity feed; or the car can be pushed into position on it if the floor is horizontal. Such a system of rollers for moving cars sidewise is konwn per se and needs no description in detail. The individual rollers are

closely spaced and are substantially smaller than the diameter of a tire so that the troughs between rollers are small and do not create barriers to easy rolling of a car sidewise.

The other car storage conveyors have similar feed conveyors associated with them, differing only in that they are progressively longer so as to intersect the other four sets of feed-lanes 32*a*–32*d*, each set being of a width to accommodate several cars. The car storage conveyors have progressively longer cycle times to meet the needs of those who wish longer parking.

The unloading means, at the right in FIGURE 1, is similarly constructed and arranged, with five horizontal roller conveyors pitched slightly downward in the direction away from the storage conveyor, and are of progressively different lengths to intersect different "out" lanes. Thus, each vertical or car storage conveyor has associated with it a pair of horizontal conveyors at opposite sides to feed cars sidewise to and from it.

As shown, the longest set of "out" lanes serves the storage conveyor Z of shortest cycle time, to accommodate a maximum number of unloaded cars awaiting driveaway. Here again, the several lanes associated with each unloading conveyor make it possible to handle several cars in close succession or even simultaneously, and provide stand-by storage to accommodate off-schedule delivery after unloading.

With this system of loading-unloading combined with a series of "endless" storage conveyors running in underground shafts, it is possible to provide a large total storage capacity with a minimum usage of surface area and with flexibility to accommodate, within reasonable limits, both the different parking time needs that are presented and also the varying rates of inflow and outflow of cars. For example, the layout shown in FIGURE 1, for five storage conveyors, requires about 0.9 acre, being about 125 feet by 315 feet in area. The five conveyors, in shafts providing vertical runs of 600 feet, apart from the turns, serve to store some 850 cars at any moment when all carriages are occupied. This is augmented to a total capacity on the order of 1000 cars by reason of the possibility of holding cars in the feed-lanes and on the roller conveyors at the surface, on both the loading and unloading sides. This represents a usage of about 40 square feet of surface area per unit of total storage capacity.

Using the same surface area for a conventional garage building, with ramps from floor to floor and the usual first floor "stand-by" space, the building would have to have about 10 floors, to a height of some 90 feet if wholly above ground. Since such a number of ramp-fed floors is undesirable, the conventional solution would require usage of a much larger land area.

By some sacrifice of flexibility in serving peaks of inflow and outflow of cars, and in accommodating off-schedule delivery of cars, the surface area usage with the present system could be reduced by reducing the number of lanes feeding to and from the roller conveyors, and correspondingly reducing the lengths of the horizonal conveyors.

I claim:

1. A car parking system comprising in combination a pair of parallel shafts extending substantially vertically underground, a plurality of car storage conveyors, each carrying a series of car carriages, mounted with their opposite courses running substantially vertically in said shafts, and connected by reverse turns above ground, a plurality of horizontal conveyors, one for each vertical conveyor, located on a common side of said vertical conveyors and extending therefrom parallel with each other in a direction normal to said vertical conveyors, and a plurality of feed lanes, at least one for each horizontal conveyor, extending normal thereto at successive spaced intervals from said vertical conveyors, for communication between the horizontal conveyors, at a juncture therewith, and an entrance location, the horizontal conveyors having different lengths ranging progressively

from the shortest length for the conveyor in closest proximity to said entrance to the greatest length for the conveyor most remote therefrom, the feed lanes having different lengths ranging progressively from the shortest length for the lane in closest proximity to said vertical conveyors to a longest length for the lane most remote therefrom, so that movement of the cars from said entrance to the vertical conveyors through said junctures avoids crossings with any of said horizontal conveyors.

2. A car parking system comprising in combination a pair of parallel shafts extending substantially vertically underground, a plurality of car storage conveyors, each carrying a series of car carriages, mounted with their opposite courses running substantially vertically in said shafts, and connected by reverse turns on a common axis above ground, each conveyor being driven in a predetermined time cycle, a plurality of horizontal conveyors, one for each vertical conveyor, located on a common side of said vertical conveyor and extending therefrom parallel with each other in a direction normal to the vertical plane of said common axis and for a distance to accommodate a plurality of cars arranged side by side with their axes parallel, and a plurality of feed lanes, at least one for each horizontal conveyor, extending normal thereto at successive spaced intervals from said plane, for communication between the horizontal conveyors, at a juncture therewith, and an entrance location, the horizontal conveyors having different lengths ranging progressively from the shortest length for the conveyor in closest proximity to said entrance to the greatest length for the conveyor most remote therefrom, the feed lanes having different lengths ranging progressively from the shortest length for the lane in closest proximity to said plane to the longest length for the lane most remote therefrom, so that movement of the cars from said entrance to the vertical conveyors through said junctures avoids crossings with any of said horizontal conveyors.

3. A car parking system comprising in combination a pair of parallel shafts extending substantially vertically underground, a plurality of car storage conveyors, each carrying a series of car carriages, mounted with their opposite courses running substantially vertically in said shafts, and connected by reverse turns on a common axis above ground, each conveyor being driven in a predetermined time cycle, a plurality of horizontal conveyors, one for each vertical conveyor, located on a common side of said vertical conveyor and extending therefrom parallel with each other in a direction normal to the vertical plane of said common axis and for a distance to accommodate a plurality of cars arranged side by side with their axes parallel, a plurality of feed lanes, at least one for each horizontal conveyor, extending normal thereto at successive spaced intervals from said plane, for communication between the horizontal conveyors, at a juncture therewith, and an entrance location, the horizontal conveyors having different lengths ranging progressively from the shortest length for the conveyor in closest proximity to said entrance to the greatest length for the conveyor most remote therefrom, the feed lanes having different lengths ranging progressively from the shortest length for the lane in closest proximity to said plane to the longest length for the lane most remote therefrom, so that movement of the cars from said entrance to the vertical conveyors through said junctures avoid crossings with any of said horizontal conveyors, and a second set of said horizontal conveyors and a second set of said feed lanes on the opposite side of the vertical conveyors from said first set for communication with an exit location.

4. A car parking system comprising in combination a pair of parallel shafts extending substantially vertically underground, a pluraiity of car storage conveyors, each carrying a series of car carriages, mounted with their opposite courses running substantially vertically in said shafts, and connected by reverse turns on a common axis above ground, each conveyor being driven in a predetermined time cycle, a plurality of horizontal conveyors, one for each vertical conveyor, located on a common side of said vertical conveyor and extending therefrom parallel with each other in a direction normal to the vertical plane of said common axis and for a distance to accommodate a plurality of cars arranged side by side with their axes parallel, a plurality of feed lanes, at least one for each horizontal conveyor, extending normal thereto at successive spaced intervals from said plane, for communication between the horizontal conveyors, at a juncture therewith, and an entrance location, the horizontal conveyors having different lengths ranging progressively from the shortest length for the conveyor in closest proximity to said entrance to the greatest length for the conveyor most remote therefrom, the feed lanes having different lengths ranging progressively from the shortest length for the lane in closest proximity to said plane to the longest length for the lane most remote therefrom, so that movement of the cars from said entrance to the vertical conveyors through said junctures avoids crossings with any of said horizontal conveyors, and a second set of said horizontal conveyors and a second set of said feed lanes on the opposite side of said vertical conveyors from said first set for communication with an exit location, the first and second sets of feed lanes and horizontal conveyors being so arranged that the shorter paths from the entrance through the feed lanes and horizontal conveyors lead to vertical conveyors from which the longer paths lead through the horizontal conveyors and feed lanes of the second set to the exit location.

5. A car parking system comprising in combination a pair of parallel shafts, having side walls, extending vertically underground, at least one endless car-storage conveyor, carrying a series of car carriages, mounted with its opposite courses running vertically in said shafts and having one reverse turn underground and the other above ground, the vertical shafts being separate from each other horizontally a distance sufficient to accommodate a plurality of car carriages traveling in semicircular courses at said reverse turns, the said shafts being interconnected at the bottom by a chamber housing said underground reverse turn, the separation of said vertical shafts being adapted for the reception therebetween of a column of earth integral with the earth surrounding the shafts and in frictional engagement with their side walls, the weight of which may be borne by said chamber to counteract hydraulic buoyancy between the shafts and the surrounding earth, and means for feeding cars to said conveyor at the ground surface at one side of one shaft and for removing them at the opposite side of the other shaft.

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