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2,911,115

STORAGE SYSTEM AND APPARATUS

Filed Sept. 25, 1956

4 Sheets-Sheet 1

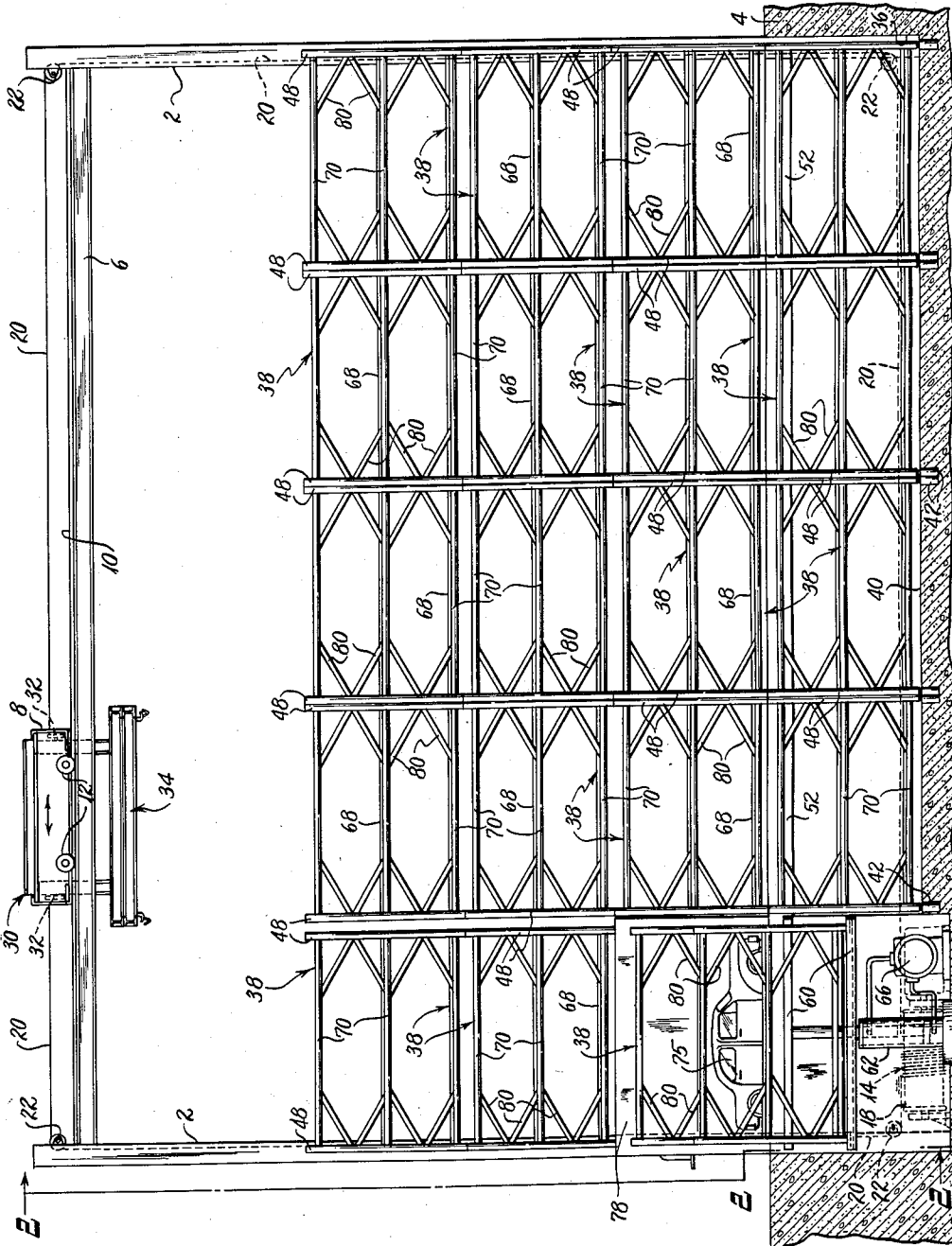


Fig. 1.

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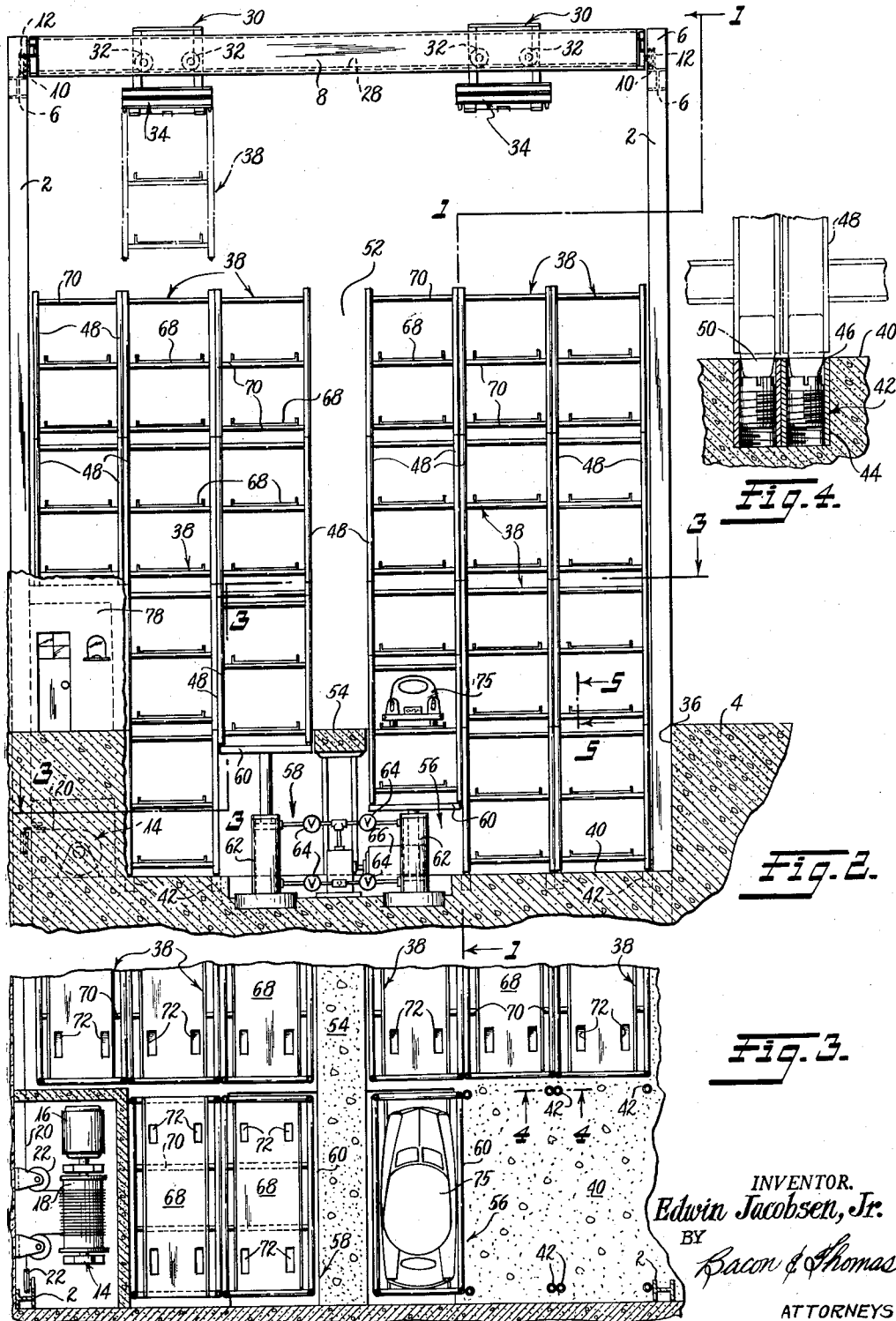
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4 Sheets-Sheet 2



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4 Sheets-Sheet 4

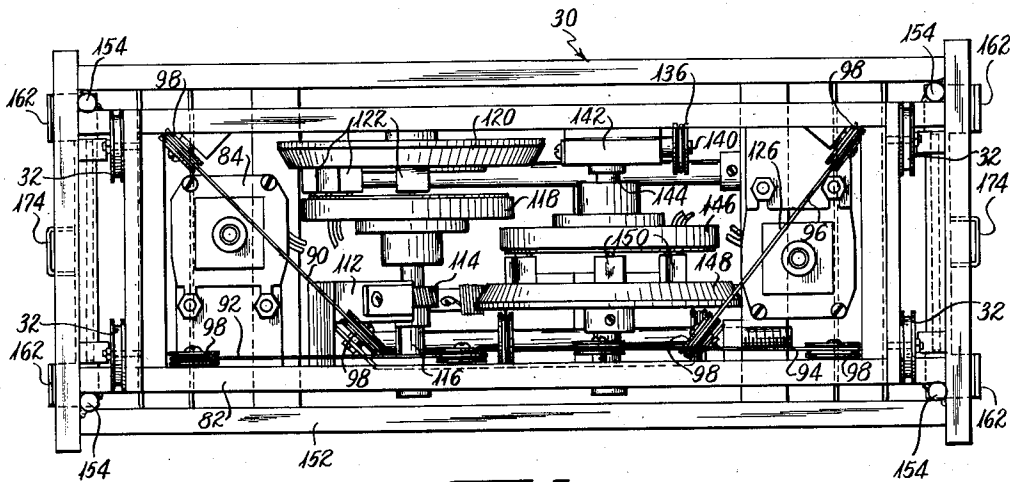


Fig. 6.

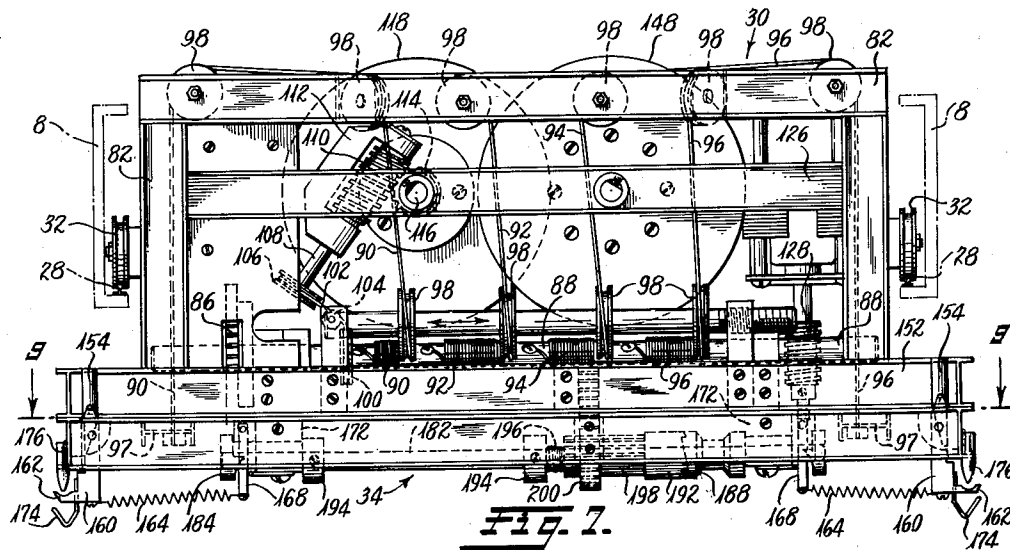


Fig. 7.

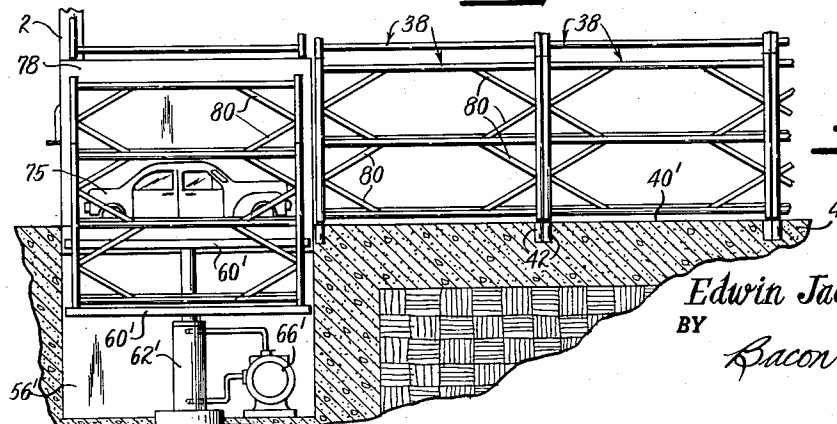


Fig. 13.

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2,911,115

STORAGE SYSTEM AND APPARATUS

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Application September 25, 1956, Serial No. 611,851

6 Claims. (Cl. 214—16.1)

This application is a continuation-in-part of my co-pending application Serial No. 528,354, filed August 15, 1955, for vehicle parking system, now abandoned.

The invention relates to a storage system and apparatus where selected articles or groups of articles can be withdrawn from a stack thereof at will.

While the specific structure described and illustrated herein relates to a vehicle parking system, it is to be understood that the principles of the invention are applicable to other storage systems for storing similar or dissimilar articles.

The description and drawings relate to parking and storing apparatus comprising a plurality of cages adapted to be stacked one upon another in contiguous stacks covering an entire available area. Suitable overhead hoisting mechanism is provided for lifting selected cages vertically out of a stack to a position above the stacks on the area and transporting that cage laterally either for disposition on an adjoining stack or for delivery to a delivery station at ground level at the edge of the area. Obviously, in the parking of vehicles by such a system, the time necessary to remove any selected vehicle from the stack is an important factor. An important feature of the invention resides in the provision of double-deck cages each adapted to receive two vehicles in superimposed relation. By such a system, the time required to remove the cage containing a particular vehicle from a stack is reduced to one-half of the time that would be necessary if the vehicles were positioned in individual cages.

The invention further includes control means for the hoisting mechanism to render the positioning of the mechanism over a preselected stack automatic and to automatically condition the hoisting apparatus to alternately grip and release cages engaged thereby without further attention of the operator, upon the mere lowering and raising of a hoist frame. The invention further includes delivery means comprising a vertically adjustable platform at a delivery station adapted to receive and support one of the double-deck cages whereby the platform may be vertically positioned so as to present either of the compartments of the cage in proper position to deliver a vehicle therefrom at a predetermined level defined by a delivery surface such as a driveway or the like. The invention includes other novel features particularly designed to speed up the operations of selecting and delivering cages from the stacks to the delivery station and rendering the apparatus susceptible to fully automatic operation.

It is therefore an object of this invention to provide a storage system and apparatus whereby maximum use of available space is possible.

Another object of the invention is to provide a novel storage system and apparatus for the parking and storage of vehicles or other articles.

Still another object is to provide a storage system wherein articles are stored in cages arranged in stacks and employing a hoisting mechanism arranged to lift and

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transport cages from the stack and wherein means are provided to prevent swinging or swaying of a cage suspended from the hoisting mechanism to permit maximum horizontal accelerations thereof.

5 A further object is to provide a system and apparatus as set forth above including automatic controls to eliminate many manual selecting operations and thereby to speed up the cycles of operation.

10 A still further object is to provide, in a system of the type set forth, novel cage means for receiving articles to be stored, such as automobiles.

An additional object is to provide a storage system as set forth and particularly adapted to fully automatic control.

15 Still further objects and advantages will become apparent to those skilled in the art as the description proceeds in connection with the accompanying drawings, wherein:

Fig. 1 is a somewhat diagrammatic vertical sectional view through a storage system and taken substantially along the line 1—1 of Fig. 2;

20 Fig. 2 is a somewhat schematic fragmentary front elevational view, partly in section, of the system of Fig. 1 as viewed substantially in plane 2—2 of Fig. 1;

25 Fig. 3 is a fragmentary horizontal sectional view taken substantially along the line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary sectional view on the line 4—4 of Fig. 3;

30 Fig. 5 is an enlarged fragmentary sectional view of portions of nested cages taken substantially along the line 5—5 of Fig. 2;

Fig. 6 is a top plan view of one of the traversing hoist carriages;

35 Fig. 7 is a front elevational view of the carriage shown in Fig. 6;

Fig. 8 is an end elevation of the hoisting carriage of Figs. 6 and 7 with the parts shown in different relative positions and with a cage shown suspended therefrom in dotted line, as viewed from the right of Fig. 7;

40 Fig. 9 is a plan view, with parts shown in section, of the lifting frame as viewed along the line 9—9 of Fig. 7;

Fig. 10 is a fragmentary sectional view taken along the line 10—10 of Fig. 9, showing the parts thereof in one position;

45 Fig. 11 is a fragmentary sectional view similar to Fig. 10 but showing the parts in different relative positions;

Fig. 12 is a schematic diagram of a cable arrangement for operating the traveling lifting mechanism in one direction; and

50 Fig. 13 is a fragmentary view similar to a portion of Fig. 1 but showing a modified arrangement.

Referring first to Figs. 1 to 3, the storage system comprises a stationary framework 2, comprising preferably structural steel members of usual form supported on a base 4 of concrete or the like. The frame 2 may be an open trusswork structure but is preferably covered with an outer sheathing to constitute a building. Sheathing and/or outer walls are omitted from the drawings to facilitate illustration of the essential features of the invention. The framework 2 includes longitudinally extending beams 6 supporting longitudinal tracks 10 at the upper outer edges of the structure. A carriage frame 8 is rollably supported on the tracks 10, on suitable supporting rollers 12. A driving mechanism 14 comprises a motor 16 arranged to rotate a drum 18 mounted in any suitable space, for instance, a compartment in the base of the storage system as clearly shown in Figs. 2 and 3. A cable 20 is wound several times around the drum 18 with both ends thereof extending from the drum and respectively trained over suitable idler pulleys 22 (see also Fig. 12) to direct the end portions of the cable longitudinally of the upper portion of the frame structure 2

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adjacent one of the tracks 10. Opposite ends of the cable 20 are fixed to opposite sides of the carriage 8 adjacent one end thereof. Obviously rotation of the drum 18 produces a corresponding movement of the carriage 8 along the tracks 10.

Referring now to Fig. 12, which shows the ends of cable 20 as being attached to the carriage 8 at one end thereof, it is obvious that the end of the carriage 8 thus driven by the mechanism 14 may be accurately controlled as to fore-and-aft position on the structure 2. However, since the carriage 8 is of considerable lateral length, means must be provided to insure equal movements of the opposite end thereof along the trackway. For this purpose, equalizing cables 24 are secured to the end portions of the carriage 8 and trained over suitable idler pulleys 26 to enforce parallel movements of the carriage 8. The equalizing cable arrangement shown schematically in Fig. 12 is a well-known arrangement and need not be described in full detail. Other equivalent means or cable arrangements may be employed instead of that specifically illustrated in Fig. 12 as long as such arrangements insure equal movements of opposite ends of the carriage 8 along the tracks 10.

The carriage 8 comprises an open rectangular rigid framework having spaced parallel structural members defining lateral trackways 28 (see also Fig. 7) upon which a pair of traversing hoists 30 is movably mounted on suitable supporting rollers 32. The structure of the traversing hoists 30 will be described in more detail later but each is provided with a hoisting frame 34 adapted to be raised and lowered thereby to raise or lower cages containing the vehicles or other articles to be stored.

In the form shown in Figs. 1 to 3, the area defining the storage space on the concrete base 4 is defined by the bottom of a pit or excavation 36 and is of such depth as to just accommodate double-deck cages 38 thereon with the tops of the cages substantially flush with ground level. Thus, as shown in Fig. 1, the cages can be stacked to a height of four cages with the stacks projecting only three cages above ground level. Such an arrangement is desirable where the height of the frame 2 is limited for any reason whatsoever and further permits the formation of stacks of greater height where greater capacity is required.

The floor or bottom 40 of the storage area is provided with spaced spotters or cage-locating devices 42 (see also Fig. 4) each of which comprises an internally threaded tubular structure 44 embedded in the concrete and an adjustable plug 46 threaded therein.

Each of the cages 38 comprises upstanding corner posts or tubes 48 having downwardly extending tapered plugs 50 projecting from their lower ends and constituting supporting feet for the cages. The threaded plugs 46 are adapted to receive and support the feet 50 of the cages, to properly "spot" the lowermost cages of each stack in the storage area. The plugs 46 are vertically adjustable and can be set to support their cages in a truly "level" position so that a stack of superposed cages will extend truly vertically. By this structure it is not necessary that the various spotting devices 42 be correctly located at exactly the same level throughout the area since they may be adjusted as described.

The spotting devices 42 are so disposed over the area as to define positions for a plurality of closely contiguous vertical stacks of cages but preferably a central aisle or space 52 is provided between groups of stacks for ready access to the stacks when the occasion demands. If desired, a permanent catwalk 54 may be positioned substantially at ground level in the aisle or space 52. The spotters 42 are so arranged as to cover the available area with stacks of cages with the exception of the aisle previously mentioned and with the exception of a pair of delivery stations 56 and 58 occupying the positions that would normally be occupied by adjacent stacks at

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the front of the structure. Each of the delivery stations 56 and 58 is provided with a vertically adjustable platform 60 supported for vertical adjustment by suitable hydraulic jack devices 62 whereby the platforms 60 may be selectively positioned at a level flush with ground level or a distance therebelow equal to half the height of one of the cages 38. Suitable control valves 64 and a suitable pump 66 are provided to supply and control hydraulic pressure to the jacks 62. The valves 64 may be controlled in any convenient manner to position the platforms 60 at the selected level.

As shown in the drawings, each of the cages 38 provides a pair of superposed compartments having bottom-defining platforms 68, each adapted to receive and hold a vehicle thereon. Each of the platforms 68 is preferably in the form of a heavy gauge sheet metal member mounted on cross members 70 of the cages and provided with depressions 72 (see Fig. 5) to receive the vehicle wheels and to hold the vehicles in position thereon. If desired, means other than the depression 72 may be provided to hold the vehicles in position, such as movable chocks or the like. Each of the vertical corner posts 48 of each cage is open at its upper end whereby to receive the tapered feet 50 of any other cage to hold superimposed cages in vertically stacked relation.

The traversing hoists 30, previously referred to, may be manipulated to assume a position over any desired stack of cages 38 and the hoisting mechanism may be then manipulated to raise and lower the hoisting frame 34 to lift the top cage off any selected stack. As shown in Fig. 2, the trackways 10 and 28 are at such height above the tops of the stacks that a cage 38 may be elevated to the maximum height permitted by the frame structure 2 and that elevated cage 38 will be substantially above the tops of the stacks of cages therebelow. With a cage 38 so elevated it may be moved to any desired position over the storage area by operation of the motor 16 and a drive motor for the traversing hoist 30, to be described. Assume it is desired to remove and deliver a vehicle resting in the lower compartment of the cage below the top cage in one of the stacks. The mechanism is manipulated to position the hoist frame 34 directly over that stack and the frame is then lowered to engage the top cage of the stack then raised to the dotted line position of Fig. 2. That top cage is then transported laterally to a position over one of the other stacks whereupon it is lowered to temporarily rest on the top of that other stack. The hoisting mechanism is then again positioned over the desired stack and frame 34 is lowered to engage the next lower cage therein. That cage is then lifted to the dotted line position of Fig. 2 and the controls manipulated to transport the cage laterally over the tops of all the stacks to a position directly over one of the delivery stations 56 or 58. Since the car to be delivered is in the lower compartment of the selected cage, the platform 60 at the selected delivery station is elevated to its uppermost position, as shown at the left in Fig. 2. Thereupon the elevated cage 38 is lowered and placed on the platform 60 so as to position the lower compartment of that cage with its platform 68 at ground level for ready delivery of the vehicle 75 therefrom. In the event the car to be delivered is in the uppermost compartment of the selected cage, the platform 60 is moved to its lower position as seen at the right in Fig. 2, to position the car 75 in the upper compartment at ground level for delivery outwardly through the open end of the cage. Obviously an empty cage may be placed on either of the platforms 60 to receive a vehicle to be stored whereupon the cage may be lifted by the hoisting mechanism and deposited on any selected stack in the area. The cage or cages previously described as having been lifted from the top of a stack and temporarily deposited on an adjoining stack are later again redeposited on their original stack for storage whereby to keep the entire upper area of the space free of cages.

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As shown in Fig. 2, the carriage 8 supports a pair of identical traversing hoist devices 30 whereby cages and their contained vehicles may be selected and moved to or from stacks on both sides of the central aisle 52 simultaneously and thus speed up operation of the system.

As previously described, the motor 16, drum 18, and related mechanisms are housed in a compartment at one corner of the area. Preferably that mechanism is below ground level as shown in the drawings. The space immediately above the compartment housing the motor 16 and drum 18 is equal to the space occupied by one of the cages and defines an office or cashier's compartment 78. The roof or upper portion of the compartment 78 is provided with spotting means similar to those described in connection with Fig. 4 whereby a small stack of cages 38 may be positioned over the compartment 78.

As previously described, each of the cages comprises transverse members 70 and generally vertical hollow posts 48. In addition, the cages include diagonal bracing members 80 (see Fig. 1) to insure rigidity thereof. As clearly shown in Fig. 1, the diagonal bracing 80 is so dimensioned and positioned that the usual doors of the vehicle 75 therein may be opened and swung outwardly through a side of the cage to permit ready ingress and egress to or from the vehicle. Preferably the cages are of such dimension as to just receive the vehicle to be stored without excess width, height or length. Clearly, however, the cages must be of such dimensions as to receive the largest vehicle to be accepted for storage.

Referring now to Figs. 6 to 11, the traversing hoist devices 30, which are both identical, each comprise a suitable rigid frame 82 rotatably supporting the rollers 32, previously described. The frame 82 supports a hoist motor 84 having a drive shaft provided with a form (not shown), engageable with a worm wheel 86 (see Fig. 7) secured to a shaft 88, which shaft comprises a hoisting drum. Four cables 90, 92, 94 and 96 are secured to the shaft 88 and wrapped thereon in the same direction. The cables 90, 92, 94 and 96 extend from the shaft 88 and are trained over guide pulleys 98 so that the cables respectively extend to and downwardly from the four corners of the frame 82. At their lower ends, the cables 90 through 96 are secured to cross members 97 the hoisting frame 34 previously referred to. The motor 84 is a reversible electric motor whereby shaft 88 may be rotated in either direction to raise or lower the hoisting frame 34. Since the motor 84 drives shaft 88 through a worm drive, the mere stopping of the motor will effect holding of the frame 34 in whatever position it is in and the weight supported by the frame is effectively braked without the necessity of providing friction or mechanical holding means. A pulley 100 is fixed to the shaft 88 and drives, through a belt 102 trained over idler pulleys 104, to a pulley 106 secured to a shaft 108 on which a worm 110 is fixed. The worm 110 is mounted in a suitable bracket 112 and meshes with a worm wheel 114 on a shaft 116. The shaft 116 carries a control disc 118 in coaxial relation to a fixed control member 120. The control member 120 is provided with a plurality of motor-control switches 122 thereon in the path of movement of a control element (not shown) on the adjacent face of control disc 118. Since the control disc 118 rotates in timed relation to the shaft 88, the angular position of the disc 118 is indicative of the elevation of the hoist frame 34. The control switches 122 are so positioned that the control device on disc 118 engages those control switches sequentially when the hoist frame 34 is at positions corresponding to the tops of successive cages in the stacks therebelow. Thus, by preselecting a particular control switch 122 (by control circuits not shown) the hoist motor may be started to lower the frame 34 a preselected distance at maximum speed and whereupon the motor is stopped. The particular switch selected will correspond to the position of the uppermost cage in the selected stack. The switches are preferably of such nature that the

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motor 84 is not only stopped, when the frame 34 reaches the desired lower position, but is also immediately reversed to start a hoisting movement. One of the switches 122 is positioned so as to always stop motor 84, in its frame hoisting direction of rotation when the hoist frame 34 reaches its uppermost position, to be described. The control mechanism comprising disc 118 and control member 120 thus permits preselection of the distance of hoisting movement of the frame 34 without the necessity of the operator effecting control of the mechanism to terminate the hoisting movement at the required time. Thus, the mechanism may be designed to operate at maximum speed without requiring further attention after preselection.

The frame 82 is provided with a second reversible motor 126 driving through a worm 128 (Fig. 8) to a worm wheel 130 mounted on a shaft 132. The shaft 132 has a cable 134 wrapped therearound and extending therefrom in one direction parallel to the trackway 28. The end of that first portion of the cable 134 is fixed to an end of the elongated carriage 8. The other portion of the cable 134 extends upwardly from the shaft 132 over a pulley 136, then downwardly therefrom and over an idler pulley 138, then extends horizontally therefrom in alignment with the first portion of the cable 134 to the other end of the carriage 8 to which it is fixed. The pulley 136 is fixed to a shaft 140 (Fig. 6) journaled in a bracket housing 142 and carrying a worm (not shown) meshing with a worm wheel (not shown) mounted on a shaft 144. The shaft 144 carries a control disc 146 in opposed relation to a fixed control member 148 on which a plurality of motor control switches 150 are mounted. The control mechanism 146—150 may be identical to the control mechanism 118—122 previously described except for the positioning of the switches 150. Upon rotation of the motor 126 in either direction, it is obvious that the cable 134 will be wrapped in a corresponding direction on the shaft 132 to thereby effect traversing movement of the frame 82 along the trackway 28. The motor 126 is reversible whereby the frame 82 may be driven in either selected direction along the trackway 28. The control mechanism 146—150 effects automatic stopping of the frame 82 directly over a preselected stack of cages whereby it is only necessary that the operator preselect the stack desired, by conditioning a selected switch 150, and effect starting of the motor 126 whereupon the motor drives the frame 82 to the desired position, then automatically stops in accurately positioned relation to the selected stack.

In like manner any suitable control mechanism may be employed in combination with the motor 16 to effect stopping of the carriage 8 over any preselected lateral row of stacks of cages.

From the mechanism thus described, it is obvious that suitable controls are provided whereby an operator in the compartment 78 may preselect the row and stack of cages from which a cage is to be selected and then start the mechanism in operation whereupon the traversing hoist 30 is automatically and accurately positioned over the selected stack and the controls may be so designed that thereafter the hoist motor 84 is automatically started to lower the frame 34 to the uppermost cage of the stack and thereupon reverse itself to hoist that cage out of the stack.

In lieu of the control mechanism 118—122, a suitable sensing device or feeler on the hoist frame 34 may be provided so that the frame is lowered at maximum velocity until the frame reaches a predetermined position above the uppermost cage in the stack and thereby cause deceleration of the motor 84 and eventual stopping thereof when the frame 34 just makes contact with the top of the cage. Such a feeler mechanism is within the contemplation of my invention.

The frame 82 of the traversing hoist 30 extends substantially downwardly below the carriage 8 and is pro-

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vided with a lower rectangular frame portion 152 rigid therewith. The hoisting frame 34 is also a rigid rectangular frame (see Fig. 9) of the same lateral and longitudinal dimensions as the frame portion 152. The frame portion 152 is provided with four downwardly extending spotting pins 154 adjacent the corners thereof, which pins are adapted to engage within the corners of the frame 34 (see Fig. 9) to accurately spot the frame 34 with relation to frame portion 152 when the frame 34 is lifted to its uppermost position, as illustrated in Fig. 7.

The rectangular frame 34 includes end members 156 provided with brackets 158 between which movable cage-supporting members 160 are pivoted. The members 160 are in the form of elongated plates having laterally extending hook elements 162 thereon. The hook elements 162 are laterally spaced (see Fig. 8) and extend to one side of the plate 160. The hook elements 162 are adapted to engage under the foremost and rearmost upper cross members 72 of the cages 38 to effect lifting thereof. However, when freely suspended, the plates 160 assume a position where their hook members 162 are not completely under the cross members 72 of the cages. A spring 164 is attached to each of the members 160 and is also secured to a swingable plate 168 pivotally suspended between brackets 170 on frame members 172 (see Fig. 9). When the pivotally suspended member 168 is moved to the right as seen in Fig. 10, the spring 164, being relatively stiff, acts as a compression member to hold the supporting members 160 in their outer positions as shown in Fig. 10. The supporting members 160 are further provided with cam devices 174 to effect inward swinging movement thereof by contact with the upper transverse member 72 of a cage, upon lowering the frame 34 onto a cage, to swing the member 160 inwardly sufficiently to permit its hooks 162 to clear the cage element 72 and thereafter to swing outwardly to position hooks 162 under the cage elements 72. The springs 164 thereupon hold the members 160 in their outer position so that subsequent lifting of the frame 34 effects lifting of the cages also. It is to be noted that as long as a cage is suspended from the members 160 and its weight applied thereto, the hook members 162 cannot disengage themselves from the cage even though the springs 164 be no longer held in compression.

The frame 34 is also provided with a spotting pin 176 adjacent each of its corners, which pins are aligned with the vertical tubular members 48 of the cages. Upon lowering the frame 34 to a cage the pins 176 enter the open upper ends of the members 48 to thereby hold the cage and frame 34 in predetermined relationship to each other. It is to be noted that the frame 34, the frame portion 152 and the cages 38 have the same lateral and longitudinal dimensions so that one member does not project outwardly beyond the other. Since the frame member 34 is suspended by the four cables 90 through 96, the frame 34 hangs suspended from the hoisting device 30 in a relatively suitable position. Raising and lowering movements of the frame 34 occur only when the hoisting devices 30 are stationary over a selected stack and, therefore, no influences tending to cause the suspended cage and its contents to sway are present. When the frame 34 is lifted into contact with the frame portion 152, as shown in Fig. 7, and a cage 38 is suspended therefrom, it is obvious that the cage, the hoisting frame and the traversing hoist are rigidly connected together against any relative swaying or swinging movement and therefore high acceleration forces may be applied to the traversing hoist 30 in any horizontal direction without causing the cage suspended therefrom to sway in the least bit.

The traversing hoist 30 is always brought to a standstill over the desired position before the frame 34 is lowered therefrom and the frame is always thereafter again returned to its uppermost position before any

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further horizontal motion is imparted to the hoisting device.

Referring again to Figs. 8 through 11, the pivotally suspended plate members 168 are provided with central cut-out portions or notches 178. A cantilever spring 180 is mounted on the frame member 172 adjacent each plate member 168 and arranged to bias or urge the plate member to swing to the right as viewed in Fig. 10.

A shaft 182 is journaled in the frame members 172 and extends through both said members and through the notches 178 of the elements 168. At its outer ends the shaft 182 carries, fixed thereto, cam devices 184, each provided with diametrically opposed cam projections 186. The diameter of each of the cam devices 184 is somewhat less than the width of the notches 178 but the depth of those notches is such that the bottoms thereof lie only slightly below the shaft 182 (see Fig. 10). When the shaft 182 is in such position that the cam projections 186 thereon lie in a vertical plane, the lowermost of such cam projections engages the pivotally suspended member 168 to move the same inwardly to the position of Fig. 11 and thereby apply tension to the spring 164 to urge the member 160 to swing inwardly. One quarter of a turn of the shaft 182 from the described position positions the cam projections 186 in a horizontal plane where they both enter the notch 178 and permit spring 180 to swing pivotally suspended member 168 outwardly and thereby apply a slight compressive force to spring 164 to resiliently hold the member 160 in its outer position.

The shaft 182 has a ratchet member 188 fixed thereto and provided with four equally spaced teeth 190 thereon. A rotary pawl element 192 is rotatable and slideable on shaft 182 and is provided with four teeth complementary to the teeth 190 on the ratchet member 188. A collar 194 on shaft 182 constitutes an abutment for a compression spring 196 between the collar 194 and an end portion of the pawl device 192. The pawl device 192 comprises the portion provided with the teeth described and an inner portion defining a pinion 198. The frame portion 152 of the traversing hoist device supports a fixedly positioned downwardly extending rack bar 200 in a position to engage and rotate the pinion 198 when the frame 34 is adjacent the frame portion 152.

Assume that a cage 38 is suspended from the frame 34 with the spring 164 under slight compression, as indicated in Fig. 10. When the frame 34 is then lifted upwardly to engage the frame portion 152 as shown in Fig. 7, the pinion 198 meshes with the rack bar 200 before the upper limit of movement is reached and the rack bar 200 is of such length that one quarter turn of rotation is imparted to the pinion 198 by the time the frame 34 reaches its uppermost position. That quarter turn rotation imparted to the pinion 198 is in such direction and acts through the ratchet 188 so as to rotate shaft 182 and cam device 184 through a quarter turn to the position of Fig. 11 and thus apply tension to the spring 164. Since the weight of the cage lifted by the frame 34 is still on the hook devices 162, the described tension in spring 164 is insufficient to withdraw the hooks 162 from the cage. Upon subsequent lowering of the frame 34, the pinion 198 is rotated a quarter turn in the opposite direction but its teeth merely ratchet over the teeth 190 without imparting rotation to the shaft 182 and leaves teeth on the pawl device in engagement with the teeth on 188 in preparation for a further actuation. Thus as the frame 34 is lowered from the position of Fig. 7, the parts are left in the position of Fig. 11 with the spring 164 under tension. When the frame 34 has been lowered sufficiently for the cage carried thereby to engage a supporting structure, whether it be a stack of cages or one of the platforms 60, the weight of the cage is then relieved from the hook devices 162 whereupon the springs 164 retract the pivoted mem-

bers 160 and effect release of the cage. The frame 34 may thereupon be raised without lifting the cage therewith. As the empty frame 34 reaches its upper position adjacent frame portion 152, the pinion 198 is again rotated in a forward direction through a quarter turn to bring the parts to the position shown in Fig. 10 whereupon the hook devices 162 are conditioned to be cammed over and engage another cage upon which the frame 34 may be lowered.

By the structure described it is obvious that the frame 34 and frame portion 152 automatically operate to condition cage-holding means so that a cage is automatically engaged and lifted by the frame 34 at alternate lowering and released therefrom on each intermediate lowering. Thus no attention of the operator is required to effect holding or releasing of the cages. All that is necessary is that the frame 34 be manipulated upwardly and downwardly.

While a specific form of cage-supporting energizing means has been shown, such is merely illustrative of the invention. Many other forms of mechanism may be employed to accomplish the same result.

Fig. 13 illustrates a modified form of storage system wherein the stacks of cages 38 are supported on a supporting surface 40' at ground level. In this form the delivery stations 56' and 58' necessarily comprise pits or depressions in the base 4 to accommodate the hydraulic mechanisms 62' and platforms 60'. The operation of this form of system is identical to that already described in connection with Figs. 1 through 3.

The description herein and the drawings refer to hoisting and traversing means employing electric motors but it is to be understood that other suitable power sources may be readily employed. For instance, hoisting movements of the frame 34 and/or traversing movements of carriages 8 and 30 may be effected by hydraulic means comprising a hydraulically-operated piston on the frame 82 and a suitable cable system extending therefrom whereby relatively small movements of the piston effect large movements of the frame 34 or carriages 8 or 30. Such a hydraulic system offers advantages in that the mere act of lowering a loaded cage may be employed to restore energy to the hydraulic system, such as by charging a pressure accumulator to conserve energy and thus reduce the cost of operation on the system. Furthermore, hydraulic systems as suggested offer relatively simple means for controlling the acceleration, starting, and stopping of the movements effected thereby.

Obviously, suitable controls can be devised to control the various cycles of operation whereby an operator at a remote station (for example, the compartment 78) need only "set up" a control mechanism to define the position in the stack of a desired vehicle. Thereupon the control mechanism initiates and controls the required operations to deliver that vehicle to the delivery station automatically and without further attention.

The drawings suggest that the different stacks of cages actually abut adjacent stacks but it is contemplated that some space be left between stacks to provide ample clearance for raising and lowering the cages. The number of cages in each stack may obviously be other than illustrated without departing from the principles of the invention.

While a limited number of embodiments of the invention have been shown and described herein, it is to be understood that the invention itself is not limited thereto but may include other forms falling within the scope of the appended claims.

I claim:

1. Article storage apparatus, comprising; a plurality of rigid cages each defining a pair of superposed open-end compartments, said cages having mutually interengaging means for guiding and retaining any one cage in vertically stacked relation to any other cage, elevated hoisting means mounted for universal horizontal move-

ment over a predetermined area and arranged to lift and lower individual cages and to transport lifted cages over said area, said predetermined area being of an extent to accommodate a plurality of stacks of said cages, means at an edge of said area defining a delivery station, said means comprising a cage-supporting vertically movable device and means defining a fixed delivery surface, said vertically movable device being selectively positionable at either of two levels whereby to position a cage thereon with a selected one of said compartments aligned with said surface.

2. Apparatus as defined in claim 1 wherein said surface is substantially at ground level, a pit adjacent said surface, said vertically movable device being mounted in said pit and comprising a power-actuated platform movable between a position substantially at ground level and a position therebelow a distance equal to the height of one of said compartments.

3. Apparatus as defined in claim 1 wherein said elevated hoisting means comprises: a hoisting device, a generally flat hoisting frame adapted to be raised and lowered by said hoisting device, means on said frame for engaging the top of a cage and supporting the same thereon, and stabilizing means on said frame and hoisting device adapted to interengage upon lifting said frame upwardly to said hoisting device to hold said frame against lateral or tilting movements relative to said hoisting device.

4. Apparatus as defined in claim 1 wherein said elevated hoisting means comprises: a hoisting device, a hoisting frame adapted to be raised and lowered by said hoisting device, holding means on said frame for engaging and supporting a cage thereon, and cyclic means for conditioning said holding means to alternately support and release a cage whereby to release said cage therefrom upon lowering said cage into supporting engagement with a fixed support and to engage and hold a cage for lifting the same upon subsequent lowering of said frame onto a cage.

5. Apparatus as defined in claim 4 wherein said cyclic means are actuated each time said frame is lifted into proximity to said hoisting device by cooperating means on said frame and hoisting device, respectively.

6. Article storage apparatus, comprising; a plurality of rigid cages each defining a pair of superposed open-end compartments, said cages having mutually interengaging means for guiding and retaining any one cage in vertically stacked relation to any other cage, elevated hoisting means mounted for universal horizontal movement over a predetermined area and arranged to lift and lower individual cages and to transport lifted cages over said area, said predetermined area being of an extent to accommodate a plurality of stacks of said cages, means adjacent said area defining loading and delivery station and including a fixed supporting surface and cage-supporting means selectively operable to support a cage with a selected one of said compartments aligned with said surface.

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