

WAREHOUSE STORAGE SYSTEM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This application is directed to a warehouse storage system wherein storage units are manipulated by one or more overhead transfer units that can lift or elevate the storage units and maneuver them into vertically oriented storage cells or into vertical stacks without the need to use conventional cranes and forklifts and in such a manner as to maximize storage space by eliminating the need for internal aisles for manipulating and/or handling equipment.

BRIEF DESCRIPTION OF THE RELATED ART

Storage space is often an issue for many people and businesses. Whether it be people living in small urban units, such as apartments and condominiums, people downsizing to smaller homes, such as for retirement, or businesses generating stacks of papers and files, storage solutions are in demand. As a result, offsite storage facilities have been increasingly popular.

Conventional storage facilities typically include a plurality of individual storage units, such as garages, rooms, or lockers, that are housed by a static structure, such as a one-story building, multi-story building, or a warehouse. These facilities are built to allow access to the unit via a doorway opening. In order to use the facility, a customer must be able to transport the items to be stored to the doorway opening via driveways, hallways, stairways, elevators, or the like. As a result,

a customer often has to rent trailers, trucks, vans or other vehicles to transport the items to be stored at the storage facility. Further, the customer may have to seek assistance in packing or loading the items to be stored.

Another drawback of conventional storage facilities is "dead space." Due to the necessary means for accessing the doorway openings of the storage units, storage facilities have a lot of "dead space" that is taken up by aisles, driveways, and hallways, and not used for storage.

In an attempt to mitigate against some of the problems associated with conventional offsite storage facilities, other forms of storage have been developed, including storage containers that are delivered to a location designated by a customer. The customer then loads the items to be stored in these containers, and the containers are picked up and stored in an offsite facility. While this type of storage system eliminates the hassles associated with transporting the items to be stored to a storage facility, these systems still suffer from "dead space" and therefore do not maximize storage space. After the storage containers are loaded, picked up from the customer's location, and delivered to an offsite facility, heavy equipment such as, fork lifts, cranes, vehicles, and the like are used to move the containers into storage areas. The use of this heavy equipment requires a large amount of "dead space," such as aisles, to enable the storage containers to be moved.

Since conventional storage systems and facilities suffer from "dead space," there is a need for a storage system that maximizes storage space.

SUMMARY

The present invention is directed to a warehouse storage system that maximizes storage space by reducing the number of aisles, hallways, and other areas of non-storage space. The warehouse storage system includes a plurality of storage units that are manipulated by one or more overhead transfer units. The overhead transfer units lift the storage units and maneuver them into vertically oriented storage cells or into vertical stacks without the need to use conventional cranes and forklifts and in such a manner as to maximize storage space by eliminating the need for internal aisles for manipulating and/or handling equipment. Thus, the warehouse storage system of the present invention stores individual storage containers with an X-Y-Z storage matrix, where X is a side-to-side direction, Y is a front-to-back direction, and Z is a top-to-bottom direction.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the invention will be had with reference to the attached drawings wherein:

Fig. 1 is a perspective view of a first embodiment of a warehouse storage facility in accordance with the teachings of the present invention illustrating a retrieval of a storage unit from a bottom of a vertical stack of storage units;

Figs. 2-19 are perspective view of the warehouse storage facility of Fig. 1 further illustrating the retrieval process;

Fig. 20 is a perspective view of one of the transfer units of the invention shown suspended from intersecting sections of overhead tracks along which the transfer units are selectively movable in both "X" and "Y" directions and also illustrating a suspension frame for cooperatively engaging and securing one of the storage units of the invention as the storage units are moved about the system and storage facility of the invention;

Fig. 21 is a top plan view of the transfer unit of Fig. 20 showing portions of gear racks associated with an overhead guide track system superposed over drive pinions of the transfer unit;

Fig. 22 is a partial cross sectional view through an intersecting section of the overhead tracks of the invention and showing a side view of one of the roller assemblies that support the transfer units of the invention;

Fig. 23 is a partial top plan view of Fig. 22, showing the intersecting section of the overhead tracks of the invention and one of the roller assemblies that support the transfer units of the invention;

Fig. 24 is a bottom view of one of the roller assemblies of the invention which support the transfer units from the guide tracks.

Fig. 25 is a top plan view of an alternative embodiment of the transfer unit of Fig. 12 showing portions of segments of an overhead guide track system superposed over rubber drive wheels of the transfer unit;

Fig. 26 is a top view showing the transfer unit of

Fig. 12 with a trunnion;

Fig. 27 is a side view of the transfer unit of Fig. 18; and

Fig. 28 is a top view similar to Fig. 18.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed to warehouse storage facilities and methods for safely and efficiently maximizing storage space. The facilities of the invention are designed and configured to permit a maximum number of storage units to be stored within a given warehouse space and yet easily accessible when their contents are needed. The warehouse facilities described herein are generally fully enclosed structures, each having outer side walls and roof that protect the storage units being stored from ambient weather conditions with the roof being cut away and walls being removed to facilitate the description of the storage systems.

With specific reference to Figs. 1-19, a first embodiment of warehouse storage facility will be described. In this embodiment, the warehouse facility includes a large warehouse-like structure 20 that includes an inner portion 21 that is supported on a solid foundation 22 that may be elevated or built up with respect to an adjacent roadway 23 so that stored items can be easily loaded onto or unloaded from trucks or other vehicles. The roadway may be a driveway or parking area.

In a preferred embodiment, the warehouse structure 20 includes a number of spaced columns 24. The spaced

columns 24 define a grid made up of a plurality of storage cells 25 so that individual storage units 28 may be stored in stacked vertical relationship relative to one another. One row and one column of this grid are always open so as to permit the retrieval of storage units 28 from their storage positions.

The columns 24 may have cross sections defined by one or more vertical guide flanges that are oriented at generally right angles relative to one another so that the storage units 28 are guidingly engageable therewith. Although each column may have the same cross section, inner columns 24A will preferably have "+" shaped cross sections so as to define four guide channels. End and side columns 24B will have generally T-shaped cross sections defining two opposing guide channels, and corner columns 24C will have flanges defining a single or L-shaped guide channel. This guidance feature will ensure that the storage units 28 being handled are not accidentally damaged.

Also in the preferred embodiment, the warehouse structure 20 includes a plurality of horizontal beams 26 that extend perpendicularly between the columns 24 and are generally parallel to the solid foundation 22. The horizontal beams 26 support the storage units 28 when they are in storage positions. As shown in Figures 1-19, the horizontal beams 26 support the storage units 28 some spaced distance above the solid foundation 22 so as form staging areas 27 where customers can park their vehicles. These staging areas 27 are preferably adjacent to the roadways 23.

Each storage unit 28 is generally an enclosed, rectilinear, box-like container having a top, bottom, and

four side walls so that the storage units 28 can easily be vertically stacked upon each other. One of either the end or side walls is openable so as to provide access to the interior of the unit 28. Alternatively, an opening or doors may be provided in one or more of the end or side walls to allow items to be added to or removed from the storage unit 28. Further, the storage units 28 may be made from any durable material, such as plastic, metal, wood, composite materials, or any combination thereof. Moreover, the storage units 28 may be reinforced with other materials, especially if large, heavy items are to be stored therein. It is also preferred that sufficient openings are provided in the enclosed storage unit walls to permit air flow there through so as to provide ventilation.

The storage units 28 are designed to be manipulated by overhead transfer units 40, as shown in detail in Figs. 19-28, with two such units being shown in Figs. 1-19. Each carriage includes a body, which in the embodiment shown, includes a rectangular steel frame 42 that is supported at each of the four corners thereof by support or pilot hanger shafts 43 that extend upwardly from the frame and through open slots 44 that are provided in an overhead track system 45. The track system is formed by a plurality of hollow steel box beams 46 that are welded or otherwise secured to steel girders or roofing "I" beams of the structure 20 so that the open slots 44 are oriented downwardly. The track system extends above the periphery of each of the cells 25 of the grid in such a manner that the transfer units 40 may be directly and selectively aligned above the cells 25 so as to place a storage unit 28 into a cell 25 or elevate the storage unit 28 from a cell 25. Load bearing flanges 47 are formed on opposite sides of the slots on which track roller carriages 48 are

movably supported. Each of the pilot hanger shafts 43 is centrally secured to a separate roller carriage.

The box beams 46 that form the track system 45 include both longitudinally extending sections 46A and transverse sections 46B that are oriented at generally right angles with respect to one another. The roller carriages include both upper and lower heavy duty roller ball sets 49 and 50, respectively, that guide the carriages within the box beams 46 with the lower set bearing the weight of the transfer units 40 and the storage units 28. Alternatively, the roller carriages can only include a lower heavy duty roller ball set 50 for guiding the carriages within the box beams 46. Each carriage also includes two pair of wheel sets 51 and 52, with the wheel sets 51 engaging the flanges 47 of the longitudinal sections 46A and the wheel sets 52 engaging the flanges 47 of the transverse sections 46B.

The lower surfaces of each of the track sections 46A/B are provided with gear racks 54 with which drive pinion gears 55A and 55B of drive assemblies carried by the transfer units 40 are in meshed engagement. With specific reference to Fig. 21, each transfer unit 40 includes eight drive pinion gears 55A/B, two on each side of the frame 42 that are engaged with the gear racks 54. Fig. 21 is a top plan view of the transfer unit 40 showing four gear track sections 46 superimposed over the drive pinion gears 55A/B with two of the sections being the longitudinal track sections 46A and two being the transverse sections 46B. Two drive motors 58 are mounted to the transfer unit 40 having outputs connected through power splitters 59 that drive first output drive shafts 60 that drive the pinion gears 55A through four gear boxes 62. Secondary drive output shafts 64 extend from the gear

boxes 62 to the drive pinion gears 55B. In this manner, all the drive pinion gears 55A/B are uniformly driven at the same rate by the two drive motors 58. The gear boxes 62 are controlled such the drive output is only possible to either the pinion gears 55A or 55B at any one time such that to move the transfer unit 40 longitudinally along the track system 46 from the back of the structure 20 toward the front thereof, only the drive pinion gears 55A are powered and such that, when the transfer unit 40 is to move transversely from side-to-side along the track system 46, only the drive pinions 55B are powered.

In an alternative embodiment shown in Fig. 25, the transfer unit 40 can be provided with rubber drive wheels 70 instead of the gear racks 54 and the drive pinion gears 55A/B. Fig. 25 is a top plan view of the transfer unit 40 showing four gear track sections 46 superimposed over the rubber drive wheels 70 with two of the track sections being the longitudinal track sections 46A and two being the transverse sections 46B. Drive motors 72 are attached to each of the rubber drive wheels 70. The drive motors 72 are controlled by a master encoder 72ML on one of the drive motors 72 along one of the longitudinal track sections 46A and another master encoder 72MT on one of the drive motors 72 along one of the transverse track section 46B. The master controllers 70ML and 70MT control slave encoders 72S on the other drive motors 72. In this manner, the drive motors 70 are controlled such that to move the transfer unit 40 longitudinally along the track system 46 from the front of the structure 20 to the back thereof and vice versa, the master encoder 72ML controls the drive motors 72 along the longitudinal track sections 46A. Likewise, to move the transfer unit 40 transversely along the track system 46 from one side of the structure 20 to the opposite side and vice versa, the master encoder

72MT controls the drive motors 72 along the transverse track sections 46B.

The transfer unit 40 is designed to raise and lower the storage units 28 of the invention. To accomplish this, two hoist motors 67 are mounted to the transfer unit 40. The outputs from these motors are connected through power splitters 65 to pairs of winding drums 66. Cables 69, as shown in Fig. 20, depend from the drums 66 to lower ends that are fixed to a lifting frame 90 that functions as a spreader beam to be in selectively locked engagement with an upper portion of one of the storage units 28 via corner locks 92. As the lifting frame 90 is lowered toward an underlying storage unit 28, by activation of the motors 67, the frame 90 will engage about the upper periphery of the storage unit 28, after which, the corner locks 72 are automatically tripped to engage the storage unit 28 such that the unit 28 can be elevated to a position immediately adjacent the transfer unit 40, as illustrated in Fig. 1. In this position, the transfer unit 40 can be moved along the track sections 46A and 46B so as to move the storage unit 28 above a desired storage cell 25 in the grid. Further, the storage unit 28 can be rotated via a trunnion 80, as shown in Figs. 26-28. After the storage unit 28 is located above the desired cell 25, the storage unit 28 is lowered until it rests on the floor of the structure 20, on horizontal beams 26, or is seated on an underlying storage unit 28.

In the operation of the warehouse storage system of the first embodiment of the invention, a storage unit 28 is seated in a work area so that a customer may load items into or unload items from the storage unit 28. Preferably, the work area is located within the structure 20. Further, the work area is a plurality of an air-

conditioned, enclosed rooms so that each customer can have a private area to load or unload a storage unit 28. Alternatively, the work area may be an open area, such as a drive-in area or dock area so that a truck or other vehicle can enter the work area. In another embodiment, the work area can be in an area other than the structure 20, such as at a customer's residence.

After a customer is done loading or unloading a storage unit 28 in the work area, the storage unit 28 is moved to the staging area 27. Once the storage unit 28 is seated in the staging area 27, an overhead transfer unit 40 maneuvers above the storage unit 28, and the lifting frame 90 of the overhead transfer unit 40 is lowered onto the storage unit 28. Once the lifting frame 90 is attached to the storage unit 28, an operator, preferably with a remote control device, begins to raise the lifting frame 90, and subsequently the storage unit 28, until they are directly beneath the body of the transfer unit 40. In this position, the storage unit 28 is moved to a predetermined cell 25 within the inner portion 21 of the building or structure 20. Thereafter, the operator lowers the lifting frame 90 and the storage unit 28 into a stored position.

When it becomes necessary to retrieve an item from a storage unit 28 that is stored beneath a stack of storage units, as shown in Fig. 1, one of the transfer units 40 is moved over the appropriate cell 25. The lifting frame 90 is lowered until it automatically locks to an uppermost storage unit 28. The uppermost unit is elevated directly beneath the body of the transfer unit 40, after which the transfer unit 40 is moved along the empty rows and columns of the grid, as illustrated in Fig. 2. The storage unit 28 is then lowered into an empty cell, as shown in Fig. 3.

This process is continued until the desired storage unit 28 is lifted from the storage cell, as shown in Figs. 4-18. During the elevating and lowering of the storage unit 28, the storage unit 28 is positively guided by the columns 25A, 25B and 25C. Further, the storage unit 28 may be rotated via the trunnion 80 so that the opening of the storage unit 28 may face a desired direction. Alternatively, the storage unit 28 may be rotated via a turntable located on the floor of the work area. Lastly, the desired storage unit 28 is then lowered to the staging area 27, where it can be moved to a work area for loading or unloading.

As previously stated, the inner enclosed portion 21 of the warehouse structure 20 may be divided into storage cells, as shown in Figs. 1-19. In an alternative embodiment, the inner portion 21 of the building 20 may be open, like a large empty warehouse with the structure of the storage units 128 permitting the vertical stacking arrangement shown in the drawings. In this respect, each storage unit 28 includes upper and lower rectangular frame components that are connected by corner vertical struts. The frames are formed of heavy steel tubing or the like that will permit the units to be stable when stacked one on another. To provide for further stability, the upper and lower corners of the storage units 28 are provided with mating male and female couplings such that the storage units 28 cannot shift relative to another.

The system of the present invention can be operated by an operator or operators at the facility, either manually or through the use of computers. Alternatively, the system can be controlled automatically. By way of example, a customer, when contracting for storage, may be given a personal code or a bar coded card that may be

entered into a control terminal placed at an accessible site adjacent the area where the storage units 28 are elevated from the staging area 27. The control terminal is connected to a computer system that verifies the number of the access or bar code. At the time of verification, the computer signals one of the transfer units 40 having a correct size of storage unit 28 available to move to the staging area 27 and lower the storage unit 28. After the customer is done loading or unloading the storage unit 28 in the work area, the hoists are subsequently automatically activated to raise the storage unit 28 from the staging area 27 to a position immediately below the transfer unit 40. The transfer unit 40 receives storage position information from the computer and automatically moves to a predetermined area or cell 25 within the storage facility and then lowers the storage unit 28 into the predetermined storage position.

Similarly, when a customer wants to retrieve items from a storage unit 28, by entering his or her code number or by use of the bar coded card, the controller communicates with the computer. The computer communicates with one or more of the transfer units 40, and the transfer unit 40 moves to the appropriate cell 25. Further, the transfer unit 40 may first move one or more storage units 28 in order to obtain access to the desired storage unit 28. After the desired storage unit 28 is secured to the lifting frame 90, the storage unit 28 is raised to beneath the transfer unit 40. Then, the transfer unit 40 moves to a position above the staging area 27 and lowers the storage unit 28.

Such an automatic system can incorporate the use of personal PIN numbers in combination with the access codes and/or bar coded cards to provide additional security.

The automated system not only provides for secured storage and access to the storage unit, but also permits items to be stored or retrieved from storage at any time, thus making the system completely compatible to the individual customers.

Further, in another alternative embodiment, the warehouse storage system of the present invention also includes means for identifying each storage unit 28. Such identification means may include a radio frequency identification system or a bar code system. For example, each storage unit 28 includes a radio frequency identification tag, and the warehouse structure 20 is equipped with various radio frequency readers. Accordingly, the readers are able to obtain data from the identification tags regarding the position of each storage unit 28 in the warehouse 20. The readers then transfer this information to the computers for analysis and storage.

The foregoing description of the present invention has been presented to illustrate the principles of the invention and not to limit the invention to the particular embodiments illustrated. It is intended that the scope of the invention be defined by all of the embodiments encompassed within the following claims and their equivalents.

We Claim:

1. An overhead warehouse storage system for selectively elevating storage units, storing the storage units within a storage facility and retrieving the storage units from the storage facility, the storage system comprising a storage structure including a first section for storing the storage units and at least one second section adjacent said first section, an overhead track system including pairs of spaced and parallel tracks that extend within said first and second sections of said storage structure, at least one powered transfer unit mounted to said overhead track system so as to be movable transversely in an X-Y plane above said first section of said storage structure and along at least one of an X or Y direction over said second section of said storage structure, a plurality of storage units each defining a frame for supporting items stored within the storage unit, said at least one transfer unit including hoist means for selectively engaging said storage units, each of said frames being constructed to permit items to be loaded into or from said storage units, and said storage units being vertically stackable one above another, whereby said at least one transfer unit can be maneuvered along said overhead track system so as to lower one of said storage units into said second section of said storage structure to be loaded with items and elevate the storage unit from said second section and thereafter convey the elevated storage unit to said first section of said storage structure wherein the storage unit is lowered into a stored position and wherein said storage units can be selectively maneuvered within said first section of said storage structure to obtain access to said storage units and wherein retrieving items stored in said first section

of said storage structure is accomplished by elevating a selected storage unit from a stored position and thereafter conveying the selected storage unit from said first section of said storage structure to said second section of said storage structure and subsequently lowering the selected storage unit into said second section such that items stored in the storage unit can be unloaded.

2. The overhead warehouse storage system of claim 1, wherein said storage structure further includes a plurality of spaced columns, said spaced columns being generally perpendicular to a ground surface of the storage facility, and said columns defining said plurality of vertical storage cells and said second section of said storage structure.

3. The overhead warehouse storage system of claim 2 wherein said spaced columns include guide means for guiding said storage units as the storage units are raised and lowered relative to the ground surface.

4. The overhead warehouse storage system of claim 3 wherein said guide means includes flanges for engaging said storage units, said flanges forming channels within said spaced columns.

5. The overhead warehouse storage system of claim 1 wherein said storage structure further includes at least one horizontal support spaced a distance from a ground surface of the storage facility, said at least one horizontal beam supports said storage units when said storage units are stored in said vertical cells.

6. The overhead warehouse storage system of claim 5

further comprising a staging area located below said horizontal support and adjacent to said second section of said storage structure.

7. The overhead warehouse storage system of claim 1 further comprising a staging area located adjacent to said second section of said storage structure.

8. The overhead warehouse storage system of claim 1 wherein said frame of each of said storage units includes upper and lower members connected by vertical frame members and between which items may be loaded such that said storage units may be vertically stacked one upon another.

9. The overhead warehouse storage system of claim 8 wherein said frame of each of said storage units is generally open at at least one end thereof to thereby permit items to be loaded into or from said storage units.

10. The overhead warehouse storage system of claim 8 wherein at least one of said storage units is substantially enclosed by wall portions to thereby protect items in storage from damage.

11. The overhead warehouse storage system of claim 1 wherein said hoist means of said at least one transfer unit includes a lifting frame for engaging one of said storage units, and cables for raising and lowering said lifting frame relative to said at least one transfer unit.

12. The overhead warehouse storage system of claim 11 wherein said at least one transfer unit includes rotating means for rotationally supporting said hoist means therefrom.

13. The overhead warehouse storage system of claim 1 wherein said plurality of storage units includes storage units of different sizes for accommodating items of different sizes.

14. The overhead warehouse storage system of claim 1 further comprising controlling means for automatically electronically controlling the storage and/or the retrieval of said storage units relative to said first section of said storage structure, said controlling means including electronic means for identifying a storage unit and activating means for activating said at least one transfer unit to appropriately store or retrieve from storage an identified storage unit.

15. A method for storing items in a protected storage structure having a first section in which storage units in which items are housed may be vertically stacked relative to one another and a second section adjacent to the first section in which items may be loaded to or from the storage units and wherein the storage units are selectively raised, lowered and maneuvered within the storage structure using at least one transfer vehicle that is movable along an overhead grid track system and which includes a hoist assembly including means for engaging one of the storage units, the method including the steps of:

A. Moving the at least one transfer unit along the overhead grid track system so as to be within the second section of the storage structure and thereafter lowering a storage unit carried thereby into the second section;

B. Moving items into the lowered storage unit and elevating the storage unit;

C. Elevating the storage unit so as to be more closely spaced to the at least one transfer vehicle;

D. Maneuvering the at least one transfer vehicle

along the overhead grid track system so as to be above a predetermined storage area in the first section of the storage structure;

E. Lowering the storage unit being stored into the predetermined storage area and releasing the storage unit;

F. Retrieving items within the storage unit by moving the at least one transfer vehicle along the overhead grid track system and above the predetermined storage area and lowering the hoist assembly to engage the storage unit;

G. Elevating the engaged storage unit and thereafter moving the at least one transfer vehicle along the overhead grid track system to the second section of the storage structure; and

H. Lowering the storage unit into the second section of the storage structure and removing items from the storage unit.

16. The method of claim 15 further comprising an additional step of positively guiding the storage unit as the storage unit is raised and lowered.

17. The method of claim 15 further comprising an additional step of moving the storage unit to staging area so that items may be loaded to or from the storage unit.

18. The method of claim 15 further comprising additional steps of electronically accessing an electronic control device for controlling movement of the at least one transfer vehicle and electronically requesting the retrieval of a predetermined storage unit, whereupon the receipt of a retrieval request, the at least one transfer vehicle automatically retrieves the requested storage unit and transfers the retrieved storage unit to a requested location.

19. The method of claim 18 further comprising additional steps of placing an identifying means for electronically identifying each of the storage units on the storage units and providing remote readers for communicating with the identifying means whereby the location of each storage unit is easily determined.