RELATED APPLICATIONS

[0001] This Application claims priority to U.S. Application No. 13/241,326 filed on 23 September 2011, which is a continuation-in-part application of U.S. Application No. 12/464,745, filed on 12 May 2009, and of U.S. Provisional Application Numbers 61/514,057, filed on 2 August 2011 and 61/127346, filed on 12 May 2008, all of which are incorporated herein by reference.

BACKGROUND

[0002] The present application relates to high density storage facilities, and more particularly to high density storage facilities for storing intermodal containers, boats and other large items.

[0003] Despite advances in building materials, material handling vehicles, and techniques, there is still a need for storage facilities for large sized objects such as intermodal containers, boats, cars, furniture and the like. Such facilities should provide mechanisms for obtaining ready and efficient access to the stored objects, as well as optimal use of storage space.

[0004] For example, conventional boat storage facilities include a large building with racks aligned along the walls and a large unoccupied floor space. This results in a large amount of unused space, as depicted in FIG. 1 for building B with corners C1, C2, C3 and C4. Two access entryways A1 and A2 are defined at an end of building B to enable a fork-lift truck to place and withdraw large items such as boats from the three stationary, fixed storage racks R1, R2 and Rs.

[0005] A more efficient system is depicted in FIG. 2 based on U.S. Patent No. 5,140,787 by the present inventor for facility F having building corners C1-C4 and a stationary rack S1 extending along length L of facility F. Multiple access doors A1, A2, A3 and A4 are provided along the length L. One or more of four movable elongated rectangular racks R1, R2, R3 and R4 can be rolled along length L to expose a selected rack row to a fork-lift truck entering through one of access doors A1-A4. However, many square feet of space must still be left open to provide turning and maneuvering room for the fork-lift truck, and

mounted on wheels set in parallel tracks for rolling the carriage racks along the floor.

[0018] **FIG. 10A** depicts an electromagnetic coupling system suitable for use with illustrative embodiments of the present invention;

[0019] **FIG. 10B** depicts an exemplary rack, mounted on an electromagnetic carriage suitable for use with a maglev system according to exemplary embodiments;

[0020] **FIG. 10C** depicts an exemplary rack, mounted on a wheeled carriage suitable for use with a maglev system according to exemplary embodiments;

[0021] **FIG. 11** is a top view of a narrow storage area converted into a high density storage facility according to the present invention;

[0022] **FIG. 12** is a top schematic view of a storage facility similar to FIG. 2 showing six rectangular racks and a wide fork-lift truck aisle area;

[0023] **FIG. 13** is a top view showing how additional storage slots can be provided according to the present invention for the facility of FIG. 12 after a retrofit;

[0024] **FIGS. 14 and 15** are schematic top views of another high-density storage facility according to the present invention;

[0025] **FIGS. 16A-16D** are schematic side elevational views of different carriage rack storage configurations according to the present invention;

[0026] **FIGS. 17A-1 and 17A-2** are top left and right views, respectively, sharing match line ML-ML, of another high density storage facility according to the present invention;

[0027] **FIGS. 18A-1 and 18A-2** are side elevational left and right views, respectively, sharing match line ML-ML, of the stationary racks of FIGS 17A-1 and 17A-2 aligned with the length of the storage facility;

[0028] **FIG. 19** is an end elevational view of the width and height of the storage facility of FIGS. 17A-1 and 17A-2;

[0029] **FIGS. 20A-1, 20-A-2, 20B, 20C and 20D** are schematic side elevational views of different carriage configurations A, B, C and D of FIGS. 17A-1 and 17A-2;

[0030] **FIG. 21** depicts an exemplary carriage rack, mounted on a wheeled carriage suitable for use with an intermodal container according to exemplary embodiments; and

[0031] **FIG. 22** depicts an exemplary overhead view of fixed racks and carriage racks configured for use with an intermodal container according to exemplary embodiments.

HIGH DENSITY STORAGE FACILITY

RELATED APPLICATIONS

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[0005] A more efficient system is depicted in FIG. 2 based on U.S. Patent No. 5,140,787 by the present inventor for facility F having building corners C1-C4 and a stationary rack S1 extending along length L of facility F. Multiple access doors A1, A2, A3 and A4 are provided along the length L. One or more of four movable elongated rectangular racks R1, R2, R3 and R4 can be rolled along length L to expose a selected rack row to a fork-lift truck entering through one of access doors A1-A4. However, many square feet of space must still be left open to provide turning and maneuvering room for the fork-lift truck, and

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[0020] **FIG. 10C** depicts an exemplary rack, mounted on a wheeled carriage suitable for use with a maglev system according to exemplary embodiments;

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[0022] **FIG. 12** is a top schematic view of a storage facility similar to FIG. 2 showing six rectangular racks and a wide fork-lift truck aisle area;

[0023] **FIG. 13** is a top view showing how additional storage slots can be provided according to the present invention for the facility of FIG. 12 after a retrofit;

[0024] **FIGS. 14 and 15** are schematic top views of another high-density storage facility according to the present invention;

[0025] **FIGS. 16A-16D** are schematic side elevational views of different carriage rack storage configurations according to the present invention;

[0026] **FIGS. 17A-1 and 17A-2** are top left and right views, respectively, sharing match line ML-ML, of another high density storage facility according to the present invention;

[0027] **FIGS. 18A-1 and 18A-2** are side elevational left and right views, respectively, sharing match line ML-ML, of the stationary racks of FIGS 17A-1 and 17A-2 aligned with the length of the storage facility;

[0028] **FIG. 19** is an end elevational view of the width and height of the storage facility of FIGS. 17A-1 and 17A-2;

[0029] **FIGS. 20A-1, 20-A-2, 20B, 20C, 20D-1 and 20D-2** are schematic side elevational views of different carriage configurations A, B, C and D of FIGS. 17A-1 and 17A-2;

[0030] **FIG. 21** depicts an exemplary carriage rack, mounted on a wheeled carriage suitable for use with an intermodal container according to exemplary embodiments; and

[0031] **FIG. 22** depicts an exemplary overhead view of fixed racks and carriage racks configured for use with an intermodal container according to exemplary embodiments.

multiple access doors must be provided along the side of an elongated building.

[0006] Container terminals for storing and retrieving intermodal containers exhibit similar problems. Conventional facilities consume large areas of valuable seaport acreage. Because conventional facilities may use numerous aisles and provide wide spaces between intermodal containers, and because such containers are generally randomly placed and widely spaced, many terminal operators have difficulty in controlling the storage, retrieval and delivery of the containers. This often results in time consuming and costly repositioning and searching operations for displaced containers.

[0007] Therefore, a need exists for a high density storage facility which provides ready and efficient access to the space within the facility where items may be stored.

SUMMARY OF THE INVENTION

[0008] An embodiment ~~An object~~ of the present invention is to provide a highly modular and adaptable storage system which increases the storage capacity of a given area.

[0009] In one aspect of the invention, ~~This invention features~~ a high density storage facility is provided. The high density storage facility includes a floor area having a length and a width, ~~including~~ a plurality of rows of independently movable carriage racks, each row having a plurality of the independently movable carriage racks. Each carriage rack has a height, a length and a width, and defines a plurality of tiers, each tier defining at least one storage slot, the slots extending substantially the length of the carriage racks and being substantially open and accessible for inserting and removing objects into and from the width ends of the carriage racks. The carriage racks are disposed within the floor area and are independently movable along the floor in a direction consistent with the width of the floor area. Preferably, the carriage racks are arranged in the rows within the floor area with the lengthwise sides of the carriage racks being arranged substantially parallel to the lengthwise sides of the floor area.

[0010] In some embodiments, the carriages include a mechanism for moving the racks, such as at least one independently controllable motor to drivably move each carriage rack across at least a portion of the width of the floor area. The carriage racks may further be coupled and uncoupled along the width of the enclosed storage area for providing access to the width ends of the racks from the doors. The carriage racks may be connected and disconnected along their lengthwise sides, forming rows which are movable in a widthwise