

APPARATUS FOR STORING GOODS

BACKGROUND OF THE INVENTION

This invention relates to improved apparatus for storing goods, or a storage apparatus that can conveniently receive and store various goods and allow picking out any
5 desired ones out of the stored goods.

Referring to Figures 5 and 6 of the accompanying drawings, these illustrate a known typical storage apparatus comprising a plurality of rows of immovable
10 multi-layer racks B, and C, each having a number of vertically arranged on-storey unit racks A, and a stacker crane D movable between a pair of oppositely arranged racks, or racks B and C for example, horizontally back and forth along the directions indicated by the double-pointed
15 arrow E, vertically up and down along the directions indicated by the double-pointed arrow F and transversally along the direction indicated by the arrow G or H in order to collect the goods stored in a particular rack or load it with given goods. Such storage apparatus is normally
20 housed in a building and is hence called a stacker-rack building system.

Figures 7 and 8 of the accompanying drawings show another known typical storage apparatus called a multiple rotary rack system. It also comprises multi-layer racks I,
25 each of which has a number of vertically arranged one-story unit racks and can rotate horizontally along the paths indicated by the arrows K, K on the floor J of the apparatus until a particular rack arrives and stops at

unloading point L, where the goods stored in the rack are collected, and then it moves further to loading point M, where given goods are put into the rack for storage.

5 The storage apparatus of figures 7 and 8 may be so modified that the rack units N, O, of the rack can rotate independently from each other or the racks of the apparatus may rotate not horizontally but vertically.

10 However, a storage apparatus as shown in Figures 5 and 6 is accompanied by such drawbacks that dead spaces P, Q, need to be provided and it requires a large stacker crane equipped with a drive mechanism and a lift device connected to each other by means of chains that can easily go out of order when any of the chains are irreversibly elongated by external force. Hence, such apparatus
15 requires frequent and time-consuming servicing and maintenance.

20 Apparatus as illustrated in Figures 7 and 8 is disadvantageous in that it consumes enormous power as a heavy multi-layer rack is rotated for operation in addition to the drawbacks described above in referring to the apparatus of Figures 5 and 6.

 Additionally, any of the above described known apparatus comprise a number of movable members and therefore is not suited for use in a dust-free clean room.

25 In view of the above identified problems of conventional storage facilities of the type under consideration, it is therefore an object of the invention to provide storage apparatus that comprises only a reduced

number of movable components and hence is free from dimensional disorders such that it affords easy maintenance and reduced time for the operation of storing and collecting goods without requiring a large space and, at the same time, it can be installed, if appropriate, in a dust-free clean room because its movable components can be sealed without difficulty.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, the above object is achieved by providing apparatus for storing goods comprising, racks arranged vertically and along first and second semicircular lines, the said semicircular lines being symmetrically disposed; and loading/unloading means having an arm, the said loading/unloading means being mounted on a column which is supported at its base and the said loading/unloading means being rotatable around a centre of the semicircular lines, the said arm being movable upwardly and downwardly along the said column, and radially back and forth, the said arm being movable outwardly to a selected one of the racks.

According to a second aspect of the invention, the apparatus may additionally comprise racks arranged vertically and along the first semicircular line to form a first semicircular multi-layer rack-row having ends; racks arranged vertically and along the second semicircular line to form a second semicircular multi-layer rack-row having ends; racks arranged vertically and along straight lines to

form straight multi-layer rack-rows; in which the ends of the first semicircular multi-layer rack row are continued to the ends of the second semicircular multi-layer rack row through the straight multi-layer rack-rows; and the said loading/unloading means is guided to move by rails arranged between a centre of curvature of the first semicircular line and a centre of curvature of the second semicircular line.

According to a third aspect of the invention, racks may be arranged vertically and along the first semicircular line to form a first semicircular multi-layer rack-row having ends; racks may be arranged vertically and along the second semicircular line to form a second semicircular multi-layer rack-row having ends; and the ends of the first semicircular multi-layer rack-row may be adjacent to the ends of the second semicircular multi-layer rack-row.

According to a fourth aspect of the present invention, there is provided apparatus for storing goods comprising racks arranged vertically and along fixed and secured semi-circular lines being symmetrically disposed, and loading/unloading means having an arm, the said loading/unloading means being mounted on a column which is supported at the bottom and at the top and the said loading/unloading means being rotatable around a centre of the semicircular lines, the said arm being movable upwardly and downwardly along the said column, and radially back and forth, the said arm being movable outwardly to a selected

one of the racks.

Since the apparatus embodying the present invention may comprise a pair of oppositely and symmetrically arranged semi-circular immovable multi-layer racks, each having a number of racks, and a loading/unloading means movable along a line connecting the centres of curvature of the semicircular racks, there being a robot having an arm capable of rotating and moving up and down and radially back and forth, passing through a rack, it eliminates any dead space that comparable known storage apparatus has at an end of the rows of racks to increase the number of racks that can be installed within a given space of storage apparatus.

Additionally, since the operation of loading a selected rack of the semicircular rack-rows with goods or collecting the goods stored in it can be carried out simply by rotating and moving up and down and radially back and forth the arm of the loading/unloading robot, the time required for the operation can be significantly reduced.

When straight racks are additionally installed and hence the loading/unloading robot has to be moved along them, the time required for loading/unloading goods can still be reduced because the movement of the arm of rotating and moving up and down and radially back and forth can be combined with the linear movement of the robot itself so that they may take place concurrently.

Since any loading/unloading operation can be carried out only by moving the arm of the robot itself, if

necessary, while the racks remain immovable, the apparatus is free from dimension disorders and hence affords easy maintenance and reduced time for the operation of storing and collecting goods.

5 Since the movable members of the apparatus are those of the loading/unloading robot, they can be hermetically sealed and hence the entire apparatus may be installed in a dust-free clean room.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Figure 1 is a schematic plan view of a first preferred embodiment of the invention.

 Figure 2 is schematic sectional view taken along line X-X in Figure 1.

15 Figure 3 is a schematic plan view of another preferred embodiment of the invention.

 Figure 4 is a schematic sectional view taken along line Y-Y in Figure 3.

20 Figure 5 is a schematic plan view of conventional storage apparatus.

 Figure 6 is a schematic side view of the apparatus of Figure 5.

 Figure 7 is a schematic plan view of further conventional storage apparatus.

25 Figure 8 is a schematic side view of the apparatus of Figure 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figures 1 and 2 illustrate a first preferred embodiment of the invention. A number of racks or pigeon-holes 3 are arranged or disposed vertically and along a semicircular line 1 to form a semicircular multi-layer (or multi-story) rack-row 4. Also, a number of racks 3 are arranged or disposed vertically and along a semicircular line 2 to form a semicircular multi-layer (or multi-story) rack-row 5. The multi-layer rack-rows 4 and 5 are arranged symmetrically. Also, a number of racks 3 are arranged or disposed vertically and along a straight line to form straight multi-layer (or multi-story) rack-rows 10 and 11.

The semicircular multi-layer rack-row 4 has ends 6 and 7. The semicircular multi-layer rack-row 5 has ends 8 and 9. The end 6 of rack-row 4 is continued to the end 8 of rack-row 5 through the straight multi-layer rack-row 10 and the end 9 of the rack-row 5 is continued to the end 7 of the rack-row 4 through the straight multi-layer rack-row 11.

A loading/unloading robot 12 is provided with its vertically axis alignment with a centre O of a curvature of the semicircular line 1 or the semicircular multi-layer rack-row 4. The robot 12 has an arm 13. The robot 12 with the arm 13 can rotate in senses indicated by a double-pointed arrow R. The arm 13 is movable upwardly and downwardly along directions indicated by a double-pointed arrow S, and radially back and forth along directions indicated by arrows T and U. The arm 13 can move outwardly to the rack 3.

Reference number 14 denotes a drive mechanism for rotating the robot 12 with the arm 13 along the direction indicated by the arrow R. Reference numeral 15 denotes a drive mechanism for driving the arm 13 of the robot 12 along the directions indicated by arrows T and U. A drive mechanism for driving the arm 13 upwardly and downwardly along the directions indicated by the arrow S is included in a hollow column housing 16.

In the illustrated embodiment, rails 17, 18 are arranged between the centre O of curvature of the semicircular line 1 and the centre V of curvature of the semicircular line 2. The loading/unloading robot 12 can be moved by a drive mechanism housed in a bottom section 19 of the hollow column 16. The loading/unloading robot 12 can be guided to move along the directions indicated by the double-pointed arrow W and hence along the straight rack-rows 10, 11 by the drive mechanism housed in the bottom section 19.

As seen in Figures 1 and 2, a roll-out conveyer 20 for outgoing goods is arranged at an outside of the rack-row 10 and a roll-in conveyer 21 for incoming goods is also arranged at the outside of the rack-row 10 and located right above the roll-out conveyer 20.

According to the embodiment illustrated in Figures 1 and 2, when the loading/unloading robot 12 is positioned at the centre O or V of the curvature, the robot 12 can access any rack or rack of the rack-row 4 or 5 to pick up the goods stored therein, or can load it with goods

by simply operating the arm, 13 to move along the directions indicated by the double-pointed arrow R and move up and down along the directions indicated by the double-pointed arrow S and radially back and forth along the directions indicated by the arrows T and U.

Thus, while the robot moves toward the roll-out conveyer 20 along the rails 17, 18 the robot can rotate the arm 13 toward the roll-out conveyer 20 so as to reduce the operation time significantly. Also, while the robot moves toward the roll-out conveyer 20 along the rails 17, 18, the arm 13 can move upwardly and downwardly so as to reduce the operation time significantly. In other words, the rotation of the arm 13 occurs simultaneously with the movement of the robot along the rails 17, 18 and the upward and downward movement of the arm 13 occurs concurrently with the movement of the robot along the rails 17, 18.

After delivering the goods to the roll-out conveyer 20, the robot 12 collects or picks up the goods on the roll-in conveyer 21. When the robot 12 moves along the rails 17, 18 toward one of racks 3, the arm 13 is rotated and moved upwardly and downwardly concurrently to store the goods in the rack 3.

Figures 3 and 4 show a second preferred embodiment of the invention. A number of racks or pigeon-holes 24 are arranged or disposed vertically and along a semicircular line 22 to form a semicircular multi-layer (or multi-storey) rack-row 25. Also, a number of racks 24 are arranged or disposed vertically and along a semicircular

line 23 to form a semicircular multi-layer (or multi-storey) rack-row 26. The multi-layer rack-rows 25 and 26 are arranged symmetrically. The semicircular multi-layer rack-row 25 has ends 27 and 28. The semicircular multi-layer rack-row 26 has ends 29 and 30. The end 27 of the rack-row 25 is adjacent to the end 29 of the rack-row 26 and the end 30 of the rack-row 26 is adjacent to the end 28 of the rack-row 25 to form a circular multi-layer (or multi-storey) rack-row.

A loading/unloading robot 31 is provided with its vertical axis aligned with the centre O of curvatures of the semicircular lines 22 and 23 or the semi-circular multi-layer racks 25 and 26. The robot 31 has an arm 32 as in the case of the first embodiment of Figures 1 and 2. The robot 31 with the arm 32 can rotate in the senses indicated by a double-pointed arrow R. The arm 32 is movable upwardly and downwardly along the direction indicated by the double-pointed arrow S, and radially back and forth along the directions indicated by the arrows T and U. The arm 32 can move outwardly to the rack 24.

A roll-out conveyer 33 for outgoing goods is arranged at the outside of the rack-rows 25, 26. A roll-in conveyer 34 for incoming goods is also arranged at the outside of the rack-rows 25, 26 and located right above the roll-out conveyer 33.

According to the above described second embodiment, since the racks 24 are arranged in the shape of a cylinder (in other words, without straight rack-rows), a

large number of racks can be provided in a relatively narrow space. Goods can be picked up from or stored in any selected rack simply by rotating and moving up and down the arm 32 of the stationary loading/unloading robot 31 located at the centre of curvature of the circular racks 24 of the semicircular rack-rows 25, 26, so that any loading/unloading operation of the goods can be conducted quickly. Thus, the loading/unloading robot 31 can be hermetically sealed so that the entire apparatus may be installed in a dust-free clean room.

ADVANTAGES OF THE INVENTION

As described above in detail, since storage apparatus embodying the invention may comprise a pair of oppositely and symmetrically arranged semicircular immovable multi-layer racks, each having a number of racks, and a loading/unloading robot movable along a line connecting the centres of curvature of the semicircular racks, it can eliminate any dead space that comparable known storage apparatus has at an end of the rows of racks to increase the number of racks that can be installed within a given space of a storage apparatus or, if the number of racks is given, the entire space required for installing the apparatus can be reduced.

Additionally, since the operation of loading a selected rack of the semicircular racks with goods or collecting the goods stored in it can be carried out simply by rotating and moving up and down and radially back and

forth the arm of the loading/unloading robot and concurrently moving the robot itself, if necessary, the time required for the operation can be significantly reduced.

5 Since any loading/unloading operation can be carried out only by moving the arm of the robot and the robot itself, if necessary, while the racks remain immovable, the entire apparatus is free from dimensional disorders and hence affords easy servicing and maintenance.

10 Since the movable members of the apparatus are those of the loading/unloading robot, they can be hermetically sealed. If the loading/unloading robot is stationary, it can be easily sealed and hence the entire apparatus may be installed in a dust-free clean room.

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CLAIMS

1. Apparatus for storing goods comprising racks arranged vertically and along first and second semicircular lines being symmetrically disposed, and loading/unloading means having an arm, the said loading/unloading means being mounted on a column which is supported at its base and the said loading/unloading means being rotatable around a centre of the semicircular lines, the said arm being movable upwardly and downwardly along the said column, and radially back and forth, the said arm being movable outwardly to a selected one of the racks.
2. Apparatus according to claim 1, in which racks are arranged vertically and along the first semicircular line to form a first semicircular multi-layer rack-row having ends, racks are arranged vertically and along the second semicircular line to form a second semicircular multi-layer rack-row having ends, racks are arranged vertically and along straight lines to form straight multi-layer rack-rows, the ends of the first semicircular multi-layer rack-row are continued to the ends of the second semicircular multi-layer rack-row through the straight multi-layer rack-rows, and the said loading/unloading means is guided to move by rails arranged between a centre of curvature of the first semicircular line and a centre of curvature of the second semicircular line.
3. Apparatus according to claim 1, wherein racks are arranged vertically and along the first semicircular line



to form a first semicircular multi-layer rack-row having ends, racks are arranged vertically and along the second semicircular line to form a second semicircular multi-layer rack-row having ends, and the ends of the first semicircular multi-layer rack-row are adjacent to the ends of the second semicircular multi-layer rack-row.

4. Apparatus for storing goods, substantially as described herein with reference to and as illustrated in Figures 1 and 2, or Figures 3 and 4 of the accompanying drawings.

5. Apparatus for storing goods comprising racks arranged vertically and along fixed and secured semicircular lines being symmetrically disposed, and loading/unloading means having an arm, the said loading/unloading means being mounted on a column which is supported at the bottom and at the top and the said loading/unloading means being rotatable around a centre of the semicircular lines, the said arm being movable upwardly and downwardly along the said column, and radially back and forth, the said arm being movable outwardly to a selected one of the racks.

6. Apparatus according to claim 5 and also according to claim 2 or claim 3.



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