

Transport and handover system for storing and removing or relocating storage goods in high-bay warehouses, and storage and retrieval machine

The invention relates to a transport and transfer system for storing and retrieving or relocating storage items in high-bay warehouses, particularly in a transshipment facility of a seaport or an inland port for storage of standard containers, wherein the high-bay warehouse consists of a plurality of storage modules which are arranged in rows in longitudinal direction and in width direction transversely thereto of the high-bay warehouse and in height have a plurality of rack bays disposed one above the other and which are separated from one another by lanes extending parallel to the storing and retrieving sides of the rack bays or of the storage modules, wherein at least one storage and retrieval apparatus, which is movable back and forth, for transporting as well as storing and retrieving or relocating the storage items is provided in each lane.

An integrated, fully automatic container transport system of the kind stated in the introduction with storage and retrieval apparatus arranged in each lane is known from WO 2015/124342 A1 for a transshipment facility of a seaport or an inland port.

The storage and retrieval apparatus, which in its dimensions is of narrow construction and which stores and retrieves the containers with the longitudinal sides thereof foremost in the rack bays, is movable in floor-bound manner in longitudinal direction of the lanes. The raising and lowering of the hoist platform, which is provided with load receiving means, of the storage and retrieval apparatus is carried out by way of a cable traction device or a hoist, comprising a cable, cable drums, deflecting rollers, motors and transmissions. Provided at the hoist platform for suspended transport of the containers are load receiving means which are constructed in particularly space-saving manner as telescopic forks or tables for gradual horizontal movement in and out together with a suspended container.

For transfer of the containers transported to the delivery side - this is usually the side of the high-bay warehouse facing the vessel - and to be transported away at the other end of the warehouse it is necessary to provide in front of and behind each lane appropriate preparation stations from which the storage and retrieval apparatus takes over the containers for storage or in which the containers can be deposited for retrieval. That is equally so in the case of high-bay warehouses for storage and retrieval of, for example, strips wound to form bundles (coils), particularly rolled metal strips, wherein the coils are

taken over from shelves and deposited on shelves or substructures in the rack bays.

In the case of a container terminal known from DE 44 9 740 C1 high transshipment rates, such as have to be guaranteed by, for example, use of several loading or container bridges at a vessel are achieved by a fully automated container transport system, which is integrated in a container transshipment facility, in conjunction with loading cranes. For that purpose, track levels, which are connected together by a plurality of supports and are offset in height, with loading and unloading positions are arranged on a step-shaped support construction offset in height, wherein each level has a track network with a plurality of transport pallets operated by linear motor and movable thereon. Apart from the fact that a large number of transport pallets specially constructed with linear motor drives as contactless drive means is needed, a substantial outlay on steel construction is unavoidable with the track network, because each level has several interconnected tracks for movement of the transport pallets on a track network to loading and/or unloading and/or junction positions. The different or individual levels interconnected by supports are predetermined by a step-shaped support construction offset in height.

A very large outlay, as described above, additionally with substantial steel structures is also required in high-bay warehouses with elevated rail tracks when the transfer stations on the uppermost storeys of the high-bay warehouse are integrated into the steel structure and storage cranes, which are compartmented by roof attachments and which extend over the lanes to serve all successive multi-storey storage modules, take over distribution of the supplied containers to the storage and retrieval apparatus.

The invention has the object of creating a transport and transfer system according to category, which enables further accelerated transshipment of storage items such as flat containers, coils and, in particular, standard containers (20 TEU and 40 FEU containers) or otherwise for take-over, by suspension, of suitable storage items, with reduced outlay and fewer steel structures.

According to the invention this object is fulfilled in that the high-bay warehouse is constructed with at least one transverse conveying device which crosses at least some lanes and which conveys the supplied storage items into and/or out of the high-bay warehouse.

Starting from the assumption that the lanes run parallel to the long sides, i.e. the longitudinal sides of the high-bay warehouse, the transverse conveying device extends or several transverse conveying devices - which can be provided in distribution at a spacing from one another at the longitudinal sides - extend over the entire width of the high-bay warehouse and advantageously end outside the high-bay warehouse near the longitudinal sides thereof. The transverse conveying device can consist of, for example, roller-path rollers of which at least some are driven and on which standard containers deposited in pallets, containers directly deposited thereon or coils deposited on shelves run out and can be positioned for further handling. The storage items which have been conveyed in can then be taken over by the storage and retrieval apparatus and stored in the rack bays or, by reverse movement sequences, retrieved. The sequence of storage and retrieval can be substantially shortened in time because the storage and retrieval apparatus no longer has to cover large travel paths, since the transverse conveying devices crossing either all lanes or - in the case of a divided construction of the transverse conveying device - at least some, for example two or three, lanes take over provision or distribution - which is selective in the high-bay warehouse - of the taken-over storage items supplied from outside the high-bay warehouse and the conveying in and out thereof. The transverse conveying device according to the invention, which optionally can be provided from a plurality of sections arranged to be horizontally offset relative to one another and crossing the high-bay warehouse, makes it possible in every case for storage items supplied below the travel plane or travel rail plane of the storage and retrieval apparatus to be handled in variable manner in the high-bay warehouse during both storage and retrieval.

A preferred embodiment of the invention provides that the transverse conveying device is constructed in a pit of the warehouse foundation. The underpasses for the transverse conveying devices can be provided in simple manner directly at the time of the foundation work, which facilitates production.

If a return path for return transport of empty pallets, conveying carriages or substructures is advantageously provided below the transverse conveying device in the pit of the warehouse foundation, in which case the return path combined with the transverse conveying device can similarly have, for example, roller-path rollers or like conveyors, it is possible to achieve closed-circuit use of the means receiving the storage items.

According to another, slightly modified embodiment of the invention the transverse

conveying device can be constructed on the warehouse foundation of the lowermost rack bay level of at least one row of successive storage modules. In this case, the transverse conveying device is constructed on the existing foundation of the lowermost rack bays, which makes retrofitting of an existing high-bay warehouse with a transverse conveyor possible in simple manner. The storage items are in that case conveyed in and out from the longitudinal side of the high-bay warehouse. In order to utilise full storage capacity, after occupation of all other rack bays the rack bays of the lowermost rack bay level can still be used.

In addition, in this variant according to an advantageous proposal of the invention a return path for return transport of empty pallets, carrier shelves or conveying carriages in closed circuit is provided below the transverse conveying device in the warehouse foundation.

The return path can optionally be provided to extend parallel to the transverse conveying device, i.e. on the warehouse foundation of the adjacent lowermost rack bay level or on the floor of the pit of the foundation. Whereas in the case of a return path which is deeper by comparison with the transverse conveying device the transport flow takes place in two height levels - in which case the height difference for raising or lowering the storage items or the pallets, conveying carriages or the like can be overcome by, for example, lifting tables - in the case of an arrangement, which runs in parallel adjacent manner in one height level, of the transverse conveying device and return path the transfer of empty pallets, conveying carriages or the like to the return path can be taken over by linear displacing means, for example cylinders.

It is proposed to make use of, for preference, storage and retrieval apparatus which comprises a frame, which consists of vertical posts and head crossbars and foot beams interconnecting these and which corresponds with the height of the multi-storey storage modules, with a hoist platform, which is moved at the vertical posts by way of drive means and which is constructed for servicing of the rack bays of the adjacent storage modules on the lefthand side and righthand side by load receiving means insertable and withdrawable orthogonally to the lane, as known per se, wherein in accordance with the invention the foot beam is of frame-like construction with a passage opening for the storage items to be lifted through. The passage opening, which is matched to the largest occurring dimension of the storage items, enables free passage of the storage items during lifting from or lowering onto the transverse conveying device arranged in the foundation pit. The same

applies in the case of use of the lowermost rack bay level for the transverse conveying device. According to the invention, in that case the storage and retrieval apparatus is movable on two rails arranged in the lanes at a horizontal spacing from and parallel to one another above the lowermost rack bay level, i.e. in the transition from the lowermost rack bay level to the rack bay level following thereabove. Such storage and retrieval apparatus having in the foot beam a passage opening for lifting through the storage items in addition enables handling of storage items provided in the lanes below the level of the travel rails.

Handling of the storage items below the travel plane of the storage retrieval apparatus is advantageously facilitated if the vertical posts of the frames are extended downwardly beyond the foot beam and protrude somewhat into the lowermost rack bay level. This thus offers a possibility for centred guidance of the lowering or rising hoist platform of the storage and retrieval apparatus by way of this downwardly prolonged path, for example by means of rollers supported on the frame extensions.

Further features and details of the invention are evident from the claims and the following description of embodiments of the invention schematically illustrated in the drawings for the transshipment of standard containers, wherein:

Figure 1 shows, as a part view of a container transshipment facility in a cross-section, a transfer station, which is upstream of a high-bay warehouse, for taking over containers supplied from a vessel (not illustrated) and conveying them to in front of the high-bay warehouse for storage by means of storage and retrieval apparatus movable in the lanes thereof on elevated rails therein or for transport away in the case of retrieval with then reverse movement sequences, wherein the high-bay warehouse has in linear alignment with the transfer station a transverse conveying device constructed in the lowermost rack bay level and a return path recessed or disposed deeper in the warehouse foundation;

Figure 2 shows, as a detail of a container transshipment facility, a high-bay warehouse in a cross-section, wherein in an association differing from Figure 1 the transfer stations (not illustrated here) are upstream of the openings of the lanes and the transverse conveying devices inclusive of return paths are provided in pits of the warehouse foundation and (not illustrated) outside the

high-bay warehouse near the longitudinal sides thereof;

- Figure 3 shows, as a detail of Figure 2, a part longitudinal view of a lane with storage and retrieval apparatus movable therein on the foundation;
- Figure 4 shows, as an overall view, storage and retrieval apparatus as seen from the longitudinal side facing the storage modules or rack bays;
- Figure 5 shows, as a detail of the storage and retrieval apparatus of Figure 4, substantially the foot beam or travel frame with the hoist platform lowered together with a suspended container to above a lowermost rack bay level or a transverse conveying device arranged in a pit of the foundation (cf. Figure 2); and
- Figure 6 shows a plan view of Figure 5.

At least one transfer station 4 for unloading containers 1 from a vessel and storage in a high-bay warehouse 2 or, conversely, retrieval and loading of a vessel or a vehicle for onward transportation is, according to Figure 1, provided in front of the high-bay warehouse 2 at the side facing the quay 3. This comprises in linear succession in feed direction (arrow) 5 on the quay from outside towards the high-bay warehouse 2 a take-over carriage 6, a distributor vehicle 7 movable out of the line parallel to the high-bay warehouse 2, a stationary deposit 8 and a lifting table 9. The transfer station 4 adjoins, in a line, a transverse conveying device 13 crossing all of the lanes 11 running in the high-bay warehouse 2 between storage modules 10, which follow one another at a mutual spacing over the width, with rack bays 12 provided therein over the entire height and parallel to the longitudinal sides of the high-bay warehouse. The transverse conveying device 13 is arranged in the lowermost rack bay level 14 on the warehouse foundation 15. A return path 16 is constructed in the warehouse foundation 15 below the transverse conveying device.

The transfer station 4 is provided in a two-level construction, i.e. the take-over carriage 6, the distributor vehicle 7, the stationary deposit 8 and the lifting table 9 have an upper level I and a lower level II, wherein the lifting table 9 serves the purpose of overcoming height differences between, on the one hand, the upper level I of the transfer station 4 as well as

the transverse conveying device 13 and, on the other hand, the lower level II as well as the return path 16, and of guaranteeing the respective linear path. This is because the container 1 lifted off a vessel by load receiving means 17 of a loading bridge (not illustrated) - optionally two containers 1 can be directly lifted off simultaneously by the load receiving means 17 and delivered to the take-over carriage 6 - is deposited, with its longitudinal side facing in feed direction 5, on the upper level I of the take-over carriage 6 on a pallet 18 provided thereat, transferred to the uppermost level I of the distributor vehicle 7 and transported through movement of the distributor vehicle 7 parallel to the high-bay warehouse 2 until in front of a free stationary deposit 8 of one of the plurality of transfer stations 4 and conveyed from this to the uppermost level I of the lifting table 9.

The lifting table 9 lowers the pallet 18 together with the container 1 until in a position aligned with the transverse conveying device 13, which then positions the previously taken-over pallet 18 together with the container 1 in one of the lanes 11 for take-over by storage and retrieval apparatus 19 arranged in each lane 11. The pallets 18 free after taking over of the containers 1 by the storage and retrieval apparatus 19 are lowered at the end of the transverse conveying device 13 by lifting means onto the return path 16, which is arranged to be recessed in the warehouse foundation 15 and is deeper and which similarly can have, for example, roller-path rollers or the like, and transported oppositely to the feed direction 5 until initially on the lifting table 9, which is adjusted with its lower level II in alignment with the return path 13, of the transfer station 4. The lifting table 9 is thereafter raised until its lower level II is in alignment with the lower levels II of the stationary deposit 8, the distributor vehicle 7 and the take-over carriage 6, so that the pallets 18 are returned by the conveying means of the aforesaid transfer station units to their starting position for reuse. For that purpose, the take-over carriage 6 is similarly equipped with lifting means which lift the pallets 18 from the lower level II to the upper level I.

The storage and retrieval apparatus 19 looks after storage and retrieval or rearranging of the containers 1 into or from the rack bays 12 of the storage modules 10 and, in the embodiment according to Figure 1, is movable on two rails 20 arranged at a horizontal spacing from one another in the lanes 11 between the lowermost (first) rack bay level 14 and the (second) rack bay level following above that. For storing, a container 1 positioned in a lane 11 is lifted off its pallet 18, for which purpose a hoist platform 21 (cf. Fig. 4) - which as known from WO 2015/123342 A1 can comprise at least two gradual telescopic

load receiving means 22, wherein these for adaptation to different lengths of the containers 1 can be movable towards one another or away from one another - is lowered until the telescopic load receiving means 22 arrives above the suspension points of the container 1 by its locking means for locking. The locked and suspended container 1 can thereafter be brought, by raising the hoist platform 21 and moving the storage and retrieval apparatus 19, in front of any rack bay 12 of the adjacent storage modules 10 and be stored in the desired rack bay 12 by gradual telescoping of the load receiving means 22 (telescopic forks or telescopic table). Retrieval takes place with reversed movement sequences.

The free passage of the containers 1, which are taken over from the lowermost rack bay level 14, during storage in the rack bay levels following thereabove, as illustrated in Figure 6, is made possible by a frame-like construction of the foot beam 23 of the storage and retrieval apparatus 19 with a passage opening 24.

The storage and retrieval apparatus 19 enabling space-saving lanes 11 which are very narrow due to the telescopic load receiving means 22 and which correspond with the width dimension of the containers, has - as apparent particularly from Figure 4 showing the hoist platform 21 with a suspended container 1 in the uppermost position and in a downwardly lowered position (cf. Figure 5) - a frame 27, which consists of vertical posts 25 and a head crossbar 26 interconnecting these as well as the connecting foot beam 23 constructed with the passage opening 24 for the containers 1 or storage items and which corresponds with the height of the multi-storey storage modules 10. The raising and lowering of the hoist platform 21 is carried out by way of hoists 28 provided at the foot beam 23 and cables 29 deflected at the head crossbar 26 by way of rollers. In the case of use in, in particular, a construction of the transverse conveying device 13 according to Figure 1, the vertical posts 25 are provided with an extension 30 projecting over a short travel path downwardly beyond the foot beam 23 (cf. Figure 4).

In the transshipment facility of Figures 2 and 3, the transverse conveying devices 113 and the return paths 116 combined therewith and deeper are provided so as to be completely recessed in pits 31, which cross under the high-bay warehouse 2, of the warehouse foundation. The storage and retrieval apparatus 19 can thus be at ground level, i.e. be moved directly on the warehouse foundation 15 (cf. Figure 3). The above-described transfer stations 4 are here provided at the quay side in a position aligned with the lanes

11. The containers 1 fed by the load receiving means 17 of the loading bridges from the vessel are again deposited on take-over carriages 6 in pallets 18, transferred to the distributor vehicle 7 and transferred from this to the stationary deposits 8. If the containers 1 are fed by the load receiving means 17 of the loading bridges so as to face not by the narrow ends thereof, but by the wide sides thereof in the direction of the lanes, a rotary table orienting the containers 1 can be provided upstream of the stationary deposits 8 in the transfer station. The containers 1 provided to be positioned in this way in front of the lanes are taken over from there by the storage and retrieval apparatus 19 for storage in the rack bays 12 of the storage modules 10 and the empty pallets 19 are lowered by the lifting table 9 for return to the lower level II.

The retrieval of the containers 1 after lowering thereof through the passage opening 24 of the foot beam 23 of the storage and retrieval apparatus 19 into the pit 31 is carried out by way of the transverse conveying device 113 and the return transport of the empty pallets 18 by way of the return path 116, wherein the transverse conveying devices 113 and the return paths 116 end outside the high-bay warehouse 1 near the longitudinal-side outer walls thereof and lifting tables for the containers 1 and on the other hand the empty pallets 18 are provided there. The lifted containers 1 can be taken over by cranes for loading of, for example, a truck or a vessel. The lowered empty pallets 18 are transported by the return path 116 or the conveying means thereof for lifting to the higher level of the transverse conveying device 113 and positioned by these for reloading with a container 1, which is to be retrieved, below a lane.

Reference numeral list

1	container / storage items
2	high-bay warehouse
3	quay
4	transfer station
5	feed direction (arrow)
6	take-over carriage
7	distributor vehicle
8	stationary deposit
9	lifting table
10	storage module
11	lane
12	rack bay
13; 113	transverse conveying device
14	lowermost rack bay level
15	warehouse foundation
16; 116	return path
17	load receiving means (of the loading bridge)
18	pallet
19	storage and retrieval apparatus
20	rails of the storage and retrieval apparatus
21	hoist platform
22	load receiving means
23	foot beam / travel frame
24	passage opening
25	vertical posts
26	head crossbar
27	frame
28	hoist
29	cable
30	extension (of the vertical posts)
31	pit
I	upper level
II	lower level

Patent claims

1. Transport and transfer system for storing and retrieving or relocating storage items (1) in high-bay warehouses (2), particularly in a transshipment facility of a seaport or an inland port for storage of standard containers, wherein the high-bay warehouse (2) consists of a plurality of storage modules (10) which are arranged in rows in longitudinal direction and in width direction transversely thereto of the high-bay warehouse (2) and in height have a plurality of rack bays (12) disposed one above the other and which are separated from one another by lanes (11) extending parallel to the storing and retrieving sides of the rack bays (12) or of the storage modules (10), wherein at least one storage and retrieval apparatus (19), which is movable back and forth, for transporting as well as storing and retrieving or relocating the storage items (1) is provided in each lane, characterised in that the high-bay warehouse (1) is constructed with at least one transverse conveying device (13; 113) which crosses at least some lanes (11) and which conveys the supplied storage items (1) into and/or out of the high-bay warehouse (2).
2. Transport and transfer system according to claim 1, characterised in that the transverse conveying device (113) is constructed in a pit (31) of the warehouse foundation (15).
3. Transport and transfer system according to claim 1, characterised in that the transverse conveying device (13) is constructed on the warehouse foundation (15) of the lowermost rack bay level (14) of at least one row of successive storage modules (10).
4. Transport and transfer system according to claim 3, characterised by a return path (16), which is provided below the transverse conveying device (13) in the warehouse foundation (5), for return transport of full or empty pallets (18) or conveying carriages.
5. Transport and transfer system according to claim 2, characterised in that a return path (116) for return transport of empty pallets (18) or conveying carriages is constructed in the pit (31) below the transverse conveying device (113).
6. Transport and transfer system according to claim 2, characterised in that the transverse conveying device (113) is provided on the floor of the pit (31) to extend parallel to a return path for empty pallets (18) or conveying carriages.

7. Transport and transfer system according to claim 1, characterised in that the storage and retrieval apparatus (19) comprises a frame (27), which consists of vertical posts (25) and head crossbars (26) and foot beams (23) connecting the posts together and which corresponds with at least the height of the multi-storey storage modules (10), with a hoist platform (21), which is moved at the vertical posts (25) by way of drive means and which is constructed for servicing the rack bays (12) or adjacent storage modules (10) on the lefthand side and righthand side by load receiving means (22) insertable and withdrawable orthogonally to the lane (11), wherein the foot beam (23) is of frame-like construction with a passage opening (24) for storage items (1) to be lifted through.

8. Transport and transfer system according to one or more of claims 3, 4 and 7, characterised in that the storage and retrieval apparatus (19) is movable on two rails (20) arranged in the lanes (11) at a horizontal spacing from and parallel to one another above the lowermost rack bay level (14).

9. Transport and transfer system according to claim 8, characterised in that the vertical posts (25) of the frames (27) of the storage and retrieval apparatus (19) are extended downwardly beyond the foot beam (23).