and the parcel, carton or other container may be shipped directly to a customer

[004] A more sophisticated system than the prior art systems described above is disclosed in U.S. Patent No. 11,607,713, a patent commonly owned by OPEX Corporation, assignee of the present invention and issued to McVaugh et al. on March 21, 2023. McVaugh et al disclose sortation of items by vehicles movable within in an aisle disposed between rows and/or columns of sort bins. Items are delivered by the vehicles, in seriatim, in their order of arrival at an input station. In an embodiment disclosed by McVaugh et al., the delivery system is implemented as a plurality of independently movable vehicles, and an indication is provided to alert attending personnel to events such as the readiness of a sort bin to be transferred to a container that is displaceable to another destination.

[005] Though the McVaugh et al. system represented a major advance in the art, the inventors herein have observed that a substantial amount of manual operation is still required once items have been sorted into the array of sort bins, with the potential for damage to the sorted items during the requisite handling. With continuing pressure to increase processing speeds and reduce manual operations required in a sorting system, it is desirable to reduce the manual processing needed to handle orders after the items have been sorted.

SUMMARY

[006] The Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[007] In accordance with embodiments of the present disclosure, the disadvantages and problems associated with conventional warehouse automation approaches to the sortation of inventory items into groups, and subsequent operations relating to the groups of sorted items, have been substantially reduced or eliminated by a sortation system configurable to perform a variety of tasks relevant to an inventory management, distribution center, and/or order fulfilment operation.

[008] The present invention provides a number of aspects that may form part

of a material handling system. The system may include one or more of a number of aspects as further described below.

[008a] In an aspect, the present disclosure refers to an item sorting apparatus including an input station for acquiring information used to identify destinations applicable to items to be sorted, a plurality of sort bins, and a rack defining an aisle and configured to support the plurality of sort bins at spatially separated locations along at least a first or second side of the aisle, characterized by:

a plurality of discharge stations proximate the aisle;

a delivery mechanism operable within the aisle for delivering items to the sort bins to thereby accumulate groups of items applicable to an order;

a retrieval mechanism operable within the aisle and configured to move with the aisle, to retrieve respective sort bins containing sorted items, to transport the respective sort bins within the aisle to one or more locations adjacent the discharge station, and to discharge items from at least one of the transported sort bins into a container displaced from the aisle; and

an outfeed conveyor for moving the container away from the aisle.

[008b] In an aspect, the present disclosure refers to a method of sorting items into groups, comprising:

loading, at a loading station, a plurality of items one at a time onto a delivery mechanism movable within an aisle;

operating the delivery mechanism within the aisle to deliver items to respective sort bins of a plurality of sort bins disposed along the aisle, the operating including

transporting each loaded item along a vertical loop within the aisle, the vertical loop encompassing the loading location and a respective destination adjacent one of the sort bins, and

operating transfer mechanisms of the delivery mechanism to respectively deposit items into the sort bins to accumulate groups of items in the sort bins;

determining that a group of items assigned to a sort bin have been accumulated in a first sort bin; and

retrieving the first sort bin, the retrieving including

moving a retrieval mechanism within the aisle to a position proximate the first sort bin;

displacing the first sort bin and the accumulated items into the aisle while retaining the first sort bin;

transporting the first sort bin within the aisle to a first discharge station;

discharging the accumulated items from the first sort bin at the first discharge station into a first container that is spaced apart from the aisle;

displacing the first container in a direction parallel to the aisle;

at a second discharge station, receiving accumulated items from a second sort bin retrieved by the sort mechanism into the first container; and

transporting the first container away from the second discharge station.

[009] According to one example, an apparatus for sorting a plurality of items is provided. In one example, the apparatus includes a plurality of sort bins, each sort bin defining an interior volume and having an inlet opening; a rack that is configured to retain each sort bin at a respective location spatially separated from other locations. The sort bins retained by the rack are organized into rows and/or columns and maintained in a configuration and orientation enabling the accumulation of items in each sort bin. The sort bins are arranged along one or both sides of an aisle within which is movable (1) an item sortation system, which accepts items arriving at an input station of the apparatus, transports the items within the aisle, and operates a first transfer mechanism to delivery items one at a time to one or more of the sort bins and (2) a sort bin retrieval mechanism operative to retrieve sort bins containing accumulated items of a groups and transport the sort bins to a transfer location disposed within the aisle and proximate a discharge station of the apparatus.

[010] In according to one example, the sort bin retrieval mechanism extends a second transfer mechanism at the transfer location to initiate, at a discharge station, the discharge of accumulated items of a group out of a sort bin into a container that is displaced from the aisle. Alternatively, or in addition, the sort bin retrieval mechanism extends a second transfer mechanism to displace, away from the aisle, a sort bins together with the accumulated items of a group contained therein. In such an embodiment, the exiting sort bin is replaced by an empty sort bin.

[011] According to an example, the sortation system movable within the aisle comprises a plurality of independently movable vehicles that are respectively movable along path segments of a vertical loop extending within the aisle. Each of at least a first group of the independently movable vehicles are movable along a corresponding item delivery path that encompasses an input station, where items are transferred onto a vehicle of the plurality of vehicles, and a delivery location adjacent to a sort bin retaining location of the rack. Each item delivery path may comprise contiguous horizontal and/or vertical segments of a vertical loop within the

aisle.

[012] In addition, or alternatively, each of at least a second group of the independently movable vehicles are respectively movable along segments of a vertical loop extending within the aisle. Each of at least a second group of the independently movable vehicles are movable along path segments of a corresponding sort bin retrieval path that encompasses a position within the aisle from which sort bins are extracted onto a vehicle, and position with the aisle from where sort bins are transferred from the vehicle and away from the aisle into a sort bin discharge station, which may be a zone for emptying accumulated items into a container displaced from the aisle. The sort bin retrieval path may comprise contiguous horizontal and/or vertical segments of a vertical loop within the aisle.

[013] According to another example, the discharge station defines one or more discharge zone(s) dimensioned and arranged to receive a sort bin of the plurality of sort bins following accumulation of items therein, wherein vehicles of at least a second group of the plurality of vehicles are movable along a horizontal and/or a vertical segment of a sort bin retrieval path extending from a retrieval location adjacent to a sort bin retaining location of the rack structure to a location adjacent to the at least one discharge zone of the discharge station.

[014] According to one example, an apparatus for sorting a plurality of items is provided. The apparatus includes a plurality of sort bins and a rack defining an aisle and configured to support the plurality of sort bins at spatially separated locations along at least a first or second side of the aisle. The apparatus further includes a delivery mechanism operable within the aisle for delivering items to the sort bins and a retrieval mechanism operable within the aisle for retrieving the sort bins after items are sorted into the sort bins.

[015] According to one example, a first group of sort bins of the apparatus is supported by the rack along a first side of the aisle, and a second group of sort bins is located along a second side of the aisle, the retrieval mechanism being operable to move the sort bins into the aisle from storage locations within the rack. According to another example, the retrieval mechanism is moveable within the aisle in a vertical and/or horizontal direction.

[016] In some examples, the delivery mechanism and/or the retrieval mechanism are realized by a plurality of independently operable vehicles. All or a subset of the vehicles may perform a delivery function, and all or a subset of the vehicles may perform a retrieval function. In an example, vehicles performing the delivery (delivery vehicles) function include a transfer mechanism operable in a first direction to transfer items from the delivery vehicles into one of the sort bins along the first side of the aisle and is operable in a second direction to transfer items from the delivery vehicle into one of the sort bins along the second side of the aisle. The delivery vehicles may be controlled within the aisle to move along segments of a vertical loop that encompasses an input station where items are received from outside the aisle and one or more of the sort bins,

[017] According to one example in which the delivery mechanism and/or the retrieval mechanism comprises vehicles, each vehicle comprises an energy storage device for providing power for operation of the vehicle and wherein a charging element is provided within the aisle for charging the vehicles as the vehicles move within the aisle.

[018] According to any of the foregoing examples which utilize vehicles as the delivery and/or retrieval mechanism, the apparatus may include a track for guiding the vehicles to the sort bins. In some such examples, both the retrieval mechanism and the delivery mechanism is realized as a plurality of vehicles movable within an aisle disposed between first and second groups of sort bins, and each vehicle incorporates either or both of a first transfer mechanism operable to discharge items into the sort bins outside of the aisle and a second transfer mechanism extendable in a first direction to retain and retract a sort bin from its support location along the rack into the aisle for movement within the aisle. In such examples, the second transfer mechanism is further configured to extend out of the aisle into a discharge position.

[019] According to another example, the apparatus comprises one or more discharge stations configured to receive one of the sort bins after items have been sorted to the sort bin. In one example, the sort bins include a movable wall and the discharge stations are configured to facilitate movement of the