

CROSS-BELT SORTING MACHINE AND CROSS-BELT SORTING SYSTEM BASED ON THREE-DIMENSIONAL TRACK

TECHNICAL FIELD

[0001] The present application relates to the technical field of cross-belt sorting machines, and in particular to a cross-belt sorting machine and a cross-belt sorting system based on a three-dimensional track.

BACKGROUND

[0002] In the logistics field, cross-belt sorting machines can be used to sort parcels, bins, or the like.

SUMMARY

[0003] Embodiments of the present application provide a cross-belt sorting machine and a cross-belt sorting system based on a three-dimensional track. By vertically arranging a pair of track units and using deflection wheels to guide track sections of the track units into at least two layers of reciprocating track sections, unloading chutes can be arranged beside the reciprocating track sections that are arranged in multiple layers in a height direction. This allows more unloading chutes to be arranged for the same footprint, thereby improving sorting efficiency and space utilization.

[0004] In a first aspect, embodiments of the present application provide a cross-belt sorting machine based on a three-dimensional track, including: a pair of track units arranged in parallel to each other in a vertical direction and arranged symmetrically with each other, each of the track units being configured in an end-to-end closed-loop in a respective vertical plane; a plurality of deflection wheels, each of which has a rotation shaft extending in a first horizontal direction, the plurality of deflection wheels being rotatably mounted at turning portions of the pair of track units in the respective vertical planes, so that the plurality of deflection wheels support the pair of track units and guide a direction of extension of the pair of track units, and at least one of the plurality of deflection wheels being a drive wheel for driving the pair of track units to circulate in the respective vertical planes; and a sorting carriage horizontally bridging the pair of track units, two sides of the sorting carriage in a width direction being respectively fixedly mounted to the pair of track units, so that the sorting carriage circulates with the pair of track units, where track sections of the pair of track units extending in the vertical direction are sequentially guided by the plurality of deflection wheels in a left-right alternating manner

in a second horizontal direction to form at least two layers of reciprocating track sections, the reciprocating track sections extending in the second horizontal direction; where a loading station is arranged beside an end of the reciprocating track sections on one side or both sides, and a plurality of unloading chutes are arranged beside the reciprocating track sections on one side or both sides; and where the sorting carriage and the loading station are communicatively connected to a sorting control device, such that: when the sorting carriage circulates with the pair of track units to the loading station, a parcel on the loading station is transferred to the sorting carriage; and when the sorting carriage circulates with the pair of track units to a designated one of the unloading chutes, the parcel on the sorting carriage is transferred to the designated unloading chute.

[0005] In an embodiment, preferably, each of the track units includes an inner sub-track and an outer sub-track arranged in parallel to each other in the first horizontal direction, and in the pair of track units, the inner sub-tracks are located inside the outer sub-tracks, and the inner sub-tracks and the outer sub-tracks have the same length; where at each of the turning portions, along the direction of extension of the reciprocating track sections, the inner sub-track and the outer sub-track are arranged in a staggered manner with a staggered distance equal to a length of the sorting carriage; and two ends of the sorting carriage in a length direction are respectively mounted to the inner sub-tracks and the outer sub-tracks, so that the sorting carriage is oriented upward on each layer of the reciprocating track sections and moves in opposite directions on adjacent layers of the reciprocating track sections.

[0006] In an embodiment, preferably, along a forward direction of the sorting carriage, a front end of the sorting carriage is fixedly mounted to a relatively forward one of the inner sub-track and the outer sub-track, and a rear end of the sorting carriage is fixedly mounted to a relatively rearward one of the inner sub-track and the outer sub-track.

[0007] In an embodiment, preferably, the inner sub-tracks and the outer sub-tracks include chain tracks; where two sides of a first end of the sorting carriage in the length direction are respectively rotatably mounted via first adapter shafts to chain links of a pair of the inner sub-tracks, and two sides of a second end of the sorting carriage in the length direction are respectively rotatably mounted via second adapter shafts to chain links of a pair of the outer sub-tracks, and a connecting member is provided on an outer end of each of the second adapter shafts and is configured to avoid a respective inner sub-track.

[0008] In an embodiment, preferably, travelling wheels are respectively provided on two sides of each of the two ends of the sorting carriage in the length direction; where the first adapter shafts and the second adapter shafts are axles of the corresponding travelling wheels.

[0009] In an embodiment, preferably, at least two of the deflection wheels are provided at each of the turning portions, and are arranged in the vertical direction.

[0010] In an embodiment, preferably, the sorting carriage includes a chassis and a conveyor belt mounted on the chassis; where a conveying direction of the conveyor belt is transverse to the length direction of the sorting carriage; the chassis includes a plurality of chassis sub-plates arranged in the length direction of the sorting carriage, adjacent chassis sub-plates being movably connected to each other; and the conveyor belt is fixedly mounted to any one of the plurality of chassis sub-plates.

[0011] In an embodiment, preferably, the sorting carriage includes a controller, the controller being electrically connected to the conveyor belt and communicatively connected to the sorting control device, so that the controller controls a rotation direction of the conveyor belt according to a loading command and an unloading command from the sorting control device.

[0012] In an embodiment, preferably, the cross-belt sorting machine further includes: a power supply unit including a conductor rail and a brush plate provided on an outer side of the chassis of the sorting carriage, the conductor rail being arranged between the pair of track units and extending along the track units, the conductor rail being electrically connected to a power source, and the brush plate being electrically connected to a controller of the sorting carriage; where the conductor rail and the brush plate are configured such that, when the sorting carriage circulates with the pair of track units, the conductor rail is electrically connected to the brush plate, so that the power source supplies power to the sorting carriage.

[0013] In an embodiment, preferably, there are a plurality of sorting carriages, which are distributed throughout the pair of track units along the direction of extension of the pair of track units, and an adjacent pair of brush plates of adjacent sorting carriages are electrically connected to each other via a conductive member; where a length of the conductor rail is at least greater than a distance between the adjacent pair of brush plates.

[0014] In an embodiment, preferably, the conductive member includes a conductive plate extending along the length direction of the sorting carriage; and first hinge shafts are respectively provided on the two sides of the sorting carriage in the width direction of the sorting carriage and extend in the width direction, the first hinge shafts being electrically connected to the brush plate; where a pair of the first hinge shafts are arranged symmetrically with respect to the length direction of the sorting carriage; and the pair of the first hinge shafts are respectively hinged via the conductive plate to a pair of sorting carriages adjacent to the sorting carriage where the pair of the first hinge shafts are located.

[0015] In an embodiment, preferably, travelling wheels are respectively provided on two

sides of each of the two ends of the sorting carriage in the length direction; where the first hinge shafts are axles of the corresponding travelling wheels.

[0016] In an embodiment, preferably, the conductive plate includes a first conductive sub-plate and a second conductive sub-plate, one end of the first conductive sub-plate being hinged to one end of the second conductive sub-plate via a second hinge shaft, and the other end of the first conductive sub-plate and the other end of the second conductive sub-plate being respectively hinged to a pair of the first hinge shafts of adjacent sorting carriages on the same side; and along the length direction of the sorting carriage, the second hinge shaft is located at the travelling wheel between the pair of the first hinge shafts of the adjacent sorting carriages on the same side.

[0017] In an embodiment, preferably, the sorting carriage is provided with a rechargeable battery, the rechargeable battery being electrically connected to the brush plate, so that the power source charges the rechargeable battery when the conductor rail is electrically connected to the brush plate.

[0018] In an embodiment, preferably, among the track sections of the pair of track units, at least the reciprocating track sections are provided, on inner sides thereof, with support plates along the direction of extension of the reciprocating track sections for the travelling wheels to travel on.

[0019] In an embodiment, preferably, the cross-belt sorting machine further includes: a frame unit arranged in the vertical direction, where the frame unit is configured to fixedly mount the rotation shafts of the deflection wheels, and at each layer of the reciprocating track sections, multiple of the unloading chutes are detachably mounted on the frame unit, the multiple unloading chutes being arranged in the direction of extension of the reciprocating track sections.

[0020] In an embodiment, preferably, at least one loading station is provided on both sides of an end of the lowermost one of the reciprocating track sections.

[0021] In a second aspect, embodiments of the present application provide a cross-belt sorting system based on a three-dimensional track, including the cross-belt sorting machine according to any one of the above embodiments, and a sorting control device for controlling the cross-belt sorting machine.

[0022] Embodiments of the present application provide a cross-belt sorting machine and a cross-belt sorting system based on a three-dimensional track. The cross-belt sorting machine includes a pair of track units arranged in parallel to each other in a vertical direction and arranged symmetrically with each other. Each of the track units is configured in a closed-loop

in a respective vertical plane. The track units are guided by a plurality of deflection wheels, where at least one of the deflection wheels is a drive wheel for driving the track units to circulate. A sorting carriage horizontally bridges the pair of track units; and track sections of the pair of track units extending in an up-down direction are sequentially guided by multiple of the plurality of deflection wheels to form at least two layers of reciprocating track sections. In this way, a loading station and a plurality of unloading chutes can be arranged on one side or both sides of the reciprocating track sections of the pair of track units.

[0023] That is to say, with the cross-belt sorting machine according to the embodiments of the present application, a pair of track units are guided by a plurality of deflection wheels in a left-right alternating manner in a horizontal direction to form a plurality of reciprocating track sections arranged in a height direction. In this way, by arranging unloading chutes beside the reciprocating track sections with different heights, the space in the height direction is fully utilized, the density of the unloading chutes is increased, and the sorting efficiency and the space utilization are improved.

BRIEF DESCRIPTION OF DRAWINGS

[0024] For the purpose of more clearly describing embodiments of the present application, the drawings to be used in the description of the embodiments of the present application will be briefly introduced below. The drawings in the following description are merely some of the embodiments of the present application, and for a person of ordinary skill in the art, other drawings may be obtained from these drawings without any creative efforts.

[0025] FIG. 1 is a schematic structural diagram of a cross-belt sorting machine according to an embodiment of the present application.

[0026] FIG. 2 is an enlarged view of portion A of the cross-belt sorting machine in FIG. 1.

[0027] FIG. 3 is a front view of a track unit according to an embodiment of the present application in a vertical plane.

[0028] FIG. 4 is a schematic diagram of the track unit in FIG. 3 from another perspective.

[0029] FIG. 5 is a schematic structural diagram of a sorting carriage located on a reciprocating track section according to an embodiment of the present application.

[0030] FIG. 6 is an enlarged view of portion B of the structure in FIG. 5.

[0031] FIG. 7 is a schematic structural diagram of a chassis of a sorting carriage formed by hinged connection of a plurality of chassis sub-plates according to an embodiment of the present application.

[0032] FIG. 8 is a schematic structural diagram of a first conductive sub-plate and a second

conductive sub-plate according to an embodiment of the present application.

[0033] FIG. 9 is a schematic structural diagram of an electrical connection between a conductor rail and a brush plate according to an embodiment of the present application.

[0034] FIG. 10 is a schematic structural diagram of a sorting carriage according to an embodiment of the present application.

[0035] FIG. 11 is a schematic diagram of distribution of conductive plates on two sides of sorting carriages in a width direction according to an embodiment of the present application.

[0036] Description of reference signs

10 - track unit

11 - inner sub-track

12 - outer sub-track

13 - reciprocating track section

14 - turning portion

15 - return area

20 - deflection wheel

21 - rotation shaft

22 - drive wheel

23 - motor

30 - sorting carriage

31 - chassis sub-plate

32 - conveyor belt

33 - controller

34 - brush plate

35 - travelling wheel

36 - connecting member

351 - wheel axle

40 - loading station

50 - unloading chute

60 - conductor rail

70 - conductive plate

71 - first conductive sub-plate

72 - second conductive sub-plate

73 - second hinge shaft

80 - frame unit

81 - support plate.

DETAILED DESCRIPTION

[0037] For a better understanding of the present application, exemplary embodiments of the present application will be described in detail below with reference to the accompanying drawings. The described embodiments are merely a part of the embodiments of the present application, not all of the embodiments of the present application. It should be understood that the present application is not limited to the exemplary embodiments described herein.

[0038] In the related art, a cross-belt sorting machine generally uses a track in a closed loop, on which sorting carriages circulate, and a loading station and unloading chutes are arranged beside the track. The sorting carriage picks up a parcel at the loading station, then travels to a designated unloading chute and releases the parcel according to a system command, thereby completing the sorting operation of the parcel.

[0039] However, in the above scheme, the track is generally configured in a closed loop in a horizontal plane, resulting in large space occupation.

[0040] In view of this, embodiments of the present application provide a cross-belt sorting machine and a cross-belt sorting system based on a three-dimensional track.

[0041] Referring to FIG. 1 and FIG. 2, a cross-belt sorting machine based on a three-dimensional track includes: a pair of track units 10 arranged in parallel to each other in a vertical direction and arranged mirror-symmetrically with each other; a plurality of deflection wheels 20, each of which has a rotation shaft 21 extending in a first horizontal direction; and a sorting carriage 30 horizontally bridging the pair of track units 10. Note that the vertical direction, up-down direction, and height direction used herein refer to the same direction.

[0042] Referring to FIG. 1, FIG. 2, and FIG. 3, the track unit 10 is configured in an end-to-end closed-loop in a vertical plane. Multiple of the plurality of deflection wheels 20 are rotatably mounted at turning portions 14 of the track unit 10 in the vertical plane, so that the multiple deflection wheels 20 support the track unit 10 and guide a direction of extension of the track unit 10. At least one of the plurality of deflection wheels 20 is a drive wheel 22 for driving the track unit 10 to circulate in the vertical plane. Two sides of the sorting carriage 30 in a width direction are respectively fixedly mounted to the pair of track units 10, so that the sorting carriage 30 circulates with the track units 10.

[0043] Track sections of the pair of track units 10 extending in the up-down direction are sequentially guided by the plurality of deflection wheels 20 in a left-right alternating manner in a second horizontal direction to form at least two layers of reciprocating track sections 13,

and the reciprocating track sections 13 extend in the second horizontal direction. In the view of FIG. 3, the first horizontal direction may be a direction perpendicular to the plane of the paper, and the second horizontal direction may be a left-right direction.

[0044] A loading station 40 is arranged beside an end of the reciprocating track sections 13 on one side or both sides, and a plurality of unloading chutes 50 are arranged beside the reciprocating track sections 13 on one side or both sides. Moreover, the sorting carriage 30 and the loading station 40 are communicatively connected to a sorting control device, such that: when the sorting carriage 30 circulates with the pair of track units 10 to the loading station 40, a parcel on the loading station 40 is transferred to the sorting carriage 30; and when the sorting carriage 30 circulates with the pair of track units 10 to a designated unloading chute 50, the parcel on the sorting carriage 30 is transferred to the designated unloading chute 50.

[0045] In this embodiment, overall, the pair of mirror-symmetrical track units 10 are guided by the plurality of deflection wheels 20 to form at least two layers of reciprocating track sections 13. Thus, when the sorting carriage 30 circulates with the pair of track units 10, the sorting carriage 30 can deliver parcels to the unloading chutes 50 on one side or both sides of the reciprocating track sections 13. In this way, by arranging the plurality of reciprocating track sections 13 in multiple layers along the height direction, the density of the unloading chutes 50 is greatly increased, and the space utilization is improved.

[0046] Referring to FIGS. 1, 3, and 4, the pair of track units 10 are arranged in parallel to each other in the vertical direction and arranged mirror-symmetrically with each other; where each of the track units 10 is configured in an end-to-end closed-loop in its respective vertical plane.

[0047] Referring to FIG. 2, the sorting carriage 30 horizontally bridges the pair of track units 10, i.e., two sides of the sorting carriage 30 in the width direction are respectively fixedly mounted to the pair of track units 10, so that the sorting carriage 30 circulates with the pair of track units 10.

[0048] Regarding the deflection wheels 20, first, it should be noted that the rotation shafts 21 of the deflection wheels 20 extend in the first horizontal direction, i.e., the rotation shafts 21 of the deflection wheels 20 are perpendicular to the vertical plane in which the track unit 10 lies. Thus, it can be understood that when the track units 10 are placed on the deflection wheels 20, the track units 10 can change the direction thereof by means of the deflection wheels 20, i.e., the deflection wheels 20 can guide the track units 10.

[0049] It can then be understood that the track unit in the vertical plane can, for example, be guided by four deflection wheels to form a simple rectangular closed track, which then includes

two track sections extending in the up-down direction and two track sections extending in the left-right direction.

[0050] Further, for any track section extending in the up-down direction, it can be sequentially guided by a number of deflection wheels in a left-right alternating manner to form at least two layers of reciprocating track sections, which extend, for example, in the left-right direction. In this case, the deflection wheels that perform guidance in the left-right alternating manner may be arranged in two vertical columns at a certain interval, and the two vertical columns of deflection wheels are arranged in a staggered manner. In other words, the above-mentioned track section extending in the up-down direction may form a multi-layer parallel arrangement in the height direction by being sequentially wound around a number of deflection wheels, i.e., multiple layers (or at least two layers) of reciprocating track sections are arranged in parallel to each other in the height direction.

[0051] Among the plurality of deflection wheels 20 guiding the track units, at least one deflection wheel 20 is the drive wheel 22, and the drive wheel 22 is driven, for example, by a motor 23, i.e., the motor 23 drives the track units 10 to circulate via the drive wheel 22, and enables the sorting carriage 30 to circulate with the track units 10.

[0052] At this time, for example, the loading station 40 may be arranged on an end of the lowermost reciprocating track section 13 on one side or both sides. Similarly, the unloading chutes 50 may be arranged on one side or both sides of all reciprocating track sections 13. That is, the unloading chutes 50 may be distributed in multiple layers corresponding to the multiple layers of reciprocating track sections 13, and multiple unloading chutes 50 may be arranged horizontally on each layer of the reciprocating track sections 13, thus greatly increasing the density of the unloading chutes 50 and improving the space utilization.

[0053] Thus, it can be understood that the sorting control device can control the circulating rotation of the sorting carriage 30 by controlling the motor 23. And, when the sorting carriage 30 circulates with the track units 10 to the loading station 40, the sorting control device controls the loading station 40 and the sorting carriage 30 to transfer the parcel from the loading station 40 to the sorting carriage 30; the parcel then circulates with the sorting carriage 30; and when the sorting carriage 30 circulates to the unloading chute 50 designated by the sorting control device, the sorting control device controls the sorting carriage 30 to deliver the parcel from the sorting carriage 30 to the designated unloading chute 50, thereby completing the sorting and delivery of the parcel.

[0054] Embodiments of the present application provide a cross-belt sorting machine based on a three-dimensional track. The cross-belt sorting machine includes a pair of track units

arranged in parallel to each other in a vertical direction and arranged mirror-symmetrically with each other. Each of the track units is configured in a closed-loop in a respective vertical plane. The track units are guided by a plurality of deflection wheels, at least one of which is a drive wheel for driving the track units to circulate. A sorting carriage horizontally bridges the pair of track units; and track sections of the pair of track units extending in an up-down direction are sequentially guided by the plurality of deflection wheels to form at least two layers of reciprocating track sections. In this way, a loading station and a plurality of unloading chutes can be arranged on one side or both sides of the reciprocating track sections of the pair of track units.

[0055] That is to say, with the cross-belt sorting machine according to the embodiments of the present application, a pair of track units are guided by a plurality of deflection wheels in a left-right alternating manner to form a plurality of reciprocating track sections arranged in a height direction. In this way, by arranging unloading chutes beside the reciprocating track sections with different heights, the space in the height direction is fully utilized, the density of the unloading chutes is increased, and the sorting efficiency and the space utilization are improved.

[0056] Moreover, the sorting carriage circulates with the pair of track units and can perform loading and unloading processes without decelerating, resulting in high sorting and delivery efficiency.

[0057] In a possible implementation, each track unit 10 includes an inner sub-track 11 and an outer sub-track 12 arranged in parallel to each other in the first horizontal direction. In the pair of track units 10, the inner sub-tracks 11 are located inside the outer sub-tracks 12, and the inner sub-tracks 11 and the outer sub-tracks 12 have the same length. At each left-right alternating turning portion, along the direction of extension of the reciprocating track sections, the inner sub-track 11 and the outer sub-track 12 are arranged in a staggered manner with a staggered distance equal to a length of the sorting carriage 30, so that the sorting carriage 30 is fixedly mounted, at two ends thereof in a front-rear direction, to the inner sub-tracks 11 and the outer sub-tracks 12, respectively, whereby the sorting carriage 30 is oriented upward on each layer of the reciprocating track sections and moves in opposite directions on adjacent layers of the reciprocating track sections. Herein, the front-rear direction of the sorting carriage 30 is the length direction of the sorting carriage 30.

[0058] It can be understood that, to ensure that the sorting carriage is oriented upward on each layer of the reciprocating track sections, this embodiment configures each track unit to have a pair of sub-tracks that are arranged in parallel to each other in the horizontal direction and have

the same length, and then, at each left-right alternating turning portion, the pair of sub-tracks are horizontally offset from each other by a distance equal to the length of the sorting carriage.

[0059] Specifically, for the pair of track units, since each track unit includes a pair of sub-tracks, the pair of track units together have four sub-tracks arranged in parallel, where the inner pair of sub-tracks are a pair of inner sub-tracks, and the outer pair of sub-tracks are a pair of outer sub-tracks. That is, each track unit includes one inner sub-track and one outer sub-track.

[0060] Moreover, the inner sub-tracks and the outer sub-tracks have the same length, or in turn, it can be said that all four sub-tracks of the pair of track units have the same length.

[0061] In this way, it can be understood, with reference to FIG. 3, that, since the inner sub-tracks and the outer sub-tracks have the same length, at one turning portion, for example, the inner sub-track is arranged further forward in a forward direction than the outer sub-track; then at the next turning portion, the outer sub-track is arranged further forward in the forward direction than the inner sub-track. Consequently, the sorting carriage, being fixedly mounted at its two ends in the front-rear direction respectively to the inner sub-tracks and the outer sub-tracks, can be oriented upward on each layer of the reciprocating track sections.

[0062] At this time, it should be understood that when the sorting carriage travels to a position where the inner sub-track and the outer sub-track are staggered, i.e., when the sorting carriage ascends vertically from a lower reciprocating track section to an adjacent upper reciprocating track section, the sorting carriage is always oriented upward during the ascent, and a movement direction of the sorting carriage on the upper reciprocating track section is opposite to that on the lower reciprocating track section.

[0063] In a possible implementation, when the sorting carriage approaches a turning portion, along the forward direction of the sorting carriage, the sorting carriage is configured such that: a front end of the sorting carriage is fixedly mounted to the relatively forward one of the inner sub-track and the outer sub-track, and a rear end of the sorting carriage is fixedly mounted to the relatively rearward one of the inner sub-track and the outer sub-track.

[0064] For ease of understanding, for a forward-moving sorting carriage, its front end may be fixedly mounted to the relatively forward one of the inner sub-track and the outer sub-track, while its rear end may be fixedly mounted to the relatively rearward one of the inner sub-track and the outer sub-track. In this way, the relatively forward one of the inner sub-track and the outer sub-track (i.e., the front end of the sorting carriage) protrudes relative to the relatively rearward one of the inner sub-track and the outer sub-track (i.e., the rear end of the sorting carriage) by a staggered distance equal to the length of the sorting carriage, so that the front end and the rear end of the sorting carriage simultaneously reach the turning portions of the

inner sub-track and the outer sub-track, preparing for vertical ascent of the sorting carriage.

[0065] Specifically, the inner sub-tracks and the outer sub-tracks include chain tracks. Two sides of a first end of the sorting carriage in the front-rear direction are respectively rotatably mounted via first adapter shafts to chain links of the pair of inner sub-tracks, and two sides of a second end of the sorting carriage in the front-rear direction are respectively rotatably mounted via second adapter shafts to chain links of the pair of outer sub-tracks, and each second adapter shaft is provided, on an outer end thereof, with a connecting member configured to avoid the respective inner sub-track.

[0066] That is, the above-mentioned inner sub-tracks and outer sub-tracks can be realized, for example, by chain tracks.

[0067] For mounting of the sorting carriage to the pair of inner sub-tracks on two sides thereof, the sorting carriage can be rotatably hinged via a pair of first adapter shafts to chain links of the pair of inner sub-tracks; similarly, for mounting of the sorting carriage to the pair of outer sub-tracks on two sides thereof, the sorting carriage can be rotatably hinged via a pair of second adapter shafts to chain links of the pair of outer sub-tracks.

[0068] Referring to FIG. 2 and FIG. 6, the first adapter shafts hinged to the inner sub-tracks extend linearly and are directly hinged to the chain links of the inner sub-tracks. For the outer sub-tracks, because they need to avoid the inner sub-tracks, each second adapter shaft extends linearly and is provided on its outer end with a connecting member 36 configured to avoid the inner sub-track, so that the second adapter shaft can cross the inner sub-track from above or below via the connecting member 36 to avoid the inner sub-track.

[0069] Further, the sorting carriage is provided, on left and right sides of each of the two ends thereof in the front-rear direction, with travelling wheels 35, respectively. The first adapter shafts and the second adapter shafts are wheel axles 351 of the corresponding travelling wheels 35.

[0070] That is, in the front-rear direction, the sorting carriage includes, for example, two travelling wheels at the first end and two travelling wheels at the second end; then the two first adapter shafts are, for example, the wheel axles of the two travelling wheels at the first end, and the two second adapter shafts are the wheel axles of the two travelling wheels at the second end. Thus, by arranging the two types of adapter shafts (i.e., the first adapter shafts and the second adapter shafts) at the wheel axles of the travelling wheels, the structure is simple and components and parts are saved.

[0071] In a possible implementation, at each left-right alternating turning portion, the track unit is guided by at least two deflection wheels arranged vertically.

[0072] For one turning portion, at least two deflection wheels arranged one above the other (e.g., two deflection wheels arranged one above the other as shown in FIG. 3) may be provided at the turning portion. A vertical spacing between the two deflection wheels is a spacing between adjacent reciprocating track sections, which can better match a height of the parcel carried on the sorting carriage. Moreover, by providing at least two deflection wheels arranged one above the other, a guiding effect similar to that of using a single larger-radius deflection wheel can be achieved with smaller-radius deflection wheels, facilitating disassembly.

[0073] In a possible implementation, as shown in FIG. 7, the sorting carriage includes a chassis and a conveyor belt 32 mounted on the chassis; where a conveying direction of the conveyor belt 32 is transverse to the front-rear direction of the sorting carriage. The chassis includes a plurality of chassis sub-plates 31 arranged in the front-rear direction of the sorting carriage, and adjacent chassis sub-plates 31 are movably connected to each other; and the conveyor belt 32 is fixedly mounted to any one of the plurality of chassis sub-plates 31.

[0074] Referring to FIG. 3, the rightmost vertical track section and the lowermost horizontal track section in FIG. 3 constitute a return area 15. To ensure that the sorting carriage can turn smoothly in the return area 15, the plurality of chassis sub-plates 31 of the chassis of the sorting carriage may be rotatably connected, for example, hinged, to each other, and are arranged in parallel to each other along the front-rear direction of the sorting carriage. Thus, referring to FIG. 7, when the sorting carriage travels to a turning portion in the return area 15, smooth passage of the sorting carriage at the turning portion can be ensured.

[0075] The conveyor belt on the sorting carriage can be fixedly mounted to any one of the plurality of chassis sub-plates, though it is usually mounted to a middle one of the chassis sub-plates.

[0076] In a possible implementation, as shown in FIG. 10, the sorting carriage 30 includes a controller 33, which is electrically connected to the conveyor belt 32 and is communicatively connected to the sorting control device, so that the controller 33 controls a rotation direction of the conveyor belt 32 according to a loading command and an unloading command from the sorting control device.

[0077] That is, each sorting carriage includes an independent controller, which is communicatively connected to the sorting control device, and can drive the conveyor belt to rotate according to commands from the sorting control device to perform loading and unloading.

[0078] In a possible implementation, as shown in FIG. 9 and FIG. 10, the cross-belt sorting machine further includes a power supply unit. The power supply unit includes a conductor rail

60 and a brush plate 34 provided on an outer side of the chassis of the sorting carriage. The conductor rail 60 is provided between the pair of track units and extends along the track units, and the conductor rail 60 is electrically connected to a power source. The brush plate 34 is electrically connected to the controller 33 of the sorting carriage. The conductor rail 60 and the brush plate 34 are configured such that, when the sorting carriage circulates with the track units, the conductor rail is electrically connected to the brush plate, so that the power source supplies power to the sorting carriage.

[0079] In this embodiment, considering the power supply for the sorting carriage, the cross-belt sorting machine further includes a power supply unit.

[0080] Specifically, a brush plate may be provided on an outer side of the chassis of the sorting carriage, for example on a bottom surface of the chassis, and the brush plate is electrically connected to the above-mentioned controller. A conductor rail is provided between the pair of track units, and the conductor rail extends along the track units and is electrically connected to a power source. In this way, when the sorting carriage circulates with the track units, the conductor rail is electrically connected to the brush plate, so that the power source can supply power to the sorting carriage.

[0081] It can be understood that, on the one hand, to ensure uninterrupted power supply to the sorting carriage during circulating rotation of the sorting carriage, the conductor rail may extend along the track units and be configured in a closed-loop, i.e., the conductor rail has the same length and turning form as the track units, thereby ensuring that the sorting carriage remains electrically connected to the conductor rail throughout its circulating rotation.

[0082] On the other hand, only a section of conductor rail may be provided, for example on a certain reciprocating track section. In that case, it can be understood that sorting carriages on the track units may be electrically connected to each other, and the conductor rail, by being electrically connected to one of the sorting carriages, can supply power to all of the sorting carriages.

[0083] In a possible implementation, specifically, along the direction of extension of the track units, a plurality of sorting carriages are distributed throughout the track units, and an adjacent pair of brush plates of adjacent sorting carriages are electrically connected to each other via a conductive member; where a length of the conductor rail is at least greater than a distance between the adjacent pair of brush plates.

[0084] That is, along the direction of extension of the track units, the sorting carriages need to be distributed all over the track units, and the adjacent pair of brush plates of adjacent sorting carriages are electrically connected to each other via the conductive member; where the length

of the conductor rail is at least greater than the distance between the adjacent pair of brush plates. In this way, when all the sorting carriages circulate, it is ensured that the conductor rail can be always electrically connected to at least one brush plate, i.e., it is ensured that the conductor rail can be always electrically connected to all the sorting carriages to supply power to them.

[0085] Considering the staggered arrangement of the inner sub-tracks and the outer sub-tracks and the fact that the sorting carriage may move in opposite directions on adjacent upper and lower reciprocating track sections, in a possible implementation, the conductive member includes a conductive plate 70 extending along the front-rear direction of the sorting carriage, and the sorting carriage is provided, on two sides thereof in the width direction, with first hinge shafts, respectively, which extend in the width direction of the sorting carriage and are electrically connected to the brush plate.

[0086] A pair of first hinge shafts respectively provided on the two sides of the sorting carriage in the width direction are arranged symmetrically with each other with respect to the front-rear direction of the sorting carriage. And, the pair of first hinge shafts are respectively hinged via the conductive plate 70 to a pair of sorting carriages (one in front and one behind) adjacent to the sorting carriage where the pair of first hinge shafts are located, as shown in FIG. 11.

[0087] That is, in view of the situation where the sorting carriage may reverse its direction, adjacent sorting carriages can be electrically connected to each other via a hinged conductive plate. This embodiment provides a specific connection structure.

[0088] Specifically, first hinge shafts are respectively provided on two sides of the sorting carriage in the width direction, and extend in the width direction of the sorting carriage. And, a pair of first hinge shafts on the two sides are arranged symmetrically with each other with respect to the front-rear direction of the sorting carriage. That is, the two first hinge shafts on the left and right sides of the sorting carriage are located at the same position of the sorting carriage in the front-rear direction, for example, both at the front end of the sorting carriage, or both at the middle of the sorting carriage, or both at the rear end of the sorting carriage, as long as the two first hinge shafts on the left and right sides are mirror-symmetrical.

[0089] Then, the two first hinge shafts on the left and right sides are respectively hinged via the conductive plate to a pair of sorting carriages (one in front and one behind) adjacent to the sorting carriage where the two first hinge shafts are located. That is, the first hinge shaft on one side is hinged via the conductive plate to the adjacent front sorting carriage in the forward direction (i.e., hinged via the conductive plate to the first hinge shaft of the adjacent front

sorting carriage on the same side), and the first hinge shaft on the other side is hinged via the conductive plate to the adjacent rear sorting carriage in the forward direction. In this way, electrical connection between adjacent sorting carriages can be achieved while accommodating the reversal of the direction of the sorting carriage.

[0090] In a specific implementation, the sorting carriage is provided, on left and right sides of each of the two ends thereof in the front-rear direction, with the travelling wheels 35, respectively; where the first hinge shafts are wheel axles 351 of the corresponding travelling wheels 35.

[0091] Similar to the adapter shafts as described above, the first hinge shafts in this embodiment may also be directly the wheel axles of the travelling wheels.

[0092] The pair of first hinge shafts as described above may be, for example, wheel axles of a pair of travelling wheels on two sides of the front end of the sorting carriage, or wheel axles of a pair of travelling wheels on two sides of the rear end of the sorting carriage. That is, both the adapter shafts and the first hinge shafts as described above can be realized by means of the wheel axles of the travelling wheels of the sorting carriage, resulting in a simple structure.

[0093] In a specific implementation, the conductive plate 70 includes a first conductive sub-plate 71 and a second conductive sub-plate 72, where one end of the first conductive sub-plate 71 is hinged to one end of the second conductive sub-plate 72 via a second hinge shaft 73, and the other end of the first conductive sub-plate 71 and the other end of the second conductive sub-plate 72 are respectively hinged to a pair of first hinge shafts of adjacent sorting carriages on the same side. And, along the front-rear direction of the sorting carriage, the second hinge shaft 73 is located at the travelling wheel between the pair of first hinge shafts of the adjacent sorting carriages on the same side.

[0094] Referring to FIG. 6 and FIG. 7, considering that the conductive plate may span a travelling wheel and that this travelling wheel needs to be hinged to either the inner sub-track or the outer sub-track, the second hinge shaft may be provided at the travelling wheel that the conductive plate spans. In other words, an entire conductive plate may be formed by hingedly connecting two conductive sub-plates, with a hinged connection point located at the travelling wheel that the conductive plate spans.

[0095] In another possible implementation, specifically, the sorting carriage may be further provided with a rechargeable battery electrically connected to the brush plate. It can be understood that, in this way, when the conductor rail is electrically connected to the brush plate, the power source can charge the rechargeable battery. It can be seen that when the sorting carriage uses a rechargeable battery, it is not necessary for the sorting carriages to distribute all

over the track units, nor is it necessary for a pair of brush plates between adjacent sorting carriages to be electrically connected to each other via a conductive member. In other words, in this case, no electrical connection is required between the sorting carriages. Each sorting carriage, when traveling to the conductor rail, can be electrically connected to the conductor rail via the brush plate to draw electrical energy, and the rechargeable battery built in the sorting carriage can store the electrical energy for use by the sorting carriage.

[0096] In a possible implementation, as shown in FIG. 9, among the track sections of the pair of track units, at least the reciprocating track sections are provided, on inner sides thereof, with support plates 81 along the direction of extension of the reciprocating track sections for the travelling wheels to travel on.

[0097] That is, the above-mentioned reciprocating track sections are generally arranged horizontally. In this case, support plates may be provided on inner sides of a pair of reciprocating track sections, and the support plates are configured to support the travelling wheels of the sorting carriage, or in other words, the support plates are provided for the travelling wheels of the sorting carriage to travel on.

[0098] In a possible implementation, as shown in FIG. 1 and FIG. 2, the cross-belt sorting machine further includes a frame unit 80 provided in the vertical direction. The frame unit 80 is configured to fixedly mount the rotation shafts 21 of the deflection wheels 20, and at each layer of the reciprocating track sections, multiple unloading chutes 50 are detachably mounted on the frame unit, and are arranged in the direction of extension of the reciprocating track sections.

[0099] That is, a frame unit extending in the vertical direction may be provided, so that the frame unit can not only provide mounting positions for the rotation shafts of the deflection wheels, but also provide mounting positions for the unloading chutes outside the reciprocating track sections.

[0100] For convenience of use, at least one loading station 40 may be provided on both sides of an end of the lowermost reciprocating track section.

[0101] Based on the cross-belt sorting machine as disclosed above, the present application further discloses a cross-belt sorting system based on a three-dimensional track, including the cross-belt sorting machine as described above and a sorting control device for controlling the cross-belt sorting machine.

[0102] The basic principles of the present application have been described above with reference to specific embodiments. However, it should be noted that the advantages, effects, etc. mentioned in the present application are only exemplary and not limiting, and these

advantages, effects, etc. should not be considered as necessary for various embodiments of the present application. In addition, the specific details as disclosed above are only for the purpose of illustration and ease of understanding, and are not limiting; and these details do not limit the present application to being implemented with the specific details as described above.

[0103] The block diagrams of devices, apparatuses, and systems involved in the present application are only illustrative examples and are not intended to require or imply that connections, arrangements, and configurations must be made as shown in the block diagrams. As those skilled in the art will recognize, these devices, apparatuses, and systems may be connected, arranged, and configured in any manner. Words such as “comprise,” “include,” “have,” etc. are open-ended words meaning “including but not limited to” and are interchangeable therewith. Words “or” and “and” as used herein refer to “and/or” and are interchangeable therewith unless the context clearly indicates otherwise. Word “such as” as used herein refers to the phrase “such as but not limited to” and is interchangeable therewith.

[0104] It should also be noted that in the devices, apparatuses, and methods of the present application, components or steps may be broken down and/or re-combined. These breakdowns and/or re-combinations should be regarded as equivalent solutions of the present application.

[0105] The above description of the disclosed aspects is provided to enable any person skilled in the art to make or use the present application. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects without departing from the scope of the present application. Therefore, the present application is not intended to be limited to the aspects shown herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

[0106] The foregoing description has been presented for purposes of illustration and description. Moreover, this description is not intended to limit the embodiments of the present application to the form disclosed herein. Although several example aspects and embodiments have been discussed above, those skilled in the art will recognize that certain variations, modifications, changes, additions, and sub-combinations thereof are intended to be included within the scope of protection of the present application.

CLAIMS

1. A cross-belt sorting machine based on a three-dimensional track, comprising:

a pair of track units arranged in parallel to each other in a vertical direction and arranged symmetrically with each other, each of the track units being configured in an end-to-end closed-loop in a respective vertical plane;

a plurality of deflection wheels, each of which has a rotation shaft extending in a first horizontal direction, the plurality of deflection wheels being rotatably mounted at turning portions of the pair of track units in the respective vertical planes, so that the plurality of deflection wheels support the pair of track units and guide a direction of extension of the pair of track units, and at least one of the plurality of deflection wheels being a drive wheel for driving the pair of track units to circulate in the respective vertical planes; and

a sorting carriage horizontally bridging the pair of track units, two sides of the sorting carriage in a width direction being respectively fixedly mounted to the pair of track units, so that the sorting carriage circulates with the pair of track units,

wherein track sections of the pair of track units extending in the vertical direction are sequentially guided by the plurality of deflection wheels in a left-right alternating manner in a second horizontal direction to form at least two layers of reciprocating track sections, the reciprocating track sections extending in the second horizontal direction;

wherein a loading station is arranged beside an end of the reciprocating track sections on one side or both sides, and a plurality of unloading chutes are arranged beside the reciprocating track sections on one side or both sides; and

wherein the sorting carriage and the loading station are communicatively connected to a sorting control device, such that:

when the sorting carriage circulates with the pair of track units to the loading station, a parcel on the loading station is transferred to the sorting carriage; and

when the sorting carriage circulates with the pair of track units to a designated one of the unloading chutes, the parcel on the sorting carriage is transferred to the designated unloading chute.

2. The cross-belt sorting machine according to claim 1, wherein each of the track units

comprises an inner sub-track and an outer sub-track arranged in parallel to each other in the first horizontal direction, and in the pair of track units, the inner sub-tracks are located inside the outer sub-tracks, and the inner sub-tracks and the outer sub-tracks have the same length;

wherein at each of the turning portions, along the direction of extension of the reciprocating track sections, the inner sub-track and the outer sub-track are arranged in a staggered manner with a staggered distance equal to a length of the sorting carriage; and

the sorting carriage is mounted, at two ends thereof in a length direction, to the inner sub-tracks and the outer sub-tracks, respectively, so that the sorting carriage is oriented upward on each layer of the reciprocating track sections and moves in opposite directions on adjacent layers of the reciprocating track sections.

3. The cross-belt sorting machine according to claim 2, wherein along a forward direction of the sorting carriage,

a front end of the sorting carriage is fixedly mounted to a relatively forward one of the inner sub-track and the outer sub-track, and

a rear end of the sorting carriage is fixedly mounted to a relatively rearward one of the inner sub-track and the outer sub-track.

4. The cross-belt sorting machine according to claim 3, wherein the inner sub-tracks and the outer sub-tracks comprise chain tracks;

wherein two sides of a first end of the sorting carriage in the length direction are respectively rotatably mounted via first adapter shafts to chain links of a pair of the inner sub-tracks, and two sides of a second end of the sorting carriage in the length direction are respectively rotatably mounted via second adapter shafts to chain links of a pair of the outer sub-tracks, and a connecting member is provided on an outer end of each of the second adapter shafts and is configured to avoid a respective inner sub-track.

5. The cross-belt sorting machine according to claim 4, wherein travelling wheels are respectively provided on two sides of each of the two ends of the sorting carriage in the length direction;

wherein the first adapter shafts and the second adapter shafts are axles of the corresponding travelling wheels.

6. The cross-belt sorting machine according to any one of claims 1 to 5, wherein at least two of the deflection wheels are provided at each of the turning portions, and are arranged in the vertical direction.

7. The cross-belt sorting machine according to any one of claims 2 to 5, wherein the sorting carriage comprises a chassis and a conveyor belt mounted on the chassis;

wherein a conveying direction of the conveyor belt is transverse to the length direction of the sorting carriage;

the chassis comprises a plurality of chassis sub-plates arranged in the length direction of the sorting carriage, adjacent chassis sub-plates being movably connected to each other; and

the conveyor belt is fixedly mounted to any one of the plurality of chassis sub-plates.

8. The cross-belt sorting machine according to claim 7, wherein the sorting carriage comprises a controller, the controller being electrically connected to the conveyor belt and communicatively connected to the sorting control device, so that the controller controls a rotation direction of the conveyor belt according to a loading command and an unloading command from the sorting control device.

9. The cross-belt sorting machine according to any one of claims 2 to 8, further comprising:

a power supply unit comprising a conductor rail and a brush plate provided on an outer side of the chassis of the sorting carriage, the conductor rail being arranged between the pair of track units and extending along the track units, the conductor rail being electrically connected to a power source, and the brush plate being electrically connected to a controller of the sorting carriage;

wherein the conductor rail and the brush plate are configured such that:

when the sorting carriage circulates with the pair of track units, the conductor rail is

electrically connected to the brush plate, so that the power source supplies power to the sorting carriage.

10. The cross-belt sorting machine according to claim 9, wherein there are a plurality of sorting carriages, which are distributed throughout the pair of track units along the direction of extension of the pair of track units, and an adjacent pair of brush plates between adjacent sorting carriages are electrically connected to each other via a conductive member;

wherein a length of the conductor rail is at least greater than a distance between the adjacent pair of brush plates.

11. The cross-belt sorting machine according to claim 10, wherein

the conductive member comprises a conductive plate extending along the length direction of the sorting carriage; and

first hinge shafts are respectively provided on the two sides of the sorting carriage in the width direction and extend in the width direction, the first hinge shafts being electrically connected to the brush plate;

wherein a pair of the first hinge shafts are arranged symmetrically with respect to the length direction of the sorting carriage; and

the pair of the first hinge shafts are respectively hinged via the conductive plate to a pair of sorting carriages adjacent to the sorting carriage where the pair of the first hinge shafts are located.

12. The cross-belt sorting machine according to claim 11, wherein travelling wheels are respectively provided on two sides of each of the two ends of the sorting carriage in the length direction;

wherein the first hinge shafts are axles of the corresponding travelling wheels.

13. The cross-belt sorting machine according to claim 12, wherein the conductive plate comprises a first conductive sub-plate and a second conductive sub-plate, one end of the first

conductive sub-plate being hinged to one end of the second conductive sub-plate via a second hinge shaft, and the other end of the first conductive sub-plate and the other end of the second conductive sub-plate being respectively hinged to a pair of the first hinge shafts of adjacent sorting carriages on the same side; and

along the length direction of the sorting carriage, the second hinge shaft is located at the travelling wheel between the pair of the first hinge shafts of the adjacent sorting carriages on the same side.

14. The cross-belt sorting machine according to claim 9, wherein the sorting carriage is provided with a rechargeable battery, the rechargeable battery being electrically connected to the brush plate, so that the power source charges the rechargeable battery when the conductor rail is electrically connected to the brush plate.

15. The cross-belt sorting machine according to claim 5 or 12, wherein among the track sections of the pair of track units, at least the reciprocating track sections are provided, on inner sides thereof, with support plates along the direction of extension of the reciprocating track sections for the travelling wheels to travel on.

16. The cross-belt sorting machine according to any one of claims 1 to 15, further comprising:

a frame unit arranged in the vertical direction;

wherein the frame unit is configured to fixedly mount the rotation shafts of the deflection wheels, and

at each layer of the reciprocating track sections, multiple of the unloading chutes are detachably mounted on the frame unit, the multiple unloading chutes being arranged in the direction of extension of the reciprocating track sections.

17. The cross-belt sorting machine according to claim 16, wherein at least one loading station is provided on both sides of an end of the lowermost one of the reciprocating track sections.

18. A cross-belt sorting system based on a three-dimensional track, comprising the cross-belt sorting machine according to any one of claims 1 to 17, and a sorting control device for controlling the cross-belt sorting machine.