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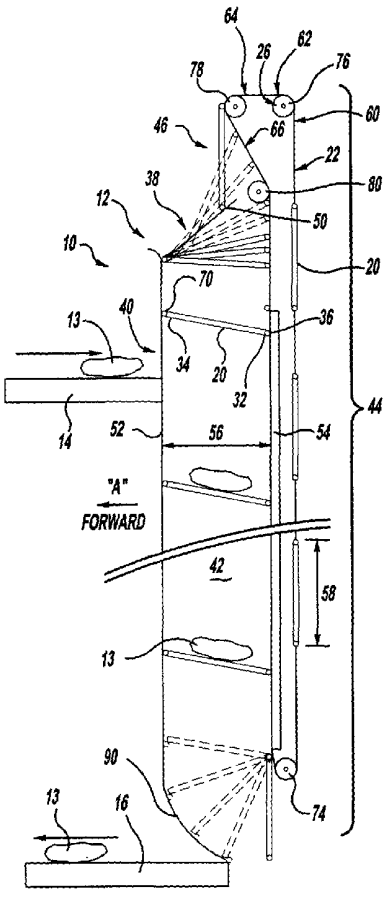
(54) Title: VERTICAL CONVEYOR



(57) Abstract: A vertical conveyor having a support, a drive coupled to the support to move in a drive path having a return zone, a conveying zone, and a transition zone between the return and conveying zone. The vertical conveyor also includes a carrier having a free end and a connected end. The connected end is pivotally coupled to the drive with the carrier being in a return position when the carrier is in the return zone and an operative position when the carrier is in the conveying zone. Finally, the vertical conveyor includes a positioning assembly that is coupled to the support and that has a guide positioned to engage the free end of the carrier as the carrier moves through the transition zone and to smoothly move the carrier from its return position to its operative position. The vertical conveyor may be used in a conveyor system having a supply conveyor and a discharge conveyor that is located vertically below the supply conveyor as well as in a multi-floor conveyor system.

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VERTICAL CONVEYOR

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates generally to vertical conveyors and, more particularly, to a continuous vertical conveyor having carrier platforms coupled to a drive and a positioning assembly that engages and smoothly moves the carriers from a return position to an operative position.

2. Discussion

Vertical conveyors are used throughout the world to efficiently transport articles. For example, bails of hay are lifted to and lowered from lofts, workpieces and parts are moved from storage to manufacturing areas, and baggage is moved from airport check-in counters to the complex conveyor system that delivers the baggage to the appropriate airplane. In general, vertical conveyors can be referred to as either continuous or reciprocating conveyors. In continuous conveyors, shelves, lifting arms, or other structure for moving the load are operably connected to the drive to move about the drive path. A payload is placed on the shelf, moved up or down the desired distance, and then removed.

Notwithstanding these and other common conveyor elements, conveyor designs vary widely. Unfortunately, presently available vertical conveyors also include many deficiencies, including overly complex assemblies for orienting the carrying shelves, structure that performs the reorientation in an abrupt manner, or a shelf support assembly that fails to support the carrying shelves in a manner that optimizes their load carrying capacity and stability.

In many systems, the drive has a conveying path where the shelves are oriented to carry the payload as well as a return path where the shelves are moved back to the loading area. In the conveying area the shelves must be retained in their carrying orientation while the shelves are often unrestrained in the return area. Accordingly, each shelf must be reoriented from its return position to its carrying orientation prior to loading. An exemplary complex orientation structure is illustrated by U.S. Patent No. 3,303,921 which uses a spring and trigger assembly to move an outer section of the shelf to its operative position.

Conveyors arrangements for raising a load include the bail conveyor described in U.S. Patent No. 2,869,708 which includes a lower curved guide that is engageable by rollers on the shelves to raise the shelves against gravitational forces and into a

position to raise the bail. Alternatively, the shelves may be fixed relative to the chain as shown in U.S. Patent No. 1,172,042. U.S. Patent No. 5,141,128 describes a vertical conveyor configured to lower its payload and includes adjustable width shelves that are pivotally coupled to the drive. The shelves hang under the force of gravity in their return orientation and, as each shelf passes the drive apex, it abruptly flops into its operative position. Additionally, each of the aforementioned vertical conveyors support the shelf in its operative position through engagement with a support that is formed on or proximate to the drive. By providing support near the drive, i.e., away from the free end of the shelf, the moment arm from the support to the load is not insignificant thereby requiring a connection design that can withstand the resulting bending forces or loading moments.

SUMMARY OF THE INVENTION

In view of the above, a need exists for a vertical conveyor having a simplified and dependable design for smoothly reorienting the carrying shelves from their return position to their carrying position as well as a structure that effectively supports the payload. In the illustrated embodiment, the present invention includes a plurality of carriers pivotally coupled to a drive. The conveyor also includes a positioning assembly that reorients the carriers from a vertically hanging return zone position into an operating position where the carriers are oriented to effectively convey a payload in a vertically downward direction. The mechanical simplicity of the vertical conveyor is most evident in that the carriers are smoothly reoriented to their operative position without the use of external forces other than those provided by the chain drive and gravity. Yet another benefit of the present invention is that its overall design has a relatively small footprint when compared to existing vertical conveyors. This benefit is particularly desirable in installations where space is at premium.

More particularly, the present invention is directed to a vertical conveyor having a support, a drive coupled to the support to move in a drive path having a return zone, a conveying zone, and a transition zone between the return and conveying zones. The vertical conveyor also includes a carrier having a free end and a connected end. The connected end is pivotally coupled to the drive with the carrier being in a return position when the carrier is in the return zone and an operative position when the carrier is in the conveying zone. Finally, the vertical conveyor includes a positioning assembly that is coupled to the support and that has a guide positioned to engage the free end of the carrier as the carrier moves through the transition zone and to smoothly move the carrier from its return position to its operative position. The vertical conveyor may be

used in a conveyor system having a supply conveyor and a discharge conveyor that is located vertically below the supply conveyor as well as in a multi-floor conveyor system.

Further scope of applicability of the present invention will become apparent from the following detailed description, claims, and drawings. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the following detailed description, the appended claims, and the accompanying drawings, wherein:

FIG. 1 is a side elevational view of a vertical conveyor of the present invention;

FIG. 2 is a front elevational view of the conveyor illustrated in FIG. 1 with the left hand positioning guide and support rail removed for clarity; and

FIG. 3 is a side elevational view similar to that shown in FIG. 1 illustrating a vertical conveyor assembly in accordance with the present invention that is configured to service multiple floors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Various directional terms are used throughout this description. For example, "vertical" is used to refer to the direction of or opposite to gravity, "horizontal" means a direction orthogonal to vertical, "forward" indicates the horizontal direction of arrow A, and "rearward" indicates the horizontal direction opposite arrow "A". Those skilled in the art will appreciate that the above nomenclature is used for illustrative purposes. Moreover, it should further be appreciated that the vertical and horizontal directions may vary from true vertical and true horizontal without departing from the general teachings of this application and the scope of the appended claims.

With reference to the drawings, and particularly FIGS. 1 and 2, a vertical conveyor system 10 is illustrated to include a vertical conveyor 12 that is configured to receive a payload 13 from a supply source such as metering conveyor 14, transport the payload downward, and discharge the payload 13 onto a discharge conveyor 16. The vertical conveyor 12 includes a support, such as a truss assembly, which is generally indicated by 18 (FIG. 2). The truss assembly 18 is configured to operatively support the components of the conveyor as well as the anticipated payload. Those skilled in the art will appreciate that a variety of structural supports other than a truss

may be used without departing from the scope of the invention as defined by the appended claims.

A plurality of carriers or pallets 20 are coupled to a drive for movement along a drive path. In the illustrated embodiment, the drive is a chain assembly 22 which is coupled to the truss assembly 18 by a plurality of sprockets 26. The sprockets establish the path of the chain and therefore the configuration of a drive path. In the illustrated embodiment, the chain assembly 22 preferably includes first and second strands 28 and 30, respectively (FIG. 2), of double pitch roller chain. Double pitch roller chain is commonly available in the art and effectively spreads torsional forces applied to the chain, such as at the connection point of the carriers. Those skilled in the art should appreciate that the present invention is not limited to double pitch roller chain and that, in fact, a wide variety of alternative chain, belt, or other configurations for interconnecting the drive and the pallets may be used.

Each of the plurality of pallets 20 each include a connected end 32 and a free end 34. Pins 36 interconnect the first and second chain strands 28 and 30 and pivotally connect the connected end 32 of the pallets to the chain strands. As a result of this configuration, the pallets are free to pivot under the force of gravity unless otherwise restrained.

Vertical conveyor 12 also includes a pallet positioning assembly 38 which operates to orient each of the pallets from a vertical hanging position and into an operative position for receiving a payload as the pallets approach a pick-up area generally indicated by reference numeral 40. For ease of reference, the chain or drive path is referred to herein as including a conveying zone 42 located between the metering conveyor 14 and discharge conveyor 16, a return zone 44 located between the discharge conveyor and a conveyor apex 62, and a transition zone 46 where the pallets are oriented into their operative position. When each pallet is in the conveying zone 42, the pallet positioning assembly 38 further functions to maintain each pallet in its operative position so as to effectively communicate the payload from the metering conveyor 14 to the discharge conveyor 16. Additionally, the pallet positioning assembly is configured to permit the pallets to move to a vertically hanging position as the pallets move from the conveying zone 42 to the return zone 44. Finally, as noted above, the pallet positioning assembly 38 reorients the pallets from their vertically hanging position to their operating position as the pallets move from the return zone, through the transition zone 46 and into the conveying zone 42. A particular benefit of the present invention is that the vertical conveyor and, more particularly, the pallet

positioning assembly effectively and smoothly reorients each of the pallets and provides adequate support for transporting a payload in a vertically downward direction without complex mechanical systems.

In the illustrated embodiment, the pallet positioning assembly 38 includes a positioning guide 50, a support rail 52, and a support plate 54 each preferably fixed to truss 18. The positioning guide 50 is configured to change the relative position of the free end 34 of each pallet 20 relative to its connected end 32. The support rail 52 prevents forward and downward movement of the free end 34 of each pallet 20 while the support plate 54 prevents rearward movement of the pallets. As a result, the support rail 52 and support plate 54 maintain each pallet in its operative position through the conveying zone 42 by the wedged positioning of the pallets between the support rail and support plate. A separation distance 56, defined by the horizontal distance between the support rail 52 and support plate 54, is maintained through the conveying zone 42 at a distance less than a pallet length 58, thereby ensuring proper wedged positioning of the pallets. Moreover, the pallet is supported in the conveying zone at both its forward and rearward extremes, *i.e.*, its connected and free ends, by the rail and chain respectively, thereby providing a strong and stable platform.

From the above general description, it should be appreciated that the chain assembly 22 translates each of the connected ends 32 of the pallets 20 about the drive path. In the return zone 44 of the drive path, and specifically an upper vertical segment 60 thereof, the pallets hang freely under the force of gravity. As the pallets approach and pass the apex 62 of the drive path, the pallets are conveyed along a forward extension 64 of the drive path and remain in the vertically downward position due to the force of gravity and free pivot connection of pin 36. Then, as each pallet begins to descend from the apex 62, the free end 34 of the pallet engages the positioning guide 50. As connected pallet end 32 continues to descend with the drive chain, and specifically along an inclined segment 66 of the drive path, the free end 34 moves along the positioning guide 50. The resulting relative movement of the free and connected ends of the pallet reorients the pallet from its vertical orientation to its operative position. In the illustrated embodiment, the operative position of the pallet is slightly reclined past horizontal, sloping downward from the free end 34 to the connected end 32. As is noted above, this downwardly sloping operative position is maintained by the wedged engagement of the pallet between the support rail 52 and support plate 54 and assists in retaining the payload on the pallet as the pallet descends through the conveying zone.

Pallet reorientation is facilitated in the illustrated embodiment by providing the free end of each pallet with rollers, by the specific configuration of the pallet positioning assembly 38, as well as by the drive path direction during the reorientation. More particularly, the illustrated embodiment includes rollers 70 on the free end 34. The rollers 70 engage the positioning guide 50 and roll therealong as the connected end of the pallet is moved downward with the chain. Those skilled in the art will appreciate that a variety of rollers, cam wheels, or other movement enhancing mechanisms may be used. Moreover, in certain embodiments it may be desirable to provide the free pallet end 34 with a pin or hub and the positioning guide with movement enhancing rollers or wheels. As is most clearly illustrated in FIG. 2, the rollers 70 are coupled to the free end 34 of each pallet and are positioned outward of the pallet sides 67 and forward of the free end 34. Accordingly, the outer extent of the rollers define the forward extent of the carrier length 58. Positioning of the rollers 70 beyond the pallet sides 66 facilitates loading of the payload onto the pallet.

The positioning guide 50 is spaced from the support rail 52 to define a gap 72 and slopes upwardly from the gap to a terminal end 75. The angled orientation of the positioning guide 50 facilitates movement of the free end 34 of the pallet toward the support rail 52. The gap 72 between the positioning guide and support rails is positioned such that the rollers pass through the gap after the connected end 32 of the pallet has been moved with the chain to a position that ensures the wedged engagement of the pallet between the support rail 52 and support plate 54. While only the right hand positioning guide and support rail are illustrated in FIG. 2, it should be appreciated that the support rail 52 includes a pair of rails spaced from one another at approximately the same distance as the spacing of the cam rollers 70. This rail and roller spacing leaves the entire width 68 of the pallet available for effective communication of the payload between the support rails and onto the pallet.

As is noted above, the orientation of the pallets from their vertical position to their operative position is further facilitated by the drive path in the transition zone. More particularly, in the illustrated embodiment, the plurality of sprockets 26 include a lower rear sprocket 74 and upper rear sprocket 76 that are vertically aligned with one another such that the chain follows a substantially vertical path in the return zone. The plurality of sprockets also include an upper forward sprocket 78 as well as an intermediate sprocket 80 positioned vertically between the rear sprockets 74 and 76 and horizontally between the upper sprockets 76 and 78. As a result of this configuration, the free pallet end 34 remains above, and is moved forward of, the

terminal end 75 of the positioning guide 50 as the pallet is conveyed along the forward extension 64. The pallet then passes to the inclined segment 66 where the connected ends 32 of the pallets move rearwardly and downwardly. The positioning guide 50 is positioned so that the free pallet end 34 is translated along the positioning guide 50 toward rail 52 as the connected end moves with the chain toward the intermediate sprocket 80. As the chain exits intermediate sprocket 80, the connected end of each pallet is aligned with the support plate 54 and the chain is spaced from the upper terminal end 75 of the positioning guide 50. Once properly positioned, further movement of the drive chain moves the connected pallet end 32 downward and the separation distance 58 between the support rail and the support plate ensures that the pallet is maintained in its operative position through the conveying zone.

As each pallet passes the metering conveyor 14, a payload is transported onto the pallet in a manner generally known in the art. The payload is then moved downward with the pallet and into a discharge area 82 wherein the support rail 52 is configured to release each pallet from its operative position, allow the force of gravity to return the pallets to their vertical position, and release the payload onto the discharge conveyor 16. While a variety of rail configurations may be used to achieve these ends, the illustrated embodiment includes a lower curved rail segment 90 that increases the separation distance 56 to a value at least as large as the pallet length 58 thereby permitting the pallet to move from its operative position to its return orientation as the payload is discharged onto the discharge conveyor 16.

From the above description, it should be understood that the vertical conveyor system 10 of the present invention provides a mechanically simple yet effective assembly for transporting a payload vertically downward. The invention is particularly applicable in baggage handling environments and similar applications where the space savings and the mechanical simplicity of the invention is desired. The vertical conveyor transports and smoothly repositions the payload carrying pallet solely through the use of a drive chain and the forces of gravity. The resulting arrangement eliminates complex drive mechanisms or trigger mechanisms commonly used in the art to transport or reposition pallets or other payload carrying devices.

Consistent with the above description, a further advantage of the present invention is the ability to use the vertical conveyor to service multiple floors without requiring significant modifications. An exemplary multi-floor conveyor system 108 is illustrated in FIG. 3 to include first and second conveyors 110a and 110b. It should be appreciated that the conveyors 110a and 110b are configured in substantially the same

manner as the conveyor illustrated in FIGS. 1 and 2. Accordingly, similar elements and features of the invention are referred to by reference numerals increased by a factor of 100. Conveyor 110a is positioned to communicate a payload from a first metering conveyor 114a to a first discharge conveyor 116a. In the illustrated embodiment, a single chain assembly 122 drives the pallets of both the first and second conveyors 110a and 110b. Conveyor 110a communicates the payload from the first metering conveyor 114a to a lower discharge conveyor 116a. The pallets then move to the second conveyor 110b to receive a payload from a second metering conveyor 114b that is discharged on the second discharge conveyor 116b.

As is illustrated, the first conveyor 110a includes a first transition zone 146a and the second conveyor 110b includes a second transition zone 146b. The pallets move from the first conveyor 110a through the second transition zone 146b prior to entering the conveying zone of the second conveyor 110b. The plurality of sprockets used to guide the movement of the chain include transitioning sprockets 184 and 186 positioned to move the pallets such that the free pallet ends 134 engage the positioning guide 150b of the second conveyor 110b after discharging the payload from the first conveyor. To achieve this end, the additional sprockets 184 and 186 move the connected end of the pallets forward in a similar manner as the upper rear and forward sprockets 176 and 178 of the first conveyor 110a.

From the above description, it should be appreciated that the multi-floor capabilities of the vertical conveyor of the present invention provide mechanical simplicity and size benefits not realized by the prior art. Further, in the multi-floor embodiment described above, the shared use of a single chain and plurality of pallets by the first and second conveyors provide additional benefits related to cost and mechanical simplicity.

The foregoing discussion discloses and describes an exemplary embodiment of the present invention. One skilled in the art will readily recognize from such discussion, and from the accompanying drawings and claims that various changes, modifications and variations can be made therein without departing from the true spirit and fair scope of the invention as defined by the following claims.

CLAIMS

What Is Claimed Is:

1. A vertical conveyor comprising:

a support;

a drive coupled to said support to move in a drive path having a return zone, a conveying zone, and a transition zone between said return zone and said conveying zone;

a carrier having a free end and a connected end, said connected end pivotally coupled to said drive, said carrier being in a return position when said carrier is in said return zone and an operative position when said carrier is in said conveying zone; and

a positioning assembly coupled to said support and having a guide, said guide positioned to engage said free end of said carrier as said carrier moves through said transition zone and smoothly move said carrier from said return position to said operative position.

2. The vertical conveyor of claim 1 wherein said positioning assembly further includes a support rail and a support plate, said support rail being separated from said support plate by a horizontal separation distance, wherein said carrier has a length that is greater than said separation distance, and wherein said rail restrains said free end against forward movement and said plate restrains said connected end against rearward movement when said carrier is in said conveying zone.

3. The vertical conveyor of claim 2 wherein said guide has a first end spaced from said rail to define a gap between the guide and rail and a second end positioned upward and rearward from said first end, said free end of said carrier passing through said gap as said carrier moves from said return position to said operative position.

4. The vertical conveyor of claim 1 wherein said carrier hangs vertically downward from said drive when said carrier moves through said return zone and into said transition zone until said free carrier end engages said guide.

5. The vertical conveyor of claim 1 wherein said connected end of said carrier is positioned downward and rearward of said free end when said carrier is in said operative position.

6. The vertical conveyor of claim 1 wherein said guide has a first end and a second end positioned upward and rearward of said first end and wherein said transition zone includes a forward extension followed by an inclined section, said free and connected ends of said carrier being moved forward of said second guide end as said connected end moves along said forward extension, said connected end being moved rearward and downward as said connected end is moved along said inclined section, and said free end moving along said guide as said connected end is moved along said inclined section.

7. The vertical conveyor of claim 6 wherein said drive path further includes a first vertical segment in said return zone and a second vertical segment in said conveying zone and wherein said vertical conveyor further includes sprockets coupling said drive to said support, said sprockets including a first sprocket at an upper end of said first vertical segment, a second sprocket at an upper end of said second vertical segment, and a third sprocket between said first and second sprockets, said third sprocket being forward of said first and second sprockets so that said inclined section of said drive path extends rearwardly from said third sprocket toward said second sprocket.

8. The vertical conveyor of claim 2 wherein said carrier includes a pair of sides defining a width therebetween and wherein said rail includes first and second rail sections spaced from one another a distance that is at least equal to said width.

9. The vertical conveyor of claim 8 wherein said carrier includes rollers coupled to said carrier and extending forward of said free end and outward from said sides.

10. The vertical conveyor of claim 9 wherein said drive includes first and second stands of chain spaced from one another by a distance greater than the distance between said rollers.

11. The vertical conveyor of claim 1 further including a pin pivotally connecting said carrier to said drive.

12. A conveyor system comprising:

a supply conveyor for delivering a payload;

a discharge conveyor located vertically below said supply conveyor for receiving the payload;

a vertical conveyor positioned to receive the payload from said supply conveyor and to transport the payload to the discharge conveyor, said vertical conveyor including:

a support;

a drive coupled to said support to move in a drive path having a conveying zone between said supply and discharge conveyors, a return zone after the discharge conveyor and a transition zone between said return zone and said conveying zone;

a carrier having a free end and a connected end, said connected end pivotally coupled to said drive, said carrier being in a return position when said carrier is in said return zone and an operative position when said carrier is in said conveying zone; and

a positioning assembly coupled to said support and having a guide, said guide positioned to engage said free end of said carrier as said carrier moves through said transition zone and move said carrier from said return position to said operative position.

13. The vertical conveyor of claim 12 wherein said positioning assembly further includes a support rail and a support plate, said support rail being separated from said support plate by a horizontal separation distance, wherein said carrier has a length that is greater than said horizontal separation distance, and wherein said rail restrains said free end against forward movement and said plate restrains said connected end against rearward movement when said carrier is in said conveying zone.

14. The vertical conveyor of claim 13 wherein said guide has a first end spaced from said rail to define a gap between the guide and rail and a second end positioned upward and rearward from said first end, said free end of said carrier passing through said gap as said carrier moves from said return position to said operative position.

15. The vertical conveyor of claim 12 wherein said carrier hangs vertically downward from said drive when said carrier moves through said return zone and into said transition zone until said free carrier end engages said guide.

16. The vertical conveyor of claim 12 wherein said guide has a first end and a second end positioned upward and rearward of said first end and wherein said transition zone includes a forward extension followed by an inclined section, said free and connected ends of said carrier being moved forward of said second guide end as said connected end moves along said forward extension, said connected end being moved rearward and downward as said connected end is moved along said inclined section, and said free end moving along said guide as said connected end is moved along said inclined section.

17. The vertical conveyor of claim 13 wherein said carrier includes a pair of sides defining a width therebetween, wherein said rail includes first and second rail sections spaced from one another a distance that is at least equal to said width, wherein said carrier includes rollers coupled to said carrier and extending forward of said free end and outward from said sides, and wherein said drive includes first and second stands of chain spaced from one another by a distance greater than the distance between said rollers.

18. A multi-floor conveyor system comprising:

first and second supply conveyors;

first and second discharge conveyors, said first supply conveyor positioned vertically above said first discharge conveyor, said first discharge conveyor positioned above said second supply conveyor, said second supply conveyor positioned above said second discharge conveyor;

a first vertical conveyor positioned to receive a payload from the first supply conveyor and transport the payload to the first discharge conveyor;

a second vertical conveyor positioned to receive a payload from said second supply conveyor and transport the payload to said second discharge conveyor; and

wherein said first and second conveyors include a support and a drive coupled to said support to move in a drive path, said first conveyor having a first conveying zone between said first supply and first discharge conveyors, said second conveyor having a second conveying zone between said second supply and second discharge

conveyors, and said drive path including a return zone after the second discharge conveyor, the drive path further including a first transition zone between said return zone and said first supply conveyor and a second transition zone between said first discharge conveyor and second supply conveyor, the first and second vertical conveyors further including a carrier having a free end and a connected end, said connected end pivotally coupled to said drive, said carrier being in a return position when said carrier is in said return zone and an operative position when said carrier is in either of said first and second conveying zones, each of said transition zones including a positioning assembly coupled to said support and having a guide, said guides positioned to engage said free end of said carrier as said carrier moves through one of said first and second transition zones and to move said carrier from said return position to said operative position.

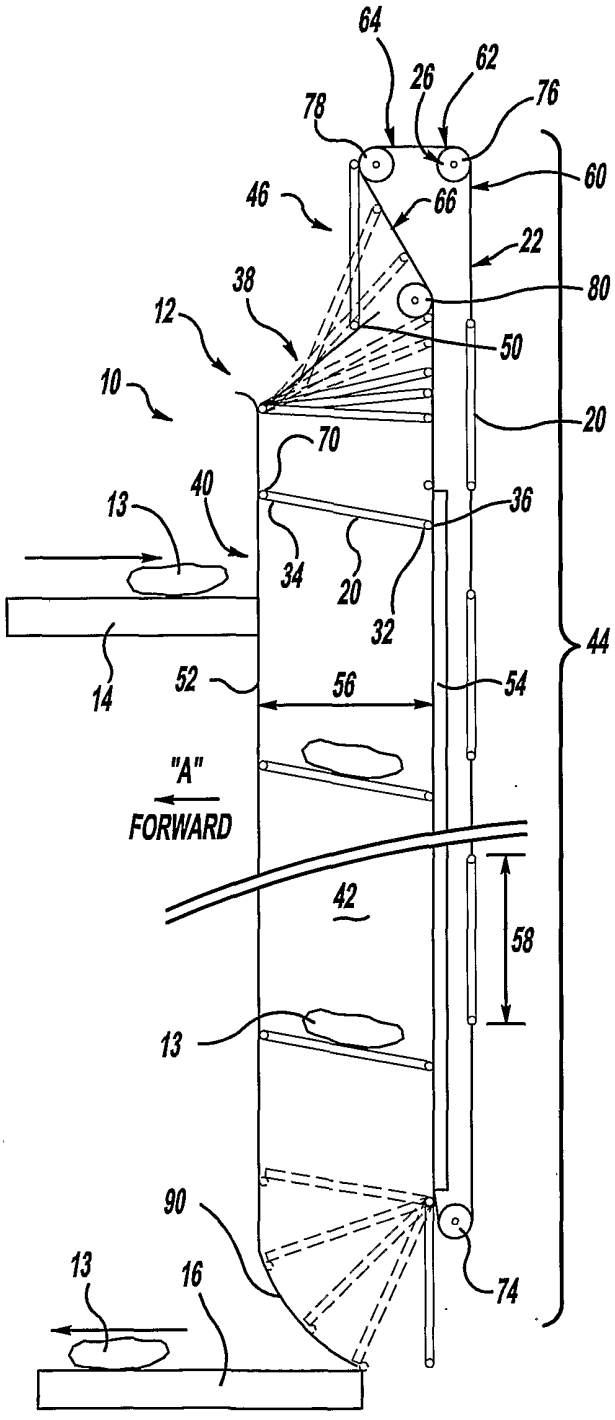

Figure - 1

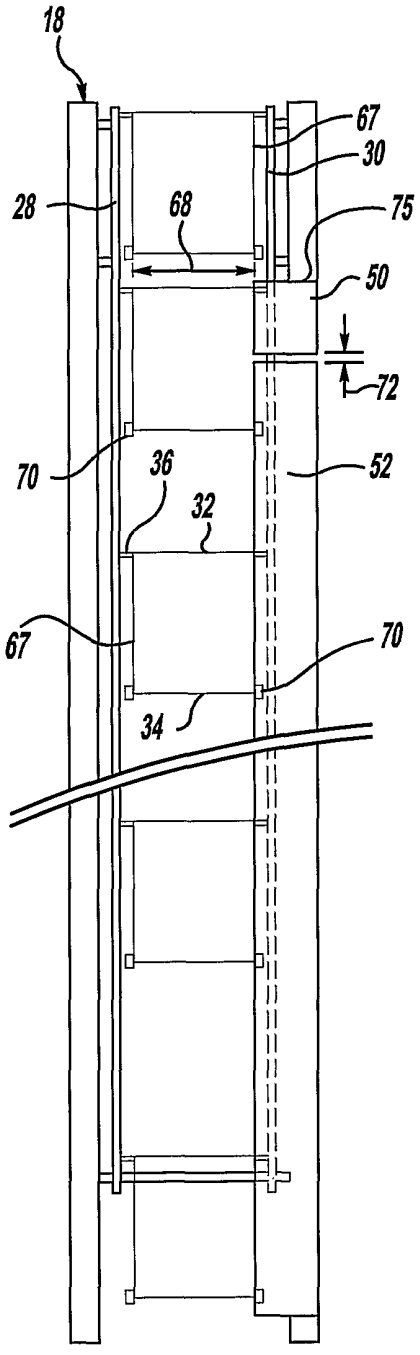

Figure - 2

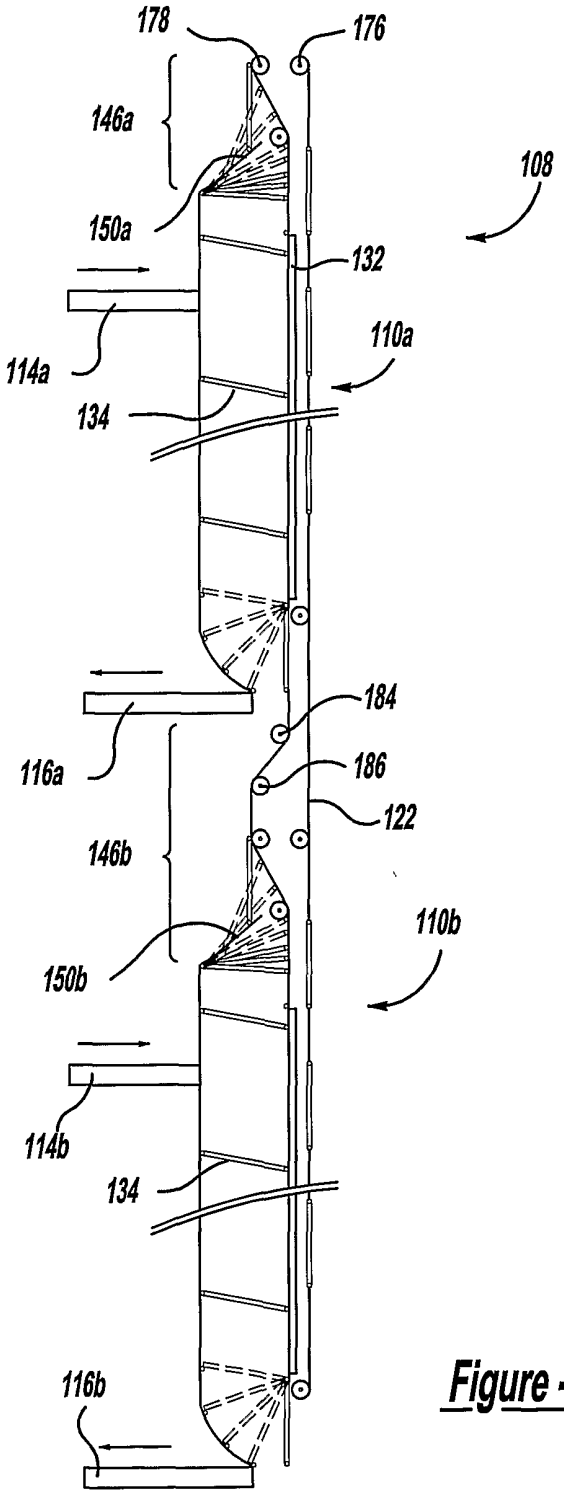
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Figure - 3