

DESCRIPTION

CONVEYOR APPARATUS

5 Technical Field

[0001]

The present invention relates to a conveyor apparatus suitably usable for carrying soil excavated from an underground excavation site through a vertical shaft or an inclined shaft to the ground through a shaft.
10

Background Art

[0002]

For example, in a shield tunneling method, after establishing a vertical shaft of a predetermined depth, a shield excavator is introduced through the vertical shaft, and the underground is excavated by this excavator. In this type of underground construction, it is common to elevate the excavation soil generated by excavation from the inside of the tunnel to the ground through the vertical shaft and discharge the soil from a soil discharge position on the ground by a dump truck or the like.
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Herein, when carrying excavation soil using a belt conveyor, depending on a conventional belt conveyor, there is a limit to the tilt angle at which soil can be conveyed. For this reason, conventionally, various types of lifting equipment have been separately required when transporting excavation soil via the vertical shaft or the inclined shaft.
25

[0003]

Therefore, to cope with such a problem, for example, PTL
1 discloses a conveyor apparatus suitable for carrying
excavation soil from an excavation site to the above ground
5 through a vertical shaft.

For example, the PTL 1 describes that a conveying member
is equipped in a vertical conveyance unit in a circulatable
manner, and the conveying member is configured to scoop a
conveyance object fed from a lower horizontal conveyance unit
10 into the vertical conveyance unit and deliver the conveyance
object to the upper horizontal conveyance unit.

Citation List

Patent Literature

15 [0004]

PTL 1: H09-020412

Summary of Invention

Technical Problem

20 [0005]

However, the technology described in PTL 1 requires the
conveying member in the vertical conveyance unit that carries
the excavation soil separately from the conveyor apparatus.
Therefore, the structure of the conveyor apparatus becomes
25 complicated.

Also, with the technology described in PTL 1, there is
a problem that the spillage of the cargo tends to occur because

the conveying member faces upside down on the return side of the vertical conveyance unit.

Therefore, the present invention has been made focusing on such a problem, and it is an object of the present invention to provide a conveyor apparatus suitable for continuous conveyance in the vertical direction without causing complicated device configuration and any spillage of cargo.

Solution to Problem

[0006]

10 In order to achieve the object mentioned above, according to an aspect of the present invention, there is provided a conveyor apparatus including: a plurality of outgoing path side guide pulleys and a plurality of returning path side guide pulleys disposed along a helical conveyance path extending in a vertical direction and arranged at positions where inflection points of the conveyance path are formed such that the plurality of outgoing path side guide pulleys and the plurality of returning path side guide pulleys form the inflection points; an endless conveyor belt wound around the plurality of outgoing path side guide pulleys in turn along the helical conveyance path in a bent state where the endless conveyor belt is folded in two in a width direction in such a manner that an upper edge portion of the endless conveyor belt is supported by the plurality of outgoing path side guide pulleys, the endless conveyor belt being wound around the 25 plurality of returning path side guide pulleys in turn along the helical conveyance path in the bent state where the endless conveyor belt is folded in two in the width direction

in such a manner that the upper edge portion is supported by the plurality of returning path side guide pulleys, and further, the endless conveyor belt being folded back at turning positions of an upper side and a lower side of the conveyance path and being in an expanded state where the endless conveyor belt is expanded in the width direction in a vicinity of each of the turning positions; a pair of an upper side turning pulley and a lower side turning pulley configured to support and guide the conveyor belt to stretch at the respective turning positions; and a drive motor configured to drive at least one of the plurality of outgoing path side guide pulleys, the plurality of returning path side guide pulleys, and the pair of upper side turning pulley and the lower side turning pulley.

[0007]

According to this conveyor apparatus, the conveyor belt circulates endlessly by driving the drive motor, and excavation soil is placed on the conveyor belt in the expanded state in the vicinity of the turning position on the lower side of the conveyance path. Then, when the conveyor belt shifts to the bent state where the conveyor belt is folded in two in the width direction, the conveyor belt holds the placed excavation soil to surround the excavation soil, and while keeping its holding state, the conveyor belt can convey the excavation soil toward the upper side of the conveyance path along the helical conveyance path on the outgoing path side.

[0008]

Furthermore, in the vicinity of the turning position on the upper side of the conveyance path, the conveyor belt is made to be in the expanded state again from the bent state to unload the excavation soil from the conveyor belt and continuously lift soil, and furthermore, Furthermore, the conveyor belt can be returned from the expanded state to the bent state again and return to the returning route.

Therefore, it is possible to provide a conveyor apparatus suitable for continuous conveyance in the vertical direction without making a complicated device configuration.

[0009]

Furthermore, according to this conveyor apparatus, in both of the outgoing path side and the returning path side, the conveyor belt is in the bent state where the conveyor belt is folded in two in the width direction in the conveyance excluding the vicinity of the turning position, and therefore, the conveyor belt can be held to surround the excavation soil, and can prevent or suppress the spillage of the cargo. In addition, the conveyor belt can lift soil by conveying the excavation soil at the outgoing path side, and convey other items such as materials on the returning path side where the excavation soil has been removed.

[0010]

In the conveyor apparatus described above, the positions where the inflection points are formed are preferably set at corner portions of the polygonal shape when viewed from above.

In the conveyor apparatus described above, the positions where the inflection points are formed are preferably set at

corner portions of a support frame having an axis extending in a vertical direction and having a polygonal shape when viewed from above.

[0011]

5 According to this conveyor apparatus, a portion forming the inflection point is set at the corner portion of the support frame having the polygonal shape, and the outgoing path side guide pulley and the returning path side guide pulley can be disposed at the corner portion of the support
10 frame.

 Further, in the above-described conveyor apparatus, the support frame preferably include a plurality of support shafts disposed such that their axes extend in a vertical direction, and disposed such that the plurality of support
15 shafts form a polygonal shape transverse section, and the plurality of outgoing path side guide pulleys and the returning path side guide pulleys are preferably disposed on the plurality of support shafts positioned at corner portions of the support frame.

20 [0012]

 According to this conveyor apparatus, it is possible to appropriately arrange a plurality of outgoing path side guide pulleys and returning path side guide pulleys after constructing the support frame with a simple structure.

25 Furthermore, in the conveyor apparatus described above, the upper edge portion of the conveyor belt in the bent state where the conveyor belts is folded in two in the width direction is preferably supported by a plurality of conveyor

belt support mechanisms, and each of the conveyor belt support mechanisms includes a roller support plate attached to each of a plurality of support shafts positioned between the corner portions of the support frame to protrude outwardly, an outer
5 side support roller attached to the position of the outer side spaced from the support shaft of the roller support plate, and an inner side support roller attached to the inner side position with respect to the outer side support roller of the roller support plate, and it is preferable to sandwich and
10 support, from the outside and inside, the upper edge portion of the conveyor belt in a bent state where the conveyor belt is folded in two in the width direction by the outer side support roller and the inner side support roller.

[0013]

15 According to this conveyor apparatus, the upper edge portion of the bent state conveyor belt folded in two in the width direction is supported by the plurality of conveyor belt support mechanisms. Therefore, it is possible to reliably maintain the bent state of the conveyor belt. Since each of
20 the conveyor belt support mechanisms sandwiches and supports, from the outside and inside, the upper edge portion of the bent state conveyor belt folded in two in the width direction with the outer side support roller and the inner side support roller, the running resistance of the conveyor belt can be
25 reduced.

[0014]

In the conveyor apparatus described above, the drive motor is preferably provided in a dispersed manner at some

locations among positions of the plurality of outgoing path side guide pulleys, the plurality of returning path side guide pulleys, the upper side turning pulley, and the lower side turning pulley.

5 According to this conveyor apparatus, since the drive motors are disposed in a dispersed manner, the tension of the conveyor belt can be reduced and a high lift conveyance can be realized.

Advantageous Effects of Invention

10 [0015]

 According to the conveyor apparatus of the present invention, it is possible to provide a conveyor apparatus suitable for continuous conveyance in the vertical direction without causing complicated device configuration and any
15 spillage of cargo.

Brief Description of Drawings

[0016]

 FIG. 1 is a schematic front view illustrating a conveyor
20 apparatus according to an embodiment of the present invention;

 FIG. 2 is a schematic left side view illustrating a conveyor apparatus illustrated in FIG. 1;

 FIG. 3 is a schematic rear view illustrating a conveyor
25 apparatus illustrated in FIG. 1;

 FIG. 4 is a schematic view taken along the line 4-4 in FIG. 1;

FIG. 5 is a schematic plan view illustrating a conveyor apparatus illustrated in FIG. 1;

FIG. 6 is a view as seen from the direction indicated by an arrow 6 in FIG. 1;

5 FIG. 7 is a view as seen from the direction indicated by an arrow 7 in FIG. 1;

FIG. 8 is an expanded view of the conveyor apparatus illustrated in FIG. 1;

10 FIGS. 9A and 9B illustrate how to support the upper edge portion of the conveyor belt in the bent state where the conveyor belt is folded in two in the width direction by the conveyor belt support mechanism, and FIG. 9A illustrates a right side view and FIG. 9B illustrates a front view;

15 FIG. 10 is a schematic diagram illustrating a modification of the conveyor belt support mechanism; and

FIG. 11 is a cross-sectional view illustrating how the upper edge portion of the conveyor belt is supported on the outer circumference of the outgoing path side first guide pulley.

20

Description of Embodiments

[0017]

An embodiment of the present invention will be described below with reference to FIGS. 1 to 10.

25 The conveyor apparatus 1 illustrated in FIG. 1 is used to carry soil excavated from the underground excavation site via a vertical shaft or an inclined shaft to the ground via the vertical shaft, and includes a horizontal conveyance unit

2 located on the lower side within the vertical shaft, a vertical conveyance unit 3 extending vertically within the vertical shaft, and a horizontal conveyance unit 4 located on the ground.

5 [0018]

In this conveyor apparatus 1, as illustrated in FIG. 1 to FIG. 6, a plurality of outgoing path side first to sixth guide pulleys 21 to 26 and returning path side second to seventh guide pulleys 32 to 37 forming inflection points P11 to P16 of conveyance path are disposed along the vertically
10 extending helical conveyance path and at positions P1 to P6 where the inflection points P11 to P16 are formed, in the vertical conveyance unit 3.

In the present embodiment, the positions P1 to P6 forming
15 the inflection points P11 to P16 of the conveyance path are set at corner portions of a quadrangular shape when viewed from above and are set in such a manner that the axis extends in the vertical direction and are set at corner portions of the support frame 10 having a quadrangular shape when viewed
20 from above.

[0019]

As illustrated in FIG. 1 to FIG. 6, the support frame 10 includes a plurality of support shafts 12 disposed in such a manner that their axes extend in a vertical direction and
25 the plurality of support shafts 12 are disposed at a predetermined pitch such that the plurality of support shafts 12 form a quadrangular shape transverse section . Each

support shaft 12 has a lower end fixed to the bottom plate 11 and an upper end fixed to the top plate 13.

The four support shafts 12 positioned at the corner portions of the support frame 10 where the positions P1 to P6 forming the inflection points P11 to P16 of the conveyance path are set respectively include a plurality of (in the present embodiment, six) outgoing path side first to sixth guide pulleys 21 to 26 and a plurality of (in this embodiment, six) returning path side second to seventh guide pulleys 32 to 37.

[0020]

Specific arrangement of these outgoing path side first to sixth guide pulleys 21 to 26 and returning path side second to seventh guide pulleys 32 to 37 will be described. At the lower part of the support shaft 12 disposed at the lower left corner portion in FIG. 4, the outgoing path side first guide pulley 21 is disposed on the upper side, and the returning path side seventh guide pulley 37 is disposed on the lower side. Also, at the position of the support shaft 12 disposed at the upper left corner portion in FIG. 4 and upper than the outgoing path side first guide pulley 21, the outgoing path side second guide pulley 22 is disposed on the upper side, and the returning path side sixth guide pulley 36 is disposed on the lower side. Similarly, at the position of the support shaft 12 disposed at the upper right corner portion in FIG. 4 and upper than the outgoing path side second guide pulley 22, the outgoing path side third guide pulley 23 is disposed on the upper side, and the returning path side fifth guide

pulley 35 is disposed on the lower side. Also, at the position of the support shaft 12 disposed at the lower right corner portion in FIG. 5 and upper than the outgoing path side third guide pulley 23, the outgoing path side fourth guide pulley 24 is disposed on the upper side, and the returning path side fourth guide pulley 34 is disposed the lower side. Also, at the position of the support shaft 12 arranged at the lower left corner portion in FIG. 5 and upper than the outgoing path side fourth guide pulley 24, the outgoing path side fifth guide pulley 25 is arranged on the upper side, and the returning path side third guide pulley 33 is arranged on the lower side. Further, at the position of the support shaft 12 disposed at the upper left corner portion in FIG. 5 and upper than the outgoing path side fifth guide pulley 25, the outgoing path side sixth guide pulley 26 is disposed on the upper side, and the returning path side second guide pulley 32 is disposed on the lower side.

[0021]

More specifically, the outgoing path side first to sixth guide pulleys 21 to 26 are provided at positions spirally gradually raising along the outer circumference of the rectangular support frame 10 to spirally raise the conveyor belt 40. Also, the returning path side second to seventh guide pulleys 32 to 37 are provided at positions spirally gradually descending along the outer circumference of the rectangular support frame 10 to spirally descend the conveyor belt 40.

[0022]

As illustrated in FIG. 1, FIG. 3 and FIG. 5, a plurality of support shafts 15 are provided in the horizontal conveyance unit 4 positioned on the ground to extend in the installation direction of the support shaft 12. On the endmost support shaft 15, the outgoing path side seventh guide pulley 27 is arranged on the upper side, and the returning path side first guide pulley 31 is arranged on the lower side.

Herein, the outgoing path side first to sixth guide pulleys 21 to 26 are inclined with respect to the horizontal direction along a helical conveyance path and are rotatable around the respective support shafts 12. Each of the returning path side second to seventh guide pulleys 32 to 37 is inclined with respect to the horizontal direction along a helical conveyance path, and is rotatable about each support shaft 12. The outgoing path side seventh guide pulley 27 is rotatable around the support shaft 15. The returning path side first guide pulley 31 is rotatable around the support shaft 15.

[0023]

The conveyor apparatus 1 also has an endless conveyor belt 40. This conveyor belt 40 is wound around the outer circumference of the outgoing path side first to seventh guide pulleys 21 to 27 in turn along a helical conveyance path in a bent state where the conveyor belt folded in two in a width direction in such a manner that the upper edge portion 41 of the conveyor belt is supported by the outer circumference of the outgoing path side first to seventh guide pulleys. Also, the conveyor belt 40 is wound around the outer circumference

of the returning path side first to seventh guide pulley 31 to 37 in turn along a helical conveyance path in the bent state where the conveyor belt folded in two in a width direction in such a manner that the upper edge portion 41 is supported
5 by the outer circumference of the returning path side first to seventh guide pulley. The conveyor belt 40 is folded back at each turning position of the horizontal conveyance unit 4 positioned on the upper side of the conveyance path and the horizontal conveyance unit 2 positioned on the lower side of
10 the conveyance path.

[0024]

Herein, an upper side turning pulley 51 is provided at the turning position of the horizontal conveyance unit 4 positioned at the upper side of the conveyance path as
15 illustrated in FIG. 1 and FIG. 5. The upper side turning pulley 51 guides the conveyor belt 40 while supporting the conveyor belt 40 to stretch at the turning position. The upper side turning pulley 51 is rotatably supported on the support member 53. Also, as illustrated in FIG. 1 and FIG.
20 5, a lower side turning pulley 52 is provided at the turning position of the horizontal conveyance unit 2 positioned on the lower side of the conveyance path. The lower side turning pulley 52 guides the conveyor belt 40 while supporting the conveyor belt 40 to stretch at the turning position. The
25 lower side turning pulley 52 is rotatably supported on the support shaft 14.

[0025]

As illustrated in FIG. 5, at the outgoing path side, the conveyor belt 40 is wound around the outer circumference of the outgoing path side seventh guide pulley 27 in the bent state where the conveyor belt is folded in two in the width direction to turn 90 degrees, and is caused to be in an expanded state where the conveyor belt is expanded in the width direction in the vicinity B of the turning position of the horizontal conveyance unit 4 positioned at the upper side of the conveyance path, and is folded back still in the expanded state with upper side turning pulley 51. Then, after the conveyor belt 40 is folded back in the expanded state with the upper side turning pulley 51, as illustrated in FIG. 7, the conveyor belt 40 passes through the guide rollers 54, 55 to be in the bent state where the conveyor belt is folded in two in the width direction on the front side of the returning path side first guide pulley 31, and is wound around the returning path side first guide pulley 31.

[0026]

Further, as illustrated in FIG. 4, the conveyor belt 40 is folded back at the returning path side with the lower side turning pulley 52 in the bent state where the conveyor belt is folded in two in the width direction, and thereafter, the conveyor belt 40 is once caused to be in the expanded state where the conveyor belt is expanded in the width direction in the vicinity A of the turning position of the horizontal conveyance unit 2 positioned on the lower side of the conveyance path. Then, the conveyor belt 40 is again wound around the outer circumference of the outgoing path side first

guide pulley 21 in the bent state where the conveyor belt is folded in two in the width direction. How to perform reciprocating conveyance and expansion of the conveyor belt 40 will be described in detail later.

5 [0027]

As illustrated in FIG. 1, a drive motor 60 for driving the upper side turning pulley 51 is connected to the upper side turning pulley 51. Although not illustrated, a plurality of drive motors for driving the guide pulley are also dispersedly arranged in the outgoing path side first guide pulley 21, the outgoing path side third guide pulley 23, and the outgoing path side fifth guide pulley 25.

In addition, the upper edge portion of the bent state conveyor belt 40 folded in two in the width direction is supported by a plurality of conveyor belt support mechanisms 70.

[0028]

In the vertical conveyance unit 3, each conveyor belt support mechanism 70 is attached to each of the plurality of support shafts 12 positioned between the corner portions of the support frame. As illustrated in FIGS. 9A and 9B, each conveyor belt support mechanism 70 includes a roller support plate 71 attached to each support shaft 12 to protrude outwardly, an outer side support roller 72 attached to the position of the outer side spaced from the support shaft 12 of the roller support plate 71, and an inner side support roller 73 attached to the position of the inner side with respect to the outer side support roller 72 of the roller

support plate 71. The upper edge portion 41 of the conveyor belt 40 in the bent state where the conveyor belt is folded in two in the width direction constituted of an end portion 40a on one side of the conveyor belt 40 and an end portion 40b on the other side is sandwiched and supported by the outer side support roller 72 and the inner side support roller 73 from the outside and inside.

[0029]

As illustrated in FIG. 9A, the roller support plate 71 of each conveyor belt support mechanism 70 includes a flat plate portion 71a in a straight shape fixed to the support shaft 12 and extending in the inward and outward direction, an extension portion 71b extending downward from the outer end of the flat plate portion 71a and extending outwardly, and a pendent portion 71c extending downwardly from the portion of the inner side with respect to the outer end of the flat plate portion 71a. The outer side support roller 72 is rotatably supported on the lower surface of the outer extension portion of the extension portion 71b. The inner side support roller 73 is formed in a truncated cone shape and is rotatably supported on the outer surface of the pendent portion 71c. Further, an auxiliary guide roller 74 is rotatably supported between the inner surface of the downward extending portion of the extension portion 71b and the outer surface of the pendent portion 71c. This auxiliary guide roller 74 guides the upper edge portion 41 of the conveyor belt 40 when the upper edge portion 41 moves upward.

[0030]

Also, in the horizontal conveyance unit 4 positioned on the upper side of the support frame 10, as illustrated in FIG. 3, each conveyor belt support mechanism 70 is attached to each of the plurality of support shafts 15 except the support shafts 15 where the outgoing path side seventh guide pulley 27 and the returning path side first guide pulley 31 are supported. The structure of the conveyor belt support mechanism 70 is the same as that of the conveyor belt support mechanism 70 described above.

10 [0031]

Furthermore, in the horizontal conveyance unit 2 located on the lower side of the conveyance path, as illustrated in FIG. 1 and FIG. 4, at positions other than the area where the conveyor belt 40 is in the expanded state, a plurality of support shafts 14 are provided to extend in the installation direction of the support shaft 12. Each conveyor belt support mechanism 70 is attached to each of the plurality of support shafts 14 except the support shaft 14 where the lower side turning pulley 52 is supported. The structure of the conveyor belt support mechanism 70 is the same as that of the conveyor belt support mechanism 70 described above.

[0032]

In the conveyor apparatus 1 thus configured, as illustrated in an expanded manner in FIG. 8, at the outgoing path side, at the horizontal conveyance unit 2, the conveyor belt 40 in the bent state where the conveyor belt is folded in two in the width direction is folded back with the lower side turning pulley 52. Thereafter, as illustrated in FIG.

4, the conveyor belt 40 is caused to be once in the expanded state where the conveyor belt is expanded in the width direction in the vicinity A of the turning position. At this time, a widening member 42 is inserted in to the conveyor belt
5 40 in the in the bent state where the conveyor belt is folded in two in the width direction, and the conveyor belt 40 is expanded in the width direction by the action of the widening member 42. Then, the conveyor belt 40 is caused to be again in the bent state where the conveyor belt is folded in two
10 in the width direction by the action of the conveyor belt support mechanism 70. The belt is conveyed up to the outgoing path side first guide pulley 21 of the vertical conveyance unit 3.

[0033]

15 The conveyor belt 40 in the bent state where the conveyor belt is folded in two in the width direction is sequentially guided along the outer circumference of the outgoing path side first guide pulley 21, the outer circumference of the outgoing path side second guide pulley 22, the outer circumference of
20 the outgoing path side third guide pulley 23, the outer circumference of the outgoing path side fourth guide pulley 24, the outer circumference of the outgoing path side fifth guide pulley 25, and the outer circumference of the outgoing path side sixth guide pulley 26 in this order, and the conveyor
25 belt 40 is conveyed to spirally rise in the support frame 10 while changing the direction by 90 degrees at the inflection point P11 to P16 of the outgoing path side first to the sixth guide pulleys 21 to 26.

[0034]

Herein, each outgoing path side first to sixth guide pulleys 21 to 26 has an extremely large diameter as compared with the support shaft 12. Therefore, the curvature of the conveyor belt 40 guided along the outer circumference of the outgoing path side first to the sixth guide pulleys 21 to 26 is small. This makes it possible to reduce running resistance of the conveyor belt 40.

The conveyor belt 40 guided along the outer side of the outgoing path side sixth guide pulley 26 is guided, in the horizontal conveyance unit 4, along the outer side of the outgoing path side seventh guide pulley 27 to be turned 90 degrees in the bent state where the conveyor belt is folded in two in the width direction.

[0035]

Herein, in the outgoing path side, the upper edge portion of the bent state conveyor belt 40 folded in two in the width direction is supported by the plurality of conveyor belt support mechanisms 70. Therefore, the bent state of the conveyor belt 40 is reliably maintained. Each conveyor belt support mechanism 70 sandwiches and supports, from the outside and inside, the upper edge portion 41 of the bent state conveyor belt folded in two in the width direction by the outer side support roller 72 and the inner side support roller 73. Therefore, the running resistance of the conveyor belt 40 can be reduced.

[0036]

The auxiliary guide roller 74 guiding the upper edge portion 41 when the upper edge portion 41 of the conveyor belt 40 moves upward is rotatably supported between the inner surface of the downwardly extending portion of the extension portion 71b supporting the outer side support roller 72 and the outer surface of the pendent portion 71c supporting the inner side support roller 73. Therefore, even if the upper edge portion 41 of the conveyor belt 40 moves upward, the traveling of the conveyor belt 40 is guided by the auxiliary guide roller 74 and does not become a resistance.
[0037]

Then, in the bent state where the conveyor belt is folded in two in the width direction, the conveyor belt 40, turned by being guided along the outer side of the outgoing path side seventh guide pulley 27, is caused to be in the expanded state where the conveyor belt is expanded in the width direction at the vicinity B of the turning position of the horizontal conveyance unit 4, and as illustrated in FIG. 7, the conveyor belt 40 is folded back in the expanded state with the upper side turning pulley 51.

Then, the conveyor belt 40 folded back in the expanded state with the upper side turning pulley 51 passes through the guide rollers 54, 55, and thereafter, the conveyor belt 40 is caused to be in the bent state where the conveyor belt is folded in two in the width direction on the front side of the returning path side first guide pulley 31 by the action of the conveyor belt support mechanism 70.

The conveyor belt 40 bent in the width direction and folded in two is guided along the outer circumference of the returning path side first guide pulley 31 and at the returning path side, the conveyor belt 40 is conveyed to the outgoing
5 path side second guide pulley 32 of the vertical conveyance unit 3.

[0038]

The conveyor belt 40 in the bent state where the conveyor belt is folded in two in the width direction is sequentially
10 guided along the outer circumference of the returning path side second guide pulley 32, the outer circumference of the returning path side third guide pulley 33, the outer circumference of the returning path side fourth guide pulley 34, the outer circumference of the returning path side fifth
15 guide pulley 35, the outer circumference of the returning path side sixth guide pulley 36, and the outer circumference of the returning path side seventh guide pulley 37 in this order, and the conveyor belt 40 is conveyed to descend spirally in the support frame 10 while changing the direction by 90
20 degrees at the inflection point P16 to P11 of the returning path side second to seventh guide pulleys 32 to 37.

[0039]

Herein, each of returning path side second to seventh guide pulley 32 to 37 has an extremely large diameter as
25 compared with support shaft 12. Therefore, the curvature of the conveyor belt 40 guided along the outer circumference of the returning path side second to seventh guide pulleys 32

to 37 is small. This makes it possible to reduce running resistance of the conveyor belt 40.

Then, the conveyor belt 40 guided along the outer side of the returning path side seventh guide pulley 37 is conveyed
5 up to the lower side turning pulley 52 in the horizontal conveyance unit 2 in the bent state where the conveyor belt is folded in two in the width direction.

[0040]

Then, as long as the drive motor is driving, the conveyor
10 belt 40 repeatedly performs the outgoing path side operation and the returning path side operation and endlessly circulates.

Herein, in the returning path side, the upper edge portion of the bent state conveyor belt 40 folded in two in
15 the width direction is supported by the plurality of conveyor belt support mechanisms 70, and therefore, the bent state of the conveyor belt 40 is reliably maintained. Each conveyor belt support mechanism 70 sandwiches and supports the upper edge portion 41 of the bent state conveyor belt folded in two
20 in the width direction by the outer side support roller 72 and the inner side support roller 73 from the outside and inside. Therefore, the running resistance of the conveyor belt 40 can be reduced.

[0041]

25 An auxiliary guide roller 74, guiding the upper edge portion 41 of the conveyor belt 40 when the upper edge portion 41 moves upward, is rotatably supported between the inner surface of the downwardly extending portion of the extension

portion 71b supporting the outer side support roller 72 and the outer surface of the pendent portion 71c supporting the inner side support roller 73. Therefore, even if the upper edge portion 41 of the conveyor belt 40 moves upward, the traveling of the conveyor belt 40 is guided by the auxiliary guide roller 74 and does not become a resistance.

[0042]

Hereinafter explained is a method of carrying the soil excavated from the underground excavation site by the conveyor apparatus 1 constituted as described above to the ground via the vertical shaft.

At the horizontal conveyance unit 2 at the outgoing path side of the conveyor belt 40, when the conveyor belt 40 is expanded in the width direction in the vicinity A of the turning position, the soil excavated from the underground excavation site is placed on the conveyor belt 40. Then, when the conveyor belt 40 is in the bent state where the conveyor belt 40 is folded in two in the width direction, the placed excavation soil is held to be surrounded by the conveyor belt 40. While the retained state is maintained by the conveyor belt 40, the excavation soil spirally ascends through the vertical conveyance unit 3 while changing the direction by 90 degrees at the inflection point P11 to P16 of the outgoing path side first to sixth guide pulleys 21 to 26, and the excavation soil is conveyed to the horizontal conveyance unit 4.

[0043]

And at the horizontal conveyance unit 4, the excavation soil is turned by 90 degrees with outgoing path side seventh guide pulley 27 together with the conveyor belt 40 while being held to be surrounded by the conveyor belt 40. The excavation
5 soil can then be removed from the conveyor belt 40 when the conveyor belt 40 is caused to be in the expanded state where the conveyor belt is expanded in the width direction in the vicinity B of the turning position.

Therefore, the excavation soil can be unloaded
10 continuously from the conveyor belt 40 in the vicinity B of the turning position.

[0044]

Then, the conveyor belt 40 from which the excavation soil has been removed is folded back in the expanded state by the
15 upper side turning pulley 51 and passes through the guide rollers 54, 55, and thereafter, with the action of the conveyor belt support mechanism 70, the conveyor belt 40 is caused to be in the bent state where the conveyor belt is folded in two in the width direction on the front side of the returning
20 path side first guide pulley 31.

Then, the conveyor belt 40 is turned by the returning path side first guide pulley 31 while being in the bent state where the conveyor belt is folded in two in the width direction at the returning path side, and furthermore, the conveyor belt
25 40 spirally descends in the vertical conveyance unit 3 while changing the direction by 90 degrees at the inflection points P16 to P11 of the returning path side second to seventh guide pulleys 32 to 37, and the conveyor belt 40 is conveyed to the

horizontal conveyance unit 2 to return to the original position.

[0045]

5 In this way, according to the conveyor apparatus 1, the continuous conveyance in the vertical direction is enabled without having a complicated device configuration. Further, continuous conveyance in the horizontal and vertical directions and in the horizontal direction is enabled with a single conveyor apparatus.

10 Herein, in both the outgoing path side and the returning path side of the conveyor belt 40, the conveyor belt 40 are in the bent state where the conveyor belt is folded in two in the width direction in the conveyance excluding the vicinities A and B of the turning positions, and the excavation soil is held to be surrounded by the conveyor belt 15 40, and therefore, the spillage of the cargo can be prevented or suppressed.

[0046]

20 Furthermore, in both the outgoing path side and the returning path side, the conveyor belt 40 is in the bent state where the conveyor belt is folded in two in the width direction in the conveyance excluding the vicinities A and B of the turning positions, and therefore, the conveyor belt can lift soil by conveying the excavation soil at the outgoing path 25 side, and convey other items such as materials on the returning path side where the excavation soil has been removed.

Furthermore, both the outgoing path side and the returning path side of the conveyor belt 40 are in the bent state where the conveyor belt is folded in two in the width direction in the conveyance excluding the vicinities A and B of the turning positions. Even when there are large stones and small sand mixed in the excavation soil, the excavation soil enclosing those big stones and small sand can be wrapped and conveyed by the conveyor belt 40.

[0047]

10 In both of the outgoing path side and the returning path side, the conveyor belt 40 is in the bent state where the conveyor belt is folded in two in the width direction in the conveyance excluding the vicinities A and B of the turning positions, and the excavation soil is held to be surrounded by the conveyor belt 40, and therefore, even when emergency stop occurs during the conveyance, there is no fear of the spillage of the cargo.

The upper side turning pulley 51, the outgoing path side first guide pulley 21, the outgoing path side third guide pulley 23, and the outgoing path side fifth guide pulley 25 are provided with drive motors respectively driving the guide pulleys at a plurality of locations in a dispersed manner, and therefore, the tension of the conveyor belt can be reduced.

25 [0048]

Although the embodiments of the present invention have been described above, the present invention is not limited

thereto and various modifications and improvements can be made.

For example, the conveyor apparatus 1 is used not only to transport soil excavated from underground excavation sites via a vertical shaft or an inclined shaft to the ground through the vertical shaft, but also to convey the stored materials such as coal to the silos that store the stored materials. [0049]

In the conveyor apparatus 1, the horizontal conveyance units 2, 4 are not always necessary. In this case, the conveyor belt 40 is folded back at the turning positions of the upper side and the lower side in the conveyance direction of the vertical conveyance unit 3 extending in the vertical direction, and is caused to be in the expanded state where the conveyor belt is expanded in the width direction at the vicinity of each turning position. In addition, the lower side turning pulley 52 and the upper side turning pulley 51 may guide and support the conveyor belt 40 so as to stretch the conveyor belt at the respective turning positions instead of the horizontal conveyance units 2 and 4. [0050]

The position P1 to P6 forming the inflection points P11 to P16, where the outgoing path side first to sixth guide pulleys 21 to 26 and the returning path side second to seventh guide pulleys 37 are disposed, do not necessarily have to be set at corner portions in a polygonal shape including a quadrangular shape when viewed from above. For example, position P1 to P6 forming the inflection points P11 to P16

may be set at corner portions in a Z shape when viewed from above.

The positions P1 to P6 forming the inflection points P11 to P16 do not necessarily have to be set at corner portions of the support frame 10 having a polygonal shape including a quadrangular shape when viewed from above. The outgoing path side guide pulleys and the returning path side guide pulleys may be disposed at the positions forming the inflection points P 11 to P 16 other than the corner portions of the support frame 10 (for example, other members disposed in the vertical shaft).

[0051]

The support frame 10 may not have a quadrangular shape when viewed from above and may have be in other polygonal shapes.

The support frame 10 may be disposed in such a manner that the axis of the support frame 10 extends in a vertical direction and has a polygonal shape when viewed from above and the plurality of support shafts 12 do not necessarily have to be disposed to form a polygonal shape when viewing from above.

[0052]

The height of the support frame 10 in the vertical conveyance unit 3 may be adjusted according to the height of the vertical shaft, and the numbers of outgoing path side guide pulleys and returning path side guide pulleys are not limited to seven, and are determined by the height of the

support frame 10 and the arrangement pitch in the helical conveyance path.

The drive motor 60 is connected to the upper side turning pulley 51, and a plurality of drive motors, not illustrated, are connected to the outgoing path side first guide pulley 21, the outgoing path side third guide pulley 23, and the outgoing path side fifth guide pulley 25. The drive motor may be connected to drive at least one of the outgoing path side first to seventh guide pulleys 21 to 27, the returning path side first to seventh guide pulley 31 to 37, the upper side turning pulley 51, and the lower side turning pulley 52. [0053]

The structure of the conveyor belt support mechanism 70 is not limited to the examples illustrated in FIGS. 9A and 9B. For example, as illustrated in FIG. 10, a plurality of rollers 75 disposed on a bracket of which lower side is supported (not illustrated) may be arranged along the outer circumference of a conveyor belt 40 folded back in two.

The outgoing path side first to sixth guide pulleys 21 to 26 and the returning path side second to seventh guide pulleys 32 to 37 may not be necessarily disposed to form a pair of upper and lower ones, and may be disposed right and left in parallel.

[0054]

FIG. 11 illustrates how the upper edge portion 41 of the conveyor belt 40 is supported on the outer circumference of the outgoing path side first guide pulley 21. Herein, on the outer circumference surface of the outgoing path side first

guide pulley 21, a first recessed portion 21a having a trapezoidal cross sectional shape is formed endlessly in the circumferential direction, and on the lower side of the first recessed portion 21a, the second recessed portion 21b having a trapezoidal cross sectional shape is formed endlessly in the circumferential direction. The end portion 40a on one side of the conveyor belt 40 constituting the upper edge portion 41 of the conveyor belt 40 is formed into a trapezoidal cross sectional shape having a complementary shape with the first recessed portion 21a, and fitted in the first recessed portion 21a to be supported. On the other hand, the end portion 40b on the other side of the conveyor belt 40 constituting the upper edge portion 41 of the conveyor belt 40 is formed into a trapezoidal cross sectional shape having a complementary shape with the second recessed portion 21b, and fitted in the second recessed portion 21b to be supported.

[0055]

In this way, the end portion 40a on one side of the conveyor belt 40 is fitted and supported in the first recessed portion 21a of the outgoing path side first guide pulley 21, and the end portion 40b on the other side of the conveyor belt 40 is fitted and supported in the second recessed portion 21b of the outgoing path side first guide pulley 21, and in this state, the conveyor belt 40 is wound around the outer circumference of the outgoing path side first guide pulley 21. Although not illustrated, also on the outer circumference surfaces of all of the outgoing path side second to seventh guide pulley 22 to 27 and the returning path side

first to seventh guide pulley 31 to 37, the first recessed portion 21a having the trapezoidal cross section in which the end portion 40a on one side of the conveyor belt 40 formed in the trapezoidal cross section is fitted is formed endlessly
5 in the circumferential direction, and on the lower side of the first recessed portion 21a, the second recessed portion 21b formed in the trapezoidal cross section in which the end portion 40b on the other side of the conveyor belt 40 formed in the trapezoidal cross section is fitted and formed
10 endlessly in the circumferential direction. Therefore, the upper edge portion 41 of the conveyor belt 40 does not slide upward and downward, and the conveyor belt 40 is supported by the outer circumference surface of the outgoing path side first to seventh guide pulleys 21 to 27 and the returning path
15 side first to seventh guide pulley 31 to 37 by appropriate frictional force achieved by concavo-convex fitting, and therefore, the conveyor belt 40 can appropriately and reliably circulate endlessly.

20 Reference Signs List

[0056]

- 1 conveyor apparatus
- 2 horizontal conveyance unit
- 3 vertical conveyance unit
- 25 4 horizontal conveyance unit
- 10 support frame
- 11 bottom plate
- 12 support shaft

13 top plate
14 support shaft
15 support shaft
21 outgoing path side first guide pulley (outgoing path side
5 guide pulley)
22 outgoing path side second guide pulley (outgoing path side
guide pulley)
23 outgoing path side third guide pulley (outgoing path side
guide pulley)
10 24 outgoing path side fourth guide pulley (outgoing path side
guide pulley)
25 outgoing path side fifth guide pulley (outgoing path side
guide pulley)
26 outgoing path side sixth guide pulley (outgoing path side
15 guide pulley)
27 outgoing path side seventh guide pulley (outgoing path side
guide pulley)
31 returning path side first guide pulley (returning path side
guide pulley)
20 32 returning path side second guide pulley (returning path
side guide pulley)
33 returning path side third guide pulley (returning path side
guide pulley)
34 returning path side fourth guide pulley (returning path
25 side guide pulley)
35 returning path side fifth guide pulley (returning path side
guide pulley)

- 36 returning path side sixth guide pulley (returning path side guide pulley)
- 37 returning path side seventh guide pulley (returning path side guide pulley)
- 5 40 conveyor belt
 - 40a end portion on one side
 - 40b end portion on the other side
 - 41 upper edge portion
 - 42 widening member
- 10 51 upper side turning pulley
 - 52 lower side turning pulley
 - 53 support member
 - 54, 55 guide roller
 - 60 drive motor
- 15 70 conveyor belt support mechanism
 - 71 roller support plate
 - 71a flat plate portion
 - 71b extension portion
 - 71c pendent portion
- 20 72 outer side support roller
 - 73 inner side support roller
 - 74 auxiliary guide roller
- A proximity at turning position of horizontal conveyance unit located on lower side of conveyance path
- 25 B proximity at turning position of horizontal conveyance unit located on upper side of conveyance path
 - P1 to P6 positions forming inflection point
 - P11 to P16 inflection points of conveyance path

CLAIMS

1. A conveyor apparatus comprising:

an endless conveyor belt wound around a plurality of outgoing path side guide pulleys and a plurality of returning path side guide pulleys in turn along a helical conveyance path extending in a vertical direction, in a bent state where the endless conveyor belt is folded in two in a width direction, in such a manner that an upper edge portion of the endless conveyor belt is supported by the plurality of outgoing path side guide pulleys and the plurality of returning path side guide pulleys, and, the endless conveyor belt being folded back at turning positions of an upper side and a lower side of the conveyance path and being in an expanded state where the endless conveyor belt is expanded in the width direction in a vicinity of each of the turning positions, and the endless conveyor belt circulating endlessly by driving the drive motor; and

a plurality of conveyor belt support mechanisms configured to support the upper edge portion of the endless conveyor belt in the bent state where the endless conveyor belt is folded in two in the width direction,

wherein, the upper edge portion of the endless conveyor belt in the bent state where the endless conveyor belt is folded in two in the width direction include: the one end of the endless conveyor belt disposed at an upper side; and the another end portion of the endless conveyor belt having an inclined lower surface, the another end portion being vertically arranged at a lower side with respect to the one end, and

each of the plurality of conveyor belt support mechanisms includes:

a roller support plate;

an outer side support roller attached to the roller support plate; and

an inner side support roller attached to a position at an inner side with respect to the outer side support roller of the roller support plate, and

the outer side support roller comes in contact with an outer surface of the one end of the endless conveyor belt and the inner side support roller comes in contact with the inclined lower surface of the another end of endless conveyor belt such that only the outer side support roller and the inner side support roller sandwich and support, from outside and inside, the upper edge portion of the endless conveyor belt in the bent state where the endless conveyor belt is folded in two in the width direction.