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(54) **METHOD FOR HORIZONTAL WINDING AND HORIZONTAL UNWINDING PARALLEL STEEL STRANDED WIRE**

(57) A method for horizontally winding and horizontally unwinding parallel steel wire strands for transport, storage or installation is provided. The method comprises the operation of winding the stranded wire and the operation of unwinding the stranded wire, and includes the following steps: when performing the winding operation, a guiding frame(1) is mounted on the ground, a rotating platform is connected with a rotating shaft (21), the lead-

ing end of the wire stranded is passed through the guiding rollers (17) and then is fixed on an inner module (4), and the platform (2) is rotated around the shaft (21); when performing the unwinding operation, the guiding frame (1) is mounted on the ground and one end of the wound stranded wire is pulled out from the guiding rollers (17). The method enables winding the stranded wire with high quality, high working efficiency and low manufacturing cost.

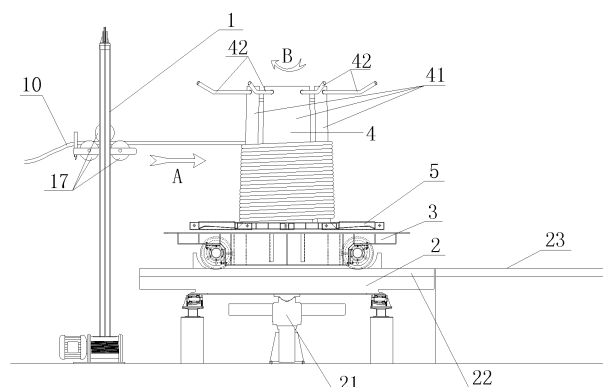


Fig 2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a parallel wire strand consisting of a multiplicity of individual wires. More particular, the invention relates to horizontally winding and unwinding a parallel wire strand consisting of a multiplicity of individual wires onto and from a cable reel for fanning out and rearranging the wire strands for transport, storage or installation.

BACKGROUND OF THE INVENTION

[0002] The main cable strands are the chief bearing members of suspension bridge. The cable strand is made of high strength galvanized wire of 5mm in diameter. Formerly specifications for the cable strand were available in 61 wires, 91 wires and 127 wires. At present the over-length large main cable strands reach 5000m in length, in 169 wires of 5mm diameter. The weight of a cable strand reaches 120 tons. Commonly the cross-section of cable strand is regular hexagon. Some special cable strands may be rectangular or other shapes. A cable strand is bound with composite material bands at interval of 1.5m~2m. Traditionally, the winding of main cable strands of suspension bridge all applied large diameter steel reels for winding horizontal parallel wire strands at home and abroad. This process is called by reel processing for short. The one of the characteristics of reel processing was that the manufacturing, shipping and unwinding of cable strands all could not get rid of large diameter steel reel. During the transportation of cable strands on steel reels to large bridge building site, cable strands could give birth to oval traumas from falling down shown in fig. 1, owing to their deadweight. Consequently the cable strands oval traumas from falling down therefore caused cable strand winding loosen and friction between cable strands generated by steel reel rotating. While cable strands were winding along with steel reel rotating continually, this kind of trauma from falling down could result in so-called "Hula-circles" effect, in consequence it disturbed the original arrangement order and could be very difficult to unwinding cable strand from steel reel. Further more, in unwinding cable strand the dragging and pulling forces suddenly made the loose cable strands to be tightened or loosened every now and then, which could aggravate the frictions between cable strands and scratch binding bands on strand until breakage and make cable strand steel wires incoherent. During the procedure of unwinding cable strands the "Hula-circles" which had emerged would become more and more bigger along with the unwinding process of cable strands, its loosen amount would increase gradually, and cable strand would collide with ground, until unwinding job implementation had no means of normal proceed. In order to remedy this phenomenon in construction site it was necessary to reshape and bind strands continually by

labor. Therefore the working machines should be shut down, after tightening cable strands wires, proceeded with unwinding strand for those already formative "Hula-circles". This not only brought unlimited inconvenience to assembly molding of main cable of suspension bridge, but also more seriously influence the time limit for a project. Particularly the longer the cable strand, the more serious the "Hula-circles" developed, furthermore the longer the cable strand, the more difficult the remedy measures carried out, even could not carry out. According to experiences under the precondition of holding good cable strand shape, adopting reel processing technology, commonly when cable strand length is over 1500m, "Hula-circles" will be easy to appear during unwinding process of cable strand. When the "Hula-circles" phenomena become serious, it will direct influence site construction schedule and cable strand quality.

SUMMARY OF THE INVENTION

[0003] A primary and general object of the present invention is to overcome the aforementioned drawbacks by providing a method for horizontally winding and unwinding a parallel wire strand with high working efficiency, fine quality of winding and unwinding cable strands and low labor intensity.

[0004] To this end, according to present invention, a method for horizontally winding and horizontally unwinding a parallel wire strand is disclosed.

[0005] A method for horizontally winding and horizontally unwinding a parallel wire strand upon a base of a cable reel for transport, storage or installation, a parallel wire strand made up of a plurality of tightly adjacent vertically and horizontally arranged parallel wires, the strand including at least a leading end fitting securing the ends of the wires together, is characterized in that the method comprises the following steps:

(a) Performing the winding operation, the operation procedure is as follows:

Fix the guide frame on the ground, the guide frame is composed of the base, support frame, electric hoist, fixed pulley, steel wire rope, lifting mechanism, roller, the pressure sensor, speed encoder, altimeter encoder and limit roller. Fix the base on the ground and fix the support frame and electric hoist on the base. A fixed pulley is equipped at the top of the support frame, also a steel wire rope which one end is connected with electric hoist and the other end is connected with lifting mechanism is wound on the fixed pulley. The lifting mechanism is equipped with three rollers, 2 pressure sensors and a speed encoder, the 3 rollers are arranged in "□" shape, that is, three straight lines connecting the circle center points of three rollers make

up of a triangle. A pressure sensor and a speed encoder are equipped at one side of the three rollers, at the side of the fixed pulley, altimeter encoder, electric hoist, pressure sensor, speed encoder are equipped. Both the speed encoder and the altimeter encoder are connected with the programmable logical controller (hereinafter referred to as PLC) by the telecommunication wires. Fix the rotation axis on the ground at one side of the guide frame, connecting the rotation platform with the rotation axis; meantime, the rotating platform rotating about the rotation axis 21. The upper surface of the rotation platform shall be flush with the ground, the platform rail is paved on the rotation platform and the railcar is located on the rail. to The characteristics of rotation platform facilitate the rail platform car easy to select multi-directions and link up with workshop rails.

The inner module is composed at least by four support plates and the support rod at the top section, the four support plates were aligned uniformly in the ring shape. There is a gap between the adjacent support plates, the gap length shall be the width of the support plate of 80% to 150%. Operator can get into the inner module to operate through gaps between support plates. The support rod shall be fixed by the hinge at the top of the support plate, each support plate shall fix two support rods and the two top rods shall be symmetrically fixed on the support plate at left and right sides. The bottom of supporting plate and the railcar are connected by the bolt. The top support plate will lean outward. After fixing the support plate and railcar, the centers of gravity of four support plates should be located outside of each hinge.

Put a ring shape tray onto the railcar and hitch it outside the inner module. Lifting points which are used for lifting the tray and looped cable strands which are winded on the tray shall be set at the tray edges, and lay the water proof film covered on the surface of the tray.

Put one end of strand through the guide rollers and fix it onto the inner module, then drive rotation platform to rotate, which will drive the railcar and inner module to rotate together. Along with the rotation, the strand will be winded on the inner module one circle by another from the bottom end of the inner module till to the top of the inner module, and then wind the strand from the top of the inner module to the bottom. Repeat this operation until all the strands wrapped into wire strands. During the upward winding procedure, the PLC will control the electric hoist to pull the steel wire rope, thus to lift the lifting mechanism which will enable the guide roller to move upward with the distance which is equivalent to

the strand diameter during each circle. During the downward winding procedure, the PLC will control the electric hoist to pull to steel wire rope, thus to pull down the lifting mechanism which will enable the guide roller to move downward with the distance which is equivalent to the strand diameter during each circle, therefore this guarantees that strands are capable of arranging on the inner module regularly and compactly. After all the strands are winded into wire strands, dismantle the bolts between the bottom of the inner module and the railcar. Lift the support rod on the inner module which will make the 4 pieces support plates gather together inward, and then extract the inner module from the wire strands. After this, use the prepared waterproof film on the tray to cover the whole outside surface of the wire strand. Connect the platform track on the rotating platform with the track on the ground, pull the railcar to remove the wire strand, until this, the strand winding operation is finished.

(b) Performing the unwinding operation, the operation procedure is as follows:

Fix the guide frame on the ground, the guide frame is composed by the base, support frame, electric hoist, fixed pulley, steel wire rope, lifting mechanism, roller, the pressure sensor, speed encoder, altimeter encoder and limit roller. Fix the base on the ground and fix the support frame and electric hoist on the base. A fixed pulley shall be equipped at the top of the support frame, also the steel wire rope whose one end is connected with electric hoist and the other end is connected with lifting mechanism shall be winded on the fixed pulley. The lifting mechanism is equipped with 3 rollers, 2 pressure sensors and a speed encoder. The 3 Rollers are arranged in " $\square$ " shape, that is, three straight lines connecting the circle center points of three rollers make up of a triangle. A pressure sensor and a speed encoder shall be equipped at one side of the three rollers, altimeter encoder at the side of the fixed pulley, electric hoist, pressure sensor, speed encoder shall be equipped. Both the speed encoder and the altimeter encoder shall be connected with PLC by the telecommunication wires. Fix the rotation axis on the ground at one side of the guide frame, connecting the rotation platform with the rotation axis, meantime, the rotating platform will rotate around the rotation axis. The hydraulic brake which is connected with PLC through pressure sensor is equipped in the rotation axis. During the rotation of the rotating platform, release the hydraulic

brake. When the rotating platform stops, the hydraulic brake is always imposing friction on the rotating platform, thus applying portion of reverse compression to prevent against rotating platform continually rotating, bring about cable strand dropped out and damaged when dragging forces temporarily stop.

The inner module is composed by at least four support plates. The four support plates are aligned uniformly in the ring shape. The gaps shall be retained between the adjacent support plates, the gap length shall be the width of the support plate of 80% to 150%. The bottoms of the support plates are connected by the hinge with the rotating platform, all the 4 pieces support plates will lean inward. In the middle of the 4 pieces support plates, a hydraulic jack is equipped. The support rod of the hydraulic jack is connected with four pieces push rods, and each push rod shall withstand a piece of support plate.

Remove the waterproof film cover from the strand, lift the strand wire strands together with the tray onto the rotating platform, meantime, set the strand wire strands over the inner module. Actuate the hydraulic jack, with the force of the support rod applied to the push rod, the 4 pieces support plates will push outward by the push rod which will fix the strand wire strands. Pull one leading end of the strand through out of the guide roller, then pull the strand to drive the inner module and the tray to rotate, thus to drive the rotating platform to rotate around the rotation axis. Along with this operation, the strand shall be released and become straight status.

During the downward winding procedure, the PLC will control the electric hoist to pull to steel wire rope, thus to pull down the lifting mechanism which will enable the guide roller move downward with the distance which is equivalent to the strand diameter during each circle. During the upward winding procedure, the PLC will control the electric hoist to pull the steel wire rope, thus to lift the lifting mechanism which will enable the guide roller move upward with the distance which is equivalent to the strand diameter during each circle. Repeat these operations back and forth till the wire strands become straight status, and fulfill the whole unwinding operation.

[0006] The method in accordance with the present invention is characterized in that the rotation axis is vertical to the ground at the side of the guide frame.

[0007] Further the method in accordance with the present invention is characterized in that in horizontal winding operation the bottom of the support plate is connected with the railcar by bolts, the top of the support

plate shall lean outward and the angle between the support plate and upper surface of railcar is between $60^\circ \sim 85^\circ$.

[0008] Further the method in accordance with the present invention is characterized in that in horizontal unwinding operation the bottom of the support plate is connected with the rotating platform by the hinge, all the 4 pieces support plate will lean inward and the angle between the support plate and upper surface of railcar is between $60^\circ \sim 85^\circ$.

[0009] Under the controlling action of the PLC, the unwinding of cable strand is restricted to prevent against out of control for strand, avoiding cable strand damage or injury or loss; in unwinding strand operation, can keep line shape relatively straight and level to protect strand and prevent binding band breakdown, when the speed of unwinding strand is slowed down or stop, gradually control hydraulic brake to lock turning axle; the introduction of pressure sensor furthermore facilitates PLC to control hydraulic brake smoothly.

[0010] Thus according to the invention it is possible to solve the "Hula-circles" effect problem, and remarkably increase cable strand erection benefits and cable strand quality of carrying out the method of the invention. The advantages of present invention are: reasonable arrangement of operating sequence, winding strand, strand wire strands formation, package and transportation, as well as unwinding complete in one breath, reduce labor intensity and operation time; cable strand wire strands formation compact and regular arrangement; winding strand and unwinding strand all may be able to go with a swing; when unwinding strand trauma from falling down phenomena is eliminated, unable to damage cable strand and binding band; Increase automaticity, equipments are controllable and tunable, real-time monitoring correlated data, reduce labor intensity, increase security; shipping reel simplicity and removable, have no use for large size reel, save a great deal of manufacture and transportation costs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 is a structure schematic for the strand drop phenomenon in the existing technology;
Figure 2 is a structure schematic for strand winding on the inner module when winding strand;
Figure 3 is the front view of the guide frame in this invention;
Figure 4 is the left view of the guide frame in this invention,
Figure 5 is a structure schematic for extraction of the inner module when winding strand finished,
Figure 6 is a structure schematic for straighten of the strand wire strands when unwinding strand.

DETAILED DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

[0012] The accompanying drawings and description herein-below disclose embodiments suitable for carrying out the method of the invention. 5

Embodiment 1

[0013] A method for horizontally winding and horizontally unwinding a parallel wire strand upon a base of a cable reel for transport, storage or installation, a parallel wire strand made up of a plurality of tightly adjacent vertically and horizontally arranged parallel wires, the strand including at least a leading end fitting securing the ends of the wires together, comprising the steps of: 10

(a) Performing the winding operation, the operation procedure is as follows: 15

As shown in figure 2, fix the guide frame 1 on the ground, the guide frame 1 is composed by the base 11, support frame 12, electric hoist 13, fixed pulley 14, steel wire rope 15, lifting mechanism 16, roller 17, the pressure sensor 181, speed encoder 182, altimeter encoder 183 and limit roller 19 as shown in figure 3 and 4. Fix the base 1 on the ground and fix the support frame 12 and electric hoist 13 on the base 1. A fixed pulley 14 is equipped at the top of the support frame 12, also a steel wire rope 15 which one end is connected with electric hoist 13 and the other end is connected with lifting mechanism 16 is wound on the fixed pulley 14. The lifting mechanism 16 is equipped with three rollers 17, 2 pressure sensors 181 and a speed encoder 182, the 3 rollers 17 are arranged in a "△" shape, that is, three straight lines connecting the circle center points of three rollers make up of a triangle. A pressure sensor 181 and a speed encoder 182 are equipped at one side of the three rollers, at the side of the fixed pulley 14, altimeter encoder 183, electric hoist 13, pressure sensor 181, speed encoder 182 are equipped. Both the speed encoder 182 and the altimeter encoder 183 are connected with PLC by the telecommunication wires. Fix the rotation axis 21 on the ground at one side of the guide frame 1, connecting the rotation platform 2 with the rotation axis, meantime, the rotating platform 2 will rotate about the rotation axis 21. The upper surface of the rotation platform 2 shall be flush with the ground, the platform rail 22 is paved on the rotation platform and the railcar 3 is located on the rail 22. Three straight lines connecting the circle center points of three rollers make up of a triangle. The characteristics of rotation platform fa- 20 25 30 35 40 45 50 55

cilitate rail platform car easy to select multi-directions and link up with workshop rails.

The inner module 4 is composed by at least four support plates 41 and the support rod 42 at the top section, the four support plates 41 was aligned uniformly in the ring shape. There are gaps between the adjacent support plates 41, the gap length shall be the width of the support plate 41 of 80% to 150% (in this embodiment, 150%). Operator can get into the inner module to operate through gaps between support plates. The support rod 42 shall be fixed by the hinge at the top of the support plate 41, each support plate 41 shall fix two support rods and the two top of the rod 42 shall be symmetrically fixed on the support plate 41 at left and right sides. The supporting plate 41 and the railcar 3 is connected by the bolt. The top of support plate 41 will lean outward. After fixing the support plate 41 and railcar 3, the centers of gravity of four support plates should be located outside of each hinge.

Put a ring shaped tray 5 onto the railcar 3 and hitch it outside the inner module 4. Lifting points which are used for lifting the tray and looped cable strands which are wound on the tray shall be set at the tray edges, and lay the water proof film cover on the surface of the tray 5.

Put one end of strand 10 through the guide rollers 11 and fix it onto the inner module 4, then drive rotation platform 2 to rotate in the direction of arrow B as shown in figure 2, which will drive the railcar 3 and inner module 4 to rotate together. Along with the rotation, the strand 10 will be wound on the inner module 4 one circle by another from the bottom end of the inner module 4 till to the top of the inner module 4, and then wind the strand 10 from the top of the inner module 4 to the bottom. Repeat this operation until all the strands 10 wrapped into wire strands. During the upward winding procedure, the PLC will control the electric hoist 13 to pull the steel wire rope, thus to lift the lifting mechanism 16 which will enable the guide roller 11 move upward with the distance which is equivalent to the strand 10 diameter during each circle. During the downward winding procedure, the PLC will control the electric hoist 13 to pull to steel wire rope 15, thus to pull down the lifting mechanism 16 which will enable the guide roller 11 move downward with the distance which is equivalent to the strand 10 diameter during each circle, therefore guarantee that strands are capable of arranging on the inner module 2 regularly and compactly.

After all the strands 10 are wound into wire strands, as shown in figure 5, dismantle the bolts between the bottom of the inner module 4 and

the railcar 3. Lift the support rod 42 on the inner module 4 in the direction of arrow C as shown in figure 3 which will make the 4 pieces support plates 41 gather together inward, and then extract the inner module 4 from the wire strand. After this, use the prepared waterproof film on the tray 5 to cover the whole outside surface of the wire strand 10. Connect the platform track 22 on the rotating platform 2 with the track on the ground, pull the railcar 3 to move the wire strand 10, until this winding operation is finished.

(b) Performing the unwinding operation, the operation procedure is as follows:

As shown in figure 6, fix the guide frame 1 on the ground, the guide frame 1 is shown in figure 3 and 4 and composed by the base 11, support frame 12, electric hoist 13, fixed pulley 14, steel wire rope 15, lifting mechanism 16, roller 17, the pressure sensor 181, speed encoder 182, altimeter encoder 183 and limit roller 19. Fix the base 1 on the ground and fix the support frame 12 and electric hoist 13 on the base 1. A fixed pulley 14 shall be equipped at the top of the support frame 12, also the steel wire rope 15 whose one end is connected with electric hoist 13 and the other end is connected with lifting mechanism 16 shall be wound on the fixed pulley 14. The lifting mechanism 16 is equipped with 3 rollers 17, 2 pressure sensors 181 and a speed encoder 182. The 3 Roller 17 is arranged in a "□" shape, that is, three straight lines connecting the circle center points of three rollers make up of a triangle. A pressure sensor 181 and a speed encoder 182 shall be equipped at one side of the three rollers, at the side of the fixed pulley 14, altimeter encoder (183), electric hoist 13, pressure sensor 181, speed encoder 182 shall be equipped. Both the speed encoder 182 and the altimeter encoder 183 shall be connected with PLC by the telecommunication wires. Fix the rotation axis 21 on the ground at one side of the guide frame 1, connecting the rotation platform 2 with the rotation axis, meantime, the rotating platform 2 will rotate around the rotation axis 21. The hydraulic brake 24 which is connected by pressure sensor and PLC is equipped in the rotation axis 21. During the rotation of the rotating platform 2, release the hydraulic brake 24. When the rotating platform stops, the hydraulic brake 24 is always imposing friction on the rotating platform 2, thus applying portion of reverse compression to prevent against rotating platform 2 continually rotating, bring about cable strand dropped out and injury when dragging forces temporarily stop.

The inner module 4 is composed by at least four support plates 41 and the support rod 42. The number of support plate 41 in this embodiment is selected as 4. The four support plates 41 are aligned uniformly in the ring shape. The gaps shall be retained between the adjacent support plates 41, the gap length shall be the width of the support plate 41 of 80% to 150% (in this embodiment, 150%). The bottoms of the support plates 41 are connected by the hinge with the rotating platform 2, all the 4 pieces support plates 41 will lean inward. In the middle of the 4 pieces support plates 41, a hydraulic jack 6 is equipped. The support rod of the hydraulic jack 6 is connected with four pieces push rods 61, and each push rod 61 shall withstand a piece of support plate 41.

Remove the waterproof film cover from the strand 10, lift the strand 10 wire strands together with the tray 5 onto the rotating platform 2, meantime, set the strand 10 wire strands over the inner module 4. Actuate the hydraulic jack 6, with the force of the support rod applied to the push rod, the 4 pieces support plates 41 will push outward by the push rod 61 which will fix the strand wire strands.

Pull one leading end of the strand 10 through out of the guide roller 11, then pull the strand 10 to drive the inner module 4 and the tray 5 to rotate, thus to drive the rotating platform 2 to rotate around the rotation axis. Along with this operation, the strand 10 shall be released and will become straight status.

During the downward winding procedure, the PLC will control the electric hoist 13 to pull to steel wire rope, thus to pull down the lifting mechanism 16 which will enable the guide roller 11 move downward with the distance which is equivalent to the strand 10 diameter during each circle. During the upward winding procedure, the PLC will control the electric hoist 13 to pull the steel wire rope 15, thus to lift the lifting mechanism 16 which will enable the guide roller 11 move upward with the distance which is equivalent to the strand 10 diameter during each circle. Repeat these operations back and forth till the wire strands strand become straight status, and fulfill the whole unwinding operation.

[0014] Under the controlling action of the PLC, the unwinding of cable strand is restricted to prevent against out of control for strand, avoiding cable strand damage or injury or loss; in unwinding strand operation, can keep line shape relatively straight and level to protect strand and prevent binding band breakdown, when the speed of unwinding strand is slowed down or stop, gradually control hydraulic brake 24 to lock turning axle; the introduction of pressure sensor furthermore facilitate PLC to

control hydraulic brake 24 smoothly.

Embodiment 2

[0015] It is a method for horizontally winding and horizontally unwinding a parallel wire strand. The method includes winding strand and unwinding strand operations. During the winding strand the container 4 is composed by 6 support plates 41 and the top support rod 42. The six support plates 41 are aligned uniformly in the ring shape. There is a gap between the adjacent support plates 41, and the gap length is 100 percent of the width of support plate 41. The rest structure and method are the same to embodiment 1.

Embodiment 3

[0016] It is a method for horizontally winding and horizontally unwinding a parallel wire strand. The method includes winding strand and unwinding strand operations. During the winding strand the container 4 is composed by 10 support plates 41 and the top support rod 42. The ten support plates 41 are aligned uniformly in the ring shape. There is a gap between the adjacent support plates 41, and the gap length is 80 percent of the width of support plate 41. The rest structure and method are the same to embodiment 1.

Claims

1. A method for horizontally winding and horizontally unwinding a parallel wire strand upon a base of a cable reel for transport, storage or installation, a parallel wire strand made up of a plurality of tightly adjacent vertically and horizontally arranged parallel wires, the strand including at least a leading end fitting securing the ends of the wires together, the method is **characterized in that** it comprises the steps of:

(a) Performing the winding operation, the operation procedure is as follows:

Fix the guide frame(1) on the ground, the guide frame (1) is composed by the base (11), support frame (12), electric hoist (13), fixed pulley (14), steel wire rope (15), lifting mechanism (16), roller (17), the pressure sensor (181), speed encoder (182), altimeter encoder (183) and limit roller (19).;Fix the base (1) on the ground and fix the support frame (12) and electric hoist (13) on the base (1); A fixed pulley (14) is equipped at the top of the support frame, also a steel wire rope (15) which one end is connected with electric hoist (13) and the other end is connected with lifting mechanism (16) is

winded on the fixed pulley (14); The lifting mechanism (16) is equipped with three rollers (17), 2 pressure sensors (181) and a speed encoder (182), the 3 rollers (17) are

arranged in a "□"shape, that is, three straight lines connecting the circle center points of three rollers make up of a trigon; A pressure sensor (181) and a speed encoder (182) are equipped at one side of the three rollers, at the side of the fixed pulley (14), altimeter encoder (183), electric hoist (13), pressure sensor (181), speed encoder (182) are equipped; Both the speed encoder (182) and the altimeter encoder (183) are connected with PLC by the telecommunication wires; Fix the rotation axis (21) on the ground at one side of the guide frame (1), connecting the rotation platform (2) with the rotation axis, meantime, the rotating platform (2) will rotate about the rotation axis (21); The upper surface of the rotation platform (2) shall be flush with the ground, the platform rail (22) is paved on the rotation platform and the railcar (3) is located on the rail (22); Three straight lines connecting the circle center points of three rollers make up of a trigon; the characteristics of rotation platform facilitate rail platform car easy to select multi-directions and link up with workshop rails;

The inner module (4) is composed by at least four support plates (41) and the support rod (42) at the top section, the four support plates (41) was aligned uniformly in the ring shape. There are gaps between the adjacent support plates (41), the gap length shall be the width of the support plate (41) of 80% to 150%; Operator can get into the inner module to operate through gaps between support plates; The support rod (42) shall be fixed by the hinge at the top of the support plate (41), each support plate (41) shall be fixed two support rods and the two top of the rod (42) shall be symmetrically fixed on the support plate (41) at left and right sides; The supporting plate (41) and the railcar (3) is connected by the bolt; The top of support plate (41) will lean outward; After fixing the support plate (41) and railcar (3), the centers of gravity of four support plates should be located outside of each hinge,

Put a ring shape tray (5) onto the railcar (3) and hitch it outside the inner module (4); Lifting points which are used for lifting the tray and looped cable strands which are wound on the tray shall be set at the tray

edges, and lay the water proof film cover on the surface of the tray (5);

Put one end of strand (10) through the guide rollers (11) and fix it onto the inner module (4), then drive rotation platform (2) to rotate, which will drive the railcar (3) and inner module (4) to rotate together; Along with the rotation, the strand (10) will be wound on the inner module (4) one circle by another from the bottom end of the inner module (4) till to the top of the inner module (4), and then wind the strand (10) from the top of the inner module (4) to the bottom; Repeat this operation until all the strands (10) wrapped into wire strands; During the upward winding procedure, the PLC will control the electric hoist (13) to pull the steel wire rope, thus to lift the lifting mechanism (16) which will enable the guide roller (11) move upward with the distance which is equivalent to the strand (10) diameter during each circle; During the downward winding procedure, the PLC will control the electric hoist (13) to pull to steel wire rope (15), thus to pull down the lifting mechanism (16) which will enable the guide roller (11) move downward with the distance which is equivalent to the strand (10) diameter during each circle, therefore guarantee that strands are capable of arranging on the inner module (2) regularly and compactly;

After all the strands (10) are winded into wire strands, dismantle the bolts between the bottom of the inner module (4) and the railcar (3); Lift the support rod (42) on the inner module (4) which will make the 4 pieces support plates (41) gather together inward, and then extract the inner module (2) from the wire strand; After this, use the prepared waterproof film on the tray (5) to cover the whole outside surface of the wire strand (10); Connect the platform track (22) on the rotating platform (2) with the track on the ground, pull the railcar (3) to move the wire strand (10), until this winding operation is finished;

(b) Performing the unwinding operation, the operation procedure is as follows:

Fix the guide frame (1) on the ground, the guide frame (1) is composed by the base (11), support frame (12), electric hoist (13), fixed pulley (14), steel wire rope (15), lifting mechanism (16), roller (17), the pressure sensor (181), speed encoder (182), altimeter encoder (183) and limit roller (19). Fix the base (1) on the ground and fix the sup-

port frame (12) and electric hoist (13) on the base (1); A fixed pulley (14) shall be equipped at the top of the support frame (12), also the steel wire rope (15) whose one end is connected with electric hoist (13) and the other end is connected with lifting mechanism (16) shall be wound on the fixed pulley (14); The lifting mechanism (16) is equipped with 3 rollers (17), 2 pressure sensors (181) and a speed encoder (182); The 3 Roller (17) is arranged in a

"品" shape, that is, cthree straight lines connecting the circle center points of three rollers make up of a triangle; A pressure sensor (181) and a speed encoder (182) shall be equipped at one side of the three rollers, at the side of the fixed pulley (14), altimeter encoder (183), electric hoist (13), pressure sensor (181), speed encoder (182) shall be equipped; Both the speed encoder (182) and the altimeter encoder (183) shall be connected with PLC by the telecommunication wires; Fix the rotation axis (21) on the ground at one side of the guide frame (1), connecting the rotation platform (2) with the rotation axis, meantime, the rotating platform (2) will rotate around the rotation axis (21); The hydraulic brake (24) which is connected by pressure sensor and PLC is equipped in the rotation axis (21); During the rotation of the rotating platform (2), release the hydraulic brake (24); When the rotating platform stops, the hydraulic brake (24) is always imposing friction on the rotating platform (2), thus applying portion of reverse compression to prevent against rotating platform (2) continually rotating, bring about cable strand dropped out and damaged when dragging forces temporarily stop;

The inner module (4) is composed by at least four support plates (41) and the support rod (42); The four support plates (41) are aligned uniformly in the ring shape. The gaps shall be retained between the adjacent support plates (41), the gap length shall be the width of the support plate (41) of 80% to 150%; The bottoms of the support plates (41) are connected by the hinge with the rotating platform (2), all the 4 pieces support plates (41) will lean inward; In the middle of the 4 pieces support plates (41), a hydraulic jack (6) is equipped; The support rod of the hydraulic jack (6) is connected with four pieces push rods (61), and each push rod (61) shall withstand a piece of support plate (41),

Remove the waterproof film cover from the strand (10), lift the strand (10) wire strands together with the tray (5) onto the rotating platform (2), meantime, set the strand (10) wire strands over the inner module (4); Actuat the hydraulic jack (6), with the force of the support rod applied to the push rod, the 4 pieces support plates (41) will push outward by the push rod (61) which will fix the strand wire strands;

Pull one leading end of the strand (10) through out of the guide roller (11), then pull the strand (10) to drive the inner module (4) and the tray (5) to rotate, thus to drive the rotating platform (2) to rotate around the rotation axis; Along with this operation, the strand (10) shall be released and will become the straight status;

During the downward winding procedure, the PLC will control the electric hoist(13) to pull to steel wire rope, thus to pull down the lifting mechanism (16) which will enable the guide roller (11) move downward with the distance which is equivalent to the strand (10) diameter during each circle. During the upward winding procedure, the PLC will control the electric hoist (13) to pull the steel wire rope (15), thus to lift the lifting mechanism (16) which will enable the guide roller (11) move upward with the distance which is equivalent to the strand(10) diameter during each circle; Repeat these operations back and forth till the wire strands strand become straight status, and fulfill the whole unwinding operation.

2. The method according to claim 1, wherein the rotation axis (21) is vertical to the ground at the side of the guide frame (1).
3. The method according to claim 1 or 2, wherein in horizontal winding operation the bottom of the support plate (41) is connected with the railcar (3) by bolts, the top of the support plate (41) shall lean outward and the angle between the support plate (41) and upper surface of railcar is between $60^{\circ} \sim 85^{\circ}$.
4. The method according to claim 1 or 2, wherein in horizontal unwinding operation the bottom of the support plate (41) is connected with the rotating platform (2) by the hinge, all the 4 pieces support plate (41) will lean inward and the angle between the support plate (41) and upper surface of railcar is between $60^{\circ} \sim 85^{\circ}$.

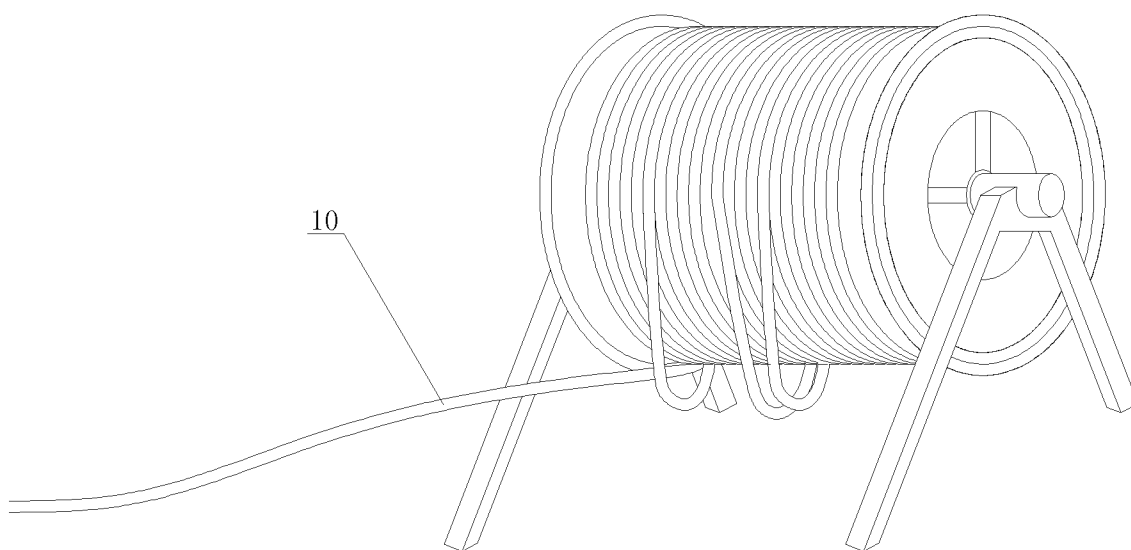


Fig 1

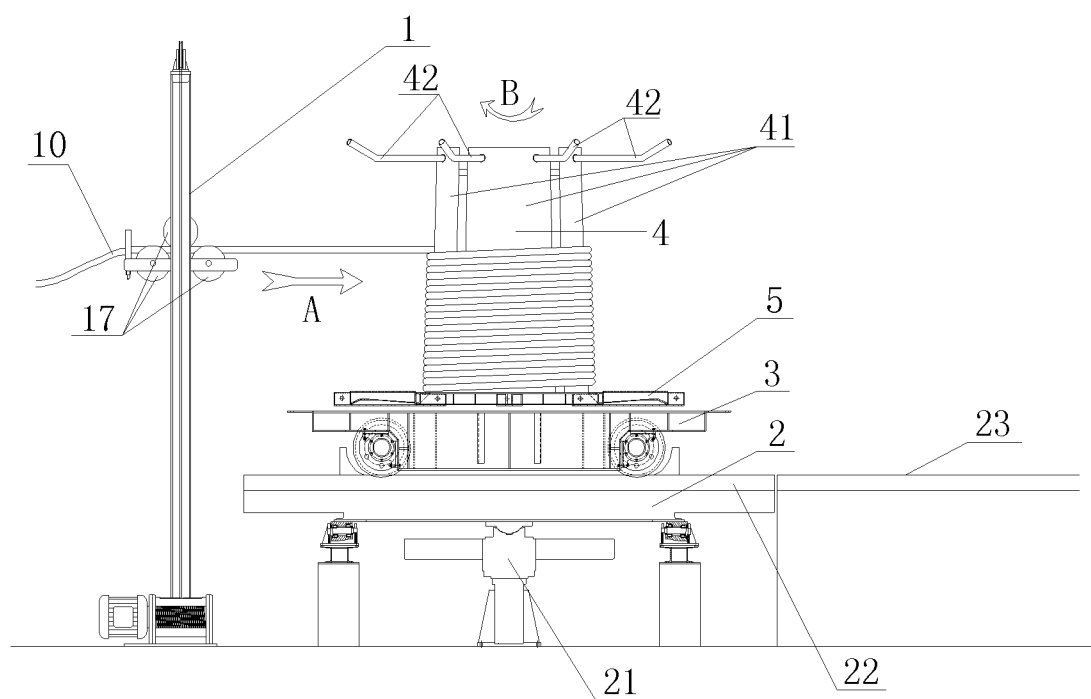


Fig 2

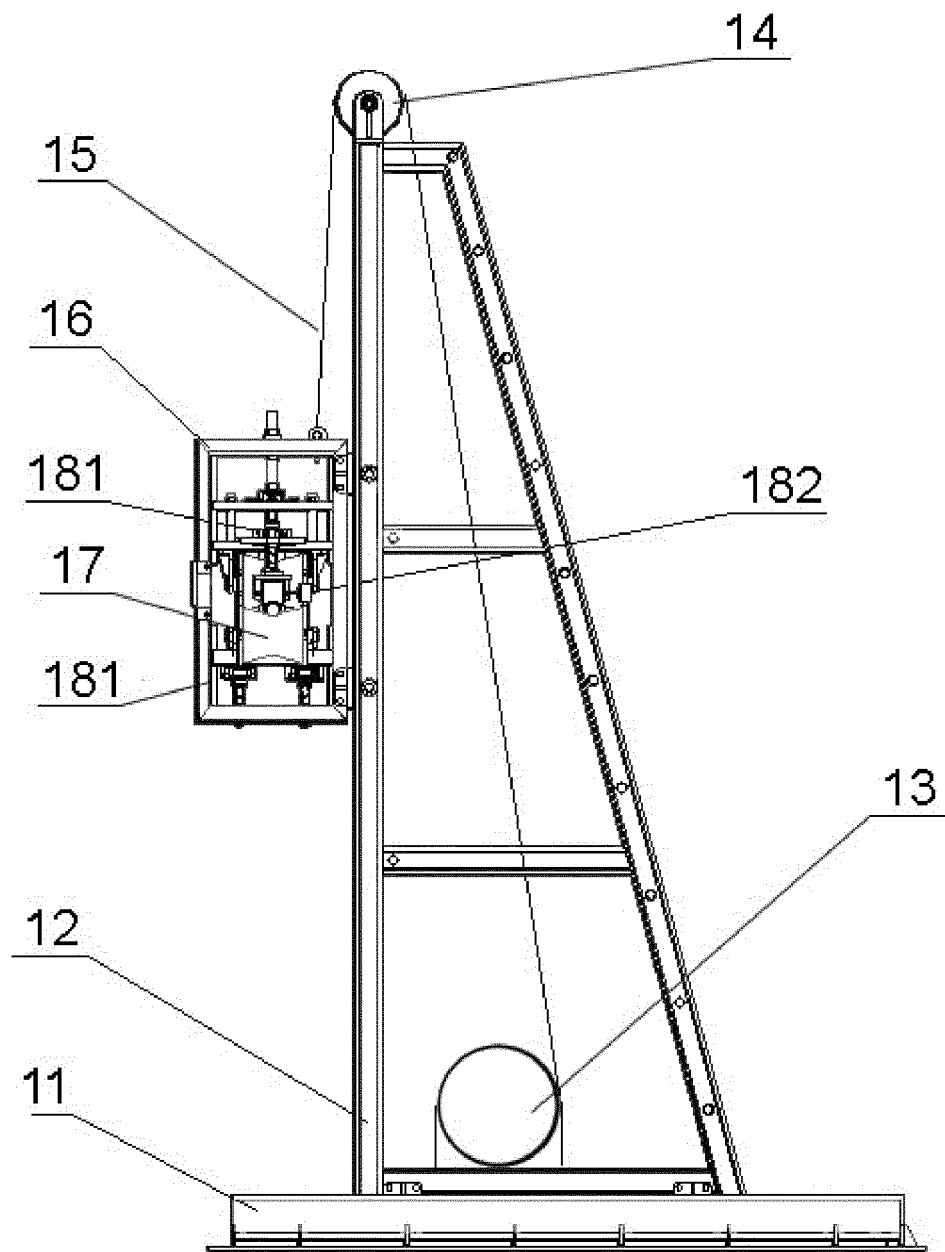


Fig 3

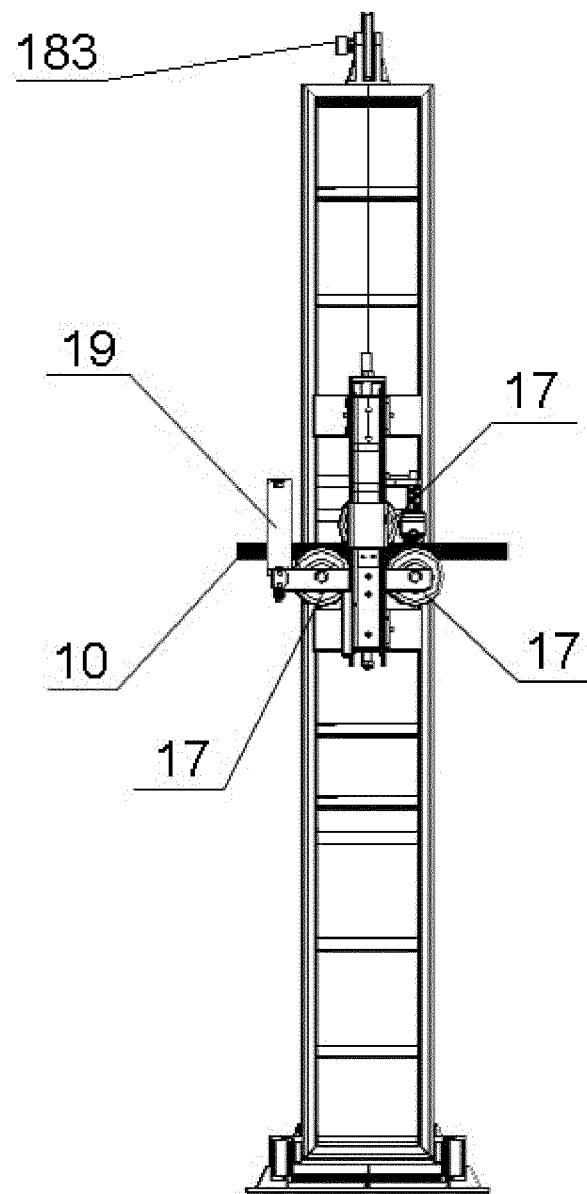


Fig 4

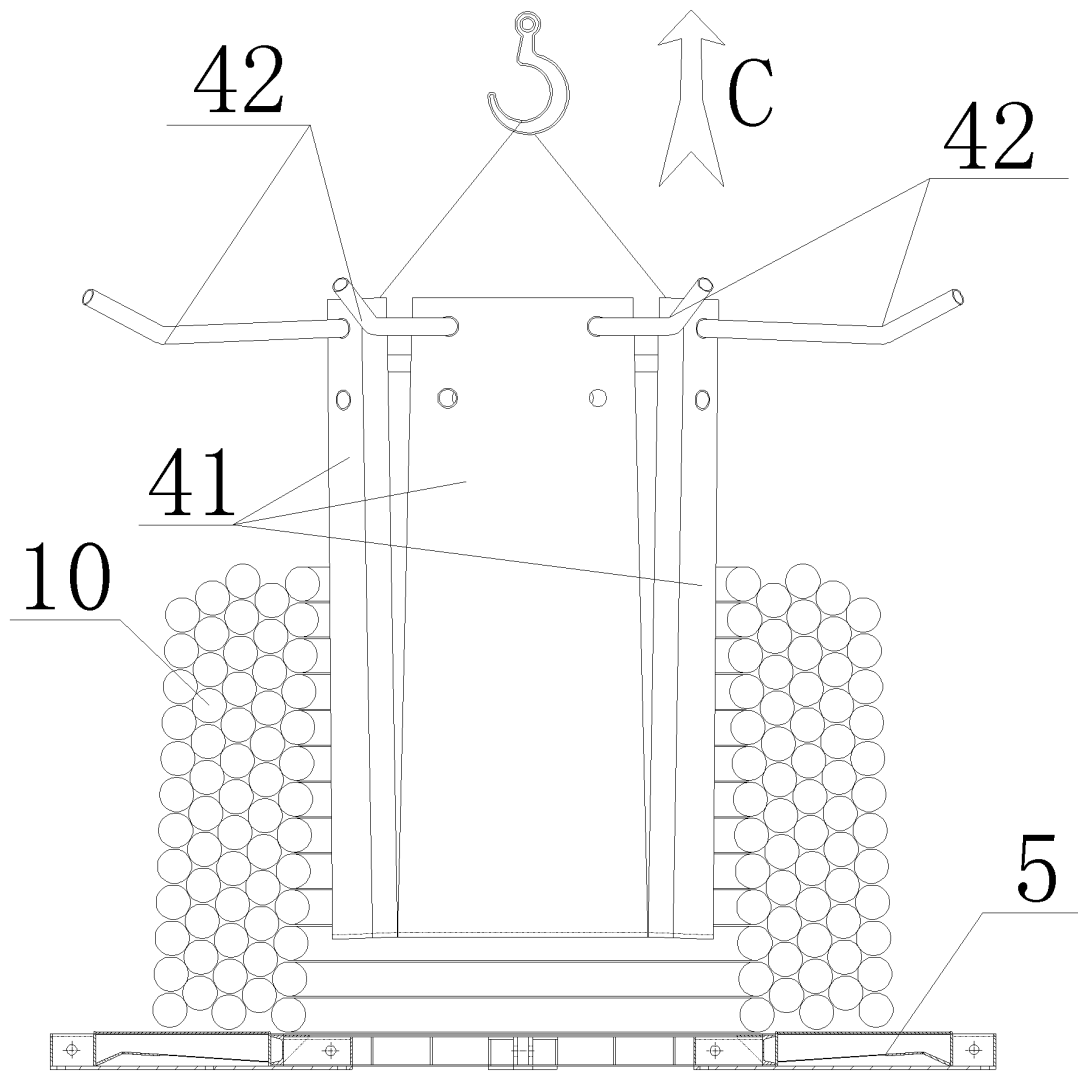


Fig 5

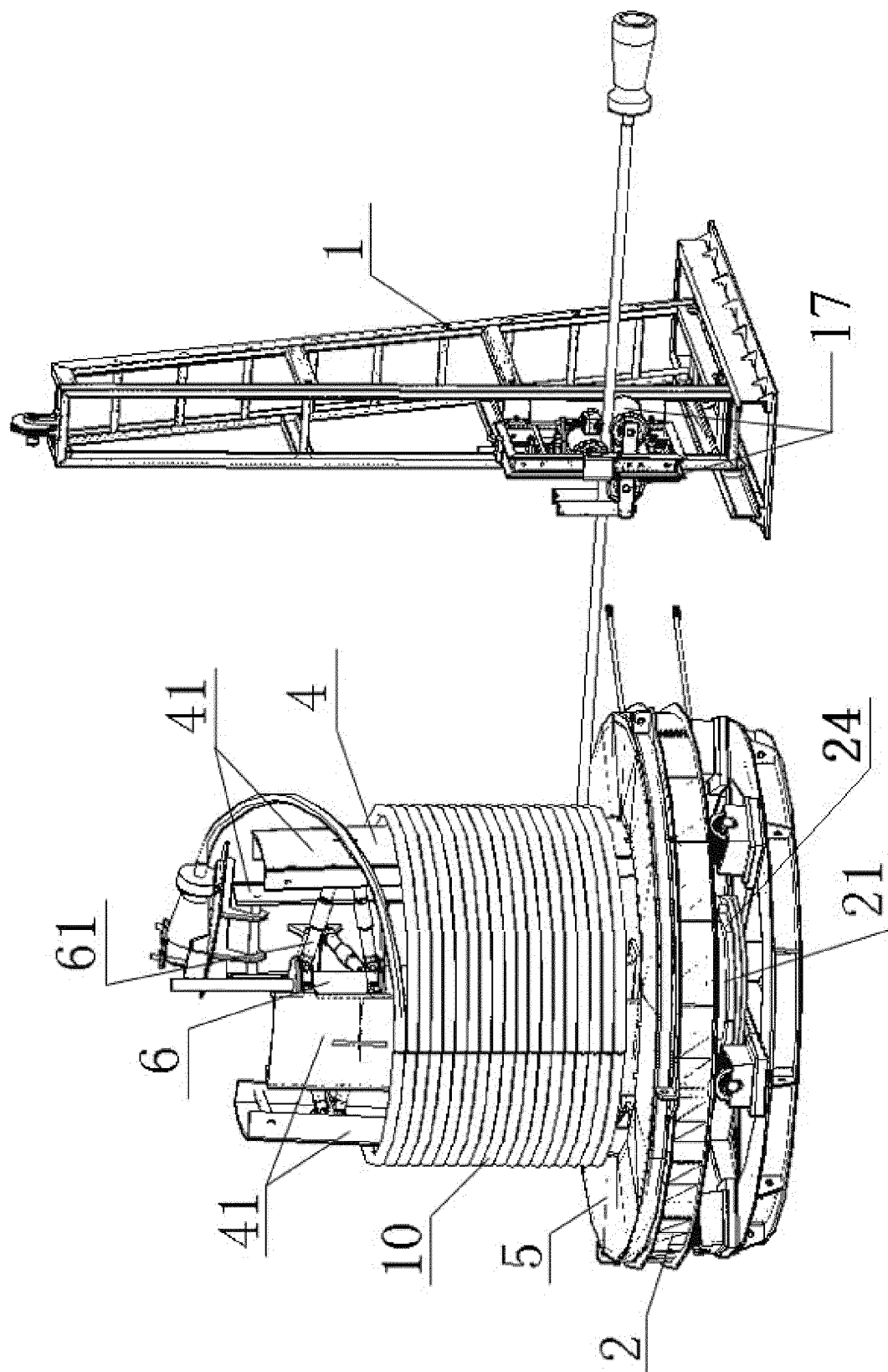


Fig 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/079953

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: E01D19/-, E01D21/-, B65H18/-, B65H16/-, B65H49/-, B65H54/-, B65H59/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CNPAT, CNKI, EPODOC: steel, wire, cable?, coil+, uncoil+, wind+, unwind, horizon+, guid+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim
A	CN201560392U(SHANGHAI PUJIANG CABLE CO., LTD.) 25 Aug. 2010(25.08.2010) Pars. [0008]-[0009] of description, fig. 1	1-4
A	CN201560386U(SHANGHAI PUJIANG CABLE CO., LTD.) 25 Aug. 2010(25.08.2010) Pars. [0013]-[0018] of description, figs. 1-5	1-4
A	CN201049853Y(SHANGHAI PUJIANG CABLE CO., LTD.) 23 Apr. 2008(23.04.2008) the whole document	1-4
A	CN201581352U(SHANGHAI PUJIANG CABLE CO., LTD.) 15 Sep. 2010(15.09.2010) the whole document	1-4
A	US2009/0152390A1(THE BOEING COMPANY) 18 June 2009(18.06.2009) the whole document	1-4
A	JP8-282979A(DAITO JUKI KOJI CO., LTD.) 29 Oct. 1996(29.10.1996) the whole document	1-4

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 20 July 2011(20.07.2011)	Date of mailing of the international search report 29 Sep. 2011 (29.09.2011)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer FANG Yong Telephone No. (86-10)62412889

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2010/079953

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN201560392U	25.08.2010	None	
CN201560386U	25.08.2010	None	
CN201049853Y	23.04.2008	None	
CN201581352U	15.09.2010	None	
US2009/0152390A1	18.06.2009	None	
JP8-282979A	29.10.1996	JP3631519B2	23.03.2005

Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/079953

Continuation of : CLASSIFICATION OF SUBJECT MATTER:

E01D 21/00 (2006.01) i
E01D 19/16 (2006.01) i
B65H 49/00 (2006.01) i
B65H 54/00 (2006.01) i
B65H 59/38 (2006.01) i