

AUTOMATIC MIDDLE-LOW VOLTAGE SIDE SELF-ADAPTING CONTACT ELECTRICITY-ACQUISITION DEVICE

Field of the Invention

The invention is new and practical, and relates to an automatic middle-low voltage side self-adapting contact electricity-acquisition device for a tire container gantry crane at port large freight yard working by network power.

Background of the Invention

Tire container gantry cranes at large freight yard in main ports all over the world always use diesel generator set to supply power thereto. They turn around flexibly. However, the effective availability of the diesel generator set is very low, which is about 25%, and it has large consumption of reactive power, amazing consumption of diesel, loud noise and causes a terrible environmental pollution. Under conditions that the energy supply is shortage and the price of diesel increases constantly, the use cost of the tire container gantry increases. The price of electricity is stable and cost is lower, so the power supply of the tire container gantry crane is changed from diesel to electricity in ports. The commercial power is used to drive the tire container gantry cranes, which can reduce operation cost, reduce air pollution and noise, save energy and clean environment.

There are many ways to change the diesel to electricity, such as overhead slide contact lines, low altitude safe slide lines, cable reels and so on. The manner of overhead slide contact lines is convenient for turning around of the tire container gantry cranes, but the input cost thereof is high. The manners of low altitude safe slide lines and cable reels have low input cost, but they are low efficient, since they need auxiliary operators to help turn around.

Due to the unavoidable auxiliary operations needed by the power supplying manners of low altitude safe slide lines and cable reels, a lot of manpower is input to research and provide an automatic middle-low voltage side self-adapting contact electricity-acquisition device applicable to middle and low altitude power supplying manner, which needs no auxiliary operators, and is automatic, effective, safe and with low cost.

Summary of the Invention

In view of the above-described problem, it is one objective of the invention to provide an automatic middle-low voltage side self-adapting contact electricity-acquisition device that features simple operation and high efficiency, and is automatically retractable, stable, safe, cost-effective, and environmental friendly, and needs no auxiliary operators.

To achieve the above objective, in accordance with one embodiment of the invention, provided is an automatic middle-low voltage side self-adapting contact electricity-acquisition device, comprising:

a pair of end posts disposed at two ends and in a center line of a blind road at freight yard of a tire container gantry crane along a direction of walking track of the tire container gantry crane; multiple middle posts disposed between the end posts with equal space and operate to support power-supply slide contact lines;

a upper bracket, a lower bracket and a photoelectrical detecting plate disposed between the end posts and the middle posts;

positive and negative power-supply slide contact lines disposed on the upper bracket and the lower bracket;

tightening devices disposed on both ends of the power-supply slide contact lines;

a first base, and a driving device of a side self-adapting contact electricity-acquisition device unit installed at lower crossbeam side of the tire container gantry crane at front and rear side;

an adjusting device disposed on the first base; and

a small trunk beam, a big pull rod, a main boom mounted on the first base; wherein

a small pull rod is connected to the head of the small trunk beam, a big trunk beam is connected to the head of the big pull rod, and the small trunk beam is connected to the big pull rod via a connecting rod, whereby the small trunk beam, the connecting rod, the small pull rod, the big trunk beam, the big pull rod and the main boom constitute a linkage mechanism; the members of the linkage mechanism are all hinge connected and rolling bearings are used at the hinge points;

one end of the main boom is hinge connected to the first base, and the other end thereof is hinge connected to the big trunk beam;

laser range acquisition sensors are mounted on the front and left of the tire container gantry

crane;

the photoelectrical detecting plate is parallel to the power-supply slide contact lines;

the electricity-acquisition arc board of the electricity-acquisition device unit is flexibly connected to the small pull rod, the big trunk beam via a vertical hinge and a follower spring; a PLC controller and a transducer driving system of a control portion are connected to the front laser range acquisition sensors and the rear laser range acquisition sensors at two sides, to the positive and negative electricity-acquisition device units, and to right and left walking motors of tire container gantry crane;

the front laser range acquisition sensor and the rear laser range acquisition sensor at a right side are connected to the photoelectrical detecting plate, and the positive and negative electricity-acquisition device units are connected to the positive and negative power-supply slide contact lines, respectively.

The invention is different with the electricity-acquisition devices using overhead slide contact line, low altitude slide contact line and cable reels. It includes a pair of end posts disposed at two ends and in a center line of a blind road at freight yard of a tire container gantry crane along a direction of walking track of the tire container gantry crane; multiple middle posts disposed between the end posts with equal space and operate to support power-supply slide contact lines; an upper bracket, a lower bracket and a photoelectrical detecting plate disposed between the end posts and the middle posts; positive and negative power-supply slide contact lines disposed on the upper bracket and the lower bracket; tightening devices disposed on both ends of the power-supply slide contact lines; a side self-adapting contact electricity-acquisition device unit, a driving device, and an adjusting device installed at lower crossbeam side of the tire container gantry crane at front and rear side. The invention guides and controls the tire container gantry crane to be automatically rectified via the photoelectrical detecting plate reflecting the signal of the laser range acquisition sensors mounted on the tire container gantry crane.

Advantages of the invention comprise:

1. The electricity-acquisition device unit uses side self-adapting electricity-acquisition contact. The electricity-acquisition arc board is always in a vertical state such that the electricity-acquisition arc board can be well contacted with the power-supply slide contact

lines. The adjusting device automatically adjusts contact pressure, which ensures normal power acquisition even if the tire container gantry crane is slightly deviates. The follower spring is capable of ensuring good adaptability of the tire container gantry crane in operation. The insulator and the insulated porcelain bottles ensure good insulation performance between the electricity-acquisition arc board and the linkage mechanism and improve safety.

2. Both sides of the power-supply slide contact lines are powered up simultaneously, whereby supplying power to two groups of tire container gantry cranes on both sides thereof or to multiple tire container gantry cranes on one side, which meets operation requirements, reduces container area and saves cost.

3. The laser range acquisition sensor controls left and right speeds of the tire container gantry crane, and keeps a distance between the side self-adapting contact electricity-acquisition device unit and the power-supply slide contact lines within $L+\Delta L$ (L is a constant, and $\Delta L \leq 200$ mm), whereby correcting deviation of the tire container gantry crane automatically. Retraction and release of the electricity-acquisition device unit is controlled in the cab and limited automatically, and no operator is needed, which makes the invention high efficient and safe.

4. In comparison with overhead, the middle-low voltage end posts and the middle posts feature light weight, simple production and installation, convenient transportation, low cost and requirements for foundation properties that is 1/20 of the overhead, small influence on occupied space, and good time effectiveness of improvement.

5. One tire container gantry crane uses four side self-adapting contact electricity-acquisition device units on both sides thereof, and the electricity-acquisition device units may comply with the same standard.

Brief Description of the Drawings

FIG. 1A is a front view of an electricity-acquisition equipment of an exemplary embodiment of the invention;

FIG. 1B is a top view of an electricity-acquisition equipment of an exemplary embodiment of the invention;

FIG. 2 is a schematic view of a side self-adapting contact electricity-acquisition portion of the

invention;

FIGS. 3A and 3B are schematic views of a driving device of the invention;

FIGS. 4A and 4B are schematic views of an adjusting device of the invention;

FIG. 5 is a schematic view illustrating that a photoelectrical detecting plate guides and controls a tire container gantry crane to automatically be rectified according to the invention; and

FIGS. 6 and 7 illustrate control and position limitation protection of the invention.

Description of the Embodiments

An electricity-acquisition device of the invention comprises a power supplying device unit, an electricity-acquisition device unit, and a control portion.

The power supplying device unit comprises posts, power-supply support, power-supply slide contact lines, and multiple tightening devices. The electricity-acquisition device unit includes a linkage mechanism, an electricity-acquisition arc board, a follower spring, an insulator, insulated porcelain bottles, a slide plate, a driving device, an adjusting device, and retraction and release limiting switch. The control portion includes laser range acquisition sensors, a photoelectrical detecting plate, a retraction and release limiting switch, a programmable logic controller (PLC) and a transducer driving system of the tire container gantry.

The following will illustrate the invention in detail referring to the figures.

Referring to Figs. 1A and 1B, in a center line of a blind road at freight yard of a tire container gantry crane, end posts 1 are disposed at two ends along a direction of walking track of the tire container gantry crane, and a plurality of middle posts 2 are disposed between the end posts 1 with equal space and operate to support the power-supply slide contact lines 8. A upper bracket 4, a lower bracket 5 and a photoelectrical detecting plate 3 are disposed between the end posts 1 and the middle posts 2. Positive and negative power-supply slide contact lines 8 are disposed on the upper bracket 4 and the lower bracket 5. Tightening devices 6 are disposed on both ends of the power-supply slide contact lines 8 and connected to the end posts 1 to make the power-supply slide contact lines 8 straight in order to meet the side contact require of a self-adapting electricity-acquisition device unit 7. The power-supply slide contact lines 8 are double-slot copper lines, and are vertically and bilaterally installed at two sides, whereby enabling multiple tire container gantry cranes on both sides thereof to acquire power

therefrom.

As shown in FIG. 2, a first base 18 of the side self-adapting contact electricity-acquisition device unit 7 is installed at lower crossbeam side 17 of the tire container gantry crane. A small trunk beam 11, a big pull rod 19, a main boom 20 are mounted on the first base 18. A small pull rod 12 is connected to the head of the small trunk beam 11, a big trunk beam 13 is connected to the head of the big pull rod 19, and the small trunk beam 11 is connected to the big pull rod 19 via a connecting rod 11A. The small trunk beam 11, the connecting rod 11A, the small pull rod 12, the big trunk beam 13, the big pull rod 19 and the main boom 20 constitute a linkage mechanism. The members of the linkage mechanism are all hinge connected and rolling bearings are used at the hinge points. One end of the main boom 20 is hinge connected to the first base 18, and the other end thereof is hinge connected to the big trunk beam 13, whereby supporting retraction of the linkage mechanism.

The right ends of the small pull rod 12 and the big trunk beam 13 are designed to be vertical axle holes, and they are hinge connected via a vertical hinge 21. An insulator 14 is disposed on the vertical hinge 21. Four insulated porcelain bottles 22 are disposed on the insulator 14 and connected to an electrical-acquisition arc board 16 via follower springs 15. The vertical hinge 21 is always vertical to the electricity-acquisition arc board 16. The insulator 14 and the insulated porcelain bottles 22 ensure good isolation performance between the electricity-acquisition arc board 16 and the linkage mechanism, and safe electricity-acquisition. As the side self-adapting contact electricity-acquisition device unit 7 is laid down, the electricity-acquisition arc board 16 is contacted with the power-supply slide contact lines 8 whereby acquiring power therefrom. In this embodiment, the follower spring 15 is a leaf follower spring. The follower spring 15 makes certain flexibility between the electricity-acquisition arc board 16 and the insulator 14, which is capable of compensating seismic displacement.

As shown in FIGS. 3A and 3B, the side self-adapting contact electricity-acquisition device unit 7 is driven by a driving device 9. A brake 9.1 is axially connected with a drum 9.2, a speed reducer 9.3, and a motor 9.4 of the driving device 9. A limiting cam 9.7 is disposed on the brake 9.1, a steel cable 9.5 is wrapped on the drum 9.2, and the speed reducer 9.3 is disposed on a second base 9.6. As the motor 9.4 is started, the steel cable 9.5 draught by the drum

controls retraction and release of the limiting cam 9.7. Once reaching a limit position, a retraction and release limiting switch of the limiting cam 9.7 sends a signal to control the motor 9.4 to stop, and gives acoustic-optic alarm indication. The acoustic-optic alarm circuit is normal.

An ear plate 10.1 of an adjusting device 10 is disposed on the first base 18, a nut 10.4 is disposed on a screw 10.3, and an extension spring 10.2 is disposed between the ear plate 10.1 and the screw 10.3. As the side self-adapted contact electricity-acquisition device unit 7 is laid down to a predetermined location, the extension spring 10.2 keeps moment balance between the adjusting device 10 and the electricity-acquisition device unit 7. A retraction force is laterally adjusted in a range of ± 300 mm, so that a stable contact force between a slide plate and the power-supply slide contact lines 8 is kept between 90 and 120 N. The adjusting device 10 is connected to the big pull rod 19 via a hinge shaft 10.5. A position of the screw 10.3 is varied, and then fixed via the nut 10.4, so that a stable contact force between the electricity-acquisition arc board 16 and the power-supply slide contact lines 8 is kept between 90 and 120 N.

As shown in FIG. 5, the PLC controller and the transducer driving system are connected to the front laser range acquisition sensors and the rear laser range acquisition sensors at two sides, to the positive and negative electricity-acquisition device units, and to walking motors of tire container gantry cranes. The front laser range acquisition sensor and the rear laser range acquisition sensor at a right side are connected to the photoelectrical detecting plate 3, and the positive and negative electricity acquisition device units 7 are connected to the positive and negative power-supply slide contact lines 8, respectively.

The photoelectrical detecting plate 3 is parallel to the positive and negative power-supply slide contact lines 8. The electricity-acquisition device unit acquires the power, detects a distance from the and the photoelectrical detecting plate via the front laser range sensors and the back laser range sensors mounted on the tire container gantry crane, and controls a velocity of the tire container gantry crane, correct deviation thereof, and keeps a distance between the side self-adapting contact electricity acquisition device unit 7 and the power-supply slide contact lines 8 within $L + \Delta L$ (L is a constant, and $\Delta L \leq 200$ mm). For example, as the tire container gantry crane travels forwards, if the front laser range acquisition sensor detects $\Delta L \geq 200$ mm

and the rear laser range acquisition sensor detects $\Delta L \leq 200\text{mm}$, the laser range acquisition sensors transmit a signal to the PLC controller and the transducer driving system, and the PLC controller and the transducer driving system control a velocity of a left walking motor of the tire container gantry crane to be 1-5% greater than that of a right walking motor thereof. After the distance is within $L + \Delta L$, a velocity of the left walking motor is the same as that of the right walking motor. The same principle applies if the tire container gantry crane travels backwards to control the right and left velocities of the tire container gantry crane, correct deviation thereof, and keeps electricity-acquisition distance automatically.

As shown in FIGS. 6 and 7, a first switch K2 and a second switch K3 disposed on the right of a cab respectively controls retraction and release of the electricity-acquisition device units on the right and left of the tire container gantry crane. For example, retraction and release of the electricity-acquisition device unit on the right of the tire container gantry crane is controlled by the switch K2 and a PLC instruction from the cab, and then retraction and release are controlled by relays K4 and K5, and interlocking is controlled by KM5 and KM6. The release process and the reaction process are reciprocal. As the switch K5 is deployed, KM6 is closed, the motor enters an inversion driving state, the first switch K2, an inverter KM6, a release limiting switch K10 controls KM1 to close, and the right positive electricity-acquisition device unit is laid down. As the right positive electricity-acquisition device unit reaches a limit position, the limiting switch K10 is opened, and the right positive electricity-acquisition device unit stops releasing and the electricity-acquisition device unit acquires power therefrom. As K4 is chosen to be retracted, KM5 is closed, the motor of the driving device enters a normal state, the first switch K2, the right limiting switch K6 and the inverter KM5 control KM1 to close, the right positive electricity-acquisition device unit is retracted, as the right positive electricity-acquisition device unit reaches a limit position, the right limiting switch K6 is opened, the right positive electricity-acquisition device unit reaches stops retracting. The same principle applies for the right negative electricity-acquisition device unit, and the right anode power acquisition equipment and the right cathode power acquisition equipment are simultaneously laid down.

As the tire container gantry crane is turned over, the right electricity-acquisition device unit is retracted, and then the tire container gantry crane acquires power from the left

electricity-acquisition device unit. At this time the second switch K3 is closed to retract and release the left electricity-acquisition device unit. The principle is the same as above.

CLAIMS

1. An automatic middle-low voltage side self-adapting contact electricity-acquisition device, comprising

a pair of end posts disposed at two ends and in a center line of a blind road at freight yard of a tire container gantry crane along a direction of walking track of the tire container gantry crane;

multiple middle posts disposed between the end posts with equal space and operate to support power-supply slide contact lines;

a upper bracket, a lower bracket and a photoelectrical detecting plate disposed between the end posts and the middle posts;

positive and negative power-supply slide contact lines disposed on the upper bracket and the lower bracket;

tightening devices disposed on both ends of the power-supply slide contact lines;

a first base, and a driving device of a side self-adapting contact electricity-acquisition device unit installed at lower crossbeam side of the tire container gantry crane at front and rear side;

an adjusting device disposed on the first base; and

a small trunk beam, a big pull rod, a main boom mounted on the first base; wherein

a small pull rod is connected to the head of the small trunk beam, a big trunk beam is connected to the head of the big pull rod, and the small trunk beam is connected to the big pull rod via a connecting rod, whereby the small trunk beam, the connecting rod, the small pull rod, the big trunk beam, the big pull rod and the main boom constitute a linkage mechanism;

the members of the linkage mechanism are all hinge connected and rolling bearings are used at the hinge points;

one end of the main boom is hinge connected to the first base, and the other end thereof is hinge connected to the big trunk beam;

laser range acquisition sensors are mounted on the front and left of the tire container gantry crane;

the photoelectrical detecting plate is parallel to the power-supply slide contact lines;

the electricity-acquisition arc board of the electricity-acquisition device unit is flexibly connected to the small pull rod, the big trunk beam via a vertical hinge and a follower spring;

a PLC controller and a transducer driving system of a control portion are connected to the front laser range acquisition sensors and the rear laser range acquisition sensors at two sides, to the positive and negative electricity-acquisition device units, and to right and left walking motors of tire container gantry crane;

the front laser range acquisition sensor and the rear laser range acquisition sensor at a right side are connected to the photoelectrical detecting plate, and the positive and negative electricity-acquisition device units are connected to the positive and negative power-supply slide contact lines, respectively.

2. The automatic middle-low voltage side self-adapting contact electricity-acquisition device of claim 1, wherein the right end of the small pull rod (12) is connected to the right end of the big trunk beam (13) via a vertical hinge (21), an insulator (14) is disposed on the vertical hinge (21), and four insulated porcelain bottles (22) are disposed on the insulator (14).

3. The automatic middle-low voltage side self-adapting contact electricity-acquisition device of claim 1, wherein a brake (9.1) of the driving device (9) is axially connected with a drum (9.2), a speed reducer (9.3), and a motor (9.4) of the driving device (9), a limiting cam (9.7) is disposed on the brake (9.1), a steel cable (9.5) is wrapped on the drum (9.2), and the speed reducer (9.3) is disposed on a second base (9.6).

4. The automatic middle-low voltage side self-adapting contact electricity-acquisition device of claim 1, wherein an ear plate (10.1) of the adjusting device (10) is disposed on the first base (18), a nut (10.4) is disposed on a screw (10.3), and an extension spring (10.2) is disposed between the ear plate (10.1) and the screw (10.3).

5. The automatic middle-low voltage side self-adapting contact electricity-acquisition device of claim 1, wherein the power-supply slide contact lines (8) are double-slot copper lines, and are vertically and bilaterally installed at two sides.