An intelligent shore power device controlled by internet of things

Feng Lu*, Haifeng Liu, Songsong Zheng, Peixiang Zhou
State Grid Zhejiang Electric Power Co., Ltd., Huzhou Power Supply Company, Huzhou, Zhejiang, China

ABSTRACT

Taking the opportunity of the construction of shore power coverage at Huzhou public ports, this paper studies the shore-based power supply technology for ships in inland ports, aiming to study the diversified design based on the ship load analysis and capacity calculation model. An intelligent shore power device and system based on Internet of things technology is developed to solve the problems of short service life and high failure rate. Based on pneumatic and crawler lifting, slide rail positioning, air cushion block, electromagnetic sealing and automatic shielding device, tension sensing technology, control of automatic cable expansion and contraction technology. The intelligent shore power equipment and marine cable expansion device based on Internet of things control are developed, and the multi-dimensional information collection and monitoring such as charging data, operating parameters and environment temperature of the shore power equipment are developed. The utility model realizes the overall state perception, high-efficient information processing, convenient and flexible man-machine interaction application, and improves the operation stability of the shore power pile.

Keywords: Shore power, internet of things, automatic cable, capacity calculation model

1. INTRODUCTION

With the development of national economic construction and trade, the shipping industry will maintain a prosperous state for a long time, and the construction of inland river ports and docks will continue to develop, and the number and density of ships will greatly increase. Due to the late start of shore power technology in China, there are mainly problems such as shore-based power supply planning and design, lack of technical specifications and construction standards, low degree of intellectualization of shore power facilities, high cost of construction and operation and maintenance, non-standard operation and maintenance management and operation service, etc. In order to solve these problems, it is urgent to improve port power technology. This paper focuses on the design of a shore electric pile, especially involving a ubiquitous intelligent shore electric device controlled by the Internet of things.

2. STATUS OF SHORE POWER TECHNOLOGY AT HOME AND ABROAD

Originated in Europe and the United States, the shore power technology has been developed so far with a high degree of application and obvious effects. In 1985, Sweden used shore power technology to power oil tankers.

China's port electricity technology started late. The high-voltage shore power system was adopted in 2010, and then the use of shore power technology by ships calling at ports was gradually promoted across the country. Shore power technology starts late, the current mainstream of port terminal power supply equipment generally consists of stand type shore power box or charging pile installation in the form of the ground, are greatly influenced by the external environment. Exposed to the external environment for a long time in actual use, it is inevitable to suffer from wind and rain, and is prone to fire of charging pile, leakage and other safety hazards. As a result, the failure rate of shore power facilities is high, the safety performance is low, and the operation failure rate is high, which reduces the experience of shore power equipment users. Huang[1] analyzed the characteristics of the energy consumption of the port logistics system and established a coupled load model of the logistics-energy system based on the status of ships at the port and the characteristics of load operation, so as to realize the synergy between the logistics system and the energy system. Zhao[2] established a comprehensive energy system planning model for the port area considering the elasticity of shore power load to help rationally allocate the port area resources, effectively improve the energy efficiency of the port area, increase

* 499909619@qq.com

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the income of the port area, and help the port area to save energy and reduce emissions. Wang[3] established a hybrid energy system model, including the shore power load prediction model, the shore power dynamic price model, the fan model and the energy storage model, which improved the problem of large error of the open-loop optimization method in an uncertain environment. Many studies discussed the energy system and transfer strategy of shore power[4-8]. However, there are still some deficiencies in these researches, which can not solve the problems of shore power load management and the suppression of inrush current of distribution transformer. Therefore, this paper designs intelligent shore power device controlled by Internet of things to solve these problems.

3. LIFTING INTELLIGENT SHORE POWER DEVICE BASED ON INTERNET OF THINGS CONTROL TECHNOLOGY

According to the different types of charging pile installation and interconnection, a lifting intelligent shore power device with ubiquitous Internet of things control technology is proposed. The device buried underground can effectively prevent man-made or natural environment from destroying the charging pile, and achieve the purpose of reducing the failure rate, prolonging the service life and beautifying the environment.

3.1 System architecture

The device includes shore electric pile and control center. The shore electric pile is provided with a main control board and a power supply circuit. The shore electric pile is located inside the shore electric box, and a lifting device is provided inside the shore electric box to drive the lifting of the shore electric pile. The top of shore electric pile is provided with a cover plate, a TWO-DIMENSIONAL code is arranged on the sealing cover, and the main control board and lifting devices are connected with the control center through the network. The main control board includes the main control chip, power supply circuit and control circuit connected with the main control chip, remote control circuit, card reader and LCD circuit, charging connection detection circuit, charging control detection circuit and network communication circuit.

The structure of the device is shown in Figure 1, and the overall schematic is shown in Figure 2. In Figure 2, 1 is the main control chip, 2 is the control circuit, 3 is the charging connection detection circuit, detection circuit for charging control, 4 is charging cable, 5 is the remote communication control circuit, 6 is the card reader and LCD circuit, 7 is the RS-485 circuit, 8 is the AD reference voltage circuit, 9 is the temperature control and detection circuit, 10 is the ferroelectric storage circuit, 11 is the clock circuit, 12 is the network communication circuit, 13 is the Power supply circuit, 14 is the control center, 15 is the lifting gear, 16 is the block device, 17 is the power supply circuit, 18 is the main control board, 19 is the shore power box, 20 is the dry layer, 21 is the installation, 22 is the air cushion, 23 is the slippery course, 24 is the limit block, 25 is the electrify coil, 26 is the skateboarding, 27 is the sealing ring, 28 is the magnetic stripe, 29 is the flat, 30 is the connecting rod, 31 is the screw, 32 is the moving block, 33 is the motor, 34 is the operation panel, 35 is the shore electric pile, 36 is the charging gun, 37 is the heat sink hole, 38 is the winding cylinder, 39 is the installation bottom plate, 40 is the lifting rod, 41 is the fixed seat, 42 is the slide block, 43 is the pneumatic device.

3.2 Functions

The main functions of the device are realized by pneumatic lifting and crawler lifting, sliding rail positioning and air cushion block, electromagnetic seal and automatic blocking device, etc. It ensures the stability and flexibility of shore electric pile lifting, safe and reliable operation, and improves the ability of shore electric device to the environment. Using high-performance master control chip technology, the devices are connected with a central server through the network connected to the charging data, operation parameters, such as environmental temperature multi-dimensional information acquisition and monitoring, with the state comprehensive information awareness, efficient processing, human-computer interaction, application features such as convenient and flexible. It realizes the intelligent operation and inspection functions of "study and judgment, early warning, isolation and self-healing" to ensure the safe and stable operation of shore power equipment.

(1) The shore power box is buried in the underground, and the wall of the shore power box is provided with a drying layer for placing the desiccant.

(2) The outer bottom of the shore power box is fixed with a fixed seat, which makes the installation of the shore power box to firm, and the internal installation of the shore power box is fixed with an installation seat.

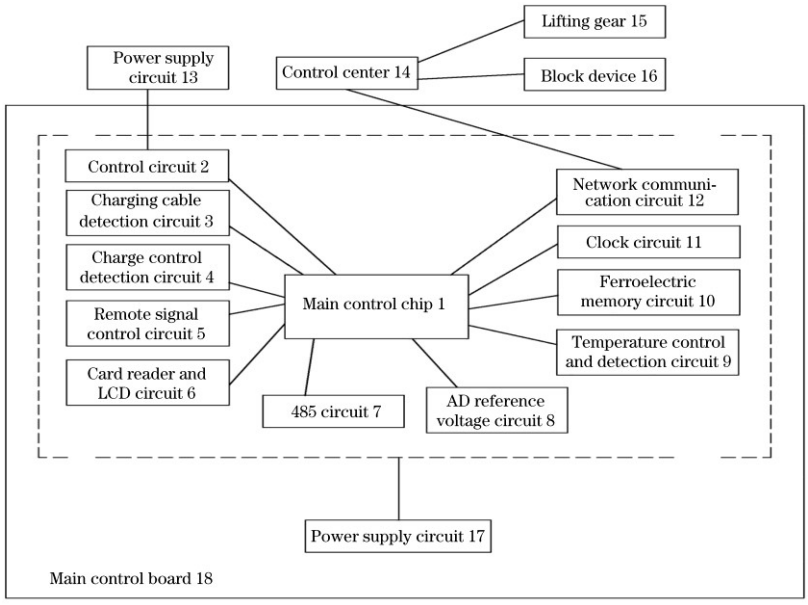


Figure 1. Device structure diagram.

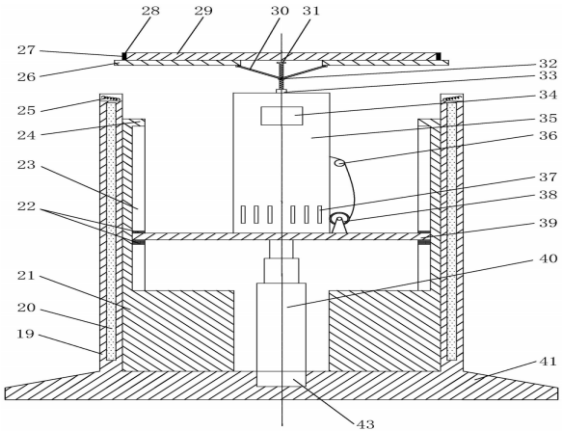


Figure 2. Schematic diagram of the whole device.

(3) There are 4 slides on the mounting seat, and the intervals between each slide are 90°, the top of each slide rail is fixed with a finite position block, and the bottom end of the lifting rod is connected with the bottom of the shore electric box.

(4) The top of the lifting rod is fixedly installed with the installation bottom plate, the lifting rod adopts pneumatic control, that is, when the lifting rod rises, the pneumatic device connected with the lifting rod receives the signal for inflation, the lifting rod rises, and when the lifting rod falls, the pneumatic device connected with the lifting rod receives the signal for deflating.

(5) The lifting rod is lowered, and the installation base plate is fixedly installed with four sliders matching the slide rail. The upper and lower surfaces of the slide block are provided with an air cushion, and the shore electric pile is fixed on the upper surface of the installation base plate.

(6) The side of the shore electric pile is provided with an operation panel and a heat dissipation hole. The side of the shore electric pile is provided with a charging gun and a winding cylinder. The top of the shore electric pile is provided with a shielding device, including a sliding plate, a screw, a connecting rod, a moving block and a motor.

(7) Skateboard with sliding connection between cover, mobile block with screw thread connection, one end of the screw and motor connection, one end of the connecting rod connected to the mobile piece of rotation, the other end connected

to the slide rotational, cover plate installed outside of the sealing ring, sealing ring and cover plate installed with a magnetic stripe, between onshore electric box at the top of the box wall installation can be energized coil, match with a magnetic stripe.

3.3 Technical features

The lifting intelligent shore power device based on Internet of Things control technology mainly solves the technical problems of high damage rate and low safety performance of the original shore power pile, reduces the hidden danger of safety of charging pile, and prevents man-made or natural environment damage. Control center receives the control command, control lifting gear up, will shore power pile up to the surface, and then through the power supply circuit to ship the power supply, power supply circuit for the main control chip and connected with the main control chip circuit of power supply, card reader and LCD circuit for charging rechargeable electricity and convenient for the user for the corresponding charging operation, The charging connection detection circuit is used to detect CC signal, the charging control detection circuit is used to detect CP signal, the control circuit controls the on-off of the power supply circuit, and the Internet communication circuit is used for information interaction between the main control chip and the control center.

(1) The main control chip controls whether the relay KM1 coil is energized by controlling the cutoff and saturation states of the triode in the control circuit, so as to control whether the power supply circuit is on, and multiple controls ensure the safety of power supply.

(2) The main control board also includes AD reference voltage circuit, temperature detection circuit, ferroelectric storage circuit and clock circuit respectively connected with the main control chip.

(3) The temperature detection circuit is used to detect the temperature of shore electric piles to avoid damage caused by excessive temperature; the clock circuit is used to control the working rhythm of the main control chip; the ferroelectric storage circuit is used to store charging data, and the ferroelectric storage circuit has low power consumption, fast storage speed and large capacity.

(4) The lifting device comprises an installation seat, installation base plate and lifting rod, the installation seat is covered in the installation box, the top surface of the installation base plate is provided with shore electric pile, the back of the installation base plate is connected with the lifting rod, and the installation base plate is connected with the installation seat.

(5) The control center controls the rise and fall of the lifting rod, so as to realize the rise and fall of the shore electric pile.

(6) A rain shield is arranged between the top of the shore electric pile and the cover plate. The shelter device comprises a sliding plate, a screw, a connecting rod, a moving block and a motor. The sliding plate is connected with the cover plate, the moving block is connected with the screw thread, one end of the connecting rod is connected with the moving block, and the other end is connected with the moving plate.

(7) Motor rotation drives the screw rotation, moving block upward movement drives the connecting rod to extend outward, thus driving the slide plate to slide out of the side, the existence of shielding device can reduce the erosion degree of shore electric pile, lifting device and shore electric box by the natural environment, prolong the service life.

(8) Dry interlayer is arranged in the wall of shore electric box.

(9) The bank electric box is located on the river bank, where the environment humidity is high. The dry interlayer can absorb part of the humidity and reduce the erosion degree of the bank electric box.

(10) There is a QR code on the seal cover. Users can charge by scanning the QR code.

Shore power system uses temperature measuring circuit to detect its own temperature in real time in idle state. When the temperature is too high, the information will be uploaded to the central server, and the central server will notify relevant staff to repair the charging pile; When the shore power system is needed to supply power to the ship, the ship's staff scan the Two-Dimensional code on the seal cover with their mobile phones and send a request to the central server to use the charging pile corresponding to the two-dimensional code; After receiving the request, the heart server controls the lifting device and lifts the charging pile to the surface. After that, the ship staff sets the charging time on the touch screen. Then connect the charging head with the ship charging base, and then charge on the touch screen to start operation. At the time, the clock circuit records the charging time. When the charging time exceeds the preset time or the ship is fully

charged, the charging will stop automatically and wait for the ship staff to remove the charging head and make settlement. The settlement can be paid by mobile phone or swipe card with the corresponding charging card. After settlement, the information related to charging is stored in ferroelectric memory, the lifting device in the central server is lowered, and the charging pile is retracted into the ground.

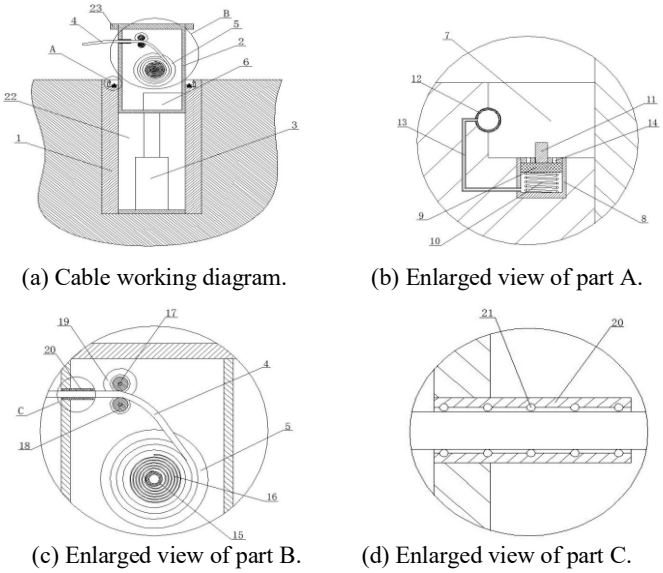
4. MARINE CABLE TELESCOPIC CHARGING DEVICE BASED ON UBIQUITOUS INTERNET OF THINGS

According to the different charging link devices, a marine cable telescopic charging device is proposed. The device is arranged in the underground sealed chamber to avoid the charging device exposed to the external environment for a long time prone to failure. The separation design of control system and charging pile can greatly reduce the investment cost of shore power system, realize the functions of remote control lifting and monitoring operation conditions, and ensure the safe and reliable operation of charging device. Device adopts automatic cable tension sensor technology control scale, avoid the ships to dock to break or damage in charging cable, damage phenomenon such as charging device, attrition rate and reduce the Marine cable and charge equipment failure rate, and equipped with FRID qr code, such as mobile phone APP technology has realized the quick user use, also improve the operational and management level of the operator.

4.1 System architecture

The charging device comprises a lifting base with a well and a lifting box body arranged in the well. Movements between the lower end of the box body and the bottom of the shaft set lifting hydraulic cylinder, lift the casing rotation connection with reel, winding are charging cable reel, lifting body profile Settings are used to make the charging cable extends to the lifting cables exported outside the enclosure, lift the casing and export a location corresponding to the rotating connection cable has the driving wheel and driven wheel, motor driving wheel connections, One end of the charging cable is connected with the power supply device, and the other end of the charging cable is passed between the driving wheel and the driven wheel, and the driving wheel and the driven wheel are respectively pressed on both sides of the charging cable; The lifting box is provided with a control device for controlling the lifting hydraulic cylinder and motor operation. The control device is connected to the central server through the network. The upper end of the lifting box is attached with a Two-Dimensional code.

The working schematic diagram of the cable is shown in Figure 3. In Figure 3, 1 is the lifting base for, 2 is the lifting body, 3 is the lift hydraulic cylinder, 4 is the charging cable, 5 is the reel, 6 is the control device, 7 is the groove, 8 is the piston cylinder, 9 is the pistons, 10 is the spring, 11 is the plunger, 12 is the inflatable sealing ring, 13 is the vent, 14 is the vent, 15 is the reel shaft, 16 is the vortex coil spring, 17 is the primary pulley, 19 is the driven wheel, 20 is the guide pipe, 21 is the ball, 22 is the well passage, 23 is the flange.



(a) Cable working diagram. (b) Enlarged view of part A.

(c) Enlarged view of part B. (d) Enlarged view of part C.

Figure 3. Cable working schematic diagram.

4.2 Function description

In the device, the lifting box is driven by the lifting hydraulic cylinder. The driving wheel is driven by the motor to realize the retracting and retracting of the charging cable.

(1) When charging is needed, the lifting box rises above the ground, and the charging cable extends out under the driving wheel to dock with the ship and charge the ship.

(2) When the charging is completed, take back the charging cable, lifting box in the hydraulic cylinder drive down to the ground below, so as to avoid the charging device for a long time exposed to the external environment, so as to avoid long-term exposure to wind and rain, the charging device has a good protection, reduce the rate of loss and failure rate of the charging device.

(3) When users need to use the charging device, through a mobile device scan the QR code of lifting system. When the QR code to be scanned, mobile devices will send a signal to the central server to a central server after treatment to send signal to control device, through the control device control lifting hydraulic cylinder and the motor running, through the QR code control system, Users can easily use the charging device by scanning.

4.3 Technical features

The upper end of the lifting box is provided with a flange, and the upper end of the lifting base is provided with a groove matching the flange. The bottom of the groove is provided with a piston cylinder, a piston cylinder is provided with a piston, and a spring is arranged between the piston and the bottom of the piston cylinder; The piston is connected to a push rod that passes up through the piston cylinder; The side of the groove is provided with an inflatable sealing ring, and the piston cylinder is connected with the inflatable sealing ring through a ventilation pipe. The vent tube is connected to the bottom side of the piston cylinder and communicates with the cavity inside the piston cylinder. Lifting box in the fall to the lowest, lifting box upper flange embedded in the groove.

Lifting body in the process of decline, the lower end of the flange and on top of the pole at resistance and the plunger down, the plunger in the process of down to drive the piston moves down, the piston moves down, in the process of piston in the cylinder gas by the gas seal, the pneumatic sealing ring expansion, such making that pneumatic sealing ring can effectively seal the clearance between the flange and the grooves, Prevent the outside dust and rain into the well, so as to play a good role in the well lifting line body.

(1) The side of the groove is provided with an annular sealing groove corresponding to the inflatable sealing ring, and the inflatable sealing ring is embedded in the sealing ring groove. The sealing ring groove plays a role in positioning the sealing ring.

(2) The upper end of the piston cylinder is provided with a vent hole.

(3) The inside of the lifting box is provided with a guide tube, which is corresponding to the cable outlet, and the charging cable passes through the guide tube. The guide tube guides the charging cable.

5. APPLICATION AND MARKETING SITUATION

The research and development of intelligent shore power devices and systems based on Internet of Things technology fundamentally solves the problems of short service life and high failure rate of traditional shore power facilities. At the same time, RFID Two-Dimensional code, mobile APP and other technologies realize quick use of users, improve the sense of user experience and acquisition, and improve the operation and maintenance and management level of operators.

Since 2018, the relevant technology had been promoted to the Beijing-Hangzhou Canal basin, and had been applied in Jiaxing, Zhejiang Province, Changzhou, Jiangsu province and other regions. The related technologies brought 59.7 million yuan of economic benefits to the enterprises in related industries.

6. CONCLUSION

(1) In this paper, an intelligent shore power device is designed with ubiquitous power Internet of things. When the shore electric pile is idle, the temperature measuring circuit is used to detect its own temperature in real time. When the

temperature exceeds the normal range set, the master chip will upload the fault information to the control center. The control center will inform the relevant staff to repair the shore electric pile.

(2) The construction of inland river ports will continue to develop, and the number and density of ships will increase greatly. The new shore power system will continue to accumulate experience in the construction, to improve the reliability and security of power supply, reduce labor costs, reduce construction investment and other aspects of continuous research.

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