

A kind of Omnidirectional Precise Dispatching Crane

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Abstract

In order to adapt to the specific lifting occasions and reduce the instability of the spreader, this paper designs a kind of omni-directional lifting crane, improves the traditional eight rope winding system, effectively prevents the sling from swinging and shaking in the transportation of goods, effectively improves the flexibility of the crane, improves the efficiency of handling goods, and effectively improves the accuracy of grasping goods.

Keywords

Crane, Anti-sway system.

1. Introduction

The crane plays a large-scale cargo handling task in the port, wharf or factory. The traditional handling equipment mainly uses the single rope winding method to carry and transport the large-size goods. The traditional lifting crane uses the single degree of freedom walking mode, walks to the designated position, and then grabs the goods through the hook. The traditional handling method greatly tests the accuracy of the control system and the experience of the operators. It is difficult to ensure the accuracy of the spreader due to its long time-consuming and difficult operation. In view of the above problems, a new type of lifting crane is proposed, which is mainly suitable for handling small goods in special occasions.

2. Research status of hoisting mechanism

2.1 Research status of eight rope anti sway system.

The single swing effect of crane refers to the load swing and shaking of flexible suspension of steel wire rope caused by the acceleration of trolley motion during the operation of crane during the carrying task. The single pendulum effect is the most obvious when the crane grabs and unloads the goods, which is mainly due to the sudden change of load when the crane starts and brakes, so it is difficult to accurately locate the goods. Li [1] analyzed the common anti sway system of crane, expounded its basic principle, advantages and disadvantages, and considered that eight rope anti sway system was the best scheme. Tang [2] analyzed two kinds of eight rope anti sway systems based on the finite element model. The simulation results show that the two anti-sway systems can reduce the single swing effect of the trolley and have significant anti sway effect. From the perspective of simulation, the rationality of "positive triangle" anti-sway system in domestic ports is explained. Zhang and Zhao [3] improved the traditional eight rope winding system, and designed an eight rope single winding system, which was applied to the tire type container crane. The servo driver position control was used to realize the synchronization of eight lifting motors, which solved the problems of energy saving force difference and overweight of traditional eight rope spreader in horizontal adjustment. Zhang [4] has designed an active anti sway system which uses the auxiliary steel wire rope to provide traction force. The auxiliary steel wire rope exerts traction force on the spreader, thus

restraining the swing of the spreader, reducing its swing kinetic energy in the starting and braking process, and controlling the swing amplitude of the spreader within a safe range to ensure the stability of the trolley during operation. Active anti sway system has complex structure, higher cost and small application range. For most ports in China, the hoisting mechanism of crane mostly adopts passive anti sway system.

2.2 Introduction of anti-sway system.

In order to improve the efficiency and accuracy of cargo handling, some scholars have designed the common anti sway system of crane. According to the classification of power input, the commonly used anti sway system of lifting mechanism is mainly divided into four categories: manual, mechanical, hydraulic and electronic [1]. Manual anti sway system is a kind of manual anti sway system, which can compensate the excess displacement by manual adjustment driver driving and reversing. It has the advantages of simple structure, low cost and wide application range, but the anti-rolling effect is not ideal. The mechanical anti rolling system refers to the anti-sway device designed by mechanical principle, which can be divided into rigid anti sway and flexible anti sway system, mainly including rigid guide cylinder brake, separation trolley and eight ropes Anti sway, mechanical anti sway system has different advantages and disadvantages according to the complexity of its structure, anti-sway effect is also different, but generally better than manual anti sway system; hydraulic anti sway system is to drive pulley block to provide power through hydraulic cylinder, which has good anti sway effect, but also has the disadvantages of complex structure, high cost, limited application range, etc.; electronic anti sway system is widely used. It means that it depends on the principle of electrical automatic control to prevent rocking, which has good anti sway effect, but it also has the disadvantages of complex structure, high cost and limited application range.

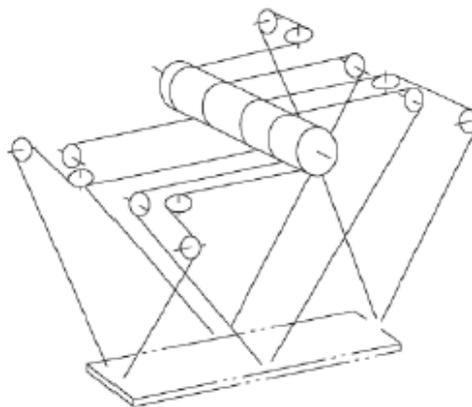


Fig. 1 Traditional eight rope anti sway system [3].

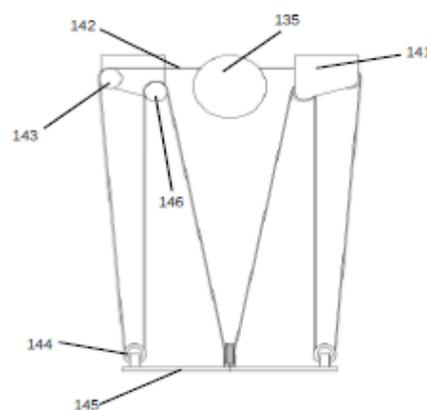


Fig. 2 lifting mechanism of crane

141-upper pulley frame, 142-rope, 143-upper pulley 1, 144-lower pulley.

This paper mainly discusses the mechanical anti sway system, designs a new anti sway system of lifting mechanism, and compares it with the traditional eight rope anti sway system. The traditional eight rope anti sway system is to wind 8 wire ropes at the four corners of the cross shaped spreader and pass through the guide pulley and drum on the trolley frame to lift the lifting appliance, which can effectively prevent the lifting appliance from shaking in the traveling direction of the trolley, as shown in Fig. 1. The traditional eight rope anti sway system has many problems, such as large distribution space, easy deviation of wire rope on drum, excessive guide pulley and serious friction of wire rope. Therefore, an omni-directional accurate dispatching crane is designed.

3. Design of new lifting mechanism

Four groups of ropes are symmetrically arranged for the hoisting mechanism, and the movable pulley is labor-saving. Each rope has the function of anti-sway and load-bearing. The gravity action is used to prevent all-round self-sway, which can meet the requirements of precise lifting. The manual operation skill is low and the efficiency will be greatly improved.

The lifting mechanism adopts rope lifting and transmission. The light weight flexible rope can be drawn into the drum to save space and control the lifting height flexibly. The lifting mechanism 14 comprises: one end of the rope 142 is wound on the drum 135, the upper pulley 1 is installed on the upper pulley frame 141, the rope 142 bypasses the upper pulley 143, the rope 142 bypasses the lower pulley 144, the lower pulley 144 is installed on the sling platform 145, the upper pulley 2 is installed on the upper pulley frame 141, the rope 142 bypasses the upper pulley 2 146, and the other end of the rope 142 is connected to the sling platform 145, as shown in Fig. 2 .

The spreader is platform type, which can be replaced according to the requirements of different scenarios, and the lifting system does not need to be replaced as a whole. The upper pulley frame 141 is installed on the trolley 134, and the spreader 147 is installed on the spreader platform 145, as shown in Fig. 3.

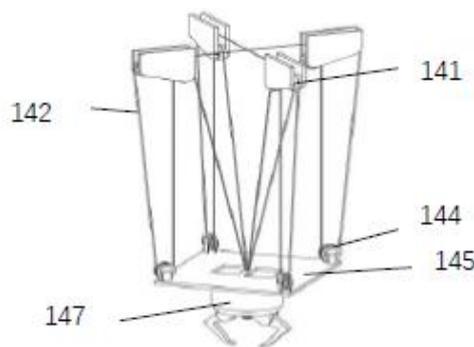


Fig. 3 lifting mechanism and spreader.

145-spreader platform, 146-upper pulley 2, 147-spreader.

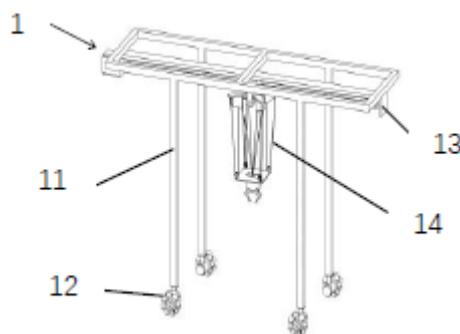


Fig. 4 overall structure of crane

1-machine body, 11-frame structure, 12-walking mechanism, 13-trolley mechanism, 14-lifting mechanism.

The new type of rope anti sway lifting mechanism has the advantages of small working space, simple structure, light weight, convenient operation, low cost and wide application range, and is superior to the traditional eight rope anti sway system.

4. A kind of omnidirectional precise dispatching crane

In this paper, an omni-directional precision transportation crane is designed, which includes frame structure, walking mechanism, trolley mechanism and lifting mechanism; the trolley mechanism includes driving motor, guide rail, driving screw, trolley and drum; the lifting mechanism includes rope, upper pulley 1, lower pulley, spreader platform, upper pulley 2 and spreader. As shown in Fig. 4, the walking mechanism 12 is fixed on the frame mechanism 11, the walking mechanism 12 is placed on the ground, the trolley mechanism is fixed on the frame mechanism 11, and the lifting mechanism 14 is installed on the frame structure 11.

The frame structure adopts the door frame structure, the connection is designed at a high position, which is convenient to cross the obstacles on the ground, and the lifting is carried out over the lifted objects. The bearing capacity is distributed to four door legs, with large span and stable anti overturning;

The walking mechanism uses mcnam wheel, which can realize omni-directional and arbitrary movement in the plane by controlling four wheels with different rotational speeds and turns;

Since the motor has no power self-locking, the trolley mechanism uses lead screw transmission to prevent the car from sliding after losing power and eliminate potential safety hazards; the drive motor 131 is installed on the guide rail 132, the guide rail 132 is fixed on the frame structure 11, the drive screw 133 is connected with the drive motor 131, the transmission screw 133 is installed on the guide rail 132, the trolley 134 is installed on the guide rail 132, and the trolley 134 is connected with the drive screw 133. The drum 135 is fixed on the trolley 134, the drum motor 136 is mounted on the trolley 134, and the drum motor 136 is connected to the drum 135, as shown in Fig. 5.

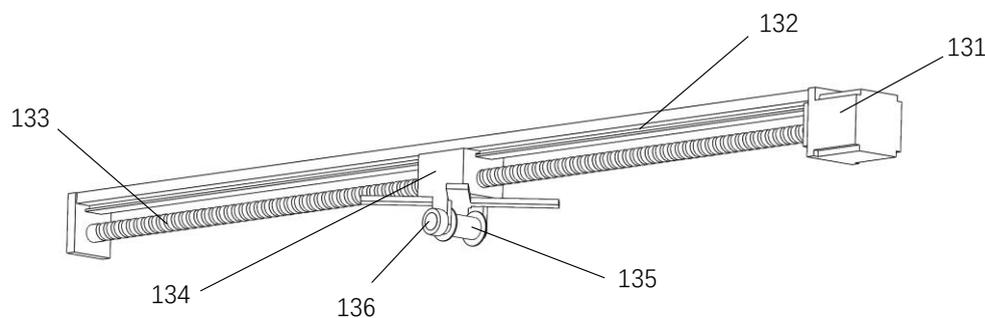


Fig. 5 transmission mechanism of crane

131-drive motor, 132-guide rail, 133-drive screw, 134-trolley, 135-reel, 136-reel motor.

When omni-directional precise transportation crane is used, the four mcnam wheels in travel mechanism 12 can realize arbitrary in plane by different steering and rotating speed

The vehicle can move and adjust its attitude by translation, rotation and revolution.

When omni-directional precision transportation crane is used, the driving motor 131 drives the driving screw 133 to drive the trolley 134 to move in a straight line. The self-locking ability of the screw drive can prevent the trolley 134 from sliding after losing power. The lead screw can accurately control the moving distance of the trolley and improve the accuracy of the whole machine.

When omni-directional precise transfer crane is used, the fixed part of the whole vehicle will not shake greatly. Through the rope system composed of four groups of ropes 142, upper pulley-143,

lower pulley 144 and upper pulley-2146, the gravity and tension concentrated at the fixed connection of the central rope of the lifting platform 143 are generated. Both forces act on the central axis of the lifting mechanism 14, which is conducive to the start and stop of the spreader and the lifting of goods. Keep stable, improve operation feasibility and transportation efficiency.

5. Summary

In this paper, an omni-directional precision transfer crane has the following advantages: simple and reliable structure, omni-directional flexible movement, trolley self-locking anti slip car, lifting system omni-directional anti sway, quick change of spreader, small space occupation, high space utilization, low manual operation skill requirements, economical and efficient, it has good practical value and promotion value.

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