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(54) **UNMANNED CRANE PROVIDED WITH AUTOMATIC UNHOOKING AND HOOKING APPARATUS, AND OPERATING METHOD THEREFOR**

(57) Disclosed is an unmanned crane provided with an automatic hooking-unhooking device and an operating method thereof. The unmanned crane comprises a grid guide frame trolley, a ground assistance frame, and a ground load transporting device. The grid guide frame trolley can perform lateral displacement along a bridge. The rigid guide frame trolley is connected to a hoisting mechanism that makes a load have no horizontal displacement in the process of lifting and lowering the load. An automatic hooking-unhooking device is disposed at the bottom end of the hoisting mechanism. The ground assistance frame is rigidly connected to the ground. The automatic hooking-unhooking device comprises a guide

wheel, a first guide rail matched with the guide wheel is rigidly connected to the bottom of the guide frame trolley, and the ground assistance frame is provided with a second guide rail matched with the guide wheel. The automatic hooking-unhooking device of the hoisting mechanism, a rigid frame of the trolley and the ground assistance frame working in conjunction with each other can achieve the functions of automatically loading and unloading a load in the unmanned crane, such that no horizontal displacement of a whole system is generated during the process of lifting and lowering a spreader, and thus high reliability and safety are provided.

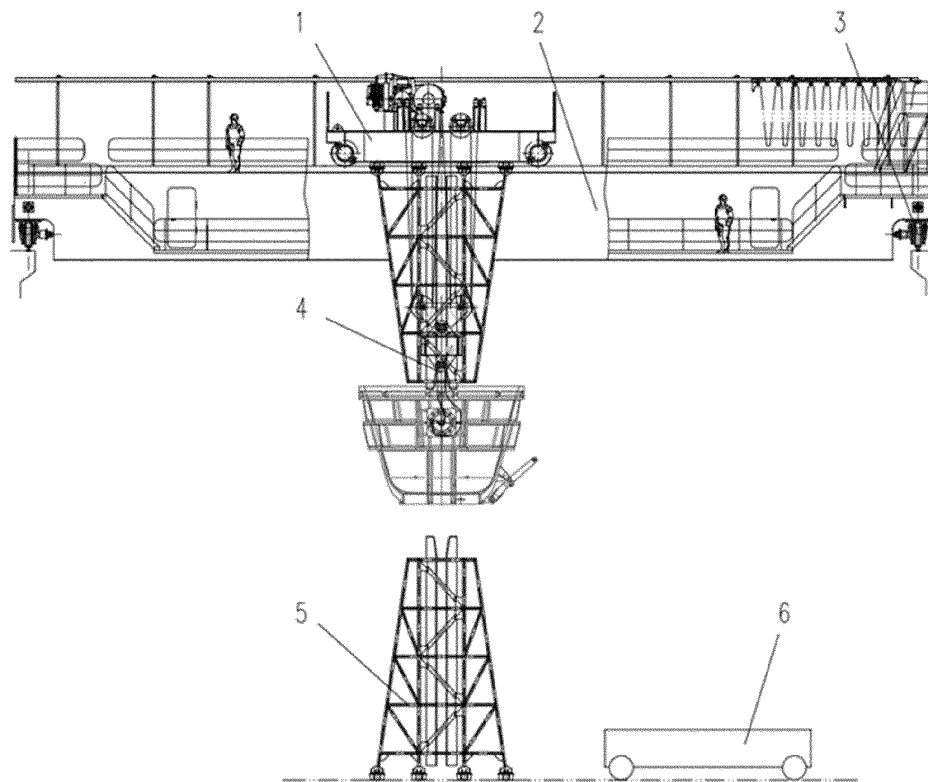


FIG. 1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of cranes, in particular to unmanned crane with automatic hooking-unhooking device and operating method thereof.

BACKGROUND

[0002] With the further implementation of *Made in China 2025*, unmanned workshops and intelligent crane equipment have been gradually applied in major steel enterprises. With the development of various intelligent crane technologies, basic technologies of cranes have developed to the "deep end". Functions including intelligent control, automatic cruise and electronic anti-sway have been realized during the development of unmanned casting cranes. However, there are technical bottlenecks in some key technologies, especially intelligent unmanned hook, hooking detection and other key technologies. Due to on-site harsh working environment (high-temperature, high-dust) and the technical level of electronic sensors, there is still a bigger risk to realize unmanned control of casting cranes based on traditional casting cranes, especially the safety and reliability of unmanned hooking and unhooking technologies.

[0003] The main disadvantages of the existing unmanned hooking technology:

1. The hoisting mechanisms of existing similar cranes are mostly flexible systems. Factors including swaying of the spreader in the lifting and braking process of the crane and imbalance of the center of gravity of the spreader have a large disturbance to the hooking action between the crane and the load, so that it is difficult to achieve accurate hooking, especially in the unmanned state.
2. The on-site harsh environment (such as high-temperature and dust) has a great influence on the scanning accuracy of the existing three-dimensional scanning system (such as laser). The scanning accuracy may only reach about ± 30 m, which is difficult for small and medium-sized casting cranes to meet unmanned hooking requirements, having a high cost and short service life.
3. Some of similar cranes adopt total stroke rigid frame to realize unmanned hooking.

However, these cranes have large boundary dimension and self-weight, which are difficult to machine, manufacture and install.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide an unmanned crane with automatic hooking-unhooking

device and an operating method thereof. The rigid frame of the crane trolley, a device having automatic hooking-unhooking function and the ground frame working in conjunction with each other can achieve the functions of automatically loading and unloading a load in the unmanned crane, ensuring high reliability and safety at the same time. The present disclosure adopts the following technical solutions:

An unmanned crane with automatic hooking-unhooking device, includes a rigid guide frame trolley, a ground assistance frame and a ground load transporting device. The rigid guide frame trolley may laterally move along a bridge and is connected to a hoisting mechanism that makes a load have no horizontal displacement in a process of lifting and lowering the load. An automatic hooking-unhooking device is disposed at a bottom end of the hoisting mechanism. The ground assistance frame is rigidly connected to the ground. The automatic hooking-unhooking device includes a guide wheel. A first guide rail matched with the guide wheel is rigidly connected to a bottom of the guide frame trolley, and the ground assistance frame is provided with a second guide rail matched with the guide wheel.

[0005] Further, the hoisting mechanism includes a transmission mechanism, a drum, steel wire ropes and pulley lifting mechanisms. The transmission mechanism is connected to the drum, the steel wire rope is wound on the drum, and both ends of the steel wire rope are respectively fixed after winding different pulley lifting mechanisms to form two suspension points by winding.

[0006] Further, four multiple suspension points hoisting systems with n multiples are formed by winding with the steel wire rope of the hoisting mechanism.

[0007] Further, the pulley lifting mechanism includes at least two fixed pulleys and movable pulleys matched with the number of the fixed pulleys. The fixed pulleys are fixed on the upper surface of the trolley, and tail ends of the steel wire rope winding the pulley lifting mechanism are fixedly connected to balancing arms of the hoisting mechanism.

[0008] Further, the transmission mechanism includes a motor, a brake and a reducer connected successively. The motor is connected to the brake through a transmission shaft and a high-speed shaft coupling, the brake is connected to the reducer through a brake coupling, and the reducer is connected to the drum through a low-speed shaft coupling.

[0009] Further, the automatic hooking-unhooking device includes a support structure hinged with the movable pulley. The support structure is provided with a plate hook and a plate hook open-close device connected with the plate hook for controlling opening and closing thereof, and the guide wheel is arranged on the support structure.

[0010] Further, the first guide rail at the bottom of the guide frame trolley is supported by its external frame, and the second guide rail is supported by its external ground assistance frame.

[0011] It's another object of the present invention to

provide a method for operating the unmanned crane with automatic unhooking and hooking device, including:

accepting a load hoisting instruction, the unmanned crane running to a designated position above the ground assistance frame with an aid of a positioning system;

lowering the automatic unhooking and hooking device to the ground assistance frame, lowering the guide wheel along the second guide rail to a designated height and then stopping it, and the open-close device of the automatic hooking-unhooking device running to open the plate hook for standby; the load transporting device transporting a load to the ground assistance frame and accurately stopping and locking the load at a designated position through a positioning device between the two; the open-close device of the automatic hooking-unhooking device running to close the plate hook so as to hook the load;

lifting a spreader to the rigid guide frame of the unmanned crane, and lifting the guide wheel along the first guide rail to the designated height and then stopping it; and

the rigid guide frame trolley moving along the bridge to transport the load to the designated position.

[0012] The present disclosure may achieve functions of automatically loading and unloading a load in the unmanned crane through combined action of the automatic hooking-unhooking device of the hoisting mechanism, the rigid frame of the trolley and the ground assistance frame. The whole system has no horizontal displacement in the process of hoisting and lowering the load of the spreader, having higher reliability and safety. The present invention realizes unmanned and automatic operation for crane to lift liquid metal and other high dangerous load. At the same time, the equipment is simple in structure, light in self-weight and large in operation range.

DETAILED DESCRIPTION OF DRAWINGS

[0013] In order to more clearly illustrate technical solutions in the embodiments of the present disclosure or in the prior art, a brief introduction to the accompanying drawings required for the description of the embodiments or the prior art will be provided below. Obviously, the accompanying drawings in the following description are some of the embodiments of the present disclosure, and those ordinary skilled in the art would also be able to derive other drawings from these drawings without making creative efforts.

FIG. 1 is a schematic diagram of a whole unmanned crane in the present invention.

FIG. 2 is a schematic diagram of the hoisting mechanism of the crane in the present invention, where

FIG. 2a is the main view, FIG. 2b is the side view, and FIG. 2c is the top view.

FIG. 3 is a schematic diagram of winding the steel wire rope of the hoisting mechanism of the crane in the present invention.

FIG. 4 is a schematic diagram of the rigid guide frame in the present invention.

FIG. 5 is a schematic diagram of the automatic hooking-unhooking device in the present invention.

FIG. 6 is a schematic diagram of the plate hook open-close device of the automatic hooking-unhooking device in the present invention.

FIG. 7 is a schematic diagram of the method for operating the unmanned crane in the present invention, where FIG. 7a shows the state of the crane in place, FIG. 7b shows the state of the spreader in place, FIG. 7c shows the state of the load in place, FIG. 7d shows the state of load lifting, and FIG. 7e shows the state of load moving.

[0014] In the figures, 1. rigid guide frame trolley; 2. bridge; 3. crane running mechanism; 4. hooking-unhooking mechanism; 5. ground assistance frame; 6. ground load transporting device; 7. motor; 8. high-speed shaft coupling; 9. transmission shaft; 10. brake; 11. brake wheel coupling; 12. reducer; 13. low-speed shaft coupling; 14. drum; 15. fixed pulley; 16. balance arm; 17. steel wire rope; 18. automatic hooking-unhooking device; 19. frame; 20. first guide rail; 21. movable pulley; 22. shaft I; 23. plate hook open-close device; 24. guide wheel; 25. beam; 26. plate hook; 27. power source; 28. shaft II; and 29. shaft III.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] To make the objectives, technical solutions and advantages of embodiments of the present disclosure more obvious, the technical solutions of the present disclosure will be clearly and completely described below in conjunction with the accompanying drawings in the embodiments of the present disclosure, and obviously, the described embodiments are some, rather than all of the embodiments of the present disclosure. Based on the embodiments of the present disclosure, all other embodiments acquired by those of ordinary skilled in the art without making creative efforts fall within the scope of protection of the present disclosure.

[0016] As shown in FIG. 1, the embodiment discloses an unmanned crane with an automatic hooking-unhooking device, including a rigid guide frame trolley 1, a ground assistance frame 5 and a ground load transporting device 6. The girder of a bridge 2 adopts a bias-rail box girder. A crane running mechanism 3 is provided with horizontal guide wheels. The rigid guide frame trolley may laterally move along the bridge 2 and is connected with a hoisting mechanism that makes a load have no horizontal displacement in process of raising and lower-

ing the load. A hooking-unhooking mechanism 4 is disposed at the bottom end of the hoisting mechanism. The ground assistance frame is rigidly connected to the ground. The hooking-unhooking mechanism includes a guide wheel 24. A first guide rail 20 matched with the guide wheel is rigidly connected to the bottom of the guide frame trolley, and the ground assistance frame is provided with a second guide rail matched with the guide wheel. A ground assistance frame 5 is used for assistance positioning of the crane when hoisting the ground load. A ground load transporting device 6 may be electric rail flat carriage, automatic guided vehicle (AGV), etc., which can horizontally transport the load to a designated position on the ground.

[0017] As shown in FIG. 3, the hoisting mechanism includes a transmission mechanism, a drum, steel wire ropes and pulley lifting mechanisms. The transmission mechanism is connected to the drum, the steel wire ropes 17 are wound on the drum, and both ends of the steel wire ropes are respectively fixed after winding different pulley lifting mechanisms to form two suspension points by winding. It can be seen from FIG. 3 that two steel wire ropes 17 from drum 14 wind the corresponding movable pulleys 21 on the automatic hooking-unhooking device 18 respectively, then wind the fixed pulleys 15 followed by directly going down to wind the movable pulleys 21, and finally are connect to the balancing arms 16. The two steel wire rope winding systems forming the suspension points are symmetrical, so that the automatic hooking-unhooking device 4 does not horizontally move in the lifting and lowering process.

[0018] Four multiple suspension points hoisting systems with n multiples are formed by winding the steel wire rope of the hoisting mechanism.

[0019] The pulley lifting mechanism includes at least two fixed pulleys 15 and movable pulleys 21 matched with the number of the fixed pulleys. The fixed pulleys are fixed on the upper surface of the trolley, and the tail ends of the steel wire rope winding the pulley lifting mechanism are fixedly connected to the balancing arms 16 of the hoisting mechanism.

[0020] As shown in FIG. 2a, FIG. 2b and FIG. 2c, the transmission mechanism includes a motor 7, a brake 10 and a reducer 12 connected successively. The motor is connected to the brake through a transmission shaft 9 and a high-speed shaft coupling 8. The brake is connected to the reducer through a brake coupling 11, and the reducer is connected to the drum through a low-speed shaft coupling 13.

[0021] As shown in FIG. 5, the hooking-unhooking device includes a support structure hinged with the movable pulley. The support structure is provided with a plate hook 26 and a plate hook open-close device 23 connected with the plate hook for controlling opening and closing thereof, and the guide wheel is arranged on the support structure. The hooking-unhooking device is an automatic hooking-unhooking device 18 which may automatically perform hooking or unhooking action. As shown in FIG. 6, every

two movable pulleys form a movable pulley block that is hinged with a beam 25 through a shaft I 22, a power source 27 is installed on the beam 25 and connected to the plate hook 26 through a shaft II 28, and the plate hook 26 is connected to the beam 25 through a shaft III 29.

[0022] The ground assistance frame is rigidly connected to the plant ground, and is rigidly connected with a spreader through the guide wheel and the guide rail, ensuring that the spreader does not shake and has no horizontal displacement during the load hooking or releasing process. A load transporting device is arranged to realize horizontal transportation of the load and accurately transport the load to the ground frame designated position. A positioning device is arranged between the load transporting device and the ground assistance frame to ensure that the load carried by the load transporting device stops at the designated position. In this embodiment, the structure of the first guide rail is the same as that of the second guide rail, but their installation method and position are different. The positioning device adopts the prior art such as encoder or photoelectric sensor. When the encoder or photoelectric sensor detects a signal, an electric control system controls the load transporting device to stop.

[0023] As shown in FIG. 4, the first guide rail at the bottom of the guide frame trolley is supported by an external frame 19, and the second guide rail is supported by its external ground assistance frame.

[0024] As shown in FIG. 7a to FIG. 7e, a method for operating the unmanned crane with automatic hooking-unhooking device includes the following steps:

Accepting a load hoisting instruction, the unmanned crane runs to a designated position above the ground assistance frame with aid of the positioning system;
The automatic hooking-unhooking device 18 is lowered to the ground assistance frame, the guide wheel is lowered along the second guide rail to a designated height and then is stopped, and the open-close device of the automatic hooking-unhooking device runs to open the plate hook for standby;
The load transporting device transports a load to the ground assistance frame and accurately stops and locks the load at a designated position through a positioning device between the two;
The open-close device of the automatic hooking-unhooking device runs to close the plate hook so as to hook the load;
The spreader is lifted to the rigid guide frame of the unmanned crane, and the guide wheel is lifted along the first guide rail to the designated height and then is stopped;
The rigid guide frame trolley moves along the bridge to transport the load to a designated position.

[0025] At last, it should be noted that the above various embodiments are merely intended to illustrate the technical solution of the present disclosure and not to limit the same. Although the present disclosure has been de-

scribed in detail with reference to the foregoing embodiments, it should be understood by those ordinary skilled in the art that the technical solutions described in the foregoing embodiments may be modified or equivalents may be substituted for some or all of the technical features thereof; and the modification or substitution does not make the essence of the corresponding technical solution deviate from the scope of the technical solution of each embodiment of the present disclosure.

Claims

1. An unmanned crane with automatic hooking-unhooking device, comprising a rigid guide frame trolley, a ground assistance frame and a ground load transporting device, wherein the rigid guide frame trolley may laterally move along a bridge and is connected to a hoisting mechanism that makes a load have no horizontal displacement in process of lifting and lowering the load, an automatic hooking-unhooking device is disposed at a bottom end of the hoisting mechanism, the ground assistance frame is rigidly connected to the ground, wherein the automatic hooking-unhooking device comprises a guide wheel, a first guide rail matched with the guide wheel is rigidly connected to a bottom of the guide frame trolley, and the ground assistance frame is provided with a second guide rail matched with the guide wheel.
2. The unmanned crane with automatic hooking-unhooking device according to claim 1, wherein the hoisting mechanism comprises a transmission mechanism, a drum, steel wire ropes and pulley lifting mechanisms, the transmission mechanism is connected to the drum, the steel wire rope is wound on the drum, and both ends of the steel wire rope are respectively fixed after winding different pulley lifting mechanisms to form two suspension points by winding.
3. The unmanned crane with automatic hooking-unhooking device according to claim 2, wherein four multiple suspension points hoisting systems with n multiples are formed by winding the steel wire rope of the hoisting mechanism.
4. The unmanned crane with automatic hooking-unhooking device according to claim 2, wherein the pulley lifting mechanism comprises at least two fixed pulleys and movable pulleys matched with the number of the fixed pulleys, the fixed pulleys are fixed on the upper surface of the trolley, and tail ends of the steel wire rope winding the pulley lifting mechanism are fixedly connected to balancing arms of the hoisting mechanism.

5. The unmanned crane with automatic hooking-unhooking device according to claim 2, wherein the transmission mechanism comprises a motor, a brake and a reducer connected successively, the motor is connected to the brake through a transmission shaft and a high-speed shaft coupling, the brake is connected to the reducer through a brake coupling, and the reducer is connected to the drum through a low-speed shaft coupling.
6. The unmanned crane with automatic unhooking-unhooking device according to claim 4, wherein the automatic hooking-unhooking device comprises a support structure hinged with the movable pulley, the support structure is provided with a plate hook and a plate hook open-close device connected with the plate hook for controlling opening and closing thereof, and the guide wheel is arranged on the support structure.
7. The unmanned crane with automatic hooking-unhooking device according to claim 1, wherein the first guide rail at the bottom of the guide frame trolley is supported by its external frame, and the second guide rail is supported by its external ground assistance frame.
8. A method for operating the unmanned crane with automatic hooking-unhooking device according to any claims of 1 to 7, comprising:
 - accepting a load hoisting instruction, the unmanned crane running to a designated position above the ground assistance frame with aid of a positioning system;
 - lowering the automatic hooking-unhooking device to the ground assistance frame, lowering the guide wheel along the second guide rail to a designated height and then stopping it, and the open-close device of the automatic hooking-unhooking device running to open the plate hook for standby;
 - the load transporting device transporting a load to the ground assistance frame and accurately stopping and locking the load at a designated position through a positioning device between the two;
 - the open-close device of the automatic hooking-unhooking device running to close the plate hook so as to hook the load;
 - lifting a spreader to the rigid guide frame of the unmanned crane, and lifting the guide wheel along the first guide rail to the designated height and then stopping it; and
 - the rigid guide frame trolley moving along the bridge to transport the load to a designated position.

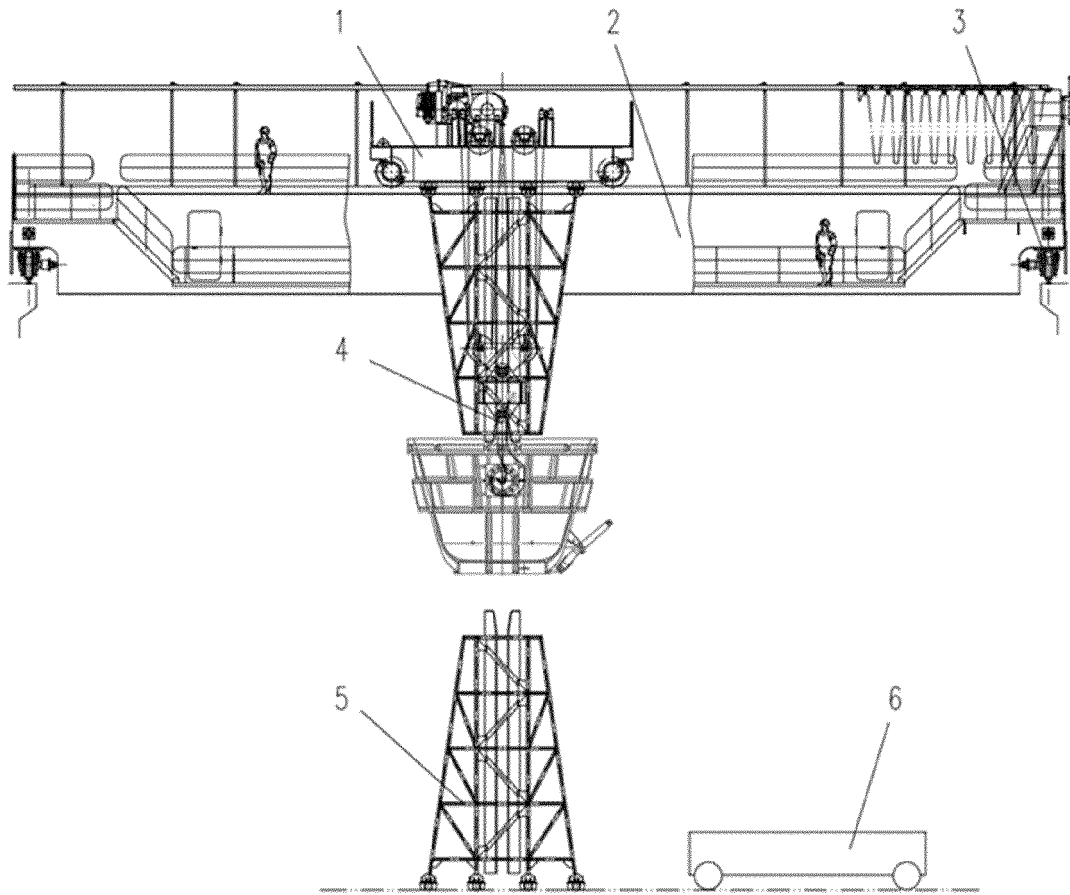


FIG. 1

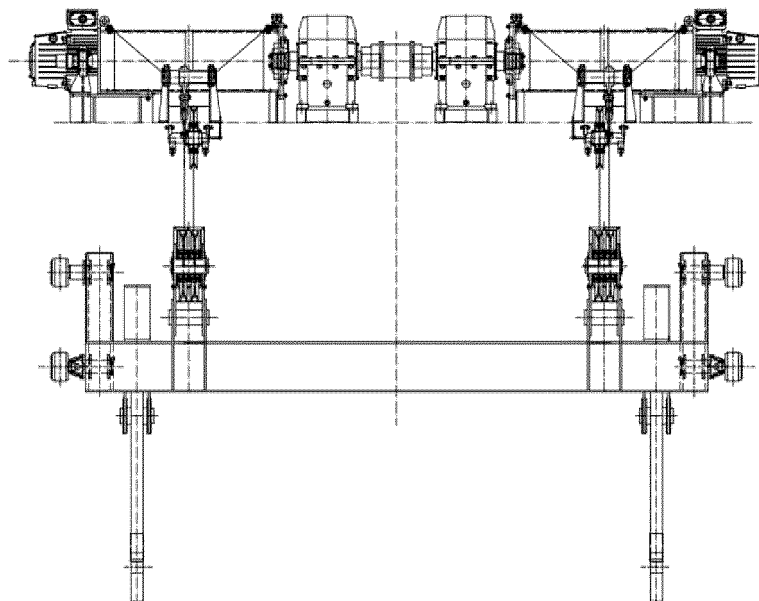


FIG. 2a

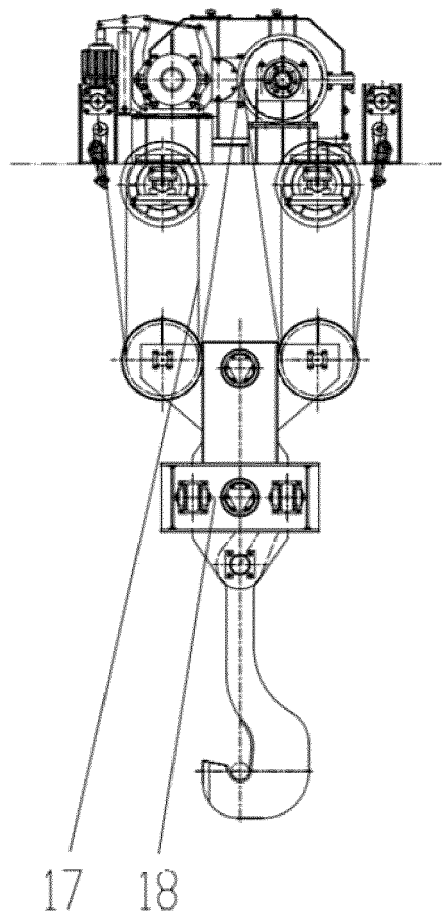


FIG. 2b

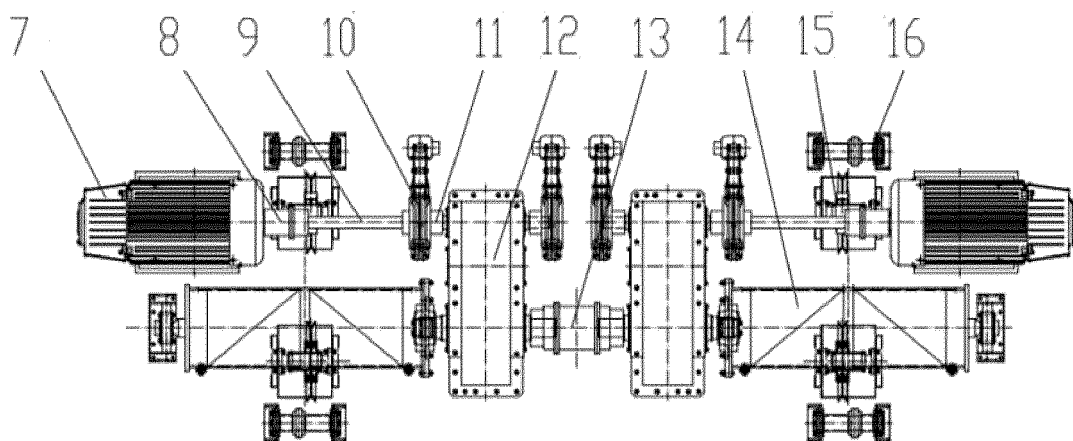


FIG. 2c

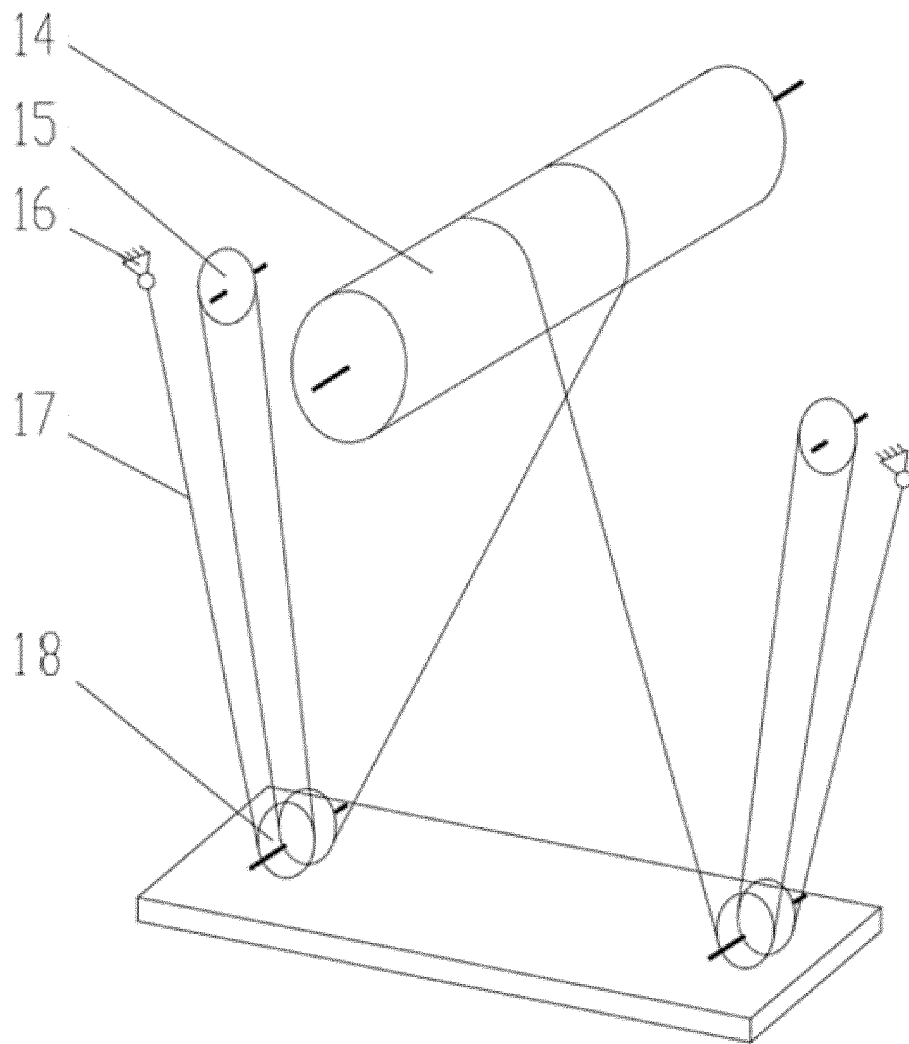


FIG. 3

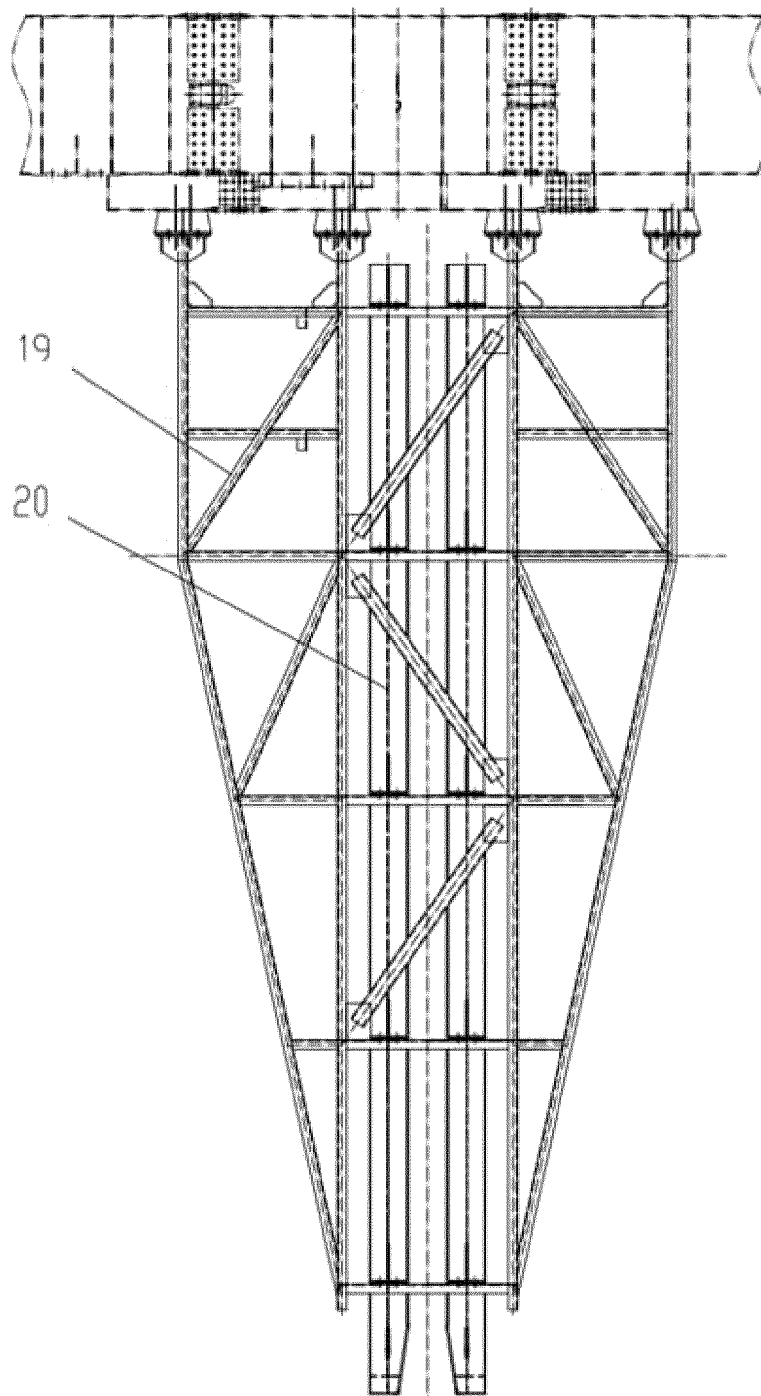


FIG. 4

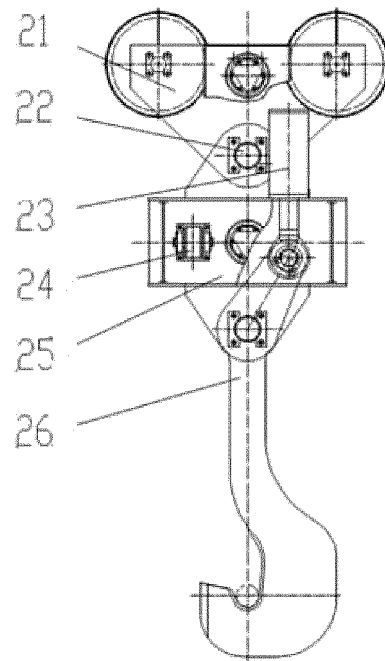


FIG. 5

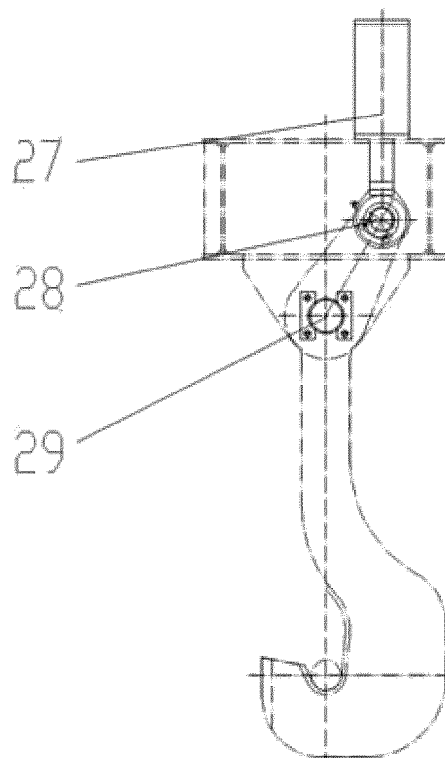


FIG. 6

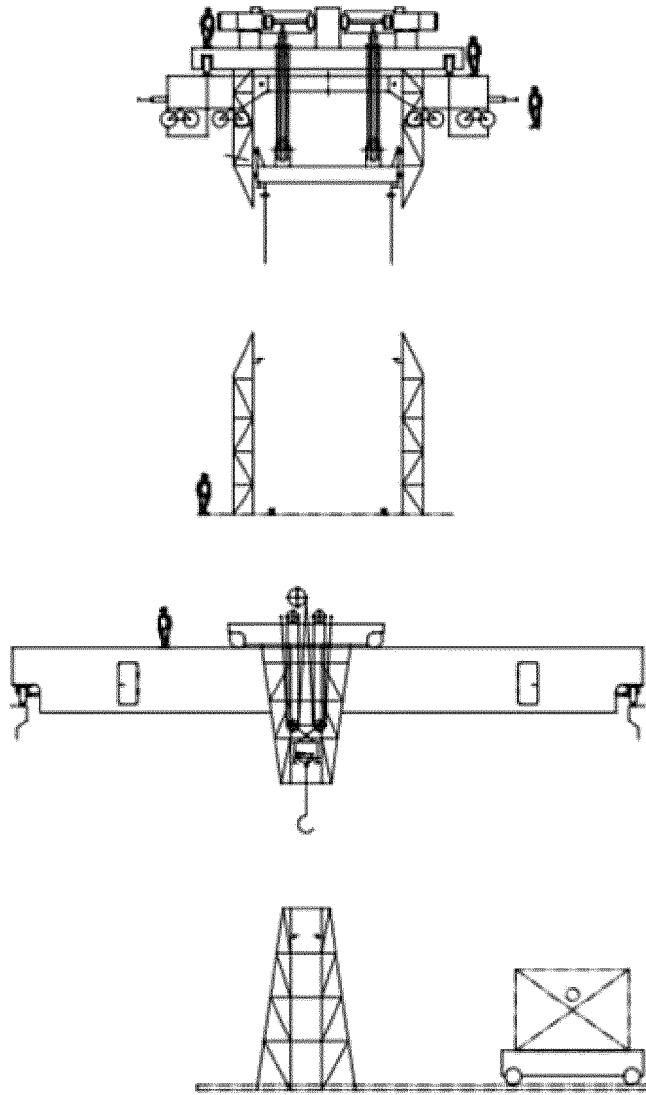


FIG. 7a

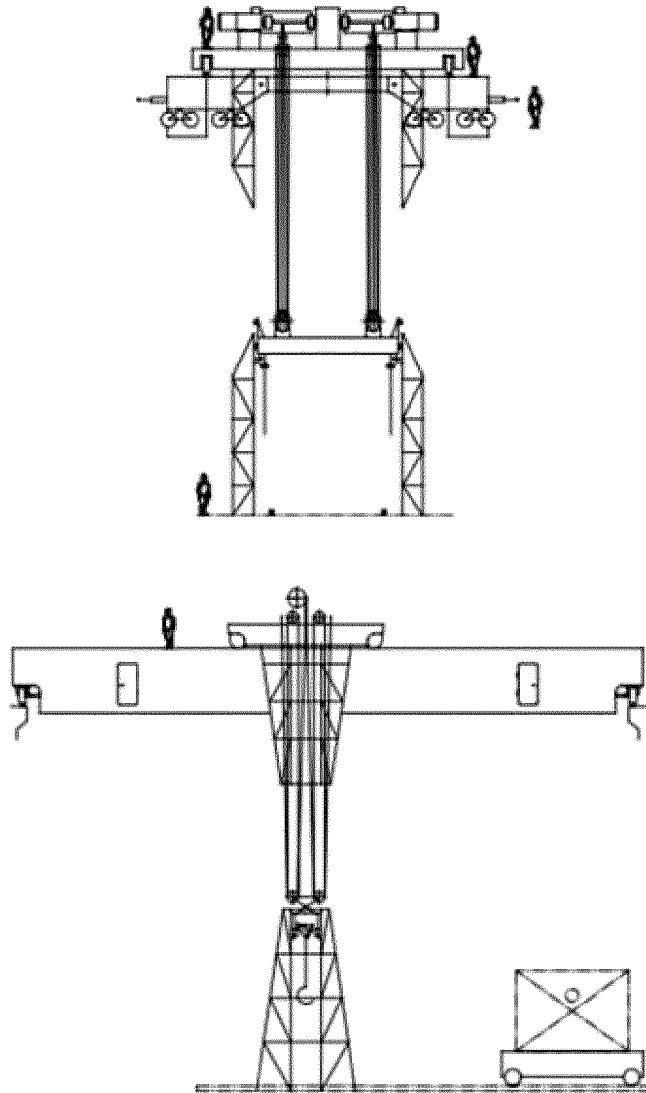


FIG. 7b

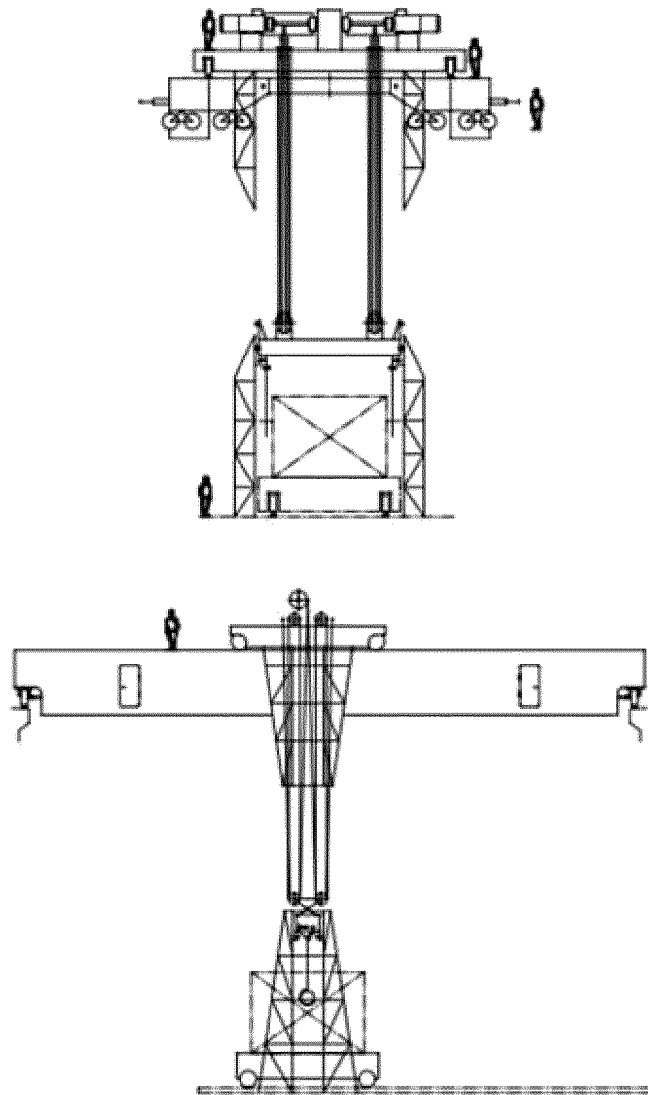


FIG. 7c

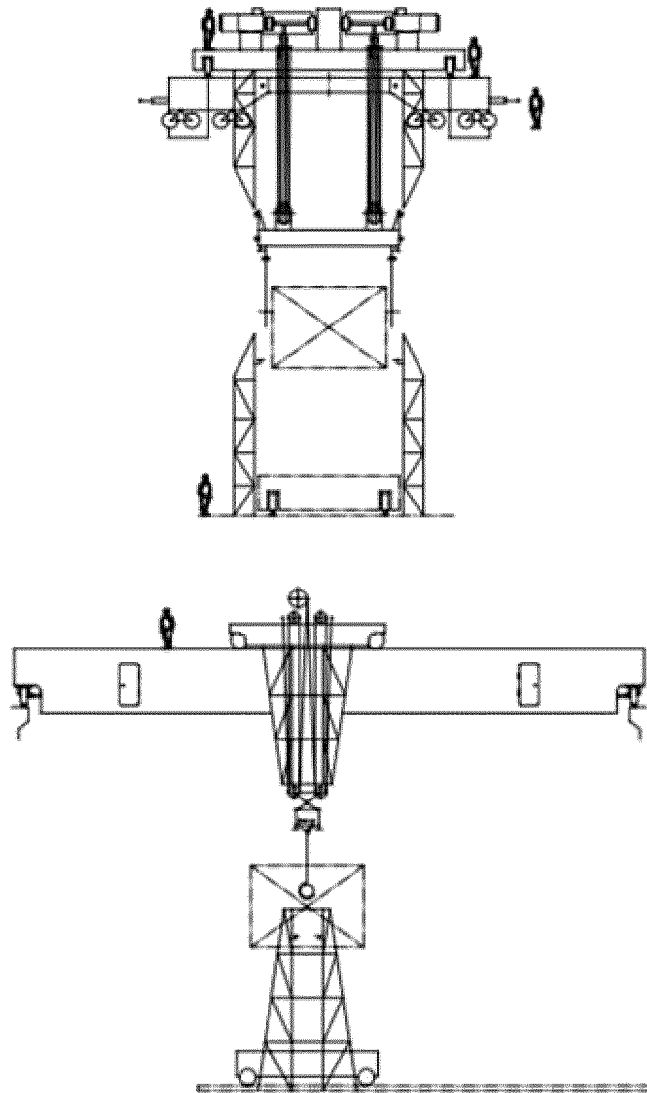


FIG. 7d

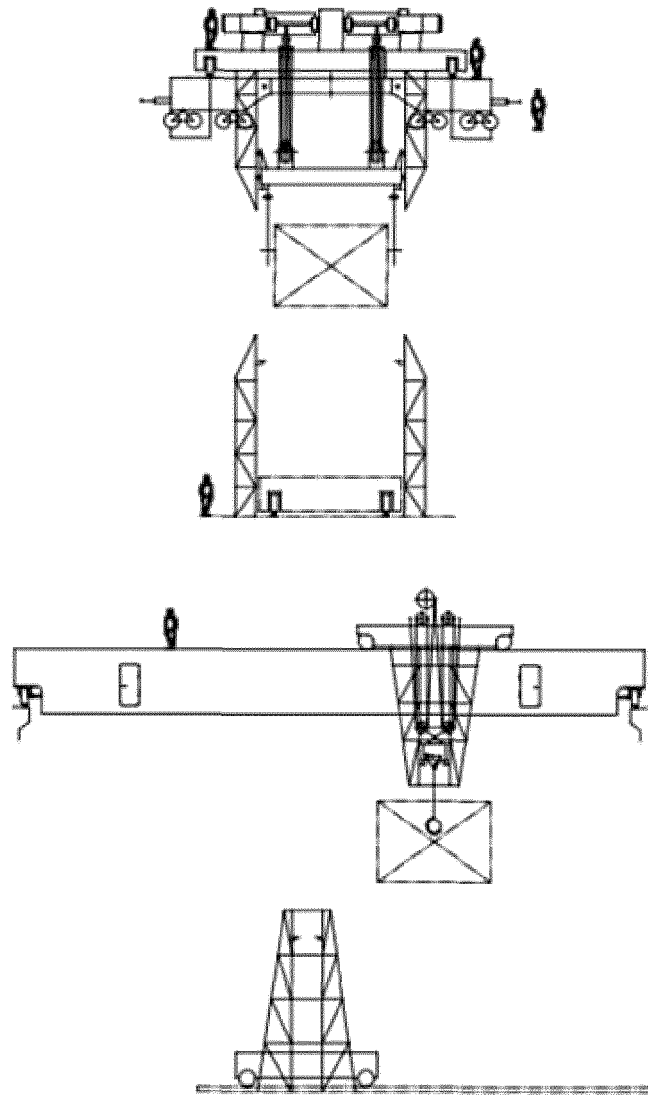


FIG. 7e

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/136408

A. CLASSIFICATION OF SUBJECT MATTER

B66C 19/00(2006.01)i; B66C 9/00(2006.01)i; B66C 9/08(2006.01)i

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)

B66C

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)

CNPAT, CNKI, DWPI, EPODOC: 大连华锐+, 起重, 提升, 举升, 起吊, 导向, 限位, 精度, 摆, 摇, 扰, 车, 运送, lift+, hoist+, rail+, vehicl+, car+, cage+, roller+, absorb+, sway+, swing+, vibrat+, shake+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101214906 A (SHANGHAI PORT MACHINERY HEAVY INDUSTRY CO., LTD.) 09 July 2008 (2008-07-09) description, pages 1-3, figures 1-7	1-8
A	CN 105502153 A (TAIYUAN HEAVY INDUSTRY CO., LTD.) 20 April 2016 (2016-04-20) entire document	1-8
A	CN 107990051 A (XI'AN UNIVERSITY OF ARCHITECTURE AND TECHNOLOGY) 04 May 2018 (2018-05-04) entire document	1-8
A	CN 201678363 U (HANGZHOU HOISTING MACHINERY CO., LTD.) 22 December 2010 (2010-12-22) entire document	1-8
A	CN 205709514 U (GUANGDONG UWELL ENVIRONMENT TECHNOLOGY CO., LTD.) 23 November 2016 (2016-11-23) entire document	1-8
A	JP 2019112184 A (TOYOTA AUTO BODY CO., LTD.) 11 July 2019 (2019-07-11) entire document	1-8

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Date of the actual completion of the international search

08 June 2021

Date of mailing of the international search report

29 July 2021

Name and mailing address of the ISA/CN

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Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/136408

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	101214906	A	09 July 2008	None			
CN	105502153	A	20 April 2016	None			
CN	107990051	A	04 May 2018	CN	107990051	B	30 July 2019
CN	201678363	U	22 December 2010	None			
CN	205709514	U	23 November 2016	None			
JP	2019112184	A	11 July 2019	JP	6812960	B2	13 January 2021