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(54) **INTERLOCKING CONTROL CIRCUIT AND DOUBLE-TOWER TYPE CRANE**

(57) An interlocking control circuit and a double-tower type crane. The interlocking control circuit is applied to the double-tower type crane. The double-tower type crane comprises a primary tower (1) and a secondary tower (2). The interlocking control circuit comprises: a primary tower control unit (100) provided on the primary tower; a secondary tower control unit (200) provided on the secondary tower; an interlocking switching unit (300) provided on the primary tower and separately communicating with the primary tower control unit and the secondary tower control unit. The interlocking switching unit is used for receiving a locking signal externally input, and sending the locking signal to the primary tower control unit and the secondary tower control unit. Under the condition that the locking signal indicates a first state, the primary tower control unit is used for controlling the primary tower to start, and the secondary tower control unit is used for forbidding the secondary tower to start; and under the condition that the locking signal indicates a second state, the primary tower control unit is used for forbidding the primary tower to start, and the secondary tower control unit is used for controlling the secondary tower to start. The described circuit design implements electric interlocking of the primary tower and the secondary tower, and improves the operation safety of the double-tower type crane.

EP 4 345 051 A1

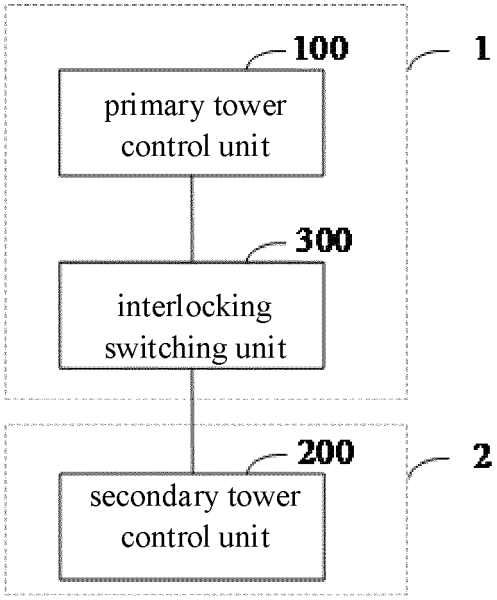

100
1
primary tower control unit
300
interlocking switching unit
200
2
secondary tower control unit

FIG. 2

Description

Cross Reference to Related Applications

[0001] This application claims the benefit of Chinese Patent Application No. 202110625597.9, filed on June 04, 2021, the contents of which are incorporated herein by reference.

Field of the Invention

[0002] The present invention relates to the field of construction machinery, and in particular to an interlocking control circuit and a double-tower type crane.

Background of the Invention

[0003] Tower cranes are widely used in all kinds of construction projects for hoisting all kinds of construction elements on the ground to the tops of building objects being built, which greatly improves the efficiency of operation. A double-tower type crane is shown in FIG. 1 and includes a primary tower 1, typically a flat boom tower, and a secondary tower 2, typically a movable-boom tower. When the double-tower type crane is operated, if the primary tower and the secondary tower are started at the same time, the equipment is prone to safety hazards due to weight imbalance, interference between the primary hook of the secondary tower and the structure of the primary tower.

Summary of the Invention

[0004] The main objective of the present invention is to provide an interlocking control circuit and a double-tower type crane, aiming at solving the technical problem of low safety during operation of the double-tower crane in the prior art.

[0005] In order to achieve the above objective, a first aspect of the present invention provides an interlocking control circuit applied to a double-tower type crane, the double-tower type crane including a primary tower and a secondary tower, and the interlocking control circuit includes:

a primary tower control unit, provided on the primary tower;
a secondary tower control unit, provided on the secondary tower;
an interlocking switching unit, provided on the primary tower and separately communicating with the primary tower control unit and the secondary tower control unit;
the interlocking switching unit is used for receiving a locking signal externally input, and sending the locking signal to the primary tower control unit and the secondary tower control unit;
wherein, under the condition that the locking signal indicates a first state, the primary tower control unit is used for controlling the primary tower to start, and the secondary tower control unit is used for forbidding the secondary tower to start; and
under the condition that the locking signal indicates a second state, the primary tower control unit is used for forbidding the primary tower to start, and the secondary tower control unit is used for controlling the secondary tower to start.

[0006] Optionally, the interlocking switching unit includes:

a two-position toggle switch, including a first normally open contact and a first normally closed contact;
a first contactor, including a first coil, a second normally open contact and a second normally closed contact; and
a second contactor, including a second coil, a third normally open contact and a third normally closed contact;
wherein, a first end of the first normally open contact is electrically connected with a first control end of the secondary tower control unit, a second end of the first normally open contact is electrically connected with a first end of the first coil, a first end of the first normally closed contact is connected with a first control end of the secondary tower control unit, a second end of the first normally closed contact is electrically connected with a first end of the second coil;
a second end of the first coil is electrically connected with the first control end of the primary tower control unit, the second normally open contact is separately electrically connected with a second control end of the primary tower control unit and the third normally closed contact, the second normally closed contact is separately electrically connected with a second control end of the secondary tower control unit and the third normally open contact; and
a second end of the second coil is electrically connected with the first control end of the primary tower control unit, the third normally closed contact is further electrically connected with a third control end of the primary tower control unit, the third normally open contact is further electrically connected with a third control end of the secondary tower control unit.

[0007] Optionally, the primary tower control unit includes:

a third contactor, including a third coil, a first normally open auxiliary contact, a first normally closed auxiliary contact and a first normally open primary contact;
a fourth contactor, including a fourth coil, a second normally open auxiliary contact, a second normally closed auxiliary contact and a second normally open primary contact;

a primary tower relay, including a fifth coil and a fourth normally closed contact;
a first safety relay, a first circuit breaker, a second circuit breaker; and
a first reset button;
wherein, a first pin of the first safety relay is electrically connected with a second pin of the first safety relay through the first normally open auxiliary contact, the second normally open auxiliary contact, and the fifth coil in sequence, a third pin of the first safety relay is electrically connected with a fourth pin of the first safety relay through the first normally closed auxiliary contact, the second normally closed auxiliary contact, the third normally closed contact, the second normally open contact, and the first reset button in sequence, a fifth pin of the first safety relay and a sixth pin of the first safety relay are both electrically connected with a first end of the first circuit breaker, a second end of the first circuit breaker is electrically connected with the first end of the first normally open contact through the fourth normally closed contact, and the first control end of the secondary tower control unit in sequence, a seventh pin of the first safety relay is electrically connected with a first end of the second circuit breaker through the third coil, and an eighth pin of the first safety relay is electrically connected with the first end of the second circuit breaker through the fourth coil;
a second end of the second circuit breaker is separately electrically connected with the second end of the first coil and the second end of the second coil; and
the first normally open primary contact and the second normally open primary contact are electrically connected with a power supply of the primary tower.

[0008] Optionally, the primary tower control unit further includes:

a primary tower emergency stop button;
a primary tower over-under-voltage detection relay; and
a primary tower phase sequence monitor relay;
wherein, a first end of the primary tower emergency stop button is electrically connected with a ninth pin of the first safety relay, and a second end of the primary tower emergency stop button is electrically connected with a tenth pin of the first safety relay through the primary tower phase sequence monitor relay and the primary tower over-under-voltage detection relay in sequence.

[0009] Optionally, the secondary tower control unit includes:

a fifth contactor, including a sixth coil, a third normally open auxiliary contact, a third normally closed auxiliary contact and a third normally open primary contact;
a sixth contactor, including a seventh coil, a fourth normally open auxiliary contact, a fourth normally closed auxiliary contact and a fourth normally open primary contact;
a secondary tower relay, including an eighth coil and a fifth normally closed contact;
a second safety relay; and
a second reset button;
wherein, a first pin of the second safety relay is electrically connected with a second pin of the second safety relay through the third normally open auxiliary contact, the fourth normally open auxiliary contact, and the eighth coil in sequence, a third pin of the second safety relay is electrically connected with a fourth pin of the second safety relay through the third normally closed auxiliary contact, the fourth normally closed auxiliary contact, the second normally closed contact, the third normally open contact, and the second reset button in sequence, a fifth pin of the second safety relay is electrically connected with the sixth coil, a sixth pin of the second safety relay is electrically connected with the seventh coil;
a first end of the fifth normally closed contact is electrically connected with the fourth normally closed contact, a second end of the fifth normally closed contact is electrically connected with the first end of the first normally open contact; and
the third normally open primary contact and the fourth normally open primary contact are electrically connected with a power supply of the secondary tower.

[0010] Optionally, the secondary tower control unit further includes:

a secondary tower emergency stop button;
a secondary tower over-under-voltage detection relay; and
a secondary tower phase sequence monitor relay;
wherein, a first end of the secondary tower emergency stop button is electrically connected with a seventh pin of the second safety relay, a second end of the secondary tower emergency stop button is electrically connected with an eighth pin of the second safety relay through the secondary tower over-under-voltage detection relay, and the secondary tower phase sequence monitor relay in sequence.

[0011] Optionally, the interlocking control circuit further includes a five-core wire through which the interlocking switching unit communicates with the secondary tower control unit.

[0012] Optionally, the interlocking control circuit further includes a wireless communication unit through which the interlocking switching unit communicates with the secondary tower control unit.

[0013] Optionally, the primary tower control unit is fur-

ther used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

[0014] A second aspect of the invention proposes a double-tower type crane including the interlocking control circuit as described above.

[0015] In the embodiments of the present invention, the interlocking control circuit includes: a primary tower control unit provided on the primary tower; a secondary tower control unit provided on the secondary tower; an interlocking switching unit provided on the primary tower and separately communicating with the primary tower control unit and the secondary tower control unit. The interlocking switching unit is used for receiving a locking signal externally input, and sending the locking signal to the primary tower control unit and the secondary tower control unit. Under the condition that the locking signal indicates a first state, the primary tower control unit is used for controlling the primary tower to start, and the secondary tower control unit is used for forbidding the secondary tower to start; and under the condition that the locking signal indicates a second state, the primary tower control unit is used for forbidding the primary tower to start, and the secondary tower control unit is used for controlling the secondary tower to start. The described circuit design implements electric interlocking of the primary tower and the secondary tower, and improves the operation safety of the double-tower type crane.

Brief Description of Drawings

[0016] To illustrate the technical solutions in the embodiments of the present invention or the prior art more clearly, the drawings required to be used in the description of the embodiments or the prior art will be briefly described below. It will be obvious that the drawings described below are only some embodiments of the invention, and other drawings may be obtained from the structure shown in these drawings without any creative effort by those of ordinary skill in the art.

FIG. 1 is a mechanical structure diagram of a double-tower type crane according to an embodiment of the present invention;

FIG. 2 is a functional module diagram of an interlocking control circuit according to an embodiment of the present invention;

FIG. 3 is a schematic diagram of an interlocking signal connection of a primary tower and a secondary tower of FIG. 2;

FIG. 4 is an alternative structure diagram of an interlocking switching unit and a primary tower control unit of FIG. 2; and

FIG. 5 is an alternative structure diagram of a secondary tower control unit of FIG. 2.

[0017] Description of Reference Numerals:
1-primary tower, KMSC1-first safety relay, 2-secondary tower, QFZ1-first circuit breaker, 100-primary tower control unit, QFZ2-second circuit breaker, 200-secondary tower control unit, F1-first reset button, 300-interlocking switching unit, SEM1-primary tower emergency stop button, SPZ-two-position toggle switch, KAP1-primary tower phase sequence monitor relay, KM1-first contactor, KAU1-primary tower over-under-voltage detection relay, KM2-second contactor, KL-secondary tower relay, KM3-third contactor, KMSC2-second safety relay, KM4-fourth contactor, F2-second reset button, KM5-fifth contactor, SEM2-secondary tower emergency stop button, KM6-sixth contactor, KAP2-secondary tower phase sequence monitor relay, KT-primary tower relay, KAU2-secondary tower over-under-voltage detection relay.

[0018] Achievement of the objective, functional features and advantages of the present invention will be further explained with reference to the accompanying drawings.

Detailed Description of the Embodiments

[0019] The technical solutions in the embodiments of the present invention will be clearly and completely described below in conjunction with the accompanying drawings in the embodiments of the present invention, it is obvious that the described embodiments are only a part of the embodiments of the present invention, rather than all of the embodiments. Based on the embodiments in the present invention, all other embodiments obtained by those of ordinary skill in the art without making inventive labor belong to the scope of protection of the present invention.

[0020] It should be noted that, if the embodiments of the present invention relate to directionality indications (such as up, down, left, right, front, back...), the directionality indications are used only for explaining the relative positional relationship, movement, etc. among components in a particular posture (as shown in the drawings), and if the particular posture is changed, the directionality indications are changed accordingly.

[0021] In addition, if there is description relating to "first", "second", etc. in the embodiments of the present invention, the description of "first", "second", etc. are for descriptive purposes only and cannot be understood as indicating or implying their relative importance or implying the number of technical features indicated. Thus, the features defined as "first", "second" may explicitly or implicitly include at least one of the features. In addition, the technical solutions among the various embodiments may be combined with each other, but must be on the basis that those of ordinary skill in the art can realize them. When the combination of technical solutions causes conflicts or cannot be realized, it should be considered that the combination of technical solutions does not exist and

is not within the scope of protection claimed by the present invention.

[0022] The embodiments of the present invention provide an interlocking control circuit.

[0023] Referring to FIG. 2, in an embodiment, the interlocking control circuit is applied to a double-tower type crane, the double-tower type crane includes a primary tower 1 and a secondary tower 2, the interlocking control circuit includes a primary tower control unit 100 provided on the primary tower 1; a secondary tower control unit 200 provided on the secondary tower 2; an interlocking switching unit 300 provided on the primary tower 1 and separately communicating with the primary tower control unit 100 and the secondary tower control unit 200; the interlocking switching unit 300 is used for receiving a locking signal externally input, and sending the locking signal to the primary tower control unit 100 and the secondary tower control unit 200; wherein, under the condition that the locking signal indicates a first state, the primary tower control unit 100 is used for controlling the primary tower 1 to start, and the secondary tower control unit 200 is used for forbidding the secondary tower 2 to start; and under the condition that the locking signal indicates a second state, the primary tower control unit 100 is used for forbidding the primary tower 1 to start, and the secondary tower control unit 200 is used for controlling the secondary tower 2 to start.

[0024] It will be appreciated that both the primary tower control unit 100 and the interlocking switching unit 300 are provided in the primary tower 1, and in particular may be provided in a drive tank of a primary tower driver's cab, and a driver operates the interlocking switching unit 300 to control one of the primary tower 1 or the secondary tower 2 to start.

[0025] In a specific implementation, the state of the locking signal may be 0 or 1, under the condition that the state of the locking signal is 1, the primary tower control unit 100 controls the primary tower 1 to start, and the secondary tower control unit 200 forbids the secondary tower 2 to start, under the condition that the state of the locking signal is 0, the primary tower control unit 100 forbids the primary tower 1 to start, and the secondary tower control unit 200 controls the secondary tower 2 to start.

[0026] Further, referring to FIG. 3 together, the interlocking control circuit further includes a five-core wire (not labeled) through which the interlocking switching unit 300 communicates with the secondary tower control unit 200 to transmit the interlocking signal to the secondary tower control unit 200.

[0027] Of course, the interlocking control circuit may also include a wireless communication unit (not shown) through which the interlocking switching unit 300 communicates with the secondary tower control unit 200 to transmit the interlocking signal to the secondary tower control unit 200.

[0028] In the embodiments of the present invention, the interlocking control circuit includes: a primary tower control unit provided on the primary tower; a secondary tower control unit provided on the secondary tower; an interlocking switching unit provided on the primary tower and separately communicating with the primary tower control unit and the secondary tower control unit. The interlocking switching unit is used for receiving a locking signal externally input, and sending the locking signal to the primary tower control unit and the secondary tower control unit. Under the condition that the locking signal indicates a first state, the primary tower control unit is used for controlling the primary tower to start, and the secondary tower control unit is used for forbidding the secondary tower to start; and under the condition that the locking signal indicates a second state, the primary tower control unit is used for forbidding the primary tower to start, and the secondary tower control unit is used for controlling the secondary tower to start. The described circuit design implements electric interlocking of the primary tower and the secondary tower, and improves the operation safety of the double-tower type crane.

[0029] Please refer to FIGS. 2, 4, and 5, wherein FIG. 4 is an alternative structure diagram of the interlocking switching unit 300 and the primary tower control unit 100 of FIG. 2, and FIG. 5 is an alternative structure diagram of the secondary tower control unit of FIG. 2.

[0030] In this embodiment, the interlocking switching unit 300 includes: a two-position toggle switch SPZ, including a first normally open contact (not labeled)) and a first normally closed contact (not labeled)); a first contactor KM1, including a first coil (not labeled), a second normally open contact KM1-1 and a second normally closed contact KM1-2; and a second contactor KM2, including a second coil (not labeled), a third normally open contact KM2-1 and a third normally closed contact KM2-2; wherein, a first end of the first normally open contact is electrically connected with the first control end of the secondary tower control unit 200, a second end of the first normally open contact is electrically connected with the first end of the first coil, a first end of the first normally closed contact is connected with a first control end of the secondary tower control unit 200, a second end of the first normally closed contact is electrically connected with a first end of the second coil; a second end of the first coil is electrically connected with the first control end of the primary tower control unit 100, the second normally open contact KM1-1 is separately electrically connected with a second control end of the primary tower control unit 100 and the third normally closed contact KM2-2, the second normally closed contact KM1-2 is separately electrically connected with a second control end of the secondary tower control unit 200 and the third normally open contact KM2-1; a second end of the second coil is electrically connected with the first control end of the primary tower control unit 100, the third normally closed contact KM2-2 is further electrically connected with a third control end of the primary tower control unit 100, and the third normally open contact KM2-1 is further electrically connected with a third control end of the sec-

ondary tower control unit 200.

[0031] It should be noted that under the condition that the two-position toggle switch SPZ is switched to the first normally open contact, the first normally open contact is closed, the first normally closed contact is opened, the locking signal indicates the first state, the primary tower control unit 100 controls the primary tower 1 to start, the primary tower 1 can perform normal operation, the secondary tower control unit 200 forbids the secondary tower 2 to start, and the secondary tower 2 is locked and can not be powered on.

[0032] Under the condition that the two-position toggle switch SPZ is switched to the first normally closed contact, the first normally open contact is opened, the first normally closed contact is closed, the lock signal indicates the second state, the primary tower control unit 100 forbids the primary tower 1 to start, the primary tower 1 is locked can not be powered on, and the secondary tower control unit 200 controls the secondary tower 2 to start, and the primary tower 1 can perform normal operation.

[0033] Further, the primary tower control unit 100 includes: a third contactor KM3, including a third coil, a first normally open auxiliary contact KM3-1, a first normally closed auxiliary contact KM3-2 and a first normally open primary contact (not shown); a fourth contactor KM4, including a fourth coil, a second normally open auxiliary contact KM4-1, a second normally closed auxiliary contact KM4-2 and a second normally open primary contact (not shown); a primary tower relay KT, including a fifth coil and a fourth normally closed contact KT-2; a first safety relay KMSC1, a first circuit breaker QFZ1, a second circuit breaker QFZ2; and a first reset button FI; wherein a first pin A1 of the first safety relay KMSC1 is electrically connected with a second pin A2 of the first safety relay KMSC1 through the first normally open auxiliary contact KM3-1, the second normally open auxiliary contact KM4-1, and the fifth coil in sequence, a third pin A3 of the first safety relay KMSC1 is electrically connected with a fourth pin A4 of the first safety relay KMSC1 through the first normally closed auxiliary contact KM3-2, the second normally closed auxiliary contact KM4-2, the third normally closed contact KM2-2, the second normally open contact KM1-1, and the first reset button F1 in sequence, a fifth pin A5 of the first safety relay KMSC1 and a sixth pin A6 of the first safety relay KMSC1 are both electrically connected with a first end of the first circuit breaker QFZ1, a second end of the first circuit breaker QFZ1 is electrically connected with the first end of the first normally open contact through the fourth normally closed contact KT-2, and the first control end of the secondary tower control unit 200 in sequence, a seventh pin A7 of the first safety relay KMSC1 is electrically connected with the first end of the second circuit breaker QFZ2 through a third coil, the eighth pin A8 of the first safety relay KMSC1 is electrically connected with a first end of the second circuit breaker QFZ2 through a fourth coil; a second end of the second circuit breaker QFZ2 is separately electrically connected with a second end of the first coil and a second end of the second coil; the first normally open primary contact and the second normally open primary contact are electrically connected with a power supply (not shown) of the primary tower.

[0034] It should be understood that when the primary tower 1 and the secondary tower 2 are not started, and the two-position toggle switch SPZ is switched to the first normally open contact, the coil of the first contactor KM1 is electrified, and the normally open contact KM1-1 of the first contactor KM1 is closed. When the driver presses the first reset button F1, the third pin A3 and the fourth pin A4 of the first safety relay KMSC1 are conducted, and the seventh pin A7 and the eighth pin A8 controlled by the first safety relay KMSC1 output electrical signals, so that the coils of the third contactor KM3 and the fourth contactor KM4 are electrified. Since the normally open primary contacts of the third contactor KM3 and the fourth contactor KM4 are both connected to the power supply of the primary tower 1, when the coils of the third contactor KM3 and the fourth contactor KM4 are electrified, the normally open primary contacts are closed, and the power supply of the primary tower 1 supplies power to the primary tower 1, thus starting the primary tower 1.

[0035] When the primary tower 1 is started, the normally open auxiliary contact KM3-1 of the third contactor KM3 and the normally open auxiliary contact KM4-1 of the fourth contactor KM4 are closed, the coil of the primary tower relay KT is electrified, the normally closed contact KT-2 of the primary tower relay KT is opened, and the coils of the first contactor KM1 and the second contactor KM2 are not electrified. At this time, no matter which contact the two-position toggle switch SPZ is switched to, the operation switching between the primary tower 1 and the secondary tower 2 cannot be realized.

[0036] When the primary tower 1 and the secondary tower 2 are not started and the two-position toggle switch SPZ is switched to the first normally closed contact, the coil of the second contactor KM2 is electrified, the normally closed contact KM2-2 of the second contactor KM2 is opened, the third pin A3 and the fourth pin A4 of the first safety relay KMSC1 are not conducted, and the first safety relay KMSC1 controls the seventh pin A7 and the eighth pin A8 to have no electrical signal output, so that the third contactor KM3 and the fourth contactor KM4 are not electrified and the primary tower 1 cannot be started.

[0037] Further, the primary tower control unit 100 further includes: a primary tower emergency stop button SEM1; a primary tower phase sequence monitor relay KAP1; and a primary tower over-under-voltage detection relay KAU1; wherein a first end of the primary tower emergency stop button SEM1 is electrically connected with a ninth pin A9 of the first safety relay KMSC1, and a second end of the primary tower emergency stop button SEM1 is electrically connected with a tenth pin A10 of the first safety relay KMSC1 through a primary tower over-under-voltage detection relay KAU1 and a primary tower phase sequence monitor relay KAP1 in sequence.

[0038] Wherein, the primary tower emergency stop

button SEM1 may be one button or a plurality of buttons connected in series to the first safety relay KMSC1, and the present embodiment is not limited thereto.

[0039] It should be understood that the primary tower emergency stop button SEM1 is used for the driver to input a primary tower emergency stop signal, the primary tower phase sequence monitor relay KAP1 is used for detecting whether a power supply phase sequence of a primary tower loop is correct, and the primary tower over-under-voltage detection relay KAU1 is used for detecting whether the primary tower loop is over-under-voltage.

[0040] Further, the secondary tower control unit 200 includes: a fifth contactor KM5, including a sixth coil (not labeled), a third normally open auxiliary contact KM5-1, a third normally closed auxiliary contact KM5-2 and a third normally open primary contact (not shown); a sixth contactor KM6, including a seventh coil (not labeled), a fourth normally open auxiliary contact KM6-1, a fourth normally closed auxiliary contact KM6-2 and a fourth normally open primary contact (not shown); a secondary tower relay KL, including an eighth coil (not labeled) and a fifth normally closed contact KL-2; a second safety relay KMSC2; and a second reset button F2; wherein the first pin A1 of the second safety relay KMSC2 is electrically connected with the second pin A2 of the second safety relay KMSC2 through the third normally open auxiliary contact KM5-1, the fourth normally open auxiliary contact KM6-1, and the eighth coil in sequence, the third pin A3 of the second safety relay KMSC2 is electrically connected with the fourth pin A4 of the second safety relay KMSC2 through the third normally closed auxiliary contact KM5-2, the fourth normally closed auxiliary contact KM6-2, the second normally closed contact KM 1-2, the third normally open contact KM2-1, and the second reset button F2 in sequence, a fifth pin A5 of the second safety relay KMSC2 is electrically connected with the sixth coil, a sixth pin A6 of the second safety relay KMSC2 is electrically connected with the seventh coil; a first end of the fifth normally closed contact KL-2 is electrically connected with the fourth normally closed contact KT-2, a second end of the fifth normally closed contact KL-2 is electrically connected with the first end of the first normally open contact; the third normally open primary contact and the fourth normally open primary contact are electrically connected with the power supply of the secondary tower 2.

[0041] It should be understood that when the primary tower 1 and the secondary tower 2 are not started, and the two-position toggle switch SPZ is switched to the first normally closed contact, the coil of the second contactor KM2 is electrified, the normally open contact KM2-1 of the second contactor KM2 is closed, when the driver presses the second reset button F2, the third pin A3 and the fourth pin A4 of the second safety relay KMSC2 are conducted, the fifth pin A5 and the sixth pin A6 controlled by the second safety relay KMSC2 output electric signals, so that the coils of the fifth contactor KM5 and the sixth contactor KM6 are electrified. Since the normally open primary contacts of the fifth contactor KM5 and the sixth contactor KM6 are both connected with the power supply of the secondary tower 2, when the coils of the fifth contactor KM5 and the sixth contactor KM6 are electrified, the power supply of the secondary tower 2 supplies power to the secondary tower 2, so that the secondary tower 2 is started.

[0042] When the secondary tower 2 is started, the normally open auxiliary contact KM5-1 of the fifth contactor KM5 and the normally open auxiliary contact KM6-1 of the sixth contactor KM6 are closed, the coil of the secondary tower relay KL is electrified, the normally closed contact KL-2 of the secondary tower relay KL is opened, the coils of the first contactor KM1 and the second contactor KM2 are not electrified. At this time, no matter which contact the two-position toggle switch SPZ is switched to, the operation switching between the primary tower 1 and the secondary tower 2 can not be achieved.

[0043] When the primary tower 1 and the secondary tower 2 are not started and the two-position toggle switch SPZ is switched to the first normally open contact, the coil of the first contactor KM1 is electrified, the normally closed contact KM1-2 of the second contactor KM1 is opened, the third pin A3 and the fourth pin A4 of the second safety relay KMSC2 are not conducted, and the second safety relay KMSC2 controls the fifth pin A5 and the sixth pin A6 to have no electrical signal output, so that the fifth contactor KM5 and the sixth contactor KM6 are not electrified and the secondary tower 1 cannot be started.

[0044] Referring back to FIG. 3, when the interlocking switching unit 300 and the secondary tower control unit 200 are connected using the five-core wire L10, the terminals of the five-core wire connected with the secondary tower control unit 200 are specifically: both ends C11-C12 of the normally closed contact of the secondary tower relay KL, both ends 49 (L)-48 (L) of the normally open contact of the first contactor KM1, and both ends 48 (L)-708 (L) of the normally closed contact of the second contactor KM2.

[0045] Further, the secondary tower control unit 200 further includes: a secondary tower emergency stop button SEM2; a secondary tower phase sequence monitor relay KAP2; and a secondary tower over-under-voltage detection relay KAU2; wherein a first end of the secondary tower emergency stop button SEM2 is electrically connected with a seventh pin A7 of the second safety relay KMSC2, and a second end of the secondary tower emergency stop button SEM2 is electrically connected with an eighth pin A8 of the second safety relay KMSC2 through the secondary tower phase sequence monitor relay KAP2 and a secondary tower over-under-voltage detection relay KAU2 in sequence.

[0046] Wherein, the secondary tower emergency stop button SEM2 may be one button or a plurality of buttons connected in series to the second safety relay KMSC2, and the present embodiment is not limited thereto.

[0047] It should be understood that the secondary tower emergency stop button SEM2 is used for the driver to

input a secondary tower emergency stop signal, the secondary tower phase sequence monitor relay KAP2 is used for detecting whether a power supply phase sequence of a secondary tower loop is correct, and the secondary tower over-under-voltage detection relay KAU2 is used for detecting whether the secondary tower loop is over-under-voltage.

[0048] In the following, the working principle of the present embodiment is explained in connection with FIGS. 1 to 5:

When the primary tower emergency stop button SEM1 and the secondary tower emergency stop button SEM2 are pressed and both the primary tower 1 and the secondary tower 2 are not started, the driver operates the two-position toggle switch SPZ in the interlocking switching unit 300 on the primary tower 1.

[0049] When the two-position toggle switch SPZ is switched to the first normally open contact, the primary tower control unit 100 controls the primary tower 1 to start and the secondary tower control unit 200 forbids the secondary tower 2 to start. When the two-position toggle switch SPZ is switched to the first normally closed contact, the primary tower control unit 100 forbids the primary tower 1 to start and the secondary tower control unit 200 controls the secondary tower 2 to start.

[0050] When either of the primary tower 1 or the secondary tower 2 is in operation, the operation switching between the primary tower 1 and the secondary tower 2 cannot be realized regardless of which contact the two-position toggle switch SPZ is switched to.

[0051] Through the specific circuit design of the interlocking switching unit, the primary tower control unit and the secondary tower control unit, the embodiment solves the problem of electrical interlocking between the primary tower and the secondary tower with low cost, ensures that the primary tower and the secondary tower cannot run at the same time, and improves the reliability of the double-tower crane.

[0052] The embodiments of the invention also provide a double-tower crane, the double-tower crane including the interlocking control circuit described in the above-mentioned embodiments. The circuit structure of the interlocking control circuit of the double-tower crane can refer to the above-mentioned embodiments and will not be described here. It can be understood that since the double-tower crane of the embodiments adopts the technical solution of the interlocking control circuit, the double-tower crane has all the beneficial effects.

[0053] The above are only preferred embodiments of the present invention, and are not therefore limiting the patent scope of the present invention. Equivalent structures or equivalent process transformations made by using the contents of the present specification and drawings, or directly or indirectly applied to other related technical fields, are similarly included in the patent protection scope of the present invention.

Claims

1. An interlocking control circuit, applied to a double-tower type crane, the double-tower type crane comprising a primary tower and a secondary tower, wherein the interlocking control circuit comprises:

   a primary tower control unit, provided on the primary tower;
   a secondary tower control unit, provided on the secondary tower;
   an interlocking switching unit, provided on the primary tower and separately communicating with the primary tower control unit and the secondary tower control unit;
   the interlocking switching unit is used for receiving a locking signal externally input, and sending the locking signal to the primary tower control unit and the secondary tower control unit;
   wherein, under the condition that the locking signal indicates a first state, the primary tower control unit is used for controlling the primary tower to start, and the secondary tower control unit is used for forbidding the secondary tower to start; and
   under the condition that the locking signal indicates a second state, the primary tower control unit is used for forbidding the primary tower to start, and the secondary tower control unit is used for controlling the secondary tower to start.

2. The interlocking control circuit of claim 1, wherein the interlocking switching unit comprises:

   a two-position toggle switch, comprising a first normally open contact and a first normally closed contact;
   a first contactor, comprising a first coil, a second normally open contact and a second normally closed contact; and
   a second contactor, comprising a second coil, a third normally open contact and a third normally closed contact;
   wherein,
   a first end of the first normally open contact is electrically connected with a first control end of the secondary tower control unit, a second end of the first normally open contact is electrically connected with a first end of the first coil, a first end of the first normally closed contact is connected with a first control end of the secondary tower control unit, a second end of the first normally closed contact is electrically connected with a first end of the second coil;
   a second end of the first coil is electrically connected with the first control end of the primary tower control unit, the second normally open contact is separately electrically connected with

a second control end of the primary tower control unit and the third normally closed contact, the second normally closed contact is separately electrically connected with a second control end of the secondary tower control unit and the third normally open contact; and
a second end of the second coil is electrically connected with the first control end of the primary tower control unit, the third normally closed contact is further electrically connected with a third control end of the primary tower control unit, the third normally open contact is further electrically connected with a third control end of the secondary tower control unit.

3. The interlocking control circuit of claim 2, wherein the primary tower control unit comprises:

a third contactor, comprising a third coil, a first normally open auxiliary contact, a first normally closed auxiliary contact and a first normally open primary contact;
a fourth contactor, comprising a fourth coil, a second normally open auxiliary contact, a second normally closed auxiliary contact and a second normally open primary contact;
a primary tower relay, comprising a fifth coil and a fourth normally closed contact;
a first safety relay, a first circuit breaker, a second circuit breaker; and
a first reset button;
wherein,
a first pin of the first safety relay is electrically connected with a second pin of the first safety relay through the first normally open auxiliary contact, the second normally open auxiliary contact, and the fifth coil in sequence, a third pin of the first safety relay is electrically connected with a fourth pin of the first safety relay through the first normally closed auxiliary contact, the second normally closed auxiliary contact, the third normally closed contact, the second normally open contact, and the first reset button in sequence, a fifth pin of the first safety relay and a sixth pin of the first safety relay are both electrically connected with a first end of the first circuit breaker, a second end of the first circuit breaker is electrically connected with the first end of the first normally open contact through the fourth normally closed contact, and the first control end of the secondary tower control unit in sequence, a seventh pin of the first safety relay is electrically connected with a first end of the second circuit breaker through the third coil, and an eighth pin of the first safety relay is electrically connected with the first end of the second circuit breaker through the fourth coil;
a second end of the second circuit breaker is separately electrically connected with the second end of the first coil and the second end of the second coil; and
the first normally open primary contact and the second normally open primary contact are electrically connected with a power supply of the primary tower.

4. The interlocking control circuit of claim 3, wherein the primary tower control unit further comprises:

a primary tower emergency stop button;
a primary tower over-under-voltage detection relay; and
a primary tower phase sequence monitor relay;
wherein,
a first end of the primary tower emergency stop button is electrically connected with a ninth pin of the first safety relay, and a second end of the primary tower emergency stop button is electrically connected with a tenth pin of the first safety relay through the primary tower phase sequence monitor relay and the primary tower over-under-voltage detection relay in sequence.

5. The interlocking control circuit of claim 4, wherein the secondary tower control unit comprises:

a fifth contactor, comprising a sixth coil, a third normally open auxiliary contact, a third normally closed auxiliary contact and a third normally open primary contact;
a sixth contactor, comprising a seventh coil, a fourth normally open auxiliary contact, a fourth normally closed auxiliary contact and a fourth normally open primary contact;
a secondary tower relay, comprising an eighth coil and a fifth normally closed contact;
a second safety relay; and
a second reset button;
wherein,
a first pin of the second safety relay is electrically connected with a second pin of the second safety relay through the third normally open auxiliary contact, the fourth normally open auxiliary contact, and the eighth coil in sequence, a third pin of the second safety relay is electrically connected with a fourth pin of the second safety relay through the third normally closed auxiliary contact, the fourth normally closed auxiliary contact, the second normally closed contact, the third normally open contact, and the second reset button in sequence, a fifth pin of the second safety relay is electrically connected with the sixth coil, a sixth pin of the second safety relay is electrically connected with the seventh coil;
a first end of the fifth normally closed contact is electrically connected with the fourth normally

closed contact, a second end of the fifth normally closed contact is electrically connected with the first end of the first normally open contact; and the third normally open primary contact and the fourth normally open primary contact are electrically connected with a power supply of the secondary tower.

6. The interlocking control circuit of claim 5, wherein the secondary tower control unit further comprises:

a secondary tower emergency stop button;
a secondary tower over-under-voltage detection relay; and
a secondary tower phase sequence monitor relay;
wherein,
a first end of the secondary tower emergency stop button is electrically connected with a seventh pin of the second safety relay, a second end of the secondary tower emergency stop button is electrically connected with an eighth pin of the second safety relay through the secondary tower over-under-voltage detection relay, and the secondary tower phase sequence monitor relay in sequence.

7. The interlocking control circuit of claim 1, wherein the interlocking control circuit further comprises a five-core wire through which the interlocking switching unit communicates with the secondary tower control unit.

8. The interlocking control circuit of claim 1, wherein the interlocking control circuit further comprises a wireless communication unit through which the interlocking switching unit communicates with the secondary tower control unit.

9. The interlocking control circuit of claim 1, wherein the primary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

10. The interlocking control circuit of claim 2, wherein the primary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

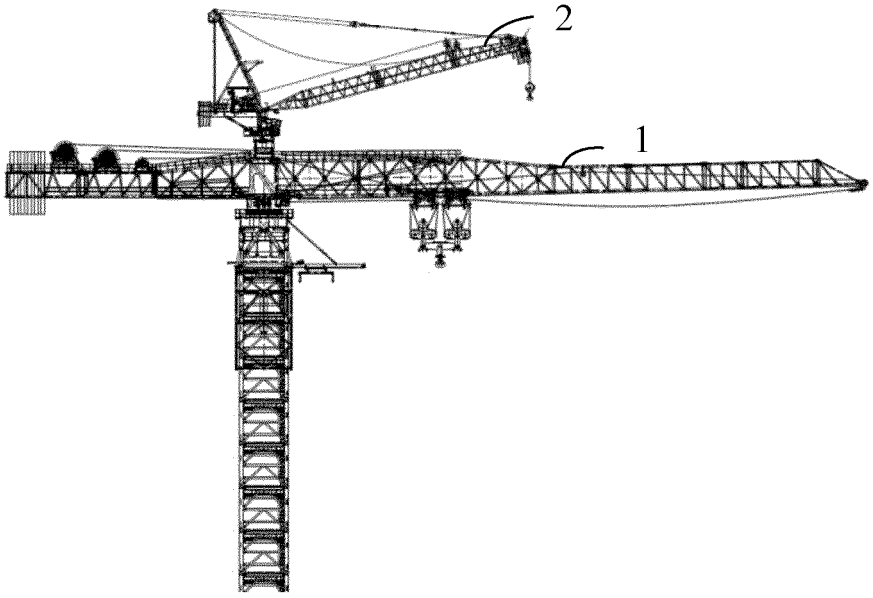
11. The interlocking control circuit of claim 3, wherein, the primary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

12. The interlocking control circuit of claim 4, wherein the primary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

13. The interlocking control circuit of claim 5, wherein the primary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

14. The interlocking control circuit of claim 6, wherein the primary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the primary tower is detected; and
the secondary tower control unit is further used for forbidding the interlocking switching unit to output the locking signal under the condition that the start-up of the secondary tower is detected.

15. A double-tower type crane, **characterized by** comprising the interlocking control circuit of any one of claims 1 to 14.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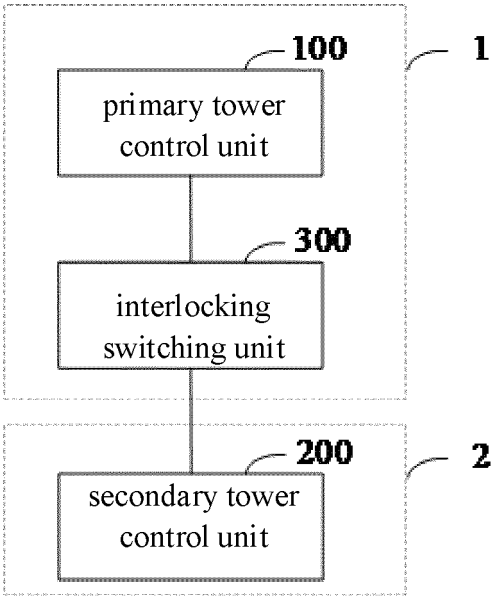
1

FIG. 1


100
1
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300
interlocking switching unit
200
2
secondary tower control unit

FIG. 2

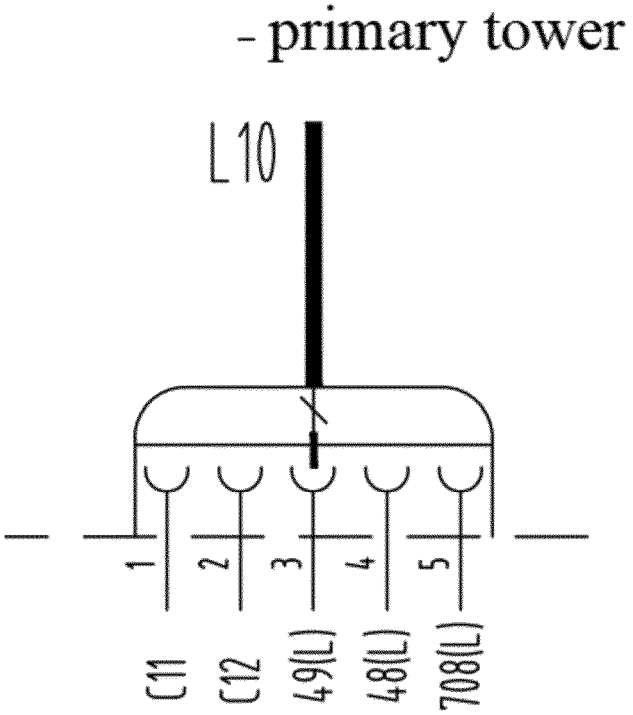
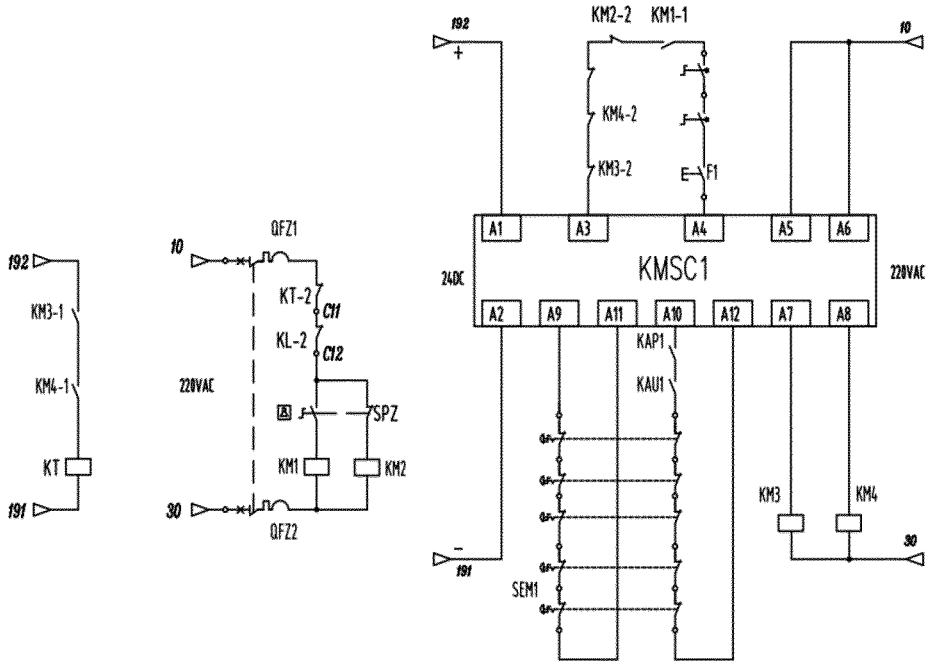


FIG. 3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KM4-2
KM3-2
F1
A1
A3
A4
A5
A6
24DC
KMSC1
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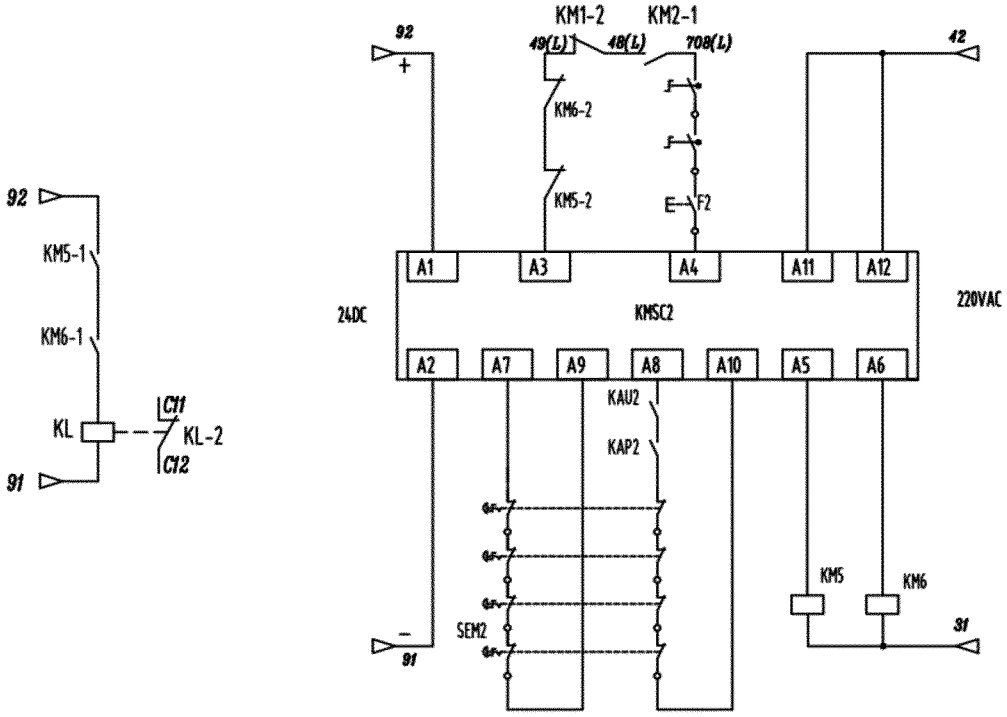
A2
A9
A11
A10
A12
A7
A8
KAP1
KAU1
KM3
KM4
SEM1

FIG. 4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KL-2
C12
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48(L)
708(L)
KM6-2
KM5-2
F2
A1
A3
A4
A11
A12
24DC
KMSC2
220VAC
A2
A7
A9
A8
A10
A5
A6
KAU2
KAP2
KM5
KM6
SEM2

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/141535

A. CLASSIFICATION OF SUBJECT MATTER

B66C 23/88(2006.01)i; B66C 23/64(2006.01)i; B66C 15/00(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)

CJFD, CNABS, WPABS, DWPI, VEN: 互锁, 双层, 双塔, 塔吊, 起重机, 干涉, 主, 副, interlock, double, tower, crane, main, auxiliary

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 206203717 U (ZHANG ZHONGZHE) 31 May 2017 (2017-05-31) description, specific embodiments, and figure 1	1-15
A	CN 109626228 A (SHENYANG JIANZHU UNIVERSITY) 16 April 2019 (2019-04-16) entire document	1-15
A	CN 106354074 A (AVIC TIANJIN AVIATION ELECTRO-MECHANICAL CO., LTD.) 25 January 2017 (2017-01-25) entire document	1-15
A	CN 205873721 U (MENG QINGXIN) 11 January 2017 (2017-01-11) entire document	1-15
A	UA 24960 U (YURII KONDRATIUK POLTAVA NATIONAL TECHNICAL UNIVERSITY) 25 July 2007 (2007-07-25) entire document	1-15
A	GB 225480 A (UELLNER, P.) 04 December 1924 (1924-12-04) entire document	1-15
A	JP 072386 U (NIPPON STEEL & SUMIKIN ENGINEERING CO., LTD. et al.) 13 January 1995 (1995-01-13) entire document	1-15

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

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"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 March 2022	**30 March 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/141535

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 206203717 U	31 May 2017	None	
CN 109626228 A	16 April 2019	None	
CN 106354074 A	25 January 2017	None	
CN 205873721 U	11 January 2017	None	
UA 24960 U	25 July 2007	None	
GB 225480 A	04 December 1924	None	
JP 072386 U	13 January 1995	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202110625597 **[0001]**