

(19)



LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

(11)

N° de publication :

LU600021

<https://patent.public.lu/fo-eregister/view/>

(12)

BREVET D'INVENTION

B1

(21)

N° de dépôt: LU600021

(51)

Int. Cl.:

B60L 1/00, G01R 31/327, G01M 13/00

(22)

Date de dépôt: 26/12/2024

(30)

Priorité:

30/10/2024 CN 2024115391444

(73)

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Date de mise à disposition du public: 26/06/2025

(72)

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Date de délivrance: 26/06/2025

(DX)

Date d'expiration: 26/12/2030

(74)

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(85)

Date d'entrée en phase nationale:

(86)

N° de dépôt de la demande internationale:

(54)

TEST DEVICE FOR ADAPTIVE ACTIVE CONTROL TECHNOLOGY OF STRADDLE-TYPE MONORAIL PANTOGRAPH.

(57)

The present invention discloses a test device for the adaptive active control technology of a straddle-type monorail pantograph, which is used to test the adaptive active control technology of the pantograph. The lifting cylinder of the pantograph is replaced with a servo electric cylinder. The device comprises a frame, on which a hanger and a cable are mounted. A detection frame and a carbon slider are installed on the pantograph, with the carbon slider fixedly assembled to one end of a contact pressure shaft. The other end of the contact pressure shaft is sleeved with a contact pressure spring, which passes through the detection frame and is assembled or compressed against the input end of a pressure sensor. The pressure sensor is mounted on the detection frame. The carbon slider is conductively pressed against the cable and connected to an external detection device via a wire. Both ends of the cable are connected through insulating joints, which are made of non-metallic insulating materials. The cable is routed around at least two first guide wheels and second guide wheels. The two first guide wheels are circumferentially rotatably mounted on the hanger through corresponding wheel shafts. The second guide wheel is sleeved on the motor shaft, which is installed inside the motor. The motor is mounted on the hanger.

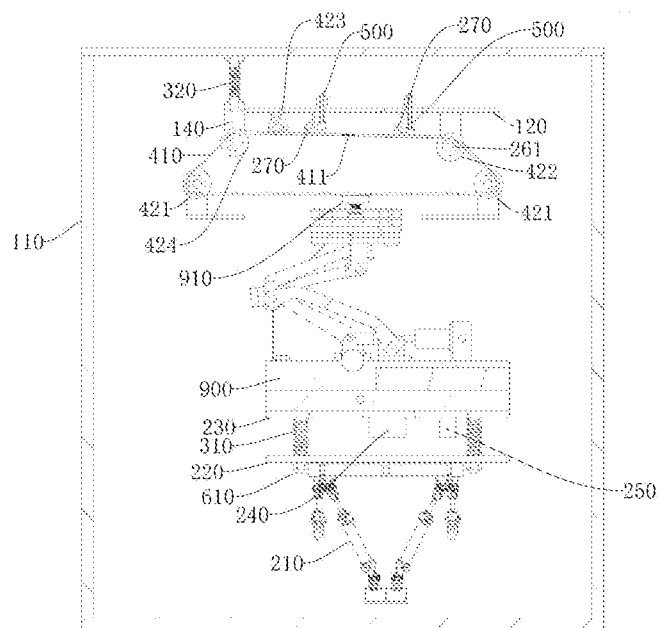


FIG.3

TEST DEVICE FOR ADAPTIVE ACTIVE CONTROL TECHNOLOGY OF STRADDLE-TYPE MONORAIL PANTOGRAPH

Technical Field

5 The present invention relates to pantograph testing equipment, particularly to a test device for the adaptive active control technology of a straddle-type monorail pantograph.

Background Technology

10 The pantograph is a device used to supply power to railway vehicles through a contact wire. Typically, the pressure between the carbon slider of the pantograph and the contact wire is controlled by a hydraulic cylinder to ensure stable power supply to the train. However, as the train operates, vibrations and tilting occur, necessitating flexible control of the pressure between the pantograph and the contact wire
15 according to the train's state. Currently, control is primarily achieved by pre-programmed automation. However, since train operation is dynamic, the pressure between the carbon slider and the contact wire is generally increased to prevent poor contact during operation. This approach results in faster wear of the carbon slider, significantly increasing maintenance frequency and costs.

20 Therefore, a design for an active control device capable of real-time adjustments to the pantograph based on the train's operating state is necessary. This would reduce wear while ensuring stable power supply. However, such technology is not yet available, and testing devices to verify the reliability of such technology are crucial to establish a foundation and validation for subsequent active control technologies.

25

Summary of the Invention

 In view of the above deficiencies in the existing technology, the technical problem the present invention aims to solve is to provide a test device for the adaptive active control technology of a straddle-type monorail pantograph. This device can actively
30 control the pressure between the pantograph and the contact wire based on simulated train operating conditions, thereby reducing wear on the carbon slider while ensuring

stable power supply, and validating the active control technology.

To achieve the above objectives, the present invention provides a test device for the adaptive active control technology of a straddle-type monorail pantograph, which is used to test the adaptive active control technology of the pantograph. The lifting
5 cylinder of the pantograph is replaced with a servo electric cylinder. The device comprises a frame, with a hanger and a cable mounted on the frame.

A detection frame and a carbon slider are installed on the pantograph. The carbon slider is fixedly assembled to one end of a contact pressure shaft, while the other end of the contact pressure shaft is sleeved with a contact pressure spring that passes
10 through the detection frame and is assembled or compressed against the input end of a pressure sensor. The pressure sensor is mounted on the detection frame.

The carbon slider is conductively pressed against the cable and connected to an external detection device via a wire. Both ends of the cable are connected through insulating joints made of non-metallic insulating materials. The cable is routed around
15 at least two first guide wheels and second guide wheels. The two first guide wheels are circumferentially rotatably mounted on the hanger via corresponding wheel shafts, and the second guide wheel is sleeved on the motor shaft, which is installed inside the motor. The motor is mounted on the hanger.

The beneficial effects of the present invention are:

20 The present invention can simulate train operating conditions, thereby testing the stability of the pantograph's active control technology under dynamic circumstances, providing a foundation for the development and validation of active control technology. Additionally, the device is relatively simple, compact, and highly suitable for laboratory operations. It can effectively replicate various operating states of a train, enabling
25 broad testing applications.

Description of the Drawings

FIGs. 1-2 are structural schematic diagrams of the present invention;

FIG.3 is a sectional view of the present invention along the central plane of the
30 axis of the insulating tube 540;

FIG.4 is a partial sectional view of the present invention along the central plane of the axis of the contact pressure shaft 620 (partial);

FIG.5 is a partial sectional view of the present invention along another central plane of the axis of the insulating tube 540 (partial);

FIG.6 is a structural schematic diagram of the present invention with the frame 110 removed;

5 FIG.7 is a structural schematic diagram of the present invention with the frame 110 and the six-degree-of-freedom platform 210 removed;

FIG.8 is a structural schematic diagram of the part where the carbon slider 910 and the cable 410 are located;

FIG.9 is a structural schematic diagram of the part where the cable 410 is located;

10 FIG.10 is a structural schematic diagram of the present invention with the frame 110, the six-degree-of-freedom platform 210, and the base plate 220 removed.

Detailed Embodiments

The technical solutions in the embodiments of the present invention will be described clearly and completely below in conjunction with the attached drawings.

Referring to FIGs. 1-10, the hydraulic cylinder of the pantograph 900 is replaced with a servo electric cylinder 930. The servo electric cylinder 930 enables precise control, providing digital control and a reference framework for subsequent testing.

Referring to FIGs. 1-10, the testing device of this embodiment includes a frame 110. A hanger 120 and a six-degree-of-freedom platform 210 are mounted on the frame 110. A base 220 is installed on the six-degree-of-freedom platform 210, which is axially slidably assembled with a vibration sliding shaft 610. One end of the vibration sliding shaft 610 is sleeved with a vibration spring 310 and fixedly assembled with a mounting seat 230. The mounting seat 230 is fixedly assembled with the pantograph 900. A vibration motor 240 and a detection box 240 are mounted on the mounting seat 230. When the vibration motor 240 is activated, it generates vibrations to drive the mounting seat 230. Inside the detection box 240, an acceleration sensor and an electronic gyroscope are installed. The acceleration sensor detects the vibrations of the mounting seat 230, while the electronic gyroscope detects the inclination state of the mounting seat 230. The six-degree-of-freedom platform 210 is controlled by six electric cylinders to adjust its tilt, leveling, and other states.

The pantograph 900 is also equipped with a detection frame 920 and a carbon

slider 910. The carbon slider 910 is fixedly assembled to one end of a contact pressure shaft 620. The other end of the contact pressure shaft 620 is sleeved with a contact pressure spring 330, which passes through the detection frame 920 and is assembled or pressed against the input end of a pressure sensor 201. The pressure sensor 201 is
5 installed on the detection frame 920. During use, the pressure sensor 201 detects the pressure applied to the carbon slider 910.

The carbon slider 910 is conductively pressed against the cable 410. The carbon slider 910 is connected to an external detection device via a wire. The external detection device is used to measure current, current changes, voltage, and voltage
10 changes, thereby assessing the power conduction capability of the pantograph. These measurements can be achieved using existing voltmeters and ammeters, relying directly on existing technology.

Both ends of the cable 410 are connected through insulating joints 411 made of non-metallic insulating materials, such as Bakelite. The cable 410 is routed around two
15 first guide wheels 421, a second guide wheel 422, a third guide wheel 423, and a fourth guide wheel 424, forming a belt-like transmission structure. The two first guide wheels 421 are circumferentially rotatably mounted on the hanger 120 via corresponding wheel shafts. The second guide wheel 422 is sleeved on a motor shaft 261, which is installed inside the motor 260. The motor 260 is mounted on the hanger 120. When
20 the motor is activated, it drives the second guide wheel 422 to rotate circumferentially, which in turn drives the cable 410 to move. This simulates the motion state of the pantograph and the contact wire cable during train operation. Additionally, the speed of the motor 260 can be controlled to simulate varying train speeds.

The fourth guide wheel 424 is circumferentially rotatably mounted on a wheel
25 frame 140. The wheel frame 140 is provided with a wheel frame sliding groove 141, which is engaged with and slidably assembled on a sliding rail 130. The sliding rail 130 is installed on the hanger 120. The wheel frame 140 and the hanger 120 are fixedly assembled with the two ends of a tension spring 320, which applies an elastic force to pull the wheel frame 140 toward the hanger 120. The third guide wheel 423 is
30 conductively pressed against the cable 410 and is circumferentially rotatably mounted on the hanger 120, keeping the cable 410 taut between the second guide wheel 422 and the third guide wheel 423.

The hanger 120 is further equipped with two power supply components 500 and two eddy current sensors 270. The detection ends of the eddy current sensors 270 face the cable 410, enabling them to detect when the insulating joint 411 passes underneath.

5 Each power supply component 500 includes a carbon brush block 510 mounted on an insulating plate 520. The insulating plate 520 is fixedly assembled with one end of an insulating sliding shaft 530 and an insulating tube 540. The insulating sliding shaft 530 is sleeved with an insulating spring 340 at one end and is axially slidably assembled with the hanger 120. The insulating tube 540 is hollow and, after passing through the
10 hanger 120, is fixedly assembled with the telescopic shaft of an electromagnet 550, which is mounted on the hanger 120. The carbon brush block 510 is conductively connected to a wire that exits the insulating tube 540 and is connected to a power source, thereby supplying power to the carbon brush block 510. When activated, the electromagnet 550 drives its telescopic shaft to extend or retract axially, thereby
15 causing the corresponding insulating tube 540 to move axially.

One power supply component 500 has its insulating spring 340 applying an elastic force to press the carbon brush block 510 against the cable 410, maintaining conductive pressing between the carbon brush block 510 and the cable. The other power supply component 500 has its insulating spring 340 applying a pulling force to
20 move the carbon brush block 510 away from the cable 410, ensuring it does not contact the cable for conduction. During operation, if the eddy current sensor 270 detects that the insulating joint 411 is passing underneath, the carbon brush block 510 that is in conductive pressing with the cable 410 moves away until it separates from the cable, while the other carbon brush block 510 moves toward the cable to press
25 against it and supply power. In this embodiment, each power supply component 500 corresponds to one eddy current sensor 270. When an eddy current sensor 270 detects the passage of the insulating joint 411 beneath it, it controls the two electromagnets 550 to switch states, causing the two carbon brush blocks 510 to switch states to selectively supply power to the cable 410. This ensures continuous
30 power supply to the cable.

The length of the insulating joint 411 does not exceed the width of the carbon slider and preferably is less than half the width of the carbon slider. This design ensures

effective power supply from the cable to the carbon slider.

During use, the six-degree-of-freedom platform controls the tilt direction of the pantograph through six electric cylinders, allowing the simulation of various tilt angles of a train. The vibration motor generates vibrations to simulate the vibration state during train operation. The motor drives the cable to simulate traveling speed, while the pressure sensor detects the pressure between the pantograph and the cable. An external detection device monitors current and voltage states, while the adaptive active control software or settings to be tested are installed. Based on the detected current and voltage states, the servo electric cylinder's extension or retraction is controlled to adjust the pressure between the carbon slider and the cable, enabling the determination of the optimal pressure or validation of whether the pressure is appropriate.

CLAIMS

1. A testing device for the adaptive active control technology of a straddle-type monorail pantograph, used for testing the adaptive active control technology of the pantograph, wherein the lifting cylinder of the pantograph is replaced with a servo electric cylinder; characterized by comprising a frame, with a hanger and a cable mounted on the frame;

a detection frame and a carbon slider mounted on the pantograph, the carbon slider being fixedly assembled to one end of a contact pressure shaft, the other end of the contact pressure shaft being sleeved with a contact pressure spring that passes through the detection frame and is assembled or compressed against the input end of a pressure sensor, the pressure sensor being mounted on the detection frame;

the carbon slider is conductively pressed against the cable and connected to an external detection device via a wire, both ends of the cable being connected through insulating joints made of non-metallic insulating materials; the cable is routed around at least two first guide wheels and second guide wheels, the two first guide wheels being circumferentially rotatably mounted on the hanger via corresponding wheel shafts, and the second guide wheel being sleeved on the motor shaft, which is installed inside the motor, the motor being mounted on the hanger.

2. The testing device according to Claim 1, characterized in that a six-degree-of-freedom platform is mounted on the frame, with a base installed on the six-degree-of-freedom platform, and the pantograph being directly or indirectly mounted on the base.

3. The testing device according to Claim 2, characterized in that the base is axially slidably assembled with a vibration sliding shaft, one end of the vibration sliding shaft being sleeved with a vibration spring and fixedly assembled with a mounting seat, the mounting seat being fixedly assembled with the pantograph, and the mounting seat being equipped with a vibration motor and a detection box; the detection box houses an acceleration sensor and an electronic gyroscope, the acceleration sensor being used to detect vibrations of the mounting seat, and the electronic gyroscope being

used to detect the inclination state of the mounting seat.

4. The testing device according to Claim 1, characterized in that the cable is further routed around a third guide wheel and a fourth guide wheel, the fourth guide wheel being circumferentially rotatably mounted on a wheel frame, the wheel frame being provided with a wheel frame sliding groove, the wheel frame sliding groove being engaged with a sliding rail and slidably assembled, the sliding rail being mounted on the hanger, and the wheel frame and the hanger being fixedly assembled with the two ends of a tension spring, the tension spring applying an elastic force to pull the wheel frame toward the hanger; the third guide wheel is conductively pressed against the cable and circumferentially rotatably mounted on the hanger.

5. The testing device according to Claim 1, characterized in that the length of the insulating joints does not exceed the width of the carbon slider.

15

6. The testing device according to Claim 5, characterized in that the length of the insulating joints is less than half the width of the carbon slider.

7. The testing device according to any one of Claims 1 to 6, characterized in that the hanger is further equipped with two power supply components and two eddy current sensors, each power supply component corresponding to one eddy current sensor, with the detection ends of the eddy current sensors facing the cable;

each power supply component comprises a carbon brush block, the carbon brush block being mounted on an insulating plate, the insulating plate being fixedly assembled with one end of an insulating sliding shaft and an insulating tube, respectively, the insulating sliding shaft being sleeved with an insulating spring at one end and axially slidably assembled with the hanger, the insulating tube being hollow inside and, after passing through the hanger, being fixedly assembled with the telescopic shaft of an electromagnet, the electromagnet being mounted on the hanger; the carbon brush block is conductively connected to a wire, the wire extending out of the insulating tube and being conductively connected to a power source;

wherein one power supply component's insulating spring applies an elastic force

to press the carbon brush block against the cable to maintain conductive pressing of the carbon brush block with the cable; the other power supply component's insulating spring applies a pulling force to move the carbon brush block away from the cable to prevent conductive contact; once the eddy current sensor detects that the insulating joint passes underneath, the carbon brush block conductively pressed against the cable moves away from the cable until separated, while the other carbon brush block moves toward and presses against the cable to supply power to the cable.

REVENDICATIONS

1. Dispositif de test pour la technologie de contrôle actif adaptatif d'un pantographe monorail à cheval, destiné à tester la technologie de contrôle actif adaptatif du pantographe, où le vérin hydraulique de levage du pantographe est
5 remplacé par un vérin électrique servo-assisté ; caractérisé en ce qu'il comprend : un châssis sur lequel sont montés un support suspendu et un câble électrique ;

le pantographe est équipé d'un cadre de détection et d'une bande de glissement en carbone, la bande de glissement en carbone est fixée à une extrémité
10 de l'arbre de pression, l'autre extrémité de l'arbre de pression est entourée par un ressort de pression qui traverse le cadre de détection et est assemblée ou pressée contre l'entrée d'un capteur de pression, le capteur de pression étant monté sur le cadre de détection ;

la bande de glissement en carbone est en contact électrique avec le câble par
15 pression, et elle est connectée à un dispositif de détection externe via un fil ; les deux extrémités du câble sont reliées par des raccords isolants faits de matériaux non métalliques isolants ; le câble est enroulé autour d'au moins deux premières poulies et d'une deuxième poulie ; les deux premières poulies sont montées de manière rotative sur le support suspendu via leurs axes respectifs, tandis que la deuxième poulie est
20 montée sur l'arbre moteur, lui-même intégré au moteur fixé au support suspendu.

2. Dispositif de test selon la revendication 1, caractérisé en ce qu'un plateau à six degrés de liberté est monté sur le châssis, le plateau à six degrés de liberté

supportant une base sur laquelle le pantographe est directement ou indirectement monté.

3. Dispositif de test selon la revendication 2, caractérisé en ce que la base est
5 assemblée de manière coulissante axialement avec un axe de glissement vibrant, une
extrémité de l'axe de glissement vibrant étant entourée par un ressort vibrant et fix
ée à un support, le support étant fixé au pantographe ; le support est en outre é
quipé d'un moteur vibrant et d'un boîtier de détection, dans lequel sont installés un
accéléromètre et un gyroscope électronique, l'accéléromètre servant à détecter les
10 vibrations du support et le gyroscope électronique à détecter son inclinaison.

4. Dispositif de test selon la revendication 1, caractérisé en ce que le câble passe
également par une troisième poulie et une quatrième poulie, la quatrième poulie é
tant montée de manière rotative sur un cadre de roues, lequel est pourvu d'une
15 rainure coulissante ; la rainure coulissante du cadre de roues s'emboîte avec un rail
coulissant et est assemblée de manière coulissante ; le rail coulissant est monté sur
le support suspendu ; le cadre de roues et le support suspendu sont respectivement
fixés aux deux extrémités d'un ressort de traction qui exerce une force élastique sur
le cadre de roues pour le tirer vers le support suspendu ; la troisième poulie est en
20 contact par pression avec le câble et est montée de manière rotative sur le support
suspendu.

5. Dispositif de test selon la revendication 1, caractérisé en ce que la longueur du
raccord isolant ne dépasse pas la largeur de la bande de glissement en carbone.

6. Dispositif de test selon la revendication 5, caractérisé en ce que la longueur du raccord isolant est inférieure à la moitié de la largeur de la bande de glissement en carbone.

5

7. Dispositif de test selon l'une quelconque des revendications 1 à 6, caractérisé en ce que le support suspendu est en outre équipé de deux ensembles d'alimentation électrique et de deux capteurs à courant de Foucault, chaque ensemble d'alimentation correspondant à un capteur à courant de Foucault, l'extrémité de détection de chaque capteur étant dirigée vers le câble électrique ;

10

chaque ensemble d'alimentation comprend un bloc de balais en carbone, monté sur une plaque isolante ; la plaque isolante est fixée à une extrémité d'un axe coulissant isolé et à une extrémité d'un tube isolant ; l'axe coulissant isolé, entouré par un ressort isolant, traverse le support suspendu et est assemblé de manière coulissante axialement avec celui-ci ; le tube isolant est creux et traverse le support suspendu pour être fixé à l'axe télescopique d'un électroaimant monté sur le support suspendu ; le bloc de balais en carbone est connecté électriquement à un fil, lequel passe à travers le tube isolant pour être relié électriquement à une source d'alimentation ;

15

20

l'un des ensembles d'alimentation exerce, par son ressort isolant, une force élastique qui presse le bloc de balais en carbone contre le câble pour maintenir le contact électrique, tandis que l'autre ensemble d'alimentation exerce une force qui éloigne le bloc de balais en carbone du câble pour empêcher le contact électrique ;

lorsque le capteur à courant de Foucault détecte que le raccord isolant passe en dessous de lui, le bloc de balais en carbone en contact avec le câble se déplace pour se séparer du câble, et l'autre bloc de balais en carbone se déplace vers le câble pour établir le contact électrique.

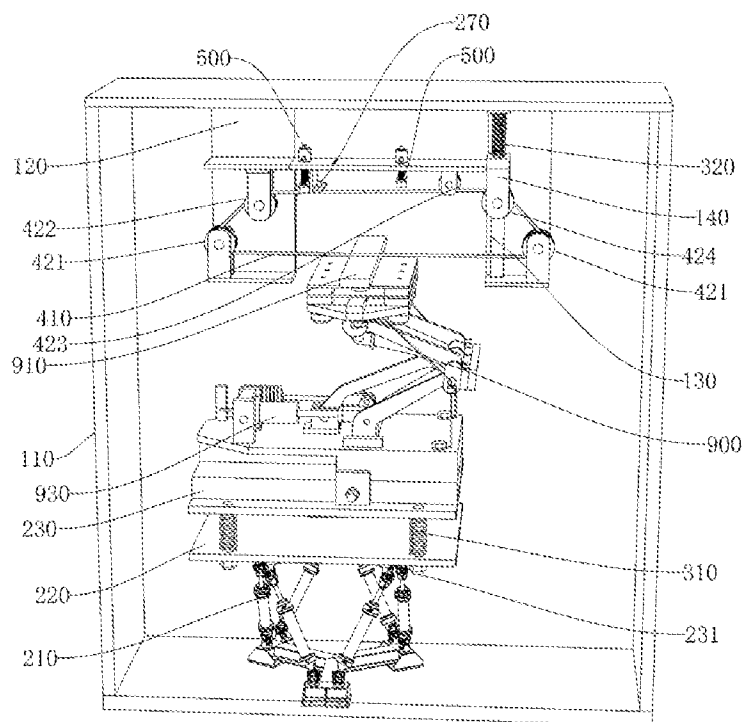


FIG.1

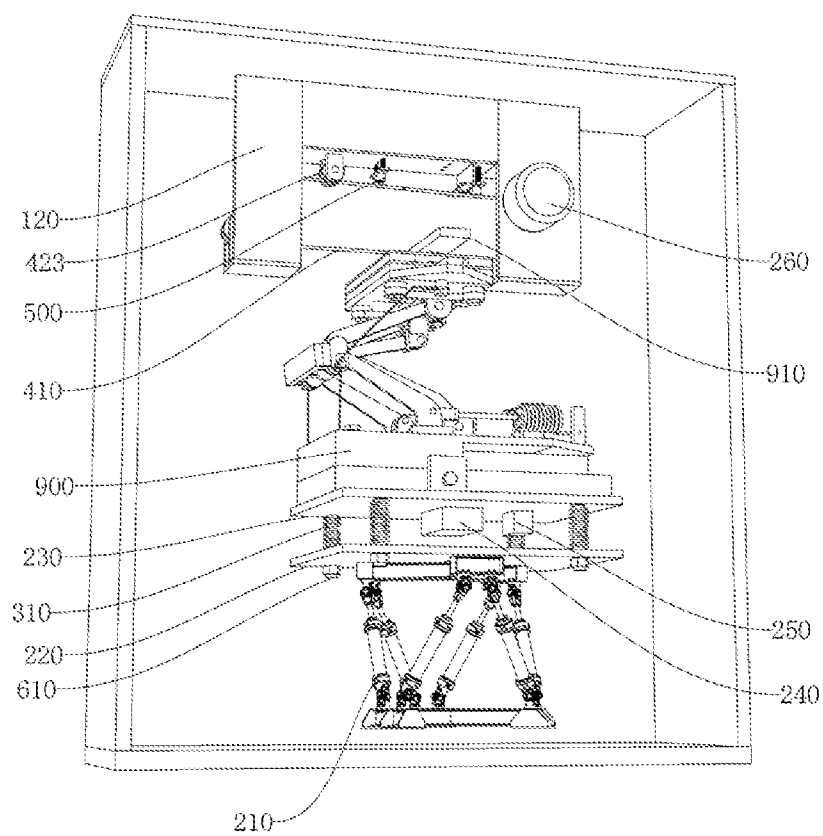


FIG.2

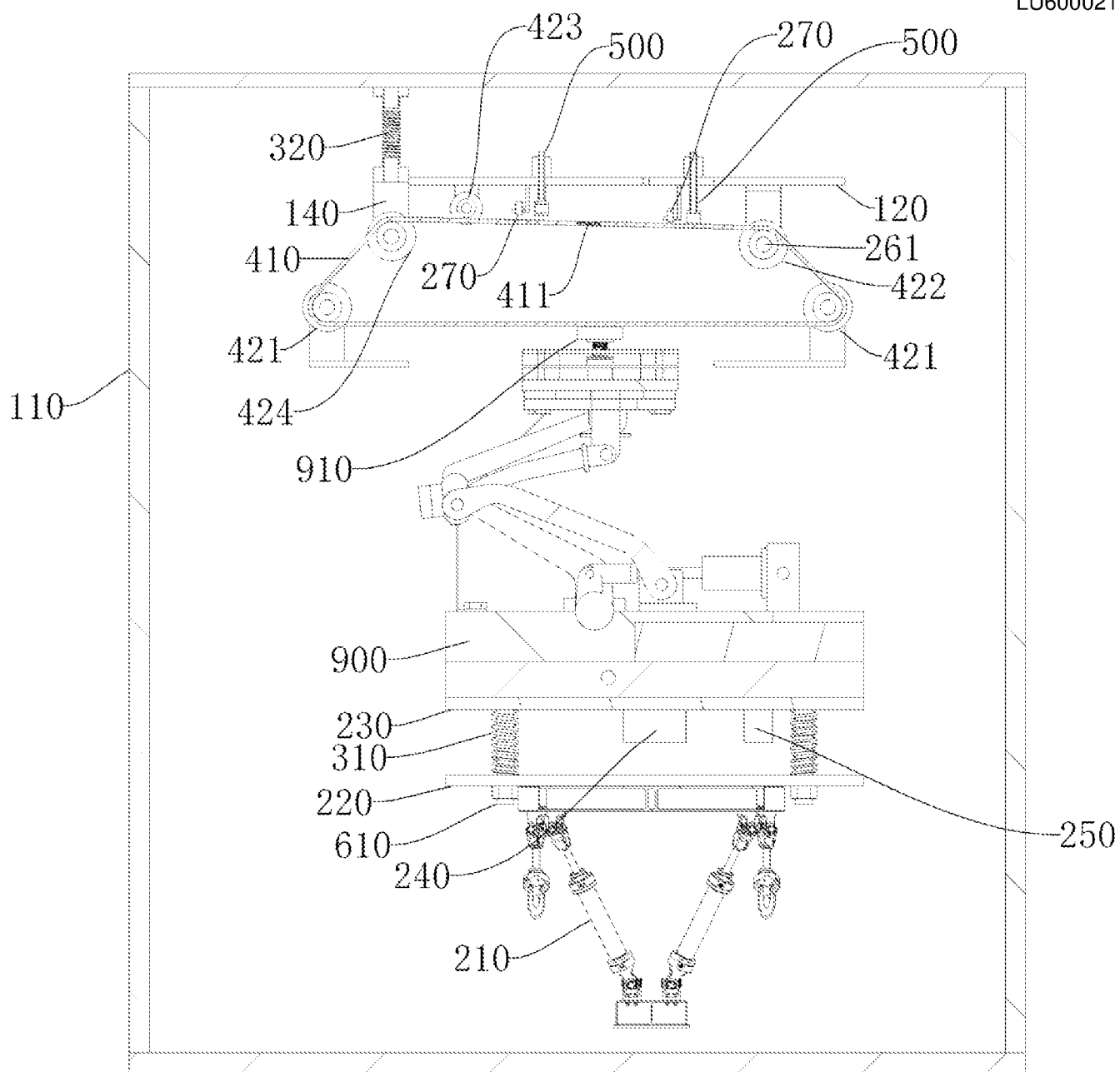


FIG.3

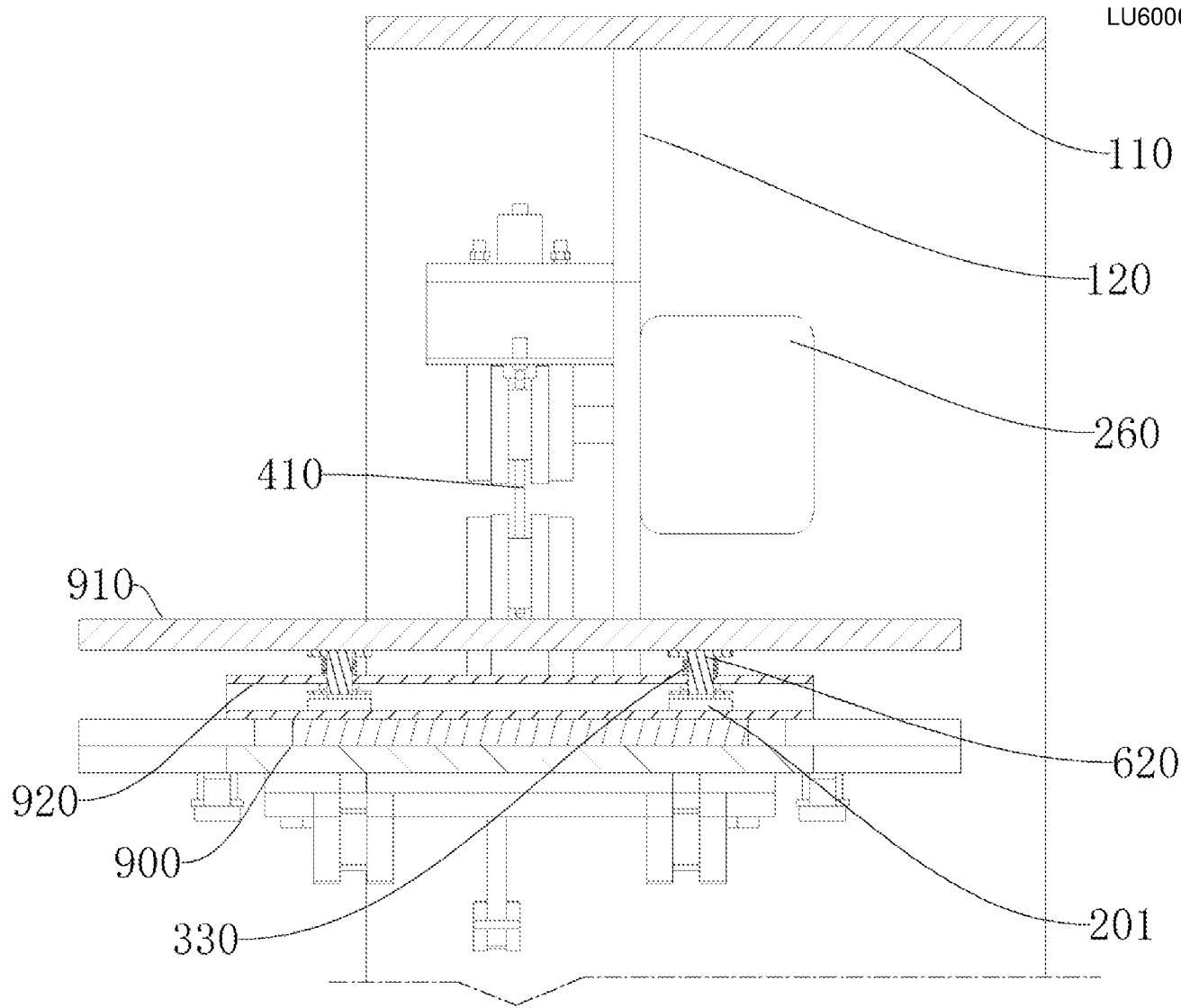


FIG.4

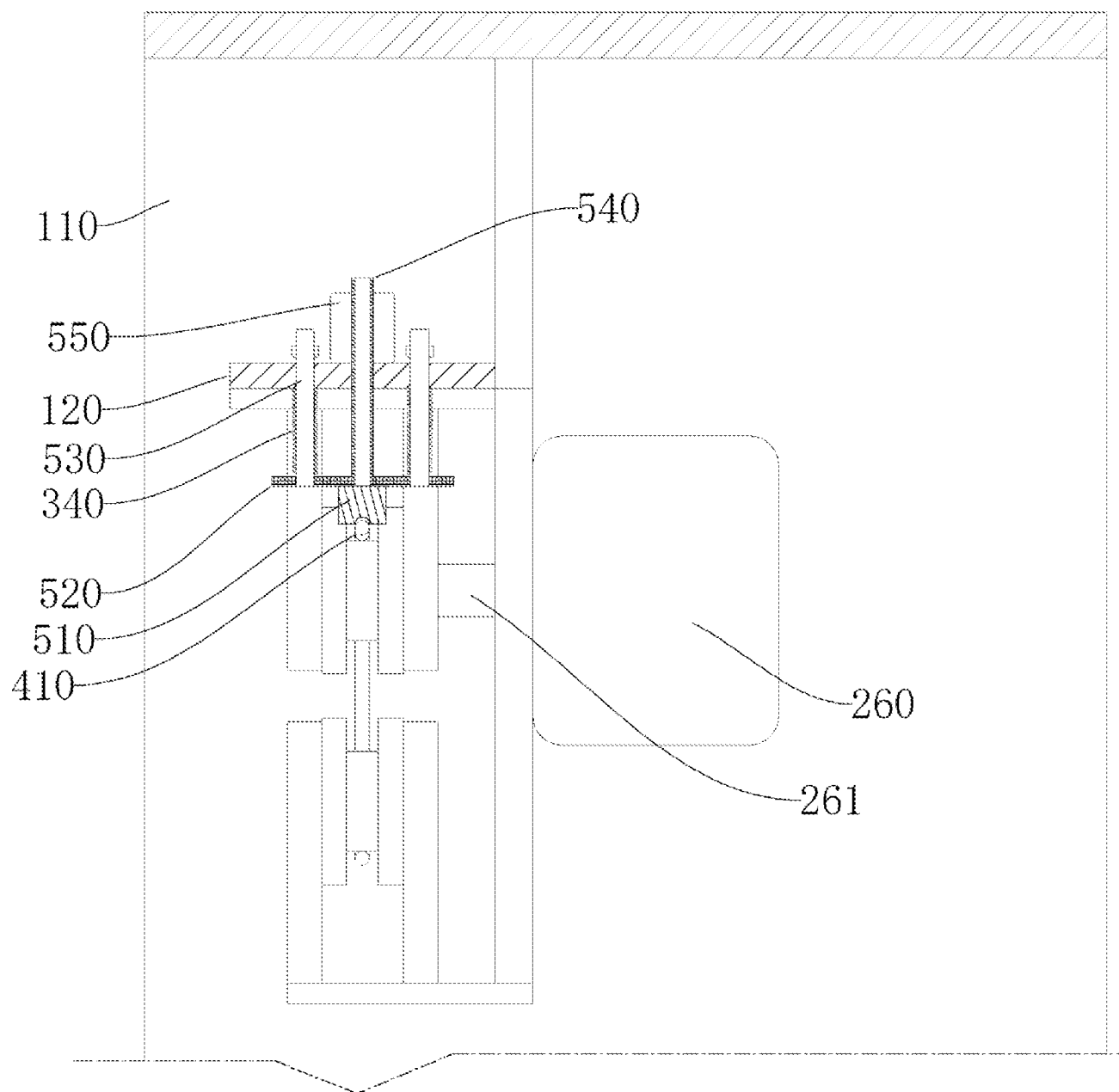


FIG.5

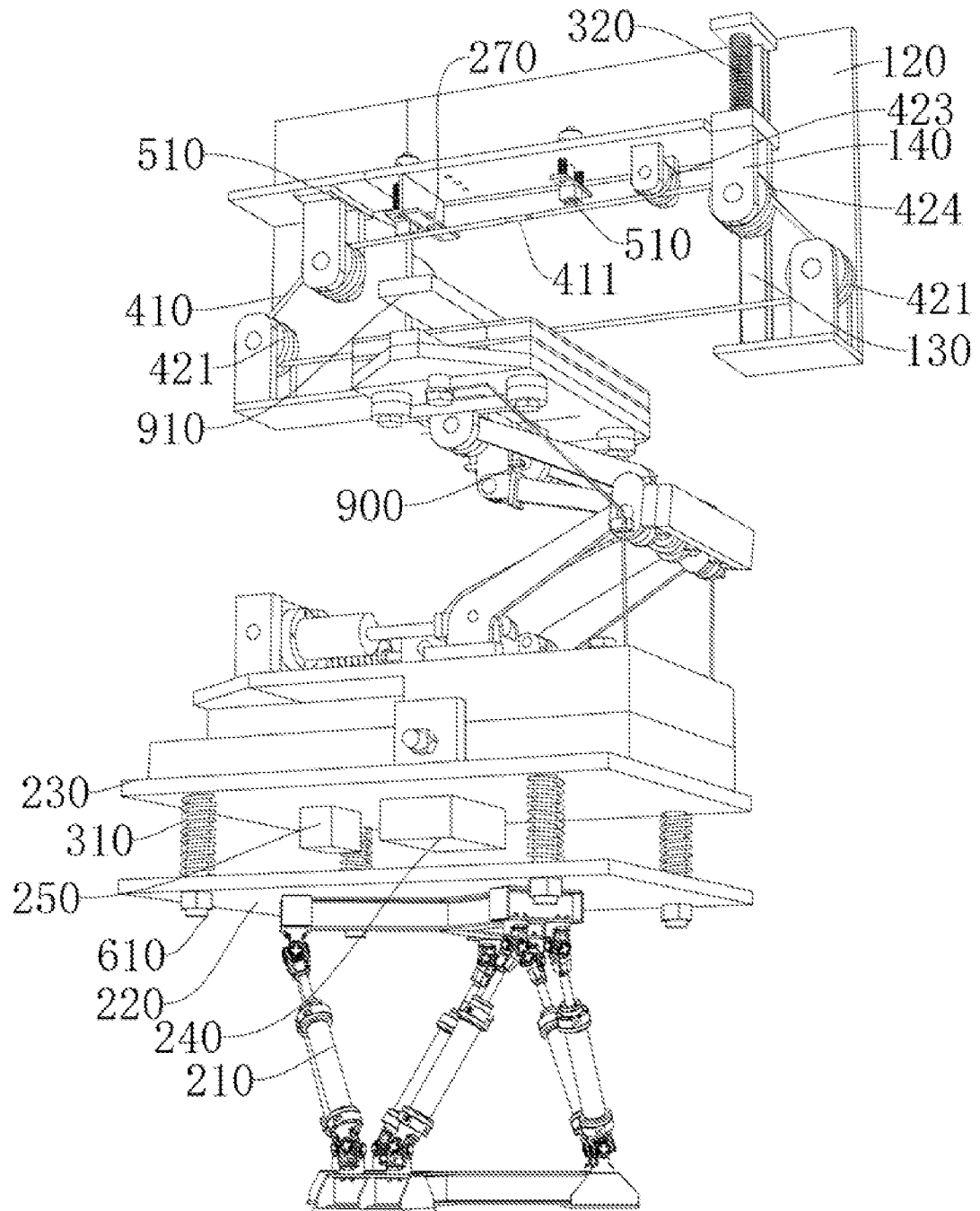


FIG.6

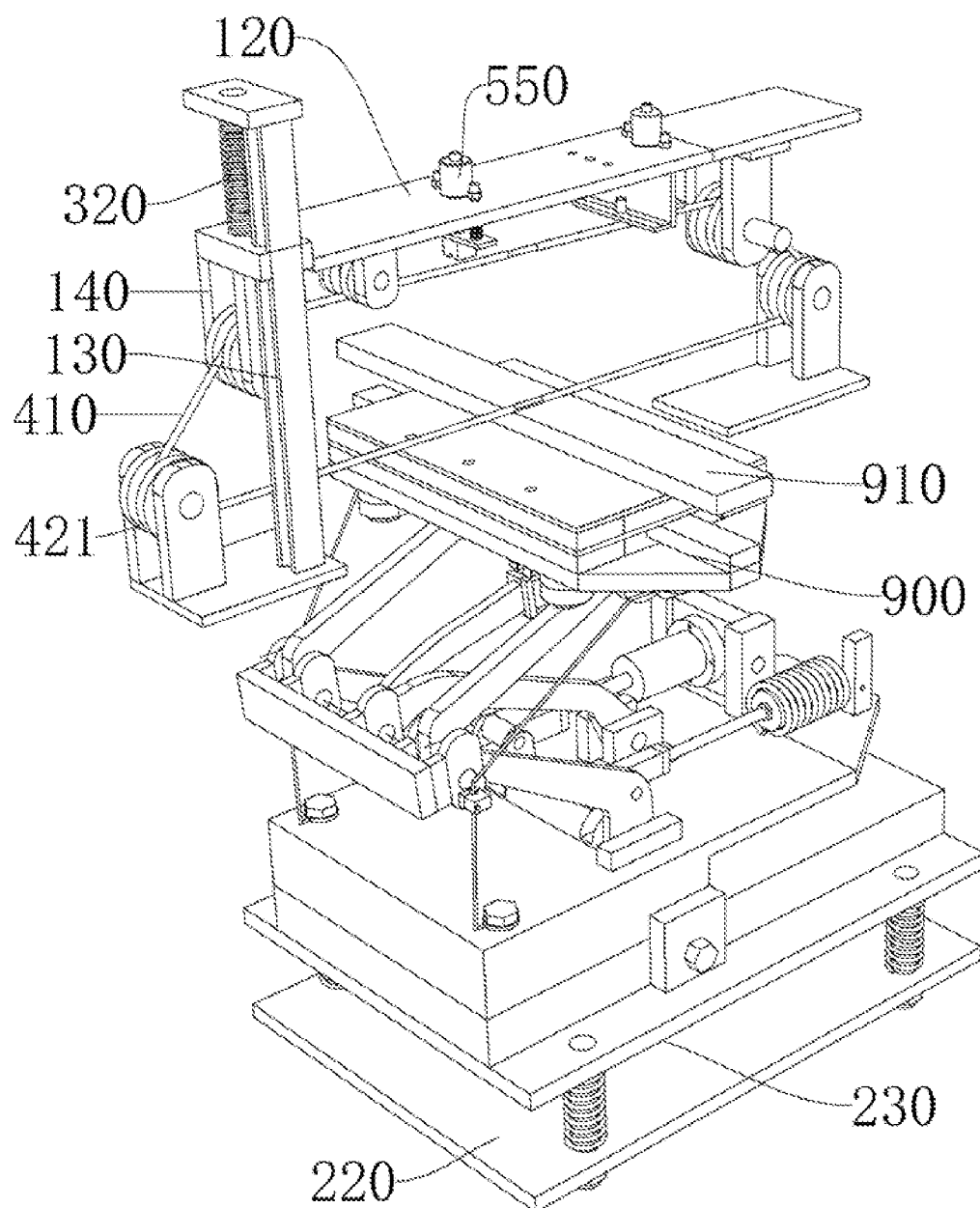


FIG. 7

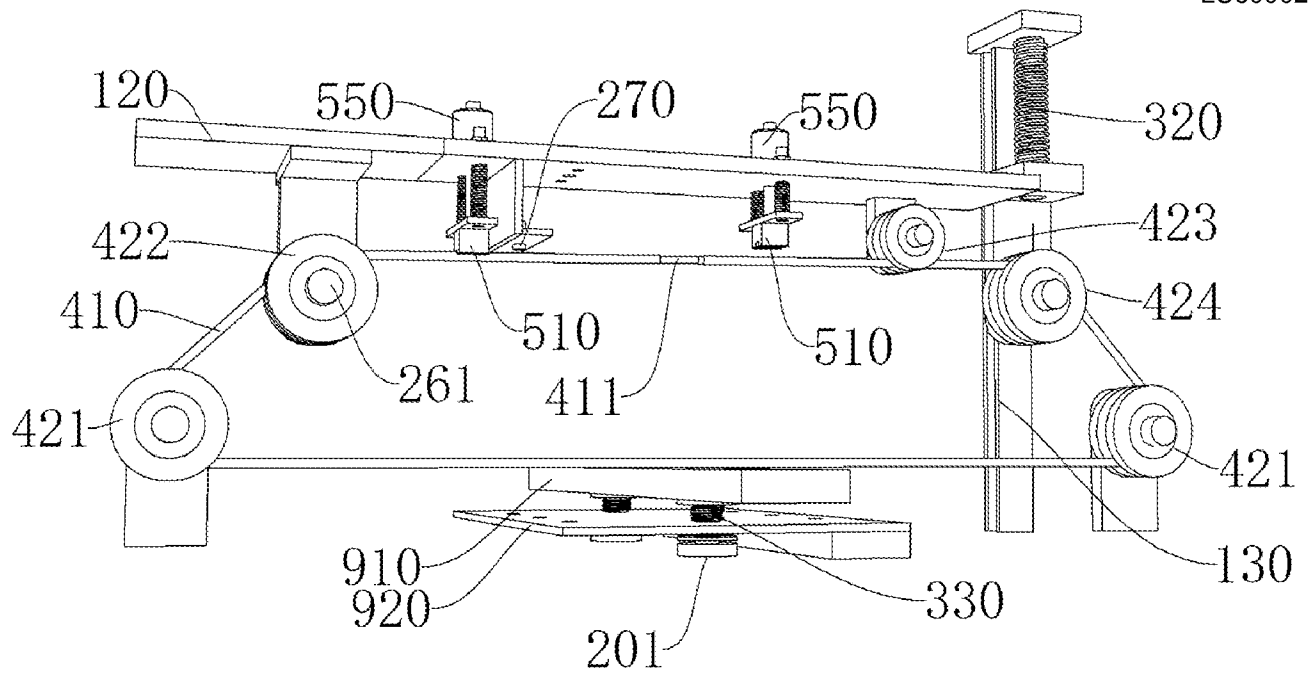


FIG. 8

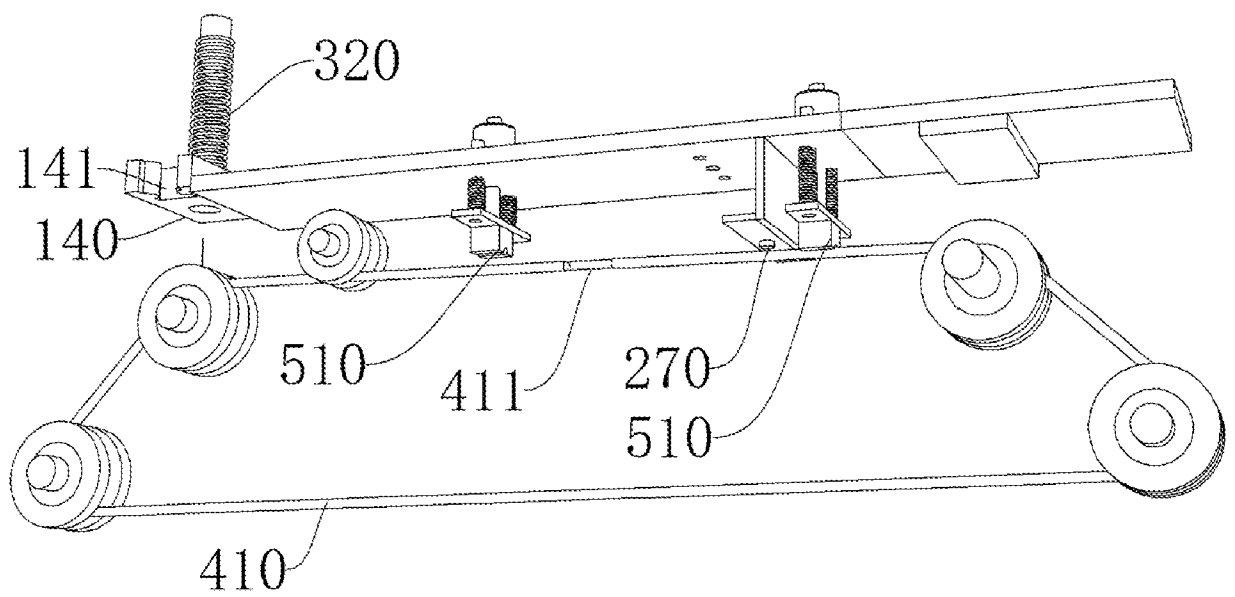


FIG. 9

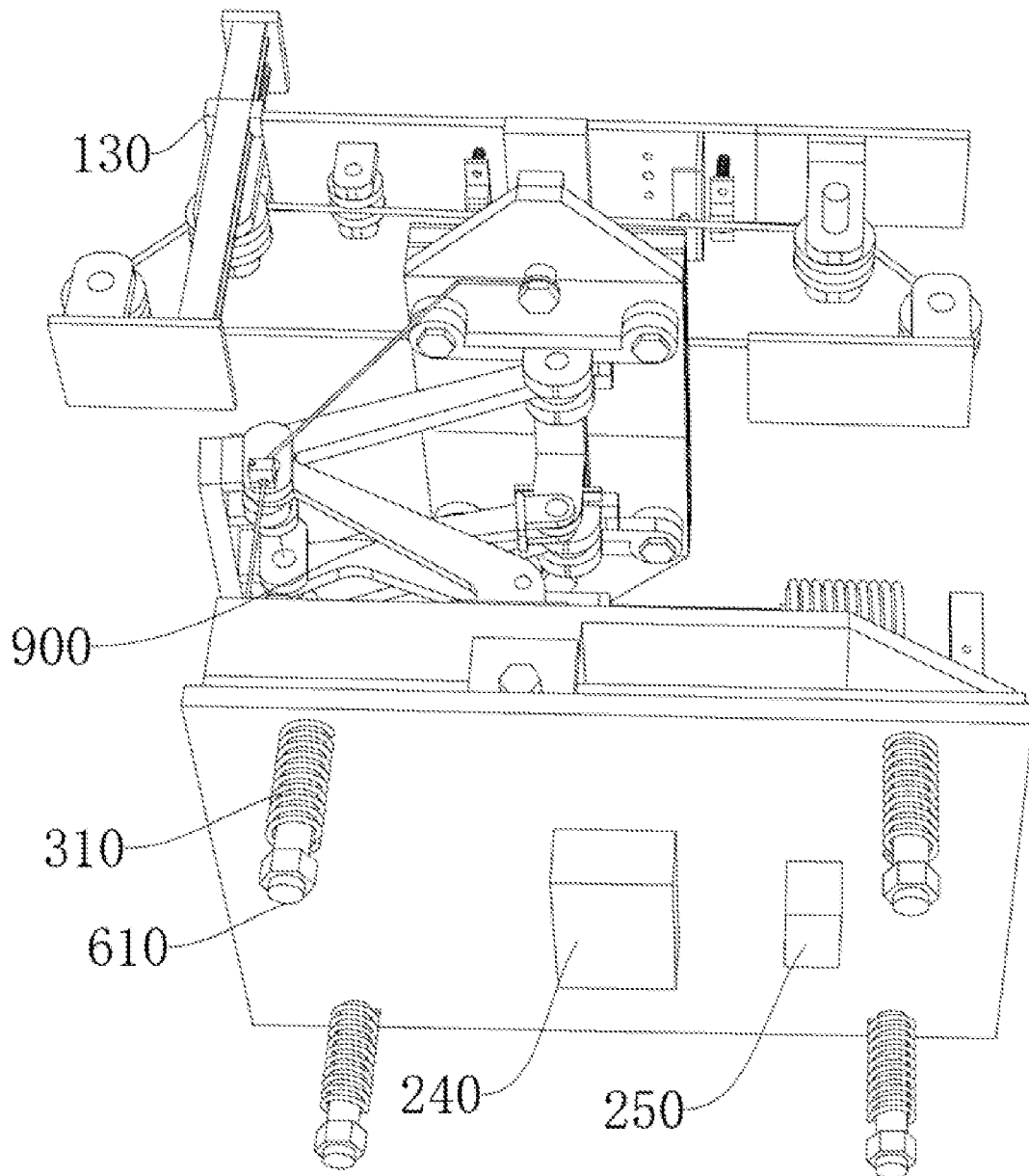


FIG.10