



(11)

EP 4 772 461 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
08.07.2026 Bulletin 2026/28

(51) International Patent Classification (IPC):
B65G 47/90 (2006.01)

(21) Application number: **24909809.6**

(52) Cooperative Patent Classification (CPC):
B65G 47/90

(22) Date of filing: **12.08.2024**

(86) International application number:
PCT/CN2024/111457

(87) International publication number:
WO 2025/138857 (03.07.2025 Gazette 2025/27)

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **28.12.2023 CN 202311834147**
29.12.2023 CN 202311845133
29.12.2023 CN 202311845141
29.12.2023 CN 202311845125
29.12.2023 CN 202311844938
29.12.2023 CN 202311845126

(71) Applicant: **Beijing Dynaflow Lab Solutions Co.,
Ltd.**
Beijing 100070 (CN)

(72) Inventors:

- **CHI, Haipeng**
Beijing 100070 (CN)
- **ZHANG, Huaidong**
Beijing 100070 (CN)
- **XING, Xixue**
Beijing 100070 (CN)
- **XI, Xiaopeng**
Beijing 100070 (CN)
- **ZHANG, Jingjun**
Beijing 100070 (CN)
- **GONG, Changhua**
Beijing 100070 (CN)

(74) Representative: **Bayramoglu et al.**
Mira Office
Kanuni Sultan Süleyman Boulevard 5387
Street Beytepe, floor 12, no:50
06800 Cankaya, Ankara (TR)

(54) **PREFABRICATED BUILDING PRODUCTION LINE AND PREFABRICATED BUILDING STRUCTURE**

(57) Provided are a prefabricated building production line and a prefabricated building structure. The prefabricated building production line includes an assembly conveyor line, a functional module conveyor line, a transfer robotic arm, an assembly robotic arm, and a control platform. An assembly area, a testing area, and an inspection area are sequentially arranged along a conveying direction of the assembly conveyor line. The assembly conveyor line is used to convey a building unit body to be assembled. A plurality of functional module conveyor branch lines are arranged on a side of the functional module conveyor line away from the assembly conveyor line. The functional module conveyor line and the functional module conveyor branch lines are used to convey functional modules. The transfer robotic arm is used to handle the functional modules and the building unit body to be assembled. The assembly robotic arm is used to install the functional modules onto the building unit body to be assembled. The prefabricated building structure

includes a lifter for installing a prefabricated building, a prefabricated building ventilation structure, an automatic production fixture for a prefabricated building, and the like.

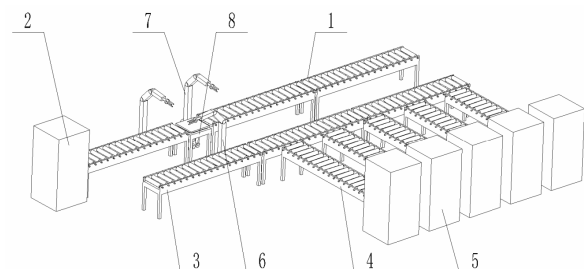


Fig. 1

EP 4 772 461 A1

Description

[0001] The present disclosure claims priority to Chinese Patent Applications Nos. 202311845133.4, 202311845141.9, 202311834147.6, 202311845125.X, 202311844938.7, and 202311845126.4, the disclosures of which are hereby incorporated by reference in their entirety.

Technical Field

[0002] The present disclosure relates to a prefabricated building production line and a prefabricated building structure, and particularly, to a prefabricated building production line and a prefabricated building structure.

Background

[0003] Once a conventional building is constructed, if a requirement changes, the building structure of the current building needs to be destroyed to construct a building with the needed functions. For example, in laboratory construction, the average service life of a common fixed laboratory is 12 to 18 months. After an experimental project is completed, the functional layout of the laboratory often needs to be changed, necessitating renovation such as expansion, relocation, and layout adjustment of the laboratory site. However, conventional laboratory designs have significant defects in sustainability, involving high costs, long time consumption, and major interference with the surrounding environment, greatly increasing the time and economic costs of scientific research. By adopting prefabricated laboratory units, different functions are set for each of the laboratory units, and a plurality of laboratory units can be assembled as needed to meet the requirements for the functional layout of the laboratory. However, existing laboratory assembly processes mostly rely on manual assembly, which not only fails to guarantee product quality and precision but also involves high-altitude operations during the assembly process, posing high safety risks.

[0004] Prefabricated modular laboratories feature fast construction speed, good seismic performance, large usable area, light building self-weight, simple construction, flexible assembly, savings in labor and materials, and designable module components, possessing great application value. Laboratory modules need to be prefabricated and processed in a factory and then transported to the site for assembly. Due to limitations on the factory area, to maximize space utilization, module production lines are usually arranged one by one to form a plurality of rows, with each of the production lines being independent. Laboratory modules undergo corresponding processing on different production lines. When transferring a module room from one production line to the next, lifting tools are adopted. This method is very time-consuming and labor-intensive, needing a large amount of labor, resulting in low overall production efficiency.

Meanwhile, for laboratory modules such as plates, a plurality of processes and multi-layer processings are usually needed. In the related art, dust easily adheres to the plate surface during transfer, requiring re-processing in subsequent steps, leading to low overall production efficiency. Therefore, aiming at the above problems, the present disclosure is proposed.

Summary

[0005] The main objective of the present disclosure is to provide a prefabricated building production line and a prefabricated building structure to solve the problems existing in the above related art.

[0006] To solve the above problems, the present disclosure involves a prefabricated building production line, including: an assembly conveyor line, an assembly area, a testing area, and an inspection area are sequentially arranged along a conveying direction of the assembly conveyor line, the assembly conveyor line is used to convey a building unit body to be assembled, and a supply warehouse for the building unit body to be assembled are arranged at an end of the assembly conveyor line away from the inspection area; a functional module conveyor line, the functional module conveyor line is arranged parallel to the assembly conveyor line, a plurality of functional module conveyor branch lines are arranged on a side of the functional module conveyor line away from the assembly conveyor line, both the functional module conveyor line and the functional module conveyor branch lines are used to convey functional modules, and a functional module supply warehouse is arranged at an end of the functional module conveyor branch lines away from the functional module conveyor line; a transfer robotic arm, the transfer robotic arm is arranged between the assembly conveyor line and the functional module conveyor line, the transfer robotic arm is arranged corresponding to the assembly area, and the transfer robotic arm is used to handle the functional modules and the building unit body to be assembled; an assembly robotic arm, the assembly robotic arm is arranged on one side of the assembly conveyor line, and the assembly robotic arm is used to install the functional modules onto the building unit body to be assembled; and a control platform, the assembly conveyor line, the functional module conveyor line, the transfer robotic arm, and the assembly robotic arm are all electrically connected to the control platform.

[0007] Further, the production line further includes: an assembly platform, the assembly platform is arranged in the assembly area of the assembly conveyor line, the assembly conveyor line is arranged on both sides of the assembly platform, and the functional modules and the building unit body to be assembled is assembled on the assembly platform.

[0008] Further, the assembly platform includes: a fixed frame, a platform support plate is arranged at a top end of the fixed frame; a height adjustment mechanism, the

height adjustment mechanism is fixedly installed inside the fixed frame, and the height adjustment mechanism is used to adjust a height of the platform support plate; a rotation adjustment mechanism, the rotation adjustment mechanism is fixedly installed on the height adjustment mechanism, and the rotation adjustment mechanism is used to drive the platform support plate to rotate; a horizontal adjustment mechanism, the horizontal adjustment mechanism is fixedly installed on a top of the rotation adjustment mechanism, and the horizontal adjustment mechanism is used to adjust a relative position of the platform support plate and the fixed frame; and the height adjustment mechanism, the rotation adjustment mechanism, and the horizontal adjustment mechanism are all electrically connected to the control platform.

[0009] Further, the height adjustment mechanism includes support beams fixedly installed at two ends of a bottom of the fixed frame, a first telescopic cylinder is fixedly connected to a bottom end of the support beam, and the first telescopic cylinder is electrically connected to the control platform; an installation plate is arranged between the two first telescopic cylinders, the installation plate is fixedly connected to the bottom end of the first telescopic cylinder, and the rotation adjustment mechanism is fixedly installed at a middle part of a top end of the installation plate.

[0010] Further, the rotation adjustment mechanism includes a first motor fixedly installed on the installation plate, and the first motor is electrically connected to the control platform; a turntable is fixedly connected to an output shaft of the first motor, the turntable is arranged inside the fixed frame, a gap is arranged between the turntable and the fixed frame, and the horizontal adjustment mechanism is fixedly installed on a top end of the turntable.

[0011] Further, the horizontal adjustment mechanism includes two slide rails parallelly arranged and fixedly connected to the top end of the turntable, a slide block is slidably connected to the slide rail, and the platform support plate is fixedly connected to a top end of the slide block; a fixed plate is fixedly connected to one end of the slide rail, a second motor is fixedly connected to a side of the fixed plate close to the slide block, and the second motor is electrically connected to the control platform; a lead screw is fixedly connected to an output shaft of the second motor, a connection block is fixedly connected between the two slide blocks oppositely arranged on the two slide rails, and the lead screw penetrates through the connection block and is threadedly matched with the connection block.

[0012] Further, a positioning mechanism is installed on the fixed frame, the positioning mechanism is arranged between the turntable and the fixed frame, and the positioning mechanism is electrically connected to the control platform.

[0013] Further, the positioning mechanism includes a second telescopic cylinder fixedly connected to the fixed frame, a wedge-shaped block is fixedly connected to an

end of the second telescopic cylinder, the wedge-shaped block is slidably matched with the fixed frame, and the second telescopic cylinder is electrically connected to the control platform; a limit slide groove is opened on a side of the wedge-shaped block away from the fixed frame, a limit block is slidably connected in the limit slide groove, a first positioning block is fixedly connected to the limit block, a surface of the first positioning block close to the turntable is an arcuate surface, and the first positioning block is used to snap between the turntable and the fixed frame and limit the turntable.

[0014] Further, a rotating shaft is fixedly connected to a side of the first positioning block close to the limit block, the rotating shaft is arranged at an end of the first positioning block away from the wedge-shaped block, two second positioning blocks are rotatably connected to the rotating shaft, the two second positioning blocks are respectively arranged on upper and lower sides of the wedge-shaped block, the second positioning block is slidably matched with the wedge-shaped block, and the second positioning block is slidably matched with the fixed frame, and the second positioning block located above the wedge-shaped block is used to limit the platform support plate.

[0015] Further, a reset torsion spring is arranged on the rotating shaft, and the second positioning block realizes reset through the reset torsion spring.

[0016] Further, the production line further includes: a plurality of production lines, the plurality of production lines are arranged at equal intervals in a plant; a transfer assembly, including a plurality of support frames and a plurality of transfer members, the plurality of support frames are respectively arranged between the two adjacent production lines, the transfer member is arranged on the support frame, the transfer member is used to transfer a building module to be assembled between an output end and an input end of the two adjacent production lines, a clamping member is arranged on the transfer member, and the clamping member is used to clamp the building module to be assembled; an uplifting assembly, including a lifting member and a limiting member, the lifting member is arranged on the support frame to control lifting of the transfer member, and the limiting member is arranged on the lifting member and is transmission-connected to the clamping member; and a dust removal assembly, including a plurality of dust removal members, the plurality of dust removal members are respectively arranged on the support frame, and the dust removal member is used to remove dust from the building module to be assembled.

[0017] Further, the transfer member includes a support shaft rotatably connected to the support frame, a support ring is fixedly connected to the support shaft, one end of a plurality of support plates are fixedly connected to an outer side wall of the support ring at equal intervals along a circumference, a support rod is arranged at the other end of the support plate, a carrying frame is fixedly connected to a top end of the support rod, the building

module to be assembled is conveyed to the carrying frame, the carrying frame docks with the production line, a first motor is fixedly connected to a bottom end of the support frame, and one end of the support shaft is fixedly connected to an output end of the first motor.

[0018] Further, the lifting member includes a support disk fixedly connected to the support frame, the support disk is located below the support rod, a boss is arranged at a top end of the support disk, lifting rods are slidably connected to two ends of the support disk close to the boss, a top plate is fixedly connected to a top end of the lifting rod, slide grooves are arranged on the support disk, the boss, and the top plate, a slide block are all fixedly connected to a bottom end of the support rod, the slide block is slidably connected to the slide groove, a control member is arranged inside the support disk, and the control member is connected to the lifting rod.

[0019] Further, the lifting member includes a rotating shaft rotatably connected inside the support disk, a control rod is fixedly connected to the rotating shaft, long holes are opened on the two lifting rods, two ends of the control rod respectively penetrate through the two long holes, a first gear is fixedly connected to one end of the rotating shaft, an electric telescopic rod is fixedly connected inside the support disk, a first rack is fixedly connected to a telescopic end of the electric telescopic rod, and the first gear meshes with the first rack.

[0020] Further, the clamping member includes a support frame fixedly connected to a bottom end of the carrying frame, a plurality of clamping plates are slidably connected to two ends of the support frame at equal intervals along an axial direction, a plurality of conveying rollers are installed on the carrying frame at equal intervals along an axial direction, the clamping plate is located between the two adjacent conveying rollers, a rotating rod is rotatably connected to the support frame, a plurality of second gears are fixedly connected to the rotating rod along an axial direction, a second rack is fixedly connected to the clamping plate, the second gear meshes with the second rack, and one end of the rotating rod is transmission-connected to the limiting member.

[0021] Further, the limiting member includes a top block fixedly connected to the boss, a top rod is slidably connected to the support rod, a top end of the top rod extends into the support frame and is fixedly connected to a third rack, a third gear is fixedly connected to the rotating rod, the third rack meshes with the third gear, a groove is opened on the slide block, the groove fits the top block, and a bottom end of the top rod extends into the groove and is in sliding contact with the top block.

[0022] According to a second aspect of the present disclosure, a prefabricated building structure is proposed, and the prefabricated building structure includes a lifter for installing a prefabricated building, including: a first rotation assembly and a second rotation assembly, a first connecting rod and a second connecting rod are hinged between the first rotation assembly and the second rotation assembly, the first rotation assembly is ar-

ranged on a base, a top plate is arranged at a top of the second rotation assembly, and the first connecting rod is hinged to the second connecting rod; a first support plate, the first support plate is fixedly connected to one side of the top plate, a second support plate is slidably connected to two sides of the first support plate, and a second hydraulic telescopic rod is arranged between the adjacent second support plates.

[0023] Further, the prefabricated building structure includes a ventilation structure, including a ventilation cabinet, and the ventilation cabinet is connected to a ventilation mechanism communicating with an outside of the prefabricated building; the ventilation mechanism includes an air inlet hood arranged inside the ventilation cabinet, and a cleaning assembly is arranged inside the air inlet hood; the air inlet hood is connected to an air outlet assembly arranged outside the ventilation cabinet; the cleaning assembly includes a cleaning brush arranged inside the air inlet hood, and the cleaning brush is in sliding contact with an inner wall of the air inlet hood; a workbench is slidably arranged inside the ventilation cabinet, a sealing assembly is arranged on a side of the workbench facing an outlet of the ventilation cabinet, and an outlet of the sealing assembly is arranged facing a top end of an inner cavity of the ventilation cabinet.

[0024] Further, the prefabricated building structure includes an automatic production fixture, including: a base, two clamping apparatus are movably arranged on the base, and the two clamping apparatus are arranged symmetrically front and back; the clamping apparatus includes an arc-shaped deflection block, the arc-shaped deflection block is rotatably arranged on the base, two clamping assemblies used to clamp an air duct are fixedly connected to a top of the arc-shaped deflection block, the two clamping assemblies are arranged symmetrically left and right, and the arc-shaped deflection block is transmission-connected to a driving part; the clamping assembly is coaxially arranged with the arc-shaped deflection block; after four clamping assemblies clamp the air duct, the air duct can be driven to rotate around an axis of the arc-shaped deflection block.

[0025] Further, the prefabricated building structure includes an automatic pipeline welding apparatus, the automatic pipeline welding apparatus includes a bottom plate, a guide rail is opened on an upper surface of the bottom plate, a guide block is slidably connected inside the guide rail, an electric push rod is fixedly installed on an inner wall of the guide rail, a telescopic end of the electric push rod is fixedly connected to a left side surface of the guide block, support plates are fixedly installed on both the upper surface of the bottom plate and the upper surface of the guide block, slide grooves are opened on both side surfaces of the two support plates facing each other, a slide block is slidably connected inside each of the slide grooves, a first connecting plate is fixedly installed on both side surfaces of the two slide blocks facing each other, a second connecting plate is fixedly installed on both side surfaces of the two support plates

facing each other, connecting columns are fixedly installed on an upper surface of each of the first connecting plates and a bottom surface of the second connecting plate, a clamping ring is fixedly installed on both side surfaces of each group of the connecting columns facing each other, two clamping springs are fixedly installed on a bottom surface of each of the first connecting plates, and bottom ends of the two groups of clamping springs are respectively fixedly connected to the upper surface of the guide block and the upper surface of the bottom plate.

[0026] The beneficial effects of the present disclosure are: the present disclosure conveys the building unit body to be assembled to the assembly area through the assembly conveyor line, each of the functional modules to be installed is sequentially conveyed to the functional module conveyor line through different functional module conveyor branch lines, then the functional module conveyor line is utilized to convey the functional module to be assembled to a position corresponding to the transfer robotic arm, the transfer robotic arm is utilized to transfer the functional module onto the building unit body to be assembled, and then the assembly robotic arm is utilized to assembly to fix the functional module to a designated position on the building unit body to be assembled; after each of the functional modules is installed, the assembly conveyor line is utilized to convey the laboratory unit body for testing and inspection sequentially, and after passing the test, when assembling a laboratory, only a plurality of building unit bodies to be assembled need to be assembled according to requirements. By utilizing the present disclosure, not only product quality and precision are improved, but also production efficiency is increased, and the amount of high-altitude operations is reduced, helping to lower operational safety risks.

Brief Description of the Drawings

[0027] The accompanying drawings that constitute a part of the present disclosure are used to provide a further understanding of the present disclosure, making other features, objects, and advantages of the present disclosure more apparent. The schematic embodiment drawings and descriptions of the present disclosure are used to explain the present disclosure and do not constitute an improper limitation of the present disclosure. In the drawings:

Fig. 1 is a schematic structural diagram of a prefabricated building production line according to a first embodiment of the present disclosure.

Fig. 2 is a schematic structural diagram of an assembly platform according to the first embodiment of the present disclosure.

Fig. 3 is a side view of the assembly platform according to the first embodiment of the present disclosure.

Fig. 4 is a cross-sectional view along the A-A direction in Fig. 3.

Fig. 5 is a schematic structural diagram of a position-

ing mechanism according to the first embodiment of the present disclosure.

Fig. 6 is a schematic structural diagram of the positioning mechanism from another perspective according to the first embodiment of the present disclosure.

In Figs. 1 to 6: 1. Assembly conveyor line; 2. Supply warehouse for the building unit body to be assembled; 3. Functional module conveyor line; 4. Functional module conveyor branch line; 5. Functional module supply warehouse; 6. Transfer robotic arm; 7. Assembly robotic arm; 8. Assembly platform; 9. Fixed frame; 10. Platform support plate; 11. Support beam; 12. First telescopic cylinder; 13. Installation plate; 14. First motor; 15. Turntable; 16. Slide rail; 17. Slide block; 18. Fixed plate; 19. Second motor; 20. Lead screw; 21. Connection block; 22. Second telescopic cylinder; 23. Wedge-shaped block; 24. Limit slide groove; 25. Limit block; 26. First positioning block; 27. Rotating shaft; 28. Second positioning block.

Fig. 7 is a schematic diagram of a production line layout according to a second embodiment of the present disclosure.

Fig. 8 is a schematic structural diagram of a transfer assembly according to the second embodiment of the present disclosure.

Fig. 9 is a schematic structural diagram of an interior of a support disk according to the second embodiment of the present disclosure.

Fig. 10 is a schematic structural diagram of an interior of a support frame according to the second embodiment of the present disclosure.

Fig. 11 is a schematic structural diagram of a second spring according to the second embodiment of the present disclosure.

In Figs. 7 to 11: 1. Production line; 2. Support frame; 3. Laboratory module; 4. Support shaft; 5. Support ring; 6. Support plate; 7. Support rod; 8. Carrying frame; 9. First motor; 10. Support disk; 11. Boss; 12. Lifting rod; 13. Top plate; 14. Slide groove; 15. Slide block; 16. Rotating shaft; 17. Control rod; 18. Long hole; 19. First gear; 20. Electric telescopic rod; 21. First rack; 22. Support frame; 23. Clamping plate; 24. Conveying roller; 25. Rotating rod; 26. Second gear; 27. Second rack; 28. Top block; 29. Top rod; 30. Third rack; 31. Third gear; 32. Groove; 33. Cylinder; 34. Cleaning roller; 35. First spring; 36. Second spring.

Fig. 12 is a schematic overall structural diagram according to a third embodiment of the present disclosure.

Fig. 13 is a schematic structural diagram of another state of a second support plate according to the third embodiment of the present disclosure.

Fig. 14 is a schematic structural diagram of a first rotation assembly and a second rotation assembly according to the third embodiment of the present disclosure.

Fig. 15 is a schematic structural diagram of another state of the first rotation assembly and the second rotation assembly according to the third embodiment of the present disclosure.

Fig. 16 is a schematic structural diagram of a lifting assembly according to the third embodiment of the present disclosure.

In Figs. 12 to 16: 1. Base; 2. Groove; 3. Motor; 4. First half gear; 5. First hinged rod; 6. Second half gear; 7. Second hinged rod; 8. First connecting rod; 9. Second connecting rod; 10. Opening; 11. Top plate; 12. First hydraulic telescopic rod; 13. First support plate; 14. Movable plate; 15. Second support plate; 16. Second hydraulic telescopic rod; 17. Counterbore; 18. Baffle; 19. Rack; 20. Gear; 21. Knob; 22. Third half gear; 23. Third hinged rod; 24. Fourth half gear; 25. Fourth hinged rod.

Fig. 17 is an axonometric view of a prefabricated building ventilation structure according to a fourth embodiment of the present disclosure.

Fig. 18 is a front view of the prefabricated building ventilation structure according to the fourth embodiment of the present disclosure.

Fig. 19 is a partial cross-sectional view of A in Fig. 18 of the present disclosure.

Fig. 20 is a partial cross-sectional view of B in Fig. 18 of the present disclosure.

Fig. 21 is a schematic structural diagram of a ventilation mechanism according to the fourth embodiment of the present disclosure.

Fig. 22 is a partial enlarged view of C in Fig. 21 of the present disclosure.

Fig. 23 is a schematic structural diagram of a dust outlet hole according to the fourth embodiment of the present disclosure.

Fig. 24 is a schematic structural diagram of a waste liquid pool according to the fourth embodiment of the present disclosure.

Fig. 25 is a partial enlarged view of D in Fig. 24 of the present disclosure.

Fig. 26 is a partial enlarged view of E in Fig. 24 of the present disclosure.

In the drawings, in Figs. 17 to 26: 1. Ventilation cabinet; 2. Air inlet hood; 3. Cleaning brush; 4. Workbench; 5. Cleaning shaft; 6. Cleaning rod; 7. Cleaning plate; 8. Air outlet hole; 9. Dust filter screen; 10. Cleaning motor; 11. Skeleton; 12. Flexible scraper; 13. Dust outlet hole; 14. Control block; 15. Telescopic rod; 16. Support plate; 17. Support spring; 18. Connecting air duct; 19. Exhaust fan; 20. Air outlet channel; 21. Waste liquid pool; 22. Waste liquid pipe; 23. Waste liquid tank; 24. Limit groove; 25. Limit block; 26. Lifting rod; 27. Guide block; 28. Guide groove; 29. Air distribution cavity; 30. Air outlet head; 31. Cabinet door; 32. Operation hole; 33. Sealing sleeve; 34. Faucet; 35. Ejection hole; 36. Ejection spring; 37. Ejection plate; 38. Relief groove; 39. Limit plate; 40. Torsion spring; 41. Dust collection box; 42. Lighting

lamp; 43. Support foot; 44. Limit hook.

Fig. 27 is a schematic structural diagram according to a fifth embodiment of the present disclosure.

Fig. 28 is a partial enlarged view of area A in Fig. 27 of the present disclosure.

Fig. 29 is a partial enlarged view of area B in Fig. 27 of the present disclosure.

Fig. 30 is a cross-sectional structural diagram according to the fifth embodiment of the present disclosure.

In Figs. 27 to 30: 1. Base; 2. Fixture support; 3. Arc-shaped slide block; 4. Gear; 5. First motor; 6. Arc-shaped slide groove; 7. Gear slot; 8. Support arm; 9. Slide way; 10. Threaded rod; 11. Slide rod; 12. Motor seat; 13. Rotating plate; 14. First bevel gear; 15. Second motor; 16. Second bevel gear; 17. Rotating shaft; 18. Support plate; 19. Clamping plate; 20. Threaded slide block; 21. Slide groove; 22. Activity groove; 23. Bidirectional threaded rod; 24. Third motor; 25. Fourth motor; 26. Fifth motor; 27. Second gear; 28. Arc-shaped tooth wall; 29. Arc-shaped deflection block; 30. Slot; 31. Sliding plate.

Fig. 31 is a three-dimensional schematic structural diagram of an automatic welding apparatus of the present disclosure.

Fig. 32 is a three-dimensional schematic structural diagram of a support plate of the present disclosure.

Fig. 33 is a three-dimensional cross-sectional schematic structural diagram of the support plate of the present disclosure.

Fig. 34 is a three-dimensional side view schematic structural diagram of a bottom plate of the present disclosure.

In Figs. 31 to 34: 1. Bottom plate; 2. Guide rail; 3. Blocking block; 4. Reinforcement plate; 5. Stabilization plate; 6. Reinforcement plate; 7. Welding mechanism; 8. Reinforcement block; 9. Support plate; 10. Second connecting plate; 11. First connecting plate; 12. Clamping spring; 13. Electric push rod; 14. Fastening block; 15. Connecting column; 16. Slide block; 17. Clamping ring; 18. Guide block; 19. Slide groove.

Fig. 35 is a schematic overall diagram according to a seventh embodiment of the present disclosure.

Fig. 36 is a schematic structural diagram according to the seventh embodiment of the present disclosure.

Fig. 37 is a partial enlarged view of area A in Fig. 36.

Fig. 38 is a partial enlarged view of area B in Fig. 36.

In Figs. 35 to 38: 1. Connecting plate; 2. First U-shaped frame; 3. First screw rod; 4. First handle; 5. First top block; 6. First frosted layer; 7. Second frosted layer; 8. First fixed hook; 9. Sleeve; 10. Slide rod; 11. Slide block; 12. Second handle; 13. Second U-shaped frame; 14. Lower mounting plate; 15. Upper mounting plate; 16. Third frosted layer; 17. First roller; 18. Hinged seat; 19. Handle; 20. Second screw rod; 21. Second roller; 22. First friction ring; 23.

Second friction ring; 24. First slide groove; 25. First spring; 26. Placement groove; 27. Through groove; 28. Second slide groove; 29. First short shaft; 30. Second short shaft; 31. Second spring; 32. Shaft seat.

Fig. 39 is a three-dimensional view of a transfer apparatus according to an eighth embodiment of the present disclosure.

Fig. 40 is a three-dimensional view of a state where a squeezing roller squeezes an air duct according to the eighth embodiment of the present disclosure.

Fig. 41 is a three-dimensional view of a state where the squeezing roller does not squeeze the air duct according to the eighth embodiment of the present disclosure.

Fig. 42 is a three-dimensional view of a connection relationship between a first plate body and a second plate body according to the eighth embodiment of the present disclosure.

Fig. 43 is a cross-sectional view of a sleeve according to the eighth embodiment of the present disclosure.

Fig. 44 is an exploded view of the connection relationship between the first plate body and the second plate body according to the eighth embodiment of the present disclosure.

Fig. 45 is a three-dimensional view of a connection relationship between the second plate body and a conveyor line according to the eighth embodiment of the present disclosure.

In Figs. 39 to 45: 1. Conveyor line; 2. Folding machine; 3. Air duct; 4. First plate body; 5. Second plate body; 6. Adsorption unit; 601. Suction cup; 602. Communication pipe; 7. Squeezing unit; 701. Squeezing roller; 702. Sleeve; 703. Piston; 704. T-shaped rod; 705. Limit plate; 706. Reset spring; 8. Negative pressure provider; 9. First conduit; 10. Second conduit; 11. L-shaped connecting plate; 12. Distance adjustment bolt; 13. Mounting hole; 14. Slide groove; 15. Threaded rod; 16. Drive rotating ring; 17. Bracket; 18. Conveyor roller group; 19. Slide table; 20. Slide block.

Fig. 46 is a schematic structural diagram of an assembly apparatus of air duct assembly according to a ninth embodiment of the present disclosure.

Fig. 47 is a schematic structural diagram of a bidirectional screw rod according to the ninth embodiment of the present disclosure.

Fig. 48 is a schematic structural diagram of a rubber layer according to the ninth embodiment of the present disclosure.

Fig. 49 is a schematic structural diagram of a steering disk member according to the ninth embodiment of the present disclosure.

[0028] In Figs. 46 to 48: 1. Frame; 2. Gantry; 3. Extension plate; 4. Guide rod; 5. Vertical plate; 6. Horizontal plate; 7. Positioning cylinder; 8. Positioning plate; 9.

Transmission motor; 10. Bidirectional screw rod; 11. Lifting motor; 12. Lifting cylinder; 13. Lifting guide rod; 14. Steering frame; 15. Steering motor; 16. Steering disk; 17. Lifting frame; 18. Lifting cylinder; 19. Arc-shaped plate; 20. Rubber layer; 21. Bottom plate; 22. Limit plate; 23. Top plate; 24. Pulley.

Detailed Description of the Embodiments

[0029] It should be noted that, in the case of no conflict, the embodiments in the present disclosure and features in the embodiments can be combined with each other. The present disclosure will be described in detail below with reference to the accompanying drawings and in combination with the embodiments.

[0030] As shown in Figs. 1 to 6, in a first embodiment of the present disclosure, Figs. 1 to 6 are schematic structural diagrams of a prefabricated building production line provided by the first embodiment of the present disclosure, providing a prefabricated building production line, including the followings.

[0031] An assembly conveyor line 1, an assembly area, a testing area, and an inspection area are sequentially arranged along a conveying direction of the assembly conveyor line 1, the assembly conveyor line 1 is used to convey a building unit body to be assembled, and a supply warehouse 2 for the building unit body to be assembled is arranged at an end of the assembly conveyor line 1 away from the inspection area; a functional module conveyor line 3, the functional module conveyor line 3 is arranged parallel to the assembly conveyor line 1, a plurality of functional module conveyor branch lines 4 are arranged on a side of the functional module conveyor line 3 away from the assembly conveyor line 1, both the functional module conveyor line 3 and the functional module conveyor branch lines 4 are used to convey functional modules, and a functional module supply warehouse 5 is arranged at an end of the functional module conveyor branch lines 4 away from the functional module conveyor line 3; a transfer robotic arm 6, the transfer robotic arm 6 is arranged between the assembly conveyor line 1 and the functional module conveyor line 3, the transfer robotic arm 6 is arranged corresponding to the assembly area, and the transfer robotic arm 6 is used to handle the functional modules and the building unit body to be assembled; an assembly robotic arm 7, the assembly robotic arm 7 is arranged on one side of the assembly conveyor line 1, and the assembly robotic arm 7 is used to install the functional modules onto the building unit body to be assembled; a control platform, the assembly conveyor line 1, the functional module conveyor line 3, the transfer robotic arm 6, and the assembly robotic arm 7 are all electrically connected to the control platform.

[0032] The present disclosure conveys the building unit body to be assembled to the assembly area through the assembly conveyor line 1, each of the functional modules to be installed is sequentially conveyed to the

functional module conveyor line 3 through different functional module conveyor branch lines 4, then the functional module conveyor line 3 is utilized to convey the functional module to be assembled to a position corresponding to the transfer robotic arm 6, the transfer robotic arm 6 is utilized to transfer the functional module onto the building unit body to be assembled, and then the assembly robotic arm 7 is utilized to assembly to fix the functional module to a designated position on the building unit body to be assembled; after each of the functional modules is installed, the assembly conveyor line 1 is utilized to convey the building unit body to be assembled for testing and inspection sequentially, and after passing the test, when assembling a building to be assembled, only a plurality of building unit bodies to be assembled need to be assembled according to requirements.

[0033] Further, to cooperate with the use of the assembly robotic arm 7 and facilitate installing the functional modules onto the building unit body to be assembled, the present disclosure further includes: an assembly platform 8, the assembly platform 8 is arranged in the assembly area of the assembly conveyor line 1, the assembly conveyor line 1 is arranged on two sides of the assembly platform 8, and the functional modules and the building unit body to be assembled are assembled on the assembly platform 8; the assembly platform 8 includes: a fixed frame 9, a platform support plate 10 is arranged at a top end of the fixed frame 9; a height adjustment mechanism, the height adjustment mechanism is fixedly installed inside the fixed frame 9, and the height adjustment mechanism is used to adjust a height of the platform support plate 10; a rotation adjustment mechanism, the rotation adjustment mechanism is fixedly installed on the height adjustment mechanism, and the rotation adjustment mechanism is used to drive the platform support plate 10 to rotate; a horizontal adjustment mechanism, the horizontal adjustment mechanism is fixedly installed on a top of the rotation adjustment mechanism, and the horizontal adjustment mechanism is used to adjust a relative position of the platform support plate 10 and the fixed frame 9; and the height adjustment mechanism, the rotation adjustment mechanism, and the horizontal adjustment mechanism are all electrically connected to the control platform. Further, to facilitate adjusting the height of the platform support plate 10, the height adjustment mechanism includes support beams 11 fixedly installed at two ends of a bottom of the fixed frame 9, a first telescopic cylinder 12 is fixedly connected to a bottom end of the support beam 11, and the first telescopic cylinder 12 is electrically connected to the control platform; an installation plate 13 is arranged between the two first telescopic cylinders 12, the installation plate 13 is fixedly connected to the bottom end of the first telescopic cylinder 12, and the rotation adjustment mechanism is fixedly installed at a middle part of a top end of the installation plate 13. By controlling the extension and retraction of the first telescopic cylinder 12, the height of the installation plate 13 is adjusted to realize the

adjustment of the height of the platform support plate 10, so as to facilitate the assembly robotic arm 7 to install the functional modules onto the building unit body to be assembled.

[0034] Further, to realize the rotation of the building unit body to be assembled on the platform support plate 10, the rotation adjustment mechanism includes a first motor 14 fixedly installed on the installation plate 13, and the first motor 14 is electrically connected to the control platform; a turntable 15 is fixedly connected to an output shaft of the first motor 14, the turntable 15 is arranged inside the fixed frame 9, a gap is arranged between the turntable 15 and the fixed frame 9, and the horizontal adjustment mechanism is fixedly installed on a top end of the turntable 15.

[0035] Further, to realize horizontal movement of the platform support plate 10, the horizontal adjustment mechanism includes two slide rails 16 parallelly arranged and fixedly connected to the top end of the turntable 15, a slide block 17 is slidably connected to the slide rail 16, and the platform support plate 10 is fixedly connected to a top end of the slide block 17; a fixed plate 18 is fixedly connected to one end of the slide rail 16, a second motor 19 is fixedly connected to a side of the fixed plate 18 close to the slide block 17, and the second motor 19 is electrically connected to the control platform; a lead screw 20 is fixedly connected to an output shaft of the second motor 19, a connection block 21 is fixedly connected between the two slide blocks 17 oppositely arranged on the two slide rails 16, and the lead screw 20 penetrates through the connection block 21 and is threadedly matched with the connection block 21.

[0036] Further, to realize position stability of the platform support plate 10 within a certain range, a positioning mechanism is installed on the fixed frame 9, the positioning mechanism is arranged between the turntable 15 and the fixed frame 9, and the positioning mechanism is electrically connected to the control platform; the positioning mechanism includes a second telescopic cylinder 22 fixedly connected to the fixed frame 9, a wedge-shaped block 23 is fixedly connected to an end of the second telescopic cylinder 22, the wedge-shaped block 23 is slidably matched with the fixed frame 9, and the second telescopic cylinder 22 is electrically connected to the control platform; a limit slide groove 24 is opened on a side of the wedge-shaped block 23 away from the fixed frame 9, a limit block 25 is slidably connected in the limit slide groove 24, a first positioning block 26 is fixedly connected to the limit block 25, a surface of the first positioning block 26 close to the turntable 15 is an arcuate surface, and the first positioning block 26 is used to snap between the turntable 15 and the fixed frame 9 and limit the turntable 15.

[0037] Further, a rotating shaft 27 is fixedly connected to a side of the first positioning block 26 close to the limit block 25, the rotating shaft 27 is arranged at an end of the first positioning block 26 away from the wedge-shaped block 23, two second positioning blocks 28 are rotatably

connected to the rotating shaft 27, the two second positioning blocks 28 are respectively arranged on upper and lower sides of the wedge-shaped block 23, the second positioning block 28 is slidably matched with the wedge-shaped block 23, the second positioning block 28 is slidably matched with the fixed frame 9, and the second positioning block 28 located above the wedge-shaped block 23 is used to limit the platform support plate 10.

[0038] Further, a reset torsion spring is arranged on the rotating shaft 27, and the second positioning block 28 realizes reset through the reset torsion spring.

[0039] The working principle of the prefabricated building production line provided by the present disclosure is as follows.

[0040] The building unit body to be assembled in the supply warehouse 2 for the building unit body to be assembled is conveyed to the assembly platform 8 through the assembly conveyor line 1, the functional modules to be installed in each of the functional module supply warehouses 5 are respectively conveyed to the functional module conveyor line 3 through the functional module conveyor branch lines 4, then the functional module conveyor line 3 is utilized to convey the functional module to be assembled to a position corresponding to the transfer robotic arm 6, the transfer robotic arm 6 is utilized to transfer the functional module onto the building unit body to be assembled, and then the assembly robotic arm 7 is utilized to assembly to fix the functional module to a designated position on the building unit body to be assembled; during the assembly process of the functional modules, the height of the installation plate 13 is adjusted by controlling the extension and retraction of the first telescopic cylinder 12 by utilizing the control platform as needed to realize the adjustment of the height of the platform support plate 10; the rotation of the first motor 14 is controlled by utilizing the control platform, and the rotation of the turntable 15 is driven by utilizing the first motor 14 to realize the rotation of the platform support plate 10; the rotation of the second motor 19 is controlled by utilizing the control platform, and the rotation of the lead screw 20 is driven by utilizing the second motor 19, thereby driving the slide block 17 to move on the slide rail 16 by utilizing the lead screw 20 through the connection block 21 to realize the horizontal movement of the platform support plate 10, thus facilitating the assembly robotic arm 7 to install the functional modules onto the building unit body to be assembled; meanwhile, to facilitate fixing the position of the turntable 15 to ensure stability during the assembly process of the functional modules, after the position of the platform support plate 10 is adjusted, the second telescopic cylinder 22 is controlled to be extended by utilizing the control platform to drive the wedge-shaped block 23 to move, and cause the first positioning block 26 on the wedge-shaped block 23 to snap between the turntable 15 and the fixed frame 9, preventing the turntable 15 from rotating by utilizing friction between the first positioning block 26 and the turntable 15; meanwhile, during the process of the wedge-

shaped block 23 pushing the first positioning block 26, the wedge-shaped block 23 is also utilized to lift the two second positioning blocks 28, raising the position of the second positioning block 28 located above, utilizing the second positioning block 28 to contact the bottom end of the platform support plate 10, and the second positioning block 28 can be utilized to further prevent the platform support plate 10 from sliding along the slide rail 16; moreover, through tight contact between the first positioning block 26 and the turntable 15, and tight contact between the second positioning block 28 and the fixed frame 9, relative sliding between the turntable 15 and the fixed frame 9 is prevented, thus helping to keep the height of the turntable 15 unchanged. When it is necessary to release the limit on the turntable 15, it only needs to control the second telescopic cylinder 22 to be retracted to pull the first positioning block 26 out of the gap between the turntable 15 and the fixed frame 9 by utilizing the wedge-shaped block 23. During the pulling-out process, the second positioning block 28 restores to a mutually contacting state under the action of the reset torsion spring, so that the second positioning block 28 does not contact the platform support plate 10, at which point the position of the platform support plate 10 can be readjusted. After each of the functional modules is installed, the assembly conveyor line 1 is utilized to convey the building unit body to be assembled for testing and inspection sequentially, and after passing the test, when assembling a building to be assembled, only a plurality of building unit bodies to be assembled need to be assembled according to requirements.

[0041] By utilizing the present disclosure, synchronous completion of installation, testing, and inspection of the building unit body to be assembled is realized, so that the implementation time of the building to be assembled is reduced by up to 98%, man-hours are reduced by up to 99%, on-site pollution emissions are reduced by up to 90%, and high-altitude operations are reduced by up to 90%, greatly improving product quality and precision. By utilizing the prefabricated building production line provided by the present disclosure, only 3 technical workers are required to complete the workload originally requiring 72 people during operation, and production efficiency is increased by 2300%. On average, one set of building unit body to be assembled may be produced every 15 minutes.

[0042] As shown in Figs. 7 to 11, in a second optional embodiment of the present disclosure, a prefabricated building production line is provided, including the followings.

[0043] A plurality of production lines 1, and the plurality of production lines 1 are arranged at equal intervals in a plant; a transfer assembly, including a plurality of support frames 2 and a plurality of transfer members, the plurality of support frames 2 are respectively arranged between two adjacent production lines 1, the transfer member is arranged on the support frame 2, the transfer member is used to transfer a building module 3 to be assembled

between an output end and an input end of the two adjacent production lines 1, a clamping member is arranged on the transfer member, and the clamping member is used to clamp the building module 3 to be assembled; an uplifting assembly, including a lifting member and a limiting member, the lifting member is arranged on the support frame 2 to control lifting of the transfer member, and the limiting member is arranged on the lifting member and is transmission-connected to the clamping member; and a dust removal assembly, including a plurality of dust removal members, the plurality of dust removal members are respectively arranged on the support frame 2, and the dust removal member is used to remove dust from the building module 3 to be assembled. As a further optimized solution, the transfer member includes a support shaft 4 rotatably connected to the support frame 2, a support ring 5 is fixedly connected to the support shaft 4, one end of a plurality of support plates 6 is fixedly connected to an outer side wall of the support ring 5 at equal intervals along a circumference, a support rod 7 is arranged at the other end of the support plate 6, a carrying frame 8 is fixedly connected to a top end of the support rod 7, the building module 3 to be assembled is conveyed to the carrying frame 8, the carrying frame 8 docks with the production line 1, a first motor 9 is fixedly connected to a bottom end of the support frame 2, and one end of the support shaft 4 is fixedly connected to an output end of the first motor 9. The first motor 9 drives the support shaft 4 to rotate, and the carrying frame 8 on the support shaft 4 performs circular motion to transfer the building module 3 to be assembled on the two adjacent production lines 1. As a further optimized solution, the lifting member includes a support disk 10 fixedly connected to the support frame 2, the support disk 10 is located below the support rod 7, a boss 11 is arranged at a top end of the support disk 10, lifting rods 12 are slidably connected to two ends of the support disk 10 close to the boss 11, a top plate 13 is fixedly connected to a top end of the lifting rod 12, slide grooves 14 are all arranged on the support disk 10, the boss 11, and the top plate 13, a slide block 15 is fixedly connected to a bottom end of the support rod 7, the slide block 15 is slidably connected to the slide groove 14, a control member is arranged inside the support disk 10, and the control member is connected to the lifting rod 12. The lifting rod 12 is arranged to drive the transfer of the carrying frame 8 from the support disk 10 to the boss 11, and from the boss 11 to the support disk 10, so that the corresponding carrying frame 8 docks with the production line 1. As a further optimized solution, the lifting member includes a rotating shaft 16 rotatably connected inside the support disk 10, a control rod 17 is fixedly connected to the rotating shaft 16, long holes 18 are opened on the two lifting rods 12, two ends of the control rod 17 respectively penetrate through the two long holes 18, a first gear 19 is fixedly connected to one end of the rotating shaft 16, an electric telescopic rod 20 is fixedly connected inside the support disk 10, a first rack 21 is

fixedly connected to a telescopic end of the electric telescopic rod 20, and the first gear 19 meshes with the first rack 21. The electric telescopic rod 20 is arranged to drive the first rack 21 to move, and when the first rack 21 moves, it drives the first gear 19 to rotate, and when the first gear 19 rotates, it drives two ends of the control rod 17 to rise and fall respectively, the rising end drives the corresponding lifting rod 12 to rise, raising the carrying frame 8 to the same height as the production line 1, so that the building module 3 to be assembled is conveyed into the carrying frame 8, and the carrying frame 8 at the falling end descends below the production line 1 after completing the transfer of the building module 3 to be assembled to the production line 1, facilitating the continued rotation of the entire transfer member. As a further optimized solution, the clamping member includes a support frame 22 fixedly connected to a bottom end of the carrying frame 8, a plurality of clamping plates 23 are slidably connected to two ends of the support frame 22 at equal intervals along an axial direction, a plurality of conveying rollers 24 are installed on the carrying frame 8 at equal intervals along an axial direction, the clamping plate 23 is located between two adjacent conveying rollers 24, a rotating rod 25 is rotatably connected to the support frame 22, a plurality of second gears 26 are fixedly connected to the rotating rod 25 along an axial direction, a second rack 27 is fixedly connected to the clamping plate 23, the second gear 26 meshes with the second rack 27, and one end of the rotating rod 25 is transmission-connected to the limiting member. The clamping plate 23 has an L-shaped structure, the rotating rod 25 is located between two opposite clamping plates 23, the second rack 27 is fixed on opposite side walls of the two opposite clamping plates 23 and meshes with the second gear 26, when the second gear 26 rotates, it synchronously drives the two clamping plates 23 to move inward, realizing stable clamping of the building module 3 to be assembled. Specifically, the plurality of conveying rollers 24 are driven by separate motors to realize rotation of the conveying rollers 24, thereby transferring the building module 3 to be assembled from the carrying frame 8 to the production line 1. As a further optimized solution, the limiting member includes a top block 28 fixedly connected to the boss 11, a top rod 29 is slidably connected to the support rod 7, a top end of the top rod 29 extends into the support frame 22 and is fixedly connected to a third rack 30, a third gear 31 is fixedly connected to the rotating rod 25, the third rack 30 meshes with the third gear 31, a groove 32 is opened on the slide block 15, the groove 32 fits the top block 28, and a bottom end of the top rod 29 extends into the groove 32 and is in sliding contact with the top block 28. The top block 28 is arranged in the slide groove 14 on the boss 11, its shape is an isosceles trapezoid structure, in an initial state, the top rod 29 is located in the groove 32, with the movement of the slide block 15, the bottom end of the top rod 29 is in sliding contact with the bottom end of the top block 28, driving the top rod 29 to rise to realize control of the rotating rod 25,

when the top rod 29 moves to the top of the isosceles trapezoid structure, the clamping plate 23 realizes stable clamping of the building module 3 to be assembled and is cleaned by a cleaning member, when cleaning is completed, the top rod 29 descends along the oblique side from the high point of the isosceles trapezoid structure, releasing the limit clamping on the building module 3 to be assembled. As a further optimized solution, the dust removal member includes a cylinder 33 fixedly connected to the support frame 2, a cleaning roller 34 is arranged at a telescopic end of the cylinder 33, and the cleaning roller 34 is arranged in contact with the building module 3 to be assembled. The cylinder 33 drives the cleaning roller 34 to move vertically, and when moving downward, it causes the cleaning roller 34 to contact the building module 3 to be assembled, the cleaning roller 34 is driven to rotate through a separate motor, realizing cleaning of the building module 3 to be assembled, facilitating the next process. As a further optimized solution, the support rod 7 is slidably connected to the support plate 6, a first spring 35 is sleeved on the support rod 7, and two ends of the first spring 35 are respectively fixedly connected to the bottom end of the support plate 6 and the top end of the slide block 15. When the lifting rod 12 moves downward, the force applied by the first spring 35 drives the support rod 7 to move downward synchronously. As a further optimized solution, a second spring 36 is sleeved on the top rod 29, and two ends of the second spring 36 are respectively fixedly connected to an inner wall of the groove 32 and the top rod 29. The force applied by the second spring 36 ensures that the top rod 29 can reset when separated from the top block 28. As a further optimized solution, a cross-section of the slide groove 14 is an inverted T-shaped structure. The slide block 15 is located inside the inverted T-shaped structure, realizing blocking of the top end of the slide block 15, ensuring stable sliding of the slide block 15, and ensuring stability of the slide block 15 when the lifting rod 12 rises, and stable sliding of the slide block 15 when the top rod 29 contacts the top block 28.

[0044] As shown in Figs. 12 to 16, in a third optional embodiment of the present disclosure, a lifter for installing a prefabricated building is provided, including: a first rotation assembly and a second rotation assembly, a first connecting rod 8 and a second connecting rod 9 are hinged between the first rotation assembly and the second rotation assembly, the first rotation assembly is arranged on a base 1, a top plate 11 is arranged at a top of the second rotation assembly, and the first connecting rod 8 is hinged to the second connecting rod 9; a first support plate 13, the first support plate 13 is fixedly connected to one side of the top plate 11, a second support plate 15 is slidably connected to two sides of the first support plate 13, and a second hydraulic telescopic rod 16 is arranged between the adjacent second support plates 15. The first rotation assembly includes a first half gear 4, a second half gear 6, a first hinged rod 5 fixedly connected to one side of the first half gear 4, a

second hinged rod 7 fixedly connected to one side of the second half gear 6, and a motor 3, the first half gear 4 is connected to an output end of the motor 3 through a coupling, the first half gear 4 meshes with the second half gear 6, an end of the first hinged rod 5 is hinged to the first connecting rod 8 through a hinged shaft, and an end of the second hinged rod 7 is hinged to the second connecting rod 9 through a hinged shaft. Openings 10 are arranged at two ends of the first connecting rod 8 and the second connecting rod 9 to facilitate hinging of the first hinged rod 5 and the second hinged rod 7 to the first connecting rod 8 and the second connecting rod 9; a rotating shaft of the first half gear 4 is connected to the output end of the motor 3 through a coupling, rotation of the second half gear 6 is rotatably connected to the base 1, a counterbore 17 is arranged on the base 1, the first rotation assembly is arranged in the counterbore 17, that is, the first half gear 4 and the second half gear 6 are arranged in the counterbore 17, and the rotating shaft of the second half gear 6 is rotatably connected to an inner wall of the counterbore 17. A middle part of the first connecting rod 8 is hinged to a middle part of the second connecting rod 9 through a hinged shaft. The second rotation assembly includes a third half gear 22, a fourth half gear 24, a third hinged rod 23 fixedly connected to one side of the third half gear 22, and a fourth hinged rod 25 fixedly connected to one side of the fourth half gear 24, the third half gear 22 meshes with the fourth half gear 24, an end of the third hinged rod 23 is hinged to the opening 10 at an end of the second connecting rod 9 away from the second hinged rod 7 through a hinged shaft, and an end of the fourth hinged rod 25 is hinged to the opening 10 at an end of the first connecting rod 8 away from the first hinged rod 5 through a hinged shaft. A corresponding groove 2 is arranged at a bottom of the top plate 11, the second rotation assembly is arranged in the groove 2 at the bottom of the top plate 11, and rotating shafts of the third half gear 22 and the fourth half gear 24 are both rotatably connected to an inner wall of the groove 2 at the bottom of the top plate 11. When the motor 3 is started, the first half gear 4 and the second half gear 6 rotate, driving the first hinged rod 5 and the second hinged rod 7 to rotate upward simultaneously, under the action of the first connecting rod 8 and the second connecting rod 9, the third hinged rod 23 and the fourth hinged rod 25 rise synchronously, and the third half gear 22 and the fourth half gear 24 cooperate to rotate, causing the top plate 11 to rise. A first support plate 13 is fixedly connected to one side of the top plate 11, a movable plate 14 is sleeved on the first support plate 13, a first hydraulic telescopic rod 12 is arranged between the movable plate 14 and the top plate 11, the two adjacent second support plates 15 are hinged to two sides of the first support plate 13, the first hydraulic telescopic rod 12 is used to control sliding of the movable plate 14 along the direction of the first support plate 13, tops of the two adjacent second support plates 15 are connected through the second hydraulic telescopic rod 16, and the second hydraulic telescopic rod 16 is used to

control mutual approach or outward expansion of the two second support plates 15 to increase the lifting area. When the movable plate 14 slides towards the top plate 11 under the action of the first hydraulic telescopic rod 12, it drives the second support plates 15 on two sides to slide towards the top plate 11, the second hydraulic telescopic rod 16 is controlled to contract, causing the two second support plates 15 to approach each other, at this point, the lifting area decreases, capable of lifting a small-volume prefabricated laboratory; when the first hydraulic telescopic rod 12 extends, the movable plate 14 moves away from the top plate 11, driving the second support plates 15 on two sides to slide away from the top plate 11, and the second hydraulic telescopic rod 16 is controlled simultaneously to extend, causing the two second support plates 15 to expand outward, realizing extension around the periphery of the first support plate 13, increasing the lifting area, capable of lifting a large-volume prefabricated building. In this embodiment, by replacing a plurality of machines in conventional technology with sliding connection between the first support plate 13 and the second support plate 15, this apparatus is easier to control and more convenient to operate. A limit plate is arranged at an end of the first support plate 13, capable of preventing the movable plate 14 from detaching from the first support plate 13. A counterbore 17 is arranged on the second support plate 15, a baffle 18 is movably connected in the counterbore 17 through a lifting assembly, and the baffle 18 can fix the edge of the prefabricated laboratory, preventing the prefabricated laboratory from moving during the lifting process. The lifting assembly includes a rack 19, a gear 20, and a knob 21, the rack 19 is arranged on one side of the baffle 18, the rack 19 meshes with the gear 20, a rotating shaft of the gear 20 is connected to the knob 21, and the knob 21 is arranged on the outside of the second support plate 15, facilitating operation by personnel. The knob 21 is rotated to cause the gear 20 to rotate, the rack 19 and the baffle 18 are controlled to lift, when it is necessary to fix the prefabricated laboratory, the knob 21 is rotated, causing the baffle 18 to rise under the action of the rack 19, and the baffle 18 is higher than the surface of the second support plate 15, realizing fixation of the prefabricated laboratory; when it is not necessary to fix the prefabricated laboratory, the knob 21 is rotated, causing the baffle 18 to descend into the counterbore 17 under the action of the rack 19, avoiding impact on the prefabricated laboratory. By arranging the lifting assembly, convenient adjustment of the height of the baffle 18 is enabled.

[0045] In this embodiment, the first half gear 4 and the second half gear 6 mesh and rotate, causing the first hinged rod 5 and the second hinged rod 7 to rotate upward or downward, driving the first connecting rod 8 and the second connecting rod 9 to rotate crosswise, exerting a uplifting or pulling effect on the third hinged rod 23 and the fourth hinged rod 25, at this point, the third half gear 22 and the fourth half gear 24 cooperatively rotate in the groove at the bottom of the top plate 11, realizing

uplifting or descending of the first support plate 13 and the second support plate 15, thereby completing lifting or lowering of the prefabricated laboratory; during the lifting process of the prefabricated laboratory, the second support plate 15 is adjusted according to the size of the prefabricated laboratory, the second support plate 15 can slide along the direction of the first support plate 13 under the drive of the movable plate 14, when sliding towards the top plate 11, the second support plates 15 approach each other under the action of the second hydraulic telescopic rod 16, gathering on two sides of the first support plate 13, reducing the lifting area to suit small-volume prefabricated laboratories, when the second support plate 15 slides away from the top plate 11, the second support plates 15 move away from each other under the action of the second hydraulic telescopic rod 16, forming an expanded state, capable of increasing the lifting area to suit large-volume prefabricated laboratories. This apparatus can flexibly adjust the lifting area through the first support plate 13 and the second support plate 15, having wider applicability.

[0046] As shown in Figs. 17 to 26, in a fourth optional embodiment of the present disclosure, a prefabricated building ventilation structure is provided, including: a ventilation cabinet 1, the ventilation cabinet 1 is connected to a ventilation mechanism communicating with an outside of the prefabricated building; the ventilation mechanism includes an air inlet hood 2 arranged inside the ventilation cabinet 1, and a cleaning assembly is arranged inside the air inlet hood 2; the air inlet hood 2 is connected to an air outlet assembly arranged outside the ventilation cabinet 1; the cleaning assembly includes a cleaning brush 3 arranged inside the air inlet hood 2, and the cleaning brush 3 is in sliding contact with an inner wall of the air inlet hood 2; a workbench 4 is slidably arranged inside the ventilation cabinet 1, a sealing assembly is arranged on a side of the workbench 4 facing an outlet of the ventilation cabinet 1, and an outlet of the sealing assembly is arranged facing a top end of an inner cavity of the ventilation cabinet 1.

[0047] The present disclosure discloses a prefabricated building ventilation structure, when the prefabricated building is a prefabricated laboratory, the prefabricated building ventilation structure is mainly used to ventilate in the laboratory; during use, experiments are mainly conducted on the workbench 4 of the ventilation cabinet 1, the ventilation mechanism is used to exhaust polluted gases or harmful gases generated by the experiment to prevent impact on experimental personnel and improve the success rate of the experiment; the air inlet hood 2 is used to collect generated gases, which are then exhausted through the air outlet assembly, while the sealing assembly on the workbench 4 realizes enclosure of the experimental space through a fresh air curtain, reducing overflow of pollutants generated by the experiment, and simultaneously providing fresh air replenishment into the ventilation cabinet 1, enabling air exchange in the ventilation cabinet 1; the experimental environment

in the ventilation cabinet 1 is ensued; a cleaning assembly is arranged inside the air inlet hood 2, used to clean the inner wall of the air inlet hood 2, preventing dust and pollutants from adhering to the inner wall of the air inlet hood 2, ensuring cleanliness of the air inlet hood 2, reducing dust accumulation in the air outlet assembly, lowering maintenance pressure, and extending service life. The present disclosure has a simple structure, is easy to use, has good ventilation effects, provides a better experimental environment for experiments, effectively reduces dust accumulation, is convenient to maintain, effectively reduces maintenance pressure of the ventilation system, and lowers maintenance costs. Further, a cabinet door 31 is arranged on the ventilation cabinet 1 of this embodiment, two operation holes 32 are opened on the cabinet door 31, used to allow hands of experimental personnel to extend into the ventilation cabinet 1 when the cabinet door 31 is closed, improving sealing of the ventilation cabinet 1 and preventing impact on the experimental personnel. Further, to further improve sealing of the cabinet door 31, a flexible sealing sleeve 33 is arranged in the operation hole 32, after hands of the operator pass through the sealing sleeve 33 and extend into the ventilation cabinet 1, the sealing sleeve 33 tightens around the arm of the experimental personnel, ensuring sealing for the experimental personnel of different body types. A plurality of lighting lamps 42 are arranged at a top end of the inner cavity of the ventilation cabinet 1, the lighting lamps 42 are disposed according to the principle of shadowless lamps in hospital operating rooms, providing illumination for experiments. Support feet 43 are arranged at a bottom end of the ventilation cabinet 1, used to support the ventilation cabinet 1 and facilitate subsequent movement. As a further optimized solution, the cleaning brush 3 includes a cleaning shaft 5 rotatably connected inside the air inlet hood 2, a plurality of cleaning rods 6 are fixedly connected to an outer wall of the cleaning shaft 5, cleaning plates 7 are fixedly connected between the cleaning shafts 5 located in the same plane, and the cleaning plate 7 is in sliding contact with the inner wall of the air inlet hood 2. During use, the cleaning shaft 5 rotates inside the air inlet hood 2, thereby driving the plurality of cleaning plates 7 to slide on the inner wall of the air inlet hood 2 through the plurality of cleaning rods 6, cleaning the inner wall of the air inlet hood 2 and preventing accumulation of dust and impurities. The cleaning plate 7 of this embodiment is arranged in a gate shape, two endpoints of the gate-shape plate are fixedly connected to the cleaning shaft 5, and three sides of the gate-shape plate are in sliding contact with the inner wall of the air inlet hood 2; the cleaning rod 6 extends into the inner cavity of the gate-shape plate and is fixedly connected to the horizontal side of the gate-shape plate. As a further optimized solution, an air outlet hole 8 is opened on a rear wall of the ventilation cabinet 1, the air outlet hole 8 is arranged corresponding to the air inlet hood 2; a dust filter screen 9 is arranged in the air outlet hole 8, and the

cleaning shaft 5 is rotatably connected to the dust filter screen 9; an end of the cleaning shaft 5 away from the dust filter screen 9 extends out of the air inlet hood 2 and is transmission-connected to a cleaning motor 10 arranged on the air inlet hood 2. The dust filter screen 9 is embedded in the air outlet hole 8, an end of the dust filter screen 9 facing the air inlet hood 2 is flush with the rear wall of the ventilation cabinet 1, the cleaning plate 7 is in sliding contact with an end face of the dust filter screen 9, facilitating cleaning of the dust filter screen 9 and preventing dust accumulation on the dust filter screen 9; meanwhile, the cleaning shaft 5 is supported between the end face of the air inlet hood 2 and the dust filter screen 9, and the cleaning motor 10 is installed on the end face of the air inlet hood 2 as cleaning power for cleaning the air inlet hood 2. As a further optimized solution, the cleaning plate 7 includes a skeleton 11 fixedly connected to the cleaning plate 7, a flexible scraper 12 is fixedly connected to a side of the skeleton 11 facing the air inlet hood 2, and the flexible scraper 12 is in sliding contact with the air inlet hood 2. The hard skeleton 11 is fixedly connected to the cleaning rod 6 and the cleaning shaft 5 to prevent deformation, while the flexible scraper 12 fixedly connected to the skeleton 11 is used to clean the inner wall of the air inlet hood 2, improving cleaning efficiency and simultaneously reducing damage to the air inlet hood 2 and the dust filter screen 9. As a further optimized solution, a cone-shaped dust outlet hole 13 is opened at a bottom end of the air inlet hood 2, a control block 14 is slidably arranged in the dust outlet hole 13, a top end of the control block 14 extends into the air inlet hood 2 and is in sliding contact with the flexible scraper 12; a telescopic rod 15 is fixedly connected to a bottom end of the control block 14, a bottom end of the telescopic rod 15 is fixedly connected to a support plate 16 arranged in the dust outlet hole 13, a support spring 17 in a compressed state is sleeved outside the telescopic rod 15, and two ends of the support spring 17 are respectively fixedly connected between the support plate 16 and the control block 14. The dust outlet hole 13 is designed in a cone shape, with the small diameter end of the cone facing the inner cavity of the air inlet hood 2, the top end of the control block 14 extends into the air inlet hood 2, supported by the telescopic rod 15 and the support spring 17, when the flexible scraper 12 passes through the dust outlet hole 13, the flexible scraper 12 presses the control block 14 into the dust outlet hole 13, creating a gap between the control block 14 and the dust outlet hole 13, facilitating discharge of collected dust and impurities from the dust outlet hole 13. Further, a dust collection box 41 is detachably connected to the bottom end of the air inlet hood 2 through a limit hook 44, the dust collection box 41 is arranged at the bottom end of the dust outlet hole 13, facilitating collection of discharged dust. As a further optimized solution, the air outlet assembly includes a connecting air duct 18 arranged on an outer wall of the ventilation cabinet 1, the connecting air duct 18 is arranged corresponding to and connected with the air outlet hole 8; an end of the con-

necting air duct 18 away from the ventilation cabinet 1 is connected to an inlet of an exhaust fan 19, and an outlet of the exhaust fan 19 is connected to an air outlet channel 20 of the laboratory. The connecting air duct 18 is arranged corresponding to the air outlet hole 8, serving as a mounting seat for the exhaust fan 19, the exhaust fan 19 serves as power for exhaust, pouring dirty air in the ventilation cabinet 1 into the exhaust channel, facilitating air exchange. As a further optimized solution, a waste liquid pool 21 is arranged on the workbench 4, a bottom end of the waste liquid pool 21 is connected to a waste liquid pipe 22, and the waste liquid pipe 22 is connected to an inlet of a waste liquid tank 23 detachably connected to the bottom end of the ventilation cabinet 1. As a further optimized solution, a limit groove 24 is opened at a bottom end of the inner cavity of the ventilation cabinet 1, a limit block 25 at the bottom end of the waste liquid tank 23 is slidably connected in the limit groove 24; a positioning assembly is arranged in the limit groove 24, and the positioning assembly is limit-connected to the waste liquid tank 23. The waste liquid pool 21 is used to collect waste liquid generated by the experiment, which is discharged into the waste liquid tank 23 through the waste liquid pipe 22 for collection, facilitating subsequent processing and improving the experimental environment of the ventilation cabinet 1. Further, the waste liquid pipe 22 and the inlet of the waste liquid tank 23 are connected through a quick connector, facilitating recovery and processing of waste liquid in the waste liquid pool 21. Further, the waste liquid pipe 22 is made of a spring tube, facilitating connection between the waste liquid pipe 22 and the waste liquid tank 23. The waste liquid tank 23 is limit-slidably arranged in the limit groove 24 through the limit block 25 at the bottom end, realizing limitation of the waste liquid tank 23; while the positioning assembly arranged in the limit groove 24 is used to automatically fix the waste liquid pool 21, preventing shaking during the experiment. Further, the positioning assembly includes an ejection hole 35 opened at an end of the limit groove 24, an ejection spring 36 is fixed in the ejection hole 35, the ejection spring 36 extends out of the ejection hole 35 and is fixedly connected to an ejection plate 37, and the ejection plate 37 abuts against an inner wall of the waste liquid tank 23, facilitating positioning of the waste liquid pool 21 and simultaneously facilitating ejection of the waste liquid tank 23 for recovery of internal waste liquid. Further, the positioning assembly further includes a relief groove 38 opened at a bottom end of the limit groove 24, a limit plate 39 is installed in the relief groove 38 through a torsion spring 40, the limit plate 39 extends out of the relief groove 38 in a free state, fixing the waste liquid pool 21 between the limit plate 39 and the ejection plate 37; when it is necessary to take out the waste liquid pool 21, the waste liquid pool 21 is first disconnected from the waste liquid pipe 22, then the limit plate 39 is pressed back into the relief groove 38, and the ejection spring 36 resets to eject the waste liquid pool 21 through the ejection plate 37. Further, a plurality of rolling balls are arranged be-

tween an outer wall of the limit block 25 and the limit groove 24, reducing resistance to movement of the waste liquid pool 21. As a further optimized solution, a plurality of lifting rods 26 are fixedly connected to a bottom end of the workbench 4, and bottom ends of the lifting rods 26 are fixedly installed at a bottom end of the inner cavity of the ventilation cabinet 1; a plurality of guide blocks 27 are fixedly connected to a side wall of the workbench 4, and the guide blocks 27 are slidably connected to guide grooves 28 opened on an inner wall of the ventilation cabinet 1. The lifting rods 26 are used to drive the workbench 4 to lift, facilitating work by different experimental personnel; the design of the guide blocks 27 and the guide grooves 28 increases lifting stability of the workbench 4. Further, a movably designed faucet 34 is arranged on the workbench 4, used to provide water for experiments and simultaneously facilitate cleaning of the workbench 4 and the waste liquid pool 21. As a further optimized solution, the sealing assembly includes an air distribution cavity 29 opened in the workbench, the air distribution cavity 29 is connected to a fresh air system of the outside world; the air distribution cavity 29 is connected to an air outlet head 30 arranged on the workbench 4, and the air outlet head 30 faces the top end of the inner cavity of the ventilation cabinet 1 and is arranged at equal intervals. The air distribution cavity 29 is designed inside the workbench 4, connected to the fresh air system of the outside world to provide fresh air or specific gases, and then sprayed upward through the air outlet head 30 to form an air curtain, which not only prevents leakage of internal dirty air but also provides fresh air to the ventilation cabinet 1, ensuring normal air circulation.

[0048] As shown in Figs. 27 to 30, in a fifth optional embodiment of the present disclosure, an automatic production fixture for a prefabricated building is provided, including: a base 1, two clamping apparatus are movably arranged on the base 1, and the two clamping apparatus are arranged symmetrically front and back; the clamping apparatus includes an arc-shaped deflection block 29, the arc-shaped deflection block 29 is rotatably arranged on the base 1, two clamping assemblies used to clamp an air duct are fixedly connected to a top of the arc-shaped deflection block 29, the two clamping assemblies are arranged symmetrically left and right, and the arc-shaped deflection block 29 is transmission-connected to a driving part; the clamping assembly is coaxially arranged with the arc-shaped deflection block 29; after four clamping assemblies clamp the air duct, the air duct can be driven to rotate around an axis of the arc-shaped deflection block 29. During use, the air duct to be welded is clamped on the base 1 through the four clamping assemblies, and a welding robot welds the seam of the air duct, when welding reaches the bottom of the air duct, due to limitations on the activity range of the welding robot itself, it cannot accurately weld the bottom seam of the air duct, at this point, the arc-shaped deflection block 29 is driven by the driving part to rotate relative to the base 1, causing the bottom of the air duct to rotate to one side, exposing the

bottom of the air duct to facilitate the welding robot to weld the bottom seam of the air duct. As a further optimized solution, the clamping assembly includes a fixture support 2, the fixture support 2 is fixedly connected to one end of the top of the arc-shaped deflection block 29, an arc-shaped slide groove 6 is opened on the fixture support 2, an arc-shaped slide block 3 is slidably matched with the arc-shaped slide groove 6, and the arc-shaped slide block 3 is coaxially arranged with the arc-shaped deflection block 29; the arc-shaped slide block 3 is transmission-connected to a second driving part, and the second driving part is arranged inside the fixture support 2; a support arm 8 is fixedly connected to the arc-shaped slide block 3, and two ends of the support arm 8 are respectively fixedly connected to two ends of the arc-shaped slide block 3; an air duct fixing part is arranged on the support arm 8. As a further optimized solution, the air duct fixing part includes a support plate 18, the support plate 18 is fixedly connected to one side of the bottom of the support arm 8, a horizontal clamping part is provided on a top of the support plate 18, and a vertical clamping part is provided above the support plate 18. As a further optimized solution, the vertical clamping part includes a sliding plate 31, the sliding plate 31 is slidably connected to the support arm 8 through a slide way 9 vertically arranged on the support arm 8, a rotating clamping part is provided on a side of the sliding plate 31 away from the slide way 9, a threaded rod 10 is threadedly connected to a side of the sliding plate 31 close to the slide way 9; a bottom of the threaded rod 10 is rotatably connected to the support plate 18, a slide rod 11 is fixedly connected to the support plate 18, the slide rod 11 is located on one side of the threaded rod 10, and the slide rod 11 is slidably connected to the sliding plate 31; the threaded rod 10 is transmission-connected to a third driving part. As a further optimized solution, the third driving part includes a fourth motor 25, a fixed end of the fourth motor 25 is fixedly connected to the bottom of the support plate 18, and an output shaft of the fourth motor 25 is axially connected to the threaded rod 10. As a further optimized solution, the rotating clamping part includes a rotating plate 13, one side of the rotating plate 13 is rotatably connected to a side of the sliding plate 31 away from the slide way 9 through a rotating shaft 17, one end of the rotating shaft 17 is axially connected to a first bevel gear 14, the first bevel gear 14 meshes with a second bevel gear 16, an output shaft of a second motor 15 is axially connected to the second bevel gear 16, and a fixed end of the second motor 15 is fixed on the sliding plate 31 through a motor seat 12. As a further optimized solution, the horizontal clamping part includes a clamping plate 19, the clamping plate 19 is horizontally slidably arranged on the support plate 18 through a slide groove 21, a through activity groove 22 is opened in a middle part of the support plate 18, the activity groove 22 is connected to the slide groove 21, a threaded slide block 20 is horizontally slidably arranged in the activity groove 22, and the threaded slide block 20 is fixedly connected to the clamp-

ing plate 19; two ends of a bidirectional threaded rod 23 are threadedly connected to two threaded slide blocks 20 located on the same arc-shaped deflection block 29, the bidirectional threaded rod 23 is rotatably arranged on the same side of two support plates 18, an output shaft of a third motor 24 is axially connected to any end of the bidirectional threaded rod 23, and a fixed end of the third motor 24 is fixedly connected to the corresponding support plate 18. When clamping the air duct, firstly, the second motor 15 drives the second bevel gear 16 to rotate, the second bevel gear 16 drives the first bevel gear 14 to rotate, the first bevel gear 14 drives the rotating shaft 17 to rotate, when the rotating shaft 17 rotates, it can drive the rotating plate 13 to rotate together, enabling the rotating plate 13 to switch between a vertical state and a horizontal state, when the rotating plate 13 is in a vertical state, the air duct can be vertically placed on the support plate 18, subsequently the second motor 15 drives the rotating plate 13 to switch to a horizontal state, after the bottom of the air duct is placed on the support plate 18, the bidirectional threaded rod 23 is driven to rotate by starting the third motor 24, two threaded slide blocks 20 are symmetrically arranged on the bidirectional threaded rod 23, when the bidirectional threaded rod 23 rotates, the two threaded slide blocks 20 can move relatively simultaneously, the two threaded slide blocks 20 approach each other, driving the two clamping plates 19 to clamp the bottom of the air duct, subsequently the fourth motor 25 is started to drive the threaded rod 10 to rotate, the threaded rod 10 rotates to cause the sliding plate 31 to slide vertically along the slide way 9 through thread action, the arrangement of the slide rod 11 can cooperate with the threaded rod 10 to restrict rotation of the sliding plate 31, thereby causing the rotating plate 13 to contact and clamp the top of the air duct, at this point the air duct is in a completely fixed state. As a further optimized solution, the second driving part includes a gear 4, the gear 4 is arranged in a gear slot 7 opened in a middle part of the fixture support 2, the gear 4 is rotatably connected to an inner wall of the gear slot 7, an outer wall of the gear 4 meshes with an inner wall of the arc-shaped slide block 3, an output shaft of a first motor 5 is axially connected to the gear 4, and a fixed end of the first motor 5 is fixedly connected to the fixture support 2. As a further optimized solution, the driving part includes a second gear 27, the second gear 27 is rotatably arranged in a slot 30 opened in the base 1, the second gear 27 meshes with an arc-shaped tooth wall 28, the arc-shaped tooth wall 28 is coaxially fixedly connected to an outer side of the arc-shaped deflection block 29, the arc-shaped deflection block 29 is rotatably connected to the base 1, an output shaft of a fifth motor 26 is axially connected to the second gear 27, and a fixed end of the fifth motor 26 is fixedly connected to an inner wall of the slot 30. During use, the second gear 27 is driven to rotate by the fifth motor 26, since the second gear 27 meshes with the arc-shaped tooth wall 28, and the arc-shaped tooth wall 28 is coaxially fixedly connected to the outer side of the arc-shaped

deflection block 29, the second gear 27 can cause the arc-shaped deflection block 29 to rotate on the base 1 through the arc-shaped tooth wall 28, thereby driving the two fixture supports 2 to rotate simultaneously, when the two arc-shaped deflection blocks 29 front and back rotate simultaneously, the air duct clamped on the fixture support 2 can rotate, exposing the bottom seam of the air duct, subsequently, to further increase the rotation angle of the air duct, by starting the first motor 5 at this point, the gear 4 can be driven by the first motor 5 to rotate, since the gear 4 meshes with the arc-shaped slide block 3, the arc-shaped slide block 3 can slide in the arc-shaped slide groove 6 opened on the fixture support 2. The arc-shaped deflection block 29 and the two arc-shaped slide blocks 3 on the same clamping apparatus are all coaxially arranged, causing all three to rotate with the same center when rotating, thereby enabling the air duct to rotate around the common center of the arc-shaped deflection block 29 and the two arc-shaped slide blocks 3. Thus, the rotation angle of the air duct is increased, enabling full exposure of the bottom seam of the air duct.

[0049] As shown in Figs. 31 to 34, in a sixth optional embodiment of the present disclosure, an automatic pipeline welding apparatus is provided, including a bottom plate 1, a guide rail 2 is opened on an upper surface of the bottom plate 1, a guide block 18 is slidably connected inside the guide rail 2, an electric push rod 13 is fixedly installed on an inner wall of the guide rail 2, a stabilization plate 5 is fixedly installed on a back surface of the bottom plate 1, a welding mechanism 7 is fixedly installed on an upper surface of the stabilization plate 5, by arranging the stabilization plate 5 and the welding mechanism 7, the purpose of welding pipelines is realized, guaranteeing welding effects. A telescopic end of the electric push rod 13 is fixedly connected to a left side surface of the guide block 18, support plates 9 are fixedly installed on both the upper surface of the bottom plate 1 and the upper surface of the guide block 18, reinforcement plates 6 are fixedly installed on two side surfaces of the welding mechanism 7, a bottom surface of each of the reinforcement plates 6 is fixedly connected to the upper surface of the stabilization plate 5, by arranging the reinforcement plate 6, the purpose of reinforcing the position of the welding mechanism 7 is realized, achieving a good working effect of the welding mechanism 7, and the problem of position change occurring when the welding mechanism 7 is working is avoided to the fullest extent. Slide grooves 19 are opened on both side surfaces of the two support plates 9 facing each other, a slide block 16 is slidably connected inside each of the slide grooves 19, a first connecting plate 11 is fixedly installed on side surfaces of the two slide blocks 16 facing each other, two reinforcement plates 4 are fixedly installed on both side surfaces of the two support plates 9 facing away from each other, side surfaces of the two groups of reinforcement plates 4 facing each other are respectively fixedly connected to two side surfaces of the bottom plate 1, by arranging the reinforcement plate 4, the purpose of strengthening and

stabilizing the connection position of the support plate 9 is realized, achieving an effect of improved stability of the support plate 9, and the problem of tilting occurring when the support plate 9 is performing support work is avoided to the fullest extent. Second connecting plates 10 are fixedly installed on both side surfaces of the two support plates 9 facing each other, connecting columns 15 are fixedly installed on an upper surface of each first connecting plate 11 and a bottom surface of the second connecting plate 10, two fastening blocks 14 are fixedly installed on an outer surface of the electric push rod 13, a left side surface of each fastening block 14 is fixedly connected to the inner wall of the guide rail 2, by arranging the fastening block 14, the purpose of fastening the connection position of the electric push rod 13 is realized, achieving a good working effect of the electric push rod 13, and the problem of position movement occurring during the working process of the electric push rod 13 is avoided to the fullest extent. A clamping ring 17 is fixedly installed on both side surfaces of each group of connecting columns 15 facing each other, two clamping springs 12 are fixedly installed on a bottom surface of each of the first connecting plates 11, reinforcement blocks 8 are fixedly installed on an upper surface of each of the second connecting plates 10, side surfaces of the two reinforcement blocks 8 facing away from each other are respectively fixedly connected to side surfaces of the two support plates 9 facing each other, by arranging the reinforcement block 8, the purpose of reinforcing the connection position of the second connecting plate 10 is realized, achieving an effect of improved load-bearing capacity of the second connecting plate 10, and the problem of falling occurring when the load-bearing capacity of the second connecting plate 10 increases is avoided to the fullest extent. Bottom ends of the two groups of clamping springs 12 are respectively fixedly connected to the upper surface of the guide block 18 and the upper surface of the bottom plate 1, a blocking block 3 is fixedly installed on a right side surface of the bottom plate 1, a left side surface of the blocking block 3 is in contact with a right side surface of the guide block 18, by arranging the blocking block 3, the purpose of blocking the movement position of the guide block 18 is realized, guaranteeing a good sliding effect of the guide block 18, and the problem of the guide block 18 sliding out of the bottom plate 1 occurring during the sliding process is avoided to the fullest extent.

[0050] The working principle of the present disclosure is: during use, staff first connect the electric push rod 13 and the welding mechanism 7 to a power source, after connection, the staff needs to place pipelines to be welded into two groups of clamping rings 17 respectively, and during the placement process, contracting and extending force can be provided by the clamping springs 12 to drive the first connecting plate 11 to move under the trajectory provided by the slide groove 19 in cooperation with the slide block 16, the connecting column 15 can be driven to move through movement of the first connecting

plate 11, the clamping ring 17 can be driven to move through movement of the connecting column 15, changing in the size between each group of clamping rings 17 can be realized through movement of the clamping ring 17, enabling clamping of pipelines of different volumes, after clamping, under the power provided by the electric push rod 13, the guide block 18 can be moved in the trajectory provided by the guide rail 2, one of the support plates 9 can be driven to move through movement of the guide block 18, one of the first connecting plate 11 and the second connecting plate 10 can be driven to move through movement of the support plate 9, the clamping ring 17 can be driven to move through movement of the first connecting plate 11 and the second connecting plate 10 in cooperation with the connecting column 15, enabling contact between two pipelines to be welded, then under the function of the welding mechanism 7 itself, the purpose of welding the contact point of the two pipelines can be achieved, thereby achieving the effect of welding pipelines of different volumes and different lengths.

[0051] As shown in Figs. 35 to 38, in a seventh optional embodiment of the present disclosure, a positioning structure for an air duct assembly is provided, including: a connecting plate 1, a first U-shaped frame 2 and a second U-shaped frame 13 are respectively hinged to a top surface of the connecting plate 1 through two hinged seats 18, the first U-shaped frame 2 and the second U-shaped frame 13 are respectively located at two ends of the connecting plate 1, openings of the first U-shaped frame 2 and the second U-shaped frame 13 are arranged on the same side, a first limiting part is arranged between the first U-shaped frame 2 and the connecting plate 1, a second limiting part is arranged between the second U-shaped frame 13 and the connecting plate 1, a first fixing part used to fix the air duct assembly is arranged inside the first U-shaped frame 2, a second fixing part used to fix the air duct assembly is arranged inside the second U-shaped frame 13, and a moving assembly is arranged on the second fixing part. When using the present disclosure, firstly the first U-shaped frame 2 is sleeved on one end of the installed air duct assembly, and the first U-shaped frame 2 is fixed to the air duct assembly through the first fixing part, then the second U-shaped frame 13 is sleeved on an end of the air duct assembly to be installed, and the second U-shaped frame 13 is fixed to the air duct assembly to be installed through the second fixing part, then the air duct assembly to be installed is uplifted, the first U-shaped frame 2 and the second U-shaped frame 13 are in a horizontal state under the action of the first limiting part and the second limiting part, at this point the second limiting mechanism is relaxed, the air duct assembly to be installed is moved to dock with the installed air duct assembly, the two air duct assemblies are fixedly connected, and the apparatus can be disassembled. As a further optimized solution, the first limiting part includes a first slide groove 24 opened on the connecting plate 1, an elastic assembly is arranged in the first slide groove 24, a movable end of the elastic assembly is fixedly connected

to a first fixed hook 8, the first fixed hook 8 is slidably connected in the first slide groove 24, two slide blocks 11 are fixedly connected to the first fixed hook 8, the two slide blocks 11 are respectively slidably connected to the top surface and the bottom surface of the connecting plate 1, a hook end of the first fixed hook 8 is arranged corresponding to the first U-shaped frame 2, a slope is opened at a top end of the first fixed hook 8, the slope faces the first U-shaped frame 2, a bottom end of the first fixed hook 8 penetrates through the slide block 11 and is fixedly connected to a handle 19; the second limiting part has the same structure as the first limiting part. Two first slide grooves 24 are opened on the connecting plate 1, the second limiting part includes a sleeve 9 fixedly connected to a side wall of the first slide groove 24 away from the second U-shaped frame 13, a first spring 25 is disposed within the sleeve 9, one end of the first spring 25 is fixedly connected to an inner side wall of the first slide groove 24, the other end of the first spring 25 is fixedly connected to a slide rod 10, the slide rod 10 is slidably connected in the sleeve 9, one end of the slide rod 10 penetrates through the sleeve 9 and is fixedly connected to the first fixed hook 8, and the first fixed hook 8 is arranged corresponding to the second U-shaped frame 13. After the two air duct assemblies are respectively fixed to the second U-shaped frame 13 and the first U-shaped frame 2, the air duct assembly to be installed is uplifted, at this point the second U-shaped frame 13, the first U-shaped frame 2, and the connecting plate 1 all rotate, the second U-shaped frame 13 and the first U-shaped frame 2 respectively abut against the slope of the first fixed hook 8, thereby pushing the first fixed hook 8 to move in the first slide groove 24, when the second U-shaped frame 13 and the first U-shaped frame 2 detach from the slope, at this point the two first fixed hooks 8 respectively hook onto the second U-shaped frame 13 and the first U-shaped frame 2, thereby causing axes of the second U-shaped frame 13 and the first U-shaped frame 2 to coincide. As a further optimized solution, the elastic assembly includes a sleeve 9 fixedly connected to a side wall of the first slide groove 24, the sleeve 9 is horizontally arranged, the sleeve 9 is located on a side of the first slide groove 24 away from the first U-shaped frame 2, a first spring 25 is disposed within the sleeve 9, one end of the first spring 25 is fixedly connected to an inner side wall of the first slide groove 24, the other end of the first spring 25 is fixedly connected to a slide rod 10, the slide rod 10 is slidably connected in the sleeve 9, one end of the slide rod 10 penetrates through the sleeve 9 and is fixedly connected to the first fixed hook 8. The first spring 25 pushes the first fixed hook 8 close to the second U-shaped frame 13/first U-shaped frame 2 through the slide rod 10. As a further optimized solution, the first fixing part includes a first screw rod 3 threadedly connected to a bottom wall of the first U-shaped frame 2, a bottom end of the first screw rod 3 penetrates through the first U-shaped frame 2 and is coaxially fixedly connected to a first handle 4, a top end of the first screw rod 3 penetrates into the first

U-shaped frame 2 and is rotatably connected to a first top block 5, and the first top block 5 is vertically slidably connected in the first U-shaped frame 2. The first top block 5 is pushed upward by rotating the first handle 4, thereby clamping the air duct assembly. As a further optimized solution, the second fixing part includes a second screw rod 20 threadedly connected to a bottom wall of the second U-shaped frame 13, a bottom end of the second screw rod 20 penetrates through the second U-shaped frame 13 and is coaxially fixedly connected to a second handle 12, a top end of the second screw rod 20 penetrates through the second U-shaped frame 13 and is rotatably connected to a lower mounting plate 14, an upper mounting plate 15 is fixedly connected to a top end of the lower mounting plate 14, and the lower mounting plate 14 and the upper mounting plate 15 are both vertically slidably connected in the second U-shaped frame 13. The lower mounting plate 14 and the upper mounting plate 15 are pushed upward by rotating the second handle 12, thereby clamping and fixing the air duct assembly. As a further optimized solution, the moving assembly includes a plurality of placement grooves 26 opened on a top surface of the lower mounting plate 14, the plurality of placement grooves 26 are distributed in an array, a plurality of through grooves 27 are opened on the upper mounting plate 15, the plurality of through grooves 27 are distributed in an array, cross-sections of the placement groove 26 and the through groove 27 are the same, and the placement groove 26 and the through groove 27 are arranged in one-to-one correspondence; second slide grooves 28 arranged vertically are opened on two opposite side walls of the through groove 27, a shaft seat 32 is vertically slidably connected in the second slide groove 28, a top end of a second spring 31 is fixedly connected to a bottom end of the shaft seat 32, a bottom end of the second spring 31 is fixedly connected to a bottom wall of the second slide groove 28, a first short shaft 29 is rotatably connected to the shaft seat 32, a first roller 17 is fixedly connected between the two first short shafts 29, and a rotation direction of the first roller 17 is a movement direction of the air duct assembly. The lower mounting plate 14 and the upper mounting plate 15 are pushed upward by rotating the second handle 12 until the upper mounting plate 15 abuts against the air duct assembly, at this point the air duct assembly is fixed to the second U-shaped frame 13; the second handle 12 is reversed, the upper mounting plate 15 separates from the air duct assembly, at this point the first roller 17 continues to exert force on the air duct assembly under the action of the second spring 31, the air duct assembly can slide in the second U-shaped frame 13 under the action of the first roller 17, docking with the installed air duct assembly. As a further optimized solution, a first frosted layer 6 is bonded to a top surface of the first top block 5, and a second frosted layer 7 is arranged above the first frosted layer 6, the second frosted layer 7 is fixedly connected to an inner top wall of the first U-shaped frame 2. By arranging the first frosted layer 6 and the

second frosted layer 7, friction between the first U-shaped frame 2 and the air duct assembly is increased, and hard contact between the first U-shaped frame 2 and the air duct assembly is avoided. As a further optimized solution, a plurality of mounting holes are opened on an inner top wall of the second U-shaped frame 13, the plurality of mounting holes are distributed in an array, a second roller 21 is rotatably connected in the mounting hole through a second short shaft 30, a bottom end of the second roller 21 extends out of the mounting hole, and a rotation direction of the second roller 21 is the movement direction of the air duct assembly. Such arrangement further increases smoothness of sliding of the air duct assembly in the second U-shaped frame 13. As a further optimized solution, a third frosted layer 16 is bonded to a top surface of the upper mounting plate 15. Friction between the second U-shaped frame 13 and the air duct assembly is increased. As a further optimized solution, a first friction ring 22 is sleeved on an outer edge of the first roller 17, and a second friction ring 23 is sleeved on an outer edge of the second roller 21. Lateral movement of the air duct assembly to be installed is avoided, causing misalignment of the two air duct assemblies.

[0052] As shown in Figs. 39 to 45, in an eighth embodiment of the present disclosure, a transfer apparatus for an air duct assembly is provided, including: a conveyor line 1, arranged at an output end of a folding machine 2; a support frame, including a first plate body 4 located above an air duct 3, and a second plate body 5 connected to the conveyor line 1, the first plate body 4 and the second plate body 5 are fixed. The first plate body 4 and the second plate body 5 are fixed, therefore the conveyor line 1 synchronously moves the first plate body 4 while conveying the second plate body 5. An adsorption unit 6, arranged on the second plate body 5, an adsorption end of the adsorption unit 6 is configured to adsorb a side wall of the air duct 3 away from the folding machine 2; a squeezing unit 7, arranged on the first plate body 4, the squeezing unit 7 includes a squeezing roller 701 moving in a vertical direction, and the squeezing roller 701 is configured to squeeze a side wall of the air duct 3 close to the folding machine 2, so that the air duct 3 is located between the squeezing roller 701 and the adsorption unit 6. Specifically, in actual production processes, protruding connection ends exist on two sides of the pipe body, these connection ends are used to connect with other air ducts 3 during actual assembly, but these connection ends affect conveyance of the air duct 3, therefore the adsorption unit 6 is utilized to adsorb the side wall of the air duct 3, realizing transfer of the air duct 3. Meanwhile, the air duct 3 produced by the folding machine 2 has two unconnected side walls, that is, a gap exists between the side wall of the air duct 3 close to the folding machine 2 and the side wall located below, since the air duct 3 is formed by bending a single plate, during the transfer process, the side wall of the air duct 3 close to the folding machine 2 and the side wall located below have a tendency to separate, therefore the squeezing

unit 7 is arranged, and the squeezing roller 701 is utilized to squeeze the side wall of the air duct 3 close to the folding machine 2, causing the two side walls to contact for convenient transfer. In this embodiment, referring to Figs. 39 and 42, the apparatus further includes: a negative pressure provider 8, fixed on the second plate body 5; a first conduit 9, connecting an air intake end of the negative pressure provider 8 to an air outlet end of the squeezing unit 7, so as to cause the squeezing roller 701 to move downward; a second conduit 10, connecting an air intake end of the squeezing unit 7 to an air outlet end of the adsorption unit 6, so as to fix the adsorption end of the adsorption unit 6 to the side wall of the air duct 3. Specifically, the negative pressure provider 8 is used to extract air and provide negative pressure, the adsorption unit 6 and the squeezing unit 7 adopt one negative pressure provider 8, when the negative pressure provider 8 works, firstly air is extracted from inside the squeezing unit 7 through the first conduit 9, causing the squeezing roller 701 inside the squeezing unit 7 to move downward to squeeze the side wall of the air duct 3, and simultaneously since the inside of the squeezing unit 7 is connected to the adsorption unit 6 through the second conduit 10, causing the adsorption unit 6 to generate adsorption force, realizing fixation of the adsorption unit 6 to the side wall of the air duct 3. In the above structure, on one hand, squeezing of the air duct 3 by the squeezing roller 701 and adsorption of the air duct 3 by the adsorption unit 6 can be realized through one negative pressure provider 8. On the other hand, when the negative pressure provider 8 starts working, the squeezing roller 701 first moves downward, and during the process of squeezing the air duct 3, it can push the air duct 3 towards the direction of the adsorption unit 6, thereby facilitating adsorption of the air duct 3 by the adsorption unit 6. The negative pressure provider 8 is one type of vacuum pump or air extraction pump. In this embodiment, referring to Figs. 39, 42, and 43, the squeezing unit 7 includes: a sleeve 702, sealed at two ends and connected to the first plate body 4, a piston 703 is slidably matched inside the sleeve 702, an air intake end of the first conduit 9 and an air outlet end of the second conduit 10 are both arranged below the piston 703; a T-shaped rod 704, a vertical end extends into the sleeve 702 and is fixed to the piston 703, a horizontal end extends out of the sleeve 702 and is located below the sleeve 702, a squeezing roller 701 is sleeved on two sides of the horizontal end of the T-shaped rod 704, and the squeezing roller 701 is rotatably connected to the horizontal end of the T-shaped rod 704. Specifically, when the negative pressure provider 8 works, gas inside the sleeve 702 is extracted, causing the piston 703 to move downward, the piston 703 drives the T-shaped rod 704 to move downward, thereby driving the squeezing roller 701 to move downward is realized, the squeezing roller 701 is utilized to squeeze the air duct 3 and push the air duct 3 towards the direction of the adsorption unit 6, and under the action of the second conduit 10, causing the adsorption unit 6 to generate

adsorption force. The first conduit 9 is located above the second conduit 10. Since the squeezing roller 701 can rotate relative to the T-shaped rod 704, and the squeezing roller 701 has a columnar structure, the squeezing roller 701 does not cause scratches on the surface of the air duct 3 during the downward movement process. In this embodiment, referring to Fig. 43, the apparatus further includes a limit plate 705, fixed on an inner wall of the sleeve 702, and located between the piston 703 and the first conduit 9, the limit plate 705 is configured to limit the piston 703. Specifically, the limit plate 705 is used to limit the piston 703, so that after the piston 703 moves downward, it always remains above the first conduit 9, when the piston 703 is limited by the limit plate 705 and cannot move, the negative pressure provider 8 can only extract air from the adsorption unit 6 through the sleeve 702 and the second conduit 10. In this embodiment, referring to Fig. 43, the apparatus further includes a reset spring 706, arranged inside the sleeve 702, and two ends are respectively fixed to a top end of the piston 703 and an inner wall of a top end of the sleeve 702. Specifically, after the air duct 3 is sent to a predetermined position for unloading, the negative pressure provider 8 is turned off or supplies air in the reverse direction into the sleeve 702, causing the piston 703 to move upward, the piston 703 drives the squeezing roller 701 to move upward, causing the squeezing roller 701 to move above the air duct 3, and the adsorption unit 6 separates from the air duct 3. By arranging the reset spring 706 inside the sleeve 702, when the piston 703 moves downward, the reset spring 706 is stretched, when the piston 703 moves upward, the reset spring 706 contracts, the reset spring 706 can assist the piston 703 to move upward, increasing the upward movement speed of the piston 703. In this embodiment, referring to Figs. 42 and 43, the adsorption unit 6 includes: a pair of suction cups 601, fixed on the second plate body 5; a communication pipe 602, two air intake ends are respectively connected to air outlet ends of the pair of suction cups 601, and an air outlet end of the communication pipe 602 is connected to the air intake end of the squeezing unit 7. Specifically, the suction cup 601 is used to adsorb onto an outer wall of the air duct 3, realizing detachable connection between the air duct 3 and the second plate body 5, the communication pipe 602 is connected to the second conduit 10, and the negative pressure provider 8 acts on the suction cup 601 through the sleeve 702, the second conduit 10, and the communication pipe 602. In this embodiment, referring to Figs. 42 and 44, the apparatus further includes an L-shaped connecting plate 11, one end is fixed to the first plate body 4, the other end is connected to a distance adjustment bolt 12, a plurality of mounting holes 13 are opened from bottom to top on a side wall of the second plate body 5, an end of the distance adjustment bolt 12 is configured to extend into one of the mounting holes 13, and the first plate body 4 and the second plate body 5 are detachably connected through the L-shaped connecting plate 11. Specifically, by arranging the L-shaped connecting plate

11 and cooperating with the distance adjustment bolt 12 and the mounting hole 13, detachable connection between the first plate body 4 and the second plate body 5 is realized, and simultaneously, the height of the first plate body 4 relative to the conveyor line 1 can be adjusted through the L-shaped connecting plate 11 according to the actual size of the air duct 3. In this embodiment, referring to Figs. 40, 41, 42, and 43, a slide groove 14 is opened on the first plate body 4, a slide block 20 is slidably connected in the slide groove 14, the squeezing unit 7 is fixed on the slide block 20; a threaded rod 15 is rotatably connected to an end of the slide block 20 away from the squeezing unit 7, the other end of the threaded rod 15 extends into the first plate body 4 and is threadedly connected to the first plate body 4, and a drive rotating ring 16 is sleeved and fixed on the threaded rod 15. Specifically, the sleeve 702 is fixed on the slide block 20, by rotating the threaded rod 15 through the drive rotating ring 16, the threaded rod 15 drives the slide block 20 to move on the first plate body 4, thereby changing the horizontal positions of the sleeve 702 and the squeezing roller 701 to adapt to air ducts 3 of different sizes. In this embodiment, referring to Figs. 39 and 45, the conveyor line 1 includes a pair of brackets 17, a conveyor roller group 18 is connected to mutually approaching ends of the pair of brackets 17, and the conveyor roller group 18 is configured to convey the second plate body 5. Specifically, the conveyor roller group 18 is transmission-connected on the bracket 17, the conveyor roller group 18 is composed of a plurality of conveyor rollers, realizing movement of the second plate body 5 on the bracket 17, and the second plate body 5 is utilized to drive the air duct 3 that has been adsorbed and clamped to move on the bracket 17. Alternatively, the conveyor line 1 can be a conveyor belt, with the second plate body 5 fixed on the conveyor belt. Alternatively, the conveyor line 1 can be other types of conveyance structures, since the second plate body 5 is a regular structure, ordinary conveyance structures can realize conveyance of the second plate body 5. In this embodiment, referring to Fig. 45, the apparatus further includes a slide table 19, fixed on an end of the second plate body 5 away from the air duct 3, a bottom end of the slide table 19 penetrates through the pair of brackets 17, and the conveyor roller group 18 is transmission-connected to a side wall of the slide table 19. The slide table 19 is used to connect with the bracket 17, the slide table 19 is a T-shaped slide table, its vertical end passes between the two brackets 17 and is fixed to the second plate body 5, its two side walls contact the conveyor rollers and are driven to progress by utilizing the conveyor rollers, and its horizontal end is located below the two brackets 17. Specifically, the folding machine 2 bends a plate to form an air duct 3, after the second plate body 5 moves on the bracket 17 to the output end of the folding machine 2, the second plate body 5 corresponds to the side wall of the air duct 3, the first plate body 4 is located above the air duct 3, subsequently the negative pressure provider 8 is started, the negative pressure

provider 8 extracts air from inside the sleeve 702 through the first conduit 9, causing the piston 703 to drive the T-shaped rod 704 and the squeezing roller 701 to move downward, the squeezing roller 701 moves downward to squeeze the air duct 3 and drive the air duct 3 to move towards the direction of the second plate body 5, after the piston 703 moves downward a certain distance and is limited by the limit plate 705, the negative pressure provider 8 continues to work, extracting air from the suction cup 601 through the sleeve 702 and the second conduit 10, causing the suction cup 601 to adsorb onto the air duct 3, subsequently the conveyor roller group 18 works, driving the air duct 3 to move on the bracket 17 to a predetermined position. When moved to the predetermined position, the negative pressure provider 8 stops working or supplies air in the reverse direction, causing the piston 703 to drive the squeezing roller 701 to move upward and separate from the air duct 3, and simultaneously the suction cup 601 separates from the air duct 3.

[0053] As shown in Figs. 46 to 49, in a ninth embodiment of the present disclosure, an air duct assembly apparatus is provided, including: a frame 1, two positioning mechanisms are respectively arranged on two sides of an inner cavity of the frame 1, the two positioning mechanisms are transmission-connected to a transmission mechanism, so that the two positioning mechanisms slide towards or away from each other through the transmission mechanism; a gantry 2, fixedly connected to a top surface of the frame 1, a lifting mechanism is arranged inside the gantry 2, a steering mechanism is fixedly connected to a top surface of the lifting mechanism, a plurality of lifting mechanisms are fixedly connected to a top surface of the steering mechanism at equal intervals in a circumferential direction, and a limiting mechanism used to limit the air duct is fixedly connected to a top surface of the lifting mechanism. The frame 1 arranged is used to load the two positioning mechanisms and realize displacement of the entire apparatus, after reaching a designated position, the transmission mechanism arranged drives the two positioning mechanisms to extend and drive, contacting the ground and increasing contact area, enhancing stability during work, and guaranteeing personal safety of staff, after completing the support process of the air duct, the transmission mechanism drives the two positioning mechanisms to move towards each other until retracting into the frame 1, minimizing occupied area to the fullest extent, and enhancing flexibility during movement, the gantry 2 arranged is used to carry the lifting mechanism, driving the lifting mechanism to drive the limiting mechanism to rise until supporting the air duct, and enhancing adaptability, the steering mechanism arranged can drive the plurality of limiting mechanisms to rotate, enabling fine-tuning of position without moving the frame 1, enhancing flexibility during work, and further improving work efficiency, the lifting mechanism arranged can drive different limiting mechanisms to act on the air duct, adapting to air ducts of different shapes. As a further optimized solution,

the positioning mechanism includes: an extension plate 3, one end of a guide rod 4 is respectively fixedly connected to two ends of the extension plate 3, the other end of the guide rod 4 penetrates through a limit plate 22 and is fixedly connected to a vertical plate 5, a horizontal plate 6 is fixedly connected to a side surface of the vertical plate 5, a positioning cylinder 7 is fixedly connected to a top surface of the horizontal plate 6, and an output end of the positioning cylinder 7 penetrates through the horizontal plate 6 and is fixedly connected to a positioning plate 8; the two extension plates 3 are transmission-connected to the transmission mechanism. The extension plate 3 arranged is used to connect the guide rod 4, thereby realizing transmission through the transmission mechanism, after the transmission mechanism drives the two positioning mechanisms to extend outward, the positioning cylinder 7 is driven to drive the positioning plate 8 to move downward, and after contacting the ground, the entire apparatus is driven to detach from the ground, thereby realizing positioning of the entire apparatus. As a further optimized solution, the transmission mechanism includes: a transmission motor 9, fixedly connected to one of the limit plates 22, one end of a bidirectional screw rod 10 is fixedly connected to an output end of the transmission motor 9, the other end of the bidirectional screw rod 10 is rotatably connected to the other limit plate 22, and the bidirectional screw rod 10 penetrates through the two extension plates 3 and is threadedly connected to the two extension plates 3. The transmission motor 9 drives the bidirectional screw rod 10 to rotate, under the limiting action of the guide rod 4, driving the two extension plates 3 to move towards or away from each other, thereby realizing the overall extension or contraction action of the positioning mechanism. As a further optimized solution, the lifting mechanism includes: a lifting motor 11, the lifting motor 11 is fixedly connected to the top surface of the frame 1, one end of a lifting screw rod is fixedly connected to an output end of the lifting motor 11, the other end of the lifting screw rod is threadedly connected to a lifting cylinder 12, and a top of the lifting cylinder 12 penetrates through the gantry 2 and is fixedly connected to a bottom of the steering mechanism; one end of two lifting guide rods 13 is respectively fixedly connected to two sides of the bottom of the steering mechanism, and the other end of the lifting guide rod 13 penetrates through the gantry 2 and is fixedly connected to the top surface of the frame 1. The lifting motor 11 drives the lifting screw rod to rotate, under the limiting action of the lifting guide rod 13, driving the steering mechanism to lift. As a further optimized solution, the steering mechanism includes: a steering frame 14, arranged at the top of the gantry 2, and a bottom surface of the steering frame 14 is fixedly connected to the lifting guide rod 13 and the lifting cylinder 12, a steering motor 15 is arranged inside the steering frame 14, an output end of the steering motor 15 penetrates through the steering frame 14 and is fixedly connected to a steering disk 16, a bottom surface of the steering disk 16 is in sliding contact

with a top surface of the steering frame 14, and the plurality of lifting mechanisms are arranged on the top surface of the steering disk 16. The plurality of lifting mechanisms are arranged on the steering disk 16, by driving lifting mechanisms at different positions to lift, clamping and positioning matched with air ducts of different shapes are realized. As a further optimized solution, the lifting mechanism includes: a lifting frame 17, fixedly connected to the top surface of the steering disk 16, a lifting cylinder 18 is arranged inside the lifting frame 17, and an output end of the lifting cylinder 18 penetrates through the lifting frame 17 and is fixedly connected to a bottom of the limiting mechanism. As a further optimized solution, the limiting mechanism includes: an arc-shaped plate 19, a bottom surface of the arc-shaped plate 19 is fixedly connected to the output end of the lifting cylinder 18, and a concave surface of the arc-shaped plate 19 fits the air duct. As a further optimized solution, a rubber layer 20 is fixedly connected to a bottom surface of the positioning plate 8. The rubber layer 20 arranged can further enhance stability. As a further optimized solution, the frame 1 includes: a bottom plate 21, a limit plate 22 is respectively fixedly connected to two sides of a top surface of the bottom plate 21, and a top plate 23 is fixedly connected to the bottom plate 21 through the two limit plates 22. As a further optimized solution, pulleys 24 are respectively fixedly connected to four corners of a bottom surface of the bottom plate 21.

[0054] The above descriptions are merely preferred embodiments of the present disclosure and are not intended to limit the present disclosure. For those skilled in the art, various modifications and changes can be made to the present disclosure. Any modifications, equivalent replacements, improvements, etc., made within the spirit and principles of the present disclosure shall fall within the protection scope of the present disclosure.

Claims

1. A prefabricated building production line, comprising: an assembly conveyor line, wherein an assembly area, a testing area, and an inspection area are sequentially arranged along a conveying direction of the assembly conveyor line, the assembly conveyor line is used to convey a building unit body to be assembled, and a supply warehouse for the building unit body to be assembled is arranged at an end of the assembly conveyor line away from the inspection area; a functional module conveyor line, wherein the functional module conveyor line is arranged parallel to the assembly conveyor line, a plurality of functional module conveyor branch lines are arranged on a side of the functional module conveyor line away from the assembly conveyor line, both the functional module conveyor line and the functional module conveyor branch lines are used to convey functional modules, and a functional module supply warehouse

- is arranged at an end of the functional module conveyor branch lines away from the functional module conveyor line; a transfer robotic arm, wherein the transfer robotic arm is arranged between the assembly conveyor line and the functional module conveyor line, the transfer robotic arm is arranged corresponding to the assembly area, and the transfer robotic arm is used to handle the functional modules and the building unit body to be assembled; an assembly robotic arm, wherein the assembly robotic arm is arranged on one side of the assembly conveyor line, and the assembly robotic arm is used to install the functional modules onto the building unit body to be assembled; and a control platform, wherein the assembly conveyor line, the functional module conveyor line, the transfer robotic arm, and the assembly robotic arm are all electrically connected to the control platform.
2. The prefabricated building production line according to claim 1, further comprising:
an assembly platform, wherein the assembly platform is arranged in the assembly area of the assembly conveyor line, the assembly conveyor line is arranged on two sides of the assembly platform, and the functional modules and the building unit body to be assembled are assembled on the assembly platform.
 3. The prefabricated building production line according to claim 2, wherein the assembly platform comprises:
a fixed frame, wherein a platform support plate is arranged at a top end of the fixed frame; a height adjustment mechanism, wherein the height adjustment mechanism is fixedly installed inside the fixed frame, and the height adjustment mechanism is used to adjust a height of the platform support plate; a rotation adjustment mechanism, wherein the rotation adjustment mechanism is fixedly installed on the height adjustment mechanism, and the rotation adjustment mechanism is used to drive the platform support plate to rotate; a horizontal adjustment mechanism, wherein the horizontal adjustment mechanism is fixedly installed on a top of the rotation adjustment mechanism, and the horizontal adjustment mechanism is used to adjust a relative position of the platform support plate and the fixed frame; and wherein the height adjustment mechanism, the rotation adjustment mechanism, and the horizontal adjustment mechanism are all electrically connected to the control platform.
 4. The prefabricated building production line according to claim 3, wherein the height adjustment mechanism comprises support beams fixedly installed at two ends of a bottom of the fixed frame, a first telescopic cylinder is fixedly connected to a bottom end of the support beam, and the first telescopic cylinder is electrically connected to the control platform; an installation plate is arranged between the two first telescopic cylinders, the installation plate is fixedly connected to the bottom end of the first telescopic cylinder, and the rotation adjustment mechanism is fixedly installed at a middle part of a top end of the installation plate.
 5. The prefabricated building production line according to claim 4, wherein the rotation adjustment mechanism comprises a first motor fixedly installed on the installation plate, the first motor is electrically connected to the control platform; a turntable is fixedly connected to an output shaft of the first motor, the turntable is arranged inside the fixed frame, a gap is arranged between the turntable and the fixed frame, and the horizontal adjustment mechanism is fixedly installed on a top end of the turntable.
 6. The prefabricated building production line according to claim 5, wherein the horizontal adjustment mechanism comprises two slide rails parallelly arranged and fixedly connected to the top end of the turntable, a slide block is slidably connected to the slide rail, and the platform support plate is fixedly connected to a top end of the slide block; a fixed plate is fixedly connected to one end of the slide rail, a second motor is fixedly connected to a side of the fixed plate close to the slide block, and the second motor is electrically connected to the control platform; a lead screw is fixedly connected to an output shaft of the second motor, a connection block is fixedly connected between the two slide blocks oppositely arranged on the two slide rails, and the lead screw penetrates through the connection block and is threadedly matched with the connection block.
 7. The prefabricated building production line according to claim 5, wherein a positioning mechanism is installed on the fixed frame, the positioning mechanism is arranged between the turntable and the fixed frame, and the positioning mechanism is electrically connected to the control platform.
 8. The prefabricated building production line according to claim 7, wherein the positioning mechanism comprises a second telescopic cylinder fixedly connected to the fixed frame, a wedge-shaped block is fixedly connected to an end of the second telescopic cylinder, the wedge-shaped block is slidably matched with the fixed frame, and the second telescopic cylinder is electrically connected to the control platform; a limit slide groove is opened on a side of the wedge-shaped block away from the fixed frame, a limit block is slidably connected in the limit slide groove, a first positioning block is fixedly connected to the limit block, a surface of the first positioning

block close to the turntable is an arcuate surface, and the first positioning block is used to snap between the turntable and the fixed frame and limit the turntable.

9. The prefabricated building production line according to claim 8, wherein a rotating shaft is fixedly connected to a side of the first positioning block close to the limit block, the rotating shaft is arranged at an end of the first positioning block away from the wedge-shaped block, two second positioning blocks are rotatably connected to the rotating shaft, the two second positioning blocks are respectively arranged on upper and lower sides of the wedge-shaped block, the second positioning block is slidably matched with the wedge-shaped block, and the second positioning block is slidably matched with the fixed frame, and the second positioning block located above the wedge-shaped block is used to limit the platform support plate.
5
10
10. The prefabricated building production line according to claim 9, wherein a reset torsion spring is arranged on the rotating shaft, and the second positioning block realizes reset through the reset torsion spring.
15
20
11. The prefabricated building production line according to claim 1, further comprising:
a plurality of production lines, wherein the plurality of production lines are arranged at equal intervals in a plant; a transfer assembly, comprising a plurality of support frames and a plurality of transfer members, wherein the plurality of support frames are respectively arranged between the two adjacent production lines, the transfer member is arranged on the support frame, the transfer member is used to transfer a building module to be assembled between an output end and an input end of the two adjacent production lines, a clamping member is arranged on the transfer member, and the clamping member is used to clamp the building module to be assembled; an uplifting assembly, comprising a lifting member and a limiting member, wherein the lifting member is arranged on the support frame to control lifting of the transfer member, and the limiting member is arranged on the lifting member and is transmission-connected to the clamping member; and a dust removal assembly, comprising a plurality of dust removal members, wherein the plurality of dust removal members are respectively arranged on the support frame, and the dust removal member is used to remove dust from the building module to be assembled.
25
30
35
40
45
50
12. The prefabricated building production line according to claim 11, wherein the transfer member comprises a support shaft rotatably connected to the support frame, a support ring is fixedly connected to the support shaft, one end of a plurality of support plates is fixedly connected to an outer side wall of the

support ring at equal intervals along a circumference, a support rod is arranged at the other end of the support plate, a carrying frame is fixedly connected to a top end of the support rod, the building module to be assembled is conveyed to the carrying frame, the carrying frame docks with the production line, a first motor is fixedly connected to a bottom end of the support frame, and one end of the support shaft is fixedly connected to an output end of the first motor.

13. The prefabricated building production line according to claim 12, wherein the lifting member comprises a support disk fixedly connected to the support frame, the support disk is located below the support rod, a boss is arranged at a top end of the support disk, lifting rods are slidably connected to two ends of the support disk close to the boss, a top plate is fixedly connected to a top end of the lifting rod, slide grooves are arranged on the support disk, the boss, and the top plate, a slide block is fixedly connected to a bottom end of the support rod, the slide block is slidably connected to the slide groove, a control member is arranged inside the support disk, and the control member is connected to the lifting rod.
25
14. The prefabricated building production line according to claim 13, wherein the lifting member comprises a rotating shaft rotatably connected inside the support disk, a control rod is fixedly connected to the rotating shaft, long holes are opened on the two lifting rods, two ends of the control rod respectively penetrate through the two long holes, a first gear is fixedly connected to one end of the rotating shaft, an electric telescopic rod is fixedly connected inside the support disk, a first rack is fixedly connected to a telescopic end of the electric telescopic rod, and the first gear meshes with the first rack.
30
35
15. The prefabricated building production line according to claim 13, wherein the clamping member comprises a support frame fixedly connected to a bottom end of the carrying frame, a plurality of clamping plates are slidably connected to two ends of the support frame at equal intervals along an axial direction, a plurality of conveying rollers are installed on the carrying frame at equal intervals along an axial direction, the clamping plate is located between the two adjacent conveying rollers, a rotating rod is rotatably connected to the support frame, a plurality of second gears are fixedly connected to the rotating rod along an axial direction, a second rack is fixedly connected to the clamping plate, the second gear meshes with the second rack, and one end of the rotating rod is transmission-connected to the limiting member.
40
45
50
55
16. The prefabricated building production line according

to claim 15, wherein the limiting member comprises a top block fixedly connected to the boss, a top rod is slidably connected to the support rod, a top end of the top rod extends into the support frame and is fixedly connected to a third rack, a third gear is fixedly connected to the rotating rod, the third rack meshes with the third gear, a groove is opened on the slide block, the groove fits the top block, and a bottom end of the top rod extends into the groove and is in sliding contact with the top block.

17. A prefabricated building structure, wherein the prefabricated building structure comprises a lifter for installing a prefabricated building, comprising: a first rotation assembly and a second rotation assembly, wherein a first connecting rod and a second connecting rod are hinged between the first rotation assembly and the second rotation assembly, the first rotation assembly is arranged on a base, a top plate is arranged at a top of the second rotation assembly, and the first connecting rod is hinged to the second connecting rod; a first support plate, wherein the first support plate is fixedly connected to one side of the top plate, a second support plate is slidably connected to two sides of the first support plate, and a second hydraulic telescopic rod is arranged between the adjacent second support plates.
18. The prefabricated building structure according to claim 17, wherein the prefabricated building structure comprises a ventilation structure, comprising a ventilation cabinet, wherein the ventilation cabinet is connected to a ventilation mechanism communicating with an outside of the prefabricated building; the ventilation mechanism comprises an air inlet hood arranged inside the ventilation cabinet, and a cleaning assembly is arranged inside the air inlet hood; the air inlet hood is connected to an air outlet assembly arranged outside the ventilation cabinet; the cleaning assembly comprises a cleaning brush arranged inside the air inlet hood, and the cleaning brush is in sliding contact with an inner wall of the air inlet hood; a workbench is slidably arranged inside the ventilation cabinet, a sealing assembly is arranged on a side of the workbench facing an outlet of the ventilation cabinet, and an outlet of the sealing assembly is arranged facing a top end of an inner cavity of the ventilation cabinet.
19. The prefabricated building structure according to claim 17, wherein the prefabricated building structure comprises an automatic production fixture, comprising: a base, wherein two clamping apparatus are movably arranged on the base, and the two clamping apparatus are arranged symmetrically front and back; the clamping apparatus comprises an arc-shaped deflection block, the arc-shaped deflection block is rotatably arranged on the base, two clamp-

ing assemblies used to clamp an air duct are fixedly connected to a top of the arc-shaped deflection block, the two clamping assemblies are arranged symmetrically left and right, and the arc-shaped deflection block is transmission-connected to a driving part; the clamping assembly is coaxially arranged with the arc-shaped deflection block; after four clamping assemblies clamp the air duct, the air duct can be driven to rotate around an axis of the arc-shaped deflection block.

20. The prefabricated building structure according to claim 17, wherein the prefabricated building structure comprises an automatic pipeline welding apparatus, wherein the automatic pipeline welding apparatus comprises a bottom plate, a guide rail is opened on an upper surface of the bottom plate, a guide block is slidably connected inside the guide rail, an electric push rod is fixedly installed on an inner wall of the guide rail, a telescopic end of the electric push rod is fixedly connected to a left side surface of the guide block, support plates are fixedly installed on both the upper surface of the bottom plate and the upper surface of the guide block, slide grooves are opened on both side surfaces of the two support plates facing each other, a slide block is slidably connected inside each of the slide grooves, a first connecting plate is fixedly installed on both side surfaces of the two slide blocks facing each other, a second connecting plate is fixedly installed on both side surfaces of the two support plates facing each other, connecting columns are fixedly installed on an upper surface of each of the first connecting plates and a bottom surface of the second connecting plate, a clamping ring is fixedly installed on both side surfaces of each group of the connecting columns facing each other, two clamping springs are fixedly installed on a bottom surface of each of the first connecting plates, and bottom ends of the two groups of clamping springs are respectively fixedly connected to the upper surface of the guide block and the upper surface of the bottom plate.

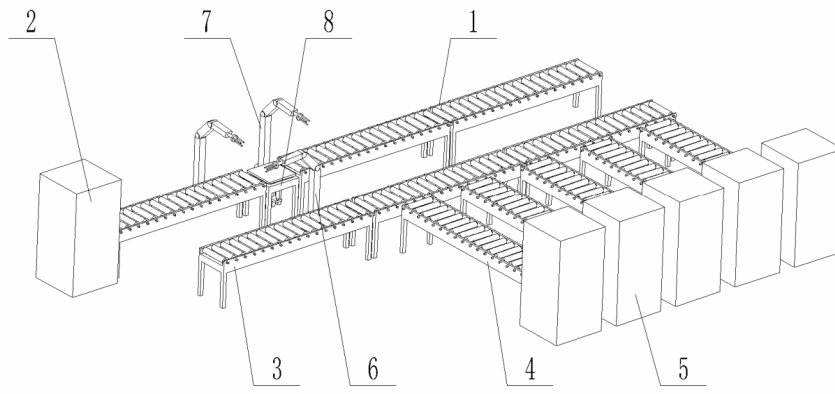


Fig. 1

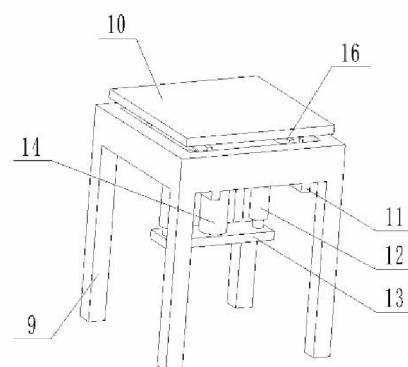


Fig. 2

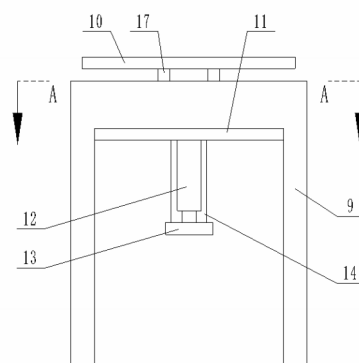


Fig. 3

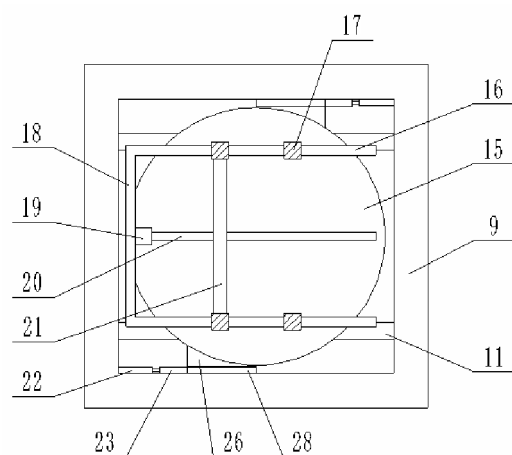


Fig. 4

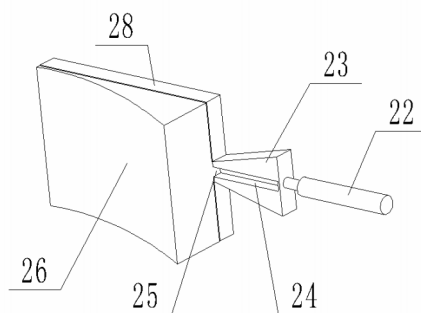


Fig. 5

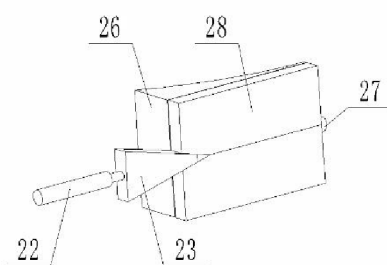


Fig. 6

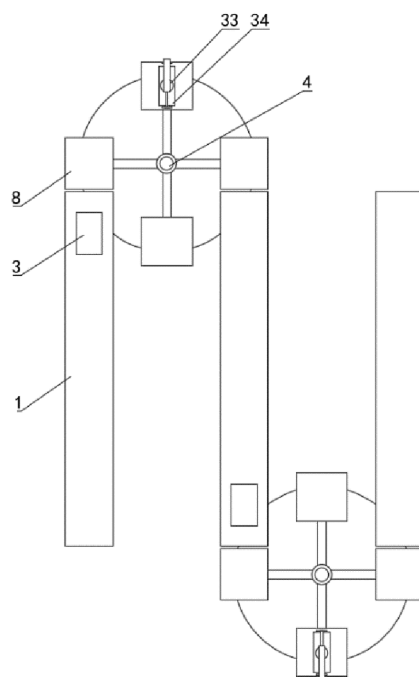


Fig. 7

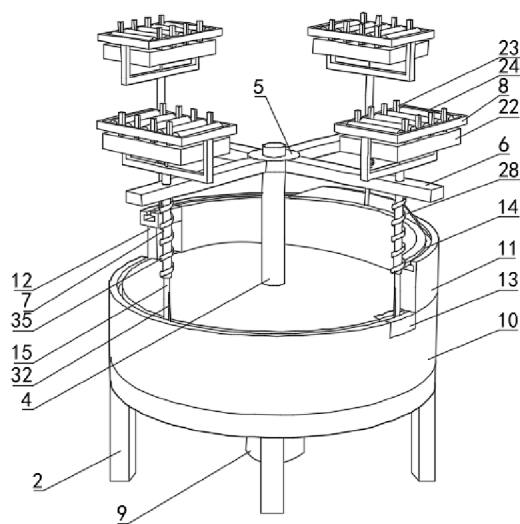


Fig. 8

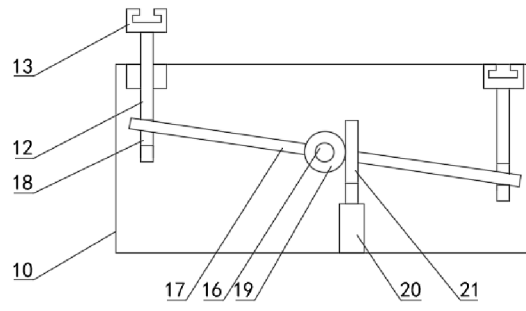


Fig. 9

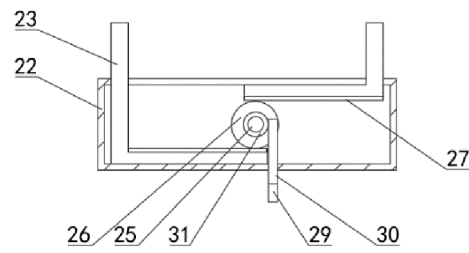


Fig. 10

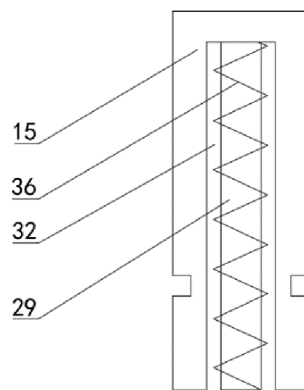


Fig. 11

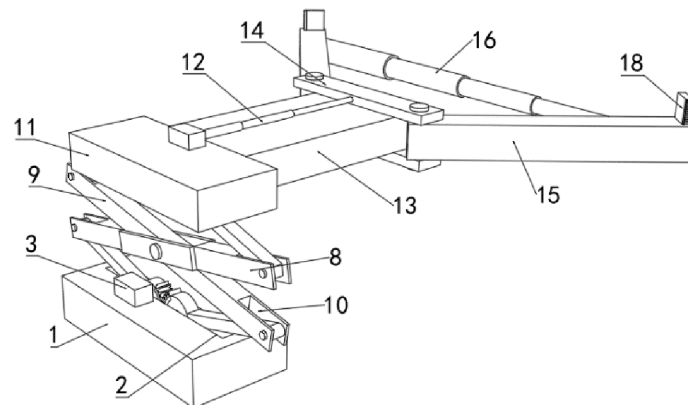


Fig. 12

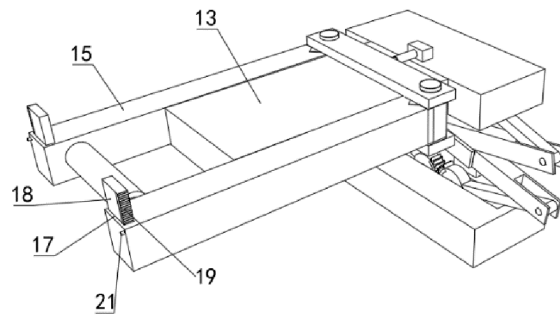


Fig. 13

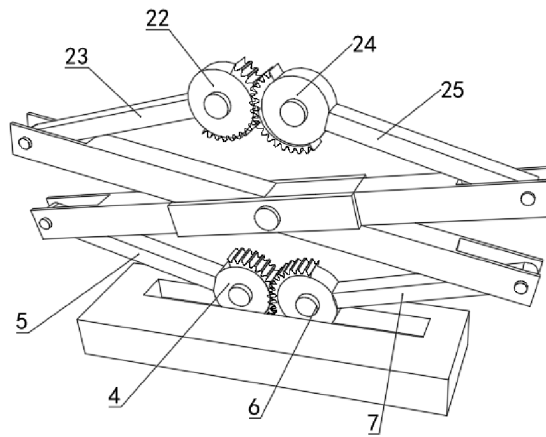


Fig. 14

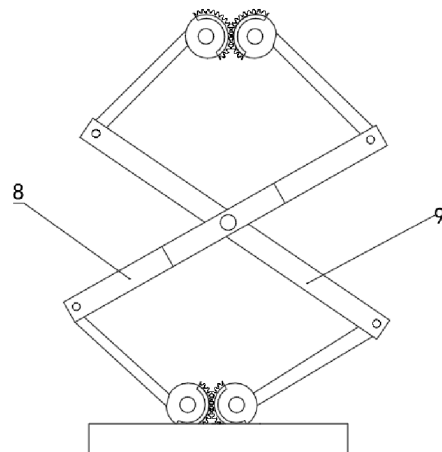


Fig. 15

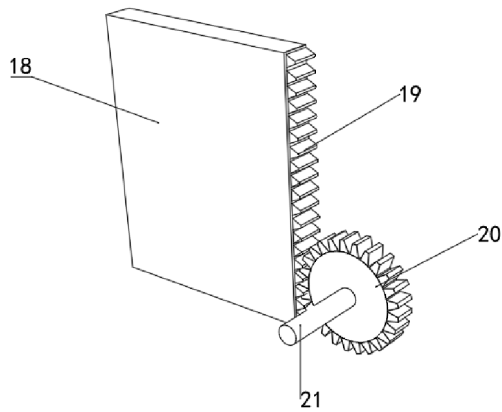


Fig. 16

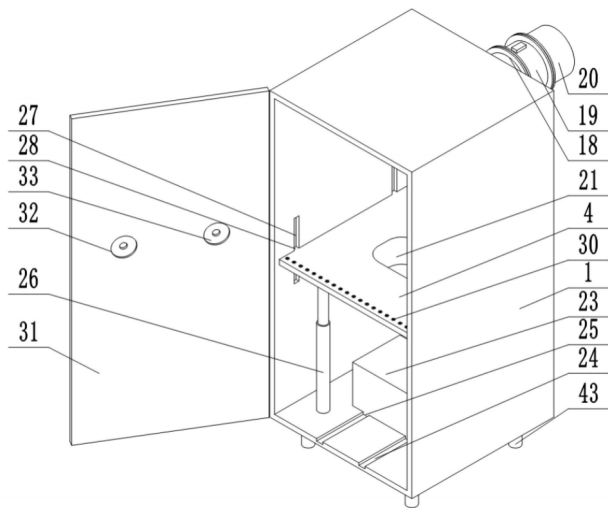


Fig. 17

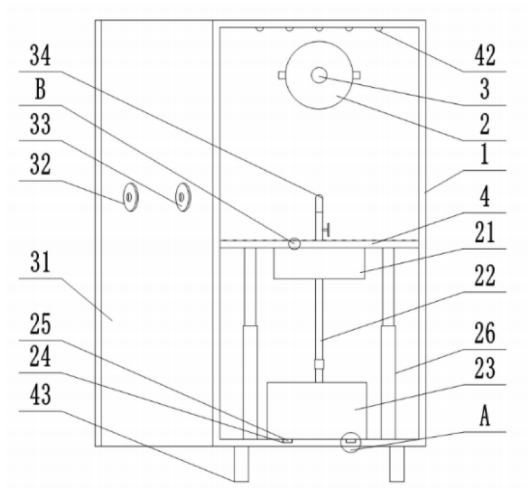


Fig. 18

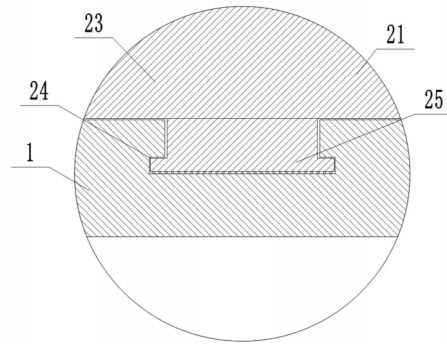


Fig. 19

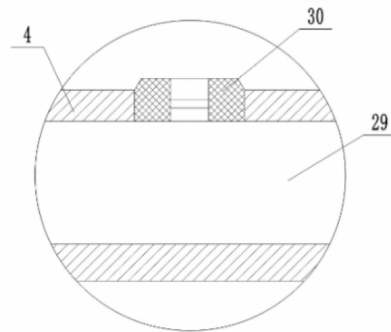


Fig. 20

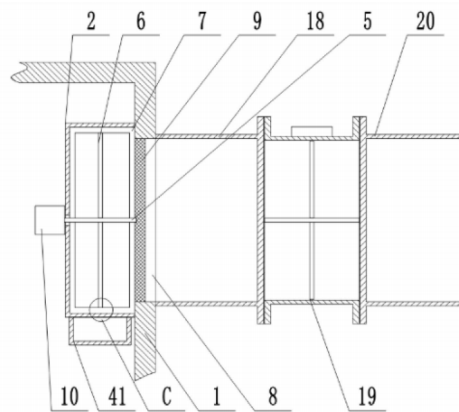


Fig. 21

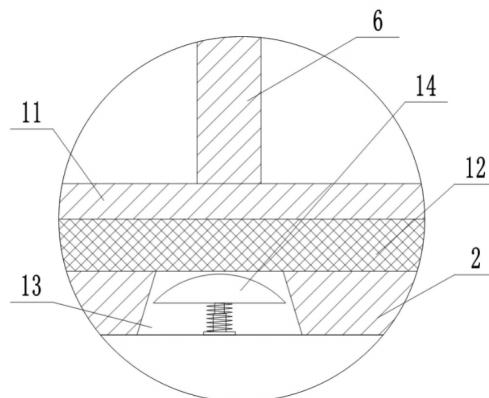


Fig. 22

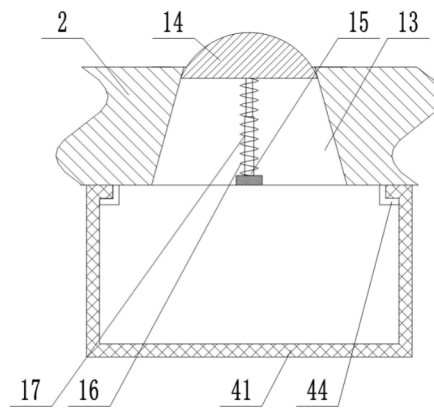


Fig. 23

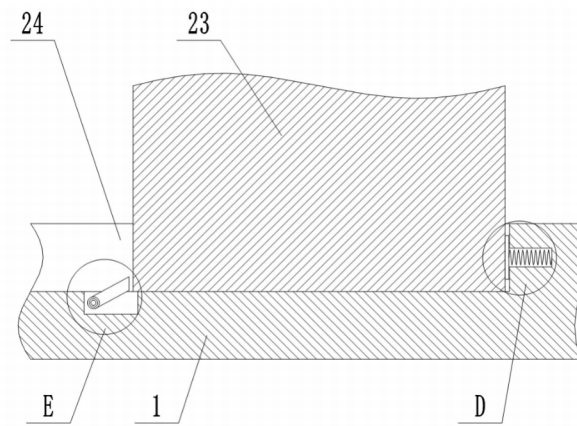


Fig. 24

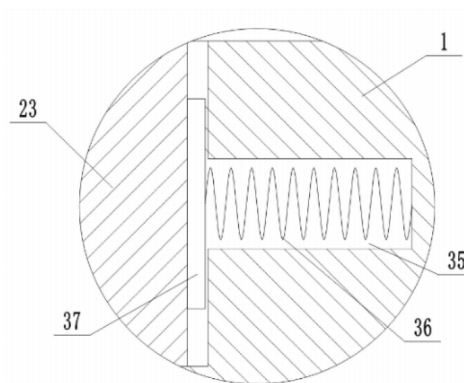


Fig. 25

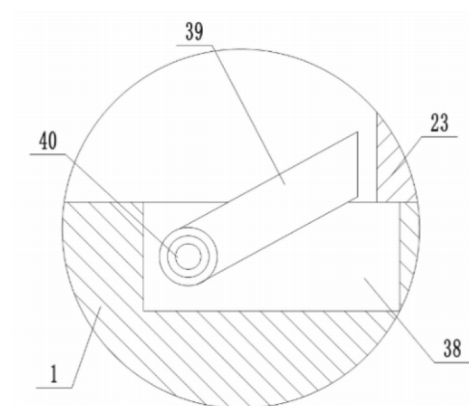


Fig. 26

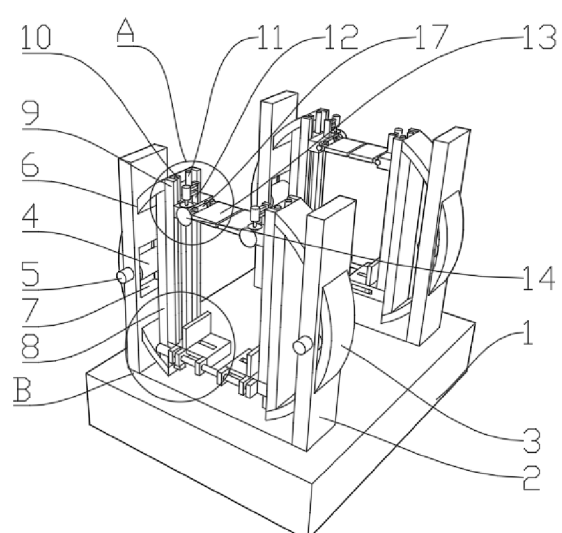


Fig. 27

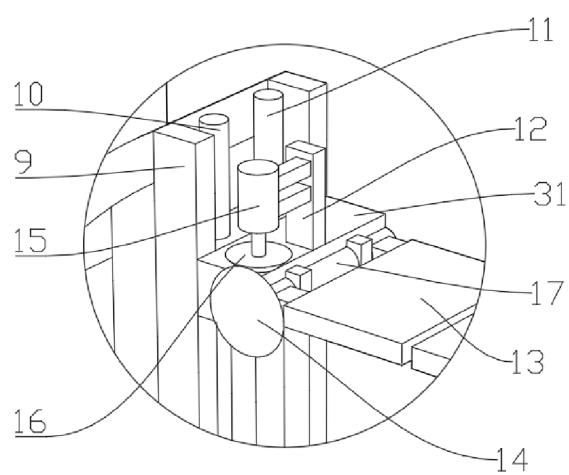


Fig. 28

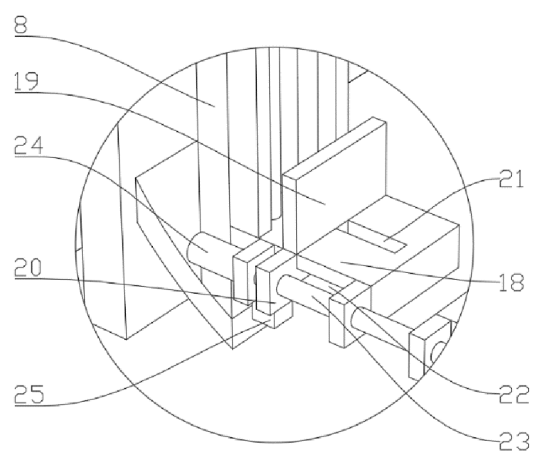


Fig. 29

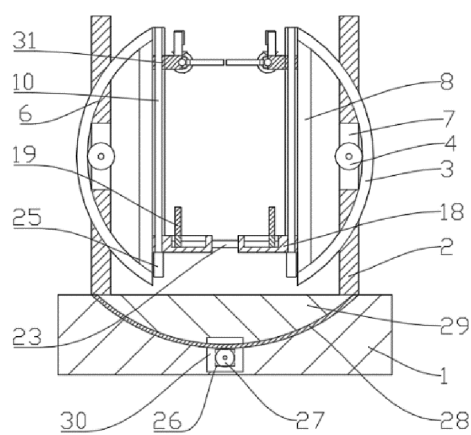


Fig. 30

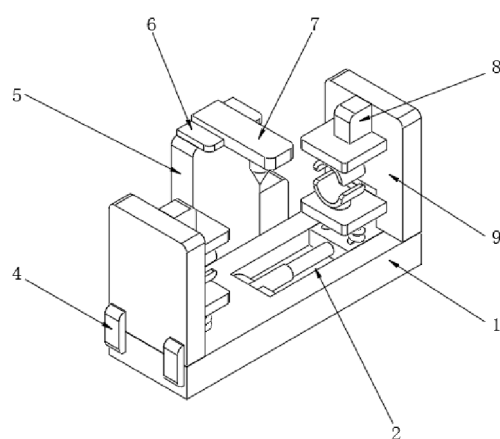


Fig. 31

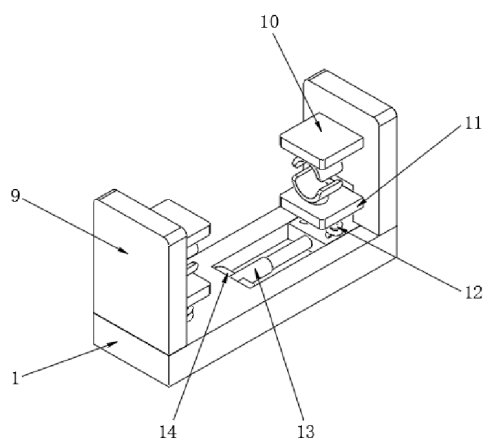


Fig. 32

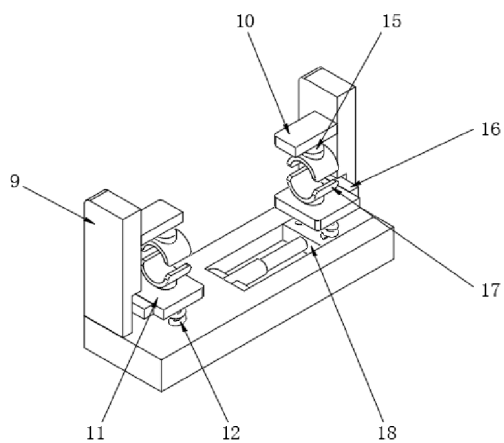


Fig. 33

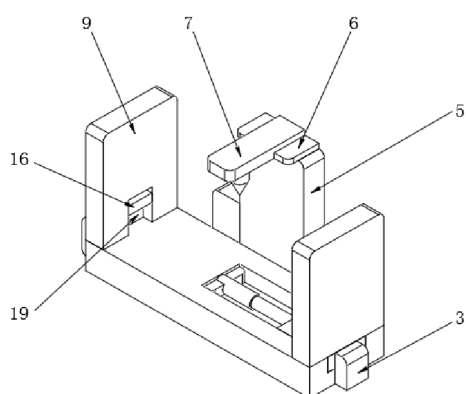


Fig. 34

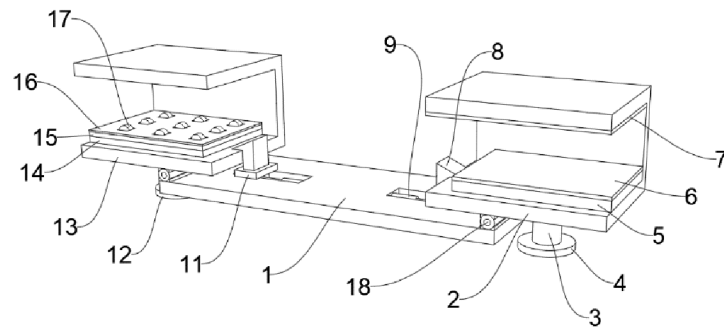


Fig. 35

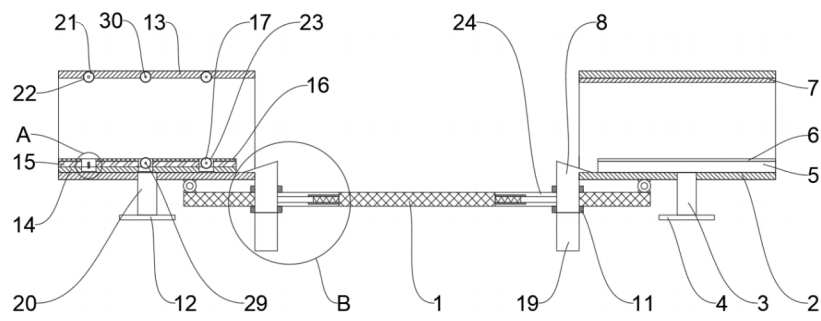


Fig. 36

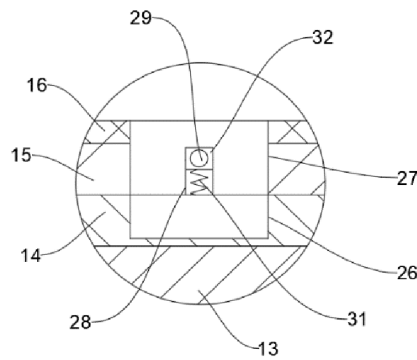


Fig. 37

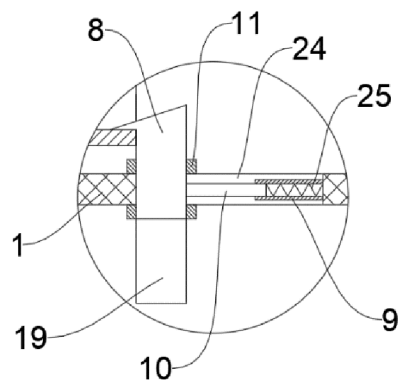


Fig. 38

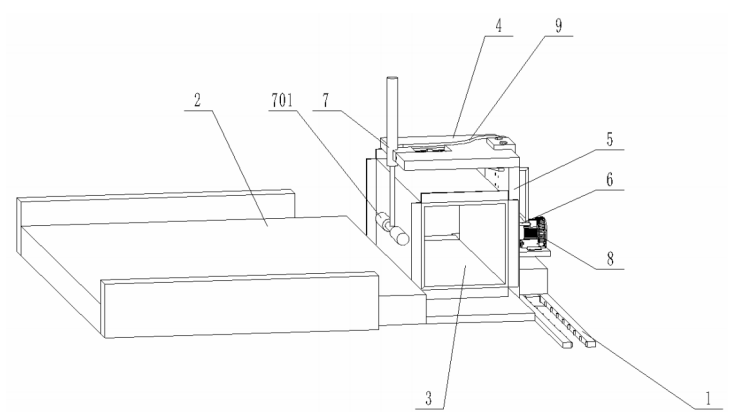


Fig. 39

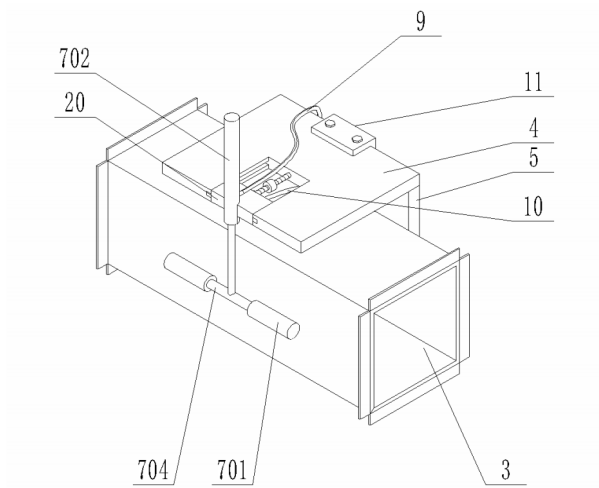


Fig. 40

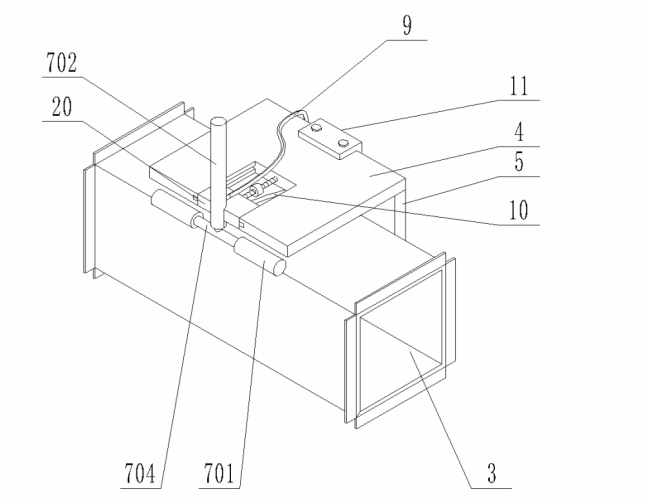


Fig. 41

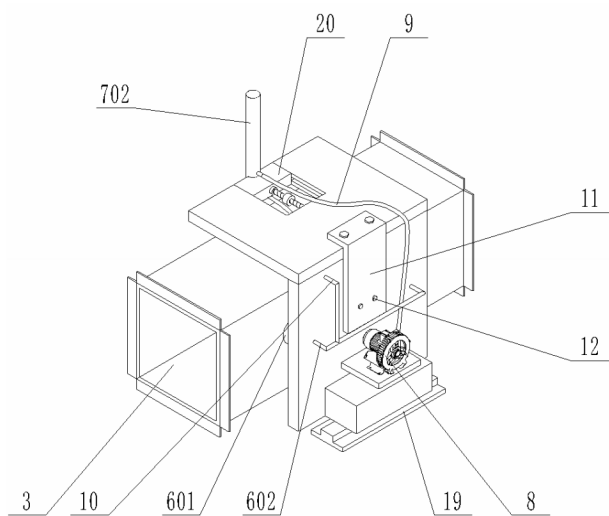


Fig. 42

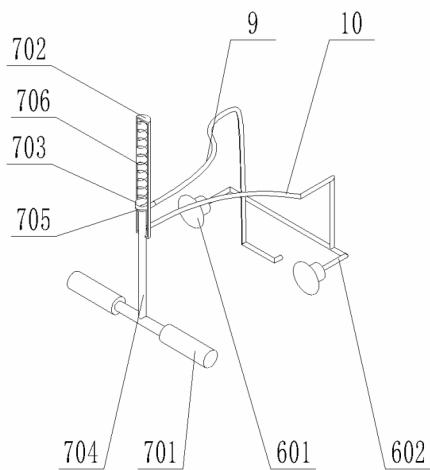


Fig. 43

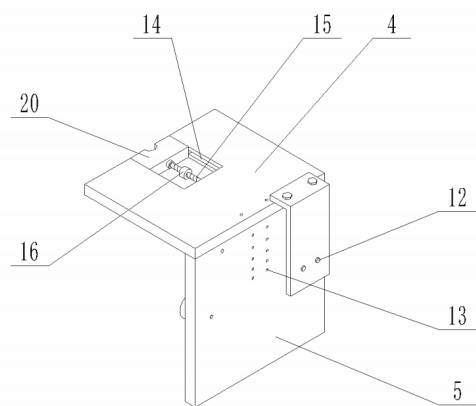


Fig. 44

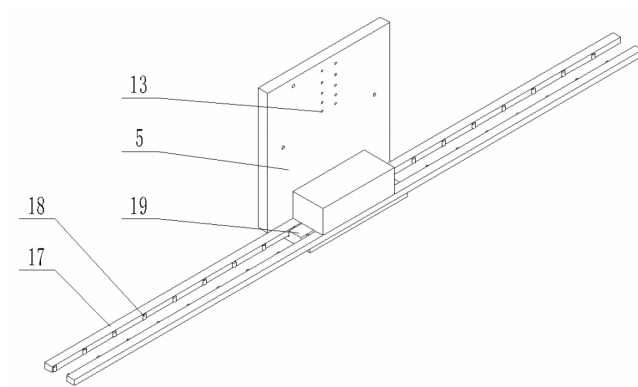


Fig. 45

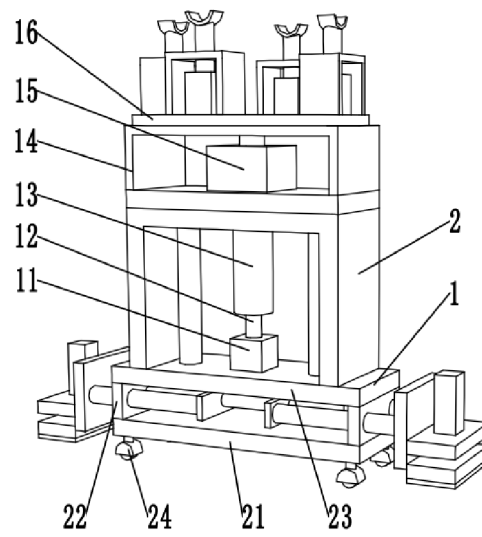


Fig. 46

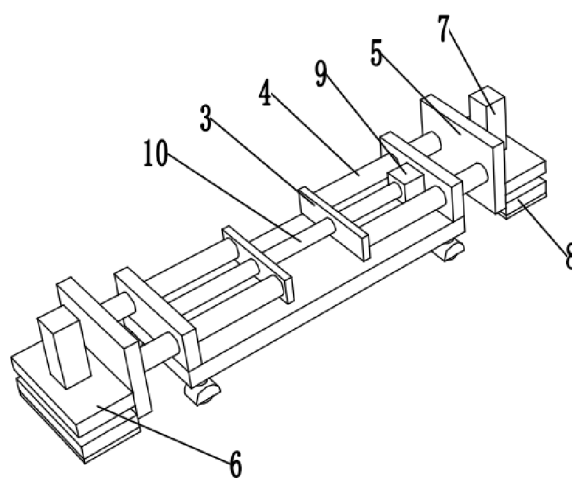


Fig. 47

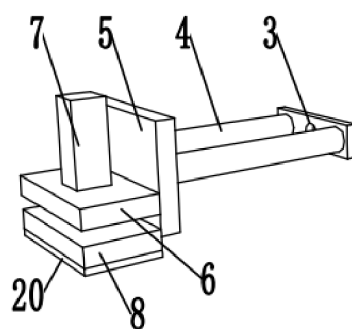


Fig. 48

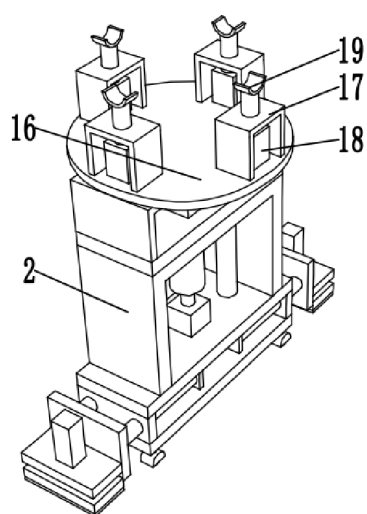


Fig. 49

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/111457

A. CLASSIFICATION OF SUBJECT MATTER

B65G 47/90(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)

IPC:B65G

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)

CNXTX, ENTXTC, WPABSC, VEN, CNKI: 摆, 产线, 弹簧, 对接, 房屋, 风幕, 风罩, 管, 焊, 弧, 机械臂, 机械爪, 夹持, 建筑, 接触, 扩, 面积, 模块, 内壁, 拼合, 拼接, 拼装, 清, 伸长, 伸缩, 实验室, 试验室, 刷, 通风柜, 新风, 增大, 展, 张, 支路, 支线, 转移, 转运, 装配, 组合, 组装, assemb+, install+, lift+, clamp+, weld+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 117864753 A (BEIJING DYNAFLOW LAB SOLUTIONS CO., LTD.) 12 April 2024 (2024-04-12) description, paragraphs 38-62, and figures 1-6	1-10
PY	CN 117864753 A (BEIJING DYNAFLOW LAB SOLUTIONS CO., LTD.) 12 April 2024 (2024-04-12) description, paragraphs 38-62, and figures 1-6	11-16
PY	CN 117864698 A (BEIJING DYNAFLOW LAB SOLUTIONS CO., LTD.) 12 April 2024 (2024-04-12) description, paragraphs 31-54, and figures 1-5	11-16
PX	CN 117800254 A (BEIJING DYNAFLOW LAB SOLUTIONS CO., LTD.) 02 April 2024 (2024-04-02) description, paragraphs 25-35, and figures 1-5	17
PY	CN 117800254 A (BEIJING DYNAFLOW LAB SOLUTIONS CO., LTD.) 02 April 2024 (2024-04-02) description, paragraphs 25-35, and figures 1-5	19

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"D" document cited by the applicant in the international application	"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
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

05 November 2024

Date of mailing of the international search report

22 November 2024

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
China No. 6, Xitucheng Road, Jimenqiao, Haidian District,
Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/111457

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PY	CN 117862805 A (BEIJING DYNAFLOW LAB SOLUTIONS CO., LTD.) 12 April 2024 (2024-04-12) description, paragraphs 35-56, and figures 1-4	19
X	CN 216142367 U (FU NAODAN) 29 March 2022 (2022-03-29) description, paragraphs 32-36, and figures 1-5	17
Y	CN 216142367 U (FU NAODAN) 29 March 2022 (2022-03-29) description, paragraphs 32-36, and figures 1-5	18-20
Y	CN 219309627 U (EDWORTH (SHANXI) INTELLIGENT EXPERIMENT TECHNOLOGY CO., LTD.) 07 July 2023 (2023-07-07) description, paragraphs 36-39, and figures 1-3	18
Y	CN 116061113 A (HUNAN GAOZHI SCIENCE AND TECHNOLOGY CO., LTD.) 05 May 2023 (2023-05-05) description, paragraphs 22-32, and figure 1	19
Y	CN 116423118 A (CHONGQING INDUSTRIAL EQUIPMENT INSTALLATION GROUP CO., LTD.) 14 July 2023 (2023-07-14) description, paragraphs 32-46, and figures 1-6	20
A	CN 219057596 U (CHINA RAILWAY PREFABRICATED CONSTRUCTION CO., LTD.) 23 May 2023 (2023-05-23) description, paragraphs 30-54, and figures 1-2	1-16
A	CN 116511821 A (CHANGCHUN SHUANGYANG XINGLONG AUTOMOBILE PARTS CO., LTD.) 01 August 2023 (2023-08-01) entire document	1-20
A	JP H07284944 A (SANGO CO., LTD.) 31 October 1995 (1995-10-31) entire document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/111457

5

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 117864753 A	12 April 2024	None	
CN 117864698 A	12 April 2024	None	
CN 117800254 A	02 April 2024	None	
CN 117862805 A	12 April 2024	None	
CN 216142367 U	29 March 2022	None	
CN 219309627 U	07 July 2023	None	
CN 116061113 A	05 May 2023	None	
CN 116423118 A	14 July 2023	None	
CN 219057596 U	23 May 2023	None	
CN 116511821 A	01 August 2023	None	
JP H07284944 A	31 October 1995	None	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 202311845133 [0001]
- CN 202311845141 [0001]
- CN 202311834147 [0001]
- CN 202311845125X [0001]
- CN 202311844938 [0001]
- CN 202311845126 [0001]