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(54) **CYLINDRICAL GRINDING MACHINE**

(57) The present disclosure provides a cylindrical grinder, which comprises a frame, a bed, a workbench, Z-axis guide rail components, X-axis guide rail components, B-axis rotating components, and a grinding frame, and the frame is fixed on the ground, the frame is connected to the bed through X-axis guide rail components, the workbench is connected to the bed through Z-axis guide rail components, and the grinding frame is connected to the workbench through B-axis rotating components. The present disclosure sets Z-axis guide rail components, X-axis guide rail components and B-axis rotating components, and by setting the Z-axis guide rail components as a negative pressure adsorption and static pressure support structure, setting the X-axis guide rail components as an air flotation unloading structure, and setting the B-axis rotating components as a direct-drive structure, the problem that the position of each component can not be adjusted quickly and efficiently is avoided.

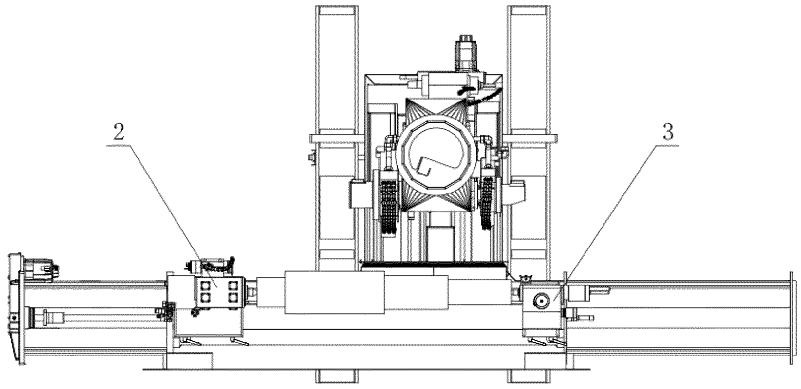

Figure 9

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Description

FIELD OF THE INVENTION

[0001] The present disclosure relates to the field of machine process, in particular to a cylindrical grinder.

BACKGROUND OF THE INVENTION

[0002] When the cylindrical grinder performs operations such as cylindrical grinding, inner hole grinding, non-circular grinding, thread grinding, etc., the X-axis, Z-axis and B-axis of the cylindrical grinder need to be controlled to achieve accurate processing. At present, most cylindrical grinders are locked by screw when the lock is needed, and the movement of the cylindrical grinders is driven by the movement of the rack and pinion. When moving, it needs to use a wrench to rotate the gear, and then through the meshing of the gear and rack, one component is driven to move in the direction of another component. After moving to the required position, the screw is locked to ensure that one component is clamped on the other component.

[0003] This structure requires great labor intensity to move various components, and the operation is complex and cumbersome, so that when installing the workpiece, more installation man-hours are consumed and the use efficiency is greatly reduced. At the same time, the transmission structure is more complex and occupies a certain space position, which makes the overall component structure larger and higher cost.

SUMMARY OF THE INVENTION

[0004] In order to solve at least one technical problem in the above prior art, the present disclosure provides a cylindrical grinder.

[0005] According to one aspect of the present disclosure, a cylindrical grinder comprises a frame, a bed, a workbench, Z-axis guide rail components, X-axis guide rail components, B-axis rotating components, and a grinding frame, and the frame is fixed on the ground, the frame is connected to the bed through the X-axis guide rail components, the workbench is connected to the bed through the Z-axis guide rail components, and the grinding frame is connected to the workbench through the B-axis rotating components.

[0006] In detail, the B-axis rotating components comprise a turntable, a box base, a torque motor and a locking module, and the turntable is rotatably connected to the box base through a turntable bearing, and the torque motor is arranged between the turntable and the box base, and stator and rotor of the torque motor are fixedly connected to the box base and the turntable respectively, and the relative position between the turntable and the box base is fixed by the locking module, and the box base is fixedly connected to the workbench, and the grinding frame is fixedly connected to the turntable.

[0007] Optionally, the turntable is a round table structure, a circular installation groove adapted to the turntable is provided inside the box base, the turntable is arranged in the circular installation groove, and the turntable is arranged in coaxial with the circular installation groove, and the upper end of the outer side surface of the turntable is rotatably connected with the upper end of the inner side surface of the circular installation groove through the turntable bearing; and

the torque motor is arranged in coaxial with the turntable and the circular installation groove, the stator of the torque motor is fixedly connected to the lower end of the circular installation groove, and the rotor of the torque motor is fixedly connected to the lower end of the turntable.

[0008] Optionally, the locking module comprises a locking ring, a hydraulic disc and disc springs, the hydraulic disc is arranged in the circular installation groove, and the lower side surface of the hydraulic disc is fixedly connected to the bottom surface of the circular installation groove, the upper side surface of the locking ring is fixedly connected to the lower end surface of the round table, and the locking ring is arranged corresponding to the hydraulic disc, and a gap is arranged between the lower side surface of the locking ring and the upper side surface of the hydraulic disc, and the height of the gap is not greater than the maximum rising stroke of the hydraulic disc; and

a plurality of disc springs are uniformly fixedly arranged on the upper side surface of the hydraulic disc, the lower end of the disc springs are fixedly connected to the hydraulic disc, and a distance between the upper end surfaces of the disc springs and the lower side surface of the locking ring is smaller than the gap.

[0009] In detail, the X-axis guide rail components comprise air flotation unloading components and moving components, the air flotation unloading components are fixedly arranged on the bed, the moving components are arranged on the frame, and the moving components are located between the bed and the frame, and the bed and the frame are movably connected by the moving components; and

the air flotation unloading components comprise gas pressure chambers, a vent pipe, a gas inlet nozzle, a gas pipe, and a gas supply system, and the gas inlet nozzle communicates with the outlet end of the gas supply system through the gas pipe , and a plurality of gas pressure chambers are arranged on the lower side surface of the bed, and the gas pressure chamber is communicated with the gas inlet nozzle through the vent pipe.

[0010] Optionally, the moving components comprise guide rail components and locking components, and the bed and the frame are fixedly connected by the locking components; and

the guide rail components comprise a guide rail groove and a guide rail, the guide rail is fixedly arranged on the upper side surface of the frame, the

guide rail groove is arranged on the lower side surface of the bed, and the guide rail groove is correspondingly arranged with the guide rail, and the upper side surface of the guide rail groove is attached to the upper side surface of the guide rail, and a vertical rising margin is provided between the upper side surface of the guide rail groove and the upper side surface of the guide rail; and

the locking components comprise a locking block, a locking screw, and an adjustment handle, and the upper side surface of the guide rail is provided with a locking groove adapted to the locking block, and the upper end of the locking block is provided with a screw hole adapted to the locking screw, and the lower end of the locking block is arranged in the locking groove, and the lower part of the bed is provided with a cylindrical cavity, and the locking screw is arranged in the cylindrical cavity, and the outer side surface of the locking screw is rotatably connected with the inner side surface of the cylindrical cavity, the inner end of the locking screw is movably connected to the locking block through a thread, and the outer end of the locking screw is arranged on the outside of the bed and is fixedly connected to the adjustment handle.

[0011] In detail, the Z-axis guide rail components comprise a guide rail body and static pressure support components, the guide rail body is fixedly set on an upper side surface of the bed, and a guide rail groove matched with the guide rail body is set on a lower side surface of the workbench; and

the static pressure support components comprise static pressure oil chamber components on lateral guide rail, main bearing static pressure oil chambers and oil supply system; the static pressure oil chamber components on lateral guide rail are set on a side surface of the guide rail groove and the static pressure oil chamber components on lateral guide rail are correspondingly set with a side surface of the guide rail body; a plurality of main bearing static pressure oil chambers are set on a bottom surface of the guide rail groove and the main bearing static pressure oil chambers are correspondingly set with a top surface of the guide rail body; and both the static pressure oil chamber components on lateral guide rail and the main bearing static pressure oil chambers are connected to an oil outlet end of the oil supply system through a static pressure oil circuit.

[0012] In detail, the Z-axis guide rail components comprise are also provided with negative pressure adsorption components, the negative pressure adsorption components adsorb the guide rail body based on negative pressure, so that a relative movement between the workbench and the guide rail body is stable; and

the negative pressure adsorption components comprise negative pressure ring groove and negative pressure system, the negative pressure ring groove is fixedly set on the bottom surface of the guide rail groove and the negative pressure ring groove is connected to a negative pressure end of the negative pressure system through a gas circuit, and the negative pressure ring groove is set between the static pressure oil chamber components on lateral guide rail and the main bearing static pressure oil chambers, and the negative pressure ring groove near the side surface of the guide rail groove is set on a periphery of the main bearing static pressure oil chambers.

[0013] Further, the cylindrical grinder further comprises a head frame, a tail frame and an adjusting device, and the head frame and the tail frame are movably connected to the bed through the adjusting device, and the adjusting device comprises fixing components and adjusting components, and the fixing components are fixedly connected with the lower side surface of the head frame / the tail frame and the upper side surface of the bed, and the adjusting components are arranged in the fixing components, and the adjusting components slidably fit with the fixing components.

[0014] In detail, the fixing components comprise a left fixing guide plate and a right fixing guide plate, both the left fixing guide plate and the right fixing guide plate are vertically arranged, and the left fixing guide plate and the right fixing guide plate are arranged between the head frame/tail frame and the bed, and the left fixing guide plate is fixedly connected to the lower side surface of the head frame/tail frame / the upper surface side of the bed, and the right fixing guide plate is fixedly connected to the upper side surface of the bed / the lower side surface of the head frame/tail frame; and

the adjusting components comprise wedge components and an adjustment assembly, the wedge components are arranged between the left fixing guide plate and the right fixing guide plate, the left side surface / right side surface of the wedge components is an inclined surface, the left side surface of the wedge components slidably attached with the right side surface of the left fixing guide plate, the right side surface of the wedge components slidably attached with the left side surface of the right fixing guide plate, and the adjustment assembly is fixedly connected to one end of the wedge components; and the wedge components comprise a wedge block and a guide rail module, the left side surface /right side surface of the wedge block is an inclined surface, and two inner sides of the guide rail module are respectively fitted with the left side surface and the right side surface of the wedge block, and the guide rail module and the wedge block are fixedly connected, and two outer sides of the guide rail module are respectively slidably attached to the left fixing guide plate and the right fixing guide plate.

[0015] According to at least one embodiment of the present disclosure, in the present disclosure, by setting the Z-axis guide rail components, the X-axis guide rail components and the B-axis rotating components, and

setting the Z-axis guide rail components as a negative pressure adsorption and static pressure support structure, setting the X-axis guide rail components as an air flotation unloading structure and setting the B-axis rotating components as a direct-drive structure, the problem that the position of each component can not be adjusted quickly and efficiently is avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings illustrate exemplary embodiments of the present disclosure and, together with its description, are used to explain the principles of the present disclosure, which are included to provide a further understanding of the present disclosure, and are included in and form a part of the specification.

Figure 1 is a schematic structural diagram of B-axis rotating components according to the present disclosure.
Figure 2 is a bottom view of X-axis guide rail components according to the present disclosure.
Figure 3 is a schematic structural diagram of a locking module according to the present disclosure.
Figure 4 is a schematic structural diagram of Z-axis guide rail components according to the present disclosure.
Figure 5 is a partial enlarged schematic diagram of Figure 4.
Figure 6 is a sectional view of static pressure oil chamber components on lateral guide rail according to the present disclosure.
Figure 7 is a cross-sectional view of an adjusting device according to the present invention.
Figure 8 is a longitudinal sectional view of the adjusting device according to the present invention.
Figure 9 is a front view of a cylindrical grinder according to the present disclosure.
Figure 10 is a rear view of a cylindrical grinder according to the present disclosure.
Figure 11 is a side view of a cylindrical grinder according to the present disclosure.

[0017] In the figures: 1- bed, 2- head frame, 3- tail frame, 4- workbench, 5- B-axis rotating components, 6- grinding frame, 11- turntable, 12- turntable bearing, 13- torque motor, 14- box base, 15- angle encoder, 16- locking ring, 17- hydraulic disc, 21- B-axis rotating components, 23-gas pressure chamber, 25- gas inlet nozzle, 26- guide rail groove, 27- locking screw, 28-adjustment handle, 29- locking block, 210- guide rail , 31- guide rail groove, 32- static pressure oil chamber components on lateral guide rail, 33- main bearing static pressure oil chamber, 34-negative pressure ring groove, 35- static pressure oil chamber on lateral guide rail, 36- static pressure oil circuit, 41- reset assembly, 43- wedge block, 45- adjustment assembly, 46- left fixing guide plate, 47- guide rail module, 49- right fixing guide plate, 410- head frame/tail frame, 411-bed.

DETAILED DESCRIPTION OF THE INVENTION

[0018] The present disclosure will be further described in detail below in conjunction with the drawings and embodiments. It can be understood that the specific embodiments described here are only used to explain related content, but not to limit the present disclosure. In addition, it should be noted that, for ease of description, only the parts related to the present disclosure are shown in the drawings.

[0019] It should be noted that the embodiments in the present disclosure and the features in the embodiments can be combined with each other if there is no conflict. Hereinafter, the present disclosure will be described in detail with reference to the drawings and in conjunction with the embodiments.

[0020] As shown in figure 9, figure 10 and figure 11, a cylindrical grinder comprises a frame, a bed 1, a workbench 4, Z-axis guide rail components, X-axis guide rail components, B-axis rotating components 5 and a grinding frame 6, and the frame is fixed on the ground, the frame is connected to the bed 1 through the X-axis guide rail components, the workbench 4 is connected to the bed 1 through the Z-axis guide rail components, and the grinding frame 6 is connected to the workbench 4 through the B-axis rotating components 5 .

[0021] The whole bed 1 is a T-shaped structure, and all the guide rail surfaces are processed and formed at one time. It has high static stiffness, high dynamic stiffness and high precision. The bed 1 is a three-point support mode without special installation foundation, and by setting the Z-axis guide rail components and X-axis guide rail components, the grinder has good shock absorption performance, and can achieve very small incremental feed without climbing phenomenon.

[0022] And by setting head frame 2 and tail frame 3, the articles to be processed can be clamped in the processing position of the grinding frame to realize the processing of the grinder.

[0023] In addition, the numbers 1, 4, 6, etc., in the figures may have duplicates with the mark names in other figures. For ease of description and understanding, the numbers in each figure shall prevail.

[0024] The B-axis rotating components comprise a turntable 11, a box base 14, a torque motor 13 and a locking module, and the turntable 11 is rotatably connected to the box base 14 through a turntable bearing 12, and the torque motor 13 is arranged between the turntable 11 and the box base 14 , and the stator and rotor of the torque motor 13 are fixedly connected to the box base 14 and the turntable 11 respectively, and the relative position between the turntable 11 and the box base 14 is fixed by the locking module, and the box base 14 is fixedly connected to the workbench 4, and the grinding frame 6 is fixedly connected to the turntable 4.

[0025] The turntable bearing 12 is arranged at the up-

per part of the turntable 11/box base 14, the torque motor 13 is arranged at the middle part of the turntable 11/box base 14, and the locking module is arranged at the lower part of the turntable 11/box base 14.

[0026] The rotatably connection between the turntable 11 and the box base 14 is realized by the turntable bearing 12, and the turntable 11 is driven to rotate by the torque motor 13.

[0027] The torque motor 13 has the characteristics of low speed, large torque, strong overload capacity, fast response and small torque fluctuation. The torque motor 13 directly drives the high-precision turntable 11, eliminating the need for reduction gears and improving the corresponding speed of the high-precision turntable 11. At the same time. the transmission error is eliminated and the operation accuracy of the system is improved.

[0028] The use of high-precision turntable bearing 12 makes the structure of the turntable 11 simple while ensuring high rotation accuracy, which solves the technical problems of high machining requirements, difficult assembly, complex hydraulic system and high failure rate caused by the use of traditional hydrostatic bearings. However, the installation of the high precision turntable bearing 12 has higher requirements for the machining accuracy of the bearing mounting surface, and there are problems such as higher requirements for the bearing assembly processability during the installation process.

[0029] The turntable 11 is a round table structure, a circular installation groove adapted to the turntable 11 is provided inside the box base 14, the turntable 11 is arranged in the circular installation groove, and the turntable 11 is arranged in coaxial with the circular installation groove, and the upper end of the outer side surface of the turntable 11 is rotatably connected with the upper end of the inner side surface of the circular installation groove through the turntable bearing 12; and

the torque motor 13 is arranged in coaxial with the turntable 11 and the circular installation groove, the stator of the torque motor 13 is fixedly connected to the lower end of the circular installation groove, and the rotor of the torque motor 13 is fixedly connected to the lower end of the turntable 11.

[0030] The torque motor 13 is a special motor with a large number of poles, which can continue to run at low speeds or even when the motor is locked (that is, the rotor cannot rotate) without causing damage to the motor. In this working mode, the motor can provide a stable torque to the load. Therefore, the motor is named as torque motor. Torque motor can also provide torque (brake torque) that is opposite to the direction of rotation. The shaft of a torque motor outputs power with constant torque rather than constant power.

[0031] The locking module comprises a locking ring 16, a hydraulic disc 17 and disc springs, the hydraulic disc 17 is arranged in the circular installation groove, and the lower side surface of the hydraulic disc 17 is fixedly connected to the bottom surface of the circular installation groove, the upper side surface of the locking ring 16 is fixedly connected to the lower end surface of the round table, and the locking ring 16 is arranged corresponding to the hydraulic disc 17, and a gap is arranged between the lower side surface of the locking ring 16 and the upper side surface of the hydraulic disc 17, and the height of the gap is not greater than the maximum rising stroke of the hydraulic disc 17; and

a plurality of disc springs are uniformly fixedly arranged on the upper side surface of the hydraulic disc 17, the lower ends of the disc spring are fixedly connected to the hydraulic disc 17, and the distance between the upper end surfaces of the disc springs and the lower side surface of the locking ring 16 is smaller than the gap.

[0032] When the turntable 11 is rotated to the required position under the drive of the torque motor 13, the turntable 11 needs to be locked so that when it does not rotate, the hydraulic pressure is provided to the hydraulic disc 17 through the hydraulic system. Under the action of pressure, the hydraulic disc 17 moves upwards and fits with the locking ring 16 to ensure that the angle of the turntable 11 will not change during long-term work, and to ensure the stability of the position of the turntable 11. After the work is completed, the pressure drops, and the hydraulic disc 17 is separated from the locking ring 16 to ensure the rotation of the turntable 11.

[0033] At the same time, in order to accelerate the separation speed of the hydraulic disc 17 and the locking ring 16, disc springs 8 are installed on the hydraulic disc 17, and the hydraulic disc 17 and the locking ring 16 are quickly separated by the elastic force of the disc springs 8 to ensure the free rotation of the turntable 11.

[0034] In addition, the B-axis rotating components further comprise an angle encoder 15. The angle encoder 15 is coaxially arranged with the turntable 11 and the circular installation groove, and the angle encoder 15 is fixedly connected to the turntable 11 and the circular installation groove. The data output end of the angle encoder 15 is electrically connected to the data input end of the torque motor 13. A cavity is provided between the lower end surface of the turntable 11 and the bottom surface of the circular installation groove, and the angle encoder 15 is fixedly arranged in the cavity.

[0035] The angle encoder 15 is used to control the angular position of the turntable 11, and the HEIDENHAIN high-precision angle encoder 15 is used, which eliminates the need for a conventional ring gear encoder. By adjusting the related installation gaps as needed, the overall structure is simple to install, and the angular position accuracy is high, which can reach $\pm$2.5", which makes the system have extremely high angular position accuracy.

[0036] The X-axis guide rail components comprise air flotation unloading components and moving components, the air flotation unloading components are fixedly arranged on the bed 1, the moving components are arranged on the frame, and the moving components are located between the bed 1 and the frame, and the bed 1 and the frame are movably connected by the moving

components.

[0037] When the bed 1 needs to be moved, an upward supporting force is generated on the bed 1 through the air flotation unloading components, so that a gap between the bed 1 and the frame is generated, thereby reducing the friction between the bed 1 and the frame , so that the bed 1 and the frame can move flexibly through the moving components.

[0038] When there is no need to move, the working state of the air flotation unloading components are canceled, the frame is in contact with the bed 1, and the bed 1 and the frame are locked by the moving components to prevent it from moving.

[0039] The air flotation unloading components comprise gas pressure chambers 23, a vent pipe, a gas inlet nozzle 25, a gas pipe, and a gas supply system, and the gas inlet nozzle 25 communicates with the outlet end of the gas supply system through the gas pipe, and a plurality of gas pressure chambers 23 are arranged on the lower side surface of the bed 1, and the gas pressure chambers 23 are communicated with the gas inlet nozzle 25 through the vent pipe.

[0040] The gas pressure chamber 23 is a shallow groove, a plurality of gas pressure chambers 23 are distributed on the upper side surface of the guide rail groove 26. The area of each of the plurality of gas pressure chambers 23 is equal, and the depth of each of the plurality of gas pressure chambers 23 is equal. The gas outlet of the vent pipe is arranged in the middle of the gas pressure chamber 23, the gas inlet of the vent pipeline is connected to the gas inlet nozzle 25, the gas inlet nozzle 25 is arranged on the side of the bed 1, the vent pipe is arranged inside the bed 1, and the opening surface of gas pressure chamber 23 is attached to the upper side surface of the guide rail 210.

[0041] When the bed 1 needs to be moved, high-pressure gas is pumped into the gas pipe and the vent pipe through the gas supply system, and the high-pressure gas enters the gas pressure chambers 23. According to the formula $F=P\times S$, wherein F is the buoyancy of the bed 1, P is the pressure of the high-pressure gas and S is the total effective bearing area of the multiple gas pressure chambers 23, by adjusting the pressure P of the high-pressure gas, the bed 1 can be floated by 0.01mm-0.03mm, thereby making the guide rail 210 and the guide rail groove 26 can slide easily.

[0042] The gas supply system may be a gas pump or a pressure bottle that can provide high-pressure gas. The gas pressure chamber 23 may be a circular shallow groove as shown in the figures, or may be a square shallow groove.

[0043] The moving components comprise guide rail components and locking components, and the bed 1 and the frame are fixedly connected by the locking components.

[0044] The guide rail components comprise a guide rail groove 26 and a guide rail 210, the guide rail 210 is fixedly arranged on the upper side surface of the frame, the guide rail groove 26 is arranged on the lower side surface of the bed 1, and the guide rail groove 26 is correspondingly arranged with the guide rail 210, and the upper side surface of the guide rail groove 26 is attached to the upper side surface of the guide rail 210, and a vertical rising margin is provided between the upper side surface of the guide rail groove 26 and the upper side surface of the guide rail 210.

[0045] The guide rail 210 is arranged in the guide rail groove 26, and can produce relative sliding. When the movement between the bed 1 and the frame is required, an upward lift force is generated on the bed 1 through the air flotation unloading components, making the bed 1 float by 0.01 *mm*-0.03 *mm,* so that there is a gap between the upper side surface of the guide rail groove 26 and the upper side surface of the guide rail 210, thereby reducing the friction components between the surfaces of the guide rail 210. The relative displacement between the bed 1 and the frame can be easily generated.

[0046] The locking components comprise a locking block 29, a locking screw 27 and an adjustment handle 28, and the upper side surface of the guide rail 210 is provided with a locking groove adapted to the locking block 29, and the upper end of the locking block 29 is provided with a screw hole adapted to the locking screw 27, and the lower end of the locking block 29 is arranged in the locking groove, and the lower part of the bed 1 is provided with a cylindrical cavity, and the locking screw 27 is arranged in the cylindrical cavity, and the outer side surface of the locking screw 27 is rotatably connected with the inner side surface of the cylindrical cavity, the inner end of the locking screw 27 is movably connected to the locking block 29 through a thread, and the outer end of the locking screw 27 is arranged on the outside of the bed 1 and is fixedly connected to the adjustment handle 28.

[0047] The cylindrical cavity is arranged horizontally, the projection of the central axis of the cylindrical cavity on the horizontal plane is perpendicular to the guide rail 210, the central axis of the locking groove is parallel to the guide rail 210, and the translation allowance in the horizontal direction and the rising allowance in the vertical direction are arranged between the locking block 29 and the locking groove.

[0048] The bed 1 is locked by the engagement between the locking block 29 and the locking groove. As shown in figure 3, the locking block 29 may be a special-shaped structure, which can be a wedge shape as shown in the figure, or a rectangular structure. When the locking block 29 is wedge-shaped, the inclination direction of the locking block 29 and the locking groove is not fixed. It is only need to ensure that the lower end of the locking block 29 is larger than the upper end of the locking block 29. It can realize the locking operation conveniently, and also can effectively avoid the falling.

[0049] When it is need to lock the bed, rotating the adjustment handle 28, and a lead screw structure is formed between the locking block 29 and the locking

screw 27. The adjustment handle 28 drives the locking screw 27 to rotate, and the rotation of the locking screw 27 drives the locking block 29 to move left and right, such as the left and right in the paper direction as shown in Figure 1, and the left and right movement of the locking block 29 makes the locking block 29 engage and disengage from the locking groove. When the locking block 29 engages with the locking groove, the bed 1 is locked on the frame; when the locking block 29 is separated from the locking groove, the bed 1 can move on the frame along the guide rail 210.

[0050] The Z-axis guide rail components comprise a guide rail body and static pressure support components, the guide rail body is fixedly set on an upper side surface of the bed, and a guide rail groove 31 matched with the guide rail body is set on a lower side surface of the workbench.

[0051] The static pressure support components comprise static pressure oil chamber components on lateral guide rail 32, main bearing static pressure oil chambers 33 and oil supply system. The static pressure oil chamber components on lateral guide rail 32 are set on the side surface of the guide rail groove 31 and the static pressure oil chamber components on lateral guide rail 32 are correspondingly set with the side surface of the guide rail body. A plurality of main bearing static pressure oil chambers 33 are set on the bottom surface of the guide rail groove 31 and the main bearing static pressure oil chambers 33 are correspondingly set with the top surface of the guide rail body. Both the static pressure oil chamber components on lateral guide rail 32 and the main bearing static pressure oil chambers 33 are connected to the oil outlet end of the oil supply system through a static pressure oil circuit 36.

[0052] The static pressure oil chamber components on lateral guide rail 32 are set on both sides of the guide rail groove 31 to provide better support and location for the workbench. The bearing oil film can be formed between the guide rail groove 31 and the side surface of the guide rail body to avoid the direct contact between the side surface of the guide rail groove 1 and the side surface of the guide rail body, which makes the guide rail groove 31 and the guide rail body are in the pure liquid friction state, so as to increase the stability, reduce the direction finding error of the workbench when operating, and improve the stability of the bed when moving and the machining precision of the workpiece.

[0053] The oil supply system can be the existing hydraulic oil pumping system and the output pressure on the static pressure oil chamber components on lateral guide rail 32 and the main bearing static pressure oil chambers 33 can be controlled by adjusting the oil supply system, so as to form an effective balance between the oil pressure and the gravity of the workbench. That is, the bearing oil film can be formed on the contact surface between the guide rail groove 31 and the guide rail body and the relative position of the workbench and the bed can be effectively controlled.

[0054] The static pressure oil chamber components on lateral guide rail 32 comprise a plurality of static pressure oil chambers on lateral guide rail 35. The resultant force of the plurality of static pressure oil chambers on lateral guide rail 35 on the side surface of the guide rail body is zero.

[0055] By setting the positions of the static pressure oil chambers on lateral guide rail 35 and controlling the area of each static pressure oil chamber on lateral guide rail 35, the resultant force on the side surface of the guide rail body is zero, so as to avoid the shaking of the workbench on the guide rail body to increase the stability.

[0056] The Z-axis guide rail components comprise are also provided with negative pressure adsorption components, the negative pressure adsorption components adsorb the guide rail body based on negative pressure, so that a relative movement between the workbench and the guide rail body is stable.

[0057] The negative pressure adsorption components comprise negative pressure ring groove 34 and negative pressure system, the negative pressure ring groove 34 is fixedly set on the bottom surface of the guide rail groove 31 and the negative pressure ring groove 34 is connected to a negative pressure end of the negative pressure system through a gas circuit, and the negative pressure ring groove 34 is set between the static pressure oil chamber components on lateral guide rail 32 and the main bearing static pressure oil chambers 33, and the negative pressure ring groove 34 near the side surface of the guide rail groove 31 is set on a periphery of the main bearing static pressure oil chambers 33.

[0058] By adding a negative pressure ring groove 34 on the bottom surface of the guide rail groove 31, and using a negative pressure system to make the negative pressure ring groove 34 in a negative pressure state, the thickness and rigidity of the bearing oil film required for the open static pressure guide rail are ensured, and at the same time it solves the drift of the static pressure guide rail in high-speed motion and the crawling phenomenon during low-speed motion, and improves the motion stability of the bed and the processing accuracy of the workpiece.

[0059] The number of negative pressure ring grooves 34 is determined according to the number of guide rail grooves 31. Assuming that the number of guide rail grooves 31 is 2, as shown in the figure, in order to improve the stability of the bed, the negative pressure ring groove 34 is set into two parts, which are respectively located in the upper and lower parts as shown in the figure, which can realize negative pressure adsorption without affecting the work of the static pressure support components.

[0060] The cylindrical grinder further comprises a head frame 2, a tail frame 3 and an adjusting device, and the head frame 2 and the tail frame 3 are movably connected to the bed 411 through the adjusting device. Wherein, the bed 411 is the same object as the number 1 in figures 9, 10, 11. The adjusting device comprises fixing components and adjusting components, and the fixing compo-

nents are fixedly connected with the lower side surface of the head frame 2/ the tail frame 3 and the upper side surface of the bed 411, and the adjusting components are arranged in the fixing components, and the adjusting components slidably fit with the fixing components.

[0061] The fixing components comprise a left fixing guide plate 46 and a right fixing guide plate 49, both the left fixing guide plate 46 and the right fixing guide plate 49 are vertically arranged, and the left fixing guide plate 46 and the right fixing guide plate 49 are arranged between the head frame/tail frame 410 and the bed 411, and the left fixing guide plate 46 is fixedly connected to the lower side surface of the head frame/tail frame 410 / the upper surface side of the bed 411, and the right fixing guide plate 49 is fixedly connected to the upper side surface of the bed 411 / the lower side surface of the head frame/tail frame 410.

[0062] The fixing components are composed of at least two fixing guide plates, and the left and right directions of the fixing components are described by the left and right directions as shown in figure 7. In order to make the adjusting components drive the fixing guide plates to move, it is need to ensure that the left fixing guide plate 46 and the right fixing guide plate 49 are fixedly connected to the head frame/tail frame 410 or the bed 411 at different times.

[0063] For example: the left fixing guide plate 46 is fixedly connected to the lower side of the head frame/tail frame 410, and the right fixing guide plate 49 is fixedly connected to the upper side surface of the bed 411. The distance between the left fixing guide plate 46 and the right fixing guide plate 49 can be adjusted through the adjusting components, so as to realize the movement of the head frame/tail frame 410.

[0064] The adjusting components comprise wedge components and an adjustment assembly 45, the wedge components are arranged between the left fixing guide plate 46 and the right fixing guide plate 49, the left side surface / right side surface of the wedge components are inclined surface, the left side surface of the wedge components can be slidably attached with the right side surface of the left fixing guide plate 46, the right side surface of the wedge components can be slidably attached with the left side surface of the right fixing guide plate 49, and the adjustment assembly 45 is fixedly connected to one end of the wedge components.

[0065] When the head frame/tail frame 410 move along the X-axis, the wedge components can slide along the Z-axis in the fixing components, and the adjustment assembly 45 is set along the Z-axis.

[0066] As shown in figuer 7, the direction of the X-axis is the horizontal direction in the figure, and the direction of the Z-axis is the vertical direction in the figure. The inclined surface of the wedge components in the figure can be various structures. The inclined surface of the wedge components can be set on the left side surface of the wedge components or on the right side surface of the wedge components. At the same time, it can be set that the width of the lower part of the wedge components (position in figure 7) is smaller than that of the upper part of the wedge components (position in figure 7), and it can also be set that the width of the upper part of the wedge components (position in figure 7) is smaller than that of the lower part of the wedge components (position in figure 7).

[0067] For example, the inclined surface is set on the right side of the wedge components, and the width of the lower part of the wedge components (position in figure 7) is smaller than that of the upper part of the wedge components (position in Figure 7).

[0068] By controlling the wedge components to move down (the position in figure 7), the left fixing guide plate 46 and the right fixing guide plate 49 on both sides of the wedge components can be pushed to separate, that is, the distance between the left fixing guide plate 46 and the right fixing guide plate 49 is increased, so that the position of the head frame/tail frame 410 can be adjusted.

[0069] By controlling the wedge components to move upward (the position in figure 7), the left fixing guide plate 46 and the right fixing guide plate 49 on both sides of the wedge components can be pushed to approach, that is, the distance between the left fixing guide plate 46 and the right fixing guide plates 49 is reduced, so that the position of the head frame/tail frame 410 can be adjusted.

[0070] The wedge components comprise a wedge block 43 and a guide rail module 47, the left side surface /right side surface of the wedge block 43 is an inclined surface, and two inner sides of the guide rail module 47 are respectively fitted with the left side surface and the right side surface of the wedge block 43, and the guide rail module 47 and the wedge block 43 are fixedly connected, and two outer sides of the guide rail module 47 are respectively slidably fitted with the left fixing guide plate 46 and the right fixing guide plate 49.

[0071] By providing the guide rail module 47, the positional relationship between the wedge block 43 and the fixing guide plates can be controlled, so that the wedge block 43 and the fixing guide plates can only move relative to each other in the Z-axis direction and cannot move in the Z-axis (vertical direction in figure 2). The guide rail module 47 may be a slidable rail.

[0072] The side bus bar adjusting device also comprises a reset assembly 41, which is arranged at the left and right ends of the machining bed and is fixedly connected to the head frame/tail frame 410 and/or the bed 411.

[0073] The reset assembly 41 comprises at least two spring plates, the spring plates are respectively arranged on the left and right ends of the machining bed, and the spring plates are fixedly connected to the head frame/tail frame 410 and/or the bed 411.

[0074] The reset assembly 41 may be spring plates, or may be flexible devices such as compression springs or pneumatic telescopic rods. A resetting force can be applied to the head frame/tail frame 410 through the reset assembly 41. When it is need to reset the head frame/tail frame 410, change the position of the wedge compo-

nents, and the head frame/tail frame 410 will reset under the force of the reset assembly 41 .

[0075] In addition, the head frame can also be slidably connected to the bed 411 by adopting a similar structure to the X-axis guide rail components.

[0076] In the description of this specification, the descriptions of the terms "one embodiment/mode", "some embodiments/modes", "examples", "specific examples", or "some examples" means that the specific features, structures, materials, or characteristics described in connection with the embodiment/mode or example are included in at least one embodiment/mode or example of the present application. In this specification, the schematic expression of the above terms does not necessarily refer to the same embodiment/mode or example. Moreover, the specific features, structures, materials, or characteristics described can be combined in any suitable manner in any one or more embodiments/modes or examples. In addition, without contradicting each other, those skilled in the art may combine different embodiments/modes or examples and features of the different embodiments/modes or examples described in this specification.

[0077] In addition, the terms "first" and "second" are used for description purposes only, and cannot be understood as indicating or implying relative importance or implicitly indicating the number of technical features indicated. Thus, the features defined as "first" and "second" may include at least one of the features either explicitly or implicitly. In the description of the present application, the meaning of "plurality" is at least two, such as two, three, etc., unless specifically defined otherwise.

[0078] Those skilled in the art should understand that the above-mentioned embodiments are only for clearly illustrating the present disclosure, rather than limiting the scope of the present disclosure. For those skilled in the art, other changes or modifications can be made on the basis of the above disclosure, and these changes or modifications are still within the scope of the present disclosure.

Claims

1. A cylindrical grinder, **characterized in that**, the cylindrical grinder comprises a frame, a bed, a workbench, Z-axis guide rail components, X-axis guide rail components, B-axis rotating components and a grinding frame, and the frame is fixed on the ground, the frame is connected to the bed through the X-axis guide rail components, the workbench is connected to the bed through the Z-axis guide rail components, and the grinding frame is connected to the workbench through the B-axis rotating components.

2. The cylindrical grinder according to the claim 1, **characterized in that**, the B-axis rotating components comprise a turntable, a box base, a torque motor and a locking module, and the turntable is rotatably connected to the box base through a turntable bearing, and the torque motor is arranged between the turntable and the box base, and stator and rotor of the torque motor are fixedly connected to the box base and the turntable respectively, and the relative position between the turntable and the box base is fixed by the locking module, and the box base is fixedly connected to the workbench, and the grinding frame is fixedly connected to the turntable.

3. The cylindrical grinder according to the claim 2, **characterized in that**, the turntable is a round table structure, a circular installation groove adapted to the turntable is provided inside the box base, the turntable is arranged in the circular installation groove, and the turntable is arranged in coaxial with the circular installation groove, and the upper end of the outer side surface of the turntable is rotatably connected with the upper end of the inner side surface of the circular installation groove through the turntable bearing; and
the torque motor is arranged in coaxial with the turntable and the circular installation groove, the stator of the torque motor is fixedly connected to the lower end of the circular installation groove, and the rotor of the torque motor is fixedly connected to the lower end of the turntable.

4. The cylindrical grinder according to the claim 3, **characterized in that**, the locking module comprises a locking ring, a hydraulic disc and disc springs, the hydraulic disc is arranged in the circular installation groove, and the lower side surface of the hydraulic disc is fixedly connected to the bottom surface of the circular installation groove, the upper side surface of the locking ring is fixedly connected to the lower end surface of the round table, and the locking ring is arranged corresponding to the hydraulic disc, and a gap is arranged between the lower side surface of the locking ring and the upper side surface of the hydraulic disc, and the height of the gap is not greater than the maximum rising stroke of the hydraulic disc; and
a plurality of disc springs are uniformly fixedly arranged on the upper side surface of the hydraulic disc, the lower ends of the disc springs are fixedly connected to the hydraulic disc, and a distance between the upper end surfaces of the disc springs and the lower side surface of the locking ring is smaller than the gap.

5. The cylindrical grinder according to the claim 2, **characterized in that**, the X-axis guide rail components comprise air flotation unloading components and moving components, the air flotation unloading components are fixedly arranged on the bed, the moving components are arranged on the frame, and the

moving components are located between the bed and the frame, and the bed and the frame are movably connected by the moving components; and
the air flotation unloading components comprise gas pressure chambers, a vent pipe, a gas inlet nozzle, a gas pipe, and a gas supply system, and the gas inlet nozzle communicates with the outlet end of the gas supply system through the gas pipe , and a plurality of gas pressure chambers are arranged on the lower side surface of the bed, and the gas pressure chambers are communicated with the gas inlet nozzle through the vent pipe.

6. The cylindrical grinder according to the claim 5, **characterized in that**, the moving components comprise guide rail components and locking components, and the bed and the frame are fixedly connected by the locking components;

the guide rail components comprise a guide rail groove and a guide rail, the guide rail is fixedly arranged on the upper side surface of the frame, the guide rail groove is arranged on the lower side surface of the bed, and the guide rail groove is correspondingly arranged with the guide rail, and the upper side surface of the guide rail groove is attached to the upper side surface of the guide rail, and a vertical rising margin is provided between the upper side surface of the guide rail groove and the upper side surface of the guide rail; and
the locking components comprise a locking block, a locking screw, and an adjustment handle, and the upper side surface of the guide rail is provided with a locking groove adapted to the locking block, and the upper end of the locking block is provided with a screw hole adapted to the locking screw, and the lower end of the locking block is arranged in the locking groove, and the lower part of the bed is provided with a cylindrical cavity, and the locking screw is arranged in the cylindrical cavity, and the outer side surface of the locking screw is rotatably connected with the inner side surface of the cylindrical cavity, the inner end of the locking screw is movably connected to the locking block through a thread, and the outer end of the locking screw is arranged on the outside of the bed and is fixedly connected to the adjustment handle.

7. The cylindrical grinder according to the claim 5, **characterized in that**, the Z-axis guide rail components comprise a guide rail body and static pressure support components, the guide rail body is fixedly set on an upper side surface of the bed, and a guide rail groove matched with the guide rail body is set on a lower side surface of the workbench; and
the static pressure support components comprise static pressure oil chamber components on lateral guide rail, main bearing static pressure oil chambers and oil supply system; the static pressure oil chamber components on lateral guide rail are set on a side surface of the guide rail groove and the static pressure oil chamber components on lateral guide rail are correspondingly set with a side surface of the guide rail body; a plurality of main bearing static pressure oil chambers are set on a bottom surface of the guide rail groove and the main bearing static pressure oil chambers are correspondingly set with a top surface of the guide rail body; and both the static pressure oil chamber components on lateral guide rail and the main bearing static pressure oil chambers are connected to an oil outlet end of the oil supply system through a static pressure oil circuit.

8. The cylindrical grinder according to the claim 7, **characterized in that**, the Z-axis guide rail components comprise are also provided with negative pressure adsorption components, the negative pressure adsorption components adsorb the guide rail body based on negative pressure, so that a relative movement between the workbench and the guide rail body is stable; and
the negative pressure adsorption components comprise negative pressure ring groove and negative pressure system, the negative pressure ring groove is fixedly set on the bottom surface of the guide rail groove and the negative pressure ring groove is connected to a negative pressure end of the negative pressure system through a gas circuit, and the negative pressure ring groove is set between the static pressure oil chamber components on lateral guide rail and the main bearing static pressure oil chambers, and the negative pressure ring groove near the side surface of the guide rail groove is set on a periphery of the main bearing static pressure oil chambers.

9. The cylindrical grinder according to the claim 7, **characterized in that**, the cylindrical grinder further comprises a head frame, a tail frame and an adjusting device, and the head frame and the tail frame are movably connected to the bed through the adjusting device, and the adjusting device comprises fixing components and adjusting components, and the fixing components are fixedly connected with the lower side surface of the head frame / the tail frame and the upper side surface of the bed, and the adjusting components are arranged in the fixing components, and the adjusting components slidably fit with the fixing components.

10. The cylindrical grinder according to the claim 9, **characterized in that**, the fixing components comprise a left fixing guide plate and a right fixing guide plate, both the left fixing guide plate and the right fixing

guide plate are vertically arranged, and the left fixing guide plate and the right fixing guide plate are arranged between the head frame/tail frame and the bed, and the left fixing guide plate is fixedly connected to the lower side surface of the head frame/tail frame / the upper surface side of the bed, and the right fixing guide plate is fixedly connected to the upper side surface of the bed / the lower side surface of the head frame/tail frame;

the adjusting components comprise wedge components and an adjustment assembly, the wedge components are arranged between the left fixing guide plate and the right fixing guide plate, the left side surface / right side surface of the wedge components is an inclined surface, the left side surface of the wedge components slidably attached with the right side surface of the left fixing guide plate, the right side surface of the wedge components slidably attached with the left side surface of the right fixing guide plate, and the adjustment assembly is fixedly connected to one end of the wedge components; and

the wedge components comprise a wedge block and a guide rail module, the left side surface /right side surface of the wedge block is an inclined surface, and two inner sides of the guide rail module are respectively fitted with the left side surface and the right side surface of the wedge block, and the guide rail module and the wedge block are fixedly connected, and two outer sides of the guide rail module are respectively slidably attached to the left fixing guide plate and the right fixing guide plate.

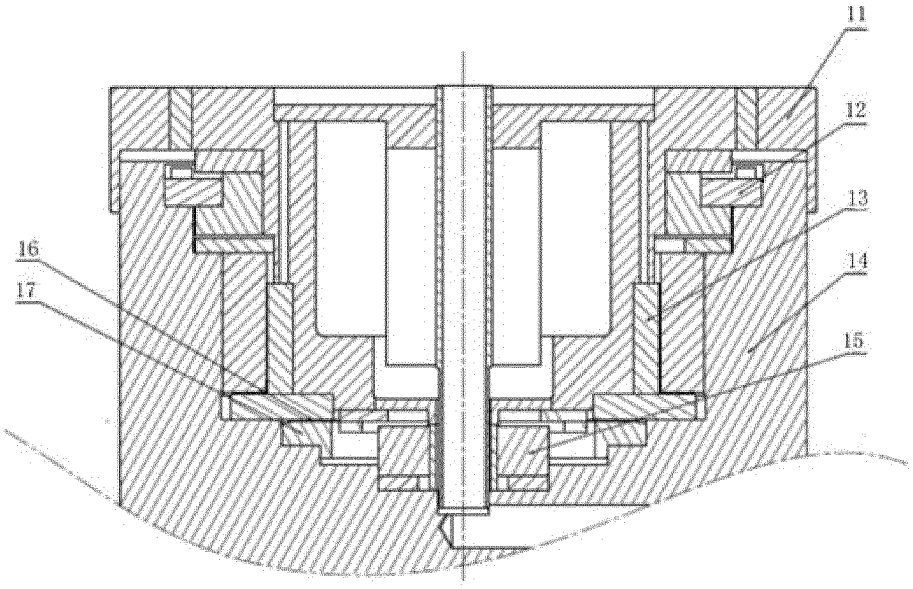

Figure 1

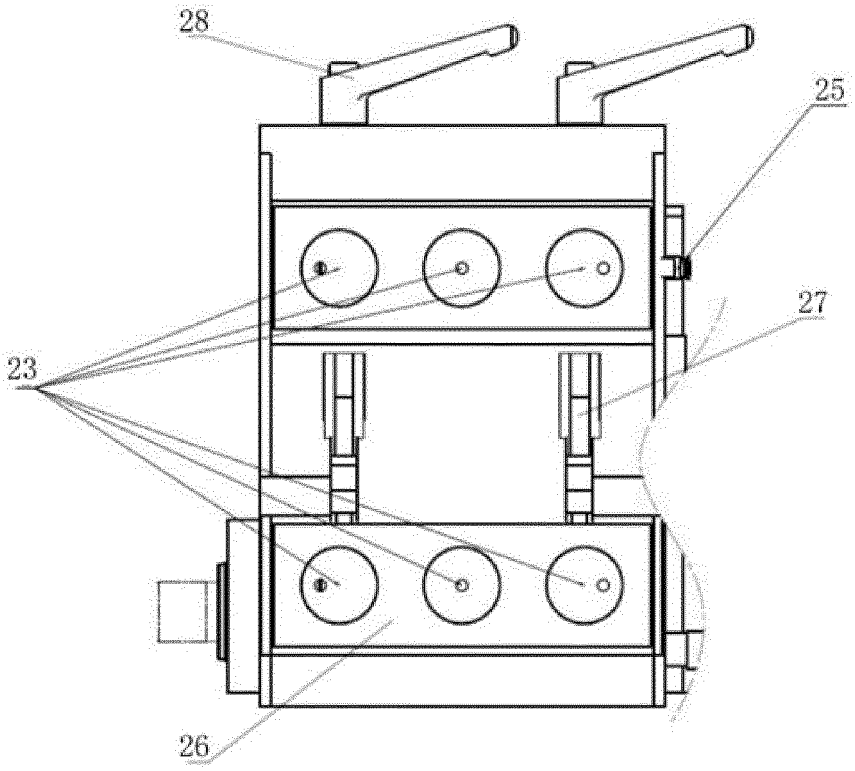

Figure 2

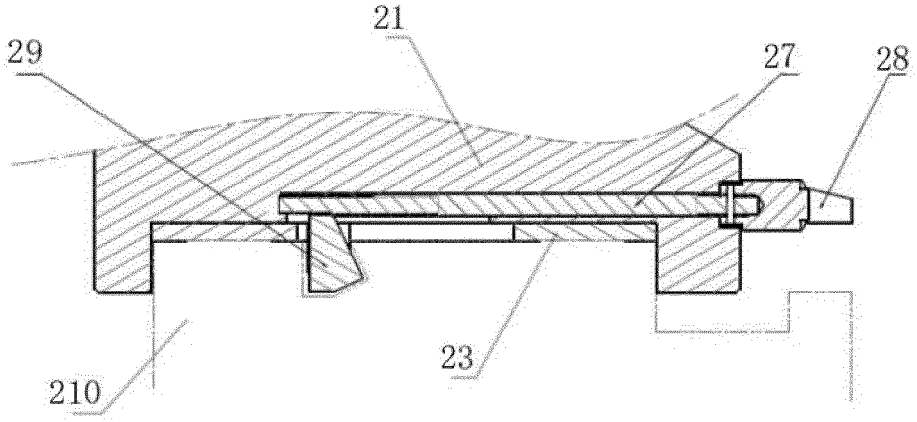

Figure 3

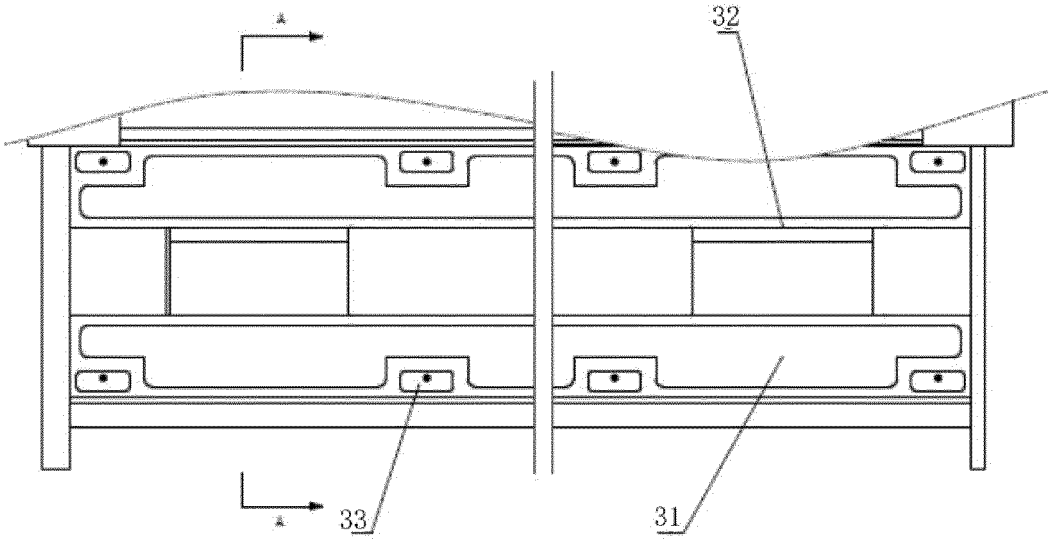

Figure 4

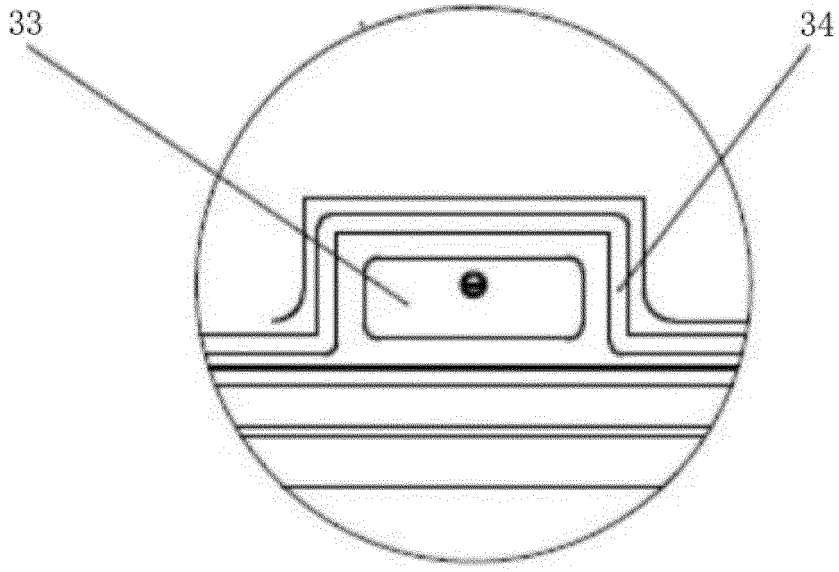

Figure 5

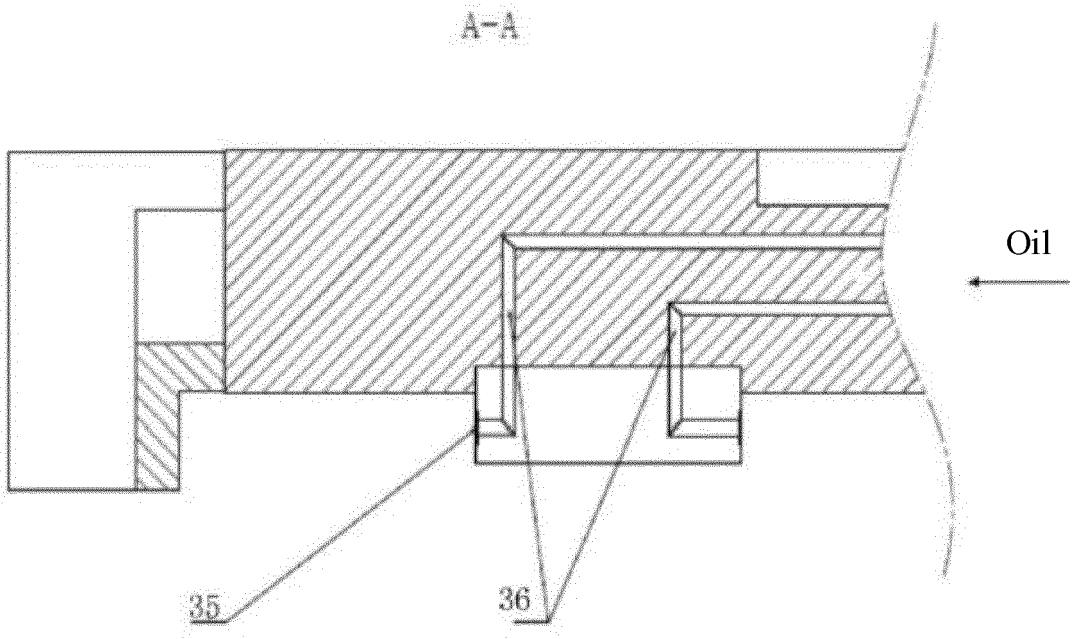

Figure 6

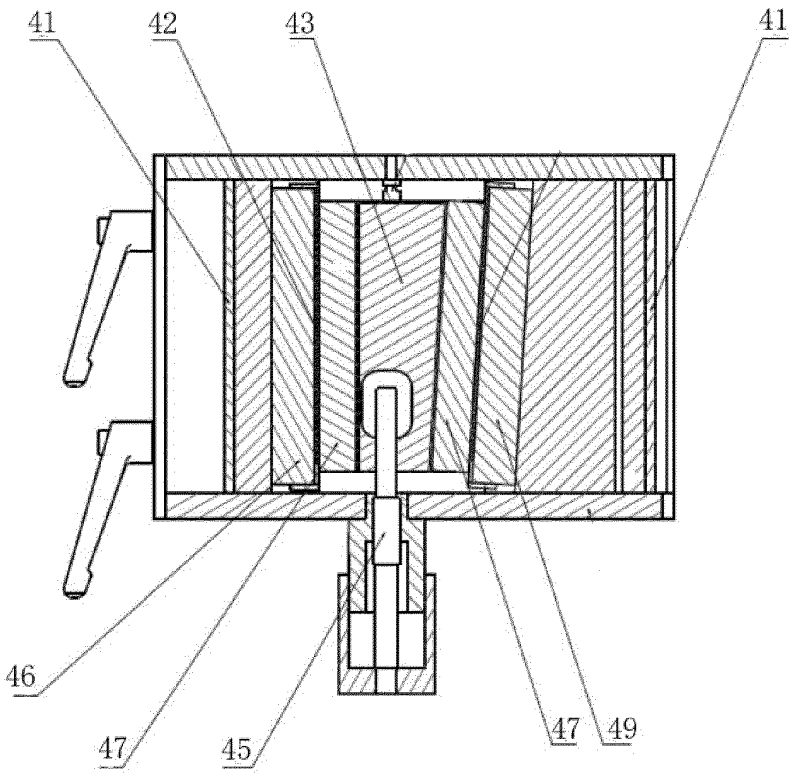

Figure 7

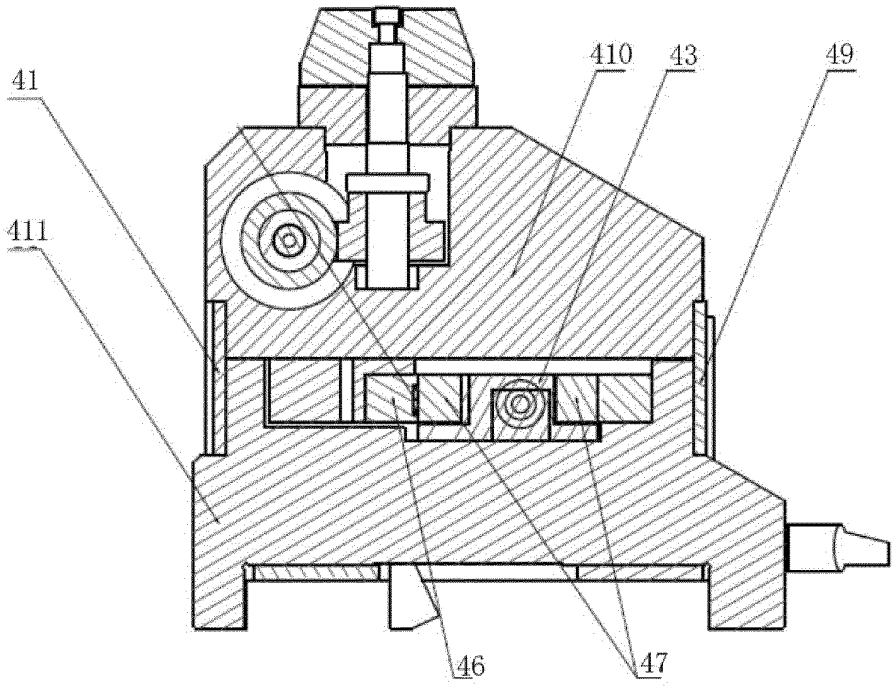

Figure 8

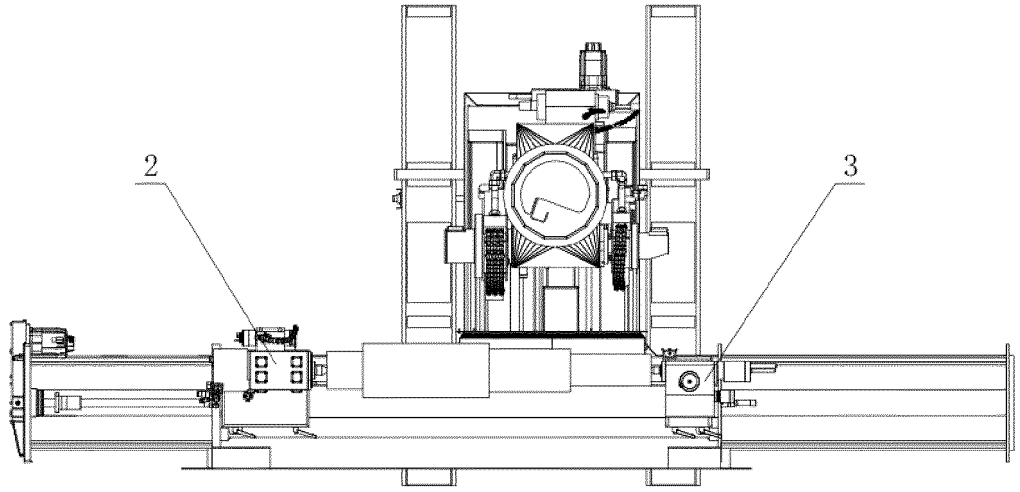

Figure 9

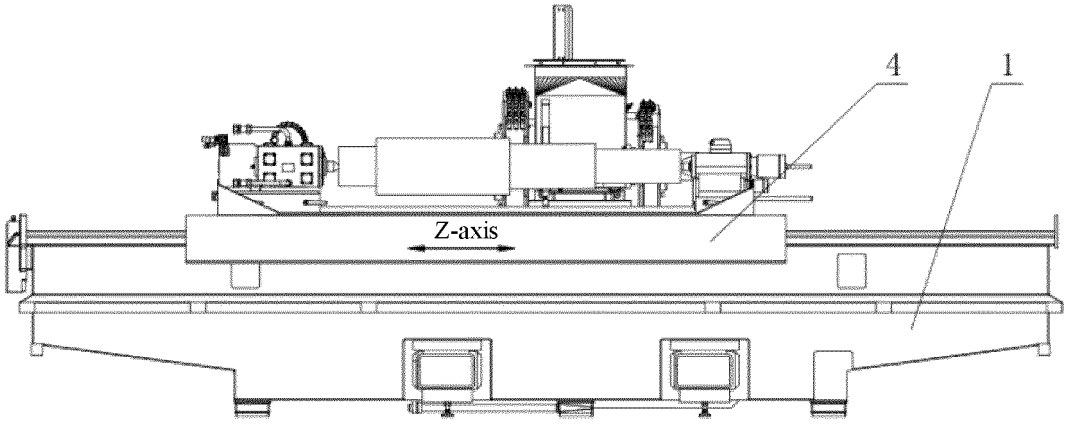

Figure 10

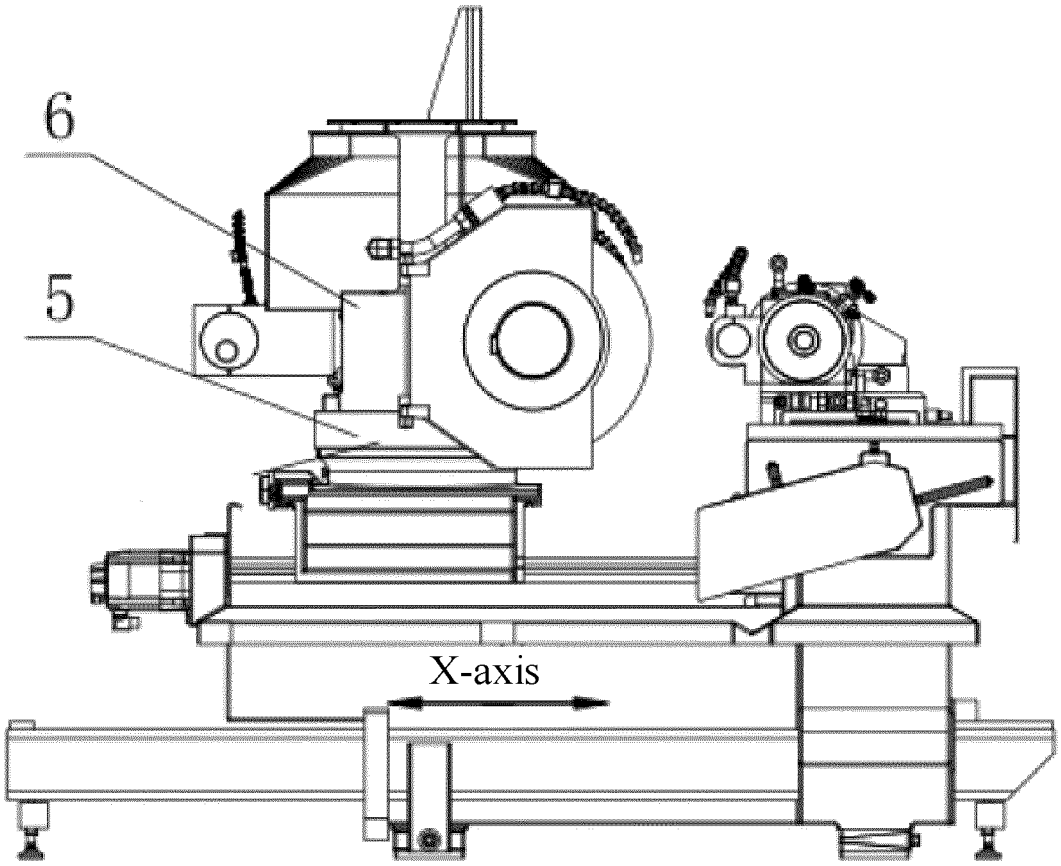

Figure 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/089928

A. CLASSIFICATION OF SUBJECT MATTER

B24B 5/04(2006.01)i; B24B 41/06(2012.01)i; B23Q 1/01(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)

B24B;B23Q

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)

CNABS, CNTXT, CNKI: 磨床, 外圆, X轴, Z轴, B轴, 旋转, 力矩电机, 气浮, 导轨, 静压, 油腔, 负压, 头架, 尾架, 调节, 楔形, 导向; VEN, UXTXT, EPTXT, WOTXT: grind, rotate, torque, motor, air, float, guide, static, wedge, pressure, oil, adjust.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 206883336 U (CHONGQING YUE CANON MACHINE TOOL CO., LTD.) 16 January 2018 (2018-01-16) description, paragraphs 24-87, and figures 1-8	1
Y	CN 206883336 U (CHONGQING YUE CANON MACHINE TOOL CO., LTD.) 16 January 2018 (2018-01-16) description, paragraphs 24-87, and figures 1-8	2-10
X	CN 201012467 Y (YANGZHOU UNIVERSITY) 30 January 2008 (2008-01-30) description, specific embodiments, and figure 1	1
Y	CN 201012467 Y (YANGZHOU UNIVERSITY) 30 January 2008 (2008-01-30) description, specific embodiments, and figure 1	2-10
Y	CN 107953217 A (SHANGHAI MACHINE TOOL WORKS LTD.) 24 April 2018 (2018-04-24) description, paragraphs 11-13, figures 1-2	2-10
Y	CN 210209420 U (YUANMENG PRECISION TECHNOLOGY (SHENZHEN) INSTITUTE) 31 March 2020 (2020-03-31) description, paragraphs 32-33, and figures 1-4	5-10

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2021	**24 December 2021**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/089928

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 209830893 U (GUANGZHOU KEQIN EDUCATION CONSULTING CO., LTD.) 24 December 2019 (2019-12-24) description, paragraphs 18-19, and figures 1-3	5-10
Y	CN 101549460 A (DONGHUA UNIVERSITY) 07 October 2009 (2009-10-07) description, embodiment 1, and figures 1-2	7-10
Y	CN 109465748 A (HUACHEN PRECISION EQUIPMENT (KUNSHAN) CO., LTD.) 15 March 2019 (2019-03-15) description, paragraphs 18-27, figures 1-3	10
A	CN 206702608 U (JIANGSU HABO PRECISION MACHINERY TECHNOLOGY CO., LTD.) 05 December 2017 (2017-12-05) entire document	1-10
A	JP 2000218527 A (OKUMA MACHINERY WORKS LTD.) 08 August 2000 (2000-08-08) entire document	1-10

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/089928

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CN 206883336 U	16 January 2018	None	
CN 201012467 Y	30 January 2008	None	
CN 107953217 A	24 April 2018	CN 207824624 U	07 September 2018
CN 210209420 U	31 March 2020	None	
CN 209830893 U	24 December 2019	None	
CN 101549460 A	07 October 2009	None	
CN 109465748 A	15 March 2019	None	
CN 206702608 U	05 December 2017	None	
JP 2000218527 A	08 August 2000	None	

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