

## **AUTOMATIC DRILLING MACHINE**

### Technical Field

5        The present invention relates to the technical field of drilling apparatus, in particular to a drilling machine capable of automatically performing drilling operations on upper and lower surfaces of a workpiece.

### Technical Background

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Currently, many steps in a process of drilling a hole in the surface of a metal part, such as an aluminum block, require manual participation, such as steps of: measuring the size of the aluminum block, the position of the hole, and the size of the hole, etc; placing the aluminum block on an operating table and pushing it to a predetermined position for fixing; drilling the hole on the surface of the aluminum block, etc. In addition, when it is intended to drill holes in upper and lower surfaces of the aluminum block respectively, it is necessary to turn over the aluminum block, and then performing fixing and measuring operations again. As a result, multiple steps of the entire drilling process require manual operation, which reduces the automation of the drilling apparatus, thus rendering the operation efficiency low. Moreover, precision of the drilling operation is not sufficient, resulting in a phenomenon that the aluminum block cannot be assembled with other components, so that the speed and accuracy of assembling operations will be affected.

### Summary of the Invention

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The present invention aims to provide an automatic drilling machine, which is of high degree of automation, high drilling accuracy, and capable of drilling holes in upper and lower surfaces of a metal part.

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The present invention proposes an automatic drilling machine, comprising: a delivering rail mounted on a working table, for receiving a metal part and allowing the metal part to move back and forth thereon; a first drilling device mounted above the

delivering rail, for drilling an upper surface of the metal part; a second drilling device mounted under the delivering rail, for drilling a lower surface of the metal part; a pushing assembly for pushing the metal part to move forward along the delivering rail; a first moving assembly for driving the pushing assembly to move back and forth  
5 along the delivering rail; a second moving assembly for driving the first drilling device to move back and forth; a third moving assembly for driving the first drilling device to move up and down; a fourth moving assembly for driving the second drilling device to move back and forth; a fifth moving assembly for driving the second drilling device to move up and down; a limiting assembly for blocking a forward  
10 movement of the metal part located at a drilling station; a locking assembly for fixing the metal part located at the drilling station; at least one sensor arranged at one side of the delivering rail, for detecting whether the metal part is on the delivering rail; and an electric control box with a PLC arranged therein. The first drilling device, the second drilling device, the pushing assembly, the first moving assembly, the second moving  
15 assembly, the third moving assembly, the fourth moving assembly, the fifth moving assembly, the limiting assembly, the locking assembly and the sensor are connected to the electric control box respectively, and controlled by the PLC.

The pushing assembly comprises a first cylinder, a supporting member, a pushing  
20 block, and a spring. The supporting member is driven up and down by the first cylinder, and the pushing block is slidably arranged in front of the supporting member, the spring being arranged between the supporting member and the pushing block.

Two pushing assemblies are provided, one located behind the other. A connecting  
25 plate, to which a connecting element is fixedly connected, is fixedly connected between said two pushing assemblies, the connecting element being connected with the first moving assembly.

The first moving assembly comprises a first guide rail, a first ball screw, a first  
30 motor, and a first synchronizing wheel assembly. The first guide rail is arranged at one side of the delivering rail and parallel to a length direction of the delivering rail. The first ball screw is parallel to the first guide rail, and the connecting element is mounted on the first guide rail, and fixedly connected to a nut seat provided on the

first ball screw. The first synchronous wheel assembly consists of a synchronous wheel fixed on an output shaft of the first motor, a synchronous wheel fixed on the first ball screw, and a synchronous belt. The first motor drives the first ball screw in rotation through the first synchronizing wheel assembly, thereby driving the  
5 connecting element to move forward or backward.

The second moving assembly includes a second guide rail, a second ball screw, a second motor, and a second synchronous wheel assembly. The second guide rail is arranged at one side above the delivering rail and is parallel to the length direction of  
10 the delivering rail. The second ball screw is parallel to the second guide rail, and the first drilling device is mounted on a first drilling device mounting assembly, which is mounted on the second guide rail and fixedly connected to a nut seat provided on the second ball screw. The second synchronous wheel assembly consists of a synchronous  
15 wheel fixed on an output shaft of the second motor, a synchronous wheel fixed to the second ball screw, and a synchronous belt. The second motor drives the second ball screw in rotation through the second synchronous wheel assembly, thus driving the first drilling device mounting assembly to move forward or backward.

The third moving assembly is mounted on the first drilling device mounting  
20 assembly, and includes a third guide rail, a third ball screw, a third motor, and a third synchronous wheel assembly. The third guide rail and the third ball screw are both vertically arranged, and the first drilling device mounting assembly includes a first fixing plate fixedly connected to the first drilling device, the first fixing plate being mounted on the third guide rail and fixedly connected to a nut seat provided on the  
25 third ball screw. The third synchronous wheel assembly consists of a synchronous wheel fixed on an output shaft of the third motor, a synchronous wheel fixed to the third ball screw, and a synchronous belt. The third motor drives the third ball screw in rotation through the third synchronous wheel assembly, thus driving the first fixing plate to move up or down.

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The fourth moving assembly includes a fourth guide rail, a fourth ball screw, a fourth motor, and a fourth synchronous wheel assembly. The fourth guide rail is mounted at one side below the delivering rail, and parallel to the length direction of

the delivering rail. The fourth ball screw is parallel to the fourth guide rail, and the second drilling device is mounted on the second drilling device mounting assembly, which is mounted on the fourth guide rail and fixedly connected to a nut seat provided on the fourth ball screw. The fourth synchronous wheel assembly consists of a synchronous wheel fixed on an output shaft of the fourth motor, a synchronous wheel  
5 fixed to the fourth ball screw, and a synchronous belt. The fourth motor drives the fourth ball screw in rotation through the fourth synchronous wheel assembly, thus driving the second drilling device mounting assembly to move forward or backward.

10 The fifth moving assembly is mounted on the second drilling device mounting assembly, and includes a fifth guide rail, a fifth ball screw, a fifth motor, and a fifth synchronous wheel assembly. The fifth guide rail and the fifth ball screw are both vertically arranged, and the second drilling device mounting assembly includes a second fixing plate fixedly connected to the second drilling device, the second fixing  
15 plate being mounted on the fifth guide rail and fixedly connected to a nut seat provided on the fifth ball screw. The fifth synchronous wheel assembly consists of a synchronous wheel fixed on an output shaft of the fifth motor, a synchronous wheel fixed to the fifth ball screw, and a synchronous belt. The fifth motor drives the fifth ball screw in rotation through the fifth synchronous wheel assembly, thus driving the  
20 second fixing plate to move up or down.

Two limiting assemblies are provided, one of which is arranged at a front end of the delivering rail while the other is arranged at a middle portion thereof. Each of the limiting assemblies includes a limiting block, a second cylinder and a limiting bracket,  
25 wherein the limiting bracket, on which the second cylinder is mounted, is mounted on one side of the delivering rail, and the limiting block is driven by the second cylinder to extend toward or retract away from the delivering rail.

The locking assembly includes a locking cylinder assembly, a rotary clamping cylinder assembly and an ejector cylinder assembly. Multiple locking cylinder  
30 assemblies are provided at a middle section of the delivering rail, each of the locking cylinder assemblies including a clamping block, a third cylinder and a clamping installation block. The clamping installation block is fixedly mounted on the working

table, the third cylinder is mounted on the clamping installation block, and the clamping block is formed as an L-shaped structure by a horizontal plate and a vertical plate, wherein the horizontal plate is fixed to the third cylinder, and driven thereby to move left and right. When the third cylinder is retracted, the vertical plate of the clamping block clamps a side surface of the metal part located at the clamping block. Multiple rotary clamping cylinder assemblies are provided at front and middle sections of the delivering rail, each of the rotary clamping cylinder assemblies including a rotary clamping cylinder, and a pressing element, which is mounted on an output shaft of the rotary clamping cylinder, and driven by the rotary clamping cylinder in rotation to press down on a top of the metal part located there. Multiple ejector cylinder assemblies are provided at the front section of the delivering rail, each of the ejector cylinder assemblies including a fourth cylinder, and an ejector rod, which is fixed to an output shaft of the fourth cylinder, and driven by the fourth cylinder to push forward a side surface of the metal part located there or retract backward.

Compared with the prior arts, the automatic drilling machine of the present invention realizes the automation of pushing, limiting, locking and drilling metal parts, and has a high degree of overall automation, which can greatly reduce labor intensity and improve processing efficiency with high accuracy. Moreover, the upper and lower surfaces of the metal parts can be drilled, so that the drilling operations are more convenient.

#### Brief Description of the Drawings

Figure 1 is a perspective view of an automatic drilling machine according to the present invention in an assembled state.

Figure 2 is a perspective view of the automatic drilling machine according to the present invention, when a metal part is placed thereon.

Figure 3 is a front view of the automatic drilling machine according to the present invention.

Figure 4 is a rear view of the automatic drilling machine according to the present invention.

5        Figure 5 schematically shows the structure of a first drilling device and a first drilling device mounting assembly thereof;

Figure 6 is a front view of a second drilling device and a lower mounting frame.

10       Figure 7 is a perspective view of the second drilling device and the lower mounting frame, viewed from the rear.

Figure 8 schematically shows the structure of a pushing assembly.

15       Figure 9 schematically shows the structure of a limiting assembly.

Figure 10 schematically shows the structure of a locking cylinder assembly.

20       Figure 11 schematically shows the structure of a rotary clamping cylinder assembly.

Figure 12 schematically shows the structure of an ejector cylinder assembly.

25       Figure 13 schematically shows the structure of a connection between a front pushing assembly and a rear pushing assembly.

#### Detailed Description of the Embodiments

30       In the following, embodiments of the present invention will be further illustrated with reference to the accompany drawings.

Referring to Figures 1 to 4, an automatic drilling machine according to the present invention mainly includes: a delivering rail 2 mounted on a working table 20,

for receiving a metal part 10 and allowing the metal part 10 to move back and forth thereon; a first drilling device 11 mounted above the delivering rail 2, for drilling an upper surface of the metal part 10; a second drilling device 12 mounted below the delivering rail 2, for drilling a lower surface of the metal part 10; a pushing assembly 3 for pushing the metal part 10 to move forward along the delivering rail 2; a first moving assembly for driving the pushing assembly 3 to move back and forth along the delivering rail 2; a second moving assembly for driving the first drilling device 11 to move back and forth; a third moving assembly for driving the first drilling device 11 to move up and down; a fourth moving assembly for driving the second drilling device 12 to move back and forth; a fifth moving assembly for driving the second drilling device 12 to move up and down; a limiting assembly 5 for blocking a forward movement of the metal part 10 located at a drilling station; a locking assembly for fixing the metal part 10 located at the drilling station; multiple sensors for detecting whether the metal part 10 is on the delivering rail 2; and an electric control box with a PLC (Programmable Logic Controller) arranged therein. The first drilling device 11, the second drilling device 12, the pushing assembly 3, the first moving assembly, the second moving assembly, the third moving assembly, the fourth moving assembly, the fifth moving assembly, the limiting assembly 5, the locking assembly and the sensors are connected to the electric control box respectively, and controlled by the PLC.

The delivering rail 2 is a linear rail extending in a front-to-rear direction. The rail is provided with two rows of rollers, a right row and a left row. The metal part 10 can be placed between said two rows of rollers, and can move along a length direction of the delivering rail 2 under a thrust force.

As shown in Figure 8, the pushing assembly 3 includes a first cylinder 31, a supporting member 32, a pushing block 33, and a spring 34. The supporting member 32 is driven by the first cylinder 31 to move up and down, and the pushing block 33 is slidably arranged in front of the supporting member 32, wherein the spring 34 is arranged between the supporting member 32 and the pushing block 33. In this embodiment, two pushing assemblies 3 are provided to push two metal parts 10, one located behind the other, at the same time. As shown in Figure 13, said two pushing assemblies 3 are arranged one behind the other, with a distance between said two

pushing assemblies 3 being greater than a length of the metal part 10. A connecting plate 35 is connected between the two pushing assemblies 3. One end of the supporting member 32 is hinged to an end of the connecting plate 35, and the other end thereof is connected to the pushing block 33. The connecting plate 35 is fixedly  
5 connected to a connecting element 36, which is used to connect with the first moving assembly. By means of which, the first moving assembly can drive the two pushing assemblies 3 to move forward or backward at the same time through the connecting element 36 and the connecting plate 35. The supporting member 32 spans over the delivering rail 2. When the first cylinder 31 drives the supporting member 32 to move  
10 down, the height of the pushing block 33 corresponds to the metal part 10 placed on the delivering rail 2. When the pushing assembly 3 moves forward, the metal part 10 will be pushed forward also, and in this case, the spring 34 can provide buffering effect against the thrust force. When the first cylinder 31 drives the supporting member 32 to move up, the height of the pushing block 33 and the supporting  
15 member 32 located therebehind is higher than the metal part 10. At this time, the pushing assembly 3 will not touch the metal part 10 even if it moves back and forth.

As shown in Figures 1 and 4, the first moving assembly includes a first guide rail 411, a first ball screw 412, a first motor 413, and a first synchronous wheel assembly  
20 414. The first guide rail 411 is arranged at one side of the delivering rail 2 and parallel to the length direction of the delivering rail 2. The first ball screw 412 is parallel to the first guide rail 411. The connecting element 36 is mounted on the first guide rail 411, and fixedly connected to a nut seat provided on the first ball screw 412. In order to move more smoothly, the connecting plate 35 is also mounted on the first guide rail  
25 411. The first motor 413 is arranged at a rear end of the delivering rail 2. The first synchronous wheel assembly 414 consists of a synchronous wheel fixed on an output shaft of the first motor 413, a synchronous wheel fixed on the first ball screw 412, and a synchronous belt. In this manner, the engagement between teeth of the synchronous belt and grooves of the synchronous wheels can provide power transmission. The first  
30 motor 413 drives the first ball screw 412 in rotation through the first synchronizing wheel assembly 414, thereby driving the connecting element 36, the connecting plate 35 fixed thereto, and two pushing assemblies 3 to move forward or backward at the same time.

As shown in Figure 5, an upper mounting frame 30 is fixed at a position above the working table 20 on a side of a middle section of the delivering rail 2. The first drilling device 11 is mounted on a first drilling device mounting assembly 81, which is mounted on the upper mounting frame 30 and includes a first fixing plate 811 fixedly connected to the first drilling device 11. After being mounted, the first drilling device 11 is located at a position above the delivering rail 2. The second moving assembly and the third moving assembly are also mounted on the upper mounting frame 30.

As shown in Figures 1 and 4, the second moving assembly includes a second guide rail 421, a second ball screw 422, a second motor 423 and a second synchronous wheel assembly 424. The second guide rail 421 and the second ball screw 422 are both parallel to the length direction of the delivering rail 2. The first drilling device mounting assembly 81 is mounted on the second guide rail 421, and fixedly connected to a nut seat provided on the second ball screw 422. The second motor 423 can be arranged at a front end of the second guide rail 421. The second synchronous wheel assembly 424 consists of a synchronous wheel fixed on an output shaft of the second motor 423, a synchronous wheel fixed to the second ball screw 422, and a synchronous belt. The second motor 423 drives the second ball screw 422 in rotation through the second synchronous wheel assembly 424, thus driving the first drilling device mounting assembly 81 and the first drilling device 11 to move forward or backward.

As shown in Figures 4 and 5, the third moving assembly is mounted on the first drilling device mounting assembly 81, and includes a third guide rail 431, a third ball screw 432, a third motor 433, and a third synchronous wheel assembly 434. Two third guide rails 431 are vertically arranged on both sides of the first drilling device mounting assembly 81. The third ball screw 432 is vertically arranged in the middle of the first drilling device mounting assembly 81. The first fixing plate 811 is arranged on both third guide rails 431, and fixedly connected to a nut seat provided on the third ball screw 432. The third motor 433 is arranged on the top of the back side of the first drilling device mounting assembly 81. The third synchronous wheel assembly 434

consists of a synchronous wheel fixed on an output shaft of the third motor 433, a synchronous wheel fixed to the third ball screw 432, and a synchronous belt. The third motor 433 drives the third ball screw 432 into rotation through the third synchronous wheel assembly 434, thus driving the first fixing plate 811 and the first drilling device  
5 11 to move up or down.

As shown in Figures 3, 4, 6 and 7, a lower mounting frame 40 is fixed at a position under the working table 20 on a side of a front section of the delivering rail 2. The second drilling device 12 is mounted on a second drilling device mounting  
10 assembly 82, which is mounted on the lower mounting frame 40 and includes a second fixing plate 821 fixedly connected to the second drilling device 12. After being mounted, the second drilling device 12 is located at a position under the delivering rail 2. Of course, the working table 20 and the delivering rail 2 are both provided with  
15 openings at appropriate positions, so that the second drilling device 12 can pass upward through the working table 20 and the delivering rail 2 to perform drilling operations on the metal part 10. The fourth moving assembly and the fifth moving assembly are also mounted on the lower mounting frame 40.

As shown in Figures. 6 and 7, the fourth moving assembly includes a fourth  
20 guide rail 441, a fourth ball screw 442, a fourth motor 443 and a fourth synchronous wheel assembly 444. The fourth guide rail 441 and the fourth ball screw 442 are both parallel to the length direction of the delivering rail 2. The second drilling device mounting assembly 82 is mounted on the fourth guide rail 441, and fixedly connected to a nut seat provided on the fourth ball screw 442. The fourth motor 443 can be  
25 arranged at a front end of the fourth guide rail 441. The fourth synchronous wheel assembly 444 consists of a synchronous wheel fixed on an output shaft of the fourth motor 443, a synchronous wheel fixed to the fourth ball screw 442, and a synchronous belt. The fourth motor 443 drives the fourth ball screw 442 in rotation through the fourth synchronous wheel assembly 444, thus driving the second drilling device  
30 mounting assembly 82 and the second drilling device 12 to move forward or backward.

The fifth moving assembly is mounted on the second drilling device mounting

assembly 82, and includes a fifth guide rail 451, a fifth ball screw 452, a fifth motor 453, and a fifth synchronous wheel assembly 454. Two fifth guide rails 451 are vertically arranged on both sides of the second drilling device mounting assembly 82. The fifth ball screw 452 is vertically arranged at the middle of the second drilling device mounting assembly 82. The second fixing plate 821 is arranged on both fifth guide rails 451, and fixedly connected to a nut seat provided on the fifth ball screw 452. The fifth motor 453 is mounted at the bottom of the back side of the second drilling device mounting assembly 82. The fifth synchronous wheel assembly 454 consists of a synchronous wheel fixed on an output shaft of the fifth motor 453, a synchronous wheel fixed to the fifth ball screw 452, and a synchronous belt. The fifth motor 453 drives the fifth ball screw 452 in rotation through the fifth synchronous wheel assembly 454, thus driving the second fixing plate 821 and the second drilling device 12 to move up or down.

In this embodiment, there are two limiting assemblies 5, one of which is arranged at the front end of the delivering rail 2 while the other is arranged at the middle thereof. As shown in Figure 9, each of the limiting assemblies 5 includes a limiting block 51, a second cylinder 52, and a limiting bracket 53. The limiting bracket 53 is mounted on one side of the delivering rail 2, and the second cylinder 52 is mounted on the limiting bracket 5. The limit block 51 is driven by the second cylinder 52 to extend toward or retract away from the delivering rail 2. Preferably, a rear end face 511 of the limiting block 51 may be provided with a cut corner, which corresponds to a front end face of the metal part 10 in terms of shape. When the limiting block 51 is driven by the second cylinder 52 to extend, it is located slightly above the delivering rail 2, so as to prevent the metal part 10 located therebehind from moving forward on the delivering rail 2. When the limiting block 51 is driven by the second cylinder 52 to retract, the limiting block 51 leaves away from the delivering rail 2, so that the metal part 10 on the delivering rail 2 is no longer blocked by the limiting block 51.

The locking assembly includes a locking cylinder assembly 61 for locking a side of the metal part 10, a rotary clamping cylinder assembly 62 for pressing a top of the metal part 10, and an ejector cylinder assembly 63 for pressing the side of the metal part 10.

As shown in Figure 10, the locking cylinder assembly 61 includes a clamping block 611, a third cylinder 612, and a clamping installation block 613. The clamping installation block 613 is fixedly mounted on the working table 20, and the third cylinder 612 is mounted on the clamping installation block 613. The clamping block 611 is formed as an L-shaped structure by a horizontal plate and a vertical plate, wherein the horizontal plate is fixed to the third cylinder 612, and the vertical plate is located outside of the side of the metal part 10. The clamping block 611 can be driven by the third cylinder 612 to move left or right. When the third cylinder 612 is retracted, the vertical plate of the clamping block 611 will clamp the side of the metal part 10 located at the clamping block 611. In this embodiment, several locking cylinder assemblies 61 are provided, and distributed along the length direction of the delivering rail 2. Of course, these locking cylinder assemblies 61 are mounted at the drilling station of the metal part 10 in the middle section of the delivering rail 2, for clamping the side of the metal part 10 to facilitate the subsequent drilling operation.

As shown in Figure 11, the rotary clamping cylinder assembly 62 includes a rotary clamping cylinder 621 and a pressing element 622. The pressing element 622 is mounted on an output shaft of the rotary clamping cylinder 621, and driven by the rotary clamping cylinder 621 in rotation to press down on the top of the metal part 10 located there. In this embodiment, multiple rotary clamping cylinder assemblies 62 are provided, and located at the drilling station of the metal part 10 in the front and middle sections of the delivering rail 2, respectively.

Multiple ejector cylinder assemblies 63 are provided, and located at the drilling station of the metal part 10 in the front section of the delivering rail 2, respectively. As shown in Figure 12, each of the ejector cylinder assemblies 63 includes a fourth cylinder 631 and an ejector rod 632. The ejector rod 632 is fixed to an output shaft of the fourth cylinder 631, and thus can be driven by the fourth cylinder 631 to move forward to press against the side of the metal member 10 located there, or retract backward.

There are three sensors distributed along one side of the delivering rail 2, for

detecting whether there is a metal part 10 on the delivering rail 2 at the positions where the sensors are located. As shown in Figure 1, in this embodiment, said three sensors include a rear sensor 71 located in the rear section of the delivering rail 2, a middle sensor 73 located in the middle section of the delivering rail 2, and a front sensor 72 located in the front section of the delivering rail 2. As shown in Figure 9, the middle sensor 73 may be arranged on the side of the delivering rail 2 where the limiting assembly 5 is located.

In addition, in order to ensure safe operations of the automatic drilling machine according to the present invention, as shown in Figure 1, a first front limit switch 92 and a first rear limit switch 91 are provided at the front and rear ends of the first ball screw 412, respectively. A first origin sensor 74 is further provided near the first rear limit switch 91. Moreover, a second front limit switch 932 and a second rear limit switch 931 are provided on the upper mounting frame 30, at the front and rear ends of the second guide rail 421, respectively. A second origin sensor 75 is further provided near the second front limit switch 932. As shown in Figure 5, a first ascending limit switch 941 and a first descending limit switch 942 are provided on upper and lower portions of a side of the first drilling device mounting assembly 81, respectively, and a third origin sensor 76 is further provided above the third rail 431. As shown in Figure 6, a third front limit switch 952 and a third rear limit switch 951 are provided on the lower mounting frame 40, at the front and rear ends of the fourth guide rail 441, respectively. A fourth origin sensor 77 is further provided near the third front limit switch 952. A second ascending limit switch 961 and a second descending limit switch 962 are provided on upper and lower portions of the side of the second drilling device mounting assembly 82, respectively, and a fifth origin sensor 78 is further provided at a lower portion of the fifth guide rail 451.

Each of the above-mentioned limit switches is a micro switch or a travel switch. In the case that a corresponding component should, after being driven forward or backward by the first motor 413 to its predetermined position, be stopped but cannot be stopped, the nut seat on the first ball screw 412 would touch the first front limit switch 92 or the first rear limit switch 91, so that the first motor 413 would immediately stop, whereby forward and backward protection can be achieved. In the

case that a corresponding component should, after being driven forward or backward by the second motor 423 to its predetermined position, be stopped but cannot be stopped, the second front limit switch 932 or the second rear limit switch 931 would be touched, so that the second motor 423 would immediately stop. In the case that the first drilling device 11 should, after being driven upward or downward by the third motor 433 to its predetermined position, be stopped but cannot be stopped, the first ascending limit switch 941 or the first descending limit switch 942 would be touched, so that the third motor 433 would immediately stop. Similarly, in the case that a corresponding component should, after being driven forward or backward by the fourth motor 443 to its predetermined position, be stopped but cannot be stopped, the third front limit switch 952 or the third rear limit switch 951 would be touched, so that the fourth motor 443 would immediately stop. And in the case that the second drilling device 12 should, after being driven upward or downward by the fifth motor 453 to its predetermined position, be stopped but cannot be stopped, the second ascending limit switch 961 or the second descending limit switch 962 would be touched, so that the fifth motor 453 would immediately stop.

Each time when the entire machine is turned on, the first motor 413 is automatically activated to drive the first ball screw 412 in rotation, thus driving the nut seat on the first ball screw 412 and the components fixed on the nut seat, such as the pushing assembly 3, to return to the position of the first origin sensor 74. When the first origin sensor 74 outputs a signal, a corresponding electrical device in the electric control box will issue an instruction to stop the first motor 413 first, and then start it, thus driving the above components to their predetermined positions respectively. Similarly, each time when the entire machine is turned on, by means of the second origin sensor 75, the second motor 423 drives the first drilling device 11, the first drilling device mounting assembly 81, and the components mounted on the first drilling device mounting assembly 81 to their predetermined positions respectively. Again, each time when the entire machine is turned on, by means of the third origin sensor 76, the third motor 433 drives the first drilling device 11 to its predetermined position; by means of the fourth origin sensor 77, the fourth motor 443 drives the second drilling device 12, the second drilling device mounting assembly 82, and the components mounted on the second drilling device mounting assembly 82 to

their predetermined positions respectively; and by means of the fifth origin sensor 78, the third motor 453 drives the second drilling device 12 to its predetermined position.

5 The process of performing drilling operations on the metal part 10 with the automatic drilling machine according to the present invention is as follows.

1. The machine is turned on, and the size and the model of the metal part 10 to be drilled are set.

10 2. At this time, the first motor 413, the second motor 423, the third motor 433, the fourth motor 443, and the fifth motor 453 are all activated to return to their origins, respectively. When corresponding origin sensors are detected respectively, each of the above motors drives its corresponding ball screw in rotation, thus driving the nut seat arranged on the ball screw and the component(s) fixed on the nut seat to their  
15 predetermined positions, respectively.

3. The metal part 10 to be drilled is placed on the rear section of the delivering rail 2, so that the rear sensor 71 can sense existence of the metal part 10.

20 4. The first motor 413 is activated again, and according to the setting, drives the first synchronous wheel assembly 414 in rotation, thereby driving the first ball screw 412 to rotate. After the first ball screw 412 rotates, it drives the nut seat arranged thereon and the pushing assembly 3 connecting to the nut seat to push the metal part 10 forward. At this time, the second cylinder 52 and the limiting block 51 of the  
25 limiting assembly 5 in the middle of the delivering rail 2 are both in an extended state.

5. When the metal part 10 is pushed to contact the limiting assembly 5 in the middle of the delivering rail 2, the cut corner of the front end of the metal part 10 just enters the cut corner of the back end face 511 of the limiting block 51 of the limiting  
30 assembly 5. At this time, the metal part 10 is located at the drilling station in the middle of the delivering rail 2, and at the same time, the middle sensor 73 also outputs a signal, so that the first motor 413 stops.

6. After the first motor 413 is stopped, the electrical control device in the electric control box issues an instruction, according to the signal from the middle sensor 73 and a signal indicating that the second cylinder 52 of the limiting assembly 5 in the middle of the delivering rail 2 extends to its predetermined position, for retracting the third cylinder 612 in the locking cylinder assembly 61. The clamping block 611 clamps the side of the metal part 10, and at the same time, the rotary clamping cylinder 621 in the middle section of the delivering rail 2 will rotate to press down, so that the pressing element 622 presses the upper surface of the metal part 10. In this manner, the metal part 10 is completely fixed at the drilling station in the middle of the delivering rail 2.

7. When the metal part 10 is fixed at the drilling station in the middle of the delivering rail 2 and the electrical element on the corresponding component sends out a signal, the first drilling device 11 and the third motor 433 are activated. At the same time, the third motor 433 drives, through the third synchronization wheel assembly 434, the third ball screw 432 in rotation, thereby driving the first drilling device 11 to move downward under the guidance of the third guide rails 431.

8. When the first drilling device 11 is lowered to touch the upper surface of the metal part 10, the drilling operation starts. The descending distance of the first drilling device 11 is preset. After the preset distance is reached so that the drilling operation is completed, the third motor 433 rotates reversely, so as to raise the first drilling device 11 to its initial position.

9. Next, if it is necessary to drill the metal part 10 at another position, the second motor 423 is activated to drive the second synchronous wheel assembly 424 in rotation, so that the second ball screw 422 rotates. The second ball screw 422 drives the first drilling device 11 fixed on the nut seat of the second ball screw 422 and the first drilling device mounting assembly 81 to move to their predetermined positions respectively, under the guidance of the second guide rail 421.

10. The above steps 7 and 8 are repeated when the first drilling device 11 reaches a position above the set position of the metal part 10, thus completing the drilling

operation.

11. After the drilling operation on the metal part 10 is completed by the first drilling device 11 at the drilling station, the limiting assembly 5 in the middle of the delivering rail 2, the rotary clamping cylinder assembly 62 and the locking cylinder assembly 61 act simultaneously and return to their respective initial positions. After these assemblies return to their initial positions, a signal is transmitted to the electric control box. Then, the electrical control device in the electric control box issues an instruction to activate the second cylinder 52 of the limiting assembly 5, which is located at the front end of the delivering rail 2, so that the limiting block 51 is extended. At the same time, the first motor 413 is activated to transport the metal part 10 to a processing position where the limiting assembly 5 at the front end of the delivering rail 2 is located, that is, the drilling station at the front portion of the delivering rail 2.

12. When the front cut corner of the metal part 10 just enters the cut corner of the rear end face 511 of the limiting block 51 of the limiting assembly 5 at the front end of the delivering rail 2, and the front sensor 72 detects existence of the metal part 10, the rotary clamping cylinder 621 of each of multiple rotary clamping cylinder assemblies 62 in the front section of the delivering rail 2 rotates to press down, so that the pressing element 622 presses against the upper surface of the metal part 10. At the same time, the cylinders in multiple ejector cylinder assemblies 63 extend to drive the ejector rod 632 fixed on the output shaft of each of the cylinders to press against the side of the metal part 10. Finally, the metal part 10 is fixed at the drilling station at the front portion of the delivering rail 2.

13. After all the actions of the above components are completed and thus a signal is sent to the electric control box, the electrical control device in the electric control box issues an instruction to activate the fourth motor 443 and the second drilling device 82.

14. After the fourth motor 443 is activated, it drives the fourth synchronous wheel assembly 444 in rotation, so that the fourth ball screw 442 rotates. Then, the

fourth ball screw 442 drives the second drill mounting assembly 82 fixed on the screw nut seat of the fourth ball screw 442 and the second drilling device 12 to their predetermined positions respectively, under the guiding action of the fourth guide rail 441.

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15. When the second drilling device 12 reaches its predetermined position, the fourth motor 443 stops, while at the same time the fifth motor 453 starts to drive the fifth synchronous wheel assembly 454 and thus the fifth ball screw 452 in rotation. Then, the fifth ball screw 452 drives the second drilling device 12 fixed on the screw nut seat of the fifth ball screw 452 to move upward. When the second drilling device 12 touches the lower surface of the metal part 10, it starts the drilling operation. After that, the fifth motor 453 rotates reversely, thus lowering the second drilling device 12 to its initial position.

15 16. If it is necessary to drill the metal part 10 at another position, steps 14 and 15 are repeated.

17. When the drilling operation is completed, the rotary clamping cylinder assembly 62 located at the front section of the delivering rail 2, the limiting assembly 20 5 at the front end of the delivering rail 2, and the ejector cylinder assembly 63 return to their respective starting positions at the same time. At this time, the finished metal part 10 can be taken away.

18. After the metal part 10 is removed and the components return to their 25 respective initial positions in step 17, the first cylinder 31 of each of said two pushing assemblies 3 is raised, thus pushing up one end of the supporting member 32 and the pushing block 33.

19. At this time, a new metal part 10 is placed at a feeding position, and is 30 detected by the rear sensor 71.

20. The first motor 413 is activated to drive the front and rear pushing assemblies 3 back to their initial positions, respectively.

21. When said two pushing assemblies 3 are in place, the first cylinder 31 in each of the assemblies is retracted, so that the end of the supporting member 32 and the pushing block 33 are pulled down. Then, the first motor 413 is activated again, so as  
5 to drive the pushing assemblies 3 to push the metal part 10 to the processing position.

22. After the metal part 10 reaches the processing position, the above steps are repeated, thus completing the drilling operations on the upper and lower surfaces of the metal part.

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It can be seen from the above that the automatic drilling machine of the present invention realizes the automation of pushing, limiting, locking and drilling metal parts, which can greatly reduce labor intensity and improve processing efficiency with high accuracy. Moreover, the upper and lower surfaces of the metal parts can be  
15 automatically drilled, so that the drilling operations are more convenient.

It should be understood that the foregoing embodiments are only used to illustrate, rather than restrict, the technical solutions of the present invention. Those of ordinary skills in the art can modify the technical solutions in the foregoing  
20 embodiments, or make equivalent replacements on some of the technical features therein. Obviously, these modifications or replacements would not deviate from the spirit and protection scope of the technical solutions of the embodiments of the present invention.

## CLAIMS

1. An automatic drilling machine, comprising:

a delivering rail (2) mounted on a working table (20), for receiving a metal part (10) and allowing the metal part (10) to move back and forth thereon;

a first drilling device (11) mounted above the delivering rail (2), for drilling an upper surface of the metal part (10);

a second drilling device (12) mounted under the delivering rail (2), for drilling a lower surface of the metal part (10);

a pushing assembly (3) for pushing the metal part (10) to move forward along the delivering rail (2);

a first moving assembly for driving the pushing assembly (3) to move back and forth along the delivering rail (2);

a second moving assembly for driving the first drilling device (11) to move back and forth;

a third moving assembly for driving the first drilling device (11) to move up and down;

a fourth moving assembly for driving the second drilling device (12) to move back and forth;

a fifth moving assembly for driving the second drilling device (12) to move up and down;

a limiting assembly (5) for blocking a forward movement of the metal part (10) located at a drilling station;

a locking assembly for fixing the metal part (10) located at the drilling station;

at least one sensor arranged at one side of the delivering rail (2), for detecting whether the metal part (10) is on the delivering rail (2); and

an electric control box with a PLC arranged therein,

wherein the first drilling device (11), the second drilling device (12), the pushing assembly (3), the first moving assembly, the second moving assembly, the third moving assembly, the fourth moving assembly, the fifth moving assembly, the limiting assembly (5), the locking assembly and the sensor are connected to the electric control box respectively, and controlled by the PLC.

2. The automatic drilling machine according to claim 1, characterized in that the pushing assembly (3) comprises a first cylinder (31), a supporting member (32), a pushing block (33), and a spring (34), wherein the supporting member (32) is driven up and down by the first cylinder (31), and the pushing block (33) is slidably arranged in front of the supporting member (32), the spring (34) being arranged between the supporting member (32) and the pushing block (33).

3. The automatic drilling machine according to claim 2, characterized in that two pushing assemblies (3) are provided, one located behind the other, and a connecting plate (35), to which a connecting element (36) is fixedly connected, is fixedly connected between said two pushing assemblies (3), the connecting element (36) being connected with the first moving assembly.

4. The automatic drilling machine according to claim 3, characterized in that the first moving assembly comprises a first guide rail (411), a first ball screw (412), a first motor (413), and a first synchronizing wheel assembly (414),

wherein the first guide rail (411) is arranged at one side of the delivering rail (2) and parallel to a length direction of the delivering rail (2);

the first ball screw (412) is parallel to the first guide rail (411), and the connecting element (36) is mounted on the first guide rail (411), and fixedly connected to a nut seat provided on the first ball screw (412);

the first synchronous wheel assembly (414) consists of a synchronous wheel fixed on an output shaft of the first motor (413), a synchronous wheel fixed on the first ball screw (412), and a synchronous belt; and

the first motor (413) drives the first ball screw (412) in rotation through the first synchronizing wheel assembly (414), thereby driving the connecting element (36) to move forward or backward.

5. The automatic drilling machine according to any one of claims 1 to 4, characterized in that the second moving assembly includes a second guide rail (421), a second ball screw (422), a second motor (423), and a second synchronous wheel assembly (424),

wherein the second guide rail (421) is arranged at one side above the delivering

rail (2) and is parallel to the length direction of the delivering rail (2);

the second ball screw (422) is parallel to the second guide rail (421), and the first drilling device (11) is mounted on a first drilling device mounting assembly (81), which is mounted on the second guide rail (421) and fixedly connected to a nut seat  
5 provided on the second ball screw (422);

the second synchronous wheel assembly (424) consists of a synchronous wheel fixed on an output shaft of the second motor (423), a synchronous wheel fixed to the second ball screw (422), and a synchronous belt; and

the second motor (423) drives the second ball screw (422) in rotation through the  
10 second synchronous wheel assembly (424), thus driving the first drilling device mounting assembly (81) to move forward or backward.

6. The automatic drilling machine according to claim 5, characterized in that the third moving assembly is mounted on the first drilling device mounting assembly (81),  
15 and includes a third guide rail (431), a third ball screw (432), a third motor (433), and a third synchronous wheel assembly (434),

wherein the third guide rail (431) and the third ball screw (432) are both vertically arranged, and the first drilling device mounting assembly (81) includes a first fixing plate (811) fixedly connected to the first drilling device (11), the first  
20 fixing plate (811) being mounted on the third guide rail (431) and fixedly connected to a nut seat provided on the third ball screw (432);

the third synchronous wheel assembly (434) consists of a synchronous wheel fixed on an output shaft of the third motor (433), a synchronous wheel fixed to the third ball screw (432), and a synchronous belt; and

25 the third motor (433) drives the third ball screw (432) in rotation through the third synchronous wheel assembly (434), thus driving the first fixing plate (811) to move up or down.

7. The automatic drilling machine according to any one of claims 1 to 4,  
30 characterized in that the fourth moving assembly includes a fourth guide rail (441), a fourth ball screw (442), a fourth motor (443), and a fourth synchronous wheel assembly (444),

wherein the fourth guide rail (441) is mounted at one side below the delivering

rail (2), and parallel to the length direction of the delivering rail (2);

the fourth ball screw (442) is parallel to the fourth guide rail (441) , and the second drilling device (12) is mounted on a second drilling device mounting assembly (82), which is mounted on the fourth guide rail (441) and fixedly connected to a nut seat provided on the fourth ball screw (442);

the fourth synchronous wheel assembly (444) consists of a synchronous wheel fixed on an output shaft of the fourth motor (443), a synchronous wheel fixed to the fourth ball screw (442), and a synchronous belt; and

the fourth motor (443) drives the fourth ball screw (442) in rotation through the fourth synchronous wheel assembly (444), thus driving the second drilling device mounting assembly (82) to move forward or backward.

8. The automatic drilling machine according to claim 7, characterized in that the fifth moving assembly is mounted on the second drilling device mounting assembly (82), and includes a fifth guide rail (451), a fifth ball screw (452), a fifth motor (453), and a fifth synchronous wheel assembly (454),

wherein the fifth guide rail (451) and the fifth ball screw (452) are both vertically arranged, and the second drilling device mounting assembly (82) includes a second fixing plate (821) fixedly connected to the second drilling device (12), the second fixing plate (821) being mounted on the fifth guide rail (451) and fixedly connected to a nut seat provided on the fifth ball screw (452);

the fifth synchronous wheel assembly (454) consists of a synchronous wheel fixed on an output shaft of the fifth motor (453), a synchronous wheel fixed to the fifth ball screw (452), and a synchronous belt; and

the fifth motor (453) drives the fifth ball screw (452) in rotation through the fifth synchronous wheel assembly (454), thus driving the second fixing plate (821) to move up or down.

9. The automatic drilling machine according to any one of claims 1 to 4, characterized in that two limiting assemblies (5) are provided, one of which is arranged at a front end of the delivering rail (2) while the other is arranged at a middle portion thereof,

wherein each of the limiting assemblies (5) includes a limiting block (51), a

second cylinder (52) and a limiting bracket (53), wherein the limiting bracket (53), on which the second cylinder (52) is mounted, is mounted on one side of the delivering rail (2), and the limiting block (51) is driven by the second cylinder (52) to extend toward or retract away from the delivering rail (2).

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10. The automatic drilling machine according to any one of claims 1 to 4, characterized in that the locking assembly includes a locking cylinder assembly (61), a rotary clamping cylinder assembly (62) and an ejector cylinder assembly (63),

wherein multiple locking cylinder assemblies (61) are provided at a middle  
10 section of the delivering rail (2), each of the locking cylinder assemblies (61) including a clamping block (611), a third cylinder (612) and a clamping installation block (613), wherein:

the clamping installation block (613) is fixedly mounted on the working  
table (20), the third cylinder (612) is mounted on the clamping installation block (613),  
15 and the clamping block (611) is formed as an L-shaped structure by a horizontal plate and a vertical plate, wherein the horizontal plate is fixed to the third cylinder (612), and driven thereby to move left and right, and

when the third cylinder (612) is retracted, the vertical plate of the clamping  
block (611) clamps a side surface of the metal part (10) located at the clamping block  
20 (611);

multiple rotary clamping cylinder assemblies (62) are provided at front and  
middle sections of the delivering rail (2), each of the rotary clamping cylinder  
assemblies (62) including a rotary clamping cylinder (621), and a pressing element  
(622), which is mounted on an output shaft of the rotary clamping cylinder (621), and  
25 driven by the rotary clamping cylinder (621) in rotation to press down on a top of the  
metal part (10) located there; and

multiple ejector cylinder assemblies (63) are provided at the front section of the  
delivering rail (2), each of the ejector cylinder assemblies (63) including a fourth  
cylinder (631), and an ejector rod (632), which is fixed to an output shaft of the fourth  
30 cylinder (631), and driven by the fourth cylinder (631) to push forward a side surface  
of the metal part (10) located there or retract backward.