

# **AUTOMATIC WORKPIECE PUNCHING SYSTEM**

## **Field of the Invention**

5

The present invention relates to a mechanical device, and in particular, to a device for punching a workpiece.

## **Background of the Invention**

10

Manual operations on a punching machine are typically performed in punching production with a conventional workpiece punching device. It is necessary for an operator to hold a workpiece and fix it at a fixture position of a punching die, in order to ensure accuracy of a punching position. A pedal is pressed to punch the workpiece after the hand of the operator is withdrawn, followed by manual removal of the workpiece. This production approach is not only ineffective and labor-intensive, thereby causing rising costs where labor costs rise, but also requires the operator to hold the workpiece to put it into the punching die. As a result, careless operations may easily lead to crush accidents and the like, which mean security risks.

20

## **Summary of the Invention**

The technical problem to be solved by the present invention is to provide an automatic workpiece punching system, with which a workpiece can be automatically fed into a punching die and then retracted after being punched without any manual operation.

According to the present invention, an automatic workpiece punching system is provided, comprising:

30

a punching die;  
a mold filling device, which is used for clamping and feeding a workpiece into the punching die, and withdraws after the workpiece is punched, wherein the mold filling device includes a clamping portion for clamping the workpiece, and a first cylinder for driving the clamping portion to move;

a sensing device used for sensing a position of the workpiece; and  
a control device, which is connected to above devices and to the punching die,  
and controls operations thereof.

5           The mold filling device further comprises a leveraged workpiece removing rod  
and a second cylinder, wherein the second cylinder acts on one end of the workpiece  
removing rod, another end of which is located above the workpiece clamped at the  
clamping portion.

10           When the clamping portion is at an initial position, a workpiece guide plate is  
provided below the workpiece clamped thereon for receiving and loading the  
workpiece.

          The clamping portion of the mold filling device comprises a workpiece fixing  
15   member, an upper clamping plate, a lower clamping plate, and a clamping and  
trimming member, wherein the lower clamping plate is fixed to a lower part of the  
workpiece fixing member, and the upper clamping plate is movably connected to an  
upper part of the workpiece fixing member and adjusted by the clamping and  
trimming member in its vertical position.

20           An avoiding groove is provided in a side wall of the workpiece fixing member,  
and a guide slope or arc surface is provided on a rear end of the side wall of the  
workpiece fixing member.

25           The automatic workpiece punching system of the present invention further  
comprises a workpiece loading and removing device connected to the control device,  
the workpiece loading and removing device including a workpiece seat for carrying  
the workpiece, a third cylinder acting on the workpiece seat from a rear portion  
thereof, a workpiece upper limit frame, and a workpiece lower limit frame. The  
30   workpiece upper limit frame and the workpiece lower limit frame are disposed  
opposite to each other behind the clamping portion at the initial position. The third  
cylinder drives the workpiece seat to move forward between the workpiece upper  
limit frame and the workpiece lower limit frame, to feed the workpiece into the  
clamping portion, and meanwhile to remove the workpiece that has been punched

from the clamping portion or to withdraw backward.

The workpiece loading and removing device further comprises a workpiece removing plate which is connected synchronously to a front part of the workpiece seat.

5

The automatic workpiece punching system of the present invention further comprises a workpiece conveying device and a workpiece displacing device for transferring the workpiece conveyed thereto to the workpiece seat, wherein the workpiece conveying device and the workpiece displacing device are both connected to the control device.

10

The workpiece displacing device comprises a workpiece holder used to receive the workpiece conveyed thereto, a suction cup, a fourth cylinder for controlling vertical displacement of the suction cup, and a fifth cylinder for controlling horizontal displacement of the suction cup. The suction cup, controlled by the fourth cylinder and the fifth cylinder, moves to the workpiece holder to draw the workpiece, and moves to the workpiece seat to put down the workpiece.

15

The workpiece conveying device comprises a motor, a drive shaft, a conveyor belt, and a vibration plate. The motor drives, through the drive shaft, the conveyor belt to move, a front end of the conveyor belt being adjacent to a rear end of the workpiece holder. The vibration plate is provided with an output portion to be connected to a rear end of the conveyor belt. The workpiece is conveyed, from the vibration plate and through the output portion, to the rear end of the conveyor belt, and after being conveyed forward in place by the conveyor belt, enters the workpiece holder.

20

25

The automatic workpiece punching system of the present invention, compared with that of the prior arts, is provided with the die filling device, so that manual feeding and discharging procedures in a conventional workpiece punching approach are replaced with automatic conveyance and retraction of the workpiece by the die filling device. This solves low efficiency and security problems of the conventional workpiece punching approach, saves labor, improves production efficiency, and thus has favorable economic and security benefits.

30

## **Brief Description of the Drawings**

Fig. 1 schematically shows the structure of an automatic workpiece punching system of the present invention;

5

Fig. 2 schematically shows the structure of a die filling device 2;

Fig. 3 schematically shows the structure of a clamping portion 21;

10 Fig. 4 schematically shows the structures of a workpiece loading and removing device 5 and a workpiece displacing device 7; and

Fig. 5 schematically shows the structure of a workpiece conveying device 6.

## **Detailed Description of the Embodiments**

The present invention will be described in further detail with reference to the accompanying drawings.

20 As shown in Fig. 1, an automatic workpiece punching system of the present invention comprises a punching die 1, a die filling device 2, a sensing device 3, a control device, a workpiece loading and removing device 5, a workpiece conveying device 6, and a workpiece displacing device 7. The punching die 1 is used to perform a punching operation on a workpiece. The die filling device 2 is used to hold the  
25 workpiece and forward it into the punching die 1, and withdraw after the workpiece is punched. The workpiece loading and removing device 5 is used to feed a workpiece into the die filling device 2, and meanwhile to remove a punched workpiece from the die filling device 2. The workpiece conveying device 6 is used for conveying the workpiece. The workpiece displacing device 7 is used to transfer the workpiece  
30 conveyed thereto by the workpiece conveying device 6 to the workpiece loading and removing device 5. The sensing device 3 includes a plurality of sensors, respectively mounted in proper positions of the above devices, for sensing positions of the workpiece. The control device (not shown) connects to the above devices and the punching die 1, and controls operations thereof through a programmable logic

controller (PLC).

For the sake of convenient explanation, in the following a conveying direction of the workpiece conveying device 6 is construed as a forward direction, and an opposite  
5 direction thereof is a backward direction.

As shown in Fig. 1, the punching die 1, which can be an existing punching die, is located substantially at a forefront of the entire automatic punching system. The die filling device 2 is provided on a left side or a right side of the punching die 1. As  
10 shown in Fig. 2, the die filling device 2 includes a clamping portion 21 for clamping the workpiece, a first cylinder 22 for driving the clamping portion 21 to move, a workpiece removing rod 23, a second cylinder 24, and a workpiece guiding plate 25.

The clamping portion 21 with the workpiece is pushed from an initial position by  
15 the first cylinder 22 into the punching die 1, and will retract to the initial position after the workpiece is punched. In order to prevent the clamping portion 21 from rotation during its displacement, the first cylinder 22 is provided with an anti-rotation rod 26.

As shown in Fig. 3, the clamping portion 21 further includes a workpiece fixing  
20 member 211, an upper clamping plate 212, a lower clamping plate 213, and a clamping fine-adjustment member 214. The lower clamping plate 213 is fixedly provided at a lower part of the workpiece fixing member 211, and in the present embodiment, the lower clamping plate 213 and the workpiece fixing member 211 are formed into one piece. The upper clamping plate 212 is movably connected to an  
25 upper part of the workpiece fixing member 211. The workpiece is sandwiched between the upper clamping plate 212 and the lower clamping plate 213. The clamping fine-adjustment member 214 can adjust a vertical position of the upper clamping plate 212, so as to adjust the clamping degree of the workpiece. As a result, the workpiece can be clamped during a back and forth punching procedure, and, after  
30 being punched, can be pushed out while the workpiece loading and removing device 5 feeds a next workpiece to be punched. In addition, a lateral clearance groove 215 is provided in a side wall of the workpiece fixing member 211, a rear end of the side wall being further provided with a guiding slope or arc surface 216 for facilitating introduction of the next workpiece.

As shown in Fig. 2, the workpiece removing rod 23 is in a lever structure. The second cylinder 24 acts on one end of the workpiece removing rod 23, another end of which is positioned above the workpiece clamped at the clamping portion 21. A workpiece guiding plate 25 is provided below the workpiece clamped at the clamping portion 21 at its initial position, for receiving and guiding out the workpiece. In addition, the die filling device 2 is further provided thereon with a sensor 31, for sensing the workpiece clamped by the clamping portion 21. In case of special circumstances, e.g., when the sensor 31 detects an excessively long residence period of the punched workpiece, the control device will activate the second cylinder 24, which drives the workpiece removing rod 23 to rotate. The workpiece clamped thereby will thus be knocked onto the workpiece guiding plate 25 and guided out therefrom.

As shown in Fig. 4, the workpiece loading and removing device 5 includes a workpiece seat 51 for carrying the workpiece, a third cylinder 52, a workpiece upper limiting bracket 53, a workpiece lower limiting bracket 54, and a workpiece removing plate 55.

The workpiece upper limiting bracket 53 and the workpiece lower limiting bracket 54 are disposed opposite to each other, immediately behind the clamping portion 21 at its initial position.

The third cylinder 52 is supported by a support 56 and acts on the workpiece seat 51 from a rear portion thereof. The third cylinder 52 is provided with an anti-rotation rod 57 in order to prevent rotation of the workpiece seat 51 during displacement thereof. At the initial position, the workpiece seat 51 is located behind the workpiece upper limiting bracket 53 and the workpiece lower limiting bracket 54. Controlled by the control device, the third cylinder 52 drives the workpiece seat 51 to move forward from the initial position. The workpiece on the workpiece seat 51 is sandwiched between the workpiece upper limiting bracket 53 and the workpiece lower limiting bracket 54, and conveyed forward to a position between the upper clamping plate 212 and the lower clamping plate 213 of the clamping portion 21. An edge portion of the workpiece seat 51 facing the clamping portion 21 enters the clearance groove 215

provided in the side wall of the clamping portion 21, so as to avoid possible collision between the workpiece seat 51 and the clamping portion 21. At such a moment, a punched workpiece 8 in the clamping portion 21 can be meanwhile pushed out. The workpiece seat 51 is then driven back to its original position by the third cylinder 52,  
5 and the workpiece thereon is clamped in the clamping portion 21.

Before the clamping portion 21 retracts from the punching die 1, the workpiece thereon may fall off in advance onto a return path of the clamping portion 21, thus blocking the way of the next workpiece moving into the punching die 1. In order to  
10 prevent this from happening, a vertical workpiece removing plate 55 is provided in front of the workpiece seat 51, and connected synchronously to the workpiece seat 51. During forward movement of the workpiece seat 51, the workpiece removing plate 55 moves forward simultaneously, to push the workpiece that has dropped in front to the workpiece guiding plate 25. The workpiece can then be guided out therefrom.

15

As shown in Fig. 4, the workpiece displacing device 7, provided at one side of the workpiece seat 51 at the initial position, includes a workpiece holder 71 for receiving a workpiece conveyed thereto, a suction cup 72, a fourth cylinder 73, and a fifth cylinder 74. The suction cup 72 is mounted below the fourth cylinder 73, and  
20 controlled by the fourth cylinder 73 for its vertical displacement. The fifth cylinder 74 is mounted on one side of the fourth cylinder 73, and can drive the fourth cylinder 73 to move in a horizontal direction, whereby displacement of the suction cup 72 in the vertical and horizontal directions can be controlled by the fourth cylinder 73 and the fifth cylinder 74 respectively. The workpiece holder 71 is provided thereon with a  
25 sensor 32. When the sensor 32 detects that the workpiece reaches the workpiece holder 71, controlled by the control device, the fifth cylinder 74 drives the suction cup 72 to move towards the workpiece holder 71, and the fourth cylinder 73 drives the suction cup 72 to move downward and draw the workpiece from the workpiece holder 71. Subsequently, the fourth cylinder 73 and the fifth cylinder 74, before finally  
30 returning to their original positions, operate again to place the workpiece into the workpiece seat 51.

As shown in Fig. 5, the workpiece conveying device 6, mounted at a rearmost position of the system, includes a motor 61, a drive shaft 62, a conveyor belt 63, and a

vibration plate 64. The motor 61 drives, through the drive shaft 62, the conveyor belt 63 to rotate. A front end of the conveyor belt 63 is adjacent to a rear end of the workpiece holder 71. The vibration plate 64 has an output portion 65 connected to a rear end of the conveyor belt 63. The workpiece is output from the vibration plate 64, through the output portion 65, to the rear end of the conveyor belt 63, and conveyed forward by the conveyor belt 63 into the workpiece holder 71. A sensor 33 is provided on a middle side of the conveyor belt 63, for determining number of workpieces. When the sensor 33 senses a signal, it means that there are insufficient workpieces. The vibration plate 64 will then, controlled by the control device, shake the workpieces contained therein out, until the sensor 33 cannot sense the signal.

In order to improve production efficiency and reduce costs, the automatic workpiece punching system of the present invention adopts a design of one vibration plate 64 provided with two output portions 65 at two sides thereof, and one single motor 61 controlling two conveyor belts 63. Correspondingly, one workpiece loading and removing device 5, one workpiece displacing device 7, and one die filling device 2 are provided in front of each conveyor belt 63, thereby forming two production lines. However, such a design will readily lead to different numbers of workpieces on the two conveyor belts 63 at two sides. In order to solve this problem, a sensor 34 is mounted to the rear end of the conveyor belt 63, and a stopper 66 is provided for each output portion 65 of the vibration plate 64. When there are insufficient workpieces on one of the conveyor belts 63, the sensor 33 will sense the signal, and the control device will control output of workpieces by the vibration plate 64. On the other hand, when the sensor 34 detects that the other of the two conveyor belts 63 has been fully loaded, the control device will activate the stopper 66 of this side, to prevent the output portion 65 of this side from outputting workpieces. If no workpieces can be sensed within a specified time period, the system will enter sleep mode after giving an alarm.

The whole working procedures of the automatic punching system of the present invention are as follows.

To start with, the vibration plate 64 of the workpiece conveying device 6 vibrates, so that the workpiece can be output, via the output portion 65, to the conveyor belt 63,

which transfers the workpiece forward to the workpiece holder 71.

Next, the fourth cylinder 73 and the fifth cylinder 74 of the workpiece displacing device 7 operate to control the suction cup 72, which places the workpiece on the  
5 workpiece holder 71 into the workpiece seat 51.

After that, the third cylinder 52 of the workpiece loading and removing device 5 operates to feed the workpiece on the workpiece seat 51 into the clamping portion 21, and meanwhile to remove the punched workpiece from the clamping portion 21. The  
10 workpiece removed will be guided out by the workpiece guiding plate 25.

Subsequently, the first cylinder 22 of the die filling device 2 operates to feed the workpiece clamped by the clamping portion 21 into the punching die 1 for punching, and the first cylinder 22 and the clamping portion 21 retract after punching is  
15 completed.

It can be seen that the entire working procedures of the workpiece automatic punching system of the present invention can be automatically controlled by the control device. Unless in special circumstances, for example, when the workpieces in  
20 the vibration plate have been used up, the whole procedures can be performed without manual participation. This can considerably save labor costs and eliminate security risks that may be otherwise caused by manpower operations. At the same time, punching accuracy can be ensured, thereby significantly improving production efficiency.

25

The foregoing description is merely illustrative of preferred embodiments of the present invention, and is not intended to limit the present invention. Various changes and modifications may be made by those skilled in the art. Any modifications, equivalent substitutions, improvements, and the like within the spirit and principles of  
30 the present invention are intended to be included within the scope of the present invention.

## Claims

1. An automatic workpiece punching system, comprising:
  - a punching die (1);
  - 5 a die filling device (2), which is used to hold and feed a workpiece into the punching die (1) and withdraw after the workpiece is punched, wherein the die filling device (2) includes a clamping portion (21) for clamping the workpiece, and a first cylinder (22) for driving the clamping portion (21) to move;
  - a sensing device (3) used for sensing a position of the workpiece; and
  - 10 a control device, which is connected to above devices and to the punching die (1), and controls operations thereof.
2. The automatic workpiece punching system according to claim 1, wherein the die filling device (2) further comprises a workpiece removing rod (23) in form of a  
15 lever, and a second cylinder (24), and
  - wherein the second cylinder (24) acts on one end of the workpiece removing rod (23), another end of which is located above the workpiece clamped at the clamping portion (21).
- 20 3. The automatic workpiece punching system according to claim 2, wherein a workpiece guiding plate (25) is provided below the workpiece clamped on the clamping portion (21) when it is at an initial position, for receiving and guiding out the workpiece.
- 25 4. The automatic workpiece punching system according to claim 1, wherein the clamping portion (21) of the die filling device (2) comprises a workpiece fixing member (211), an upper clamping plate (212), a lower clamping plate (213), and a clamping fine-adjustment member (214), and
  - wherein the lower clamping plate (213) is fixed to a lower part of the workpiece
  - 30 fixing member (211), and the upper clamping plate (212) is movably connected to an upper part of the workpiece fixing member (211) and adjusted by the clamping fine-adjustment member (214) in its vertical position.
5. The automatic workpiece punching system according to claim 4, wherein a

clearance groove (215) is provided in a side wall of the workpiece fixing member (211), and a guiding slope or arc surface (216) is provided on a rear end of the side wall of the workpiece fixing member (211).

5           6. The automatic workpiece punching system according to any one of claims 1-5, further comprising a workpiece loading and removing device (5) connected to the control device, the workpiece loading and removing device (5) including a workpiece seat (51) for carrying the workpiece, a third cylinder (52) acting on the workpiece seat (51) from a rear portion thereof, a workpiece upper limiting bracket (53), and a  
10       workpiece lower limiting bracket (54),

          wherein the workpiece upper limiting bracket (53) and the workpiece lower limiting bracket (54) are disposed opposite to each other behind the clamping portion (21) at the initial position thereof, and

          wherein the third cylinder (52) drives the workpiece seat (51) to move forward  
15       between the workpiece upper limiting bracket (53) and the workpiece lower limiting bracket (54), to feed the workpiece into the clamping portion (21), and meanwhile to remove the workpiece that has been punched from the clamping portion (21) or to withdraw backward.

20           7. The automatic workpiece punching system according to claim 6, wherein the workpiece loading and removing device (5) further comprises a workpiece removing plate (55), which is connected synchronously to a front part of the workpiece seat (51).

          8. The automatic workpiece punching system according to claim 6, further  
25       comprising a workpiece conveying device (6) and a workpiece displacing device (7) for transferring the workpiece conveyed thereto to the workpiece seat (51), wherein the workpiece conveying device (6) and the workpiece displacing device (7) are both connected to the control device.

30           9. The automatic workpiece punching system according to claim 8, wherein the workpiece displacing device (7) comprises a workpiece holder (71) used to receive the workpiece conveyed thereto, a suction cup (72), a fourth cylinder (73) for controlling vertical displacement of the suction cup (72), and a fifth cylinder (74) for controlling horizontal displacement of the suction cup (72), and

wherein the suction cup (72), controlled by the fourth cylinder (73) and the fifth cylinder (74), moves to the workpiece holder (71) to draw the workpiece and moves to the workpiece seat (51) to put down the workpiece.

5        10. The automatic workpiece punching system according to claim 8, wherein the workpiece conveying device (6) comprises a motor (61), a drive shaft (62), a conveyor belt (63), and a vibration plate (64),

wherein the motor (61) drives, through the drive shaft (62), the conveyor belt (63) to move, a front end of the conveyor belt (63) being adjacent to a rear end of the  
10        workpiece holder (71),

wherein the vibration plate (64) is provided with an output portion (65) to be connected to a rear end of the conveyor belt (63), and

wherein the workpiece is conveyed, from the vibration plate (64) and through the output portion (65), to the rear end of the conveyor belt (63), and after being conveyed  
15        forward in place by the conveyor belt (63), enters the workpiece holder (71).