

Automatic Punching/Riveting Machine for Printed Circuit Boards

Background of the Invention

1. Field of the Invention

The present invention relates to an automatic punching/riveting machine for punching and riveting all of the layer boards to produce a printed circuit board.

2. Description of the Related Art

Conventionally, punching machines and riveting machines for producing printed circuit boards are separate from each other. When manufacturing a printed circuit board consisting of a plurality of layer boards, the positioning holes of each layer board are extended through by positioning pins on a punching machine that punches rivet holes in the layer board. After punching, the layer boards are removed by a worker and then placed on a riveting machine with the rivet holes in each layer board extended through by positioning pins on the riveting machine for subsequent riveting which rivets all of the layer boards together to form a complete printed circuit board. Nevertheless, such a process requires repetitive labor work for moving the layer boards from the punching machine to the riveting machine, which is relatively inefficient.

The layer boards are made from different material and thus have different expansion/shrinkage coefficients. When the ambient temperature or moisture changes, the layer boards expand or shrink by different amounts and thus have shifts (the so-called "layer shifts") in their positioning holes. As a result, it is difficult to place the layer boards to the positioning pins of the punching machine and the riveting machine. The layer boards might even bend (see Fig. 6) when they are mounted to the positioning pins if stress is generated as a result of large expansion of the layer boards.

Summary of the Invention

The present invention provides an automatic punching/riveting machine for punching and riveting all of the layer boards of a printed circuit board to thereby eliminate the layer shift problem in prior art.

It is an object of the present invention to provide an automatic punching/riveting machine for eliminating repetitive manual placing of the layer boards to the positioning pins.

It is another object of the present invention to provide a positioning hole structure for layer boards such that no stress will be generated between the positioning holes and the positioning pins even if the layer boards have different deformation amounts due to expansion or shrinkage.

In order to achieve the above objects, the present invention provides an automatic punching/riveting machine comprising a punching device, a riveting device, and a conveying device. The conveying device moves a working platform that carries layer boards for punching and riveting to thereby avoid repetitive labor work for mounting the layer boards to the punching device and the riveting device. Each layer board includes elongated holes to eliminate the layer shift problem as a result of expansion or shrinkage in each layer board.

Other objects, specific advantages, and novel features of the invention will become more apparent from the following detailed description and preferable embodiments when taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a front elevational view of an automatic punching/riveting machine in accordance with the present invention.

Fig. 2 is a top view of the automatic punching/riveting machine in accordance with the present invention.

Fig. 3 is a schematic side view of a conveying device of the automatic punching/riveting machine in accordance with the present invention.

Fig. 4 is a top view of a layer board.

Fig. 4A is an enlarged view of a circle in Fig. 4.

Fig. 5 is a side view of an elevating device for the conveying device

Fig. 6 is a schematic side view illustrating bending of layer boards during manufacture of a printed circuit board according to prior art.

Detailed Description of the Preferred Embodiment

Referring to Figs. 1 and 2, an automatic punching/riveting machine in accordance with the present invention generally includes one or more sets of punching/riveting assemblies 1 and a conveying device 2.

Each punching/riveting assembly 1 includes a punching device 11 and a riveting device 12. The layer boards 3 that constitutes a printed circuit board are accurately moved to a position below the punching device 11 for punching rivet holes in each layer board 3. The riveting device 12 is disposed downstream of an associated punching device 11. Namely, the riveting device 12 is far away from the associated punching device 11 by an amount Δx along a conveying axis 4 for the layer boards 3. The punched layer boards 3 are conveyed to a position below the riveting device 12 along the conveying axis 4 for subsequent riveting of the layer boards 3 by the riveting device 12. A second punching/riveting assembly may be provided at a position which has a distance of Δz to the first mentioned punching/riveting assembly 1. The conveying device 2 can be used with several punching/riveting assemblies 1 for proceeding with riveting of several sets of layer boards 3. Namely, a plurality of punching/riveting assemblies 1 can be provided according to need. The distances Δy of the punching device 11 and the riveting device 12 to the conveying axis 4 and the distance Δz between each two adjacent punching/riveting assemblies 1 can be adjusted in response to different dimensions of the layer boards 3. The layer boards 3 can be moved to accurate positions below the punching device 1 and the riveting device 2 by means of fixing the center of gravity of the layer boards 3 of the printed circuit board relative to the conveying axis 4.

Still referring to Fig. 2 and further to Fig. 3 that schematically illustrates a conveying device 2 of the automatic punching/riveting machine in accordance with the present invention, the conveying device 2 comprising a step motor 21, a screw 22, a moving seat 23, a working platform 24, and a set of rails 25 (a rail means). The conveying device 2 further comprises a microcomputer (not shown) for controlling movements of all elements of the conveying device 2 and the punching/riveting assemblies 1.

The step motor 21 is the power mechanism of the conveying device 2 for driving the screw 22, which, in turn, drives the moving seat 23 mounted on the screw 22. The moving seat 23 includes a threaded hole (not shown) so as to be mounted around the screw 22 in a manner that the moving seat 23 moves along a longitudinal axis of the screw 22 when the screw 22 is driven by the step motor 21. Displacement of the moving seat 23 can be controlled precisely since rotational movement of the step motor 21 can be controlled precisely. The transmission mechanism mentioned above can be replaced by other transmission devices, such as gears. In addition, the step motor 21 can be replaced by other motors that can be controlled precisely, such as servomotors.

The set of rails 25 is arranged along the moving direction of the moving seat 23. The working platform 24 is mounted on top of the moving seat 23 to move therewith along the rails 25. In this embodiment, the working platform 24 includes engaging holes (not labeled) for engaging with engaging pegs 231 on the moving seat 23. In addition, the working platform 24 includes positioning pins 241 for retaining the layer boards 3 to be riveted in place (see positioning holes 31 in each layer board 3).

By means of using the conveying device 2 and the punching/riveting assemblies 1, the labor work during punching and riveting of the layer boards 3 of the printed circuit board can be reduced to the greatest extent, as the labor work can be replaced by automatic process provided by the automatic punching/riveting machine in accordance with the present invention.

In accordance with the present invention, a method for punching/riveting the layer boards of a printed circuit board comprises:

- (1) manually moving each of layer boards 3 with positioning holes 31 to the platform 24, the platform 24 being carried by the moving seat 23 that moves along the conveying axis 4;
- (2) moving the layer boards 3 to a position below the punching device 11 by the step motor 3 under control of the microcomputer;

(3) punching the layer boards by the punching device 11 according to information of predetermined positions of rivet holes relative to the positioning holes for the layer boards inputted into the microcomputer;

(4) moving the layer boards 3 to a position below the riveting device 12 by the step motor 21 under the control of the microcomputer;

(5) riveting the layer boards 3 together via the rivet holes in each layer board 3 according to the information of the determined positions of the rivet holes relative to the positioning holes for the layer boards inputted into the microcomputer, thereby producing a riveted printed circuit board; and

(6) manually removing the riveted printed circuit board.

Comparing the method of the present invention with prior art process, repetitive labor work for placing the layer boards 3 to the positioning pins of the punching machines and riveting machines is eliminated. The overall efficiency is thus increased.

In step (1) of the method of the present invention, the positioning holes 31 in each layer board 3 for placing the layer boards 3 onto the positioning pins 241 of the working platform 24 are formed by punching well before executing the method of the present invention. Referring to Fig. 5, in order to further automate the overall process, an elevator 26 may be provided at the end of the rails 25 for moving the riveted printed circuit boards via a conveyor 27 back to a place where the worker mounts the layer boards. Thus, automation of the production process is further improved.

Referring to Fig. 4, each layer board 3 includes two sets of positioning holes 311 and 312 to eliminate the expansion or shrinkage problem resulting from a change in the ambient temperature and/or moisture. Each positioning hole 311, 312 is an elongated hole with two parallel sides. The distance between the two parallel sides equals to an outer diameter of an associated positioning pin 241 to prevent lateral movement of the positioning pin 241 relative to a longitudinal axis of the elongated hole. Namely, the positioning pin 241 can only be moved along the longitudinal axis of the elongated hole. It is noted that the longitudinal axis

(first longitudinal axis) passing through the first set of positioning holes 311 may be perpendicular to or at an angle with the longitudinal axis (second longitudinal axis) passing through the second set of positioning holes 312. The positioning pin 241 may be a non-cylindrical peg with a rectangular or square section. Although the elongated holes may force the positioning pins 241 to move along the direction of expansion or shrinkage of the layer board 3, yet the movements of the positioning pins 241 are the so-called layer shifts. In order to minimize the layer shift in each layer board 3, the center of gravity for each layer board must be fixed. By this reason, the two sets of positioning holes 311 and 312 of each layer board are fixed such that an intersection of the first longitudinal axis and the second longitudinal axis coincides with the center of gravity of the respective layer board 3. Thus, when each layer board 3 expands or shrinks, position of the center of gravity of the layer board 3 remains unchanged with respect to the positioning pins 241. The layer shift for riveting position of the respective layer board 3 is smaller than a half of the maximum deformation of the respective layer board 3. Thus, the stress problem in the layer board 3 and the positioning pins 241 is solved at the cost of minimized layer shift.

According to the above description, it is appreciated that the automatic punching/riveting machine in accordance with the present invention has the following advantages:

1. Only one step of manual mounting of the layer boards is required.
2. The stress problem in the layer board 3 and the positioning pins 241 is solved at the cost of minimized layer shift.

Although the invention has been explained in relation to its preferred embodiment as mentioned above, it is to be understood that many other possible modifications and variations can be made without departing from the scope of the invention. It is, therefore, contemplated that the appended claims will cover such modifications and variations that fall within the true scope of the invention.



What is claimed is:

1. An automatic punching/riveting machine for a printed circuit board consisting of a plurality of layer boards, the automatic punching/riveting machine comprising:

a conveying device for conveying the layer boards, the conveying device including a power mechanism, a transmission mechanism, and a working platform to which the layer boards to be riveted are mounted;

a punching device mounted above the conveying device, the punching device punching rivet holes in each of said layer boards that are moved to a position below the punching device; and

a riveting device mounted at a level the same as that of the punching device and located downstream of the punching device along a conveying direction of the conveying device, the riveting device riveting the layer boards punched by the punching device together.

2. The automatic punching/riveting machine for a printed circuit board as claimed in claim 1, further comprising a further one or more punching device and a further one or more riveting device.

3. The automatic punching/riveting machine for a printed circuit board as claimed in claim 2, wherein each two adjacent sets of punching devices/riveting devices have an identical distance therebetween.

4. The automatic punching/riveting machine for a printed circuit board as claimed in claim 1, wherein the power mechanism is a motor, the transmission mechanism includes a screw and a moving seat including a threaded hole so as to be mounted around the screw, wherein the moving seat moves along a longitudinal direction of the screw when the screw is driven by the motor.

5. The automatic punching/riveting machine for a printed circuit board as claimed in claim 4, wherein the moving seat includes engaging pegs for retaining the working platform on the moving seat.



6. The automatic punching/riveting machine for a printed circuit board as claimed in claim 4, wherein the conveying device further comprises a rail means for guiding movements of the working platform and preventing shift of the working platform.
7. The automatic punching/riveting machine for a printed circuit board as claimed in claim 4, wherein the conveying device further comprises an elevator at an end of a path of the working platform for moving the working platform to another conveyer.
8. The automatic punching/riveting machine for a printed circuit board as claimed in claim 1 or 2, wherein punching positions of the punching device relative to the riveting positions of the riveting device are adjustable with respect to a center of gravity of each said layer board of the printed circuit board.
9. The automatic punching/riveting machine for a printed circuit board as claimed in claim 1, wherein the working platform includes positioning pins for mounting the layer boards.
10. The automatic punching/riveting machine for a printed circuit board as claimed in claim 9, wherein the working platform includes at least two sets of positioning pins.
11. The automatic punching/riveting machine for a printed circuit board as claimed in claim 10, wherein the working platform is cruciform and wherein the sets of the positioning pins are provided on two protruded portions of the cruciform working platform.
12. A layer board constituting a layer of a printed circuit board, the layer board comprising two sets of positioning holes, each said positioning hole being an elongated hole with two parallel sides for mounting an associated positioning pin, a distance between the two parallel sides being equal to a size of the associated positioning pin, each said set of positioning holes being so arranged to restrain the layer board in a longitudinal axis that passes through the positioning pins cooperating with the set of positioning holes, thereby positioning the layer board relative to the positioning pins.
13. The layer board as claimed in claim 12, wherein a first longitudinal axis that passes through one of the two sets of positioning holes and a second longitudinal axis that passes



through the other of the sets of positioning holes intersects at a point that coincides with a center of gravity of the layer board.

14. The layer board as claimed in claim 12, wherein a first longitudinal axis that passes through one of the two sets of positioning holes is perpendicular to a second longitudinal axis that passes through the other of the sets of positioning holes.