

## DESCRIPTION

COMPONENT HOLDING HEAD, COMPONENT MOUNTING  
APPARATUS, AND COMPONENT HOLD METHOD

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## Technical Field

The present invention relates to a component holding head for use, e.g., in mounting electronic components on electronic circuit boards, a component mounting apparatus equipped with the component holding head, and a component hold method carried out by the component mounting apparatus.

## Background Art

A component suction head part set in a component mounting apparatus adapted to automatically mount electronic components onto electronic circuit boards has nozzles to suck and mount the electronic components to the electronic circuit boards. Lately, precise control on coming the nozzle in contact with electronic components in sucking and mounting the electronic components is considered as one of factors to improve quality of the electronic circuit boards to be produced. An example of the conventional electronic component mounting apparatus will be described with reference to Fig. 4.

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Fig. 4 shows a component suction head part 101

including the aforementioned nozzles, a sucking device 103 for sucking the electronic components with the use of the nozzles, an X-Y robot 102 moving the head part 101 in X, Y directions, and a control device 104 controlling operations of the head part 101, the X-Y robot 102, and the sucking device 103 in the conventional electronic component mounting apparatus. The head part 101 is constructed in a structure as will be described below. Only essential parts constituting the head part 101 are indicated in Fig. 4 and, for instance, a body part of the head part 101 and the like are not illustrated. A reference numeral 135 in Fig. 4 is a spline shaft which has a nozzle 136 set at one end part 135a for sucking an electronic component 138 through a suction action and a rotation receiver 143 at the other end part 135b. The suction action is conducted by the sucking device 103, whereby the air is guided into the sucking device 103 through the nozzle 136 and the spline shaft 135. Two nuts 131, 134 are fitted to the spline shaft 135 in an axial direction of the spline shaft 135 to make the spline shaft 135 slidable in the axial direction. These nuts 131, 134 are held to the body part (not shown) of the head part 101 via respective bearings 132, 133. The spline shaft 135 is accordingly rendered movable in the axial direction and rotatable in a circumferential direction thereof to the body part.

The rotation in the circumferential direction of the spline shaft 135 is achieved by a motor 142. Specifically, a pulley 139 rotating along with the spline shaft 135 is fitted to the spline shaft 135. The spline shaft 135 is movable in the axial direction to the pulley 139. On the other hand, a pulley 141 is attached to a driving shaft of the motor 142 and is coupled to the pulley 139 via a belt 140. When the motor 142 rotates the pulley 141, the spline shaft 135 is accordingly rotated in the circumferential direction via the belt 140 and the pulley 139.

Meanwhile, the movement in the axial direction of the spline shaft 135 is made by a motor 149. More specifically, a nut 146 whereat a lever 147 projects is meshed with a ball screw 145 connected to a driving shaft of the motor 149 via a coupling 148. A roller 144 at a leading end of the lever 147 is engaged with a groove 143a formed in the rotation receiver 143. When the ball screw 145 is rotated by the motor 149, the lever 147 moves in the axial direction while the roller 144 is engaged with the rotation receiver 143, thereby moving the spline shaft 135 in the axial direction.

The conventional component mounting apparatus of the above constitution operates in the following manner.

When the X-Y robot 102 operates under the control

of the control device 104, the head part 101 is moved to a component suction position where the electronic component is to be sucked. The motor 149 is driven under the control of the control device 104, lowering the spline shaft 135 and the nozzle 136. At the same time, the sucking device 103 is driven to make the nozzle 136 suck the electronic component. Subsequently the ball screw 145 is rotated backward by the motor 149 to raise the nozzle 136. In order to correct a mount direction of the sucked electronic component, the motor 142 is driven through the control action of the control device 104 to rotate the nozzle 136 to a proper position. The X-Y robot is driven again to move the head part 101 to a component mount position on the electronic circuit board, and then the motor 149 is driven to move down the nozzle 136. The electronic component 138 is thus mounted on the electronic circuit board.

The above-described constitution of the conventional component mounting apparatus has drawbacks, though.

In these days, the component mounting apparatus is adapted to handle not only electronic components in which silicon substrates having electronic circuits formed thereon are sealed with resin material, but bare ICs and the like. In the case of bare ICs, a mount pressure by the nozzle 136 to the bare ICs at the time of mounting is

required to be controlled to prevent damage to the bare ICs. Therefore, the component mounting apparatus is constituted to correctly manage a position of the nozzle 136 to the bare ICs in X, Y directions, and also to manage the pressure of the nozzle 136 onto the bare ICs on the basis of a torque of the motor 149 moving the nozzle 136 up and down. Although a sensor is preferred to be directly installed at the nozzle 136 in the component mounting apparatus to correctly measure the position of the nozzle 136 in the X, Y directions and an up-down direction, it is impossible to set the sensor to the spline shaft which moves in the axial direction and the circumferential direction as described above. As such, the position of the nozzle 136 in the up-down direction is actually controlled on the basis of output information from a rotary encoder 150 incorporated in the motor 149.

On the other hand, the position of the spline shaft 135 in the axial direction is hard to correctly grasp, because the movement of the spline shaft 135 in the axial direction is carried out via the rotation receiver 143 and the roller 144, etc. which is dependent on movement accuracy of the ball screw 145 in the axial direction, and moreover the rotation receiver 143 and the roller 144, etc. are formed of non-rigid material. Under the circumstances, the conventional electronic component mounting apparatus

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finds difficulty in accurate control on the movement of a leading end of the nozzle, having an impediment to improvement of mount quality.

5 The present invention is devised to solve the  
aforementioned issue and has for its object to provide a  
component holding head, a component mounting apparatus  
equipped with the component holding head, and a component  
hold method executed by the component mounting apparatus  
which can improve mount quality of components to articles  
10 to which the components are to be mounted.

#### Disclosure Of Invention

In accomplishing this and other objects, the present invention is constituted as below.

15 According to a first aspect of the present  
invention, there is provided a component holding head  
equipped with a shaft which has a nozzle for holding of a  
component set at one end part thereof and is driven in an  
axial direction thereof, in which a magnet is fixed to a  
circumferential face of the shaft and a coil is disposed in  
20 a circumference of the shaft, thereby constituting a voice  
coil motor for driving the shaft in the axial direction, so  
that the shaft is controlled in movement in the axial  
direction through controlling of power supply to the voice  
coil motor.

25 According to a second aspect of the present

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invention, there is provided a component holding head according to the first aspect, further comprising a detecting device which is installed at the shaft for detecting the movement of the shaft in the axial direction, so that an amount of the movement of the shaft in the axial direction by the voice coil motor is controlled on the basis of a detection result of the detecting device.

According to a third aspect of the present invention, there is provided a component holding head according to the second aspect, wherein the detecting device comprises: a member to be detected which extends concentrically with the shaft, is directly fitted to the other end part of the shaft, and moves in the axial direction in accordance with the movement of the shaft in the axial direction; and

a sensor for detecting movement of the member to be detected.

According to a fourth aspect of the present invention, there is provided a component holding head, according to the third aspect, wherein the member to be detected of the detecting device is a magnetic scale, the head comprising a transmission sensor is set in a noncontact state to detect presence/absence of shutting of light by a leading end of the magnetic scale, thereby detecting an origin position of the movement of the shaft.

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According to a fifth aspect of the present invention, there is provided a component holding head according to the second aspect, wherein the detecting device comprises: a sensor which is directly set at the other end part of the shaft via a bearing so as to be prevented from rotating together with the shaft when the shaft is driven in a circumferential direction thereof, while being allowed to move in the axial direction in accordance with the movement of the shaft in the axial direction; and

a member to be detected by the sensor which extends in parallel to the axial direction of the shaft.

According to a sixth aspect of the present invention, there is provided a component mounting apparatus for mounting components is provided which is equipped with the component holding head according to any one of the first through fifth aspects.

According to a seventh aspect of the present invention, there is provided a component mounting apparatus according to the sixth aspect, further comprising: a detecting device which is set at the shaft to detect the movement of the shaft in the axial direction; and a control device which controls an amount of the movement of the shaft in the axial direction by the voice coil motor on the basis of a detection result of the detecting device.



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According to an eighth aspect of the present invention, there is provided a component mounting apparatus according to either the sixth aspect or the seventh aspect, wherein the shaft is arranged movably to a casing of the voice coil motor, with a nozzle suction pipe installed at the casing, while an opening of a through hole penetrating the shaft to communicate with the nozzle is opened in the casing, whereby the pipe and the opening of the through hole are communicated with each other in the casing.

According to a ninth aspect of the present invention, there is provided a component hold method which is carried out with the use of a component holding head having a shaft which is equipped with a nozzle for holding of a component at one end part thereof and is driven in an axial direction thereof, whereat a magnet is fixed to a circumferential face of the shaft and a coil is arranged in a circumference of the shaft, thereby constituting a voice coil motor for driving the shaft in the axial direction,

the method comprising: detecting the movement of the shaft in the axial direction by the voice coil motor by a detecting device installed at the shaft; and

controlling power supply to the voice coil motor on the basis of a detection result of the detecting device, thereby controlling a movement amount of the shaft in the axial direction to hold the component.

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According to the first aspect of the present invention, there is provided a component hold method according to the ninth aspect, wherein a magnetic scale which is a member to be detected of the detecting device, with having a transmission sensor set in a state without contact to the magnetic scale to detect presence/absence of shutting of light by a leading end of the magnetic scale 28, thereby detecting an origin position of the movement of the shaft.

#### 10 Brief Description Of Drawings

These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a view of the constitution of a component holding head in one embodiment of the present invention;

Fig. 2 is a perspective view of a component mounting apparatus equipped with the component holding head of Fig. 1;

Fig. 3 is a view of a detecting device in Fig. 1 in a different embodiment;

Fig. 4 is a view showing the structure of a conventional component holding head;

Fig. 5 is a block diagram showing how a voice coil motor of the component holding head of the embodiment is controlled to drive; and

Fig. 6 is a conventional component mounting apparatus using a linear motor.

#### Best Mode for Carrying Out the Invention

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

A first embodiment of the present invention will be described in detail below with reference to the drawings.

A component holding head, a component mounting apparatus equipped with the component holding head, and a component hold method carried out by the component mounting apparatus, according to one preferred embodiment of the present invention will be described with reference to the drawings. The same parts in each drawing including Fig. 4 used in the foregoing description are denoted by the same reference numerals and the detailed description will be omitted here. An embodiment functioning as the component holding head corresponds to a component suction head part 6. An electronic component and an electronic circuit board are exemplified as an example of the component and an example of the article to which the component is mounted,

respectively.

Fig. 2 schematically shows the whole of the component mounting apparatus of the embodiment. 2 is a transfer part for carrying in, carrying out electronic circuit boards 1, and holding the circuit boards 1 on the occasion of production. 3 and 4 are electronic component feed parts storing and feeding electronic components to be mounted to the circuit boards 1. The electronic component feed part 3 is a reel-type electronic component feed part wherein electronic components are accommodated in a reel, while the electronic component feed part 4 is a tray-type electronic component feed part wherein the electronic components are stored in a tray. A component suction head part 6 equipped with a nozzle 8 for sucking of an electronic component moves the nozzle 8 up, down, and rotates the nozzle. The component suction head part 6 is mounted to an X-Y robot 5 for moving the head part 6 in X, Y directions. At the suction time of electronic components, the head part 6, namely, the nozzle 8 is moved by the X-Y robot 5 to an electronic component hold position at the electronic component feed part 3 or 4 and then lowered to suck the electronic component. The nozzle 8 is moved up after sucking the electronic component. An image of a suction state of the electronic component sucked by the nozzle 8 is picked up by a component recognition camera 7.

Whether a suction angle of the electronic component is to be corrected or not, etc., is judged on the basis of the picked-up image information before the electronic component is mounted to the electronic circuit board 1. The  
5 electronic component sucked by the nozzle 8 is moved in the X, Y directions through the movement of the head part 6 caused by the X-Y robot 5 to a predetermined position on the electronic circuit board 1. The nozzle 8 is lowered by an operation of the head part 6, so that the electronic  
10 component is mounted to a predetermined component mount position on the electronic circuit board 1. The electronic component sucked by the nozzle 8 is released at this time. Through repetition of the above sequence of operations, each electronic component is mounted from the electronic  
15 component feed part 3 or 4 onto the electronic circuit board 1.

Fig. 1 shows the component suction head part 6 having the nozzle 8, the above-described X-Y robot 5, a sucking device 103 for sucking of an electronic component  
20 with the nozzle 8, and a control device 11 for controlling operations of the component suction head part 6, the X-Y robot 5, and the sucking device 103. While the X-Y robot 5 is illustrated in Fig. 1 for the sake of convenience as if to directly drive a spline shaft 13 having the nozzle 8,  
25 practically, as described above, the X-Y robot 5 moves the

head part 6 thereby driving the spline shaft 13.

Although it will be detailed later, according to the embodiment in contrast to the prior art, a voice coil motor is set at the spline shaft 13 to move in an axial direction the spline shaft 13 having the nozzle 8 fixed at a leading end part 13a thereof, and further a detecting device is fitted to the spline shaft 13 so as to detect a movement amount of the spline shaft 13 in the axial direction. The constitution in other points is similar to that in the head part 101 of the prior art, and therefore the other points of the similar constitution will be depicted schematically.

Two nuts 131, 134 are fitted in the axial direction of the spline shaft 13 to allow the spline shaft 13 to slide in the axial direction. The nuts 131, 134 are supported to a body part (not shown) of the component suction head part 6 via respective bearings 132, 133. The spline shaft 13 is accordingly movable in the axial direction and rotatable in a circumferential direction thereof to the body part. The rotation in the circumferential direction of the spline shaft 13 is carried out by a motor 142 set at the component suction head part 6 via a belt 140. The motor 142 is connected to the control device 11. A rotation angle in the circumferential direction of the spline shaft 13 is calculated by the

control device 11 based on, e.g., a signal sent out from an encoder set at the motor 142. The operation of the motor 142 is feedback-controlled on the basis of a calculation result, thereby controlling the rotation angle. The nozzle 8 is set at the leading end part 13a of the spline shaft 13 to suck the electronic component 138. A filter 137 is disposed inside the nozzle 8 to prevent invasion of dust at the suction time. An air hole 27 is formed in the spline shaft 13 in the axial direction from the leading end part 13a to an internal part of the voice coil motor 21 which will be described later. The air hole becomes a path for the air sucked through the filter 137. The air hole 27 communicates with an interior 24 of the voice coil motor 21 through a shaft opening 27a opened in a diametrical direction of the spline shaft 13.

The voice coil motor 21 is set with using the spline shaft 13 as a driving shaft therefor, specifically, at a part of the spline shaft 13 held between the bearings 132 and 133 for supporting the spline shaft 13 rotatably to the body part of the component suction head part 6. A magnet 23 is fixed to a circumferential face of the spline line 13. A voice coil 22 is installed in the periphery of the magnet 23 in a noncontact state to the magnet 23 in parallel to the axial direction of the spline shaft 13 in a movement range in the axial direction of the spline shaft

13 in a casing 21a of the voice coil motor 21. The voice coil motor 21 is connected to the control device 11 of the component mounting apparatus and controlled to drive by the control device 11. That is, when the power is supplied to the voice coil 22, the magnet 23 of the voice coil motor 21 moves between an up position 12a and a down position 12b, thereby moving the spline shaft 13 and the nozzle 8 in the axial direction. The voice coil motor 21 can be constructed alternatively to have the voice coil fixed to the circumferential face of the spline shaft 13, with the magnet set in the periphery of the voice coil in a noncontact state to the voice coil in the axial direction of the spline shaft 13 within the movement range of the spline shaft 13.

A hole 26 is opened in the casing 21a of the voice coil motor 21 so as to guide the air entering the interior 24 of the voice coil motor 21 through the air hole 27 and the shaft opening 27a in the spline shaft 13 to the outside of the voice coil motor 21 for suction. An air joint 25 is provided at a part of a surface of the casing 21a where the hole 26 is opened. The air joint 25 is connected to the sucking device 103 of the component suction head part 6 or component mounting apparatus via a hose. The sucking device 103 is controlled in operation by the control device 11. Accordingly, the air is sucked

through a suction action of the sucking device 103 from a leading end of the nozzle 8 via the hole 26, the interior 24 of the voice coil motor 21, the shaft opening 27a, the air hole 27, and the filter 137, so that the electronic  
5 component 138 is sucked to the leading end of the nozzle 8.

An effect exhibited when the sucking device 103 is arranged as above will be discussed in detail.

A component mounting apparatus using a linear motor has been suggested heretofore as shown in Fig. 6. In  
10 Fig. 6, 401 is a permanent magnet, 402, 403, 404, 405, and 406 are yokes formed of material of a large magnetic permeability, and 407 is a gap constituting a magnetic circuit which generates a constant magnetic field by the permanent magnet and the yokes. 408 is a bobbin having a  
15 wire wound therearound, generating a thrust when a current is fed thereto. A slide shaft 410 is fixed to the bobbin 408. A component suction vacuum nozzle 413 is fixed to a lower end of the slide shaft 410. 416 is a linear potentiometer for up-down movement detection fitted to the  
20 yoke 402 to detect an origin and the present position of the slide shaft 410.

In the thus-constituted apparatus, a tube 414 connecting the vacuum nozzle 413 with a vacuum generation apparatus protrudes from an upper end of the slide shaft  
25 410, moving subsequent to an up-down and a horizontal

movements of the slide shaft 410. The tube 414 unavoidably comes in touch with other members during the movement, thus increasing frictional resistance and causing resistance to a driving force of the slide shaft 410, eventually obstructing smooth up-down movement of the nozzle 413.

To the contrary, in the embodiment, a pipe for the suction action is fixed to the casing 21a of the voice coil motor 21, not tracing the up-down movement and a movement within a schematically horizontal plane of the nozzle 8. The frictional resistance and driving resistance given rise to in the conventional apparatus are eliminated, and accordingly the nozzle 8 can move smoothly up and down. Since only a magnetic scale 28 without a wiring moves along with the spline shaft 13 while a magnetic sensor 29 having a wiring does not move as will be detailed later, generation of the frictional resistance and driving resistance due to the wiring is avoided in the present embodiment, different from the conventional apparatus, thereby enabling smooth up-down movement of the nozzle 8.

The rod-shaped magnetic scale 28 is fitted at the other end part 13b of the spline shaft 13 concentrically with the spline shaft 13 and in parallel to the axial direction of the spline shaft 13. The magnetic scale 28 and a magnetic scale 20 to be described later correspond to an embodiment functioning as the member to be detected. S

poles and N poles are alternately magnetized via a constant distance in an axial direction of the magnetic scale 28. The reason why the magnetic scale 28 is disposed concentrically with the spline shaft 13 is that the magnetic scale 28 is prevented from rotating in a circle subsequent to the circumferential rotation of the spline shaft 13 by the motor 142, thereby facilitating magnetic detection by the magnetic sensor 29 described later.

In order to detect the magnetism of the magnetic scale 28, the magnetic sensor 29 is secured to the component suction head part 6 in a state without contact to the magnetic scale 28. A change of magnetism because of the movement of the magnetic scale 28 in the axial direction resulting from the axial movement of the spline shaft 13 is detected by the magnetic sensor 29. Detected information is sent to the control device 11 from the magnetic sensor 29. A transmission sensor 30 is securely set at the component suction head part 6 at a leading end part of the magnetic scale 28 to detect an origin of the movement of the spline shaft 13. The transmission sensor 30 is fixed in a noncontact state to the magnetic scale 28. The transmission sensor 30 is, for instance, a photosensor having a light-emitting and a photodetecting elements, detecting the presence/absence of shutting of light at the leading end of the magnetic scale 28, and sending a

detected result to the control device 11. The above-described magnetic scale 28, magnetic sensor 29, and transmission sensor 30 correspond to one embodiment of the detecting device.

5           As shown in Fig. 5, the control device 11 judges as the origin by an origin detection part 301 based on the detected result fed from the transmission sensor 30, for example, a time point when the absence of shutting of light changes to the presence of shutting of light. At the same  
10       time, the control device 11 operates at an operation part 303 a movement amount of the spline shaft 13 detected at a position detection part 302 on the basis of change information of the magnetized magnetic poles of the magnetic scale 28 which is supplied from the magnetic  
15       sensor 29, and controls at a driving part 305 the power supply to the voice coil motor 21 on the basis of an operated result, thus controlling the operation of the voice coil motor 21. Upon necessities, the operated result at the operation part 303, etc. is recorded to a memory 304.

20           Meanwhile, an origin of the slide shaft 410 is detected by the potentiometer 416 in the conventional apparatus of Fig. 6. Since the potentiometer requires an origin detection band of a predetermined breadth in the circumference of the shaft moving up and down to obtain an  
25       origin signal, the origin is not determined at one point

and spans a width. The origin cannot be detected accurately and also an origin detection band area is difficult to form at the same position in the circumferential direction.

5           According to the embodiment, the transmission sensor 30 is set in the noncontact state to the magnetic scale 28 at the leading end of the magnetic scale 28 to detect the presence/absence of shutting of light by the leading end of the magnetic scale 28, thereby detecting a  
10   position of the origin. The origin can be detected more accurately than in the prior art. Moreover, since it is enough to detect merely the presence/absence of shutting of light by the leading end of the magnetic scale 28, the position of the origin can be detected accurately at the  
15   same position in the circumferential direction as well.

          The detecting device can be constituted in a different structure, e.g., as shown in Fig. 3 although it is slightly complicated more than the above embodiment. Specifically, a magnetic sensor 18 equal to the above-  
20   described magnetic sensor 29 is fixed via a bearing 17 to the other end part 13b of the spline shaft 13. The reason for the structure is to prevent the magnetic sensor 18 from rotating interlockingly with the rotation of the spline shaft 13 in the circumferential direction. Further, a part  
25   of the magnetic sensor 18 is engaged with a stop shaft 19

so that the magnetic sensor 18 can move in the axial direction of the spline shaft 13, but cannot rotate in the circumferential direction. The stop shaft 19 is fixed to the component suction head part 6 and extends in parallel to the axial direction. The magnetic sensor 18 is hence rendered movable in the axial direction in a state while the magnetic sensor 18 is hindered from rotating in the circumferential direction. The magnetic scale 20 similar to the earlier-described magnetic scale 28 is secured to the component suction head part 6 in a state not to be in touch with the magnetic sensor 18 in a movement range of the magnetic sensor 18. The magnetic sensor 18 is connected to the control device 11.

The detecting device for detecting the movement amount of the spline shaft 13 is not limited to the above-described magnetic scales 28, 20, magnetic sensors 29, 18, and transmission sensor 30. Any known instrument that can measure the movement amount of the spline shaft 13 is employable.

The component mounting apparatus including the component suction head part 6 of the embodiment constituted as above operates in the following fashion.

Under the control of the control device 11, the transfer part 2 carries in the electronic circuit board 1 from a previous process and supports the circuit board at a

mount position. In the meantime, the transmission sensor 30 set at the component suction head part 6 detects the origin of the movement of the spline shaft 13 when the light is shut by the leading end of the magnetic scale 28.

5 The detected information of the origin is fed from the transmission sensor 30 to the control device 11.

Subsequently, because of the control by the control device 11, the X-Y robot 5 moves the component suction head part 6 to a component hold position at the  
10 reel-type electronic component feed part 3 or the tray-type electronic component feed part 4.

When the power is supplied to the voice coil motor 21 by the control of the control device 11, the spline shaft 13 is descended. At this time, the control  
15 device 11 controls a descent amount of the spline shaft 13 on the basis of output information from the magnetic sensor 29 in consequence of the downward movement of the magnetic scale 28. After the voice coil motor 21 is driven thereby lowering the spline shaft 13 and the nozzle 8, the sucking  
20 device 103 starts the suction action under the control of the control device 11. That is, the air is sucked from the leading end of the nozzle 8 via the air joint 25, the hole 26, the interior 24 of the voice coil motor 21, the shaft opening 27a, the air hole 27, and the filter 137. When the  
25 leading end of the nozzle 8 approaches or comes in touch

with the electronic component 138 stored in the reel-type electronic component feed part 3 or the tray-type electronic component feed part 4, the electronic component 138 is sucked to the leading end of the nozzle 8.

5           After the suction of the electronic component 138, the control device 11 controls to drive the voice coil motor 21 to move the nozzle 8 upward until the magnet 23 of the voice coil motor 21 arrives at the up position 12a. Thereafter, under the control by the control device 11, the  
10 X-Y robot 5 moves the component suction head part 6 over the component recognition camera 7 which in turn picks up an image of a suction attitude of the electronic component 138 sucked by the nozzle 8 and sends picked-up image information to the control device 11. Based on the  
15 obtained information, if necessary, the control device 11 drives the motor 142 to rotate the spline shaft 13 in the circumferential direction via the belt 140 to correct the position of the suction attitude.

          The X-Y robot 5 under the control of the control  
20 device 11 moves the component suction head part 6 over the electronic circuit board 1. The control device 11 electrifies the voice coil motor 21 again, whereby the spline shaft 13 and the nozzle 8 move down to mount the sucked electronic component 138 to the component mount  
25 position on the circuit board 1.

As described hereinabove, according to the component holding head, the component mounting apparatus equipped with the component holding head, and the component hold method for being carried out by the component mounting apparatus in the embodiment, the spline shaft 13 is moved by the voice coil motor 21 set thereat and, the power supply to the voice coil motor 21 is controlled by the control device 11, thus enabling the spline shaft 13 to move correctly. The pressure applied by the nozzle 8 to the electronic component 138 when the electronic component is sucked by the nozzle 8 and when the sucked electronic component 138 is mounted to the circuit board 1 can be controlled by controlling of the power supplied to the voice coil motor 21.

The magnetic scale 28 detecting the movement of the spline shaft 13 is directly coupled to the rigid spline shaft, and the nozzle alike is directly coupled to the rigid spline shaft 13. Therefore a movement amount of the magnetic scale 28 subsequent to the movement of the spline shaft 13 in the axial direction perfectly agrees with a movement amount of the nozzle 8 in the axial direction. In the structure adopted in the embodiment, a down movement amount of the spline shaft 13 when the leading end of the nozzle 8 is brought into touch with the electronic component 138 and when the electronic component 138 sucked

to the nozzle 8 is mounted on the electronic circuit board  
1 can be correctly detected by detecting the movement  
amount of the magnetic scale 28.

Accordingly the embodiment improves mount quality  
5 for the electronic components as much as, for example, to  
reduce a mounting error from  $1\mu\text{m}$  to about  $0.5\mu\text{m}$ .

Although the spline shaft 13 equipped with the  
nozzle 8 moves in a vertical direction in the embodiment, a  
movement direction of the spline shaft 13 is not limited to  
10 this and can be set to match the component feed parts and  
circuit boards.

According to the embodiment, the component is  
exemplified by the electronic component, but not restricted  
to the electronic component, and similarly, the article to  
15 which the component is mounted is exemplified by the  
electronic circuit board and not limited to this.

As is fully described hereinabove, according to  
the component holding head of the first aspect of the  
present invention and the component mounting apparatus of  
20 the second aspect of the present invention, the voice coil  
motor for directly driving the shaft is installed at the  
shaft, and the power supply to the voice coil motor is  
controlled thereby controlling the movement of the shaft in  
the axial direction, so that the movement of the shaft in  
25 the axial direction is known correctly. Hence the movement

of the nozzle set at one end part of the shaft is controlled correctly and thus, the mount quality is improved.

According to the component hold method of the  
5 third aspect of the present invention, both the voice coil motor for directly driving the shaft and the detecting device for detecting the movement of the shaft are provided at the shaft. The power supply to the voice coil motor is controlled on the basis of the detected result by the  
10 detecting device thereby controlling the movement amount of the shaft, so that the movement of the shaft in the axial direction can be detected correctly. As a result, the movement of the nozzle set at one end part of the shaft is controlled correctly to improve mount quality.

15 The entire disclosure of Japanese Patent Application No. 8-345069 filed on December 25, 1996, including specification, claims, drawings, and abstract are incorporated herein by reference in its entirety.

Although the present invention has been fully  
20 described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the  
25 scope of the present invention as defined by the appended

claims unless they depart therefrom.



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## CLAIMS

1. A component holding head equipped with a shaft (13) which has a nozzle (8) for holding of a component set at one end part thereof and is driven in an axial direction thereof,

in which a magnet (23) is fixed to a circumferential face of the shaft and a coil (22) is disposed in a circumference of the shaft, thereby constituting a voice coil motor (21) for driving the shaft in the axial direction, so that the shaft is controlled in movement in the axial direction through controlling of power supply to the voice coil motor.

2. A component holding head according to claim 1, wherein further a detecting device (28, 29) is installed at the shaft for detecting the movement of the shaft in the axial direction, so that an amount of the movement of the shaft in the axial direction by the voice coil motor is controlled on the basis of a detection result of the detecting device.

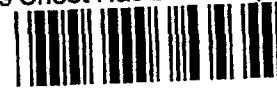
3. A component holding head according to claim 2, wherein the detecting device comprises: a member (28) to be detected which extends concentrically with the shaft, is directly fitted to the other end part of the shaft, and moves in the axial direction in accordance with the movement of the shaft in the axial direction; and



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a sensor (29) for detecting movement of the member to be detected.

4. A component holding head according to claim 3, wherein the member to be detected of the detecting device  
5 is a magnetic scale,

the component holding head comprising a transmission sensor (30) set in a noncontact state thereto to detect presence/absence of shutting of light by a leading end of the magnetic scale (28), thereby detecting  
10 an origin position of the movement of the shaft.

5. A component holding head according to claim 2, wherein the detecting device comprises: a sensor (18) which is directly set at the other end part of the shaft via a bearing (17) so as to be prevented from rotating together  
15 with the shaft when the shaft is driven in a circumferential direction thereof, while being allowed to move in the axial direction subsequent to the movement of the shaft in the axial direction; and

a member (20) to be detected by the sensor which  
20 extends in parallel to the axial direction of the shaft.

6. A component mounting apparatus for mounting components which is equipped with the component holding head according to any one of claims 1-5.

7. A component mounting apparatus according to claim  
25 6, further comprising: a detecting device which is set at



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the shaft to detect the movement of the shaft in the axial direction; and a control device (11) which controls an amount of the movement of the shaft in the axial direction by the voice coil motor on the basis of a detection result  
5 of the detecting device.

8. A component mounting apparatus according to either claim 6 or claim 7, wherein the shaft is arranged movably to a casing (21a) of the voice coil motor, with a nozzle suction pipe (25, 26) installed at the casing, while  
10 an opening (27a) of a through hole (27) penetrating the shaft to communicate with the nozzle is opened in the casing, whereby the pipe and the opening of the through hole are communicated with each other in the casing.

9. A component hold method carried out with the use  
15 of a component holding head having a shaft (13) which is equipped with a nozzle (8) for holding of a component at one end part thereof and is driven in an axial direction thereof, whereat a magnet (23) is fixed to a circumferential face of the shaft and a coil (22) is  
20 arranged in a circumference of the shaft, thereby constituting a voice coil motor (21) for driving the shaft in the axial direction thereof,

the method comprising: detecting the movement of the shaft in the axial direction by the voice coil motor by  
25 a detecting device (28, 29) installed at the shaft; and



controlling power supply to the voice coil motor on the basis of a detection result of the detecting device, thereby controlling a movement amount of the shaft in the axial direction to hold the component.

- 5 10. A component hold method according to claim 9, wherein the member to be detected of the detecting device is a magnetic scale with a transmission sensor (30) set in a noncontact state to the magnetic scale to detect presence/absence of shutting of light by a leading end of  
10 the magnetic scale 28, thereby detecting an origin position of the movement of the shaft.

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