DESCRIPTION

Title of Invention

ELECTRONIC CIRCUIT COMPONENT MOUNTING SYSTEM

Technical Field

[0001]

The present invention relates to a component mounting system that mounts an electronic circuit component (hereinafter, is referred to as a component as long as there is no particular requirement) held by a component holding tool on a mounting target member held by a target member holding device. In the component mounting system, the component holding tool such as an adsorbing nozzle is lowered by a holding tool lifting and lowering device, for mounting, thereby being in contact with a component which is supplied from a component supplying device, or a component held by the component holding tool is in contact with a mounting target member, but in this type of a component mounting system, a component can be damaged at the time of the contact. The present invention relates to the detection of damage of the component and the prevention of damage.

Background Art

[0002]

In recent years, miniaturization of an electronic circuit of one layer has been required, and in order to meet the requirement, a component-embedded printed circuit board in which components are embedded in a circuit board with a plurality of layers has been manufactured, for example, as described in PTL 1 below. In the component-embedded printed circuit board, in order to make the entire board thin, making a circuit board and components thin is attempted, but it is necessary to ensure electrical characteristics despite being thin, and thus a hard member such as a wafer is frequently used as a material. In addition, in order to achieve miniaturization of one layer, an attempt is made to not only make a passive component, such as a resistor, a capacitor or the like, be thin, but to also make an active component, such as an IC be thin, and manufacture of a stacked printed circuit board in which thin components (components that have to be respectively referred to as an electronic circuit) are stacked is also performed. In the stacked printed circuit board that is currently manufactured, stacked printed circuit boards are connected to each other by wire bonding, but when a CPU and a memory are stacked, examination of the stacked CPU that is connected by a through silicon via (TSV) in the inside of the stacked printed circuit board is also performed.

Citation List

Patent Literature

[0003]

[PTL 1] JP-A-2011-187831

[0004]

However, a hard and thin material is brittle, and when a component holding tool is in contact with a component, or when a component held by a component holding tool is in contact with a circuit board or a mounting target member of other components or the like, the component may be damaged. The damage can be generated when a plane mounting printed circuit board on which a component is mounted in a circuit board is manufactured, and a detection technology or a preventive technology of damage is useful, but is further important in a component-embedded printed circuit board or a multi-layer printed circuit board. In a case in which a component is damaged at the time of manufacture of a plane mounting printed circuit board, it is possible to perform repair, such as replacing the component with another component. However it is substantially impossible to repair a component-embedded printed circuit board or a multi-layer printed circuit board. Furthermore, a component such as an IC is expensive in most cases, thereby great loss occurs, and thus it is more important. However, a technology of configuring a component mounting system as a device which can detect damage is not described in other patent documents in addition to PTL 1.

[0005]

Meanwhile, a component manufacturer publicizes the maximum estimate of a contact force that is applied to a component for mounting, in order to prevent the damage of a component, but even if a parameter of a mounting operation is determined in accordance with the estimate, damage can be generated. It is assumed that a condition when the component manufacturer determines the estimate is different from a condition when a component is actually mounted on a mounting target member. In addition, it is assumed that the condition is affected by a structure or the like of the mounting system, and if the structures of the mounting systems are different from each other, it is assumed that parameters of the mounting operation may be modified. Furthermore, when the component manufacturer determines the estimate of a contact force, a predetermined margin may be added, but it is assumed that, even in a case in which a component user determines the operation parameter, a certain magnitude of margin is added. As a result, the added margin can be excessive, and as the result, the manufacturing efficiency of an electronic circuit can be suppressed so as to be lower than necessary. In order to suppress such that the upper limit of a contact force which is added to a component for mounting is lowered, there are means for decreasing a set weight or an elastic coefficient of a compression coil spring that functions as a cushion, but eventually, it is necessary to decrease lowering speed of a component holding tool.

Summary of Invention

Technical Problem

[0006]

An object of the present invention is to remove an abnormality described above.

Solution to Problem

[0007]

The object is achieved by providing an electronic circuit component mounting system including (a) a component supplying device that supplies an electronic circuit component, (b) a target member holding device that holds a mounting target member which has to mount the electronic circuit component, (c) a mounting device that includes a component holding tool which holds the electronic circuit component and a lifting and lowering device which lifts and lowers the component holding tool, receives the electronic circuit component from the component supplying device using the component holding tool, and mounts the electronic circuit component in the mounting target member held by the target member holding device, and (d) a damage detecting device which detects that the electronic circuit component is damaged in at least one of when the electronic circuit component held by the component holding tool is in contact with the mounting target member, and when the electronic circuit component held by the component holding tool is in contact with a mounting target member, in a case in which the component holding tool is lowered by the lifting and lowering device.

The object is also achieved by providing an electronic circuit component mounting system including (a) a component supplying device, (b) a target member holding device, (c) a mounting device, and (d) a damage detecting device, and further including (e) a damage operation parameter acquiring unit that acquires an operation parameter, in a case in which, with respect to one set of the target member holding device, the electronic circuit component, and the mounting target, an operation of making the electronic circuit component held by the component holding tool be in contact with the mounting target member held by the target member holding device is repeatedly performed, the operation parameter that is a parameter of the operation is changed in accordance with a predetermined rule, and damage of the electronic circuit component is detected by the damage detecting device.

The object is also achieved by providing an electronic circuit component mounting system including (a) a component supplying device, (b) a target member holding device, (c) a mounting device, and (d) a damage detecting device, and further including (e) a damage operation parameter acquiring unit that acquires an operation parameter, in a case in which, with respect to one set of the component supplying device and the electronic circuit component, an operation of making the component holding tool be in contact with the electronic circuit component held by the component supplying device is repeatedly performed, the operation parameter that is a parameter of the operation is changed in accordance with a predetermined rule, and damage of the electronic circuit component is detected by the damage detecting device.

In a rule in which the operation parameter is changed, an electronic circuit component that is not easily damaged may be changed to an electronic circuit component that is easily damaged and vice versa, but the former is preferred in that the electronic circuit component is less damaged.

If an operation parameter at the time of being damaged is obtained, based on this, it is also possible to obtain a boundary parameter that is an operation parameter of a boundary between a case in which the damage is detected and a case in which the damage is not detected. It is preferable that the boundary operation parameter is automatically obtained, but it is not essential, and the boundary operation parameter can also be obtained by a person.

Advantageous Effects of Invention

[0008]

If a component is damaged during mounting works, an electronic circuit component mounting system that includes a damage detecting device immediately detects the damage. Thus, in a case in which damage is detected during manufacture of a component-embedded printed circuit board or a stacked printed circuit board, it is possible to immediately stop the mounting works at the time. The related art is only for finding damage of a component in the beginning through electrical inspection after the component-embedded printed circuit board or the stacked printed circuit board is manufactured, and thus repair cannot be done at the time which damage is found, and since many components are integrated, loss is significant. In contrast to this, if damage is immediately found, repair is done if possible, and even in a case in which the repair cannot be done, mounting works are stopped thereafter, and thus it is possible to reduce waste of components or time as much as possible. Particularly, the effect is greater at the time of manufacture of the component-embedded printed circuit board or the stacked printed circuit board, but it is also advantageous at the time of manufacture of a plane mounting printed circuit board.

In addition, according to the electronic circuit component mounting system that includes a damage operation parameter acquiring unit in addition to the damage detecting device, it is possible to acquire the damage operation parameter acquiring unit in the same condition as at the time of actual manufacture of a circuit board. It is possible to acquire a boundary operation parameter that is an operation parameter of a boundary between a case in which the damage is detected and a case in which the damage is not detected, based on the operation parameter at the time of damage, and it is possible to efficiently manufacture a circuit board using a proper operation parameter to which a proper margin is added. Moreover, the damage detecting device can function even during actual manufacture of the circuit board, and in this case, if damage is generated, the damage can be detected. Thus, the margin can be set to a relatively small value, and it is possible to more efficiently manufacture the circuit board.

Brief Description of Drawings

[0009]

Fig. 1 is a plan view illustrating an electronic circuit component mounting machine that is a main portion of an electronic circuit component mounting system according to an embodiment of the present invention.

Fig. 2 is a front view illustrating an example of a mounting head of the electronic circuit component mounting machine.

Fig. 3 is a view illustrating an adsorbing nozzle of the mounting head and periphery thereof, Fig. 3A is a partial sectional front view, and Fig. 3B is a view taken along an A arrow of Fig. 3A.

Fig. 4 is a block diagram illustrating a control system of the electronic circuit component mounting machine in the electronic circuit component mounting system.

Fig. 5 is a graph illustrating a change of a reaction force against a second linear motor, a solid line illustrated a case in which a high frequency control is performed, and a two-dot chain line illustrates a case in which the high frequency control is not performed, but a normal control is performed.

Fig. 6 is a graph in which, in a case in which the high frequency control illustrated in Fig. 5 is performed, a main portion of an example of a detection reaction force that is detected by a reaction force detection section of the control system is illustrated in an enlarged manner, and a graph in which a solid line illustrates a change of a detection reaction force at the time of not being damaged, and a two-dot chain line illustrates a change of the detection reaction force at the time of being damaged.

Fig. 7 is a view schematically illustrating a state in which a component is damaged at the time of making contact with a mounting target member.

Fig. 8 is a flowchart illustrating a proper operation parameter determination routine that is performed by a controller of the control system.

Fig. 9 is a view corresponding to Fig. 3 illustrating another example of the mounting head of the electronic circuit component mounting machine.

Fig. 10 is a front view illustrating still another example of the mounting head according to another embodiment of the present invention.

Description of Embodiments

[0010]

Hereinafter, embodiments of the present invention will be described with reference to the drawings. The present invention can be performed by aspects in which various modifications are performed based on knowledge of those skilled in the art, differently from the embodiments below.

[0011]

Fig. 1 illustrates an electronic circuit component mounting machine 10 that is a main portion of an electronic circuit component mounting system. Hereinafter, the electronic circuit component mounting system and the electronic circuit component mounting machine 10 are respectively referred to as a mounting system and a mounting machine 10. The electronic circuit component mounting machine 10 includes a mounting body 12, and tape feeders 14 and tray feeders 16 which are component supplying devices that are supported by the mounting body 12. Each of the tape feeders 14 draws a holding tape that is held so as to be able to take out one type of a component from a reel, moves the holding tape by one pitch, and supplies the holding tape to a predetermined position. The tape feeders 14 are installed on a supporting base 18 in parallel with each other in the X direction. The tray feeders 16 position and support components in trays in parallel with each other in a plane, and is also installed on a supporting base 20 in parallel with each other in the X direction.

[0012]

Furthermore, a circuit board, a target member conveyor 24 that transports a mounting target member 22 of an electronic circuit or the like in the X direction, a target member holding device 26 that positions and holds the transported mounting target member 22, and a mounting device 28 that receives a component from the tape feeder 14 or the tray feeder 16 and mounts the component in the mounting target member 22 which is held in the target member holding device 26, are provided on the mounting body 12. The mounting device 28 includes a mounting head 30, and a head moving device 32 that can move the mounting head 30 to an arbitrary position on a horizontal surface defined by an X axis and a Y axis. The head moving device 32 includes an X slide 36 that is moved by an X axis drive device 34 in the X axis direction on the mounting body 12, and a Y slide 40 that is moved by a Y axis drive device 38 in the Y axis direction on the X slide 36. The mounting head 30 can be attached to and detached from the Y slide 40.

[0013]

An example of the mounting head 30 is illustrated in Fig. 2. The mounting head 30 includes a head body 50 that is attached to or detached from the Y slide 40. The head body 50 includes a first section 54 that holds a rotational lifting and lowering shaft 52 in a state in which lifting and lowering in a direction parallel with an axis line of the rotational lifting and lowering shaft 52 and rotation of the periphery of the axis line is allowed, and a second section 60 that fixedly holds a first linear motor 58. In the present embodiment, the first section 54 and the second section 60 are fixed to each other. The rotational lifting and lowering shaft 52 holds an adsorbing nozzle 62 that is a component holding tool in a lower end portion. As illustrated in Fig. 3A, the rotational lifting and lowering shaft 52 includes a lifting and lowering shaft body 66, and a nozzle holding section 68 that can be attached to or detached from the lifting and lowering shaft body 66. The nozzle holding section 68 is held by the lifting and lowering shaft body 66 so as to be able to relatively move the adsorbing nozzle 62 in an axis direction and to not be able to relatively rotate the adsorbing nozzle 62, and is attached to or detached from the lifting and lowering shaft body 66. After being mounted in the lifting and lowering shaft body 66, the nozzle holding section 68 functions as a part of the rotational lifting and lowering shaft 52.

[0014]

The lifting and lowering shaft body 66 includes a fitting hole 70 whose sectional shape is circular in a lower end portion, the nozzle holding section 68 includes a nozzle holding member 74 of a cylindrical shape, and the nozzle holding member 74 is fit to the fitting hole 70 in an outer circumferential surface so as to be able to relatively rotate and relatively move in an axis direction, meanwhile the nozzle holding section 68 is fit to an axis section 76 of the adsorbing nozzle 62 so as to be able to relatively rotate in an axis direction in an inner circumferential surface. A pin 78 that penetrates the nozzle holding member 74 in a diameter direction is fixed to the nozzle holding member 74. The pin 78 slidably penetrates a long hole 80 that is formed to be long in an axis direction of an axis portion 76 in the axis portion 76 of the adsorbing nozzle 62, in a central portion, meanwhile both end portions of the pin 74 protrude from the outer circumferential surface of the nozzle holding member 74, slidably penetrate two notches 82 that are formed in the lower end portion of the lifting and lowering shaft body 66, and protrude from the outer circumferential surface of the lifting and lowering shaft body 66. As illustrated in Fig, 3B, after each notch 82 extends upwards from the lower end surface of the lifting and lowering shaft body 66, the notch 82 extends in a circumference in a state of being perpendicularly curved, and further has a shape of being shortly pendent downwards from a tip thereof. The nozzle holding member 74 is fit to the lifting and lowering shaft body 66 from a lower end opening of the fitting hole 70, lowers after being rotated in a predetermined angle. According to this, both end portions of the pin 78 are fit to the notch 82, and finally, are received to a pin receiving section 84 in which the pin 78 is shortly pendent. In this state, the pin 78 penetrates the lifting and lowering shaft body 66, and the axis portion 76 of the nozzle holding member 74 and the adsorbing nozzle 62, and enters a state in which tripartite relative rotation is prevented. Thus, if the rotational lifting and lowering shaft 52 is rotated, the adsorbing nozzle 62 is also rotated.

[0015]

A negative pressure path 90 is formed in the central portion of the lifting and lowering shaft body 66, and communicates with the fitting hole 70. After the axis portion 76 of the adsorbing nozzle 62 penetrates the nozzle holding member 74, compression coil springs 92 are fit to each other, and a flange member 94 is stuck on an upper end of the axis portion 76. As described above, in a state in which the nozzle holding member 74 is fit to the fitting hole 70 and the pin 78 is received to the pin receiving section 84, the flange member 94 is separated from an end portion surface 96 that is formed at a boundary between the fitting hole 70 and the negative pressure path 90, meanwhile an end portion surface 98 of the adsorbing nozzle 62 is held in a state of being pressed to a lower end surface 100 of the nozzle holding member 74. The lower end surface 100 configures a stopper that defines a relative rising limit with respect to the lifting and lowering shaft body 66 of the adsorbing nozzle 62. As described above, since the negative pressure path 90 communicates with the fitting hole 70, if a negative pressure is supplied to the negative pressure path 90, force that draws upwards the adsorbing nozzle 62 and the nozzle holding member 74 is applied to the adsorbing nozzle 62 and the nozzle holding member 74, but, in order to prevent the pin 78 from floating upwards from the pin receiving section 84 based on the force, a lock machine is provided. A lock slip 102 is slidably fit to the outer circumferential surface of the lifting and lowering shaft body 66, and presses the pin 78 to the pin receiving section 84 after being biased downwards by a compression coil spring 104. The negative pressure path 90 in the rotational lifting and lowering shaft 52 communicates with a negative pressure path 106 in the adsorbing nozzle 62. As illustrated in Fig. 3A, the adsorbing nozzle 62 includes a large diameter section 110 in an intermediate section in an axis direction, includes a small diameter 112 that extends in a direction opposite to the axis portion 76 from the large diameter section 110, and a nozzle slip 114 is slidably fit to the small diameter section 112. The nozzle slip 114 is biased toward a base end of the adsorbing nozzle 62 by a compression coil spring 116, and is normally in contact with an end surface 118.

[0016]

As described in Fig. 2, the first linear motor 58 functions as a first lifting and lowering drive device that lifts and lowers the rotational lifting and lowering shaft 52 which is a first lifting and lowering member and a second linear motor 120 which is a second lifting and lowering drive device. For this reason, a lifting and lowering drive member 122 that is the second lifting and lowering member is attached to the first linear motor 58. The lifting and lowering drive member 122 perpendicularly elongates an outer side of the first section 54 of the head body 50 along the rotational lifting and lowering shaft 52, includes a first fitting section 124 in an intermediate section, and holds the second linear motor 120 in a lower end portion. The second linear motor 120 includes a second fitting section 126 (is configured by a roller which can rotate in the periphery of a horizontal axis line). The first fitting section 124 is fit to a flange 128 that is provided in the vicinity of an upper end of the rotational lifting and lowering shaft 52, and the second fitting section 126 is fit to a flange 130 of the nozzle slip 114 in a state in which rotation of the rotational lifting and lowering shaft 52 and the adsorbing nozzle 62 is allowed. A guide 132 is attached to the second section 60 of the head body 50, and guides the lifting and lowering drive member 122.

[0017]

A gear 140 is provided over a flange 128 of the rotational lifting and lowering shaft 52, and meshes with a gear 144 fixed to a rotation shaft of the electric motor 142 that is a rotation drive source attached to the head body 50. The gears 140 and 144 allow lifting and lowering of the rotational lifting and lowering shaft 52, and transfer the rotation of the electric motor 142 to the rotational lifting and lowering shaft 52. The rotation drive device of the rotational lifting and lowering shaft 52 is configured by the electric motor 142 and the gears 140 and 144, the rotation of the rotational lifting and lowering shaft 52 is transferred to the nozzle holding member 74 by fitting of the pin receiving section 84 and the pin 78, and is transferred to the adsorbing nozzle 62 by fitting of the pin 78 and the long hole 80.

[0018]

The mounting head 30 configured as described above is moved over the tape feeders 14 or the tray feeders 16, and the target member holding device 26 along an X-Y plane by the head moving device 32. The first linear motor 58 lowers the lifting and lowering drive member 122, and lowers the rotational lifting and lowering shaft 52 and the second linear motor 120. In addition, the second linear motor 120 relatively lowers the adsorbing nozzle 62 with respect to the rotational lifting and lowering shaft 52 through the nozzle slip 114 and the compression coil spring 116. Furthermore, at the same time, a negative pressure of the negative pressure path 90 is controlled by a negative pressure control valve that is not illustrated, and the holding and release of a component 146 performed by the adsorbing nozzle 62 is controlled. In addition, the electric motor 142 operates if necessary, and a rotation posture of a component that is held in the adsorbing nozzle 62 is modified or changed. Since the control of the first linear motor 58, a negative pressure control valve, the electric motor 142, or the like is the same as that of a normal mounting head, description thereof will be omitted, and hereinafter, a special control of the second linear motor 120 will be described.

[0019]

The second linear motor 120 is controlled by a control system 150 illustrated in Fig. 4. The control system 150 is configured by a part of a controller 152 that controls the entirety of the mounting device 28 including the mounting head 30, a drive circuit 154, and an encoder 156 that is subordinate to the second linear motor 120. The controller 152 designates the position of the second linear motor 120, and the drive circuit 154 supplies, to the second linear motor 120, a current that is necessary for making the designated position coincide with the position indicated by the encoder 156. At this time, the reaction force that is received by the second linear motor 120 is an elastic force of the compression coil springs 92 at first. However, after the adsorbing nozzle 62 is in contact with the component 146 held by a component supplying device, or the component 146 held by the adsorbing nozzle 62 is in contact with the mounting target member 22 held by the target member holding device 26 and is compressed by the compression coil spring 116, the second linear motor 120 receives the elastic force of the compression coil spring 116. That is, the set weight of the compression coil spring 116 is greater than the elastic force of the compression coil springs 92, the nozzle slip 114 integrally lowers with the adsorbing nozzle 62 until contact is made, and after contact is made, the compression coil spring 116 starts elastic deformation and thereby contact force is reduced. The set weight of the compression coil spring 116 does not damage the component 146, and the pressure of the component 146 to the mounting target member 22 has a sufficient magnitude, but at the time of making contact, an inertial force of the adsorbing nozzle 62 further operates additionally with a frictional force between the adsorbing nozzle 62 and the nozzle slip 114, and thereby if the inertial force is excessively increased, there is a possibility that a weak component 146 may become damaged. In other words, if the lowering speed of the adsorbing nozzle 62 performed by the second linear motor 120 is sufficiently decreased, there is no possibility that the component 146 may be damaged by the set weight of the compression coil spring 116. However, if the lowering speed of the adsorbing nozzle 62 is increased in order to increase mounting efficiency, there is a possibility that the inertial force of the adsorbing nozzle 62 at the time of making contact is increased and thereby the component 146 may become damaged.

[0020]

Damage can be generated at the time of manufacturing a plane mounting substrate on which the component 146 is mounted on a piece of circuit board, but particularly, in a case in which a component-embedded printed circuit board or a stacked printed circuit board is manufactured, regardless of whether the component 146 is a passive component, such as a resistor or a capacitor, or is an active component, such as an IC, the printed circuit board can be thinned, is manufactured by a brittle material for ensuring electrical performance, and is easily damaged. When manufacturing the component-embedded printed circuit board or the stacked printed circuit board, a printed circuit board is mounted on another printed circuit board, and thus with regard to the mounting target member 22 and the component 146, the component 146 can be held by the adsorbing nozzle 62 and be mounted on the mounting target member 22, and there is no substantial difference between the component 146 and the mounting target member 22.

[0021]

As described above, damage to the present mounting head 30 can be avoided even in a case of being the component 146 formed of a thin and brittle material, and furthermore, examination is necessary to perform efficient mounting work. That is, when lowering the adsorbing nozzle 62, the first linear motor 58 first operates, the lifting and lowering drive member 122 is lowered, and thereby the rotational lifting and lowering shaft 52 and the second linear motor 120 are lowered. In a case in which the lifting and lowering distance of the adsorbing nozzle 62 is long during a main work, the first linear motor 58 operates in order to satisfy the requirements, and before at least the component 146 is in contact with the adsorbing nozzle 62 or the mounting target member 22, the first linear motor 58 stops the operation, the second linear motor 120 operates, and thereby the adsorbing nozzle 62 is separated by a set distance from the lower end surface 100 that is a stopper against a biasing force of the compression coil springs 92. A cruising period in Fig. 5 is a period during which the adsorbing nozzle 62 is lowered in the state.

[0022]

Soon, the adsorbing nozzle 62 is in contact with the component 146 held by a component supplying device, or the component 146 held by the adsorbing nozzle 62 is in contact with the mounting target member 22 held by the target member holding device 26. If the second linear motor 120 and the control system 150 are not provided, and the compression coil spring 116 which functions as a cushion is provided in the same manner as a mounting head of the related art, a contact force at the time of making contact, that is, a reaction force against the adsorbing nozzle 62 is rapidly increased, and thus the component 146 can be damaged. In addition, in a case in which the control of the control system 150 is sufficient, the reaction force against the second linear motor 120 is greatly changed as illustrated by a two-dot chain line in Fig. 5, and furthermore, the component 146 can be damaged. However, in the present embodiment, the drive circuit 154 and the control system 150 become systems that can perform high-frequency control, that is, a high-frequency system is implemented in which a reaction force rapidly increases due to the contact and a control cycle of at least two cycles can be performed while the contact force exceeds an allowable contact force and thereby becoming excessive, a reaction detecting unit 158 is provided in the drive circuit 154, and as soon as a detection force of the reaction detecting unit 158 rapidly increases in accordance with being in contact, the control system 150 starts a control of the current supplied to the second linear motor 120 in order to control a reaction force so as to be a target reaction force. As a result, variation of the reaction force is suppressed so as to be decreased as denoted by a solid line, and at the time of making contact, the contact force is suppressed to a magnitude at which the component 146 is not damaged. A section in which the control system 150 performs a current control described above configures a contact impact absorbing section.

[0023]

For example, a rod cell that is provided between the adsorbing nozzle 62 and the second linear motor 120 can be employed as a main body unit of the reaction detecting unit 158. In the present embodiment, as illustrated in Fig. 2, a rod cell 159 that is provided between the second fitting section 126 and the second linear motor 120 can be employed. A damage detecting unit 160 that is a damage sensing device is provided, together with the reaction detecting unit 158, in the drive circuit 154. As described above, the detected reaction force that is detected by the reaction detecting unit 158 is rapidly increased in accordance with the reaction force against the second linear motor 120, which is caused by the contact of the adsorbing nozzle 62 with the component 146, or by the contact of the component 146 held by the adsorbing nozzle 62 with the mounting target member 22. However, if a portion that is rapidly increased is enlarged, and a horizontal axis which indicates time is elongated significantly more than a vertical axis which indicates reaction force and is illustrated, the result is the same as illustrated in Fig. 6, and eventually the detected reaction force is controlled so as to be the target reaction force. However, if the component 146 is damaged during this process as illustrated in Fig. 7, the detected reaction force is rapidly decreased as denoted by a tow-dot chain line of Fig. 6. In the present embodiment, as the damage detecting unit 160 detects the rapid decrease of the detected reaction force, the damage of the component 146 is detected. In a case in which an amount of the rapid decrease of the detected reaction force is greater than a set value, it is defined that the rapid decrease of the reaction force is detected. In Fig. 6, a portion denoted by “o” indicates a control time point of a drive current, and a portion denoted by “X” indicates a damage time point of the component 146. In addition, the numeral 166 in Fig. 7 indicates cream solder.

[0024]

Acquisition of “amount of rapid decrease” of the reaction force can be performed by calculating a difference (denoted by DF1 in Fig. 6) between the detected reaction forces of two time points in which reaction force detection time points illustrated by a plurality of thin lines parallel to a vertical line in Fig. 6 are adjacent to each other, or can be performed by calculating a difference (denoted by DF2 in Fig. 6) between an expected reaction force at a subsequent time point that is expected based on increased tendency of the detected reaction force until the rapid decrease occurs, and the detected reaction force which is actually detected at the same time point. A determination unit which determines that damage occurs in a case in which an amount of rapid decrease acquired by the former is equal to or greater than a set value, can be considered as a type of “a reaction rapid-decrease amount relying determination unit which determines that the component 146 is damaged in a case in which the reaction force detected by the reaction force detecting unit is rapidly decreased to an amount equal to or more than a set value during an increase”. The determination unit which determines that damage occurs in a case in which an amount of rapid decrease acquired by the latter is equal to or greater than the set value, can be considered as a type of “the reaction rapid-decrease amount relying determination unit which determines that the component is damaged in a case in which a change state of the reaction force detected by the reaction force detecting unit is different from a set change state set in advance by a state equal to or more than a set state”. The above-described “increase tendency of the detected reaction force until the rapid decrease occurs” may be an increase gradient that is acquired based on a reaction force of two or more time points before the occurrence of damage at the time of mounting during which damage actually occurs, and may be an average value of the increase gradient of the detected reaction force at the time of a plurality of mounting processes that is performed in the past when damage had not occurred.

[0025]

The controller 152 includes a damage reporting unit 162 that reports the fact, in a case in which damage of a component is detected by the damage detecting unit 160, and a mounting operation stopping unit 164 that stops a mounting operation of the mounting machine 10. The damage reporting unit 162 is a unit that displays damage occurrence on a display which is not illustrated. The mounting operation stopping unit 164 stops the operation of the unit that performs a mounting operation, such as the head moving device 32, the first linear motor 58, or the second linear motor 120, and does not stop the operation of the controller 152, a display or the like. If the operation of the unit that performs the mounting operation is stopped, an operator can know how much abnormality there is, and thus the mounting operation stopping unit 164 can also be used as a damage reporting unit. However, abnormality of the mounting device 28 is frequently generated in addition to the damage of the component 146, and thus it is preferable that it is reported that the abnormality is caused by the damage of the component 146, together with the operation stop.

[0026]

The controller 152 further includes a proper operation parameter determining unit 168 that determines a proper operation parameter using the reaction detecting unit 158 and the damage detecting unit 160, when the adsorbing nozzle 62 is in contact with the component 146, or when the component 146 held by the adsorbing nozzle 62 is in contact with the mounting target member 22. The proper operation parameter determining unit 168 determines a proper operation parameter by executing a proper operation parameter determination routine illustrated in the flowchart of Fig. 8, with regard to a combination of various types of a component supplying device (the tape feeders 14 and the tray feeders 16 in the present embodiment) and various types of the component 146, and a combination of various types of the target member holding device 26 and the mounting target member 22 and various types of the component 146. If the mounting target member 22 is coated with solder 166 in the form of a cream, or adhesive, the mounting target member 22 includes the coating materials. The coating materials can also affect the damage of the component 146.

[0027]

When executing a proper operation parameter determination routine, in S1, any one of the combinations to determine a proper operation parameter is first input. In S2, an expected proper contact force F0 with regard to the component 146 included in the combination is input. An expected value based on the past experience or the like of a user using the system is used as the expected proper contact force F0, but in a case in which there is none, a value of a recommended contact force that is recommended by a component manufacturer is used. Subsequently, in S3, an expected proper lowering speed V0 of the adsorbing nozzle 62 is determined as a type of the expected proper operation parameter. In general, the lower the lowering speed of the adsorbing nozzle 62 is, the smaller the contact force is, and thus in the present embodiment, in S2, as the expected proper contact force F0 that is input is smaller, the expected proper lowering speed V0 is determined to be a lower value. For example, the speed V0 is calculated by an equation V0=a×F0. Here, a is a proportional coefficient, but even if the components 146 are the same as each other, as rigidity of a supporting surface of a component supplying device that holds the component 146, rigidity of the mounting target member 22 that is in contact with the component 146, or rigidity of the supporting surface of the mounting target member 22 that holds the component 146 is strong, a large force is generated by a lowering speed, and thus, it is preferable that the proportional integer a is changed depending on the rigidity. The component supplying device and the target member holding device 26 are small, but have an elastic deformation capability. In addition, the mounting target member 22 usually has significant deformation capability (deformation capability of at least one of elasticity and plasticity) (particularly, in a case in which the solder 166 in the form of a cream, or adhesive is applied), and thus the deformation capability of the elasticity or the plasticity has a function of cushioning that reduces the contact force.

[0028]

Subsequently, in S4, an initial lowering speed Vi is calculated by an equation Vi=b´V0. Here, b is an integer smaller than 1 and is a predetermined coefficient. For example, in a case in which the initial lowering speed Vi is intended to be set to half of the expected proper lowering speed V0, b is set to 0.5. Next, in S5, an increased amount of the lowering speed DV is calculated by DV=(V0-Vi)/s. The symbol s represents the number of stages when a lowering speed V gradually increases from the initial lowering speed Vi to the expected proper lowering speed V0, and is determined in advance. After a positive integer N is initialized to 1 in S6, execution is performed once in S7. In a case in which the tape feeders 14 or the tray feeders 16 is included in the combination that is input in S1, making the adsorbing nozzle 62 be in contact with the component 146 that is supported by the tape feeders 14 or the tray feeders 16 is executed once with the lowering speed V (initially, with the initial lowering speed Vi that is determined in S4) in each time point. In addition, In a case in which the mounting target member 22 is included in the combination, making the component 146 held by the adsorbing nozzle 62 be in contact with the mounting target member 22 held by the target member holding device 26 is executed once with the lowering speed V (initially, with the initial lowering speed Vi that is determined in S4) in each time point. After the execution, it is determined whether or not damage is detected in S8, but since the initial lowering speed Vi is set to a sufficiently small value, the component 146 is not damaged, the determination is NO, the lowering speed V is increased by DV in S9, and S7 is executed again. After that, S7 to S9 are repeatedly executed, and furthermore if the determination of S8 is YES, the lowering speed at the time point becomes the lowering speed Vb at the time of damage detection that is a type of an operation parameter at the time of the damage detection, and is stored in a lowering speed memory at the time of damage detection. The lowering speed Vb at the time of the damage detection is a type of boundary lowering speed that is an operation parameter of a boundary between a case in which the damage of the component 146 is detected by the damage detection device and a case in which the damage is not detected. However, it is also possible to set an intermediate value between the lowering speed Vb at the time of the damage detection and the lowering speed in a case in which the damage is not detected immediately before the damage is detected, to the boundary lowering speed.

[0029]

In S10 described above, it is also possible to determine the proper lowering speed based on the lowering speed Vb at the time of damage detection of one piece stored in the lowering speed memory at the time of damage detection. However, in the present embodiment, for the sake of reliability, S7 to S9 are executed by N0 times. In S11, a positive integer N is increased by 1, and in S13, the lowering speed V returns to the initial lowering speed Vi. Then, S7 to S13 are repeatedly executed, until the positive integer N reaches N0 and thereby the determination of S12 becomes YES. As a result, when the determination of S12 becomes YES, the lowering speeds Vb at the time of damage detection of N0 pieces are stored in the lowering speed memory at the time of damage detection, and in S14, the proper lowering speed is determined based on the lowering speeds at the time of damage detection of the N0 pieces. The determination can be performed by various methods, but in the present embodiment, the proper lowering speed is determined by dividing an average value of the lowering speeds Vb at the time of damage detection of the N0 pieces by a safety rate c.

[0030]

The safety rate c is also a value higher than 1, but it is preferable that the safety rate is set to a greater value, as variation of the lowering speeds at the time of damage detection of the N0 pieces is great.

In addition, it is also possible to determine the proper lowering speed to a value smaller than any one of the lowering speeds Vb at the time of damage detection of the N0 pieces, or to a value greater than the smallest lowering speed Vb at the time of damage detection. In a case of the former, while the damage of the component 146 can be efficiently avoided during manufacture of an actual electronic circuit later, manufacturing capability can be excessively decreased. In a case of the latter, in contrary to this, while an excessive decrease of manufacturing capability can be avoided, the damage of the component 146 can be generated during manufacture of an actual electronic circuit. Based on the magnitude or the like of the damage in a case in which the component 146 is damaged, the positive integer N0 (the number of acquisition of the lowering speed Vb at the time of damage detection) and safety rate c has to be determined by considering which is actually desired.

[0031]

As can be apparent from the above description, in the present embodiment, the lifting and lowering device which lifts and lowers the adsorbing nozzle 62 that is a component holding tool is configured by the first linear motor 58, the second linear motor 120, the lifting and lowering drive member 122, and the like. A boundary lowering speed acquiring unit that acquires boundary lowering speed that is a boundary operation parameter is configured by a unit that executes S7 to S10 of the proper operation parameter determination routine, or a unit that executes S6 to S13. In addition, the proper lowering speed determining unit which determines the proper lowering speed that is a type of the proper operation parameter based on the boundary lowering speed acquired by the boundary lowering speed acquiring unit is configured by a unit that executes S14.

[0032]

In the embodiment, the compression coil spring 116 is provided between the second linear motor 120 and the adsorbing nozzle 62, and the set weight and the elastic coefficient of the compression coil spring 116 becomes a proper magnitude, and thereby if the lowering speed of the adsorbing nozzle 62 is properly set by the second linear motor 120, the component 146 can be prevented from being damaged. However, as illustrated in Fig. 9, it is also possible to omit the compression coil spring between the second linear motor 120 and the adsorbing nozzle 62. In this case, the second fitting section 126 of the second linear motor 120 is directly fit to the adsorbing nozzle 62, for example, is fit to the flange 130 that is a part of the adsorbing nozzle 62.

[0033]

In the present embodiment, as soon as the contact of the adsorbing nozzle 62 with the component 146 supported by the component supplying device, or the contact of the component 146 supported by the adsorbing nozzle 62 with the mounting target member 22 supported by the target member holding device 26, is detected, conversion from a lowering control of the adsorbing nozzle 62 to a lifting and lowering control thereof is performed. Thus, the lowering speed of the adsorbing nozzle 62 is variously changed, the contact is repeatedly performed, and the boundary lowering speed that is the lowering speed of the boundary between a case in which the damage of the component 146 is detected and a case in which the damage thereof is not detected, is acquired. Even in the present embodiment, the lowering speed of the adsorbing nozzle 62 can avoid the damage of the component 146, and becomes the operation parameter that has to be controlled to efficiently perform manufacture of a circuit board.

However, in order to detect the contact, it is required to detect that an increase of the reaction force against the adsorbing nozzle 62 exceeds a set increase, and the increase can be considered as a type of an operation parameter. If the increase is considered so, in the present embodiment, both the proper lowering speed of the adsorbing nozzle 62 and the increase of the reaction force become the proper operation parameters.

[0034]

In the embodiment described above, the rod cell 159 is used for detecting the reaction force against the second linear motor 120, but in a case in which the control for the operation of the second linear motor 120 is performed by the drive circuit 154 in accordance with the command from the controller 152, if the reaction force against the second linear motor 120 increases, a drive current of the second linear motor 120 increases, and thus it is possible to configure that the reaction force against the second linear motor 120 is detected based on the drive current. Thus, since an increase of the drive current can be performed by the drive circuit 154 and the increase of the drive current can also be detected by the drive circuit 154, there are advantages in which, based on a rapid increase of the reaction force against the second linear motor 120, the contact of the adsorbing nozzle 62 with the component 146 or the mounting target member 22 can be detected as a small delay, and the control of the contact force performed by the second linear motor 120 can also be performed at a small delay.

In the present embodiment, the drive current of the second linear motor 120 is at least one of the operation parameters that have to be controlled for avoiding the damage of the component 146 and for efficiently performing manufacture of a circuit board, and the proper drive current that is a drive current which has to detect the contact and to be converted from a lowering control to a lifting and lowering control of the adsorbing nozzle 62 becomes a proper operation parameter.

[0035]

In addition, in the embodiment described above, the mounting head 30 includes one adsorbing nozzle 62 that is a component holding tool, and the first section 54 and the second section 60 of the head body 50 are fixed to each other. However, the mounting head 30 includes a plurality of the adsorbing nozzles 62, and can also be configured such that the first section and the second section can relatively move. For example, a mounting head 178 is configured as illustrated in Fig. 10, and a head body 180 is configured by two sections, which can be relatively moved to each other, that is, a rotor 182 which is a first section that is rotatable table around one axis line, and a Y slide 184 which is a second section that rotatably hold the rotor 182.

The rotational lifting and lowering shaft 52 is slidably and rotatably provided in a direction parallel to a rotational axis line at a plurality of positions of equal angular intervals on one circumference having a rotational axis line of the rotor 182 as a center, that is, six positions in the illustrated example. The rotor 182 is rotated by a rotor rotation drive motor 190. In addition, integral gears 192 and 194 are relatively and rotatably fit to the rotor 182 in the outer circumference of the rotor 182, are rotated by a nozzle rotation drive motor 198 through a pinion 196, and simultaneously rotate the rotational lifting and lowering shaft 52 and the adsorbing nozzle 62 through a plurality of pinions 200.

[0036]

One of the plurality of rotational lifting and lowering axes 52, which is pivoted to a component receiving and mounting position by the rotation of the rotor 182 is lifted and lowered by a first lifting and lowering drive device 202. In the present embodiment, the first lifting and lowering drive device 202 is configured by a lifting and lowering drive motor 204 that is a rotation motor, a feed screw 206, and a nut 208. In addition, the rotational lifting and lowering shaft 52 is biased in an upper direction by a compression coil spring 210, and a snap ring 212 that is attached to the vicinity of a lower end of the rotational lifting and lowering shaft 52 is held in a lifting and lowering limitation position by being in contact with a lower surface of the rotor 182. Thus, a first fitting section 124 of a lifting and lowering drive member 214 is fit to an upper end surface of the rotational lifting and lowering shaft 52, and lowers the rotational lifting and lowering shaft 52 against a biasing force of the compression coil spring 210. The lifting and lowering drive member 214 guides lifting and lowering using a guide rod 218 and a guide 220.

[0037]

Even in the present embodiment, the rotational lifting and lowering shaft 52 and the second linear motor 120 are lifted and lowered together by the first lifting and lowering drive device 202, and furthermore, the second linear motor 120 that is a second lifting and lowering drive device lifts and lowers the adsorbing nozzle 62 with respect to the rotational lifting and lowering shaft 52. When the adsorbing nozzle 62 is in contact with the component 146, and when the component 146 held by the adsorbing nozzle 62 is in contact with the mounting target member 22, contact impact is mitigated. In addition, a point in which the first fitting section and the second fitting section are fit to the rotational lifting and lowering shaft 52 and the adsorbing nozzle 62 in a state of allowing the rotation thereof is the same as that of the embodiment, but the present embodiment further allows fitting and separation in a direction orthogonal to a lifting and lowering direction of the rotational lifting and lowering shaft 52 and the adsorbing nozzle 62 according to the rotation of the rotor 182.

Even in the present embodiment, a control of the second linear motor 120, damage detection of the component 146, determination of a set increase of a reaction force that determines a proper lowering speed of the adsorbing nozzle 62 and a conversion period from a lowering control to a lifting and lowering control of the adsorbing nozzle 62, or the like is the same as that of the embodiment.

However, in the mounting head 178 illustrated in Fig. 10, the adsorbing nozzle 62 and the periphery thereof are configured as illustrated in Fig. 3, and it is also possible for the determination of a proper operation parameter that has to be controlled to avoid the damage of the component 146 and to efficiently perform manufacture of a circuit board, to be performed by execution of the proper operation parameter determination routine illustrated in Fig. 8.

[0038]

Reference Signs List

10:ELECTRONIC CIRCUIT COMPONENT MOUNTING MACHINE (MOUNTING MACHINE) 14:TAPE FEEDER 16:TRAY FEEDER 22:MOUNTING TARGET MEMBER 26:TARGET MEMBER HOLDING DEVICE 28:MOUNTING DEVICE 30:MOUNTING HEAD 50:HEAD BODY 52:ROTATIONAL LIFTING AND LOWERING AXIS 58:FIRST LINEAR MOTOR 62:ADSORBING NOZZLE 68:NOZZLE HOLDING SECTION 74 120:SECOND LINEAR MOTOR 150:CONTROL SYSTEM 152:CONTROLLER 154:DRIVE CIRCUIT 156:ENCODER 158:REACTION FORCE DETECTING UNIT 160:DAMAGE DETECTING UNIT 162:DAMAGE REPORTING UNIT 164:MOUNTING OPERATION STOPPING UNIT 168:PROPER OPERATION PARAMETER DETERMINING UNIT

Claim(s)

[Claim 1]

An electronic circuit component mounting system including a component supplying device that supplies an electronic circuit component; a target member holding device that holds a mounting target member which has to mount the electronic circuit component; and a mounting device that includes a component holding tool which holds the electronic circuit component and a lifting and lowering device which lifts and lowers the component holding tool, receives the electronic circuit component from the component supplying device using the component holding tool, and mounts the electronic circuit component in the mounting target member held by the target member holding device, the system comprising:

a damage detecting device which detects that the electronic circuit component is damaged in at least one of when the electronic circuit component held by the component holding tool is in contact with the mounting target member, and when the electronic circuit component held by the component holding tool is in contact with the mounting target member, in a case in which the component holding tool is lowered by the lifting and lowering device.

[Claim 2]

The electronic circuit component mounting system according to Claim 1,

wherein the damage detection device includes

a reaction force detecting unit that detects a reaction force against the component holding tool in at least one of when the component holding tool is in contact with the electronic circuit component, and when the electronic circuit component held by the component holding tool is in contact with the mounting target member; and

a damage determining unit that determines presence or absence of damage of the electronic circuit component based on a changed state of the reaction force detected by the reaction force detecting unit.

[Claim 3]

The electronic circuit component mounting system according to Claim 2, wherein the reaction force detecting unit includes a drive source current detecting unit that detects a current of a drive source of the lifting and lowering device as an amount corresponding to the reaction force against the component holding tool.

[Claim 4]

The electronic circuit component mounting system according to Claim 2 or 3, wherein the reaction force detection unit includes a reaction sensor that is disposed between the drive source of the lifting and lowering device and the component holding tool, and detects the reaction force which is added to the drive source from the component holding tool.

[Claim 5]

The electronic circuit component mounting system according to any one of Claims 2 to 4, wherein the damage determining unit includes a reaction force change state relying determination unit which determines that the electronic circuit component is damaged, in a case in which a changed state of the reaction force detected by the reaction force detection unit is different from a set change state which is set in advance by a state equal to or more than the set change state.

[Claim 6]

The electronic circuit component mounting system according to Claim 5, wherein the reaction force change state relying determination unit includes a reaction force rapid-decrease relying determination unit determining that the electronic circuit component is damaged, in a case in which the reaction force detected by the reaction force detecting unit is rapidly decreased to an amount equal to or more than a set amount during an increase of the reaction force.

[Claim 7]

The electronic circuit component mounting system according to any one of Claims 1 to 6, further comprising:

at least one of a damage reporting unit which reports that damage of the electronic circuit component is detected by the damage detecting device; and a mounting operation stopping unit that, in a case in which damage of the electronic circuit component is detected by the damage detecting device, stops a mounting operation of the electronic circuit component which is performed by the electronic circuit component mounting system.

[Claim 8]

The electronic circuit component mounting system according to any one of Claims 1 to 7, further comprising:

a damage operation parameter acquiring unit that acquires an operation parameter, in a case in which, with respect to one set of the target member holding device, the electronic circuit component, and the mounting target, an operation of making the electronic circuit component held by the component holding tool be in contact with the mounting target member held by the target member holding device is repeatedly performed, the operation parameter that is a parameter of the operation is changed in accordance with a predetermined rule, and damage of the electronic circuit component is detected by the damage detecting device.

[Claim 9]

The electronic circuit component mounting system according to any one of Claims 1 to 8, further comprising:

a damage operation parameter acquiring unit that acquires an operation parameter, in a case in which, with respect to one set of the component supplying device and the electronic circuit component, an operation of making the component holding tool be in contact with the electronic circuit component held by the component supplying device is repeatedly performed, the operation parameter that is a parameter of the operation is changed in accordance with a predetermined rule, and damage of the electronic circuit component is detected by the damage detecting device.

Abstract

A decrease of working performance performed by an electronic circuit component mounting machine can be avoided if possible and an electronic circuit component can be prevented from being damaged.

In the electronic circuit component mounting machine, an adsorbing nozzle is lowered by a first linear motor and a second linear motor by two stages, and a drive circuit of the second linear motor includes a reaction force detecting unit and a damage detecting unit that detects damage of an electronic circuit component. In addition, a controller that controls the drive circuit includes a proper operation parameter determining unit that determines a proper value of an operation parameter of the second linear motor using the reaction detecting unit and the damage detecting unit. The second linear motor is controlled by the proper operation parameter which is determined by the proper operation parameter determining unit, and thus a decrease of working performance can be avoided if possible and the electronic circuit component can be prevented from being damaged.

Drawings

Fig. 4

152: CONTROLLER

168: PROPER OPERATION PARAMETER DETERMINING UNIT

162: DAMAGE REPORTING UNIT

164: MOUNTING OPERATION STOPPING UNIT

154: DRIVE CIRCUIT

158: REACTION FORCE DETECTING UNIT

160: DAMAGE DETECTING UNIT

120: SECOND LINEAR MOTOR

156: ENCODER

Fig. 5

REACTION FORCE

CRUISING PERIOD

CONTACT

TIME

Fig. 6

DETECTED REACTION FORCE

TARGET REACTION FORCE

TIME

Fig. 8

PROPER OPERATION PARAMETER DETERMINATION ROUTINE

S1: INPUT COMBINATION THAT HAS TO DETERMINE PROPER OPERATION PARAMETER

S2: INPUT EXPECTED PROPER CONTACT FORCE VALUE

S3: DETERMINE EXPECTED PROPER LOWERING SPEED V0

S4: CALCULATE INITIAL LOWERING SPEED Vi

S5: CALCULATE INCREASED AMOUNT OF LOWERING SPEED DV

S7: EXECUTE ONCE

S8: IS DAMAGE DETECTED ?

S9: INCREASE LOWERING SPEED BY DV

S10: STORE LOWERING SPEED Vb AT THE TIME OF DETECTING DAMAGE

S13: RETURN TO INITIAL LOWERING SPEED Vi

S14: DETERMINE PROPER LOWERING SPEED