DESCRIPTION

COMPONENT MOUNTING APPARATUS AND METHOD

Technical Field

The present invention relates to a component mounting apparatus and method for placing components fed from a component feeding device onto a board or other circuit formation article, and also relates to a component mounting system equipped with a plurality of such component mounting apparatuses.

Background Art

Conventionally, as shown in Fig. 9, the present applicant has already proposed a component mounting apparatus in which its component mounting work area 2200 is divided into a front-side component mounting work area 2201 and a rear-side component mounting work area 2202 viewed from an operator, each of the areas is provided with component feeding devices 2008A, 2008B, 2018A and 2018B and component recognition devices 2009 and 2019, and a front-side board conveying and holding device 2003 and a rear-side board conveying and holding device 2013 which can be laterally joined together are provided at the center of the component mounting work area 2200, in which arrangement when the front-side board conveying and holding device 2003

and the rear-side board conveying and holding device 2013 are joined together at the center, two boards 2002 and 2002 are loaded and held by the front-side board conveying and holding device 2003 and the rear-side board conveying and holding device 2013, respectively, and thereafter the front-side board conveying and holding device 2003 is moved to the front-side component mounting work area 2201 to perform component mounting, and the rear-side board conveying and holding device 2013 is moved to the rear-side component mounting work area 2202 to perform component mounting.

However, with the above structure, the board 2002 can be loaded and unloaded only when the front-side board conveying and holding device 2003 and the rear-side board conveying and holding device 2013 are joined together at the center. Therefore, if the component mounting is stopped due to some errors during the component mounting in, for example, the rear-side component mounting work area 2202, then the board 2002 cannot be unloaded when so tried unless the board is made to pass through the rear-side board conveying and holding device 2013 even though the component mounting has ended in the front-side component mounting work area 2201. Therefore, if the unloading of the component-mounted board, i.e. a completed product of which the component mounting has ended, is stopped for a

long term, solder of the component-mounted board would be deteriorated, which may lead to a degraded mounting quality. Moreover, when mounting process time for performing the component mounting of boards of different models differs between the front-side component mounting work area and the rear-side component mounting work area or when the mounting process time differs due to a suction error or a recognition error during the component mounting in, for example, the rear-side component mounting work area even in the case of the mounting of identical boards and components. If the component-mounted board of which the component mounting has previously ended is made to stand by for a long period, then solder of the component-mounted board would be deteriorated, which may lead to a degraded mounting quality, as in the above case.

Accordingly, an object of the present invention is to solve the aforementioned problems and provide a component mounting apparatus and method by which, in concurrently performing component mounting operations in a plurality of component mounting work areas, respectively, if either component mounting has ended in advance, the board that has been undergone the component mounting can be unloaded without awaiting the end of the other mounting operation or board unloading, allowing the areal productivity to be further improved, as well as a component mounting system

equipped with a plurality of such component mounting apparatuses.

Disclosure Of Invention

In order to achieve the above object, the present invention has the following constitution.

According to a first aspect of the present invention, there is provided a component mounting apparatus comprising:

a first mounting unit, which is arranged in a first component mounting work area out of the first component mounting work area and a second component mounting work area that are two parts obtained by dividing a component mounting work area and do not overlap each other, able to hold a first board on which a component is to be mounted in a first pre-placement standby position, a first placement position, and a first post-placement standby position that are located along a first conveyance path inside the first component mounting work area and places a component that is fed from a first component feeding device, held by a first placement head, and recognized by a first recognition device on the first board located in the first placement position on basis of a recognition result of the first recognition device by the first placement head; and

a second mounting unit, which is arranged in the second component mounting work area, able to hold a second board on which a component is to be mounted in a second pre-placement standby position, a second placement position, and a second post-placement standby position that are located along a second conveyance path different from the first conveyance path inside the second component mounting work area and places a component that is fed from a second component feeding device, held by a second placement head, and recognized by a second recognition device on the second board located in the second placement position on basis of a recognition result of the second recognition device.

According to a second aspect of the present invention, there is a component mounting apparatus as defined in the first aspect, wherein the first mounting unit is operatively controlled independently of the second mounting unit.

According to a third aspect of the present invention, there is provided a component mounting apparatus in which a component mounting work area is divided into two parts of a first component mounting work area and a second component mounting work area; a first mounting unit arranged in the first component mounting work area; a second mounting unit arranged in the second component mounting work area,

the first mounting unit comprising:

a first board conveying and holding device, which is able to convey a first board on which a component is to be mounted along a first conveyance path, able to position and hold the first board in a first pre-placement standby position located along the first conveyance path, a first placement position located on a downstream side of the first pre-placement standby position, and a first post-placement standby position located on a downstream side of the first placement position, and in which the first pre-placement standby position, the first placement position, and the first post-placement standby position are linearly arranged;

a first component feeding device, which is arranged in a vicinity of the first placement position, for feeding the component;

a first placement head drive device for moving a first placement head between the first component feeding device and the first placement position, holding the component from the first component feeding device by means of the first placement head, and placing the component held by the first placement head on the first board that is positioned and held in the first placement position by the first placement head; and

a first recognition device, which is arranged in

a vicinity of the first placement position, for recognizing the component held by the first placement head, and

the second mounting unit comprising:

a second board conveying and holding device, which is able to convey a second board on which a component is to be mounted along a second conveyance path different from the first conveyance path, able to position and hold the second board in a second pre-placement standby position located along the second conveyance path, a second placement position located on a downstream side of the second pre-placement standby position, and a second post-placement standby position located on a downstream side of the second placement position, and in which the second pre-placement standby position, the second placement position, and the second post-placement standby position are linearly arranged;

a second component feeding device, which is arranged in a vicinity of the second placement position, for feeding the component;

a second placement head drive device for moving a second placement head between the second component feeding device and the second placement position, holding the component from the second component feeding device by means of the second placement head, and placing the component held by the second placement head on the second board that

is positioned and held in the second placement position by the second placement head; and

a second recognition device, which is arranged in a vicinity of the second placement position, for recognizing the component held by the second placement head, whereby

the first mounting unit operates to hold the component from the first component feeding device by means of the first placement head, recognize the component held by the first placement head by means of the first recognition device, and thereafter place the component held by the first placement head on the first board that is positioned and held in the first placement position by the first board conveying and holding device on basis of a recognition result of the first recognition device, while the second mounting unit operates to hold the component from the second component feeding device by means of the second placement head, recognize the component held by the second placement head by means of the second recognition device, and thereafter place the component held by the second placement head on the second board that is positioned and held in the second placement position by the second board conveying and holding device on basis of a recognition result of the second recognition device.

According to a fourth aspect of the present

invention, there is provided a component mounting apparatus as defined in the third aspect, wherein

the board conveying and holding devices are provided with: pre-placement conveyance units for positioning the boards in the pre-placement standby positions located along the respective conveyance paths; placement conveyance units that are located adjacently on downstream sides of the pre-placement conveyance units, for positioning the boards at the placement positions and; post-placement conveyance units that are located adjacently on downstream sides of the placement conveyance units, for positioning the boards in the post-placement standby positions, and

at least one of the recognition devices is provided with a two-dimensional camera that is located adjacent to the placement position and arranged in a vicinity of a center portion of the component feeding device, for taking in a two-dimensional image of the component.

According to a fifth aspect of the present invention, there is provided a component mounting apparatus as defined in the third or fourth aspect, wherein

the placement heads are each provided with a component holding member for holding the component fed by the component feeding device, and

the placement head drive devices are each provided with a pair of Y-axis ball screw shafts extended parallel in a Y-axis direction perpendicular to the conveyance path of the board, a Y-axis rotation drive device for forwardly and reversely rotating the pair of Y-axis ball screw shafts in synchronism, a Y-axis movable unit that can advance or retreat in the Y-axis direction while being meshed with the pair of Y-axis ball screw shafts, an X-axis ball screw shaft extended in an X-axis direction parallel to the board conveyance path perpendicular to the Y-axis direction in the Y-axis movable unit, an X-axis rotation drive device for forwardly and reversely rotating the X-axis ball screw shaft, and an X-axis movable unit that can advance or retreat in the X-axis direction while being meshed with the X-axis ball screw shaft.

According to a sixth aspect of the present invention, there is provided a component mounting apparatus as defined in any one of the first through fifth aspects, wherein the component mounting work area is divided into two parts of the first component mounting work area and the second component mounting work area which do not overlap each other.

According to a seventh aspect of the present invention, there is provided a component mounting apparatus

as defined in any one of the first through sixth aspects, further comprising a bypass conveyance unit, which is arranged between the first conveyance path and the second conveyance path, for passing there through a board that is not subjected to the mounting operation in the first mounting unit and the second mounting unit.

According to an eighth aspect of the present invention, there is provided a component mounting apparatus as defined in the seventh aspect, wherein the bypass conveyance unit is comprised of an upper bypass conveyance unit and a lower bypass conveyance unit arranged below the upper bypass conveyance unit.

According to a ninth aspect of the present invention, there is provided a component mounting apparatus as defined in the seventh aspect, wherein the bypass conveyance unit is comprised of two bypass conveyance units arranged parallel to each other.

According to a 10th aspect of the present invention, there is provided a component mounting apparatus as defined in any one of the first through ninth aspects, wherein the second board is loaded into the second mounting unit while being turned at a phase angle of 180 degrees with respect to the first board loaded into the first mounting unit, and the second board is unloaded from the second mounting unit while being further turned at a phase

angle of 180 degrees when unloaded from the second mounting unit.

According to an 11th aspect of the present invention, there is provided a component mounting apparatus as defined in any one of the first through ninth aspects, wherein an in-phase mode in which the second board is loaded into the second mounting unit in phase with the first board and a reverse mode in which the second board is loaded into the second mounting unit while being turned at a phase angle of 180 degrees with respect to the first board are selectively used.

According to a 12th aspect of the present invention, there is provided a component mounting apparatus as defined in any one of the first through 11th aspects, wherein the placement heads are each provided with a plurality of component holding members for holding the components fed by the component feeding devices that have a plurality of component feeding units, and a direction in which the plurality of component holding members are arranged and a direction in which the plurality of component feeding units of the component feeding devices are arranged are extended in an identical direction.

According to a 13th aspect of the present invention, there is provided a component mounting apparatus as defined in any one of the first through 12th aspects,

wherein the placement heads are each provided with a plurality of component holding members for holding the components fed by the component feeding devices that each have a plurality of component feeding units, the plurality of component holding members and the plurality of component feeding units of the component feeding devices are arranged at equal intervals, and a plurality of components can be collectively held in the plurality of component feeding units by the plurality of component holding members.

According to a 14th aspect of the present invention, there is provided a component mounting method for executing a first mounting operation comprising of:

holding a first board on which a component is to be placed in a first placement position via a first pre-placement standby position located along a first conveyance path in a first component mounting work area out of the first component mounting work area and a second component mounting work area that are two parts obtained by dividing a component mounting work area and do not overlap each other;

holding a component fed from a first component feeding device by means of a first placement head;

recognizing the component held by the first placement head by means of a first recognition device;

placing the component recognized on basis of a

recognition result on the first board located in the first placement position by means of the first placement head;

unloading the first board located in the first placement position toward a first post-placement standby position and holding the board after ending the component placing; and

holding a second board on which a component is to be placed in a second placement position via a second pre-placement standby position located along a second conveyance path different from the first conveyance path inside the second component mounting work area and

a second mounting operation comprising of:

holding a component fed from a second component feeding device by means of a second placement head;

recognizing the component held by the second placement head by means of a second recognition device;

placing the component recognized on basis of a recognition result on the second board located in the second placement position by means of the second placement head; and

unloading the second board located in the second placement position toward a second post-placement standby position and holding the board after ending the component placing, and

the method being able to independently performing

the loading and unloading of the first board and the loading and unloading of the second board.

According to a 15th aspect of the present invention, there is provided a component mounting method as defined in the 14th aspect, wherein the first mounting operation and the second mounting operation are independently performed.

According to a 16th aspect of the present invention, there is provided a component mounting method for executing a first mounting operation comprising of:

holding a first board on which a component is to be placed in a first placement position via a first pre-placement standby position located along a linear first conveyance path in a first component mounting work area out of the first component mounting work area and a second component mounting work area that are two parts obtained by dividing a component mounting work area and do not overlap each other;

holding a component fed from a first component feeding device arranged in a vicinity of the first placement position;

recognizing the held component by means of a first recognition device arranged in a vicinity of the first placement position;

placing the component recognized on basis of a

recognition result, on the first board located in the first placement position;

unloading the first board located in the first placement position toward a first post-placement standby position from the first placement position in the linear first conveyance path and holding the board after ending the component placing; and

holding a second board on which a component is to be placed in a second placement position via a second pre-placement standby position along a linear second conveyance path different from the first conveyance path inside the second component mounting work area and

a second mounting operation comprising of:

holding a component fed from a second component feeding device arranged in a vicinity of the second placement position;

recognizing the held component by means of a second recognition device arranged in a vicinity of the second placement position;

placing the component recognized on basis of a recognition result, on the second board located in the second placement position; and

unloading the second board located in the second placement position toward a second post-placement standby position from the second placement position along the linear

second conveyance path and holding the board after ending the component placing.

According to a 17th aspect of the present invention, there is provided a component mounting method as defined in any one of the 14th through 16th aspects, wherein the component mounting work area is divided into two equal parts of the first component mounting work area and the second component mounting work area that do not overlap each other.

According to an 18th aspect of the present invention, there is provided a component mounting method as defined in any one of the 14th through 17th aspects, wherein a board that is not subjected to the first mounting operation and the second mounting operation is made to pass through a bypass conveyance unit arranged between the first conveyance path and the second conveyance path.

According to a 19th aspect of the present invention, there is provided a component mounting method as defined in any one of the 14th through 18th aspects, wherein the second mounting operation is performed by turning the second board at a phase angle of 180 degrees with respect to the first board subjected to the first mounting operation, and the second board is unloaded while being further rotated at a phase angle of 180 degrees when unloaded after performing the second mounting operation.

According to a 20th aspect of the present invention, there is provided a component mounting method as defined in any one of the 14th through 18th aspects, wherein an in-phase mode in which the second mounting operation of the second board is performed in phase with the first board subjected to the first mounting operation and a reverse mode in which the second mounting operation is performed by turning the second board at a phase angle of 180 degrees with respect to the first board subjected to the first mounting operation are selectively used.

According to a 21st aspect of the present invention, there is provided a component mounting method as defined in any one of the 14th through 20th aspects, wherein, when the components fed from a plurality of component feeding units of the component feeding devices are held by a plurality of component holding members of the placement heads, the plurality of components can be concurrently collectively held by the plurality of component holding members in the plurality of component feeding units.

According to a 22nd aspect of the present invention, there is provided a component mounting apparatus comprising:

a first mounting unit, which is provided with a first loader that is arranged in a first component mounting work area out of the first component mounting work area and

a second component mounting work area that are two parts obtained by dividing a component mounting work area and do not overlap each other, for positioning and holding a first board on which a component is to be placed in a first pre-placement standby position located along a first conveyance path inside the first component mounting work area, a first board conveying and holding unit for positioning and holding the board in a first placement position where the board is conveyed beyond the first pre-placement standby position in a conveyance direction, and a first unloader for positioning and holding the board in a first post-placement standby position where the board is conveyed beyond the first placement position in the conveyance direction, wherein a component that is fed from a first component feeding device and held by a first placement head is placed on the first board located in the first placement position, by means of the first placement head;

a second mounting unit, which is provided with a second loader that is arranged in the second component mounting work area, for positioning and holding a first board on which a component is to be placed in a second pre-placement standby position located along a second conveyance path different from the first conveyance path inside the second component mounting work area, a second board conveying and holding unit for positioning and

holding the board in a second placement position where the board is conveyed beyond the second pre-placement standby position in the conveyance direction, and a second unloader for positioning and holding the board in a second post-placement standby position where the board is conveyed beyond the second placement position in the conveyance direction, wherein a component that is fed from a second component feeding device and held by a second placement head is placed on the second board located in the second placement position, by means of the second placement head;

a connective conveyance unit for loading a board into either the first loader or the second loader;

detection devices for detecting presence or absence of a board in the first loader, the first board conveying and holding unit, the second loader, and the second board conveying and holding unit; and

a control section for executing control so that, with highest order of priority given to a state in which no board exists in both either loader and the board conveying and holding unit succeeding the loader on basis of a detection signal from the detection device, a board is fed to the loader relevant to the highest order of priority by the connective conveyance unit, and a board is loaded by the connective conveyance unit into a loader with no board in a state in which no board exists in the first loader or

the second loader according to a next order of priority.

According to a 23rd aspect of the present invention, there is provided a component mounting apparatus as defined in the 22nd aspect, further comprising a bypass conveyance unit, which is roughly parallel to a first mounting conveyance path comprised of the first loader, the first board conveying and holding unit, and the first unloader and a second mounting conveyance path comprised of the second loader, the second board conveying and holding unit, and the second unloader and arranged independently of the first mounting conveyance path and the second mounting conveyance path, and

wherein the detection device further detects presence or absence of a board in the bypass conveyance unit and wherein it is controlled to load a board by means of the connective conveyance unit into a loader with no board or the bypass conveyance unit with no board in a state in which no board exists in the first loader or the second loader or the bypass conveyance unit following the highest order of priority under control of the control section.

According to a 24th aspect of the present invention, there is provided a component mounting system comprising:

the component mounting apparatus defined in the

23rd aspect; and

a component mounting apparatus which has a third mounting unit for placing a component that is fed from a third component feeding device and held by a third placement head on a third board that is fed from the bypass conveyance unit and positioned and held in the third placement position, by means of the third placement head,

wherein the detection device further detects presence or absence of a board in the third placement position in addition to the bypass conveyance unit, and

the control section executes control so that: with a highest order of priority given to either a state in which no board exists in both either loader and the board conveying and holding unit succeeding the loader or a state in which no board exists in both the bypass conveyance unit and the third placement position and with a second-highest order of priority given to the other on basis of a detection signal from the detection device, a board is fed to the loader relevant to the highest order of priority by the connective conveyance unit, a board is fed to the bypass conveyance unit relevant to the second-highest order of priority according to a next order of priority; and, in a state in which no board exists in the first loader or the second loader or the bypass conveyance unit, a board is loaded into the loader with no board or the bypass

conveyance unit with no board by the connective conveyance unit according to a next order of priority.

According to a 25th aspect of the present invention, there is provided a component mounting system comprising:

a first mounting unit, which is provided with a first loader that is arranged in a first component mounting work area out of the first component mounting work area and a second component mounting work area that are two parts obtained by dividing an upstream-side component mounting work area and do not overlap each other, for positioning and holding a first board on which a component is to be placed in a first pre-placement standby position located along a first conveyance path inside the first component mounting work area, a first board conveying and holding unit for positioning and holding the board in a first placement position where the board is conveyed beyond the first pre-placement standby position in a conveyance direction, and a first unloader for positioning and holding the board in a first post-placement standby position where the board is conveyed beyond the first placement position in the conveyance direction, wherein a component that is fed from a first component feeding device and held by a first placement head is placed on the first board located in the first placement position, by means of the first

placement head;

a second mounting unit, which is provided with a second loader that is arranged in the second component mounting work area, for positioning and holding a first board on which a component is to be placed in a second pre-placement standby position located along a second conveyance path different from the first conveyance path inside the second component mounting work area, a second board conveying and holding unit for positioning and holding the board in a second placement position where the board is conveyed beyond the second pre-placement standby position in the conveyance direction, and a second unloader for positioning and holding the board in a second post-placement standby position where the board is conveyed beyond the second placement position in the conveyance direction, wherein a component that is fed from a second component feeding device and held by a second placement head is placed on the second board located in the second placement position, by means of the second placement head;

a bypass conveyance unit, which is roughly parallel to a first mounting conveyance path comprised of the first loader, the first board conveying and holding unit, and the first unloader and a second mounting conveyance path comprised of the second loader, the second board conveying and holding unit, and the second unloader

and arranged independently of the first mounting conveyance path and the second mounting conveyance path;

an upstream-side connective conveyance unit for loading a board into any one of the first loader, the second loader and the bypass conveyance unit;

an upstream-side detection device for detecting presence or absence of a board in the first loader, the first board conveying and holding unit, the second loader, the second board conveying and holding unit, and the bypass conveyance unit;

a third mounting unit, which is provided with a third loader that is arranged in a third component mounting work area out of the third component mounting work area and a fourth component mounting work area that are two parts obtained by dividing a downstream-side component mounting work area and do not overlap each other, for positioning and holding a third board on which a component is to be placed in a third pre-placement standby position located along a third conveyance path inside the third component mounting work area, a third board conveying and holding unit for positioning and holding the board in a third placement position where the board is conveyed beyond the third pre-placement standby position in a conveyance direction, and a third unloader for positioning and holding the board in a third post-placement standby position where

the board is conveyed beyond the third placement position in the conveyance direction, wherein a component that is fed from a third component feeding device and held by a third placement head is placed on the third board located in the third placement position, by means of the third placement head;

a fourth mounting unit, which is provided with a fourth loader that is arranged in the fourth component mounting work area, for positioning and holding a third board on which a component is to be placed in a fourth pre-placement standby position located along a fourth conveyance path different from the third conveyance path inside the fourth component mounting work area, a fourth board conveying and holding unit for positioning and holding the board in a fourth placement position where the board is conveyed beyond the fourth pre-placement standby position in the conveyance direction, and a fourth unloader for positioning and holding the board in a fourth post-placement standby position where the board is conveyed beyond the fourth placement position in the conveyance direction, wherein a component that is fed from a fourth component feeding device and held by a fourth placement head is placed on the fourth board located in the fourth placement position, by means of the fourth placement head;

a downstream-side connective conveyance unit for

unloading the board from any one of the first unloader, the second unloader, and the bypass conveyance unit and loading a board into either one of the third loader and the fourth loader;

a downstream-side detection device for detecting the presence or absence of a board in the first loader, the second unloader, the third unloader, the third board conveying and holding unit, the fourth loader, the fourth board conveying and holding unit, and the bypass conveyance unit;

an upstream-side control section for executing control so that, with highest order of priority given to either a state in which no board exists in both either one of the first and second loaders and the board conveying and holding unit succeeding the loader or a state in which no board exists in both the bypass conveyance unit, the third or fourth loader, and the board conveying and holding unit succeeding the loader or the bypass conveyance unit and with the next order of priority given to the other, on basis of detection signals from the upstream-side detection device and the downstream-side detection device, a board is fed to the loaders according to the order of priority by the upstream-side connective conveyance unit, and, in a state in which no board exists in the first loader or the second loader or the bypass conveyance unit according to a

next order of priority, a board is loaded by the upstream-side connective conveyance unit into the loader with no board or the bypass conveyance unit; and

a downstream-side control section for executing control so that, with highest order of priority given to a state in which no board exists in both either one of the third and fourth loaders and the board conveying and holding unit succeeding the loader on basis of detection signal from the downstream-side detection device, a board is fed to the loader relevant to the highest order of priority by the downstream-side connective conveyance unit, and, in a state in which no board exists in the third loader or the fourth loader according to a next order of priority, a board is loaded by the downstream-side connective conveyance unit into the loader with no board, and executing control so that, with the highest order of priority given to a state in which a board exists in both either loader and the board conveying and holding unit located on an upstream side of the unloader, a board is unloaded from the unloader relevant to the highest order of priority toward the downstream-side connective conveyance unit, and, in a state in which a board exists in the first unloader or the second unloader or the bypass conveyance unit according to a next order of priority, the board is unloaded from the unloader with the board or the bypass

conveyance unit with the board toward the downstream-side connective conveyance unit.

According to a 26th aspect of the present invention, there is provided a component mounting system as defined in the 25th aspect, further comprising a second bypass conveyance unit, which is roughly parallel to a third mounting conveyance path comprised of the third loader, the third board conveying and holding unit, and the third unloader and a fourth mounting conveyance path comprised of the fourth loader, the fourth board conveying and holding unit, and the fourth unloader and arranged independently of the third mounting conveyance path and the fourth mounting conveyance path, and

wherein the downstream-side control section unloads the board unloaded from the first unloader or the second unloader toward the second bypass conveyance unit and loads the board unloaded from the bypass conveyance unit into the third loader or the fourth loader.

According to a 27th aspect of the present invention, there is provided a component mounting system as defined in the 26th aspect, further comprising:

a downstream-side second connective conveyance unit for unloading the board from any one of the third loader, the fourth loader, and the second bypass conveyance unit;

a downstream-side second detection device for detecting presence or absence of a board in the third unloader, the third board conveying and holding unit, the fourth unloader, the fourth board conveying and holding unit, and the second bypass conveyance unit; and

a downstream-side second control section for executing control so that, with the highest order of priority given to a state in which a board exists in both either one of the third and fourth unloaders and the third or fourth board conveying and holding unit succeeding the unloader on basis of a detection signal from the downstream-side second detection device, the board is unloaded from the unloader relevant to the highest order of priority by the downstream-side second connective conveyance unit and, in a state in which a board exists in the third unloader or the fourth unloader or the second bypass conveyance unit according to the next order of priority, the board is unloaded from the unloader with the board or the second bypass conveyance unit with the board toward the downstream-side second connective conveyance unit.

According to a 28th aspect of the present invention, there is provided a component mounting system as defined in the 27th aspect, wherein,

with the highest order of priority given to a

state in which a board exists in both the second bypass conveyance unit and either one of the first and second unloaders and the first or second board conveying and holding unit succeeding the unloader on basis of a detection signal from the downstream-side second detection device, the downstream-side second control section further unloads the board from the second bypass conveyance unit relevant to the highest order of priority by the downstream-side second connective conveyance unit.

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 detailed plan view of a component mounting apparatus according to a first embodiment of the present invention;

Fig. 2 is an enlarged plan view of a first mounting unit of the component mounting apparatus of Fig. 1;

Fig. 3 is an overall schematic arrangement view of the component mounting apparatus of Fig. 1;

Fig. 4 is an explanatory view for explaining the

mounting operation of the component mounting apparatus of Fig. 1, where the capitalized English letter "A" at the center of each board is a mark indicating the direction of each board;

Fig. 5 is a block diagram showing a relation of connection between the control unit, drive devices and sensors of the component mounting apparatus of Fig. 1;

Fig. 6 is an explanatory view showing a state in which a second board is loaded into a second mounting unit while being turned at a phase angle of 180 degrees with respect to a first board loaded into a first mounting unit and the boards are subjected to mounting operations, respectively, in the component mounting apparatus of Fig. 1, where the capitalized English letter "A" at the center of each board is a mark indicating the direction of each board;

Fig. 7 is an explanatory view showing a state in which the first board loaded into the first mounting unit and the second board loaded into the second mounting unit are subjected to mounting operations, respectively, in an identical phase in the component mounting apparatus of Fig. 1, where the capitalized English letter "A" at the center of each board is a mark indicating the direction of each board;

Fig. 8 is an explanatory view showing a series of

component-mounted board producing system that has a solder paste printing device, three component mounting apparatuses of Fig. 1, and a reflow device;

Fig. 9 is a schematic explanatory view of the component mounting apparatus that has already been proposed by the present applicant;

Fig. 10 is schematic plan view showing an electronic component-mounted board production line in which two mounting apparatus groups each of which is composed of three component mounting apparatuses of Fig. 1 as one group are joined together and first, second, and third connective conveyance units are arranged on the upstream side and the downstream side of each of the mounting apparatus groups in a component mounting system according to a second embodiment of the present invention, where the upward and downward arrows in the figure indicate the directions of movement of the connective conveyance units;

Fig. 11 is a view showing a flowchart of the operation of the first connective conveyance unit of the component mounting system according to the second embodiment;

Fig. 12 is a view showing a flowchart of the operation of the second connective conveyance unit of the component mounting system according to the second embodiment;

Fig. 13 is a view showing a flowchart of the operation of the third connective conveyance unit of the component mounting system according to the second embodiment;

Fig. 14 is an enlarged schematic plan view showing a mounting apparatus group A and a first connective conveyance unit located on the upstream side of Fig. 10, where the upward and downward arrows in the figure indicate the directions of movement of the connective conveyance unit;

Fig. 15 is an enlarged schematic plan view showing the uppermost-stream-side component mounting apparatus in the upstream-side mounting apparatus group A of Fig. 10, the first connective conveyance unit, and a printer located on its upstream side, where the upward and downward arrows indicate the directions of movement of the connective conveyance unit and the sidewise arrows indicate the board conveyance direction;

Fig. 16 is an enlarged schematic plan view showing the downmost-stream-side component mounting apparatus in the upstream-side mounting apparatus group A of Fig. 10, the second connective conveyance unit, and the uppermost-stream-side component mounting apparatus in the downstream-side mounting apparatus group B, where the upward and downward arrows in the figure indicate the

directions of movement of the connective conveyance unit and the sidewise arrows therein indicate the board conveyance direction;

Fig. 17 is an enlarged schematic plan view showing the downmost-stream side component mounting apparatus in the downstream-side mounting apparatus group B of Fig. 10, the third connective conveyance unit, and a reflow device on its downstream side, where the upward and downward arrows in the figure indicate the directions of movement of the connective conveyance unit and the sidewise arrows therein indicate the board conveyance direction;

Fig. 18 is a schematic plan view showing the two mounting apparatus groups A and B and the first and second connective conveyance units in the component mounting system according to the second embodiment of Fig. 10, where the upward and downward arrows in the figure indicate the directions of movement of the connective conveyance units;

Fig. 19 is a block diagram showing the structure of the control section of the electronic component-mounted board production line of the component mounting system according to the second embodiment;

Fig. 20 is a block diagram partially showing the unique portion of the component mounting system of the second embodiment in the control unit of each component mounting apparatus in the electronic component-mounted

board production line of the component mounting system according to the second embodiment;

Fig. 21 is a perspective view showing a board conveying device which is an example of the connective conveyance unit of the electronic component-mounted board production line of the component mounting system according to the second embodiment; and

Fig. 22 is a plan view of the board conveying device which is an example of the connective conveyance unit of Fig. 21;

Fig. 23 is a sectional view of the board conveying device which is an example of the connective conveyance unit shown in Fig. 21;

Fig. 24 is a sectional view of a holding and conveying device provided in the board conveying device shown in Fig. 21, as viewed at A - A portion of Fig. 25;

Fig. 25 is a plan view of the holding and conveying device shown in Fig. 24;

Fig. 26 is a plan view of a turning device shown in Fig. 23;

Fig. 27 is a sectional view of a modification of the board conveying device shown in Fig. 21;

Fig. 28 is a detailed plan view of a main frame of the component mounting apparatus according to the first embodiment of Fig. 1;

Fig. 29 is a detailed front view of the main frame of Fig. 28;

Fig. 30 is a detailed right-hand side view of the main frame of Fig. 28;

Fig. 31 is a front view of a first placement-position determining conveyance unit as an example of a placement-position determining conveyance unit of the component mounting apparatus according to the first embodiment;

Fig. 32 is a plan view of the first placement-position determining conveyance unit of Fig. 31;

Fig. 33 is a right-hand side view of the first placement-position determining conveyance unit of Fig. 31; and

Fig. 34 is a plan view in a cross section taken along the line C - C of Fig. 31.

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.

Embodiments of the present invention will be described in detail below with reference to the drawings.

(First Embodiment)

As shown in Figs. 1 through 3, a component mounting apparatus capable of carrying out the component mounting method according to the first embodiment of the present invention can mount components on a board 2, which is one example of a circuit formation article and on which components are to be mounted, with remarkably improved productivity per device installation area. It is noted here that the term, components, includes electronic components, mechanical components, optical components and the like. The terms, circuit formation article, refer to objects on which a circuit is formed, exemplified by such circuit boards as resin boards, paper-phenol boards, ceramic boards, glass epoxy boards and film boards, such circuit boards as single-layer boards or multilayer boards, and components, casings, frames or the like.

In the component mounting work area of one component mounting apparatus described above, two electronic circuit boards 2 (first board 2a and second board 2b) are arranged opposite to each other so as to allow components to be mounted thereon independently of each other. For these purposes, two sets of component feeding devices 8 and 18, placement heads 4 and 14, placement head drive devices 5 and 15 for the heads, board conveying and holding devices 1 and 11, recognition cameras 9 and 19 and so on are arranged. The above-mentioned various constituent elements

are provided point-symmetrically with respect to a center point 100 (see Fig. 1) of a component mounting work area 200.

More specifically, with regard to the above-mentioned component mounting apparatus, a first mounting section 101 is disposed in a first component mounting work area 201 out of two parts of the first component mounting work area 201 and a second component mounting work area 202, which are obtained by dividing the component mounting work area 200 and which do not overlap each other, and a second mounting section 102 is disposed in the second component mounting work area 202. In order to make it easy to compare the areal productivity between the component mounting work areas, it is preferable to divide the component mounting work area 200 into two equal parts so that the first component mounting work area 201 and the second component mounting work area 202 come to have identical areas.

The first mounting section 101 and the second mounting section 102 are independently controlled in operation by a control unit 1000. Therefore, various operations such as conveyance for board loading and unloading, board positioning, component feed, component suction, recognition, placement, placement-head movement and so on can be made synchronous or asynchronous.

The first mounting section 101 can hold the first board 2a on which components are to be mounted (the board 2 targeted for the mounting in the first mounting section 101 is denoted by 2a for explanation; moreover, the board 2 is denoted by the reference numeral 2a when indicated regardless of the position, and the board 2a in a specific position is denoted by reference numerals 2a-1, 2a-2, 2a-3 or the like) in a first pre-placement standby position FA, a first placement position FB and a first post-placement standby position FC along a first conveyance path within the first component mounting work area 201, and places a component, which has been fed from the first component feeding device 8, held and recognized by the first recognition device 9, onto the first board 2a located in the first mounting position FB based on a recognition result by the first recognition device 9.

The first mounting section 101 is provided with the first board conveying and holding device 1, the first component feeding device 8, the first placement head drive device 5 and the first recognition device 9.

The first board conveying and holding device 1 is able to convey the first board 2a, on which components are to be mounted, along the first conveyance path and to position and hold the first board 2a in the first pre-placement standby position FA extending along the first

conveyance path, the first placement position FB located on the downstream side of the first pre-placement standby position FA and the first post-placement standby position FC located on the downstream side of the first placement position FB. The first pre-placement standby position FA, the first placement position FB and the first post-placement standby position FC are linearly arranged. More specifically, the first board conveying and holding device 1 is constructed in a manner that a first loader 1A as an example of the pre-placement conveyance unit, a first placement-position determining conveyance unit 1B as an example of the placement conveyance unit, and a first unloader 1C as an example of the post-placement conveyance unit are arranged in this order from the upstream side to the downstream side along the first conveyance path. The first loader 1A loads the first board 2a into the first conveyance path of the first component mounting work area 201 and positions and holds the board in the first pre-placement standby position FC. The first placement-position determining conveyance unit 1B is disposed between the first loader 1A and the first unloader 1C, receives from the first loader 1A the first board 2a that has been positioned and held in the first pre-placement standby position FC, positions and holds the board in the first placement position FB, and unloads the board toward the

first unloader 1C when the component placement operation of the first board 2a is completed. The first unloader C positions and holds the board in the first post-placement standby position FA and unloads the first board 2a from the first conveyance path. The first loader 1A, the first placement-position determining conveyance unit 1B, the first unloader 1C and a bypass conveyance unit 30 described later, which are all roughly identical in structure, can synchronously drive a pair of belt conveyors back and forth in the direction of the first conveyance path by a drive device of one motor or two motors or the like. Moreover, according to the width of the first board 2a, the position of at least one belt conveyor can be moved in the widthwise direction with respect to the position of the other belt conveyor, thus allowing width adjustment to be performed according to the width of the first board 2a (see a solid-line position and a two-dot chain line position of the right-hand movable-side rail in Fig. 33 as described below).

The first placement-position determining conveyance unit 1B, which is similar in structure to a later-described second placement-position determining conveyance unit 11B, has a pair of movable-side rails 95B extending along the board conveyance direction and disposed parallel to each other to convey and support the boards 2 as shown in Figs. 28 to 34, with conveyor belts 92B disposed on

the pair of movable-side rails 95B on their confronting face side. A driving gear 93a is rotated by rotational drive of a conveyor-belt drive motor 93 fixed on one longitudinal end side of the first placement-position determining conveyance unit 1B, causing a gear 93b meshed with the driving gear 93a to rotate, so that both-side pulleys 93c fixed to a rotating shaft 93e having a rectangular cross section with the gear 93b fixed thereto are rotated. As a result of this, the conveyor belts 92B stretched around the both-side pulleys 93c and arranged along the both-side movable-side rails 95B so as to be guided by a multiplicity of guide rollers are synchronously moved, by which the boards 2 placed on the both-side conveyor belts 92B are conveyed in the board conveyance direction.

When a board 2 has been conveyed by the both-side conveyor belts 92B into a specified position, the board 2 is hit at its fore end and stopped by a positioning pin 91a upwardly projecting into the board conveyance path by the drive of an up/down driving cylinder 91, thus the board 2 being positioned in the specified position. It is noted that, assuming that the board 2 is conveyed from left to right or from right to left in Fig. 34, this up/down driving cylinder 91 is located at a position 'a' of the solid line in a case where the left-end edge of the board 2 is hit and stopped by the positioning pin 91a so as to be referenced

for the positioning, or at a position 'b' of the solid line in another case where the right-end edge of the board 2 is hit and stopped by the positioning pin 91a so as to be referenced for the positioning.

Then, by the drive of a drive device such as a piston 94, a multiplicity of support pins 99a supported by the support table 99 are moved up together with the support table 99 from the lower-face side of the board 2 so that both-end edge portions of the board 2 are pressed against an upper end portion of the movable-side rail 95B, by which the board 2 is gripped and positioned and held in the specified position. For releasing the positioning and holding, by the drive of the drive device such as the piston 94, the support pins 99a are moved down together with the support table 99 so that the pressing of the both-end edge portions of the board 2 against the upper end portion of the movable-side rail 95B is released, by which the gripping of the board 2 is released. In addition, in the figures, reference numeral 94a denotes up/down guide rods for moving the support table 99 up and down in parallel.

Also, numerals 95A and 95C of Fig. 31 denote a movable-side rail of the upstream-side loader and a movable-side rail of the downstream-side unloader, respectively. For these movable-side rails also, conveyor belts 92A and 92C are disposed on a pair of movable-side rails on their

confronting face side, respectively, as in the movable-side rails 95B, so that the conveyor belts 92A and 92C can convey the boards 2 in the board conveyance direction by rotational drive of a drive motor. Drive devices for driving the conveyor belts 92A, 92B and 92C are drive-controlled independently of one another.

The first component feeding device 8 is arranged in the vicinity of the first placement position FB and feeds the components. More concretely, the first component feeding device 8 is composed of first component feeding units 8A and 8B, and each of the first component feeding units 8A and 8B is disposed on one side of the first component mounting work area 201 closer to the operator, i.e., at front-side end portions for the operator, and made up of a multiplicity of parts cassettes or the like accommodating taped components in which components to be mounted on the first board 2a are accommodated and held in a tape form. It is also acceptable that a tray type component feeding unit accommodating tray components in which components to be mounted on the first board 2a such as semiconductor chips are accommodated and held in a tray form is disposed in place of the whole or part of the first component feeding unit 8A or 8B.

The first placement head drive device 5 moves the first placement head 4 between the first component feeding

device 8 and the first placement position FB, holds the component from the first component feeding device 8 by the first placement head 4, and places by the first placement head 4 the component held by the first placement head 4 onto the first board 2a positioned and held in the first placement position FB. In this first placement head 4, a plurality of, for example, ten component suction nozzles 10 for sucking and holding electronic components in the first component mounting work area 201 are arranged replaceably.

In detail, the first placement head drive device 5 is implemented by a first X-Y robot for positioning the first placement head 4 located inside the first component mounting work area 201 in a specified position in X- and Y-directions, which are two orthogonal directions in the first component mounting work area 201. This first X-Y robot 5 has the following constitution. Two Y-axis direction ball screw shafts 5b and 5b extending parallel in the Y-axis direction perpendicular to the first conveyance path of the first board 2a are arranged forward-and-reverse rotatable at front-and-rear end edges in the direction of the first conveyance path of the first component mounting work area 201 on a mounting apparatus base 31. The two Y-axis direction ball screw shafts 5b and 5b rotate forward and reverse in synchronism by the synchronous driving of Y-axis direction motors 5a and 5a as an example of a Y-axis

rotation drive device fixed to one end of the two Y-axis direction ball screw shafts 5b and 5b. There are provided a Y-axis movable unit 5c that can advance or retreat along the Y-axis direction in mesh with the two Y-axis direction ball screw shafts 5b and 5b, one X-axis ball screw shaft 5d that is arranged forward-and-reverse rotatable in the Y-axis movable unit 5c and that extends in the X-axis direction perpendicular to the Y-axis direction and parallel to the first conveyance path of the first board 2a, an X-axis direction motor 5e as an example of an X-axis rotation drive device for rotating forward and reverse the X-axis ball screw shaft 5d, and an X-axis movable unit 5f that can advance or retreat along the X-axis direction in mesh with the X-axis ball screw shaft 5d. Further, the first placement head 4 that moves in the first component mounting work area 201 is fixed to the X-axis movable unit 5f and arranged movably in the X-axis direction integrally with the X-axis movable unit 5f. Therefore, the first placement head 4 can be advanced and retreated in the X-axis direction and the Y-axis direction by the first X-Y robot 5.

In Fig. 1, reference numeral 7 denotes a first nozzle station, which is arranged in the vicinity of a later-described first component feeding unit 8B in the first component mounting work area 201 and houses a

plurality of types of nozzles 10 suitable for a plurality of types of electronic components so as to replace the nozzle 10 set on the first placement head 4 as the need arises.

The first recognition device 9 is disposed at a proximity of the first placement position FB, for example, on the front side of the first placement position FB as viewed from the operator, and performs imaging and recognition of sucking posture or the like of the component held by the first placement head 4. It is noted that reference numeral 9a in Fig. 1 denotes a two-dimensional camera for two-dimensionally imaging the sucking posture of the component out of the recognition device 9, while 9b denotes a three-dimensional camera for three-dimensionally imaging the sucking posture of the component out of the recognition device 9.

On the other hand, the second mounting section 102 can hold the second board 2a on which components are to be mounted (the board 2 targeted for the mounting in the second mounting section 102 is denoted by 2b for explanation; moreover, the board 2 is denoted by the reference numeral 2b when indicated regardless of the position, and the board 2b in a specific position is denoted by reference numerals 2b-1, 2b-2, 2b-3 or the like) in a second pre-placement standby position SA, a second

placement position SB and a second post-placement standby position SC along a second conveyance path other than the first conveyance path within the second component mounting work area 202, and places a component, which has been fed from the second component feeding device 18, held and recognized by a second recognition device 19, onto the second board 2b located in the second placement position SB based on a recognition result by the second recognition device 19.

The second mounting section 102 is provided with the second board conveying and holding device 11, the second component feeding device 18, the second placement head drive device 15 and the second recognition device 19.

The second board conveying and holding device 11 is able to convey the second board 2b, on which the component is to be mounted, along the second conveyance path other than the first conveyance path and to position and hold the second board 2b in the second pre-placement standby position SA extending along the second conveyance path, the second placement position SB located on the downstream side of the second pre-placement standby position SA and the second post-placement standby position SC located on the downstream side of the second placement position SB. The second pre-placement standby position SA, the second placement position SB and the second post-

placement standby position SC are linearly arranged. More specifically, the second board conveying and holding device 11 is constructed in a manner that a second loader 11A as an example of the pre-placement conveyance unit, a second placement-position determining conveyance unit 11B as an example of the placement conveyance unit and a second unloader 11C as an example of the post-placement conveyance unit are arranged in this order from the upstream side to the downstream side along the second conveyance path. The second loader 11A loads the second board 2b into the second conveyance path of the second component mounting work area 202, and positions and holds the board in the second pre-placement standby position SA. The second placement-position determining conveyance unit 11B is disposed between the second loader 11A and the second unloader 11C, receives from the second loader 11A the second board 2b that has been positioned and held in the second pre-placement standby position SA, positions and holds the board in the second placement position SB, and unloads the board toward the second unloader 11C when the component placement operation of the second board 2b is completed. The second unloader 11C positions and holds the board in the second post-placement standby position SC and unloads the second board 2b from the second conveyance path. The second loader 11A, the second placement-position

determining conveyance unit 11B and the second unloader 11C, which are all roughly identical in structure, can synchronously drive a pair of belt conveyors back and forth in the direction of the second conveyance path by a drive device of one motor or two motors or the like. Moreover, according to the width of the second board 2b, the position of at least one belt conveyor can be moved in the widthwise direction with respect to the position of the other belt conveyor, thus allowing width adjustment to be performed according to the width of the second board 2b.

The second component feeding device 18 is arranged in the vicinity of the second placement position SB and feeds the components. More concretely, the second component feeding device 18 is composed of second component feeding units 18A and 18B, and each of the second component feeding units 18A and 18B is disposed at a deeper-side end portion of the second component mounting work area 202 as viewed from the operator, and made up of a multiplicity of parts cassettes or the like accommodating taped components in which components to be mounted on the second board 2b are accommodated and held in a tape form. It is also acceptable that a component feeding unit accommodating tray components in which components to be mounted on the second board 2b such as semiconductor chips are accommodated and held in a tray form is disposed in place of the whole or

part of the second component feeding unit 18A or 18B.

The second placement head drive device 15 moves a second placement head 14 between the second component feeding device 18 and the second placement position SB, holds the component from the second component feeding device 18 by the second placement head 14, and places by the second placement head 14 the component held by the second placement head 14 onto the second board 2b positioned and held in the second placement position SB. In this second placement head 14, a plurality of, for example, ten component suction nozzles 10 for sucking and holding electronic components in the second component mounting work area 202 are arranged replaceably.

In detail, the second placement head drive device 15 is implemented by a second X-Y robot for positioning the second placement head 14 located inside the second component mounting work area 202 in a specified position in X- and Y-directions, which are two orthogonal directions in the second component mounting work area 202. This second X-Y robot 15 has the following constitution. Two Y-axis direction ball screw shaft 15b and 15b extending parallel in the Y-axis direction perpendicular to the second conveyance path of the second board 2b are arranged forward-and-reverse rotatable at front-and-rear end edges in the direction of the second conveyance path of the

second component mounting work area 202 on a mounting apparatus base 31. The two Y-axis direction ball screw shafts 15b and 15b rotate forward and reverse in synchronism by the synchronous driving of Y-axis direction motors 15a and 15a as an example of a Y-axis rotation drive device fixed to one end of the two Y-axis direction ball screw shafts 15b and 15b. There are provided a Y-axis movable unit 15c that can advance or retreat along the Y-axis direction in mesh with the two Y-axis direction ball screw shafts 15b and 15b, one X-axis ball screw shaft 15d that is arranged forward-and-reverse rotatable in the Y-axis movable unit 15c and that extends in the X-axis direction perpendicular to the Y-axis direction and parallel to the second conveyance path of the second board 2b, an X-axis direction motor 15e as an example of an X-axis rotation drive device for rotating forward and reverse the X-axis ball screw shaft 15d, and an X-axis movable unit 15f that can advance or retreat along the X-axis direction in mesh with the X-axis ball screw shaft 15d. Further, the second placement head 14 that moves in the second component mounting work area 202 is fixed to the X-axis movable unit 15f and arranged movably in the X-axis direction integrally with the X-axis movable unit 15f. Therefore, the second placement head 14 can be advanced and retreated in the X-axis direction and the Y-axis direction by the second X-Y

robot 15.

In Fig. 1, reference numeral 17 denotes a second nozzle station, which is arranged in the vicinity of a later-described second component feeding unit 18B in the second component mounting work area 202 and houses a plurality of types of nozzles 10 suitable for a plurality of types of electronic components so as to replace the nozzle 10 set on the second placement head 14 as the need arises.

The second recognition device 19 is disposed at a proximity of the second placement position SB, for example, on the deeper side of the second placement position SB as viewed from the operator, and performs imaging and recognition of sucking posture or the like of the component held by the second placement head 14. It is noted that reference numeral 19a in Fig. 1 denotes a two-dimensional camera for two-dimensionally imaging the sucking posture of the component out of the recognition device 19, while 19b denotes a three-dimensional camera for three-dimensionally imaging the sucking posture of the component out of the recognition device 19.

In the first mounting section, the component is held from the first component feeding device 8 by the first placement head 4, and the recognition of the component held by the first placement head 4 is performed by, for example,

the two-dimensional camera 9a of the first recognition device 9. Thereafter, on the basis of a recognition result of the first recognition device 9, the component held by the first placement head 4 is placed on the first board 2a positioned and held in the first placement position FB by the first board conveying and holding device 1.

On the other hand, in the second mounting section 102, the component is held from the second component feeding device 18 by the second placement head 14, and the recognition of the component held by the second placement head 14 is performed by, for example, the two-dimensional camera 19a of the second recognition device 19. Thereafter, on the basis of a recognition result of the second recognition device 19, the component held by the second placement head 14 is placed on the second board 2b positioned and held in the second placement position SB by the second board conveying and holding device 11.

Board passage detection sensors (not shown) for detecting the passage of the circuit boards 2a and 2b, respectively, are arranged at one-side end portions of the first and second placement-position determining conveyance units 1B and 11B, the one side being closer to the loaders 1A and 11A, respectively, and board stoppers 32 for stopping the circuit boards 2a and 2b in the respective specified positions are arranged at end portions on the

side closer to the unloaders 1C and 11C, respectively. Board arrival detection sensors (not shown) for detecting approach and arrival of the circuit boards 2a and 2b in the board conveyance directions of the conveyance paths from the loaders 1A and 11A side toward the unloaders 1C and 11C to the specified positions are provided in the vicinity of the board stoppers 32. More specifically, a cylinder for driving each board stopper is provided with an upper-end position detection sensor for detecting the upper end position of its piston rod although not shown in the figure. The board stoppers are positioned in the elevated positions during the mounting operation while abutting against the respective boards 2a and 2b.

Moreover, in order to place electronic components on the circuit boards 2a and 2b with high quality, the boards 2a and 2b need to be supported from below. Accordingly, the first and second placement-position determining conveyance units 1B and 11B of the board conveying and holding device are provided with a support plate (not shown) that has a size equal to or larger than the largest board and that can be moved up and down. A required number of support pins (not shown) are planted on the support plates, and the support plates are moved up by respective support plate driving cylinders (not shown) so as to support the lower surfaces of the circuit boards 2a

and 2b by the support pins. Both side portions of the boards 2a and 2b are held between support rail portions so as to be held in specified positions, respectively.

As shown in Fig. 5, the aforementioned sensors and drive devices are connected to a control unit 1000, and the drive devices are driven and controlled based on a specified mounting program. That is, the control unit 1000 is connected at least to the board passage detection sensors, the board arrival detection sensors, the first and second recognition cameras 9 and 19, the first and second X-Y robots 5 and 15, the first and second placement heads 4 and 14, the first and second loaders 1A and 11A, the first and second placement-position determining conveyance units 1B and 11B, the first and second unloaders 1C and 11C, the belt drive motor, the board stopper driving cylinder, a database 1001 having stored therein information pertaining to the mounting operation or other information, such as information as to the size and the like of the board 2 on which components are to be mounted, information as to the shapes, heights and the like of components, information as to the placement positions on the board in which the components are to be mounted, the mounting sequence therefor, the shape and the like of the component suction nozzles, information as to the pre-placement standby positions of the loaders, the placement positions of the

placement-position determining conveyance units, or the post-placement standby positions of the unloaders, an operating section 1002 for executing desired operations, a timer T for establishing timing between individual operations, and so on.

The operation of the electronic component mounting apparatus of the first embodiment constructed as described above is executed under the control of the control unit 1000.

First of all, in the first mounting section 101, the first loader 1A, the first placement-position determining conveyance unit 1B and the first unloader 1C are adjusted in width according to the width of the first board 2a to be loaded into the first conveyance path. Thereafter, the first board 2a-1 is positioned in the first placement position FB of the first placement-position determining conveyance unit 1B through the first loader 1A, and the first board 2a-2 to be mounted next is positioned and held in the first pre-placement standby position FA of the first loader 1A.

Next, the first placement head 4 is moved from the position of the origin to the first component feeding device 8, and the components are sucked and held by the nozzles 10 of the first placement head 4 from the component feeding unit 8A or 8B of the first component feeding device

8.

Next, the first placement head 4 is moved from the first component feeding device 8 to the first recognition device 9, and the postures of the components held by the nozzles 10 of the first placement head 4 are each recognized.

Next, the first placement head 4 is moved from the first recognition device 9 to the first placement-position determining conveyance unit 1B, and the component held by the first placement head 4 is placed by the first placement head 4 on the first board 2a positioned and held in the first placement position FB of the first placement-position determining conveyance unit 1B. Subsequently, the first placement head 4 returns to the component feeding unit 8A or 8B of the first component feeding device 8 and performs the suction of the component to be mounted next.

As described above, by repeating the component suction, recognition and placement, all the components to be placed are mounted.

After the end of the mounting, the component-mounted board 2a-1 is unloaded from the first placement-position determining conveyance unit 1B toward the first unloader 1C, positioned and held in the first post-placement standby position FC of the first unloader 1C and thereafter further unloaded out of the component mounting

work area 201 by the first unloader 1C. At this time, the next first board 2a-2 that has been positioned and held in the first pre-placement standby position FA of the first loader 1A is concurrently positioned and held in the first placement position FB of the first placement-position determining conveyance unit 1B through the first loader 1A, and the next first board 2a-3 is positioned and held in the first pre-placement standby position FA of the first loader 1A. The board positions in Fig. 1 and Fig. 2 are in this state.

The mounting operation in the second mounting section 102 is performed concurrently with and independently of the aforementioned mounting operation in the first mounting section 101.

That is, in the second mounting section 102, the second loader 11A, the second placement-position determining conveyance unit 11B and the second unloader 11C are adjusted in width according to the width of the second board 2b to be loaded into the second conveyance path. Thereafter, the second board 2b-1 is positioned in the second placement position SB of the second placement-position determining conveyance unit 11B through the second loader 11A, and the second board 2b-2 to be mounted next is positioned and held in the second pre-placement standby position SA of the second loader 11A.

Next, the second placement head 14 is moved from the position of the origin to the second component feeding device 18, and the components are sucked and held by the nozzles of the second placement head 14 from the component feeding unit 18A or 18B of the second component feeding device 18.

Next, the second placement head 14 is moved from the second component feeding device 18 to the second recognition device 19, and the postures of the components held by the nozzles of the second placement head 14 are each recognized.

Next, the second placement head 14 is moved from the second recognition device 19 to the second placement-position determining conveyance unit 11B, and the component held by the second placement head 14 is placed on the second board 2b positioned and held in the second placement position SB of the second placement-position determining conveyance unit 11B by the second placement head 14. Subsequently, the second placement head 14 returns to the component feeding unit 18A or 18B of the second component feeding device 18 and performs the suction of the component to be mounted next.

As described above, by repeating the component suction, recognition and placement, all the components to be placed are mounted.

After the end of the mounting, the component-mounted board 2b-1 is unloaded from the second placement-position determining conveyance unit 11B toward the second unloader 11C, positioned and held in the second post-placement standby position SC of the second unloader 11C and thereafter further unloaded out of the component mounting work area 202 by the second unloader 11C. At this time, the next second board 2b-2 that has been positioned and held in the second pre-placement standby position SA of the second loader 11A is concurrently positioned and held in the second placement position SB of the second placement-position determining conveyance unit 11B through the second loader 11A, and the next second board 2b-3 is positioned and held in the second pre-placement standby position SA of the second loader 11A. The board positions in Fig. 1 and Fig. 2 are in this state.

According to the first embodiment, in one component mounting apparatus, the component mounting work area 200 of the board 2 is divided into the two parts of the first component mounting work area 201 and the second component mounting work area 202. In each of the first component mounting work area 201 and the second component mounting work area 202, there are independently performed the operations of the loading of the boards 2a and 2b by the first loader 1A and the second loader 11A, the

positioning and holding of the boards 2a and 2b by the first placement-position determining conveyance unit 1B and the second placement-position determining conveyance unit 11B, the component feed by the first and second component feeding devices 8 and 18, the suction, holding and movement of components by the first and second placement heads 4 and 14, the recognition of components by the first and second recognition devices 9 and 19 and the unloading of the boards 2a and 2b by the first and second placement-position determining conveyance units 1B and 11B, the first unloader 1C and the second unloader 11C. More concretely, the board 2a-1 is loaded into the first component mounting work area 201 by the first loader 1A in the first component mounting work area 201. The board 2a-1 is positioned and held by the first placement-position determining conveyance unit 1B for the mounting operation in the first placement position FB that is a portion located closest to the component feeding units 8A and 8B arranged along the board conveyance direction in the first component mounting work area 201 and closest to the camera to be usually most frequently used as one example of the first component recognition device, e.g., two-dimensional camera 9a. Next, the first placement head 4 is driven to suck and hold the component from the component feeding unit 8A or 8B, the component is recognized by the two-dimensional camera 9a, and then the

mounting on the board 2a is performed. After repeating this and after ending the mounting work in the first mounting section 101, the board 2a-1 is unloaded from the first placement-position determining conveyance unit 1B toward the first unloading 1C and further unloaded out of the first component mounting work area 201 by the first unloading 1C. On the other hand, concurrently with the mounting operation in the first mounting section 101, the board 2b-1 is loaded into the second component mounting work area 202 by the second loader 11A in the second component mounting work area 202. The board 2b-1 is positioned and held by the second placement-position determining conveyance unit 11B for the mounting operation in the second placement position SB that is a portion located closest to the component feeding units 18A and 18B arranged along the board conveyance direction in the second component mounting work area 202 and closest to the camera to be usually most frequently used as one example of the second component recognition device, e.g., two-dimensional camera 19a. Next, the second placement head 14 is driven to suck and hold the component from the component feeding unit 18A or 18B, the component is recognized by the two-dimensional camera 19a, and then the mounting on the board 2b is performed. After repeating this and after ending the mounting work in the second mounting section 102, the board

2b-1 is unloaded from the second placement-position determining conveyance unit 11B toward the second unloader 11C and further unloaded out of the second component mounting work area 202 by the second unloading 11C.

As a result, in the first and second mounting sections 101 and 102, the board loading, the component holding, the component recognition, the component placement and the board unloading can be performed independently of each other in the respective optimum states, and the productivity can be further improved. That is, when either component mounting ends in advance in concurrently performing the component mounting operations in the plurality of component mounting work areas, respectively, the component-mounted board can be unloaded without awaiting the end of the other component mounting operation or board unloading, and the areal productivity can be further improved. Moreover, the shortest distances between the boards 2a and 2b positioned and held in the respective component mounting work areas 201 and 202, the component feeding units 8A, 8B, 18A and 18B and the cameras that are usually most frequently used, e.g., two-dimensional camera 9a and 19a, respectively, can be remarkably shortened in comparison with the case where the boards are held in the board conveyance paths in the center portions of the component mounting work areas as in the conventional case,

and this can reduce the mounting time and improve the productivity.

Moreover, with regard to the width adjustment (widthwise shift of board) references of the first loader 1A, the first placement-position determining conveyance unit 1B, the first unloader 1C, the second loader 11A, the second placement-position determining conveyance unit 11B and the second unloader 11C of the board conveying and holding devices 1 and 11 according to the widths of the boards 2a and 2b, the front-side edge portion is set as the reference in the first component mounting work area 201 located on the front side near the operator out of the component mounting work areas divided into two, and the deeper-side edge portion is set as the reference in the second component mounting work area 202 located on the deeper side far from the operator. Therefore, by setting the placement positions FB and SB in the placement-position determining conveyance units 1B and 11B with reference to the support rail portion located closest to the component feeding units 8A, 8B, 18A and 18B and the cameras to be usually most frequently used as one example of the component recognition devices 9 and 19, e.g., two-dimensional cameras 9a and 19a among the pair of support rail portions of the placement-position determining conveyance units 1B and 11B and by making the other support

rail portion moved close to or apart from the one support rail portion, it is enabled to cope with the board size. Therefore, the component suction and holding in the component feeding units 8A, 8B, 18A and 18B and the recognition by the two-dimensional cameras 9a and 19a are performed consistently near the position in the shortest distance, not depending on the sizes of the circuit boards 2a and 2b. The distances of the movement of the placement heads 4 and 14, i.e., the distances between the positions of the three operations of the component suction, recognition and placement are linked in the shortest distance, and this can reduce the mounting process time and increase the production efficiency. In particular, conventionally, when components are mounted on the board in the vicinity of the board conveyance position, the distances between the positions of the three operations of the component suction, recognition and placement would become long in the case of small boards, and the mounting process time would be increased. In contrast to this, according to the first embodiment, the board is positioned and mounted in the position where the distances between the positions of the three operations of the component suction, recognition and placement become short even for small boards and large boards, and therefore, the mounting process time can be remarkably reduced. Particularly, in

each component mounting work area, the component feeding units 8A, 8B, 18A and 18B are arranged along the end edges in the board conveyance direction of the component mounting work area as shown in Fig. 1 through Fig. 3. Therefore, the recognition devices 9 and 19 are arranged on the center side in the conveyance direction of the component mounting work areas 201 and 202, and the placement positions FB and SB of the boards 2a and 2b in the placement-position determining conveyance units 1B and 11B are also arranged on the center side in the conveyance direction of the component mounting work areas 201 and 202 for the reduction of the distances between the positions of the three operations of the component suction, recognition and placement. Therefore, the mounting process time can be further improved. Moreover, by dividing one component mounting work area 200 into two parts, the distances of movement of the placement heads 4 and 14 are reduced to allow the mounting process time to be improved. For example, in the mounting apparatus of the first embodiment, the time for mounting one component can be reduced to about one-half that of the conventional case, and the mounting process time can be remarkably improved.

Moreover, the two boards 2a and 2b are arranged as a pair oppositely in the component mounting work area 200 in one component mounting apparatus, and therefore, the

mounting efficiency per unit area can be improved in comparison with the case where only one board 2 is arranged.

Moreover, if the component mounting in the first mounting section 101 and the component mounting in the second mounting section 102 are concurrently performed, then the mounting operation can be performed more efficiently, and the mounting process time can be improved.

Moreover, the first placement head drive device 5 of the first mounting section 101 and the second placement head drive device 15 of the second mounting section 102 have driving regions that does not overlap each other. Therefore, the mounting operation in the mounting sections can be freely set without consideration for the mutual interference of both the units.

Moreover, the two-dimensional images of the components are taken in by arranging the two-dimensional cameras 9a and 19a that are most frequently used for performing the recognition of the components in positions located adjacent to the placement positions FB and SB and in the vicinity of the center portions of the component feeding devices 8 and 18. Therefore, the distance from the component feed to the component recognition can be shortened, and the mounting process time can be further shortened.

Moreover, the component mounting work area 200 is

divided into the two equal parts of the first component mounting work area 201 and the second component mounting work area 202 that do not overlap each other, and the component feeding devices 8 and 18, the placement heads 4 and 14, the placement head drive devices 5 and 15 of the heads, the board conveying and holding devices 1 and 11, the recognition cameras 9 and 19 and so on are provided point-symmetrically with respect to the center point 100 of the component mounting work area 200. Therefore, if a program of the component mounting operation is formed in either one of the mounting sections in forming the program of the component mounting operation, then the program can be used as it is or utilized in the other mounting section, enabling the easy formation of the program of the component mounting operation.

It is to be noted that the present invention is not limited to the first embodiment and is able to be put into practical use in a variety of forms.

For example, a bypass conveyance unit 30, which is arranged between the first conveyance path and the second conveyance path and through which the board 2 that is not subjected to the mounting operation in the first mounting section 101 and the second mounting section 102 is made to pass, is further provided. Therefore, when a plurality of component mounting apparatuses of the first embodiment are

joined together or joined to another component mounting apparatus, the board that is not subjected to the mounting operation in the first mounting section 101 and the second mounting section 102 of the component mounting apparatus of the first embodiment can be conveyed to the adjacent component mounting apparatus without regard to the mounting operations of the first mounting section 101 and the second mounting section 102. This enables the improvement of the overall productivity of the mounting system and also the provision of flexibility for production. In particular, the component mounting can be performed by the other component mounting apparatus even during the maintenance of the first mounting section 101 and the second mounting section 102, and the overall productivity of the mounting system can be further improved.

Moreover, if the bypass conveyance unit 30 is composed of an upper bypass conveyance unit and a lower bypass conveyance unit arranged below the upper bypass conveyance unit, then two bypass conveyance units can be secured even through the installation area is small, and this enables the further improvement of space utilization efficiency.

Moreover, if the bypass conveyance unit 30 is composed of two juxtaposed bypass conveyance units, then a plurality of bypass conveyance units can be more simply

provided.

Moreover, as shown in Fig. 6, if the second board 2b is loaded into the second mounting section 102 while being turned at a phase angle of 180 degrees with respect to the first board 2a loaded into the first mounting section 101, then the phase of the first board 2a in the first mounting section 101 with respect to the component feeding device 8 and the recognition device 9 becomes identical to the phase of the second board 2b in the second mounting section 102 with respect to the component feeding device 18 and the recognition device 19. This enables the use of an identical mounting program and facilitates the designing. Furthermore, the mounting operation can be performed through an utterly identical procedure in the two mounting sections 101 and 102. Therefore, the mounting process time of the mounting operations in the mounting sections 101 and 102 becomes identical, and the productivity can be improved. In this case, it is also possible to provide board turning conveyance units that are arranged on the upstream side of the first conveyance path and the second conveyance path, able to turn the board at an angle of 180 degrees and load the board selectively into the first conveyance path and the second conveyance path and make the units perform the above-mentioned operation.

Moreover, if an in-phase mode in which the second

board 2b is loaded into the second mounting section 102 in phase with the first board 2a as shown in Fig. 7 and a reverse mode in which the second board 2b is loaded into the second mounting section 102 while being turned at a phase angle of 180 degrees with respect to the first board 2a as shown in Fig. 6 are selectively used, then the mounting operation can be performed with the optimum mode selected according to the board type or the like, and the mounting process time can be improved still further.

Moreover, by providing the placement heads 4 and 14 with a plurality of component holding members of, for example, the nozzles 10 for holding the components fed by the component feeding devices 8 and 18 that have the plurality of component feeding units 8A, 8B, 18A and 18B and arranging the plurality of nozzles 10 and the plurality of component feeding units 8A, 8B, 18A and 18B of the component feeding devices 8 and 18 in an identical direction of arrangement, the placement heads 4 and 14 are only required to move in the X-axis direction without being moved in the Y-axis direction when sucking and holding the plurality of components, and the mounting process time can be further shortened.

Moreover, by providing the placement heads 4 and 14 with a plurality of component holding members of, for example, the nozzles 10, for holding the components fed by

the component feeding devices 8 and 18 that have the plurality of component feeding units 8A, 8B, 18A and 18B, arranging the plurality of nozzles 10 and the component feeding units 8A, 8B, 18A and 18B of the component feeding devices 8 and 18 in an identical direction of arrangement and providing identical intervals between the plurality of nozzles 10 and the plurality of component feeding units 8A, 8B, 18A and 18B of the component feeding devices 8 and 18, the plurality of components can be concurrently collectively sucked and held by the plurality of nozzles 10 in the plurality of component feeding units 8A, 8B, 18A and 18B, and the mounting process time can be shortened still further.

Moreover, when performing the operations of component feed, holding, recognition and placement in the first mounting section 101, the operations of loading, positioning in the first placement position FB and unloading of the first board 2a, the operations of component feed, holding, recognition and placement in the second mounting section 102, the operations of loading, positioning in the second placement position SB and unloading of the second board 2b and the recognizing operation or the placement operation in either one of the mounting sections of the first mounting section 101 and the second mounting section 102, the loading and unloading operations in the other mounting sections can be controlled

so as not to be performed. By so doing, the recognizing operation or the placement operation can be performed more accurately.

Moreover, it is acceptable to selectively use an in-phase mode operation program for loading the second board 2b into the second mounting section 102 in phase with the first board 2a and performing the operations of component feed, holding, recognition and placement and the operations of positioning in the second placement position SB and unloading of the second board 2b and a reverse mode operation program for loading the second board 2b into the second mounting section 102 by turning the board at a phase angle of 180 degrees with respect to the first board 2a and the operations of component feed, holding, recognition and placement and the operations of loading, positioning in the second placement position SB and unloading of the second board 2b. By so doing, the optimum one can be selected from the in-phase mode operation program and the reverse mode operation program according to the mounting operation, and the productivity can be improved still further.

Moreover, it is acceptable to selectively use an in-phase mode operation program for loading the second board 2b into the second mounting section 102 in phase with the first board 2a and performing the operations of component feed, holding, recognition and placement and the

operations of positioning in the second placement position SB and unloading of the second board 2b and a reverse mode operation program for loading the second board 2b into the second mounting section 102 by turning the board at a phase angle of 180 degrees with respect to the first board 2a and the operations of component feed, holding, recognition and placement and the operations of positioning in the placement position B and unloading of the second board 2b, construct the in-phase mode operation program and the reverse mode operation program so that a fundamental operation program for executing the fundamental operations of component feed, holding, recognition and placement and the operations of positioning in the placement position B and unloading of the second board 2b is identical, and the operation data section for executing the fundamental operations is only varied and selectively use the in-phase mode operation program and the reverse mode operation program. By so doing, the fundamental operation program in the two mounting sections 101 and 102 can be commonly used, and the formation of the program can be more efficiently performed.

Moreover, it is acceptable to provide a first mounting operation program for performing the operations of component feed, holding, recognition and placement in the first mounting section 101 and the operations of loading,

positioning in the placement position B and unloading of the first board 2a and a second mounting operation program for performing the operations of component feed, holding, recognition and placement in the second mounting section 102 and the operations of loading, positioning in the placement position B and unloading of the first board 2a differently from the first mounting operation program, use the first mounting operation program in the first mounting section 101 and use the second mounting operation program in the second mounting section 102. By so doing, the optimum operation according to the mounting operation in each mounting section can be performed without being influenced by the mounting operation in the other mounting section.

Moreover, it is also possible to determine the type and phase of the board to be loaded into each of the first mounting section 101 and the second mounting section 102 in consideration of the apparatus construction information of the first mounting section 101 and the second mounting section 102. By so doing, the phase of the board can be set to the optimum state according to the device construction of each mounting section and the optimum mounting operation can be performed. For example, although the two-dimensional camera 9a is arranged as the first recognition device 9 in the first mounting section

101, when only the three-dimensional camera 19b is arranged as the second recognition device 19 in the second mounting section 102, it is possible to make the second mounting section 102 perform the mounting operation only for three-dimensional component recognition and make the first mounting section 101 provided with the two-dimensional camera 9a perform the operation for two-dimensional component recognition.

Moreover, it is possible to perform the operations of component feed, holding, recognition and placement in the first mounting section 101 and the operations of loading, positioning and unloading of the first board 2a, perform the operations of component feed, holding, recognition and placement in the second mounting section 102 and the operations of loading, positioning and unloading of the second board 2b independently of the operations in the first mounting section 101. Even when any one of the operations of component feed, holding, recognition and placement and the operations of loading, positioning and unloading of the board cannot be performed through some errors in either one of the first mounting section 101 and the second mounting section 102, it is also possible to perform the operations of component feed, holding, recognition and placement and the operations of loading, positioning and unloading of the board in the

other mounting section. This will be described more specifically with reference to Fig. 8. Fig. 8 shows a series of component-mounted board producing system. Reference numeral 900 denotes a solder cream printing device for printing lands and the like in specified portions of the board with a solder cream, reference numerals 901, 902 and 903 denote board conveyance path changing units, reference numeral 904 denotes a reflow device for performing a reflow process, and reference numeral 905 denotes a board conveyance lane. Reference numerals 1-1, 1-2 and 1-3 denote the first, second and third component mounting apparatuses of the aforementioned embodiment, reference numerals 101-1, 101-2 and 101-3 denote the first mounting sections of the first, second and third component mounting apparatuses, and reference numerals 102-1, 102-2 and 102-3 denote the second mounting sections of the first, second and third component mounting apparatuses. Therefore, in this component-mounted board producing system, the board unloaded from the solder cream printing device 906 is normally properly distributed via the conveyance lane 90 into a first conveyance path (lower conveyance path in Fig. 8) and a second conveyance path (upper conveyance path in Fig. 8) by the conveyance path changing unit 901. Two boards 2a and 2b are loaded into the first component mounting apparatus 1-1, and the

mounting operation is performed in each of the first mounting section 101-1 and the second mounting section 102-1. After the end of the mounting operation, the two boards 2a and 2b are loaded into the second component mounting apparatus 1-2 via the conveyance path changing unit 902. Then, the mounting operation is performed in each of the first mounting section 101-2 and the second mounting section 102-2. After the end of the mounting operation, the two boards 2a and 2b are loaded into the third component mounting apparatus 1-3 via the conveyance path changing unit 903. Then, the mounting operation is performed in the first mounting section 101-3 and the second mounting section 102-3. After the end of the mounting operation, the boards are loaded into the reflow device 904 so as to be subjected to the reflow process, and the component-mounted board is completed. These devices are operated under the control of the control unit 1000.

In a series of component-mounted board producing system as described above, if the mounting operation is stopped due to the occurrence of a supply error, a holding error, a recognition error or a placement error in the first mounting section 101-1 of the first component mounting apparatus 1-1, then the mounting operation is continued or stopped in the second mounting section 101-2 of the first component mounting apparatus 1-1. When the

mounting operation is continued, the board 2b is unloaded from the second mounting section 101-2 when the mounting operation of the board 2b ends, and the next board is loaded. At this time, it is properly performed to receive the board 2a to be mounted next in the first mounting section 101-1, make the board pass as it is without undergoing mounting in the second mounting section 101-2 and load the board into the conveyance path changing unit 902. Then, the board 2a located in the second conveyance path is moved to the first conveyance path side in the conveyance path changing unit 902 and thereafter loaded into the first mounting section 101-2 of the second component mounting apparatus 1-2, and the same mounting operation as the mounting operation that should properly be performed in the first mounting section 101-1 of the first component mounting apparatus 1-1 is performed in the first mounting section 101-2. At this time, by supplying the information necessary for the mounting operation such as mounting operation data and an operation program for the first mounting section 101-1 of the first component mounting apparatus 1-1 to the second component mounting apparatus 1-2 by the control unit 1000, the same mounting operation can be performed without any trouble. It is to be noted that the first mounting section 101-1 of the first component mounting apparatus 1-1 and the first mounting

section 101-2 of component mounting apparatus 1-2 are required to have fundamentally identical device constructions. With this arrangement, the mounting operation in the other mounting section can be performed without being influenced by various errors (for example, supply error, holding error, recognition error or placement error) in one mounting section, and constant productivity can be maintained even if the mounting operation in the other mounting section is stopped due to an error or the like.

Moreover, it is acceptable to provide a continuous mode in which, even when the mounting operation in either one mounting section of the first mounting section 101 and the second mounting section 102 cannot be performed, the mounting operation is continued in the other mounting section and a stop mode in which the mounting operation is stopped in the other mounting section and selectively use either one of the modes. By so doing, it is permitted to select the optimum mode by properly selecting the continuous mode and the stop mode according to the component mounting apparatus or the apparatus located adjacently on the downstream side of the apparatus. Even when the mounting operation in either one of the mounting sections cannot be performed, the optimum operation can be performed from the viewpoint of the

overall production system that includes the aforementioned component mounting apparatus.

Moreover, it is acceptable to provide a first continuous mode in which, even when the mounting operation in either mounting section of the first mounting section 101 and the second mounting section 102 cannot be performed, the mounting operation of the board currently undergoing the mounting is continued but the mounting operation of the next board is not performed, a second continuous mode in which the mounting operation of not only the board currently undergoing the mounting but also the mounting operation of the next board are performed and a stop mode in which the mounting operation is stopped in the other mounting section and selectively use any one of the modes. By so doing, the optimum mode can be selected by properly selecting the first continuous mode, the second continuous mode or the stop mode, and the optimum operation can be performed from the viewpoint of the overall production system that includes the component mounting apparatus even when the mounting operation in either one of the mounting sections cannot be performed.

Moreover, it is acceptable to provide a component mounting system that has a third continuous mode in which, when the mounting operation in either mounting section of the first mounting section 101 and the second mounting

section 102 cannot be performed in the first component mounting apparatus of joined two devices of either one of the component mounting apparatuses, the mounting operation is continued in the other mounting section, a fourth continuous mode in which the mounting operation is continued not in the other mounting section of the first component mounting apparatus but in either mounting section of the first mounting section 101 and the second mounting section 102 of the second device and a stop mode in which the mounting operation is stopped in the other mounting section of the first component mounting apparatus and selectively uses any one of the modes. With this arrangement, the optimum mode can be selected by properly selecting the third continuous mode, the fourth continuous mode or the stop mode. Even when the mounting operation in either one of the mounting sections of the first component mounting apparatus cannot be performed, the optimum operation can be performed from the viewpoint of the overall production system that includes the two component mounting apparatuses by making either mounting section of the other mounting section of the first component mounting apparatus and the mounting section of the second component mounting apparatus perform the substitute mounting operation.

Moreover, teaching information of the reference

position in the board placement position of the first mounting section 101 (for example, teaching information of the reference position obtained by abutting a corner portion of the board against the positioning portion of the placement-position determining conveyance unit) and so on can be used as teaching information of the reference position of the board in the second mounting section 102. With this arrangement, a work for making each mounting section perform the teaching operation can be eliminated.

Moreover, it is possible to selectively use a synchronous mode in which the conveyance operation of the first board 2a of the first mounting section 101 and the conveyance operation of the second board 2b of the second mounting section 102 are synchronized with each other and an asynchronous mode in which the conveyance operation of the first board 2a of the first mounting section 101 and the conveyance operation of the second board 2b of the second mounting section 102 are not synchronized with each other. By so doing, the mounting operation can be performed by selecting the optimum mode from the synchronous mode and the asynchronous mode according to the type of the board, the mounting operation and so on, and the mounting process time can be improved still further. In particular, when the synchronous mode is selected during the mounting operation of boards of an identical model, the

mounting operations in both mounting sections start concurrently and end concurrently, and therefore, the mounting process time can be further improved.

Moreover, the component mounting apparatus is arranged just before the reflow furnace, and the first board 2a and the second board 2b can also be unloaded synchronously from the first mounting section 101 and the second mounting section 102 when the mounted boards are unloaded to the reflow process in the reflow furnace. By so doing, the reflow process can be concurrently performed by concurrently loading the first board 2a and the second board 2b into the reflow furnace, so that the reflow process can be efficiently performed in comparison with the case where the reflow process is performed by loading the first board 2a and the second board 2b into the reflow furnace in accordance with varied timing.

Moreover, as shown in Fig. 3, by providing the unloaders 1A and 11A, the placement-position determining conveyance units 1B and 11B and the unloaders 1C and 11C with a board positioning stopper 32 and a board arrival detection sensor (not shown) at both the front and rear ends in the board conveyance direction, the boards 2a and 2b can be positioned either at the front end or the rear end in the board conveyance direction. Therefore, the pre-placement standby positions FA and SA, the placement positions FB and

SA and the post-placement standby positions FC and SC for positioning the boards 2a and 2b in the component mounting work areas 201 and 202 can be arbitrarily determined on the basis of the information of the sizes of the boards 2a and 2b, the state of distribution of the positions in which the components are to be mounted, the state of distribution of the positions in which the components are sucked and held from the component feeding device and so on.

When a tray type component feeding unit is arranged in place of the first component feeding unit 8A or 8B or the second component feeding unit 18A or 18B, it is acceptable to provide an automatic tray replacing unit to automatically replace the tray type component feeding unit. By so doing, the mounting operation is not stopped by the shortage of components of the component feeding device or the like during the component mounting, and the component feed is continuously performed. In addition, the performances during the actual production, such as a fast mounting speed, i.e., the real production capacity can be improved.

Moreover, if the constituent elements of the component mounting apparatuses, such as the component feeding units, their automatic replacing units, the recognition devices, the loaders, the placement-position determining conveyance units and the unloaders, are each

formed into a module, then the component mounting apparatus can be developed by properly replacing the elements according to the improvement of the mounting apparatus in the future. That is, the component mounting apparatus can be developed only by replacing the module of each constituent element on the basis of the fundamental elements. Moreover, if the constituent elements are formed into modules as described above, it is possible to cope with the change of the types of the boards and components only by properly replacing the module of each constituent element even at the time of changing the types of the boards and components, and the productivity per device installation area, i.e., the areal productivity can also be improved.

Moreover, although the component mounting work area 200 of the aforementioned mounting apparatus is divided into the two parts of the first component mounting work area 201 and the second component mounting work area 202, the structure is not limited to the division into two equal parts and may be divided into two parts at an arbitrary ratio.

(Second Embodiment)

The component mounting system and method of the second embodiment of the present invention will be described next with reference to Fig. 10 through Fig. 22.

According to this second embodiment, as shown in Fig. 10, a plurality of component mounting apparatuses according to the first embodiment are joined together to constitute an electronic component-mounted board production line, and a board (unmounted board or bare board) 2c to be mounted with components is efficiently loaded into each component mounting apparatus, and a mounted board 2d is unloaded. It is to be noted that this second embodiment is provided for handling the board that is unloaded from the printer and mounted with no electronic component. However, the present invention is not limited to this and is allowed to be applied even in, for example, the case where an electronic component(s) is to be further mounted on a board on which electronic components have already been partially mounted in the course of the production line of the electronic component-mounted board. In the above case, the term of "unmounted board" in the following description means the board on which electronic components have already been partially mounted.

In the component mounting system of the second embodiment shown in Fig. 10, three component mounting apparatuses of Fig. 1 according to the first embodiment are joined together to constitute one mounting apparatus group. Two mounting apparatus groups are joined together, and they are referred to as a mounting apparatus group A and a

mounting apparatus group B. In the three places of a place located on the pre-processing side of the mounting apparatus group A, a place located on the post-processing side of the mounting apparatus group A and the pre-processing side of the mounting apparatus group B and a place located on the post-processing side of the mounting apparatus group B are arranged first, second and third connective conveyance units CC1, CC2 and CC3 (corresponding to the conveyance path changing units 901, 902 and 903 of the first embodiment) which can be moved in a direction perpendicular to the direction in which the board 2 is conveyed and is able to turn the board 2 at an angle of 180 degrees. As a result, the electronic component-mounted board production line is composed of the mounting apparatus group A, the mounting apparatus group B and the first, second and third connective conveyance units CC1, CC2 and CC3. The upward and downward arrows in Fig. 10 indicate the directions of movement of the connective conveyance unit CC.

Fig. 11 is a flowchart showing the operation of the first connective conveyance unit CC1 of the component mounting system of the second embodiment.

Fig. 12 is a flowchart showing the operation of the second connective conveyance unit CC2 of the component mounting system of the second embodiment.

Fig. 13 is a flowchart showing the operation of the third connective conveyance unit CC3 of the component mounting system of the second embodiment.

Fig. 14 is an enlarged schematic plan view showing a mounting apparatus group A and a first connective conveyance unit CC1 located on the upstream side of the board conveyance direction of Fig. 10. The upward and downward arrows in the figure indicate the directions of movement of the first connective conveyance unit CC1.

Fig. 15 is an enlarged schematic plan view showing a component mounting apparatus AI located on the uppermost-stream side of the mounting apparatus group A located on the upstream side, the first connective conveyance unit CC1 and a printer 900 located on the upstream side of the unit CC1 in the board conveyance direction of Fig. 10. The upward and downward arrows in the figure indicate the directions of movement of the first connective conveyance unit CC1, and the sidewise arrows indicate the board conveyance direction.

Fig. 16 is an enlarged schematic plan view showing a component mounting apparatus AIII located the downmost-stream side of the mounting apparatus group A located on the upstream side, a second connective conveyance unit CC2 and a component mounting apparatus BI located on the uppermost-stream side of the mounting

apparatus group B located on the downstream side of the board conveyance direction of Fig. 10. The upward and downward arrows in the figure indicate the directions of movement of the second connective conveyance unit CC2, and the sidewise arrows indicate the board conveyance direction.

Fig. 17 is an enlarged schematic plan view showing a component mounting apparatus BIII located on the downmost-stream side of the mounting apparatus group B located on the downstream side, a third connective conveyance unit CC3 and a reflow device 904 located on the downstream side of the unit CC3 in the board conveyance direction of Fig. 10. The upward and downward arrows in the figure indicate the directions of movement of the third connective conveyance unit CC3, and the sidewise arrows indicate the board conveyance direction.

Fig. 18 is a schematic plan view showing the two mounting apparatus groups A and B and the first and second connective conveyance units CC1 and CC2 in the component mounting system of the second embodiment of Fig. 10. The upward and downward arrows in the figure indicate the directions of movement of the first and second connective conveyance units CC1 and CC2, and the sidewise arrows indicate the board conveyance direction.

Fig. 19 is a block diagram showing the structure of the control section of the electronic component-mounted

board production line of the component mounting system of the second embodiment.

Fig. 20 is a block diagram partially showing the peculiar portion of the component mounting system of the second embodiment in the control unit 1000 of each component mounting apparatus in the electronic component-mounted board production line of the component mounting system of the second embodiment.

Fig. 21 is a perspective view showing an example of the connective conveyance unit CC of the electronic component-mounted board production line of the component mounting system of the second embodiment.

Fig. 22 is a plan view of the connective conveyance unit CC of Fig. 21.

Among the three component mounting apparatuses AI, AII and AIII of the mounting apparatus group A of the component mounting system, the front-side mounting sections A1, A2 and A3 (each corresponding to the first mounting section 101 of Fig. 1) are arranged on the front side of Fig. 10, and the rear-side mounting sections a1, a2 and a3 (each corresponding to the second mounting section 102 of Fig. 1) are arranged on the rear side. The front-side mounting section A1 and the rear-side mounting section a1 constitute the first one component mounting apparatus AI, the front-side mounting section A2 and the rear-side mounting section

a2 constitute the second one component mounting apparatus AII, and the front-side mounting section A3 and the rear-side mounting section a3 constitute the third one component mounting apparatus AIII. Likewise, among the three component mounting apparatuses BI, BII and BIII of the mounting apparatus group B, the front-side mounting sections B1, B2 and B3 (each corresponding to the first mounting section 101 of Fig. 1) are arranged on the front side of Fig. 10, and the rear-side mounting sections b1, b2 and b3 (each corresponding to the second mounting section 102 of Fig. 1) are arranged on the rear side. The front-side mounting section B1 and the rear-side mounting section b1 constitute the first one component mounting apparatus BI, the front-side mounting section B2 and the rear-side mounting section b2 constitute the second one component mounting apparatus BII, and the front-side mounting section B3 and the rear-side mounting section b3 constitute the third one component mounting apparatus BIII. Similarly to the component mounting apparatus of Fig. 1, each mounting section is provided with a loader L (one example of the pre-placement conveyance unit, corresponding to the first loader 1A or the second loader 2A of the first embodiment), a Y-table T (one example of the placement conveyance unit, corresponding to the first placement-position determining conveyance unit 1B or the second placement-position

determining conveyance unit 11B of the first embodiment) and an unloader U (one example of the post-placement conveyance unit, corresponding to the first unloader 1C or the second unloader 2C of the first embodiment). Moreover, a bypass lane BP (corresponding to the bypass conveyance unit 30 of the first embodiment) is provided in the middle portion of the front-side mounting section and the rear-side mounting section.

Moreover, a first mounting lane JA is composed of a loader LA1, a Y-table TA1, an unloader UA1, a loader LA2, a Y-table TA2, an unloader UA2, a loader LA3, a Y-table TA3 and an unloader UA3, which belong to a series of front-side mounting sections A1, A2 and A3 of the mounting apparatus group A. A second mounting lane Ja is composed of a loader La1, a Y-table Ta1, an unloader Ua1, a loader La2, a Y-table Ta2, an unloader Ua2, a loader La3, a Y-table Ta3 and an unloader Ua3, which belong to a series of rear-side mounting sections a1, a2 and a3 of the mounting apparatus group A. A first bypass lane BPA is composed of first through third bypass conveyance units BP1, BP2 and BP3 arranged in the center portions of the three component mounting apparatuses AI, AII and AIII, respectively, of the mounting apparatus group A.

Moreover, a first mounting lane JB is composed of a loader LB1, a Y-table TB1, an unloader UB1, a loader LB2,

a Y-table TB2, an unloader UB2, a loader LB3, a Y-table TB3 and an unloader UB3, which belong to a series of front-side mounting sections B1, B2 and B3 of the mounting apparatus group B. A second mounting lane Jb is composed of a loader Lb1, a Y-table Tb1, an unloader Ub1, a loader Lb2, a Y-table Tb2, an unloader Ub2, a loader Lab, a Y-table Tb3 and an unloader Ub3, which belong to a series of rear-side mounting sections b1, b2 and b3 of the mounting apparatus group B. A second bypass lane BPB is composed of fourth through sixth bypass conveyance units BP4, BP5 and BP6 arranged in the center portions of the three component mounting apparatuses BI, BII and BIII, respectively, of the mounting apparatus group B.

If the bypass conveyance units BP or at least the bypass conveyance unit BP located on the downstream side of the board conveyance direction is composed of an upper-side bypass lane and a lower-side bypass lane arranged on the lower side of the upper-side bypass lane, then two bypass lanes can be secured even though the installation area is small, and the space utilization efficiency can be increased. Moreover, in this case, it is acceptable to arrange each mounting lane on a roughly identical plane as that of, for example, the upper-side bypass lane, use the upper-side bypass lane specially as an unmounted board conveyance lane and use the lower-side bypass lane

specially as a mounted board conveyance lane.

If the bypass conveyance units BP or at least the bypass conveyance unit BP located on the downstream side is composed of two bypass conveyance units juxtaposed right and left, then a plurality of bypass lanes can be more easily provided.

Each connective conveyance unit CC (CC1, CC2, CC3) receives one board 2 (2a, 2b, 2c, 2d) from one lane that is located adjacently to each connective conveyance unit CC and located on the upstream side of the board conveyance direction and enables the unloading of the board to one conveyance lane that is located adjacently to each connective conveyance unit CC and located on the downstream side of the board conveyance direction. Each connective conveyance unit CC has a structure roughly identical to that of the aforementioned loader L (LA1, LA2, LA3, La1, La2, La3, LB1, LB2, LB3, Lb1, Lb2, Lb3), the Y-table T (TA1, TA2, TA3, Ta1, Ta2, Ta3, TB1, TB2, TB3, Tb1, Tb2, Tb3) and the unloader U (UA1, UA2, UA3, Ua1, Ua2, Ua3, UB1, UB2, UB3, Ub1, Ub2, Ub3) and has a structure roughly identical to that of the first and second loaders 1A and 2A, the first and second placement-position determining conveyance units 1B and 2B, the first and second unloaders 1C and 2C of the component mounting apparatus of the first embodiment. The section CC can be driven back and forth in the board

conveyance direction by synchronizing a pair of belts by means of a drive device of one connective conveyance unit motor or two connective conveyance unit motors. Moreover, width adjustment can be performed according to the width of the board 2 by making the position of at least one belt movable with respect to the other belt according to the width of the board 2 to be conveyed on the basis of the size data of the board 2 preparatorily stored in the memory MEM or a database 1001. More specifically, the adjustment can be performed by rotating a ball screw arranged in the widthwise direction by the driving of a motor for width adjustment in the widthwise direction and moving a member for supporting one belt fixed to a nut portion meshed with the ball screw close to or apart from a member for supporting the other belt in the widthwise direction. If the motor for the width adjustment is a pulse motor, then the width adjustment can be performed by rotating the pulse motor by the number of pulses with an automatic widthwise shift pulse signal fed from the control unit 1000 or the like. This width adjustment operation is not performed when the board is detected by the board detection sensor DC of the connective conveyance unit CC and performed only when no board is detected.

Fig. 21 and Fig. 22 show one example of the connective conveyance unit CC. Details will be described

later. A pair of conveyor rail portions 112 and 112 for loading and unloading the board 2 are placed on a turning device 121, and the turning device 121 is made rotatable to an angle of at least 180 degrees, preferably 360 degrees, by means of a rotation drive device 122 such as a rotary actuator. The turning device 121 is moved in a direction perpendicular to the board conveyance direction by a drive section 302, such as two air cylinders 3021 and 3022, of a later-described second moving unit 301 and enables the conveyance of the board 2 held by the pair of conveyor rail portions 112 and 112 with respect to any one of the first mounting lane JA, the first bypass lane BPA and the second mounting lane Ja. The air cylinder 3021 enables the turning device 121 to be positioned in either one of the mounting lane JA and the bypass lane BPA, while the air cylinder 3022 enables the turning device 121 to be positioned in either one of the first mounting lane JA and the second mounting lane Ja. Moreover, when the first bypass lane BPA is composed of the two upper and lower bypass lanes, boards can be conveyed to their respective bypass lanes by moving up and down the turning device 121 by a drive device 1202, such as a rotary actuator, of a first moving unit 1201. Reference numeral 309 denotes the control section of the connective conveyance unit CC, the control section receiving a variety of signals described in

detail below, controlling a distributing or integrating operation on the basis of the received signal and outputting a signal described in detail below. It is preferable to provide each conveyor rail portion 112 with a contraction rail 1121 at its both ends or at least one end portion so that the radius of the turning device 121 in its turns can be reduced as much as possible by bending or expansion and contraction.

As an example of the connective conveyance unit CC, a board conveying device for conveying circuit boards 2 to be fed to the electronic component mounting apparatus, more specifically, a board conveying device that performs distribution of circuit boards 2 for a plurality of board conveyance paths is described below in detail with reference to Figs. 21 to 27. It is noted that like constituent members are designated by like reference numerals throughout the drawings.

Fig. 21 shows the board conveying device CC, and Fig. 22 is a plan view of the board conveying device which is an example of the connective conveyance unit of Fig. 21. This board conveying device operates for conveying a board 2 carried in from any one of a first conveyor position 11-1, a second conveyor position 11-2 and a third conveyor position 12-2, which are located on the upstream side, to any one of a first board-conveying conveyor portion 21, a

second board-conveying conveyor portion 22, a third board-conveying conveyor portion 23 and a fourth board-conveying conveyor portion 24, which are located on the downstream side. It is noted that the first board-conveying conveyor portion 21, the third board-conveying conveyor portion 23 and the fourth board-conveying conveyor portion 24 that serves for use as a bypass lane are arranged at an equal height level, while the second board-conveying conveyor portion 22 is arranged for use as a second bypass lane above or below the fourth board-conveying conveyor portion 24, although the second board-conveying conveyor portion 22 may be omitted as in the foregoing embodiment.

The board conveying device CC is provided with a conveying and turning device 1101, a first moving unit 1201, a second moving unit 301 and a control section 309, where these units are integrally formed into one unit so as to execute functions of the board conveying device. Since the devices of the conveying and turning device 1101 and the like are integrally formed into one unit, the board conveying device CC can be made quite compact in terms of its installation space as compared with the conventional connective conveyance unit including no rail contracting unit in a conveyance direction 3Y of the circuit board 2 as shown in Fig. 22. As a concrete example, whereas the conventional connective conveyance unit requires an

installation space of about 1.8 m, the board conveying device CC of this embodiment requires only about 0.45 m. In the following description, the conveying and turning device 1101, the first moving unit 1201, the second moving unit 301 and the control section 309 are explained in detail.

First, the conveying and turning device 1101 is explained.

The conveying and turning device 1101 is provided with a holding and conveying device 111, a turning device 121 and a rail contracting unit 131, and performs the conveyance of the circuit board 2 along the conveyance direction 3Y and the turning of the circuit board 2, as well as the contraction of rails.

The holding and conveying device 111, which is a unit for holding and conveying the circuit board 2 toward the conveyance direction 3Y, has a pair of conveyor rail portions 112, conveyor belts 113, and a belt drive portion 114 for driving the conveyor belts 113 as shown in Figs. 24 and 25. Each of the conveyor rail portions 112 has a rail member 1127 which extends along the conveyance direction 3Y so as to be able to support both-side end edge portions of the board 2 along the conveyance direction 3Y, and a contraction rail 1121 which is rotatably fitted to each rail member 1127 at both end portions of the rail member 1127 as

detailed later and which is moved between a conveyance position 1122 and a bending position 1123 by the rail contracting unit 131. Each conveyor rail portion 112 is provided on a base plate 1124. Moreover, in order that the width between the conveyor rail portions 112 extending along an orthogonal direction 5Y orthogonal to the conveyance direction 3Y and to a thicknesswise direction 4Y of the circuit board 2 to be conveyed can be adjusted according to the width of the circuit board 2 to be conveyed, the conveyor rail portion 112 shown on the upper side in Fig. 25 can be moved along a pair of sliders 1125, which are laid on the base plate 1124 along the orthogonal direction 5Y, by rotating a rotational screw 1126 in its circumferential direction.

The conveyor belts 113 are belts which extend along the conveyor rail portions 112 and which support the circuit board 2 with both-side end edge portions of the circuit board 2 placed thereon and convey the circuit board 2 toward the conveyance direction 3Y. The belt drive portion 114 is provided with, in this embodiment, a motor 1142 for driving the conveyor belts 113, as well as a pulley 1141-1, a belt-tension pulley 1141-2 and conveyance pulleys 1141-3 to 1141-9 mounted on an output shaft of the motor 1142, as shown in Fig. 24. The conveyor belts 113 are wound around the pulleys 1141-1 to 1141-9 as shown in

the figure, and move in a sequence of pulley 1141-1 to 1141-9 to pulley 1141-1 so as to move the circuit board 2 toward the conveyance direction 3Y.

In addition, the conveyor belts 113, the belt drive portion 114 and the pulleys 1141-2 to 1141-9 are provided in each of the conveyor rail portions 112.

With the holding and conveying device 111 constructed as described above, the circuit board 2 is conveyed toward the conveyance direction 3Y by the drive of the motor 1142 with both-side end edge portions of the circuit board 2 supported on the conveyor belts 113 provided in the pair of conveyor rail portions 112, respectively.

The turning device 121 is a unit for turning the holding and conveying device 111 about the rotating shaft 1237 in a direction 124 around the axis of the rotating shaft 1237, which extends along the thicknesswise direction 4Y of the circuit board 2, as shown in Fig. 23. The turning device 121 is equipped with a rotary actuator 122 as a turn driving source, and a turning mechanism 123 which is driven by the rotary actuator 122 to turn the holding and conveying device 111. The turning mechanism 123 is explained below.

As shown in Figs. 23 and 26, an output shaft 122a of the rotary actuator 122 fitted to a base plate 125 of the turning mechanism 123 is fitted to one end of a lever 1231

serving for transfer of rotational drive, and a rod 1233 having a shaft 1232 is rotatably fitted at its one end to the other end of the lever 1231. A planet gear 1234 is rotatably fitted to the other end of the rod 1233. The planet gear 1234 is to be engaged with an internal gear 1235 and a gear 1236, and a plate 1237a fixed to the rotating shaft 1237 is fitted to the gear 1236. The rotating shaft 1237 is supported against a frame member 1110 of the board conveying device CC via two bearings 1111 so as to be turnable in their circumferential direction, while the bearings 1111 support the base plate 125. One end of the rotating shaft 1237 is connected to the base plate 1124 of the holding and conveying device 111, while the other end of the rotating shaft 1237 is connected to a later-described shaft 2035. Also, a shaft 1238 for both rotation and up-and-down move is insertable into a guide hole of the plate 1237a. In addition, reference numeral 1239 denotes a stopper. Also, the frame member 1110 is fitted onto a base plate 3032 fitted to a slider 3031 laid along the orthogonal direction 5Y on a frame 1120 of the board conveying device CC.

Operation of the turning mechanism 123 constructed as described above is explained.

When the output shaft 122a of the rotary actuator 122 is turned forward in its circumferential direction 126,

the rotating shaft 1237 and the plate 1237a are turned in the direction 124 around the axis by 180 degrees from a first position 127 to a second position 128 by the planet gear 1234, the internal gear 1235 and the gear 1236 via the lever 1231, the shaft 1232 and the rod 1233. Resultantly, the holding and conveying device 111 connected to the rotating shaft 1237 is turned by 180 degrees. It is noted that when the output shaft 122a of the rotary actuator 122 is turned reverse, the rotating shaft 1237 and the plate 1237a can be turned by 180 degrees from the second position 128 to the first position 127.

Although the turning drive device is implemented by the rotary actuator 122 in this embodiment as described above, it is still allowable to employ a motor. Further, although the description has been made on a constitutional example involving horizontal turns in Figs. 24 and 26, the invention may be carried out similarly also with turns in other vertical or inclined directions.

Next, the rail contracting unit 131 is explained with reference to Figs. 24 and 25.

It is noted that the rail contracting unit 131 is provided in each of the conveyor rail portions 112 of the above-described holding and conveying device 111 with the same structure.

Reference numeral 132 denotes a drive device in

the rail contracting unit 131, and an air cylinder is employed therefor in this example. An output shaft of the drive device 132 is connected to one end portion of a lever 133 which is fitted to the conveyor rail portions 112 so as to be rotatable about a center portion 133a as a rotational center. Also, one end of a link rod 134 is rotatably connected to the one end portion of the lever 133, while the other portion of the rod 134 is rotatably connected to one end of a lever 1121a provided on the contraction rail 1121-1. Similar to these, one end of a link rod 135 is rotatably connected to the other end portion of the lever 133, while the other end of the rod 135 is rotatably connected to one end of a lever 1121a provided on a contraction rail 1121-2. It is noted that in Figs. 24 and 25, a contraction rail 1121 located on the right side is assumed as the contraction rail 1121-1 and a contraction rail 1121 located on the left side is assumed as the contraction rail 1121-2 for explanation's sake.

The contraction rail 1121-1 and the contraction rail 1121-2 are rotatably fitted to their corresponding conveyor rails 112, respectively, so as to turn between the conveyance position 1122 and the bending position 1123 as described above about the rotating shaft of the pulley 1141-3 shown in Fig. 24 in the case of the contraction rail 1121-1 and about the rotating shaft of the pulley 1141-8.

Therefore, the pulley 1141-3 and the pulley 1141-8 can be said to be rotational-center pulleys for the contraction rails 1121.

Further, the pulleys 1141-5 and 1141-7 are provided at one-end portions of the contraction rails 1121, respectively, and rotating shafts of the pulleys 1141-5 and 1141-7 are disposed so as to be located on circumferences about the pulley 1141-3 and the pulley 1141-8, respectively. Therefore, even when the contraction rails 1121 are turned between the conveyance position 1122 and the bending position 1123 about the pulley 1141-3 and the pulley 1141-8, neither the distance between the pulley 1141-3 and the pulley 1141-4 nor the distance between the pulley 1141-8 and the pulley 1141-7 does not change. Accordingly, even when the contraction rails 1121 are turned as described above, occurrence of any changes in tensile force that is acting on the conveyor belts 113 is prevented.

Operation of the rail contracting unit 131 constructed as described above is described below.

When the output shaft of the drive device 132 is moved along an arrow 136a so that the lever 133 is turned about the center portion 133a along an arrow 137a, the rods 134 and 135 are moved, causing the levers 1121a of the contraction rails 1121-1 and 1121-2, respectively, to be moved along an arrow 138a. This movement in turn causes the

contraction rail 1121-1 and the contraction rail 1121-2 to be turned from the conveyance position 1122 to the bending position 1123 as described above about the rotating shaft of the pulley 1141-3 as a rotational center for the contraction rail 1121-1 and about the rotating shaft of the pulley 1141-8 as a rotational center for the contraction rail 1121-2.

Meanwhile, when the output shaft of the drive device 132 is moved along an arrow 136b, the lever 133 is turned along an arrow 137b and the levers 1121a are turned along an arrow 138b. Accordingly, the contraction rails 1121 are turned from the bending position 1123 to the conveyance position 1122.

As described above, with the provision of the rail contracting unit 131, the contraction rails 1121 provided at both end portions of the conveyor rail portions 112 become bendable so that the overall length of the conveyor rail portions 112 can be shortened. Accordingly, in the case where the holding and conveying device 111 is turned by the turning device 121 without bending the contraction rails 1121, the range of a locus drawn by an end portion of each of the conveyor rail portions 112 becomes a circle shown by reference numeral 139a in Fig. 25. On the other hand, when the contraction rails 1121 are bent and turned, the range of a locus drawn by an end portion of each of the conveyor rail portions 112 becomes a circle shown by reference numeral

139b narrower than the range 139a. Therefore, the circuit board 2 can be turned in a space smaller than in the conventional case, and moreover it is no longer necessary to move up and down the conveyor rail portions 112 for turning operations, as would be necessary in the conventional case. In addition, providing the rail contracting unit 131 is effective also as measures for avoidance of interference with adjacent conveyors or operative units.

Furthermore, with the pulleys 1141-4 and 1141-7 added and by changing the way of stretching the conveyor belts 113 between the pulleys as described above, it becomes implementable to shorten the overall length of the conveyor rail portions 112 without adding any tensioners for the conveyor belts 113.

Although an air cylinder is used as the drive device 132 in this embodiment as described above, it is also possible to use a motor. The rotation of the lever 133 may also be implemented by using a rotary actuator or a motor.

Further, although the contraction rails 1121 are provided at both ends of the conveyor rail portions 112 and both moved in the above description, it is also allowable that only either one of them is moved according to relations of the installation space or the like. It is also possible to provide a contraction rail 1121 only at one end of the conveyor rail portion 112.

Further, the contraction rails 1121 are formed so as to be bendable in the gravitational direction in the above-described embodiment. However, without being limited to this, it is also possible to adopt a structure that allows the overall length of the conveyor rail portions 112 to be reduced without changing the tensile force of the conveyor belts 113 as compared with the conventional case. As an example, a structure that the contraction rails 1121 are bent in the anti-gravitational direction or extended and contracted relative to the rail member 1127 in its extension direction.

Further, the turning operation of the holding and conveying device 111 by the turning device 121 and the bending operation of the contraction rails 1121 by the rail contracting unit 131 can be carried out either independently of each other or simultaneously.

Next, the first moving unit 1201 is explained below with reference to Fig. 23.

The first moving unit 1201 has a drive device 1202 of the first moving unit 1201, which is implemented by a rotary actuator in this embodiment, and a first moving mechanism 1203 which is driven by the drive device 1202 to move the rotating shaft 1237 along the thicknesswise direction 4Y.

The first moving mechanism 1203 has a pin 2032, a

lever 2031 mounted on the output shaft of the drive device 1202, a pin 2032 protrusively provided on the lever 2031 at one end of the lever 2031, a shaft 2033 which has one end rotatably engaged with the pin 2032 and the other end connected to a link ball 2034 and which is arrayed coaxial with the rotating shaft 1237, and a shaft 2035 which has one end connected to the link ball 2034 and the other end connected to the rotating shaft 1237 and which is arrayed coaxial with the rotating shaft 1237.

It is noted that the drive device 1202 is fixed to a fitting plate 2036 which is fixed to the base plate 3032 fitted to the slider 3031 on the frame 1120 and which extends in the thicknesswise direction 4Y. Therefore, as described later, when the conveying and turning device 1101 is moved in the orthogonal direction 5Y along the slider 3031 by the second moving unit 301, the first moving unit 1201 is also moved together.

Also, whereas the rotation of the rotating shaft 1237 in its circumferential direction causes the shaft 2035 to rotate in the same direction as described above, the provision of the link ball 2034 prohibits the shaft 2033 from being rotated similar in the circumferential direction together with the circumferential rotation of the shaft 2035.

Operation of the first moving unit 1201 constructed as described above is explained.

Upon rotation of the output shaft of the drive device 1202, the lever 2031 starts to rotate in the state shown in Fig. 23, where one end of the shaft 2033 is resultantly rotated on a fulcrum of the link ball 2034 via the pin 2032. This rotational motion is transformed into linear motion by the link ball 2034, pushing up the shaft 2035 and the rotating shaft 1237 along the thicknesswise direction 4Y. As a result, the holding and conveying device 111 connected to the rotating shaft 1237 as described above is moved from a first height position 204 indicated by solid line in Fig. 23 to a second height position 205 indicated by two-dot chain line along the thicknesswise direction 4Y. The first height position 204 corresponds to, for example, an installation level of the second board-conveying conveyor portion 22, and the second height position 205 corresponds to, for example, an installation level of the fourth board-conveying conveyor portion 24. In addition, rotating reverse the output shaft of the drive device 1202 allows the holding and conveying device 111 to be moved from the second height position 205 to the first height position 204 along the thicknesswise direction 4Y.

With the provision of the first moving unit 1201 as described above, it becomes implementable to move the holding and conveying device 111 along the thicknesswise direction 4Y.

Although a rotary actuator is used as the drive device 1202 in the above description, it is still allowable to use a motor. Further, although the thicknesswise direction 4Y corresponds to the vertical, up-and-down direction in this embodiment, the invention may also be carried out similar also with other horizontal or inclined directions.

Next, the second moving unit 301 is explained below with reference to Figs. 21 and 23.

The second moving unit 301, which is a unit for moving the above-described conveying and turning device 1101 and the first moving unit 1201 mounted on the conveying and turning device 1101 along the orthogonal direction 5Y, has a drive section 302 including two air cylinders 3021 and 3022, and a conveyance unit 303 in this embodiment.

The conveyance unit 303 has a pair of sliders 3031 laid on the frame 1120, a base plate 3032 fitted to the sliders 3031, and a slider 3033 laid on the frame 1120 along the orthogonal direction 5Y and serving for sliding an air cylinder 3022, where the base plate 3032 is fixed to the drive section 302. Further, the frame member 1110 of the turning device 121 is fitted to the base plate 3032.

The air cylinder 3021 serves to move the conveying and turning device 1101 and the first moving unit 1201 between the first board-conveying conveyor portion 21

(corresponding to the first mounting lane JA in the case where the board conveying device CC is the first connective conveyance unit CC1, and to the first mounting lane JB in the case where the board conveying device CC is the second connective conveyance unit CC2), and the second board-conveying conveyor portion 22 or the fourth board-conveying conveyor portion 24 (corresponding to the first bypass lane BPA in the case where the board conveying device CC is the first connective conveyance unit CC1, to the second bypass lane BPB in the case where the board conveying device CC is the second connective conveyance unit CC2, and to one conveyance lane directed toward the reflow device 904 in the case where the board conveying device CC is the third connective conveyance unit CC3). The air cylinder 3022 serves for movement between the second board-conveying conveyor portion 22 or the fourth board-conveying conveyor portion 24, and the third board-conveying conveyor portion 23 (corresponding to the second mounting lane Ja in the case where the board conveying device CC is the first connective conveyance unit CC1, to the second mounting lane Jb in the case where the board conveying device CC is the second connective conveyance unit CC2). The air cylinder 3022 is fitted to the slider 3033 so as to be movable by air cylinder 3021.

Operation of the second moving unit 301

constructed as described above is explained.

In the case where the conveying and turning device 1101 and the first moving unit 1201 are arranged in correspondence, for example, to the first board-conveying conveyor portion 21, the air cylinder 3022 is moved on the slider 3033 by driving the air cylinder 3021. Accordingly, the conveying and turning device 1101 and the first moving unit 1201 mounted on the drive section 302 are moved from the arrangement position of the first board-conveying conveyor portion 21 to the arrangement position of the second board-conveying conveyor portion 22 or the fourth board-conveying conveyor portion 24. Further, by driving the air cylinder 3022, the conveying and turning device 1101 and the first moving unit 1201 are moved from the arrangement position of the second board-conveying conveyor portion 22 or the fourth board-conveying conveyor portion 24 to the arrangement position of the third board-conveying conveyor portion 23.

Also, by operating the air cylinder 3021 and the air cylinder 3022 in a direction reverse to the foregoing, the conveying and turning device 1101 and the first moving unit 1201 can be moved from the arrangement position of the third board-conveying conveyor portion 23 to the arrangement position of the second board-conveying conveyor portion 22 or the fourth board-conveying conveyor portion

24, and further to the arrangement position of the first board-conveying conveyor portion 21.

Indeed using an air cylinder as the drive section 302 as in this embodiment allows the apparatus manufacturing cost to be reduced, but, of course, this mode is not limitative. A pulse motor or AC servomotor may be used as the drive section 302. It is also possible to adopt a ball screw structure as the drive section 302, in which case one ball screw will do.

Further, although the description has been made on an example in which the orthogonal direction 5Y is a horizontal direction in this embodiment, yet the invention may be carried out similarly also with other vertical or inclined directions.

The control section 309 performs operation control over individual drive sections in the conveying and turning device 1101, the first moving unit 1201 and the second moving unit 301 as described above, and moreover performs control over the conveyance operation of the circuit board 2 in the board conveying device CC as described below.

Operation of the board conveying device CC of this embodiment constructed as described above is explained below.

As shown in Fig. 22, the circuit board 2 that has been conveyed up along a preceding-step conveyance path 1212 is loaded into the conveyor rail portions 112 of the

conveying and turning device 1101 preliminarily arranged at the first conveyor position 11-1 (corresponding to a position located along the first mounting lane JA in the case where the board conveying device CC is the first connective conveyance unit CC1, and to a position located along the first mounting lane JB in the case where the board conveying device CC is the second connective conveyance unit CC2). It is noted that in the conveying and turning device 1101, the contraction rails 1121 are arranged at the conveyance positions 1122 during loading and unloading of the circuit board 2.

In compliance with a board demand signal derived from a succeeding-step unit, for example, from the uppermost-stream side component mounting apparatus AI among the upstream-side mounting apparatus group A in the case where the board conveying device CC is the first connective conveyance unit CC1, or from the uppermost-stream side component mounting apparatus BI among the upstream-side mounting apparatus group B in the case where the board conveying device CC is the second connective conveyance unit CC2, or from the reflow device 904 in the case where the board conveying device CC is the third connective conveyance unit CC3, the conveying and turning device 1101 is moved along the orthogonal direction 5Y by the second moving unit 301 as described above, and thereafter unloads the circuit

board 2 to a pertinent one of the first board-conveying conveyor portion 21, either the second board-conveying conveyor portion 22 or the fourth board-conveying conveyor portion 24, or the third board-conveying conveyor portion 23. In addition, in the case where the board conveying device CC is the third connective conveyance unit CC3, the circuit board 2 is unloaded to only one conveyance lane directed to the reflow device 904.

Then, for movement of the conveying and turning device 1101 along the orthogonal direction 5Y by the second moving unit 301, for example, for its movement from the first conveyor position 11-1 to the second conveyor position 11-2 (corresponding to a position located along a bypass lane arranged above or below the first bypass lane BPA in the case where the board conveying device CC is the first connective conveyance unit CC1, to a position located along a bypass lane arranged above or below the second bypass lane BPB in the case where the board conveying device CC is the second connective conveyance unit CC2, and to a position located along a bypass lane arranged above or below one conveyance lane directed toward the reflow device 904 in the case where the board conveying device CC is the third connective conveyance unit CC3) that allows the conveying and turning device 1101 to face the second board-conveying conveyor portion 22, the first moving unit 1201 is operated

so that the height level is changed simultaneously as the second moving unit 301 is operated. On the other hand, for movement, for example, from the first conveyor position 11-1 to the second conveyor position 11-2 (corresponding to a position located along the first bypass lane BPA in the case where the board conveying device CC is the first connective conveyance unit CC1, to a position located along the second bypass lane BPB in the case where the board conveying device CC is the second connective conveyance unit CC2, and to a position located along one conveyance lane directed toward the reflow device 904 in the case where the board conveying device CC is the third connective conveyance unit CC3) that allows the conveying and turning device 1101 to face the fourth board-conveying conveyor portion 24, it is enough to operate only the second moving unit 301 because of the same height level, and there is no need for changing the height level of the holding and conveying device 111 by operating the first moving unit 1201. Furthermore, for movement, for example, from the first conveyor position 11-1 to the third conveyor position 12-2 (corresponding to a position located along the second mounting lane Ja in the case where the board conveying device CC is the first connective conveyance unit CC1, and to a position located along the second mounting lane Jb in the case where the board conveying device CC is the second connective conveyance unit CC2), the

turning device 121 is operated, simultaneously as the second moving unit 301 is operated, so that the holding and conveying device 111 turned to make the reference end face of the circuit board 2 adjusted to the mounting apparatus 26. In addition, for execution of the turning of the holding and conveying device 111, the rail contracting unit 131 is operated before the start of the turning operation so that the contraction rails 1121 are placed in the bending position 1123.

In this way, while the conveying and turning device 1101 is being moved along the orthogonal direction 5Y by the second moving unit 301, the movement of the holding and conveying device 111 toward the thicknesswise direction 4Y and the turning toward the direction 124 around the axis around the axis are concurrently performed, by which the conveyance process time can be shortened as compared with the conventional case.

According to the board conveying device CC of this embodiment, as described above, by virtue of the provision of the conveying and turning device 1101, the first moving unit 1201 and the second moving unit 301, it becomes implementable to move the circuit board 2 along any one of the its thicknesswise direction 4Y, the orthogonal direction 5Y and the direction 124 around the axis. Also, even in the case where a plurality of lines of conveyance paths are

provided, by virtue of the provision of the conveying and turning device 1101, the first moving unit 1201 and the second moving unit 301, it becomes implementable to convey the circuit board 2 to their respective conveyance paths with a one-device constitution. Further, the attribute that the constitution can be implemented by one device allows the installation space of the board conveying device to be remarkably reduced as compared with the conventional case.

Further, the provision of the rail contracting unit 131 in the conveying and turning device 1101 makes it possible to reduce the space involved in the turning of the holding and conveying device 111. This contributes to space saving of the board conveying device as well as to the prevention of interference with other devices adjacent to the conveying and turning device 1101 as well.

Further, by operating the conveying and turning device 1101, the first moving unit 1201 and the second moving unit 301 either sequentially or sequentially and simultaneously, it also becomes implementable to convey the circuit board 2 to any arbitrary conveyance position out of, for example, upper-stage three lines and lower-stage one line, as well as to move the circuit board 2 for a direction change. Therefore, the conveyance process time can be shortened as compared with the conventional case. Furthermore, it is also possible to simultaneously perform

two or more operations out of the four operations of the board conveying operation and the turning operation in the conveying and turning device 1101, the moving operation in the first moving unit 1201 and the moving operation in the second moving unit 301. Therefore, the conveyance process time can be shortened as compared with the conventional case.

Furthermore, although the board conveying device CC in the above-described embodiment is equipped with the conveying and turning device 1101, the first moving unit 1201 and the second moving unit 301, it is also allowable to make up a board conveying device equipped with only the holding and conveying device 111 and the rail contracting unit 131. For example, a board conveying device equipped with only the holding and conveying device 111 and the rail contracting unit 131 can be adopted for the so-called loader and unloader which are provided in the component mounting apparatus to perform the loading and the unloading, respectively, of circuit boards to and from an X-Y table movable in X- and Y-directions perpendicular to each other. Thus, with the adoption of such a board conveying device equipped with the rail contracting unit 131 for the loader and the unloader, the rail length in the conveyor rail portions 112 can be reduced by operating the rail contracting unit 131 for the movement of the X-Y table in the X- and Y-directions, so that interference with the X-Y

table can be avoided, allowing the movable range of X-Y table to be ensured.

Further, in the board conveying device CC of the above-described embodiment, the first moving unit 1201 moves the holding and conveying device 111 alone in the thicknesswise direction 4Y. However, it is also possible to provide a constitution that the conveying and turning device 1101 with the turning device 121 included as well is moved in the thicknesswise direction 4Y as shown in Fig. 27.

As described in detail above, according to the board conveying device of the present invention, which includes the holding and conveying device and the rail contracting unit, the overall length of the conveyor rail portions is contracted by the rail contracting unit, so that the installation space of the board conveying device can be reduced as compared with the conventional case. Further, the prevention of interference with devices adjacent to the holding and conveying device can be fulfilled by the rail contracting unit.

Further, when the conveying and turning device having the turning device is provided and the holding and conveying device is turned by the turning device, the overall length of the conveyor rail portions is contracted by the rail contracting unit, so that the space involved in the turning of the holding and conveying device can be

reduced. Therefore, the installation space of the board conveying device can be reduced as compared with the conventional case.

Also, with the first moving unit further provided, the operation of contracting the overall length of the conveyor rail portions by the rail contracting unit and the operation of moving the circuit board in its thicknesswise direction can be performed simultaneously. Therefore, even in the case where a plurality of conveyance paths for conveying circuit boards are disposed at different positions along the circuit-board thicknesswise direction, the conveying and turning device can be disposed so as to correspond to each of the conveyance paths. Thus, while space saving is fulfilled, the circuit-board conveyance process time can be reduced as compared with the conventional case.

Furthermore, with the second moving unit provided, it becomes implementable to perform the turning operation of the circuit board and the moving operation in the thicknesswise direction while moving the circuit board in the orthogonal direction. Therefore, even in the case where a plurality of conveyance paths are arrayed on the same plane and moreover the conveyance paths are arranged at different positions along the circuit-board thicknesswise direction, the conveying and turning device can be disposed

so as to correspond to each of the conveyance paths. Thus, while space saving is fulfilled, the circuit-board conveyance process time can be reduced as compared with the conventional case.

Furthermore, since the conveying and turning device, the first moving unit and the second moving unit are provided in a one-unit device, the installation work for the board conveying device becomes simpler, as compared with the conventional case where those units are provided in a plurality of devices. Also, with the provision of the control unit for performing the operation control of the conveying and turning device, the first moving unit and the second moving unit, it becomes achievable to implement the distributive conveyance of circuit boards for a plurality of lines of conveyance paths with a minimum installation space and with a short process time.

Fig. 19 shows the structure of the control section of the electronic component-mounted board production line of the component mounting system of the second embodiment.

As shown in Fig. 19, the control unit 1000A of the mounting apparatus group A, the control unit 1000B of the mounting apparatus group B, the first connective conveyance unit CC1, the second connective conveyance unit CC2, the third connective conveyance unit CC3, the first

bypass lane BPA and the second bypass lane BPB are connected together.

Moreover, power supply to the individual component mounting apparatuses of the mounting apparatus group A, power supply to the individual component mounting apparatuses of the mounting apparatus group B, power supply to and the first connective conveyance unit CC1, power supply to and the second connective conveyance unit CC2 and power supply to the third connective conveyance unit CC3 are performed individually independently.

With the above constitution, board size information for the width adjustment in each connective conveyance unit CC can be outputted from the control unit 1000A of the mounting apparatus group A and the control unit 1000B of the mounting apparatus group B to the first connective conveyance unit CC1, the second connective conveyance unit CC2 and the third connective conveyance unit CC3. In each mounting apparatus group, the width adjustment in the loader L, the Y-table T, the unloader U and the bypass conveyance path BP can be automatically performed according to the information from the control unit.

Moreover, according to the aforementioned constitution, the first connective conveyance unit CC1 can drive the first and second bypass conveyance units BP1 and

BP2 by obtaining board detection information from the apparatuses located on the downstream side of the board conveyance direction, or, for example, the first, second and third bypass conveyance units BP1, BP2 and BP3 and the component mounting apparatuses AI and AII located on the uppermost-stream side and the downstream side of the mounting apparatus group A or outputting a drive signal and electric power to the first and second bypass conveyance units BP1 and BP2 for the driving of the first and second bypass conveyance units BP1 and BP2. As one example, in the second embodiment, the first connective conveyance unit CC1 obtains the board detection information indirectly via the first, second and third bypass conveyance units BP1, BP2 and BP3, not directly from the second connective conveyance unit CC2. However, the board detection information may be obtained directly from the second connective conveyance unit CC2.

Moreover, with the aforementioned constitution, the second connective conveyance unit CC2 can drive the third and fourth bypass conveyance units BP3 and BP4 by obtaining board detection information from the apparatuses located on the downstream side of the board conveyance direction, or, for example, the fourth, fifth and sixth bypass conveyance units BP4, BP5 and BP6 and the component mounting apparatuses BI and BII located on the uppermost-

stream side and the downstream side of the mounting apparatus group B and the apparatuses located on the upstream side of the board conveyance direction, or, for example, the third bypass conveyance unit BP3 and the component mounting apparatuses AII and AIII located on the uppermost-stream side and the downstream side of the mounting apparatus group A or outputting a drive signal and electric power to the third bypass conveyance unit BP3 and the fourth bypass conveyance unit BP4 for the driving of the third bypass conveyance unit BP3 and the fourth bypass conveyance unit BP4.

Moreover, with the aforementioned constitution, the third connective conveyance unit CC3 obtains board detection information from the fourth through sixth bypass conveyance units BP4 through BP6, the component mounting apparatus AIII located on the downmost-stream side of the mounting apparatus group A and the component mounting apparatuses BIIII and BII located on the downmost-stream side and the upstream side of the mounting apparatus group B.

Therefore, if, for example, the operations of all or part of the component mounting apparatuses of the mounting apparatus group A all or part of the component mounting apparatuses of the mounting apparatus group B are stopped, the bypass conveyance unit BP relevant to the

driven connective conveyance unit CC can be driven by driving the first connective conveyance unit CC1 or the second connective conveyance unit CC2 or the third connective conveyance unit CC3, and the board conveyance with respect to the bypass lane can be performed without regard to the stop of the driving of the component mounting apparatus.

The control unit 1000A of the mounting apparatus group A is connected to a control unit 1000AI of the component mounting apparatus AI, a control unit 1000AII of the mounting apparatus group AII and a control unit 1000AIII of the mounting apparatus group AIII. Moreover, the control unit 1000B of the mounting apparatus group B is connected to a control unit 1000BI of the component mounting apparatus BI, a control unit 1000BII of the mounting apparatus group BII and a control unit 1000BIII of the mounting apparatus group BIII.

The control unit of each component mounting apparatus has a relation of connection to the drive devices and sensors as shown in Fig. 5 and controls the component mounting operations described in connection with, for example, the first embodiment. It is to be noted that the loaders 1A and 11A correspond to the loader L (LA1, LA2, LA3, La1, La2, La3, LB1, LB2, LB3, Lb1, Lb2, Lb3), the placement conveyance units 1B and 11B correspond to the Y-

table T (TA1, TA2, TA3, Ta1, Ta2, Ta3, TB1, TB2, TB3, Tb1, Tb2, Tb3), and the first unloader 1C or the second unloader 2C corresponds to the unloader U (UA1, UA2, UA3, Ua1, Ua2, Ua3, UB1, UB2, UB3, Ub1, Ub2, Ub3).

The first connective conveyance unit CC1 is provided with a board detection sensor DC1 for detecting the presence or absence of the board 2 and a motor MC1 for synchronously rotatively driving a pair of conveyance belts for board conveyance in the first connective conveyance unit CC1. The board is being conveyed when the board 2 is detected by the board detection sensor DC1, and the board can be conveyed when the board 2 is not detected.

The second connective conveyance unit CC2 is provided with a board detection sensor DC2 for detecting the presence or absence of the board 2 and a motor MC2 for synchronously rotatively driving a pair of conveyance belts for board conveyance in the second connective conveyance unit CC2. The board is being conveyed when the board 2 is detected by the board detection sensor DC2, and the board can be conveyed when the board 2 is not detected.

The third connective conveyance unit CC3 is provided with a board detection sensor DC3 for detecting the presence or absence of the board 2 and a motor MC3 for synchronously rotatively driving a pair of conveyance belts for board conveyance in the third connective conveyance

unit CC3. The board is being conveyed when the board 2 is detected by the board detection sensor DC3, and the board can be conveyed when the board 2 is not detected.

The first through third bypass conveyance units BP1, BP2 and BP3 that constitute the first bypass lane BPA are provided with board detection sensors DPA1, DPA2 and DPA3 for detecting the presence or absence of the board 2 and motors MPA1, MPA2 and MPA3 for synchronously rotatively driving a pair of conveyance belts for board conveyance in the first bypass lane BPA. The bypass conveyance unit BP is in a board standby state when the board 2 is detected by the board detection sensors DPA1, DPA2 and DPA3, and the bypass conveyance unit BP is in a board awaiting state when the board 2 is not detected. The bypass conveyance unit BP that has the board detection sensor DPA by which the board 2 is not detected outputs a "board demand signal" to the bypass conveyance unit BP located on the upstream side of the bypass conveyance unit BP or to the connective conveyance unit CC. When the third bypass conveyance unit BP3 is in the board standby state, a "board unloading awaiting signal" is outputted to the second connective conveyance unit CC2 located on the downstream side.

The fourth through sixth bypass conveyance units BP4, BP5 and BP6 that constitute the second bypass lane BPB are provided with board detection sensors DPB1, DPB2 and

DPB3 for detecting the presence or absence of the board 2 and motors MPB1, MPB2 and MPB3 for synchronously rotatively driving a pair of conveyance belts for board conveyance in the second bypass lane BPB. The bypass conveyance unit BP is in the board standby state when the board 2 is detected by the board detection sensors DPB1, DPB2 and DPB3, and the bypass conveyance unit BP is in the board awaiting state when the board 2 is not detected. The bypass conveyance unit BP that has the board detection sensor DPB by which the board 2 is not detected outputs the "board demand signal" to the bypass conveyance unit BP located on the upstream side of the bypass conveyance unit BP or to the connective conveyance unit CC. When the sixth bypass conveyance unit BP6 is in the board standby state, the "board unloading awaiting signal" is outputted to the third connective conveyance unit CC3 located on the downstream side.

Moreover, the peculiar portion of the component mounting system of the second embodiment in the control unit 1000 of each component mounting apparatus is partially shown in Fig. 20. The other constitution is shown in Fig. 5. As shown in Fig. 20, the control unit 1000 of each component mounting apparatus is connected to the loader L, the Y-table T, the unloader U and the memory MEM, and the driving of the loader L, the Y-table T and the unloader U

can be controlled by the control unit 1000 on the basis of the program and data stored in the memory MEM.

The loader L is provided with a board detection sensor DL for detecting the presence or absence of the board 2 and a motor ML for synchronously rotatively driving a pair of conveyance belts for the board conveyance of the loader L. The loader L is in the board standby state when the board 2 is detected by the board detection sensor DL, and the loader L is in the board awaiting state when the board 2 is not detected. The control unit 1000AI or 1000AII or 1000AIII or 1000BI or 1000BII or 1000BIII of the component mounting apparatus that has the loader L in the board awaiting state outputs the "board demand signal" to the unit or device located on the upstream side of the loader L, or for example, the connective conveyance unit CC or the unloader U. When the unloader U receives the "board demand signal" and the unloader U is making the board 2 stand by, the board 2 in the standby state is unloaded toward the loader L. When the connective conveyance unit CC receives the "board demand signal", a board distributing operation described later is performed.

The Y-table T is provided with a board detection sensor DT for detecting the presence or absence of the board 2 and a motor MT for synchronously rotatively driving a pair of conveyance belts for the board conveyance of the

Y-table T. When the board 2 is detected by the board detection sensor DT, the Y-table T is in a component mounting state or immediately before or after component mounting. At this time, when the board standby state is provided in the unloader U located on the downstream side of this Y-table T, the already mounted board on the Y-table T cannot be unloaded toward the unloader U located on the downstream side. The unmounted board 2c cannot be fed onto the Y-table T, and the mounting operation is stopped. Consequently, the "board unloading awaiting production stop signal" is outputted to the loader L located on the downstream side of the unloader U or to the connective conveyance unit CC. When the board 2 is not detected, the Y-table T is in the board awaiting state, and the "board demand signal" is outputted to the loader L located on the upstream side of the Y-table T by the control unit 1000AI or 1000AII or 1000AIII or 1000BI or 1000BII or 1000BIII of the component mounting apparatus that has the Y-table T in the board awaiting state. When the loader L receives the "board demand signal" and the loader L is making the board 2 stand by, the board 2 in the standby state is unloaded toward the Y-table T. When the loader L is in the board awaiting state too, a "Y-table and loader with no board signal" is outputted to the connective conveyance unit CC located on the upstream side of the loader L.

The unloader U is provided with a board detection sensor DU for detecting the presence or absence of the board 2 and a motor MU for synchronously rotatively driving a pair of conveyance belts for the board conveyance of the unloader U. When the board 2 is detected by the board detection sensor DU, the unloader U is in the board awaiting state, and a "board unloading awaiting signal" is outputted to the connective conveyance unit CC located on the downstream side. When the board 2 is not detected, the unloader U is in the board awaiting state, and a board unloading enable signal is outputted to the Y-table T located on the upstream side of the unloader U by the control unit 1000AI or 1000AII or 1000AIII or 1000BI or 1000BII or 1000BIII of the component mounting apparatus that has the unloader U in the board awaiting state. Only when the Y-table T receives the board unloading enable signal and the component mounting operation is completed, the mounted board 2d is unloaded from the Y-table T toward the unloader U.

Information of various data and programs necessary for the board distributing operation, the component mounting operation and so on can be stored in the memory MEM. For example, when the "board demand signal", the "Y-table and loader with no board signal", the "board unloading awaiting signal" and a "board unloading awaiting

production stop signal" are simultaneously outputted from two or more lanes in each connective conveyance unit, it is acceptable to store the signals and the information of the order of priority of unloading of the lanes in such a case, the signals and information being predetermined by the operator or the mounting program.

The component mounting system of the second embodiment of the aforementioned constitution operates as follows.

First of all, after describing the outline of the first through third connective conveyance units CC1 through CC3, the board conveyance operation of the component mounting system will be described in detail.

The first connective conveyance unit CC1 can perform the board distributing operation in consideration of a balance between the mounting apparatus group A and the mounting apparatus group B by awaiting the "board demand signal" outputted from the first mounting lane JA, the second mounting lane Ja and the first bypass lane BPA when there is no board and conveying a board to the lane on the basis of the "board demand signal" issued from the lane. For example, in the case where same component-mounted boards are produced in the mounting apparatus group A and the mounting apparatus group B and the component-mounted board production efficiency of the mounting apparatus group

B is higher than the component-mounted board production efficiency of the mounting apparatus group A, by conveying the board to be mounted (i.e., the board before component mounting) to the mounting apparatus group B by priority with respect to the mounting apparatus group A by means of the first bypass lane BPA, a board distributing operation in consideration of the balance between the mounting apparatus group A and the mounting apparatus group B can be performed from the viewpoint of production efficiency. Moreover, in the case where different component-mounted boards are produced in the mounting apparatus group A and the mounting apparatus group B and a component-mounted board production time in the mounting apparatus group B is shorter than the component-mounted board production time in the mounting apparatus group A, by conveying the board to be mounted to the mounting apparatus group B by priority with respect to the mounting apparatus group A by means of the first bypass lane BPA, a board distributing operation in consideration of the balance between the mounting apparatus group A and the mounting apparatus group B can be performed from the viewpoint of production efficiency.

The second connective conveyance unit CC2 can perform the board distributing operation in consideration of "board unloading awaiting" and "board conveyance request" by awaiting the "board demand signal" outputted

from the first mounting lane JB, the second mounting lane Jb and the second bypass lane BPB when there is no board and conveying a board to the lane on the basis of the "board demand signal" issued from the lane.

The unmounted board 2c is conveyed to any one of the first or second mounting lane JA or Ja or the first bypass lane BPA of the first mounting apparatus group A by the first connective conveyance unit CC1. The unmounted board 2c conveyed to any one of the first or second mounting lane JA or Ja of the first mounting apparatus group A is subjected to the component mounting operation in the front-side mounting units A1, A2 and A3 or the rear-side mounting units a1, a2 and a3 of the component mounting apparatuses AI, AII and AIII of the mounting apparatus group A. The unmounted board 2c conveyed to the first bypass lane BPA is conveyed as it is to the second connective conveyance unit CC2 without undergoing any component mounting operation. It is also possible to make the board stand by in the standby positions of the bypass conveyance units BP1, BP2 and BP3 of the bypass lane BPA of the component mounting apparatuses AI, AII and AIII of the mounting apparatus group A, which constitutes the first bypass lane BPA as the occasion demands. The unmounted board 2c from the first bypass lane BPA is conveyed to the first or second mounting lane JB or Jb of the mounting

apparatus group B by the second connective conveyance unit CC2. The mounted board 2d from the first or second mounting lane JA or Ja of the mounting apparatus group A is conveyed to the second bypass lane BPB by the second connective conveyance unit CC2.

The third connective conveyance unit CC3 can perform an integrating operation of the mounted board 2d with the first lane. More specifically, the board conveyance can be performed so that the mounted boards 2d unloaded from the three conveyance lanes of the first and second mounting lanes JB and Jb and the second bypass lane BPB of the front-side and rear-side mounting units B3 and b3 of the third component mounting apparatus BIII of the mounting apparatus group B are integrated into one conveyance lane toward, for example, the reflow device 904. It is to be noted that the board unloaded from the second mounting lane Jb of the rear-side mounting unit b3 is turned at an angle of 180° when conveyed into the second mounting lane Jb. Therefore, the board is required to be set back to the original reference phase by being turned at an angle of 180° on the third connective conveyance unit CC3 after being unloaded. However, when not turned at an angle of 180° in being loaded into the second mounting lane Jb, there is no need for taking the above action.

The following will describe an example in which

same component-mounted boards 2 are produced in each of the first mounting lane JA of the mounting apparatus group A, the second mounting lane Ja of the mounting apparatus group A, the first mounting lane JB of the mounting apparatus groups B and the second mounting lane Jb of the mounting apparatus groups B of the electronic component-mounted board production line.

The connective conveyance unit CC with a board turn function as shown in Fig. 21 and Fig. 22 is arranged between the mounting apparatus groups, and the connective conveyance unit CC performs the board distributing operation for unloading in a distributing manner the boards received from the board received from any one of the three lanes or received from the bypass lane into either of the lanes or the integrating operation for unloading in an integrating manner the board received from any one of the three lanes toward one downstream lane.

In order to provide a line balance of electronic component-mounted board production line, the boards 2b loaded into the second mounting lanes Ja and Jb are turned at an angle of 180°, thereafter subjected to board loading, turned at an angle of 180° and thereafter subjected to board unloading. By so doing, quite the same component mounting operation can be performed by quite the same production program as those of the first mounting lanes JA

and JB even by the second mounting lanes Ja and Jb, and the management of the production process time can be easily managed in unity.

The fundamental component mounting operation of this electronic component-mounted board production line is as follows.

As indicated by the conveyance routes (1) and (2) in Fig. 15, the unmounted board 2c on which solder is printed by the printer 900 is unloaded to the first mounting lane JA or the second mounting lane Ja of the mounting apparatus group A via the first connective conveyance unit CC1, and the component mounting operation is performed by the front-side mounting units A1, A2 and A3 or the rear-side mounting units a1, a2 and a3 as shown in Fig. 10 and Fig. 14. As indicated by the conveyance routes (4) and (5) in Fig. 16, the mounted board 2d of which the mounting has been completed in the front-side mounting units A1, A2 and A3 or the rear-side mounting unit a1, a2 and a3 of the mounting apparatus group A is unloaded toward the second connective conveyance unit CC2 located on the downstream side of the mounting apparatus group A. In the second connective conveyance unit CC2, the mounted board 2d is unloaded toward the rear-side mounting unit of the mounting apparatus group B, or, for example, the reflow device 904 via the second bypass lane BPB while being

distributed into the second bypass lane BPB of the mounting apparatus group B, as indicated by a conveyance route (10) in Fig. 17. In Fig. 10, Figs. 14 through 16 and Fig. 18, the board obtained after the unloading of the unmounted board 2c toward the first mounting lane JA or the second mounting lane Ja is denoted by 2a or 2b.

On the other hand, as indicated by a conveyance route (3) in Fig. 15, the unmounted board 2c on which solder is printed by the printer 900 is distributed into the first bypass lane BPA of the mounting apparatus group A via the first connective conveyance unit CC1 and conveyed to the second connective conveyance unit CC2 by way of the first bypass lane BPA. In the second connective conveyance unit CC2, the unmounted board 2c is unloaded toward the first mounting lane JB or the second mounting lane Jb of the mounting apparatus group B, and the component mounting operation is performed by the front-side mounting units B1, B2 and B3 or the rear-side mounting units b1, b2 and b3 as shown in Fig. 10. As indicated by the conveyance routes (6) and (7) in Fig. 16, the mounted board 2d of which the mounting has been completed in the front-side mounting units B1, B2 and B3 or the rear-side mounting unit b1, b2 and b3 of the mounting apparatus group B is unloaded toward the third connective conveyance unit CC3 located on the downstream side of the mounting apparatus group B. In the

third connective conveyance unit CC3, the mounted board 2d is unloaded toward the rear-side mounting unit of the mounting apparatus group B, or, for example, the reflow device 904, as indicated by conveyance routes (8) and (9) in Fig. 17. In Fig. 10 and Figs. 15 through 18, the board obtained after the unloading of the unmounted board 2c toward the first mounting lane JB or the second mounting lane Jb is denoted by 2a or 2b.

In the third connective conveyance unit CC3, the board 2b unloaded from the first mounting lane JB and the second mounting lane Jb of the mounting apparatus group B and the second bypass lane BPB is loaded into the rear-side mounting unit, or, for example, the reflow device 904.

The board 2b unloaded from the second mounting lane Jb of the mounting apparatus group B in the third connective conveyance unit CC3 is turned at an angle of 180° on the third connective conveyance unit CC3 and thereafter loaded into the rear-side mounting unit, or, for example, the reflow device 904.

For example, in order to continue the production in the mounting apparatus group B while a procedural change for board model change, the replenishment of the components in short supply and so on are performed, the first and second bypass conveyance units BP1 and BP2 of the first bypass lane BPA perform operation control in the first

connective conveyance unit CC1, and the third bypass conveyance unit BP3 performs operation control in the second connective conveyance unit CC2. Moreover, power supply is performed from the first connective conveyance unit CC1 and the second connective conveyance unit CC2, by which the first through third bypass lanes BPA, BP2 and BP3 of the first bypass lane BPA can be operated even when the electronic component mounting apparatuses AI, AII and AIII of the mounting apparatus group A are all off.

By ending the board conveyance operation by the connective conveyance unit CC within the line process time of the electronic component-mounted board production line (i.e., the process time of the operation that needs the longest time out of the operations of the component mounting apparatuses, the printer 900 and the reflow device 904, as exemplified here by the process time of unloading the mounted board 2d from the reflow device 904 through the reflow process), the production efficiency can be prevented from being reduced through the board conveyance operation.

The board distribution and integrating operations in the connective conveyance unit CC will be described in detail below.

The fundamental rule of the board distribution function of the first connective conveyance unit CC1 will be described first.

As a prerequisite, if there is no board 2 held or standing by in the conveyance lane (the loader LA1 of the first mounting lane JA, the loader La1 of the second mounting lane Ja and the first bypass conveyance unit BP1 of the first bypass lane BPA) located adjacent to the first connective conveyance unit CC1 of the component mounting apparatus AI located on the uppermost-stream side of the mounting apparatus group A (when no board is detected by the board detection sensor), then the "board demand signal" is inputted from the lane with no board to the control section of the first connective conveyance unit CC1.

When the "board demand signal" comes from the conveyance lane (the loader LA1 of the first mounting lane JA, the loader La1 of the second mounting lane Ja and the first bypass conveyance unit BP1 of the first bypass lane BPA) (when the "board demand signal" is turned on), the first connective conveyance unit CC1 sends the board 2 to the lane that has outputted the "board demand signal". Therefore, on the basis of the "board demand signal", any one of the conveyance routes (1), (2) and (3) is selected, and the board 2 is conveyed along the selected conveyance route. If the "board demand signal" comes from two or more lanes at the same time (i.e., when two or more "board demand signals" are turned on at the same time), the boards 2 are successively conveyed to the lanes according to the

order of priority predetermined by the operator or the mounting program. When the "board demand signals" come from the three lanes of, for example, the first mounting lane JA, the second mounting lane Ja and the first bypass lane BPA in this order according to the order of priority, the boards 2 are sent to the lanes in this order. This order of priority should preferably be able to be changed and added by the program in the first connective conveyance unit CC1. It is to be noted that the "board demand signal" outputted from the first bypass lane BPA is outputted when there are boards less than the number (three in the second embodiment) of boards that can be stocked in the first bypass lane BPA, i.e., the first through third bypass conveyance units BP1 through BP3.

The presence or absence of the "board demand signal" in the first connective conveyance unit CC1 is checked in accordance with the timing when the first connective conveyance unit CC1 is not performing the board conveyance (in other words, the timing when the board detection sensor DC1 is detecting no board). That is, the first connective conveyance unit CC1 does not perform the checking at all during the board conveyance operation, and the first connective conveyance unit CC1 checks the "board demand signal" in accordance with the timing when the board conveyance operation in the first connective conveyance

unit CC1 ends. When the board conveyance operation is not performed, the first connective conveyance unit CC1 consistently checks the "board demand signal". However, when two or more "board demand signals" come at the point of time when the "board demand signal" is checked, the boards are successively conveyed to all the lanes that are outputting the "board demand signal", and thereafter, the "board demand signal" is checked again. It is to be noted that this operation is performed when the "board unloading awaiting production stop signal" and the "Y-table and loader with no board signal" described later are not outputted.

As a result of making the first connective conveyance unit CC1 perform the board distributing operation as described above, the boards 2 can be distributed to the first mounting lane JA and the second mounting lanes Ja of the mounting apparatus group A in a well-balanced manner. In the case where the aforementioned distributing operation is not performed, for example, if the board is conveyed only to the lane from which the "board demand signal" has come in advance, then the boards 2 are to be one-sidedly unloaded toward either one of the first mounting lane JA and the second mounting lane Ja, consequently loosing line balance.

It is also acceptable to input the board

unloading stop signal toward the lane to the control section of the first connective conveyance unit CC1 while the procedural change for board model change, the replenishment of the components in short supply and so on are performed in either the first mounting lane JA or the second mounting lane Ja so as to prevent the board from being unloaded from the first connective conveyance unit CC1 toward the lane where the procedural change is being performed and perform no check of the output of the "board demand signal" from the lane where the procedural change is being performed.

The fundamental rule of the board distribution function of the second connective conveyance unit CC2 will be described next.

As a prerequisite, if there is no board 2 held or standing by in the conveyance lane (the loader LB1 of the first mounting lane JB, the loader Lb1 of the second mounting lane Jb and the fourth through sixth bypass conveyance units BP4 through BP6 of the second bypass lane BPA) located adjacent to the second connective conveyance unit CC2 of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B (when no board is detected by the board detection sensor), then the "board demand signal" is inputted from the lane with no board to the control section of the second

connective conveyance unit CC2.

When the "board demand signal" comes from the conveyance lane (the loader LB1 of the first mounting lane JB, the loader Lb1 of the second mounting lane Jb and the fourth through sixth bypass conveyance units BP4 through BP6 of the second bypass lane BPA) (when the "board demand signal" is turned on), the second connective conveyance unit CC2 sends the board 2 to the lane that has outputted the "board demand signal". Therefore, on the basis of the "board demand signal", any one of the conveyance routes (4), (4) (6) and (7) is selected, and the board 2 is conveyed along the selected conveyance route. If the "board demand signal" comes from two or more lanes at the same time (i.e., when two or more "board demand signals" are turned on at the same time), the boards 2 are successively conveyed to the lanes according to the order of priority predetermined by the operator or the mounting program. When the "board demand signals" come from the three lanes of, for example, the first mounting lane JB, the second mounting lane Jb and the second bypass lane BPB in this order according to the order of priority, the boards 2 are sent to the lanes in this order. This order of priority should preferably be able to be changed and added by the program in the second connective conveyance unit CC2. It is to be noted that the "board demand signal" outputted from the second bypass lane

BPB is outputted when there are boards less than the number (three in the second embodiment) of boards that can be stocked in the second bypass lane BPB, i.e., the fourth through sixth bypass conveyance units BP4 through BP6.

The presence or absence of the "board demand signal" in the second connective conveyance unit CC2 is checked in accordance with the timing when the second connective conveyance unit CC2 is not performing the board conveyance (in other words, the timing when the board detection sensor DC2 is detecting no board). That is, the second connective conveyance unit CC2 does not perform the checking at all during the board conveyance operation, and the second connective conveyance unit CC2 checks the "board demand signal" in accordance with the timing when the board conveyance operation in the second connective conveyance unit CC2 ends. When the board conveyance operation is not performed, the second connective conveyance unit CC2 consistently checks the "board demand signal". However, when two or more "board demand signals" come at the point of time when the "board demand signal" is checked, the boards are successively conveyed to all the lanes that are outputting the "board demand signal", and thereafter, the "board demand signal" is checked again. It is to be noted that this operation is performed when the "board unloading awaiting production stop signal" and the "Y-table and

loader with no board signal" described later are not outputted.

As a result of making the second connective conveyance unit CC2 perform the board distributing operation as described above, the boards 2 can be distributed to the first mounting lane JB and the second mounting lanes Jb of the mounting apparatus group B in a well-balanced manner. In the case where the aforementioned distributing operation is not performed, for example, if the board is conveyed only to the lane from which the "board demand signal" has come in advance, then the boards 2 are to be one-sidedly unloaded toward either one of the first mounting lane JB and the second mounting lane Jb, consequently loosing line balance.

It is also acceptable to input the board unloading stop signal toward the lane to the control section of the second connective conveyance unit CC2 while the procedural change for board model change, the replenishment of the components in short supply and so on are performed in either the first mounting lane JB or the second mounting lane Jb so as to prevent the board from being unloaded from the second connective conveyance unit CC2 toward the lane where the procedural change is being performed and perform no check of the output of the "board demand signal" from the lane where the procedural change is

being performed.

The fundamental rule of the board distribution function of the third connective conveyance unit CC3 will be described next.

As a prerequisite, if the "board unloading awaiting signal" comes from the conveyance lanes of the unloader UB3 of the first mounting lane JB of the component mounting apparatus BIII that is adjacent to the third connective conveyance unit CC3 and located on the downmost-stream side of the mounting apparatus group B, the loader Ub3 of the second mounting lane Jb of the component mounting apparatus BIII and the sixth bypass conveyance path BP6 of the second bypass lane BPB, the mounted board 2d of the conveyance lane that has outputted the "board unloading awaiting signal" is sent. Therefore, according to the "board unloading awaiting signal", selection between the conveyance routes (8), (9) and (10) is performed, and the mounted board 2d is conveyed to the reflow device 904.

The "board unloading awaiting signal" of the first mounting lane JB and the second mounting lane Jb is outputted when a board exists in the "board standby position" of the unloaders UB3 and Ub3 of the first mounting lane JB and the second mounting lane Jb.

The "board unloading awaiting signal" of the second bypass lane BPB is outputted when the board 2 exists

in the board unloading position of the sixth bypass conveyance unit BP6 of the first bypass lane BPB.

When a plurality of "board unloading awaiting signals" are outputted, the board conveyance is performed according to the determined order of priority. The board outputted from the second mounting lane Ja is turned at an angle of 180° in the third connective conveyance unit CC3 and thereafter loaded into the reflow device 904.

The board distributing operation in consideration of the line balance of the mounting apparatus group A and the mounting apparatus group B will be described next in addition to the fundamental rule of the board distribution function of the connective conveyance units CC.

First of all, in the first connective conveyance unit CC1 located on the uppermost-stream side of the mounting apparatus group A, unless board distribution is performed by grasping the states of production of the first mounting lane JA and the second mounting lane Ja of the mounting apparatus group A and the first mounting lane JA and the second mounting lane Ja of the mounting apparatus group B, the line balance of the electronic component-mounted board production line is worsened and the productivity cannot be improved. Therefore, it is required to perform the distributing operation according to several rules of operation practice.

The rule of operation practice of the first connective conveyance unit CC1 is as follows.

When the "board demand signal" comes from the loader LA1 of the first mounting lane JA and the loader La1 of the second mounting lane Ja of the mounting apparatus AI located on the uppermost-stream side of the mounting apparatus group A and the first bypass conveyance unit BP1 of the first bypass lane BPA, the first connective conveyance unit CC1 sends the board.

When two or more "board demand signals" come at the same time, the boards are conveyed according to the determined order of priority.

The "board demand signal" is checked while the first connective conveyance unit CC1 is not performing the board conveyance.

Further, when no board exists in both the loader LA1 of the first mounting lane JA of the component mounting apparatus AI located on the uppermost-stream side of the mounting apparatus group A and the Y-table TA1 located on the downstream side of the loader or when no board exists in both the loader La1 of the second mounting lane Ja of the component mounting apparatus AI located on the uppermost-stream side of the mounting apparatus group A and the Y-table Ta1 located on the downstream side of the loader, the "Y-table and loader with no board signal" is outputted from

the control unit 1000AI of the component mounting apparatus AI to the first connective conveyance unit CC1 located on the upstream side of the loaders LA1 and La1.

When the "Y-table and loader with no board signal" comes to the first connection unloading section CC1, meaning a state in which the production is stopped for the reason that the component mounting apparatus AI is awaiting the loading of a board, the board is sent to the lane that is outputting the "Y-table and loader with no board signal" prior to the "board demand signal" which means that no board exists only in the loaders LA1 and La1.

The "Y-table and loader with no board signal" is also outputted from the first bypass lane BPA. That is, when no board exists in both the loader LB1 of the first mounting lane JB of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B located on the downstream side of the first bypass lane BPA and the Y-table TB1 located on the downstream side of the loader or when no board exists in both the loader Lb1 of the second mounting lane Jb of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B and the Y-table Tb1 located on the downstream side of the loader, the "Y-table and loader with no board signal" is outputted from the control unit 1000BI of the component mounting apparatus

BI to the second connective conveyance unit CC2 located on the upstream side of the loaders LB1 and Lb1. The second connective conveyance unit CC2 that has received the signal outputs the signal to the first bypass lane BPA of the mounting apparatus group A. The first bypass lane BPA of the mounting apparatus group A outputs the "Y-table and loader with no board signal" to the first connective conveyance unit CC1.

When the "Y-table and loader with no board signal" comes from the first bypass lane BPA to the first connection unloading section CC1, meaning a state in which the production is stopped for the reason that the component mounting apparatus BI is awaiting the loading of a board, the board is sent to the first bypass lane BPA that is outputting the "Y-table and loader with no board signal" prior to the "board demand signal" which means that no board exists only in the loaders LA1 and La1.

Fig. 11 shows a flowchart of the concrete distributing operation of the first connective conveyance unit CC1.

It is determined in step S1 whether or not a conveyance operation command is on. That is, it is first determined that the conveyance operation can be performed. Only when the conveyance operation can be performed, the program flow proceeds to step S2 to execute the following

board conveyance operation. When the conveyance operation command is not on, meaning an end, the board loading operation by the first connective conveyance unit CC1 is stopped at the end. The conveyance operation command is not on when the driving of the component mounting apparatus is stopped for some reasons of, for example, component feed to the component feeding unit and maintenance. In such a case, the above-mentioned determination is made in order to prevent the board from being loaded.

Next, it is determined in step S2 whether or not there is a conveyance route of which the "Y-table and loader with no board signal" is on. More specifically, it is determined whether or not the "Y-table and loader with no board signal" has come from any one of the first mounting lane JA and the second mounting lane Ja of the mounting apparatus group A and the first bypass lane BPA.

When there is a conveyance route of which the "Y-table and loader with no board signal" is on in step S2, the boards are conveyed in step S3 to all the conveyance routes that conform to the conditions of step 2. Subsequently, the program flow returns to step S1. That is, when there is a conveyance route of which the "Y-table and loader with no board signal" is on, the boards are conveyed to all the conveyance routes that conform to the conditions according to the order of priority, and the processes of

step S1 and step S2 are executed again after the end of conveyance.

When there is no conveyance route of which the "Y-table and loader with no board signal" is on in step S2, it is determined in step S4 whether or not there is a conveyance route of which the "board demand signal" is on. That is, when the "Y-table and loader with no board signal" is not outputted, search of the conveyance route of which the "board demand signal" is on is executed. More specifically, it is determined whether or not the "board demand signal" has come from any one of the first mounting lane JA and the second mounting lane Ja of mounting apparatus group A and the first bypass lane BPA. When there is no conveyance route of which the "board demand signal" is on, the program flow returns to step S1.

When there is a conveyance route of which the "board demand signal" is on in step S4, the conveyance route that conforms to the conditions of step 4 is registered in step S5 as conveyance route information in the memory MEM.

Next, the board is conveyed to the conveyance route of the highest order of priority in step S6, and the conveyance route information of the route to which the board has been conveyed is deleted from inside the memory MEM.

Next, it is determined in step S7 whether or not the conveyance route information registered in step 5 is remaining in the memory MEM. When the conveyance route information registered in step 5 is not remaining in the memory MEM, the program flow returns to step S1.

When it is determined in step S7 that the conveyance route information registered in step 5 is remaining in the memory MEM, it is determined in step S8 whether or not there is a conveyance route of which the "Y-table and loader with no board signal" is on.

When there is a conveyance route of which the "Y-table and loader with no board signal" is on in step S8, the boards are conveyed in step S9 to all the conveyance routes of which the "Y-table and loader with no board signal" is on, and the conveyance route information of the board conveyance routes to which the boards have been conveyed is deleted from inside the memory MEM. Subsequently, the program flow returns to step S7.

When there is no conveyance route of which the "Y-table and loader with no board signal" is on in step S8, the program flow returns to step S6.

Next, the second connective conveyance unit CC2 located on the downstream side of the mounting apparatus group A is required to unload the mounted boards 2d produced in the first and second mounting lanes JA and Ja

of the mounting apparatus group A toward the second bypass lane BPB of the mounting apparatus group B and distribute the unmounted boards 2c that have passed through the first bypass lane BPA of the mounting apparatus group A into the first and second mounting lanes JB and Jb of the mounting apparatus group B. When the unloading of the first mounting lane JA and the second mounting lane Ja of the mounting apparatus group A is not performed for a long time, the mounted boards 2d cannot be unloaded, and the production of the mounting apparatus group A stops. If the unmounted board 2c is not loaded into the mounting apparatus group B for a long time, the production of the mounting apparatus group B stops while awaiting the board. Therefore, the second connective conveyance unit CC2 is required to perform the board unloading from the mounting apparatus group A and the board loading into the mounting apparatus group B in consideration of the situation in which the mounting apparatus groups A is awaiting the mounted board 2d and the situation in which the unmounted board 2c is loaded into the mounting apparatus group B.

The rule of operation practice of the second connective conveyance unit CC2 is as follows.

The second connective conveyance unit CC2 performs selection between the conveyance routes (4), (5), (6) and (7) in consideration of the "board demand signal"

and the "board unloading awaiting signal" from the conveyance lane and performs board conveyance.

The conveyance route can be changed and added by the program.

When there is no board in the loader LB1 of the first mounting lane JB of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B or when there is no board in the loader Lb1 of the second mounting lane Jb of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B, the "board demand signal" is outputted from the control unit 1000BI of the component mounting apparatus BI to the second connective conveyance unit CC2 located on the upstream side of the loaders LB1 and Lb1.

Further, when no board exists in both the loader LB1 of the first mounting lane JB of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B and the Y-table TB1 located on the downstream side of the loader or when no board exists in both the loader Lb1 of the second mounting lane Jb of the component mounting apparatus BI located on the uppermost-stream side of the mounting apparatus group B and the Y-table Tb1 located on the downstream side of the loader, the "Y-table and loader with no board signal" is outputted from

the control unit 1000BI of the component mounting apparatus BI to the second connective conveyance unit CC2 located on the upstream side of the loaders LB1 and Lb1.

When the boards exist in both the unloader LA3 of the first mounting lane JA of the component mounting apparatus AIII located on the downmost-stream side of the mounting apparatus group A and the Y-table TA3 located on the upstream side of the unloader or when the boards exist in both the unloader La3 of the second mounting lane Ja of the component mounting apparatus AIII located on the downmost-stream side of the mounting apparatus group A and the Y-table Ta3 located on the upstream side of the unloader, the "board unloading awaiting production stop signal" is outputted from the control unit 1000AIII of the component mounting apparatus AIII to the second connective conveyance unit CC2 located on the downstream side of the unloaders LA3 and La3. This means a state in which the production is stopped in the component mounting apparatus AIII since the board unloading is not performed.

When the board exists in the unloader LA3 of the first mounting lane JA of the component mounting apparatus AIII located on the downmost-stream side of the mounting apparatus group A or when the board exists in the unloader La3 of the second mounting lane Ja of the component mounting apparatus AIII located on the downmost-stream side of the

mounting apparatus group A, the "board unloading awaiting signal" is outputted from the control unit 1000AIII of the component mounting apparatus AIII to the second connective conveyance unit CC2 located on the downstream side of the unloaders LA3 and La3.

The second connective conveyance unit CC2 determines to which conveyance route of the routes (4) through (7) of Fig. 16 the board is to be conveyed in consideration of the "board demand signal" and the "Y-table and loader with no board signal" from the mounting apparatus group B and the "board unloading awaiting signal" and the "board unloading awaiting production stop signal" from the mounting apparatus group A.

It is to be noted that the board conveyance is performed with priority given to the conveyance route from which the "Y-table and loader with no board signal" and the "board unloading awaiting production stop signal" are outputted. When the signals are outputted from two or more conveyance routes, the board conveyance is performed according to the determined order of priority.

Further, when there are boards 2d less than the number of boards that can be stocked in the second bypass lane BPB inside the second bypass lane BPB, i.e., the fourth through sixth bypass conveyance units BP4 through BP6 of the second bypass lane BPB, the "board demand

signal" is outputted from the fourth through sixth bypass conveyance units BP4 through BP6 of the second bypass lane BPB.

Moreover, when there is a board in the board unloading standby position of the third bypass unloading section BP3 of the first bypass lane BPA, the "board unloading awaiting signal" is outputted from the first bypass lane BPA.

Fig. 12 shows a flowchart of the concrete distributing operation of the second connective conveyance unit CC2.

It is determined in step S11 whether or not the conveyance operation command is on. That is, it is first determined whether or not the conveyance operation may be performed. Only when the conveyance operation may be performed, the program flow proceeds to step S12 to perform the following board conveyance operation. When the conveyance operation command is not on, meaning an end, the board loading operation by the second connective conveyance unit CC2 is stopped at the end. The conveyance operation command is not on when the driving of the component mounting apparatus is stopped for some reasons of, for example, component feed to the component feeding unit and maintenance. In such a case, the above-mentioned determination is made in order to prevent the board from

being loaded.

Next, it is determined in step S12 whether or not there is a conveyance route of which the "Y-table and loader with no board signal" or the "board awaiting production stop signal" is on and the "board demand signal" and the "board unloading awaiting signal" are both on. More specifically, it is determined whether or not the "Y-table and loader with no board signal" and the "board demand signal" have come from any one of the first mounting lane JB and the second mounting lane Jb of the mounting apparatus group B and the second bypass lane BPB and whether or not the "board awaiting production stop signal" and the "board unloading awaiting signal" have come from any one of the first mounting lane JA and the second mounting lane Ja of the mounting apparatus group A and the first bypass lane BPA.

When there is a conveyance route of which the "Y-table and loader with no board signal" or the "board waiting production stop signal" is on and the "board demand signal" and the "board unloading awaiting signal" are both on in step S12, the boards are conveyed in step S13 to all the conveyance routes that conform to the conditions of step 12 according to the predetermined order of priority. Subsequently, the program flow returns to step S11.

When there is no conveyance route of which the "Y-

table and loader with no board signal" or the "board waiting production stop signal" is on and the "board demand signal" and the "board unloading awaiting signal" are both on in step S12, it is determined in step S14 whether or not there is a conveyance route of which the "board demand signal" or the "board unloading awaiting signal" is on. More specifically, it is determined whether or not the "board demand signal" has come from any one of the first mounting lane JB and the second mounting lane Jb of the mounting apparatus group B or the second bypass lane BPB and whether or not the "board unloading awaiting signal" has come from any one of the first mounting lane JA and the second mounting lane Ja of the mounting apparatus group A and the first bypass lane BPA. When there is no conveyance route of which the "board demand signal" or the "board unloading awaiting signal" is on, the program flow returns to step S11.

When there is a conveyance route of which the "board demand signal" or the "board unloading awaiting signal" is on in step S14, the conveyance route that conforms to the conditions of step 14 is registered in step S15 as conveyance route information in the memory MEM.

Next, the board is conveyed to the conveyance route of the highest order of priority in step S16, and the conveyance route information of the route to which the

board has been conveyed is deleted from inside the memory MEM.

Next, it is determined in step S17 whether or not the conveyance route information registered in step 14 is remaining in the memory MEM. When the conveyance route information registered in step 14 is not remaining in the memory MEM, the program flow returns to step S11.

When the conveyance route information registered in step 14 is remaining in the memory MEM, it is determined in step S18 whether or not there is a conveyance route of which the "Y-table and loader with no board signal" or the "board unloading awaiting production stop signal" is on.

When there is a conveyance route of which the "Y-table and loader with no board signal" or the "board unloading awaiting production stop signal" is on in step S18, the boards are conveyed in step S19 to all the conveyance routes that conform to the conditions of step 18, and the conveyance route information of the board conveyance routes to which the boards have been conveyed is deleted from inside the memory MEM. Subsequently, the program flow returns to step S17.

When there is no conveyance route of which the "Y-table and loader with no board signal" or the "board unloading awaiting production stop signal" is on in step S18, the program flow returns to step S16.

Next, the rule of operation practice of the third connective conveyance unit CC3 is as follows.

Selection between the conveyance routes (8), (9) and (10) is performed according to the "board unloading awaiting signal" from the unloader UB3 of the first mounting lane JB of the mounting apparatus group B, the unloader Ub3 of the second mounting lane Jb of the component mounting apparatus BIII and the conveyance lane of the sixth bypass conveyance path BP6 of the second bypass lane BPB, and the mounted board 2d is conveyed..

When a plurality of "board unloading awaiting signals" are outputted, the board conveyance is performed according to the determined order of priority.

The board outputted from the second mounting lane Jb of the mounting apparatus group B is turned at an angle of 180° in the third connective conveyance unit CC3 and thereafter loaded into the reflow device 904.

When the boards exist in both the unloader LB3 of the first mounting lane JB of the component mounting apparatus BIII located on the downmost-stream side of the mounting apparatus group B and the Y-table TB3 located on the upstream side of the loader or when the boards exist on both the unloader Lb3 of the second mounting lane Jb of the component mounting apparatus BIII located on the downmost-stream side of the mounting apparatus group B and the Y-

table Tb3 located on the upstream side of the loader, the "board unloading awaiting production stop signal" is outputted from the control unit 1000BIII of the component mounting apparatus BIII to the third connective conveyance unit CC3 located on the downstream side of the unloaders LB3 and Lb3. This means a state in which the production is stopped in the component mounting apparatus BIII since the board unloading is not performed.

Further, when the boards have already been standing by the number of boards that can be stocked in the second bypass lane BPB and there are boards in the unloader LA3 of the first mounting lane JA of the component mounting apparatus AIII located on the downmost-stream side of the mounting apparatus group A and the Y-table TA3 located on the upstream side of the loader or in the unloader La3 of the second mounting lane Ja and the Y-table Ta3 located on the upstream side of the loader, the "board unloading awaiting production stop signal" is outputted. This means a state in which the production is stopped in the component mounting apparatus AIII since the board unloading is not performed.

Fig. 13 shows a flowchart of the concrete distributing operation of the third connective conveyance unit CC3.

It is determined in step S21 whether or not the

conveyance operation command is on. That is, it is first determined whether or not the conveyance operation may be performed. Only when the conveyance operation may be performed, the program flow proceeds to step S22 to perform the following board conveyance operation. When the conveyance operation command is not on, meaning an end, the board loading operation by the third connective conveyance unit CC3 is stopped at the end. The conveyance operation command is not on when the driving of the component mounting apparatus is stopped for some reasons of, for example, component feed to the component feeding unit and maintenance. In such a case, the above-mentioned determination is made in order to prevent the board from being loaded.

Next, it is determined in step S22 whether or not there is a conveyance route of which the "board unloading awaiting production stop signal" is on. More specifically, it is determined whether or not the "board unloading awaiting production stop signal" has come from the first mounting lane JB of the component mounting apparatus BIII located on the downmost-stream side of the mounting apparatus group B or the second mounting lane Jb of the component mounting apparatus BIII located on the downmost-stream side of the mounting apparatus group B or the second bypass lane BPB.

When there is a conveyance route of which the "board unloading awaiting production stop signal" is on in step S22, the boards are conveyed in step S23 to all the conveyance routes that conform to the conditions of step 22 according to the predetermined order of priority.

When there is no conveyance route of which the "board unloading awaiting production stop signal" is on in step S22, it is determined in step S24 whether or not there is a conveyance route of which the "board unloading awaiting signal" is on. That is, when the "board unloading awaiting production stop signal" is not outputted, search of the conveyance route of which the "board unloading awaiting signal" is on is executed. When there is no conveyance route of which the "board unloading awaiting signal" is on in step S24, the program flow returns to step S21.

When there is a conveyance route of which the "board unloading awaiting signal" is on in step S24, the conveyance route that conforms to the conditions of step 24 is registered in step S25 as conveyance route information in the memory MEM.

Next, the board is conveyed to the conveyance route of the highest order of priority in step S26, and the conveyance route information of the route to which the board has been conveyed is deleted from inside the memory

MEM.

Next, it is determined in step S27 whether or not the conveyance route information registered in step 24 is existing in the memory MEM. When the conveyance route information registered in step 24 is not existing in the memory MEM, the program flow returns to step S21.

When the conveyance route information registered in step 24 is existing in the memory MEM, it is determined in step S28 whether or not there is a conveyance route of which the "board unloading awaiting production stop signal" is on. When there is no route of which the "board unloading awaiting production stop signal" is on in step S28, the program flow returns to step S26.

When there is a conveyance route of which the "board unloading awaiting production stop signal" is on in step S28, the boards are conveyed in step S29 to all the conveyance routes of which the "board unloading awaiting production stop signal" is on, and the conveyance route information of the board conveyance routes to which the boards have been conveyed is deleted from inside the memory MEM. Subsequently, the program flow returns to step S27.

It is also possible to perform a board conveyance operation such that the electronic component mounting apparatus where troubles have occurred at the time of electronic component mounting apparatus trouble is bypassed

by using the first through third connective conveyance units CC1 through CC3 and the first and second bypass lanes BPA and BPB.

As described above, according to the component mounting system of the second embodiment, by operating each bypass lane BP and each connective conveyance unit CC as described above in response to the board conveyance request from each component mounting apparatus and each bypass lane BP, the unmounted board 2c can be conveyed by being distributed into the optimum conveyance lane from the viewpoint of production efficiency, and the mounted board 2d can be unloaded from the optimum conveyance lane from the viewpoint of production efficiency, allowing the boards to be conveyed integrally into one conveyance lane.

In particular, by performing the board distribution in consideration of the states of operation of the electronic each component mounting apparatuses in the mounting apparatus group A and the mounting apparatus group B, stop in the board awaiting state can be restrained to a minimum in each electronic component mounting apparatus.

In order to perform board distribution in consideration of the "board demand signal" and the "board unloading awaiting signal" from each electronic component mounting apparatus and to achieve the line balance of the electronic component-mounted board production line, by

performing the board distribution also in consideration of the "Y-table and loader with no board signal" and the "board unloading awaiting production stop signal", the optimum board conveyance can be achieved from the viewpoint of production efficiency.

As shown in Fig. 18, it is acceptable to arrange a defective board unloading section BD on, for example, the front side of the second connective conveyance unit CC2, and, when a defective board is generated during the component mounting operation in the component mounting apparatus of the mounting apparatus group A, to unload the defective board into the defective board unloading section BD by turning the second connective conveyance unit CC2 at an angle of 90 degrees instead of conveying the defective board to the downstream side of the second connective conveyance unit CC2 when the board is made to pass through the second connective conveyance unit CC2. It is also acceptable to arrange a similar defective board unloading section BD on, for example, the front side of the third connective conveyance unit CC3 and unload the defective board generated during the component mounting operation in the component mounting apparatus of the mounting apparatus group B.

The constitution of the aforementioned production line is one example, and all the component mounting

apparatuses are not required to be provided with the front-side mounting unit and the rear-side mounting unit. The present invention can also be applied to a production line in which component mounting apparatuses each being composed of one mounting unit and a bypass lane are joined together, a production line in which a component mounting apparatus provided with a front-side mounting unit, a rear-side mounting unit and a bypass lane and a component mounting apparatus composed of one mounting unit and a bypass lane are mixed, or the like.

Moreover, the board conveyance direction can be properly changed according to the specifications of the production line. The conveyance direction may be extended not only in one way but also diverged partway into a plurality of ways or partially reversed.

Moreover, each bypass lane is not limited to the one arranged midway between the front-side mounting unit and the rear-side mounting unit and is allowed to be arranged above or below the front-side mounting unit or the rear-side mounting unit or arranged on the front side of the front-side mounting unit or arranged on the rear side of the rear-side mounting unit. Each bypass lane is only required to be roughly parallel to the first mounting conveyance path, i.e., the first mounting lane and the second mounting conveyance path, i.e., the second mounting

lane and independent of the first mounting conveyance path and the second mounting conveyance path.

By properly combining the arbitrary embodiments of the aforementioned various embodiments, the effects owned by the respective embodiments can be produced.

According to the present invention, in one component mounting apparatus, the component mounting work area of the board is divided into the two parts of the first component mounting work area and the second component mounting work area. In each of the first component mounting work area and the second component mounting work area, there are independently performed the loading of the boards by the first loader and the second loader, the positioning and holding of the boards by the first placement-position determining conveyance unit and the second placement-position determining conveyance unit, the supply of components by the first and second component feeding devices, the suction, holding and movement of components by the first and second placement heads, the recognition of components by the first and second recognition devices and the unloading operations of the boards by the first and second placement-position determining conveyance units, the first unloader and the second unloader. More concretely, the board is loaded into the first component mounting work area by the first loader

in the first component mounting work area. The board is positioned and held by the first placement-position determining conveyance unit for the mounting operation in the first placement position that is a portion located closest to the component feeding unit arranged along the board conveyance direction in the first component mounting work area and closest to the camera to be usually most frequently used as one example of the first component recognition device, i.e., the two-dimensional camera. Subsequently, a component from the component feeding unit is sucked and held by driving the first placement head, recognized by the two-dimensional camera and thereafter placed on the board. After repeating this and after ending the mounting operation in the first mounting unit, the board is unloaded from the first placement-position determining conveyance unit to the first unloading and further unloaded out of the first component mounting work area by the first unloading 1C. On the other hand, concurrently with the mounting operation in the first mounting unit, the board is loaded into the second component mounting work area by the second loader in the second component mounting work area. The board is positioned and held by the second placement-position determining conveyance unit for the mounting operation in the second placement position that is a portion located

closest to the component feeding unit arranged along the board conveyance direction in the second component mounting work area and closest to the camera to be usually most frequently used as one example of the second component recognition device, i.e., the two-dimensional camera. Subsequently, a component from the component feeding unit is sucked and held by driving the second placement head, recognized by the two-dimensional camera and thereafter placed on the board. After repeating this and after ending the mounting operation in the second mounting unit, the board is unloaded from the second placement-position determining conveyance unit to the second unloading and further unloaded out of the second component mounting work area by the second unloading.

As a result, in the first and second mounting units, the board loading, the component holding, the component recognition, the component placement and the board unloading can be performed independently of one another in the respective optimum states, and the productivity can be further improved. That is, when either component mounting ends in advance in concurrently performing the component mounting operations in the plurality of component mounting work areas, the board obtained after the component mounting can be unloaded without awaiting the end of the other component mounting

operation or the board unloading, and the areal productivity can be further improved. Moreover, the distances between the board positioned and held in each component mounting work area, the component feeding unit and the two-dimensional camera that is usually most frequently used can be remarkably shortened in comparison with the case where the board is held in the board conveyance path in the center portion of the component mounting work area as in the conventional case. This enables the reduction in the mounting time and the improvement of productivity.

Moreover, in regard to the placement position in each placement-position determining conveyance unit, with reference to the component feeding unit and the support rail portion located closest to the camera to be usually most frequently used as one example of the component recognition device, or, for example, the two-dimensional cameras of the pair of support rail portions of each placement-position determining conveyance unit, the other support rail portion is moved close to or apart from the one support rail portion. In order to cope with the board size, the component suction, holding and recognition by the two-dimensional camera in each component feeding unit are performed always near the position in the shortest distance, not depending on the size of the circuit board. Therefore,

the distance of movement of each placement head, i.e., the positions of the three operations of component suction, recognition and placement are linked in the shortest distance, by which the mounting process time can be reduced and the production efficiency can be increased. In particular, conventionally in the case where the component mounting is performed on a board in the vicinity of the board conveyance position, the distances between the positions of the three operations of component suction, recognition and placement have been elongated and the mounting process time has been increased in the case of small boards. According to the present embodiment, even in the case of small boards or large boards, the boards are positioned and mounted in the positions where the distances between the positions of the three operations of component suction, recognition and placement become short. Therefore, the mounting process time can be remarkably reduced. In particular, in each component mounting work area, the component feeding unit is arranged along the end edge in the board conveyance direction of the component mounting work area. Therefore, when the recognition device is arranged on the center side in the conveyance direction of each component mounting work area and the board placement position in each placement-position determining conveyance unit is also arranged on the center side in the conveyance

direction of each component mounting work area, the distances between the positions of the three operations of the component suction, recognition and placement become shorter, and therefore, the mounting process time can be further improved. Moreover, by dividing one component mounting work area into two parts, the distance of movement of the placement head is reduced to allow the mounting process time to be improved. For example, in the mounting apparatus of the present embodiment, the time for mounting one component can be reduced to one-half that of the conventional case, and the mounting process time can be remarkably improved.

Moreover, since two boards are arranged oppositely as a pair in the component mounting work area in one component mounting apparatus, the mounting efficiency per unit area can be improved in comparison with the case where only one board is arranged.

Moreover, by concurrently performing the component mounting in the first mounting unit and the component mounting in the second mounting unit, the mounting operation can be performed more efficiently, and the mounting process time can be improved.

Moreover, the first placement head drive device of the first mounting unit and the second placement head drive device of the second mounting unit have their driving

areas that do not overlap each other. Therefore, the mounting operation in each mounting unit can be freely set without consideration for the mutual interference of both the drive devices.

Although the present invention has been fully 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 scope of the present invention as defined by the appended claims unless they depart therefrom.

CLAIMS

1. A component mounting apparatus comprising:

a first mounting unit (101), which is arranged in a first component mounting work area (201) out of the first component mounting work area (201) and a second component mounting work area (202) that are two parts obtained by dividing a component mounting work area (200) and do not overlap each other, able to hold a first board (2a) on which a component is to be mounted in a first pre-placement standby position (FA), a first placement position (FB), and a first post-placement standby position (FC) that are located along a first conveyance path inside the first component mounting work area (201) and places a component that is fed from a first component feeding device (8), held by a first placement head (4), and recognized by a first recognition device (9) on the first board (2a) located in the first placement position (FB) on basis of a recognition result of the first recognition device (9) by the first placement head (4);

a second mounting unit (102), which is arranged in the second component mounting work area (202), able to hold a second board (2b) on which a component is to be mounted in a second pre-placement standby position (SA), a second placement position (SB), and a second post-placement standby position (SC) that are located along a second conveyance path different from and in parallel to the first conveyance path inside the second component mounting work area (202) and places a component that is fed from a second component feeding device (18), held by a second

placement head (14), and recognized by a second recognition device (19) on the second board (2b) located in the second placement position (SB) on basis of a recognition result of the second recognition device (19); and

a bypass conveyance unit (30), which is arranged between the first conveyance path and the second conveyance path, for passing there through a board that is not subjected to the mounting operation in the first mounting unit (101) and the second mounting unit (102).

2. A component mounting apparatus as claimed in claim 1, wherein the bypass conveyance unit (30) is comprised of an upper bypass conveyance unit and lower bypass conveyance unit arranged below the upper bypass conveyance unit.

3. A component mounting apparatus as claimed in claim 1, wherein the bypass conveyance unit (30) is comprised of two bypass conveyance units arranged parallel to each other.

4. A component mounting method for executing a first mounting operation comprising of:

holding a first board (2a) on which a component is to be placed in a first placement position (FB) via a first pre-placement standby position (FA) located along a first conveyance path in a first component mounting work area (201) out of the first component mounting work area (201) and a second component mounting work area (202) that are two parts

obtained by dividing a component mounting work area (200) and do not overlap each other;

holding a component fed from a first component feeding device (8) by means of a first placement head (4);

recognizing the component held by the first placement head (4) by means of a first recognition device (9);

placing the component recognized on basis of a recognition result on the first board (2a) located in the first placement position (FB) by means of the first placement head (4);

unloading the first board (2a) located in the first placement position (FB) toward a first post-placement standby position (FC) and holding the board after ending the component placing; and

holding a second board (2b) on which a component is to be placed in a second placement position (SB) via a second pre-placement standby position (SA) located along a second conveyance path different from and in parallel to the first conveyance path inside the second component mounting work area (202) and

a second mounting operation comprising of:

holding a component fed from a second component feeding device (18) by means of a second placement head (14);

recognizing the component held by the second placement head (14) by means of a second recognition device (19);

placing the component recognized on basis of a recognition result on the second board (2b) located in the second placement position (SB) by means of the second placement head (14); and

unloading the second board (2b) located in the second placement position (SB) toward a second post-placement standby position (SC) and holding the board after ending the component placing, and

the method being able to independently performing the loading and unloading of the first board and the loading and unloading of the second board, wherein a board that is not subjected to the first mounting operation and the second mounting operation is made to pass through a bypass conveyance unit (30) arranged between the first conveyance path and the second conveyance path.

5. A component mounting system comprising:

a first mounting unit (101), which is provided with a first loader (L) that is arranged in a first component mounting work area (201) out of the first component mounting work area (201) and a second component mounting work area (202) that are two parts obtained by dividing a upstream-side component mounting work area (200) and do not overlap each other, for positioning and holding a first board (2a) on which a component is to be placed in a first pre-placement standby position (FA) located along a first conveyance path inside the first component mounting work area (201), a first board conveying and holding unit (T) for positioning and holding the board in a first placement position (FB) where the board is conveyed beyond the first pre-placement standby position (FA) in a conveyance direction, and a first unloader (U) for positioning and holding the board in a first post-placement standby position (FC) where the board is conveyed beyond the first placement

position (FB) in the conveyance direction, wherein a component that is fed from a first component feeding device (8) and held by a first placement head (4) is placed on the first board (2a) located in the first placement position (FB), by means of the first placement head (4);

a second mounting unit (102), which is provided with a second loader (L) that is arranged in the second component mounting work area (202), for positioning and holding a first board (2b) on which a component is to be placed in a second pre-placement standby position (SA) located along a second conveyance path different from the first conveyance path inside the second component mounting work area (202), a second board conveying and holding unit (T) for positioning and holding the board in a second placement position (SB) where the board is conveyed beyond the second pre-placement standby position (SA) in the conveyance direction, and a second unloader (U) for positioning and holding the board in a second post-placement standby position (SC) where the board is conveyed beyond the second placement position (SB) in the conveyance direction, wherein a component that is fed from a second component feeding device (18) and held by a second placement head (14) is placed on the second board (2b) located in the second placement position (SB), by means of the second placement head (14);

a bypass conveyance unit (BPA), which is roughly parallel to a first mounting conveyance path comprised of the first loader, the first board conveying and holding unit, and the first unloader and a second mounting conveyance path comprised of

the second loader, the second board conveying and holding unit, and the second unloader and arranged independently of the first mounting conveyance path and the second mounting conveyance path;

an upstream-side connective conveyance unit (CC1) for loading a board into any one of the first loader, the second loader and the bypass conveyance unit (BPA);

an upstream-side detection device (DL) for detecting presence or absence of a board in the first loader, the first board conveying and holding unit, the second loader, the second board conveying and holding unit, and the bypass conveyance unit (BPA);

a third mounting unit (101), which is provided with a third loader that is arranged in a third component mounting work area out of the third component mounting work area and a fourth component mounting work area that are two parts obtained by dividing a downstream-side component mounting work area and do not overlap each other, for positioning and holding a third board on which a component is to be placed in a third pre-placement standby position located along a third conveyance path inside the third component mounting work area, a third board conveying and holding unit for positioning and holding the board in a third placement position where the board is conveyed beyond the third pre-placement standby position in a conveyance direction, and a third unloader for positioning and holding the board in a third post-placement standby position where the board is conveyed beyond the third placement position in the conveyance direction, wherein a component that is fed from a third component feeding device and held

by a third placement head is placed on the third board located in the third placement position, by means of the third placement head;

a fourth mounting unit, which is provided with a fourth loader that is arranged in the fourth component mounting work area, for positioning and holding a third board on which a component is to be placed in a fourth pre-placement standby position located along a fourth conveyance path different from the third conveyance path inside the fourth component mounting work area, a fourth board conveying and holding unit for positioning and holding the board in a fourth placement position where the board is conveyed beyond the fourth pre-placement standby position in the conveyance direction, and a fourth unloader for positioning and holding the board in a fourth post-placement standby position where the board is conveyed beyond the fourth placement position in the conveyance direction, wherein a component that is fed from a fourth component feeding device and held by a fourth placement head is placed on the fourth board located in the fourth placement position, by means of the fourth placement head;

a downstream-side connective conveyance unit (CC2) for unloading the board from any one of the first unloader, the second unloader, and the bypass conveyance unit and loading a board into either one of the third loader and the fourth loader;

a downstream-side detection device for detecting the presence or absence of a board in the first loader, the second unloader, the third unloader, the third board conveying and holding unit, the fourth

loader, the fourth board conveying and holding unit, and the bypass conveyance unit (BPA);

an upstream-side control section for executing control so that, with highest order of priority given to either a state in which no board exists in both either one of the first and second loaders and the board conveying and holding unit succeeding the loader or a state in which no board exists in both the bypass conveyance unit (BPA), the third or fourth loader, and the board conveying and holding unit succeeding the loader or the bypass conveyance unit and with the next order of priority given to the other, on basis of detection signals from the upstream-side detection device and the downstream-side detection device, a board is fed to the loaders according to the order of priority by the upstream-side connective conveyance unit (CC1), and, in a state in which no board exists in the first loader or the second loader or the bypass conveyance unit (BPA) according to a next order of priority, a board is loaded by the upstream-side connective conveyance unit (CC1) into the loader with no board or the bypass conveyance unit (BPA); and

a downstream-side control section for executing control so that, with highest order of priority given to a state in which no board exists in both either one of the third and fourth loaders and the board conveying and holding unit succeeding the loader on basis of detection signal from the downstream-side detection device, a board is fed to the loader relevant to the highest order of priority by the downstream-side connective conveyance unit (CC2), and, in a state in which no board exists in the third

loader or the fourth loader according to a next order of priority, a board is loaded by the downstream-side connective conveyance unit (CC2) into a loader with no board, and executing control so that, with the highest order of priority given to a state in which a board exists in both either loader and the board conveying and holding unit located on an upstream side of the unloader, a board is unloaded from the unloader relevant to the highest order of priority toward the downstream-side connective conveyance unit (CC2), and, in a state in which a board exists in the first unloader or the second unloader or the bypass conveyance unit (BPA) according to a next order of priority, the board is unloaded from the unloader with the board or the bypass conveyance unit (BPA) with the board toward the downstream-side connective conveyance unit (CC2).

6. A component mounting system as claimed in claim 5, further comprising a second bypass conveyance unit (BPB), which is roughly parallel to a third mounting conveyance path comprised of the third loader, the third board conveying and holding unit, and the third unloader and a fourth mounting conveyance path comprised of the fourth loader, the fourth board conveying and holding unit, and the fourth unloader and arranged independently of the third mounting conveyance path and the fourth mounting conveyance path, and

wherein the downstream-side control section unloads the board unloaded from the first unloader or the second unloader toward the second bypass conveyance unit (BPB) and loads the board unloaded

from the bypass conveyance unit (BPA) into the third loader or the fourth loader.

7. A component mounting system as claimed in claim 6, further comprising:

a downstream-side second connective conveyance unit (CC3) for unloading the board from any one of the third loader, the fourth loader, and the second bypass conveyance unit;

a downstream-side second detection device for detecting presence or absence of a board in the third unloader, the third board conveying and holding unit, the fourth unloader, the fourth board conveying and holding unit, and the second bypass conveyance unit (BPA); and

a downstream-side second control section for executing control so that, with the highest order of priority given to a state in which a board exists in both either one of the third and fourth unloaders and the third or fourth board conveying and holding unit succeeding the unloader on basis of a detection signal from the downstream-side second detection device, the board is unloaded from the unloader relevant to the highest order of priority by the downstream-side second connective conveyance unit (CC3) and, in a state in which a board exists in the third unloader or the fourth unloader or the second bypass conveyance unit (BPB) according to the next order of priority, the board is unloaded from the unloader with the board or the second bypass conveyance unit (BPB) with the board toward the downstream-side second connective conveyance unit (CC3).

8. A component mounting system as claimed in claim 7, wherein,

with the highest order of priority given to a state in which a board exists in both the second bypass conveyance unit (BPB) and either one of the first and second unloaders and the first or second board conveying and holding unit succeeding the unloader on basis of a detection signal from the downstream-side second detection device, the downstream-side second control section further unloads the board from the second bypass conveyance unit (BPB) relevant to the highest order of priority by the downstream-side second connective conveyance unit (CC3).