REMOVABLE ATTACHING DEVICE, AND BURN-IN BOARD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a removable attaching device and a burn-in board, and particularly relates to a removable attaching device which facilitates removal of a fastened object such as a sub-board, and to a burn-in board using such a removable attaching device.

Background Art

As an apparatus for performing a burn-in test, which is one type of screening test for finding out initial failures of semiconductor devices such as electronic parts and removing initially failed products, a burn-in apparatus is known. The burn-in apparatus is one type of semiconductor test apparatus, in which a burn-in board to which a plurality of semiconductor devices as devices under test are attached is housed, an electrical stress is given to the devices under test by applying a voltage, and a thermal stress at a predetermined temperature is given by heating air in a constant temperature bath, to thereby find out initial failures. Further, in this burn-in test, a predetermined test signal is supplied to the devices under test to perform an operation test of the devices under test, so as to check whether the devices under test operate normally or not.

In such a burn-in apparatus, a burn-in test for a long time ranging from a few hours to several tens of hours is performed. Thus, for improving the test efficiency, it is common that a plurality of devices under test are attached to one burn-in board, and a plurality of such burn-in boards are housed in the burn-in apparatus, so as to perform the burn-in test (see, for example, Japanese Patent Laid-open Publication No. 2005-265665).

Among such burn-in boards, there is a type such that one or more sub-boards are attached to a burn-in board. On such a burn-in board, semiconductor devices such as a memory and a logic circuit are attached to a sub-board, so as to mount various

functions on the sub-board.

However, specifications of the devices under test which are test objects may be changed, and accompanying this, there may arise a need to replace the sub-boards with other sub-boards. Specifically, when the type of devices under test is changed, it is necessary to remove the current sub-boards and attach sub-boards with different designs according to the change. Further, in a process using the burn-in board several times, the sub-boards may fail. To fix this failure or replace the sub-boards themselves, there may arise a need to remove the sub-boards from the burn-in board.

Expecting such cases, the sub-boards are attached to the burn-in board using removable attaching devices such as screws and bolts. That is, the sub-boards are structured to be removable from the burn-in board by loosening fastened screws and bolts.

However, there are numerous sockets to insert devices under test around the sub-boards, and an operation to remove the sub-boards from the burn-in board can be quite difficult. Specifically, since the burn-in board has a limited mounting area, sockets and sub-boards are disposed densely on the burn-in board, so as to provide more sockets for devices under test on the burn-in board. Accordingly, when a sub-board is removed, it may happen that fingers and/or a tool cannot enter around the sub-board, making the removal operation very difficult.

Moreover, in the burn-in board, the height of the sub-boards on the burn-in board needs to be lower than the height of sockets for uniforming the temperature in the burn-in apparatus during the burn-in test. Even when the fastened screws and bolts are loosened, the presence of surrounding sockets may hinder removal of the sub-boards.

Furthermore, numerous signals are exchanged between a base board of the burn-in board and the sub-boards, and hence a connector with multiple pins is used for electrically connecting the base board and the sub-boards. Depending on the number of signals to be exchanged, a plurality of connectors may also be provided on one sub-board. In such cases, it is possible to

damage the sub-board itself by stress generated during attachment or removal of the sub-board.

SUMMARY OF THE INVENTION

Accordingly, the present invention is made in view of the above-described problems, and an object thereof is to provide a removable attaching device which facilitates removal of a fastened object, such as a sub-board, and to provide a burn-in board using such a removable attaching device.

In order to accomplish the aforementioned and other objects, according to one aspect of the present invention, a removable attaching device comprises:

a first fixing member provided fixedly on a base board and having an insertion hole formed therein, the insertion hole having a role of female screw;

a penetrating member having a role of male screw with respect to the insertion hole of the first fixing member, the penetrating member having one end side and the other end side, the one end side being screwed into the insertion hole of the first fixing member when the penetrating member is rotated in a fastening direction, the other end side being inserted in a through hole of a fastened object, and the penetrating member further having a flange formed in an intermediate part between the one end side and the other end side; and

a second fixing member located on the other end side of the penetrating member, the second fixing member operating in cooperation with the flange of the penetrating member to clamp the fastened object,

wherein by rotating the penetrating member in a reverse-fastening direction which is reverse to the fastening direction, the flange moves the fastened object in a direction to depart from the first fixing member.

According to a further aspect of the present invention, a removable attaching device comprises:

a first fixing member provided fixedly on a base board and having an insertion hole formed therein, the insertion hole having a

role of female screw;

a first screw member having a role of male screw with respect to the insertion hole of the first fixing member, the first screw member having one end side and the other end side, the one end side being screwed into the insertion hole of the first fixing member when the first screw member is rotated in a fastening direction, and the other end side being provided with a head part operating in cooperation with the first fixing member to clamp the fastening object, the first screw member being not screwed with a through hole having a role of female screw formed in the fastened object, and

a second screw member which is screwed with the through hole formed in the fastened object but which is not screwed into the insertion hole of the first fixing member,

wherein in a state that the first screw member has been pulled out, the second screw member is screwed with the through hole of the fastened object, and the second screw member is rotated in an entering direction which causes the second screw member to enter the through hole, to thereby move the fastened object in a direction to depart from the first fixing member.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an overall front view of a burn-in apparatus in a burn-in system according to one embodiment of the present invention;

Fig. 2 is a front layout view for describing an example of an internal structure in a state that burn-in boards are housed in the burn-in apparatus of Fig. 1;

Fig. 3 is a block diagram showing an example of an internal configuration for exchanging necessary control signals and output signals between the burn-in apparatus of Fig. 1 and devices under test;

Fig. 4 is a plan layout view of a burn-in board according to one example of the present invention;

Fig. 5 is an A-A' line cross-sectional view of the burn-in board shown in Fig. 4;

Fig. 6 is a side view of the burn-in board shown in Fig. 4 seen from an arrow B direction;

Fig. 7 is a front view of the burn-in board shown in Fig. 4 seen from an arrow C direction;

Fig. 8 is a partial front view of a chamber for describing a state that the burn-in board shown in Fig. 4 is stored in the chamber;

Fig. 9 is an enlarged view of a sub-board in a state of being attached to a base board of the burn-in board seen from a side;

Fig. 10 is an enlarged cross-sectional view for describing a manner of attaching or removing the sub-board to or from the base board using removable attaching devices according to a first embodiment of the present invention;

Fig. 11 is a plan view of one of the removable attaching devices according to the first embodiment of the present invention seen from above, which are provided at four corners of the sub-board;

Fig. 12 is a side view of the removable attaching device shown in Fig. 11;

Fig. 13 is a cross-sectional view for describing a manner of attaching or removing the sub-board using the removable attaching device shown in Fig. 11;

Fig. 14 is a cross-sectional view for describing a process of removing the sub-board when the sub-board is attached to the base board using the removable attaching device shown in Fig. 11;

Fig. 15 is a side view for describing a modification example of a structure omitting a washer in the removable attaching device according to the first embodiment;

Fig. 16 is a plan view of one of removable attaching devices according to a second embodiment of the present invention seen from above, which are provided at four corners of a sub-board;

Fig. 17 is a side view of the removable attaching device shown in Fig. 16;

Fig. 18 is a cross-sectional view for describing a manner of attaching or removing the sub-board using the removable attaching device shown in Fig. 16;

Fig. 19 is a side view for describing a modification example of a structure omitting a washer in the removable attaching device according to the second embodiment;

Fig. 20 is a plan view of one of removable attaching devices according to a third embodiment of the present invention seen from above, which are provided at four corners of a sub-board;

Fig. 21 is a side view of the removable attaching device shown in Fig. 20;

Fig. 22 is a cross-sectional view for describing a manner of attaching or removing the sub-board using the removable attaching device shown in Fig. 20;

Fig. 23 is a side view for describing a modification example of a structure omitting a washer in the removable attaching device according to the third embodiment;

Fig. 24 is a plan view of one of removable attaching devices according to a fourth embodiment of the present invention seen from above, which are provided at four corners of a sub-board;

Fig. 25 is a side view of the removable attaching device shown in Fig. 24;

Fig. 26 is a cross-sectional view for describing a manner of attaching or removing the sub-board using the removable attaching device shown in Fig. 24;

Fig. 27 is a plan view for describing the structure of an E-ring which is an example of a stopper member used in the removable attaching device according to the fourth embodiment;

Fig. 28 is a plan view of one of removable attaching devices according to a fifth embodiment of the present invention seen from above, which are provided at four corners of a sub-board;

Fig. 29 is a side view of the removable attaching device shown in Fig. 28;

Fig. 30 is a cross-sectional view for describing a manner of attaching or removing the sub-board using the removable attaching device shown in Fig. 28;

Fig. 31 is a plan view (in an attached state) of one of removable attaching devices according to a sixth embodiment of the present invention seen from above, which are provided at four

corners of a sub-board;

Fig. 32 is a side view of the removable attaching device shown in Fig. 31;

Fig. 33 is a cross-sectional view for describing a manner of attaching or removing the sub-board using the removable attaching device shown in Fig. 31;

Fig. 34 is a cross-sectional view for describing a manner of removing a sub-board when the sub-board is attached to the base board using the removable attaching device shown in Fig. 31; and

Fig. 35 is a plan view (in a state in the course of removal) of one of the removable attaching devices according to the sixth embodiment of the present invention seen from above, which are provided at four corners of the sub-board.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, embodiments of the present invention will be described with reference to the drawings. It should be noted that the embodiments described below do not limit the technical scope of the present invention.

[First Embodiment]

Fig. 1 is an overall front view of a burn-in apparatus 10 according to one embodiment of the present invention, showing a state that doors 20 are closed. Fig. 2 is a front layout view for describing a substantial part of the internal structure of the burn-in apparatus 10, showing a state that burn-in boards BIB are inserted in the burn-in apparatus 10. The burn-in apparatus 10 shown in Fig. 1 and Fig. 2 is one type of semiconductor test apparatus, and the burn-in apparatus 10 and the burn-in boards BIB form a burn-in system according to this embodiment.

As shown in Fig. 1 and Fig. 2, in the burn-in apparatus 10 according to this embodiment, a chamber 40 is formed by a space defined by heat insulating walls 30. In this chamber 40, one or more burn-in boards BIB are housed.

In this embodiment, as shown in Fig. 2, the burn-in boards BIB are housed together with carrier racks CR in the chamber 40. In each carrier rack CR, specifically, slots 50 for supporting the

burn-in boards BIB are formed. The carrier racks CR are stored in the chamber 40 in a state that the burn-in boards BIB are inserted in these slots 50. In this embodiment, one carrier rack CR is structured to allow insertion of 15 burn-in boards BIB.

Further, in this embodiment, the chamber 40 is structured to be capable of housing four carrier racks CR. Therefore, by housing four carrier racks CR in the chamber 40, 60 burn-in boards BIB in total can be housed in the chamber 40. However, the number and arrangement of carrier racks CR which can be housed in the chamber 40 and the number and arrangement of burn-in boards BIB in the carrier rack CR may be changed arbitrarily.

Moreover, without using the carrier racks CR, the burn-in boards BIB may be housed directly in the chamber 40. In this case, slots 50 are formed in the chamber 40, and the burn-in boards BIB are inserted directly in these slots 50.

As shown in Fig. 1, this burn-in apparatus 10 is provided with two doors 20, and when the doors 20 are in an open state, the carrier racks CR can be carried in and out of the chamber 40. Further, an insulating material is also incorporated in the doors 20, and when the doors 20 are in a closed state, the chamber 40 which is a space thermally insulated from the surroundings is formed.

As shown in Fig. 2, the burn-in apparatus 10 according to this embodiment is further provided with a heater 60 and a cooling unit 70. In the chamber 40, an air circulation duct DT extending leftward, upward, and rightward is also provided, which is structured such that a fan 80 provided in this air circulation duct DT circulates and stirs air in the air circulation duct DT so as to uniform the temperature in the chamber 40.

The cooling unit 70 is formed of two cooling compressors 72 and two heat exchangers 74. In this embodiment, this cooling unit 70 employs a cooling method using a refrigerant. The cooling compressors 72 are compressors for circulating the refrigerant, and the heat exchangers 74 are exchangers for exchanging cold heat of the refrigerant with the air in the chamber 40. The two heat exchangers 74 are provided in the air circulation duct DT. Accordingly, by circulating air with the fan 40, the circulated air can

be cooled by the heat exchangers 74, to thereby decrease the temperature in the chamber 40.

Further, the heater 60 is formed of an electric heater for example, and is structured to develop heat when supplied with electric power. By circulating air in the air circulation duct DT with the heater 60 developing heat, the temperature of the air in the air circulation duct DT can be increased.

On the other hand, a control unit CL is provided on the right side of the burn-in apparatus 10. This control unit CL controls the burn-in apparatus 10 according to a predetermined setting and sequence, so as to perform the burn-in test. In this embodiment, particularly during the burn-in test, the heater 60 and the cooling unit 70 are controlled to make the temperature around the burn-in boards BIB become a target temperature set by the user or the like.

Fig. 3 is a block diagram showing an example of an internal configuration for exchanging necessary control signals and output signals between the burn-in apparatus 10 and the devices under test. As shown in this Fig. 3, the burn-in apparatus 10 is provided with a test control device 100, a buffer board 110, driver boards 120, and extension boards 130. The test control device 100 and the buffer board 110 are provided in the control unit CL for example, and the driver boards 120 and the extension boards 130 are provided in the chamber 40.

The test control device 100 performs overall control in the burn-in test which is performed in this burn-in apparatus 10. In this embodiment, the test control device 100 is formed of, for example, an independent computer such as a personal computer provided in the above-described control unit CL. The burn-in test is carried out according to the control by this test control device 100. Necessary control signals for carrying out the burn-in test are outputted to a plurality of driver boards 120 via the buffer board 110 which is an output buffer.

The driver boards 120 and the extension boards 130 are disposed corresponding to the respective slots 50 in the chamber 40. That is, in this embodiment, a pair of a driver board 120 and

an extension board 130 is provided corresponding to one burn-in board BIB. Therefore, in the burn-in apparatus 10 shown in Fig. 1 and Fig. 2, 60 pairs of a driver board 120 and an extension board 130 are provided. Control signals supplied to the driver boards 120 are finally supplied to the burn-in boards BIB via the extension boards 130.

Conversely, output signals of data related to test results and so on outputted from the burn-in boards BIB are inputted to the test control device 100 via the extension boards 130, the driver boards 120, and the buffer board 110. Thus, the test control device 100 can obtain data related to various test results.

Next, based on Fig. 4 to Fig. 7, the overall structure of a burn-in board BIB according to this embodiment will be described. Fig. 4 is a view showing an example of a plan layout of the burn-in board BIB according to this embodiment. Fig. 5 is an A-A' line cross-sectional view of the burn-in board BIB of Fig. 4. Fig. 6 is a side view of the burn-in board BIB of Fig. 4 seen from an arrow B direction. Fig. 7 is a front view of the burn-in board BIB of Fig. 4 seen from an arrow C direction.

As shown in these views, insertion edges 140 are provided in an end portion in an inserting direction of the burn-in board BIB. In this example, the insertion edges 140 are disposed at three positions.

When the burn-in board BIB is housed in the chamber 40, the insertion edges 140 are inserted in connectors provided on the extension board 130. A plurality of signal pads are formed on the insertion edges, and a plurality of signal pins are formed on the connectors on the extension board 130 side. These signal pins and signal pads are disposed corresponding to each other, and the signal pins and the signal pads are connected electrically. Thus, the burn-in board BIB is connected electrically to the extension board 130, allowing exchange of signals between the burn-in apparatus 10 and the burn-in board BIB. When the burn-in test is finished, this burn-in board BIB is pulled out in a pulling direction to disconnect the insertion edges 140 on the burn-in board BIB side and the connectors on the extension board 130 side.

On the burn-in board BIB, eight programmable logic devices 160 are provided via sub-boards 150. In this example, sub-boards are aligned in an inserting/pulling direction in an arrangement of 4 pieces × two rows.

A base board BB of the burn-in board BIB and the sub-boards 150 are connected electrically via connectors 152. In this example, one sub-board 150 is connected electrically to the base board BB of the burn-in board BIB via five connectors 152. Then, four corners of the sub-board 150 are fixed to the base board BB by removable attaching devices 154A.

Further, sockets SKT are provided in an arrangement such that 24 devices under test are assigned to one programmable logic device 160, and devices under test DUT are attached to these sockets SKT. To sum up, 24 × 8 = 192 devices under test DUT are attached to one burn-in board BIB.

More specifically, 12 sockets SKT are disposed on one side in a width direction of one programmable logic device 160, and 12 sockets SKT are disposed on the other side in the width direction of this programmable logic device 160. The 24 devices under test DUT attached to these 24 sockets SKT are supplied with a signal of a test pattern from the one programmable logic device 160, and the respective devices under test DUT output an output signal as an operating result thereof to the one programmable logic device 160.

This programmable logic device 160 is a configurable device whose circuit configuration can be changed after being manufactured, and can be formed of an FPGA (Field Programmable Gate Array) for example. In this embodiment, configuration data for changing the configuration of the programmable logic device 160 are supplied from the burn-in apparatus 10 to the programmable logic device 160. Then, the programmable logic device 160 operates autonomously to generate the signal of a test pattern, so as to perform the burn-in test of the devices under test DUT. That is, the test signal itself is not supplied from the burn-in apparatus 10, and the output signals from the devices under test DUT are not outputted to the burn-in apparatus 10.

Fig. 8 is a view showing a state that the burn-in boards BIB according to this embodiment are housed in the chamber 40 of the burn-in apparatus 10, and showing a state that the chamber 40 is seen from a front direction of the burn-in apparatus 10.

As shown in this Fig. 8, when the burn-in boards BIB are housed in the chamber 40 of the burn-in apparatus 10 and the burn-in test is started, air is circulated so that the temperature in the chamber 40 becomes uniform as described above. In this embodiment, as can be seen from this Fig. 8 and above-described Fig. 2, air flowing in from the right side of the burn-in apparatus 10 flows leftward over the devices under test DUT inserted in the sockets SKT of the burn-in boards BIB.

Thus, the height of the sub-boards 150 is desired to be lower than the heights of the sockets SKT and the devices under test DUT. If the height of the sub-boards 150 is higher than the heights of the sockets SKT and the devices under test DUT, the sub-boards obstruct the flow of air, hinder smooth air circulation, and become an obstacle to uniformization of temperature.

On the other hand, it is conceivable that accompanying a change in type of the devices under test DUT, a need will arise to remove the sub-boards 150 and attach other sub-boards. Alternatively, it is also conceivable that the sub-boards 150 themselves or the programmable logic devices 160 provided on the sub-boards 150 will fail. In such cases, there arises a need to remove the sub-boards 150 from the base board BB for repair or replacement. Accordingly, the sub-boards 150 need to be attached removably to the base board BB by the removable attaching devices 154A.

Fig. 9 is a view of a sub-board 150 in a state of being attached to the base board BB of the burn-in board BIB seen from a side, and is a view enlarging a part of a sub-board 150 in Fig. 5. Fig. 10 is a cross-sectional view for describing a manner of attaching or removing the sub-board 150 to or from the base board BB using the removable attaching devices 154A. Fig. 11 is a plan view of one of the removable attaching devices 154A seen from above, which are provided at four corners of the sub-board 150.

Fig. 12 is a side view of the removable attaching device 154A of Fig. 11. Fig. 13 is a cross-sectional view for describing a manner of attaching or removing the removable attaching device 154A of Fig. 12.

As shown in Fig. 9 and Fig. 10, the above-described connectors 152 are provided on a rear face 150a of the sub-board 150. Further, sockets 170 are provided at the positions corresponding to the connectors 152 on a front face 302 of the base board BB. When the sub-board 150 is attached to the base board BB by the removable attaching devices 154A, the connectors 152 are inserted in the sockets 170, and the connectors 152 and the sockets 170 are connected electrically. Thus, the programmable logic devices 160 on the sub-board 150 and the burn-in board BIB are connected electrically.

Note that although 5 connectors 152 and five sockets 170 are provided in this embodiment, the numbers of connectors 152 and sockets 170 are not limited thereto. For example, across the programmable logic device 160, two connectors 152 and two sockets 170 may be provided on the right side in the view, and two connectors 152 and two sockets 170 may be provided on the left side in the view, thereby arranging the same number of connectors 152 and sockets 170 on the left side and right side on the basis of the programmable logic device 160.

As can be seen from Fig. 9 to Fig. 13, the removable attaching device 154A according to this embodiment includes a spacer 200, a penetrating bolt member 220, a washer 240, and a nut member 260.

The spacer 200 is provided with an inserting projection 202 projecting from a space retaining part 204, and is inserted in an opening 300 formed in the base board BB and fixed to the base board BB. For example, it is possible to fix the spacer 200 and the base board BB to each other with an adhesive or the like, or it is possible to form a screw thread in the inserting projection 202 to make it as a male screw, and form a thread groove in the opening 300 to make it as a female screw, for screwing the spacer 200 into the base board BB.

The space retaining part 204 is a base part of this spacer 200 and an insertion hole 206 is formed therein, and a thread groove is formed in this insertion hole 206. In this embodiment, the insertion hole 206 has a hollow structure with a bottom, which is formed by boring into the space retaining part 204, and the penetrating bolt member 220 is inserted therein. That is, in this embodiment, the spacer 200 has a role of female screw, and the penetrating bolt member 220 has a role of male screw.

A screw thread is formed in the penetrating bolt member 220, and one end side 222 thereof is inserted in the insertion hole 206 of the space retaining part 204. A slot 226 is formed in the other end side 224 of the penetrating bolt member 220, with which a tool such as a flat-head screwdriver can be used to rotate the penetrating bolt member 220 about the center axis of the penetrating bolt member 220.

In the penetrating bolt member 220, a flange 230 is formed on an intermediate part 228 between the one end side 222 and the other end side 224. The flange 230 has a brim-like shape projecting concentrically about the center axis of the penetrating bolt member 220, and is fixed to the intermediate part 228 of the penetrating bolt member 220. When the penetrating bolt member 220 is rotated using the slot 226 and the one end side 222 of the penetrating bolt member 220 is rotated and screwed into the insertion hole 206 of the space retaining part 204, a rear face 232 of the flange 230 abuts on a top surface 208 of the spacer 200, thereby positioning the penetrating bolt member 220. That is, by the flange 230 and a top surface of the space retaining part 204 in contact with each other, insertion of the penetrating bolt member 220 is stopped, thereby determining the insertion depth of the penetrating bolt member 220. Therefore, in this embodiment, a length L1 of the penetrating bolt member 220 extending downward to the one end side 222 from a rear face of the flange 230 is formed to be shorter than a depth L2 of the insertion hole 206 formed in the spacer 200.

The other end side 224 of the penetrating bolt member 220 is inserted through the through hole 156 of the sub-board 150.

The rear face 150a of the sub-board 150 in which the penetrating bolt member 220 is inserted abuts on a front face 234 of the flange 230 and is positioned. The through hole 156 of the sub-board 150 has no screw thread or thread groove formed therein, and has a smooth face. However, an inner diameter D1 of the through hole 156 is formed to be slightly larger than an outer diameter D2 of the penetrating bolt member 220, and thus it is possible to insert the penetrating bolt member 220 in the through hole 156 of the sub-board 150 without rotating the penetrating bolt member 220.

When the penetrating bolt member 220 penetrates through the through hole 156, the other end side 224 of the penetrating bolt member 220 projects from a front face 150b of the sub-board 150 since a length L3 from the front face 234 of the flange 230 to the tip of the other end side 224 in the penetrating bolt member 220 is longer than a thickness T1 of the sub-board 150. The washer 240 is placed around the penetrating bolt member 220 projecting from the front face 150b of the sub-board 150, and is fastened by the nut member 260.

More specifically, a through hole 242 is formed in the washer 240, and the penetrating bolt member 220 is inserted in the through hole 242 of the washer 240 via the other end side 224 of the penetrating bolt member 220. The through hole 242 has no screw thread or thread groove formed therein, and has a smooth face. However, an inner diameter D3 of the through hole 242 is formed to be slightly larger than the outer diameter D2 of the penetrating bolt member 220, and thus it is possible to insert the penetrating bolt member 220 in the through hole 242 of the washer 240 without rotating the penetrating bolt member 220 or the washer 240.

A through hole 262 is formed also in the nut member 260, and a thread groove is formed in the through hole 262. Thus, when the penetrating bolt member 220 is inserted in this through hole 262 of the nut member 260 and the nut member 260 is rotated and screwed therewith, the sub-board 150 can be fastened and fixed to the base board BB via the washer 240.

Next, based on Fig. 9 to Fig. 13, an attaching process of

attaching the sub-board 150 to the burn-in board BIB using the removable attaching devices 154A will be described.

First, penetrating bolt members 220 are attached to spacers 200 provided at the positions corresponding to four corners of one sub-board 150. Specifically, while rotating a penetrating bolt member 220 in a fastening direction, the one end side 222 of the penetrating bolt member 220 is inserted in the insertion hole 206 of the spacer 200, and the penetrating bolt member 220 is fastened into the spacer 200. When the penetrating bolt member 220 is rotated in the fastening direction, in a state that a tool such as a flat-head screwdriver is inserted in the slot 226, it is possible to rotate the penetrating bolt member 220 in the fastening direction by rotating the tool such as a flat-head screwdriver in the fastening direction. When the penetrating bolt member 220 is inserted in the insertion hole 206 while being rotated, the rear face 232 of the flange 230 abuts on the top surface 208 of the spacer 200, creating a state that no further insertion is possible. Thus, the height of the penetrating bolt member 220 is positioned.

Subsequently, the penetrating bolt members 220 located at the four corners of the sub-board 150 are inserted through the respective through holes 156 of the sub-board 150 via the other end sides 224 of the penetrating bolt members 220. Thus, the front faces 234 of the flanges 230 abut on the rear face 150a of the sub-board 150, and the connectors 152 provided on the rear face 150a of the sub-board 150 are inserted in the sockets 170 provided on the front face 302 of the base board BB, thereby electrically connecting the five connectors 152 and the five sockets 170.

As can be seen from this, the positioning of the sub-board 150 can be determined by the sum of a height H1 of the spacer 200 at the top surface 208 and a thickness H2 of the flange 230. Specifically, by the sum of the height H1 from the front face 302 of the base board BB to the top surface 208 of the spacer 200 and the thickness H2 of the flange 230, the height from the front face 302 of the base board BB to the rear face 150b of the sub-board 150 can be determined, and the depth of insertion of the connector 152

with respect to the socket 170 can be determined.

Subsequently, the washer 240 is placed around each of the penetrating bolt members 220 projecting from the front face 150b of the sub-board 150 via the other end side 224, and the nut member 260 is fastened via this washer 240. That is, the other end side 224 of the penetrating bolt member 220 is inserted in the through hole 262 of the nut member 260, and the nut member 260 is rotated in the fastening direction, thereby screwing the nut member 260 onto the penetrating bolt member 220. By such fastening of the nut members 260 by screwing, the sub-board 150 as a fastened object can be clamped between the flanges 230 and the nut members 260, thereby attaching the sub-board 150 to the base board BB. That is, the flanges 230 of the penetrating bolt members 220 and the nut members 260 operate together to clamp the sub-board 150, thereby fixing the sub-board 150 to the base board BB.

Next, a removing process of removing the once-attached sub-board 150 from the base board BB by loosening the removable attaching devices 154A will be described based on Fig. 9 to Fig. 14.

First, the nut members 260 and the washers 240 are loosened and removed from the respective removable attaching devices 154A located at the four corners of the sub-board 150. Specifically, the nut members 260 are rotated in a reverse-fastening direction which is reverse to the fastening direction and remove the nut members 260 from the other end sides 224 of the penetrating bolt members 220, and then the washers 240 are removed from the other end sides 224 of the penetrating bolt members 220.

Subsequently, the penetrating bolt members 220 are rotated in the reverse-fastening direction to loosen the penetrating bolt members 220 fastened into the insertion holes 206 of the spacers 200. Specifically, a tool such as a flat-head screwdriver is inserted in the slot 226 and rotated in the reverse-fastening direction, so as to move the penetrating bolt member 220 in a direction to be removed from the insertion hole 206. At this time, as shown in Fig. 14, since the front face 234 of the flange 230 is in

contact with the rear face 150b of the sub-board 150, the sub-board 150 floats upward simultaneously in the course of pulling out the penetrating bolt member 220 from the insertion hole 206 while rotating the penetrating bolt member 220 in the reverse-fastening direction. That is, by rotating the penetrating bolt member 220 in the reverse-fastening direction, the penetrating bolt member 220 having the flange 230 can be moved in a direction to depart from the spacer 200, and thereby the sub-board 150 can be moved in the direction to depart from the spacer 200. Accordingly, by rotating and loosening the penetrating bolt member 220 in the reverse-fastening direction, the sub-board 150 can be floated gradually to a position higher than the sockets SKT of the burn-in board BIB. This creates a state that the sub-board 150 can be removed easily.

Further, when the penetrating bolt member 220 is rotated and loosened in the reverse-fastening direction, the removing operation can be performed while keeping a horizontal state of the sub-board 150 by rotating the penetrating bolt members 220 at four corners in order by the same rotation number. For example, by repeating an operation to rotate each of the penetrating bolt members 220 at four corners in the reverse-fastening direction in order by 1/4 rotation, the sub-board 150 can be removed from the base board BB without causing distortion of the sub-board.

Note that in this embodiment, the washers 240 are not always necessary, and can be omitted as shown in Fig. 15 depending on the strength of the sub-board 150 and the rigidity of the front face 150b. That is, in this Fig. 15 corresponding to above-described Fig. 12, the nut member 260 is fastened onto the penetrating bolt member 220 without using the washer 240. Accordingly, the nut member 260 contacts directly with the front face 150b of the sub-board 150, and the sub-board 150 as a fastened object is clamped between the nut member 260 and the flange 230, thereby attaching the sub-board 150 to the base board BB.

[Second Embodiment]

In the above-described first embodiment, the slot 226 is provided in the other end side 224 of the penetrating bolt member 220. In a second embodiment of the present invention, a hexagonal hole is provided instead of this slot 226. Hereinafter, parts different from the above-described first embodiment will be described.

Fig. 16 to Fig. 18 are views describing the structure of a removable attaching device 154B according to the second embodiment of the present invention, and correspond to Fig. 11 to Fig. 13 in the above-described first embodiment. Specifically, Fig. 16 is a plan view of one of removable attaching devices 154B seen from above, which are provided at four corners of the sub-board 150. Fig. 17 is a side view of the removable attaching device 154B of Fig. 16. Fig. 18 is a cross-sectional view for describing a manner of attaching or removing the removable attaching device 154B of Fig. 17.

As can be seen from Fig. 16 to Fig. 18, in the removable attaching device 154B according to this embodiment, a hexagonal hole 320 is provided in the other end side 224 of the penetrating bolt member 220. That is, the penetrating bolt member 220 is formed of a bolt with a hexagonal hole.

In this hexagonal hole 320, it is possible to insert a tool such as what is called a hexagonal wrench, and using this tool such as a hexagonal wrench, the penetrating bolt member 220 can be fastened or loosened and removed. Thus, except the use of a tool such as a hexagonal wrench for fastening and removing the removable attaching device 154B, the structure is the same as that of the above-described first embodiment.

Note that also in the second embodiment, the washers 240 are not always necessary, and can be omitted as shown in Fig. 19 depending on the strength of the sub-board 150 and the rigidity of the front face 150b. That is, in this Fig. 19 corresponding to above-described Fig. 17, the nut member 260 is fastened onto the penetrating bolt member 220 without using the washer 240. Accordingly, the nut member 260 contacts directly with the front face 150b of the sub-board 150, and the sub-board 150 as a

fastened object is clamped between the nut member 260 and the flange 230, thereby attaching the sub-board 150 to the base board BB.

[Third Embodiment]

In the above-described first embodiment, the slot 226 is provided in the other end side 224 of the penetrating bolt member 220. In a third embodiment of the present invention, a flat portion is provided instead of this slot 226. Hereinafter, parts different from the above-described first embodiment will be described.

Fig. 20 to Fig. 22 are views describing the structure of a removable attaching device 154C according to the third embodiment of the present invention, and correspond to Fig. 11 to Fig. 13 in the above-described first embodiment. Specifically, Fig. 20 is a plan view of one of removable attaching devices 154C seen from above, which are provided at four corners of the sub-board 150. Fig. 21 is a side view of the removable attaching device 154C of Fig. 20. Fig. 22 is a cross-sectional view for describing a manner of attaching or removing the removable attaching device 154C of Fig. 21.

As can be seen from Fig. 20 to Fig. 22, in the removable attaching device 154C according to this embodiment, a flat portion 330 is provided on the other end side 224 of the penetrating bolt member 220. That is, two flat faces 332, 332 are formed on the other end side 224 of the penetrating bolt member 220. These flat faces 332, 332 are formed by cutting off a portion of the other end side 224 of the penetrating bolt member 220 to form mutually parallel faces.

By holding this flat portion 330 with a tool such as a spanner for example, it is possible to rotate the penetrating bolt member 220. That is, by rotating the penetrating bolt member 220 using a tool such as a spanner, the penetrating bolt member 220 can be fastened into the spacer 200, or loosened and removed. Thus, except the use of a tool such as a spanner for fastening and removing the removable attaching device 154C, the structure is the same as that of the above-described first embodiment.

Note that also in the third embodiment, the washers 240 are not always necessary, and can be omitted as shown in Fig. 23 depending on the strength of the sub-board 150 and the rigidity of the front face 150b. That is, in this Fig. 23 corresponding to above-described Fig. 21, the nut member 260 is fastened onto the penetrating bolt member 220 without using the washer 240. Accordingly, the nut member 260 contacts directly with the front face 150b of the sub-board 150, and the sub-board 150 as a fastened object is clamped between the nut member 260 and the flange 230, thereby attaching the sub-board 150 onto the base board BB.

[Fourth Embodiment]

In the above-described first embodiment, the sub-board 150 is clamped by the nut member 260 and the flanges 230. In a fourth embodiment of the present invention, E-rings which can serve as a stopper member are used instead of the nut member 260, so as to clamp the sub-board 150 by the E-rings and the flanges 230. Hereinafter, parts different from the above-described first embodiment will be described.

Fig. 24 to Fig. 26 are views describing the structure of a removable attaching device 154D according to the fourth embodiment of the present invention, and correspond to Fig. 11 to Fig. 13 in the above-described first embodiment. Specifically, Fig. 24 is a plan view of one of removable attaching devices 154D seen from above, which are provided at four corners of the sub-board 150. Fig. 25 is a side view of the removable attaching device 154D of Fig. 24. Fig. 26 is a cross-sectional view for describing a manner of attaching or removing the removable attaching device 154D of Fig. 25. Fig. 27 is a plan view of an E-ring 340 used in the removable attaching device 154D according to this embodiment.

As can be seen from Fig. 24 to Fig. 27, in the penetrating bolt member 220 of the removable attaching device 154D according to this embodiment, no screw thread is formed in an insertion intermediate part 350 between the other end side 224

and the flange 230. That is, the insertion intermediate part 350 is in a columnar shape having a smooth surface. In this insertion intermediate part 350 in a columnar shape, one groove 352 is formed. This groove 352 is formed around the circumference of the insertion intermediate part 350 in a columnar shape, and the E-ring 340 is inserted therein.

The E-ring 340 is an example of a stopper member, which is also called an E-shaped snap ring. This E-ring 340 in plan view has a shape such that a portion of an O-shaped ring member is cut out to form an insertion opening 342, and three projections 344, 346, and 348 projecting inward of the O-shaped ring member are formed. In the vicinity of the insertion opening 342 of the E-ring 340, guide portions 344a, 346a are formed to facilitate insertion into the groove 352 of the penetrating bolt member 220. When the E-ring 340 is inserted in the groove 352 of the penetrating bolt member 220, the three projections 344, 346, and 348 engage with the groove 352, creating a state that the E-ring 340 cannot be removed easily.

An outer diameter of the other end side 224 of the penetrating bolt member 220 and an outer diameter of the insertion intermediate part 350 are both D3 and are formed to be slightly smaller than the inner diameter D4 of the through hole 156 of the sub-board 150. Thus, in a state that the penetrating bolt member 220 is fastened into the spacer 200, the penetrating bolt member 220 can be inserted in the through hole 156 of the sub-board 150.

When the penetrating bolt member 220 is thus inserted in the through hole 156 of the sub-board 150, the groove 352 of the penetrating bolt member 220 is located just above the front face 150b of the sub-board 150. In this state, by inserting the E-ring 340 in the groove 352 via its insertion opening 342 and engaging the E-ring therewith, the sub-board 150 can be clamped between the flange 230 and the E-ring 340, to thereby fix the sub-board 150. In this case, since the E-ring 340 cannot be pulled out from the groove 352 easily, the sub-board 150 can be fastened to the base board BB of the burn-in board BIB by the removable attaching

devices 154D located at four corners of the sub-board 150.

As can be seen from this, a length L4 from the front face 234 of the flange 230 to a lower edge 352a of the groove 352 on the penetrating bolt member 220 is formed substantially equal to the thickness T1 of the sub-board 150. That is, the relation between the length L4 and the thickness T1 is defined so that the sub-board 150 is clamped without looseness by inserting the E-ring 340 in the groove 352.

When the sub-board 150 is removed from the base board BB, the E-ring 340 is pulled out from the groove 352 of the penetrating bolt member 220 using a removal tool or the like. In this embodiment, the removable attaching devices 154D are provided at positions of four corners of the sub-board 150. Thus, by removing the E-rings 340 from the respective removable attaching devices 154D, the sub-board 150 can be released from the state of being fixed to the base board BB by the removable attaching devices 154D.

Subsequently, by inserting a tool such as a flat-head screwdriver in the slot 226, and rotating the penetrating bolt member 220 in the reverse-fastening direction in which the penetrating bolt member is loosened, the penetrating bolt member 220 moves to float upward from the spacer 200. Accompanying this, the flange 230 also moves in a direction to depart from the spacer 200. Thus, the sub-board 150 is lifted by this flange 230, and the sub-board 150 floats up gradually to a position higher than the sockets SKT of the burn-in board BIB. This creates a state that the sub-board 150 can be removed easily.

As described above, in the removable attaching device 154D according to this embodiment, the stopper member such as the E-ring 340 is used instead of the nut member 260, and thus operations of attaching and removing the sub-board 150 with respect to the removable attaching device 154D become more efficient. Specifically, it is conceivable that the operation of inserting the E-ring 340 in the groove 352 is easier than the operation of fastening the nut member 260 using a tool or the like, and the operation of pulling out the E-ring 340 from the groove

352 is easier than the operation of loosening and removing the nut member 260 using a tool or the like.

[Fifth Embodiment]

In the above-described first embodiment to fourth embodiment, two work processes are needed in the attaching work process, the first work process of fastening the penetrating bolt member 220 into the spacer 200, and the second work process of inserting the penetrating bolt member 220 in the through hole 156 of the sub-board 150 and thereafter fixing the sub-board 150. In the removing work process of the sub-board 150, two work processes are likewise needed. Accordingly, in a fifth embodiment of the present invention, these two work processes in the attaching work process or the removing work process can be combined into one. Hereinafter, parts different from the above-described first embodiment will be described.

Fig. 28 to Fig. 30 are views describing the structure of a removable attaching device 154E according to the fifth embodiment of the present invention, and correspond to Fig. 11 to Fig. 13 in the above-described first embodiment. Specifically, Fig. 28 is a plan view of one of removable attaching devices 154E seen from above, which are provided at four corners of the sub-board 150. Fig. 29 is a side view of the removable attaching device 154E of Fig. 28. Fig. 30 is a cross-sectional view for describing a manner of attaching or removing the removable attaching device 154E of Fig. 29.

As can be seen from Fig. 28 to Fig. 30, in this embodiment, a cutout through hole 158 is formed at each of four corners of the sub-board 150. This cutout through hole 158 has a U-shape in plan view, a part of which is opened in an edge portion of the sub-board 150 to form an insertion opening 158a. Thus, it is possible to insert or remove the removable attaching device 154E in or out of the through hole 158 via the insertion opening 158a from a lateral direction of the sub-board 150.

In the other end side 224 of the penetrating bolt member 220, a large head part 360 is formed, in which a slot 226 is formed.

An outer diameter D5 of this large head unit 360 is formed to be larger than an inner diameter D6 of the through hole 158. An insertion intermediate part 370 is located between this head part 360 and the flange 230. In this insertion intermediate part 370, no screw thread is formed. That is, the insertion intermediate part 370 is in a columnar shape having a smooth surface. A length L5 of the insertion intermediate part 370 is substantially equal to the thickness T1 of the sub-board 150. Further, an outer diameter D7 of the insertion intermediate part 370 is formed to be slightly smaller than the inner diameter D6 of the through hole 158. Therefore, the penetrating bolt member 220 inserted in this through hole 158 is able to rotate while the head part 360 slidably contacts the front face 150b of the sub-board 150, and while the front face 234 of the flange 230 slidably contacts the rear face 150a of the sub-board 150.

Accordingly, when the sub-board 150 is attached to the base board BB of the burn-in board BIB, the removable attaching devices 154E are attached in a state that the insertion intermediate parts 370 of the penetrating bolt members 220 are inserted respectively in the through holes 158 at four corners of the sub-board 150. Then, each penetrating bolt member 220 is rotated in the fastening direction to fasten the penetrating bolt member 220 into the spacer 200. Specifically, a tool such as a flat-head screwdriver is inserted in the slot 226 of the penetrating bolt member 220, and the penetrating bolt member 220 is rotated in the fastening direction which is a direction to fasten the penetrating bolt member 220, thereby fastening the penetrating bolt member 220 into the spacer 200. Thus, the sub-board 150 can be fixed to the base board BB through one attaching work process.

On the other hand, when the sub-board 150 is removed from the base board BB, the penetrating bolt members 220 located at four corners of the sub-board 150 can be loosened to removal the sub-board 150 from the base board BB. Specifically, a tool such as a flat-head screwdriver is inserted in the slot 226 of each penetrating bolt member 220, and the penetrating bolt member

220 is rotated in the reverse-fastening direction which is a direction to loosen the penetrating bolt member 220, thereby removing the penetrating bolt member 220 from the spacer 200.

At this time, by rotating the penetrating bolt member 220 in the reverse-fastening direction, the penetrating bolt member 220 moves to float upward. Along with this moving, the flange 230 also moves in a direction to depart from the spacer 200. Thus, the sub-board 150 is lifted by this flange 230, and the sub-board 150 floats up gradually to a position higher than the sockets SKT of the burn-in board BIB. This creates a state that the sub-board 150 can be removed easily. Then, after the sub-board 150 is removed, the removable attaching devices 154E are removed from the respective through holes 158 located at four corners of the sub-board 150. In this manner, the removing work process of the sub-board 150 also becomes one work process.

Note that either when attaching the sub-board 150 to the base board BB or when removing the sub-board 150 from the base board BB, the numbers of rotations of the penetrating bolt members 220 at four corners of the sub-board 150 can be set to the same number for allowing working while keeping the horizontal state of the sub-board 150. For example, by repeating an operation to rotate each of the penetrating bolt members 220 at four corners in order by 1/4 rotation, the sub-board 150 can be removed from the base board BB without causing distortion of the sub-board.

[Sixth Embodiment]

The above-described first embodiment to fifth embodiment are structured such that the sub-board 150 floats up during the removing work process by the penetrating bolt members 220 having the flange 230. A sixth embodiment of the present invention is structured such that the sub-board 150 floats up during the removing work process by reinforcing members 420 provided on the sub-board 150 side. Hereinafter, parts different from the above-described first embodiment will be described.

Fig. 31 to Fig. 35 are views describing the structure of a

removable attaching device 154F according to the sixth embodiment of the present invention. Specifically, Fig. 31 is a plan view of one of removable attaching devices 154F seen from above, which are provided at four corners of the sub-board 150. Fig. 32 is a side view of the removable attaching device 154F of Fig. 31. Fig. 33 is a cross-sectional view for describing a manner of attaching the removable attaching device 154F of Fig. 32. On the other hand, Fig. 34 is a view corresponding to Fig. 33 and is a cross-sectional view for describing a manner of removing the removable attaching device 154F of Fig. 32. Fig. 35 is a view corresponding to Fig. 31 and is a plan view of the removable attaching device 154F seen from above when the sub-board 150 is removed.

In the removable attaching device 154F according to this embodiment, the structure of the spacer 200 is the same as that of the above-described first embodiment. However, this embodiment is different in that a fixing screw 400, a reinforcing member 420, and a removing screw 440 are included instead of the penetrating bolt member 220 of the above-described first embodiment.

In a shaft part 402 of the fixing screw 400, a screw thread is formed, which is screwed with a thread groove formed in the insertion hole 206 of the spacer 200. That is, in this embodiment, the spacer 200 has the role of female screw, and the fixing screw 400 has the role of male screw. In a head part 404 of the fixing screw 400, a plus-shaped cross hole is formed. Further, on a neck part at the joint between the head part 404 and the shaft part 402, a brim part 406 is formed. This brim part 406 forms a flange projecting from the head part 404, and is formed concentrically with the center axis of the shaft part 402 of the fixing screw 400.

The reinforcing member 420 is inserted in the through hole 156 of the sub-board 150. A through hole 422 is formed in this reinforcing member 420, and a thread groove is formed in a surface of the through hole 422. However, an outer diameter D9 of the shaft part 402 of the fixing screw 400 is smaller than an inner diameter D8 of the through hole 422, and thus the fixing screw 400 will not be screwed into the through hole 422.

On the other hand, an outside diameter D10 of the brim part 406 of the fixing screw 400 is formed to be larger than the inner diameter D8 of the through hole 422. Thus, when the fixing screw 400 is screwed into the insertion hole 206 of the spacer 200, the sub-board 150 can be clamped by the top surface 208 of the spacer 200 and the brim part 406.

A flange 424 is formed at a portion of the reinforcing member 420 which contacts the top surface 208 of the spacer 200. This flange 424 contacts the rear face 150a of the sub-board 150 and extends in a circumferential direction from the reinforcing member 420, and has a role of preventing pulling out of the reinforcing member 420 when the sub-board 150 is removed, by supporting the sub-board 150 from a lower side and reinforcing the coupling between the sub-board 150 and the reinforcing member 420.

When the sub-board 150 is attached to the burn-in board BIB by using such removable attaching devices 154F, first, the positions of the through holes 422 of reinforcing members 420 provided at four corners of one sub-board 150 are aligned with the positions of the insertion holes 206 of the spacers 200 corresponding thereto. By this operation, the connectors 152 provided on the rear face 150a of the sub-board 150 are inserted in the sockets 170 provided on the front face 302 of the base board BB, and the five connectors 152 and the five sockets 170 are connected electrically to each other.

Subsequently, one end side 408 of the shaft part 402 of the fixing screw 400 is inserted through the through hole 422 of each reinforcing member 420, and is screwed into the insertion hole 206 of a spacer 200. Specifically, a tool such as a Phillips screwdriver is inserted in the cross hole formed in the head part 404 of the fixing screw 400, and the fixing screw 400 is rotated in the fastening direction, thereby screwing and fastening the one end side 408 of the shaft part 402 into the insertion hole 206 of the spacer 200. Thus, the sub-board 150 is clamped between the brim part 406 located at the head part 404 of the fixing screw 400 and the top surface 208 of the spacer 200, and thereby the

sub-board 150 as a fastened object can be attached to the base board BB.

When the attached sub-board 150 is removed from the base board BB, first, fastened fixing screws 400 are removed. Specifically, each of the fixing screws 400 of the removable attaching devices 154F located at four corners of the sub-board 150 is rotated in the reverse-fastening direction which is a direction reverse to the fastening direction. Then, each of the fixing screws 400 is removed from the insertion hole 206 of the spacer 200, and is also removed from the through hole 422 of the reinforcing member 420.

Subsequently, as shown in Fig. 34 and Fig. 35, the removing screw 440 is inserted in the through hole 422 of each reinforcing member 420. Specifically, a screw thread is formed in a shaft part 442 of the removing screw 440 and is screwed with the thread groove formed in the through hole 422 of the reinforcing member 420. That is, in this embodiment, the through hole 422 has the role of female screw, and the removing screw 440 has the role of male screw. In a head part 444 of this removing screw 440, a plus-shaped cross hole similar to that of the fixing screw 400 is formed. When the sub-board 150 is removed, a tool such as a Phillips screwdriver is inserted in this cross hole, and the removing screw 440 is rotated in an entering direction which causes the removing screw to enter the through hole 422.

An outer diameter D11 of the shaft part 442 of the removing screw 440 is formed to be larger than an inner diameter D12 of the insertion hole 206 of the spacer 200. Further, a tip portion 446 of the shaft part 442 of the removing screw 440 is formed as a flat face. Thus, when the shaft part 442 of the removing screw 440 proceeds in the through hole 422 of the reinforcing member 420 and reaches a lower end of the through hole 422, the tip portion 446 of the shaft part 442 abuts on the top surface 208 of the spacer 200.

In this state, when the removing screw 440 is rotated further in the entering direction, the sub-board 150 floats up in a removing direction accompanying the rotation of the screw thread

of the shaft part 442 of the removing screw 440. That is, by sliding movement of the screw thread of the shaft part 442 of the removing screw 440 and the thread groove of the through hole 422 of the reinforcing member 420, the sub-board 150 moves in a direction to depart from the spacer 200, and the sub-board 150 rises upward.

By performing this operation on removing screws 440 provided at four corners of the sub-board 150, the sub-board 150 can be floated gradually to a position higher than the sockets SKT of the burn-in board BIB. This creates a state that the sub-board 150 can be removed easily.

Further, when the removing screw 440 is rotated in the inserting direction, the removing operation can be performed while keeping a horizontal state of the sub-board 150 by rotating the removing screws 440 at four corners of the sub-board 150 in order by the same rotation number. For example, by repeating an operation to rotate each of the removing screws 440 at four corners in order by 1/4 rotation, the sub-board 150 can be removed from the base board BB without causing distortion of the sub-board.

By thus structuring the removable attaching device 154F, a screw having a general shape and structure can be used for the fixing screw 400 and the removing screw 440. Thus, the manufacturing cost of the removable attaching device 154F can be reduced.

[Modification Examples for the Embodiments]

The present invention is not limited to the above-described embodiments, and can be changed in various ways. For example, in the above-described embodiments, the present invention is described with an example in which the fastened object of the removable attaching devices 154A to 154F is the sub-board 150. However, the fastened object to be attached by the removable attaching devices 154A to 154F is not limited to the sub-board 150, and various types of fastened objects may be attached to the member as a base board. For example, when a sub-board to be

some kind of reinforcement is attached as a fastened object to the above-described driver board 120 and extension board 130, the removable attaching devices 154A to 154F according to the present invention can be used. Further, when a sub-board to be some kind of reinforcement is attached as a fastened object to a base board not only in the burn-in apparatus 10 but also in a tester apparatus or the like, the removable attaching devices 154A to 154F according to the present invention can be used.

Moreover, in the above-described embodiments, the removable attaching devices 154A to 154F are used at four positions to fasten one sub-board 150 to the base board BB of the burn-in board BIB, but the fastening positions and the number thereof can be changed arbitrarily. For example, the removable attaching devices 154A to 154F may be used at two, three, five, or six positions or the like to fasten one sub-board 150 to the base board BB of the burn-in board BIB.

Furthermore, the shapes and structures of the spacer 200, the penetrating bolt member 220, the washer 240, the nut member 260, and so on of the removable attaching devices 154A to 154E in the above-described first embodiment to fifth embodiment are merely examples, and can be changed in various ways depending on the size, material, and so on of the base board BB and the sub-board 150. Likewise, the shapes and structures of the spacer 200, the fixing screw 400, the reinforcing member 420, the removing screw 440, and so on of the removable attaching device 154F in the above-described sixth embodiment are merely examples, and can be changed in various ways depending on the size, material, and so on of the base board BB and the sub-board 150.

CLAIMS

1. A removable attaching device comprising:

a first fixing member provided fixedly on a base board and having an insertion hole formed therein, the insertion hole having a role of female screw;

a penetrating member having a role of male screw with respect to the insertion hole of the first fixing member, the penetrating member having one end side and the other end side, the one end side being screwed into the insertion hole of the first fixing member when the penetrating member is rotated in a fastening direction, the other end side being inserted in a through hole of a fastened object, and the penetrating member further having a flange formed in an intermediate part between the one end side and the other end side; and

a second fixing member located on the other end side of the penetrating member, the second fixing member operating in cooperation with the flange of the penetrating member to clamp the fastened object,

wherein by rotating the penetrating member in a reverse-fastening direction which is reverse to the fastening direction, the flange moves the fastened object in a direction to depart from the first fixing member.

2. The removable attaching device according to claim 1, wherein

the other end side of the penetrating member has the role of male screw,

the second fixing member is formed of a nut member having a role of female screw, and

the nut member is placed on from the other end side of the penetrating member and rotated in the fastening direction to fasten the nut member onto the penetrating member, thereby clamping the fastened object by the nut member and the flange.

3. The removable attaching device according to claim 2,

wherein a slot is formed in a tip portion of the other end side of the penetrating member, and by inserting a tool in the slot, it is possible to rotate the penetrating member in the fastening direction and the reverse-fastening direction.

4. The removable attaching device according to claim 2, wherein a hexagonal hole is formed in a tip portion of the other end side of the penetrating member, and by inserting a tool in the hexagonal hole, it is possible to rotate the penetrating member in the fastening direction and the reverse-fastening direction.

5. The removable attaching device according to claim 2, wherein a flat portion having flat faces opposing each other is formed on a tip portion of the other end side of the penetrating member, and by holding the flat portion with a tool, it is possible to rotate the penetrating member in the fastening direction and the reverse-fastening direction.

6. The removable attaching device according to claim 1, wherein

a groove extending around a circumference of the penetrating member is formed in an insertion intermediate part between the other end side and the flange of the penetrating member,

a stopper member inserted in the groove forms the second fixing member, and

the fastened object is clamped by the stopper member inserted in the groove and the flange.

7. The removable attaching device according to claim 1, wherein

a head part formed on the other end side of the penetrating member forms the second fixing member, and

the through hole of the fastened object has a U-shape in plan view, a part of which is opened in an edge portion of the fastened object, and it is possible to insert the penetrating member

in the through hole via this opening in a lateral direction of the fastened object, and the fastened object is clamped by the head part and the flange.

8. A burn-in board, comprising a sub-board attached to the burn-in board by the removable attaching device according to any one of claim 1 to claim 7, wherein the fastening object is the sub-board to be attached to the burn-in board.

9. The burn-in board according to claim 8, wherein

a plurality of sockets are provided on the burn-in board, devices under test being inserted in the plurality of sockets, and

a height of the sub-board attached to the burn-in board is lower than a height of the plurality of sockets.

10. The burn-in board according to claim 9, wherein four corners of the sub-board are fastened to the burn-in board using the removable attaching devices according to any one of claim 1 to claim 7.

11. A removable attaching device comprising:

a first fixing member provided fixedly on a base board and having an insertion hole formed therein, the insertion hole having a role of female screw;

a first screw member having a role of male screw with respect to the insertion hole of the first fixing member, the first screw member having one end side and the other end side, the one end side being screwed into the insertion hole of the first fixing member when the first screw member is rotated in a fastening direction, and the other end side being provided with a head part operating in cooperation with the first fixing member to clamp the fastening object, the first screw member being not screwed with a through hole having a role of female screw formed in the fastened object, and

a second screw member which is screwed with the through hole formed in the fastened object but which is not screwed into

the insertion hole of the first fixing member,

wherein in a state that the first screw member has been pulled out, the second screw member is screwed with the through hole of the fastened object, and the second screw member is rotated in an entering direction which causes the second screw member to enter the through hole, to thereby move the fastened object in a direction to depart from the first fixing member.