

AUTOMATIC MULTIPLE SORTING APPARATUS FOR INTEGRATED
CIRCUIT PRODUCTS ✓

BACKGROUND OF THE INVENTION

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Field of the Invention

The present invention relates to an automatic sorting
apparatus for automatically carrying out the feeding, pick-up,
and removal of integrated circuit (IC) packages, of various
types, of monitoring burn-in tester (MBT) boards in an MBT
10 process while sorting those packages in accordance with
grades. Particularly, the present invention relates to an
automatic multiple sorting apparatus for IC products which has
an efficient arrangement of constituting elements thereof
15 capable of eliminating the use of a centering unit, sorting IC
products irrespective of their board and tray types, and
allowing the entire machine to be managed by one person,
thereby achieving a reduction in costs and weight while
reducing the sorting time.

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Description of the Prior Art

Generally, sorters for IC products are well known. In
particular, sorters of the tray and tube types are widely
used. However, such conventional sorters have a drawback in
25 that their functions are limited because the whole sorting

operation thereof including operations of inserting and feeding IC products is carried out in a fashion using cams. Due to such an operation using cams, the sorters have a complex arrangement. Furthermore, skilled persons are required in manipulating those sorters. In such sorters, only one IC product is fed to be sorted for every sorting operation that is carried out in a circulating manner. As a result, the whole sorting time is extremely lengthened. This results in a hindrance to mass production.

10 In order to solve the above mentioned problems involved in the conventional sorters, the inventor has recently proposed an automatic sorting machine capable of feeding and sorting a pair of IC terminals for every sorting operation. This automatic sorting machine is disclosed in Korean Patent Application Nos. 96-11049 and 96-67941. The sorting machine includes a centering unit, a DC (direct current) testing unit, an inserting/removing unit, a waiting unit, and a DC rejecting unit. A plurality of tools adapted for pickup or insertion of IC terminals are arranged above those units which constitute a feeding unit. Two tools are associated with each unit and driven by servo motors mounted on those tools, respectively. The centering unit has a pocket in which a lateral moving unit, a longitudinal moving unit, and an actuating unit consisting of a pickup unit and a landing unit are installed.

25 In order to supply and discharge trays, a tray-on unit

and a tray-off unit are also provided in the sorting machine. However, since the tray-on and tray-off units are arranged at the front and rear ends of a rectangular large-size body of the sorting machine, it is required for two persons to
5 manipulate those units. For this reason, there is waste of labor. Furthermore, the complex arrangement of the sorting machine results in an inconvenience in maintenance and repair. In addition, the task of the sorting machine to sort IC products is carried out at a low rate due to a structural
10 limitation of the sorting machine, thereby resulting in a hindrance to mass production.

SUMMARY OF THE INVENTION

15 Therefore, an object of the invention is to provide an improvement over the invention disclosed in the above patent application, and to provide an automatic multiple sorting apparatus for integrated circuit products which has an efficient arrangement of constituting elements thereof capable
20 of eliminating the use of a centering unit, thereby achieving a reduction in costs and weight while efficiently sorting IC products.

In accordance with one aspect, the present invention provides an automatic multiple sorting apparatus for IC
25 products comprising an apparatus body, a tray or tube type

stacker, a pickup unit provided with a plurality of pickup members adapted to pick up IC products from the tray or tube type stacker, a feeding unit adapted to feed the IC products supplied from the pickup unit, a processor adapted to control the feeding unit, a board X-Y-feeder adapted to control X-Y-movements of a burn-in board, an X-Y-Z-feeder adapted to sort the IC products in accordance with grades, further comprising: a board loader and a board unloader arranged at one side end portion of the apparatus body; a direct current (DC) rejecting unit, a tray loading unit and DC testing unit arranged on the apparatus body, in this order, adjacent to the portion of the apparatus body where the board loader and the board unloader are arranged; a Y-table arranged on the apparatus body adjacent to the DC testing unit, the Y-table being provided with a turning/returning unit configured to turn 90°; a bin pocket arranged adjacent to the Y-table; a tray unloading unit arranged adjacent to the bin pocket; and a sorting unit arranged adjacent to the tray unloading unit.

In accordance with another aspect, the present invention provides an automatic multiple sorting apparatus for IC products comprising: a board loader unit arranged on one side end of a body of the apparatus in such a manner that it moves longitudinally and laterally; a tray unloading unit arranged adjacent to the board loader unit; a tray-off loader unit arranged adjacent to the tray unloading unit; an X-Y table and

a tray transfer unit arranged between the tray unloading unit and the tray-off loader unit; a DC testing unit arranged over the tray transfer unit; a removal pocket unit arranged over the X-Y table; a DC rejecting tray, a contact rejecting tray and bin rejecting trays arranged, in this order, adjacent to the tray-off loader unit; a sorting robot disposed over the trays; and a feeding unit arranged over the apparatus body and adapted to feed IC products.

10 BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and aspects of the invention will become apparent from the following description of embodiments with reference to the accompanying drawings in which:

15 FIG. 1 is a schematic block diagram illustrating the entire arrangement of a sorting apparatus according to an embodiment of the present invention;

FIG. 2 is a schematic block diagram illustrating operations of tools according to the present invention;

20 FIG. 3 is a sectional view illustrating a turning/returning unit according to the present invention;

FIG. 4 is a plan view illustrating the operation of the turning/returning unit according to the present invention;

25 FIG. 5 is a schematic block diagram illustrating the entire arrangement of a sorting apparatus according to another

embodiment of the present invention;

FIG. 6 is a schematic block diagram illustrating operations of tools according to the embodiment of the present invention illustrated in FIG. 5;

5 FIG. 7 is a schematic block diagram illustrating process lines according to the embodiment of the present invention illustrated in FIG. 5;

10 FIG. 8 is a schematic sectional view illustrating the entire arrangement of the sorting apparatus illustrated in FIG. 5;

FIG. 9 is a plan view illustrating the entire arrangement of the sorting apparatus illustrated in FIG. 5;

FIG. 10 is a plan view illustrating a tray holding unit according to the present invention;

15 FIG. 11 is a perspective view illustrating a corner holding member included in a tray holding unit according to the present invention;

FIG. 12 is a sectional view illustrating the corner holding member of FIG. 11;

20 FIG. 13 is a perspective view illustrating an intermediate holding member included in the tray holding unit according to the present invention;

FIG. 14 is a sectional view illustrating the intermediate holding member of FIG. 13;

25 FIG. 15 is a sectional view illustrating an impact

absorbing unit used for tools in accordance with the present invention;

FIG. 16 is a sectional view illustrating a pad of the tool, to which the impact absorbing unit is applied, in accordance with the present invention;

FIG. 17 is a schematic sectional view illustrating an overload absorbing unit according to the present invention;

FIG. 18 is a plan view illustrating the condition in which the tools are set to operate in a tray pitch state by a tray pitch adjusting unit in accordance with the present invention;

FIG. 19 is a front view corresponding to FIG. 18;

FIG. 20 is a side view corresponding to FIG. 18;

FIG. 21 is a plan view illustrating the condition in which the tools are set to operate in a board pitch state by the tray pitch adjusting unit in accordance with the present invention;

FIG. 22 is a front view corresponding to FIG. 21;

FIG. 23 is a schematic view illustrating states of a link mechanism included in the tray pitch adjusting unit according to the present invention;

FIG. 24 is an exploded perspective view illustrating the tray pitch adjusting unit according to the present invention;

FIG. 25 is a front view illustrating an operation of the tray pitch adjusting unit according to the present invention;

FIG. 26 is a schematic front view illustrating a sorter transfer moving unit according to an embodiment of the present invention;

5 FIG. 27 is a side view illustrating the sorter transfer moving unit illustrated in FIG. 26;

FIG. 28 is a sectional plan view illustrating the sorter transfer moving unit illustrated in FIG. 26;

FIG. 29 is a schematic view illustrating an operation of the sorter transfer moving unit illustrated in FIG. 26;

10 FIG. 30 is a schematic view illustrating a sorter transfer moving unit according to another embodiment of the present invention;

FIG. 31 is a plan view illustrating a socket opening unit according to the present invention;

15 FIG. 32 is a sectional view illustrating operations of the socket opening unit according to the present invention;

FIG. 33 is a schematic sectional view illustrating an part of the socket opening unit according to the present invention;

20 FIG. 34 is a front view illustrating a part of the socket opening unit according to the present invention;

FIG. 35 is a sectional view illustrating a socket replacing unit according to the present invention, the socket replacing unit being in a coupled state;

25 FIG. 36 is a plan view illustrating the socket replacing

unit in the coupled state;

FIG. 37 is a side view illustrating the socket replacing unit in a separated state; and

FIG. 38 is a cross-sectional view illustrating the socket replacing unit in the coupled state.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a sorting apparatus according to an embodiment of the present invention is schematically illustrated. The sorting apparatus includes a tray or tube type stacker, a pickup unit provided with a plurality of pickup members adapted to pick up IC products from the tray or tube type stacker, a feeding unit adapted to feed the IC products supplied from the pickup unit, a processor adapted to control the feeding unit, a board X-Y-feeder adapted to control X-Y-movements of a burn-in board, an X-Y-Z-feeder adapted to sort the IC products in accordance with the grade. This configuration of the sorting apparatus is similar to those of conventional sorters.

In accordance with the present invention, the sorting apparatus includes a board loader 2 and a board unloader 3 arranged at one side end portion of a body 1 of the sorting apparatus, as shown in FIG. 1. The sorting apparatus also includes a DC rejecting unit 4, a tray loading unit 5 and DC

testing unit 6 arranged on the body 1, in this order, adjacent to the portion of the body 1 where the board loader 2 and board unloader 3 are arranged. Adjacent to the DC testing unit 6, a Y-table 8 is arranged on the body 1. The Y-table 8 is provided with a turning/returning unit 7 configured to turn 90°. The sorting apparatus further includes a bin pocket 9 arranged adjacent to the Y-table 8, a tray unloading unit 10 arranged adjacent to the bin pocket 9, and a sorting unit 11 arranged adjacent to the tray unloading unit 10.

Four tools 12, 13, 14 and 15 are arranged over the above mentioned units installed on the body 1, as shown in FIG. 2. The first tool 12 is arranged in such a manner that it moves horizontally and vertically among the DC rejecting unit 4, tray loading unit 5 and DC testing unit 6 by a servo motor. The second tool 13 is arranged in such a manner that it moves horizontally and vertically between the DC testing unit 6 and Y-table 8. The third tool 14 is arranged in such a manner that it moves horizontally and vertically between the Y-table 8 and bin pocket 9. The fourth tool 15 is arranged in such a manner that it moves horizontally and vertically between the bin pocket 9 and sorting unit 11.

As shown in FIGS. 3 and 4, the turning/returning unit 7 includes a pair of spaced guide rails 16 fixedly mounted on the body 1. The Y-table 8 is supported by the guide rails 16. The turning/returning unit 7 also includes a ball screw 18

rotatably coupled to a servo motor 17 fixed to the body 1. A movable member 19 is engaged with the ball screw 18. The movable member 19 is fixedly mounted to the Y-table 8 in order to move the Y-table 8 along the guide rails 16 by its movement. A rotor 20 is centrally mounted on the Y-table 8. A circular guide 21 is arranged around the rotor 20. A rotating plate 22 is mounted on the rotor 20. The rotating plate 22 is coupled to the guide 21 by means of bearings 23. Board guides 24 are mounted on the rotating plate 22. Sockets are coupled to the board guides 24, respectively.

In accordance with an embodiment of the present invention, a tray-off loader unit 25 is arranged adjacent to the board loader 2 along with the tray unloading unit 10, as shown in FIG. 5. A reject line and a good line are arranged forwardly and rearwardly of the central portion between the tray unloading unit 10 and tray-off loader unit 25, respectively. An X-Y table 26 and a tray transfer unit 27 are arranged between the tray unloading unit 10 and tray-off loader unit 25. The DC testing unit 6 is arranged over the tray transfer unit 27. A removal pocket unit 29 is arranged over the X-Y table 26. A DC rejecting tray 28, a contact rejecting tray 30 and bin rejecting trays 31 are arranged, in this order, adjacent to the tray-off loader unit 25. A sorting robot 32 is disposed over the trays.

A plurality of tools having a transfer function or other

function are arranged over the body 1, as shown in FIG. 6. The first tool 12, which is a transfer tool, is adapted to be fed between the tray unloading unit 10 and the DC testing unit 6. The second tool 13, which is another transfer tool, is adapted to be fed between the removal pocket unit 29 and the tray-off loader unit 25. The third tool 14, which is an insert tool 14, is adapted to be fed between the DC testing unit 6 and a board unit 33. The fourth tool 15, which is a remove tool 15, is adapted to be fed between the board unit 33 and the removal pocket unit 29. The fifth tool 34, which is a sorting tool 34 is adapted to be fed between the DC testing unit 6 and the sorting or DC rejecting unit 10.

As shown in FIGS. 9 and 10, a tray holding unit 40 is provided for the bin rejecting trays 31 in order to attenuate rolling and pitching movements of the bin rejecting trays 31. An impact absorbing unit 60 and an overload absorbing unit 80 are provided at each tool, as shown in FIG. 8. As shown in FIG. 15, the impact absorbing unit 60 includes a spring 67 adapted to damp an impact applied to the associated tool, thereby preventing a pad 62 included in the tool from being worn. The overload absorbing unit 80 includes a regulator 87 in order to absorb an overload applied to the associated tool.

Each tool includes a tool body, and a plurality of several sucking members respectively mounted to the tool body adapted to pick up IC's. In order to adjust the pitch of the

sucking members, a sucking member pitch adjusting unit 90 is provided. The sucking member pitch adjusting unit 90 includes a link fixedly mounted at one end thereof to the body of the associated tool and at the other end thereof to a movable
5 member operated by a rotating cylinder. As the rotating cylinder rotates, the movable member moves the associated sucking members toward or away from one another.

As shown in FIG. 8, a sorter transfer moving unit 110 is included in the sorting apparatus. The sorter transfer moving
10 unit 110 includes a servo motor arranged at one side of the sorting unit 11 and a fixed shaft spaced apart from the servo motor by a distance corresponding to a desired movement distance of a transfer unit for each tool. A driven pulley is mounted to the fixed shaft. Driven pulleys are also mounted
15 to the transfer unit. A belt formed with teeth extends via the servo motor and the driven pulleys provided at the fixed shaft and transfer unit. By such a configuration, when the servo motor rotates, the belt moves, thereby causing the transfer unit to move laterally.

20 A socket opening unit 130 is provided at a DC unit which has sockets receiving IC products to be tested, as shown in FIG. 9. When the first tool supplies an IC product, the corresponding socket is automatically opened by an associated one of cylinders included in the socket opening unit 130.
25 After the socket receives an IC product from the first tool,

it accurately holds the received IC product. In accordance with the present invention, the sorting apparatus also includes a socket replacing unit 140 provided at the DC unit, as shown in FIG. 9. The socket replacing unit 140 is
5 configured to directly mount the sockets on a circuit board included in the DC unit. Accordingly, it is possible to achieve a simple replacement of sockets by separating the circuit board itself from the body of the DC unit.

As shown in FIG. 10, the tray holding unit 40 includes a
10 tray holding plate 43 mounted on a feeding unit body 41. A plurality of trays 42 are laid on the tray holding plate 43. The tray holding unit 40 also includes a plurality of corner holding members 46 mounted on the feeding unit body 41 at respective corners of the tray holding plate 43, a plurality
15 of intermediate holding members 47 mounted on the feeding unit body 41 at positions corresponding respectively to the side surfaces of the trays laid on the tray holding plate 43, and a plurality of end holding members 48 mounted on the feeding unit body 41 at positions corresponding respectively to the
20 rear ends of the trays laid on the tray holding plate 43.

As shown in FIGS. 11 and 12, each corner holding member 46 includes an L-shaped body, and a tray supporting portion 49 protruding inwardly from the inner surface of the body of the corner holding member 46 to support a tray 42 seated thereon.
25 The corner holding member 46 also includes a stepped through

hole 51 formed through one leg of the corner holding member body. An urging pin 45, which has a head at its upper end, is received in the through hole 51. A compression coil spring 44 is arranged around the urging pin 45 in the through hole 51.

5 The compression coil spring 44 serves to urge the urging pin 45 away from the through hole 51. A snap ring 52 is fitted around the lower end of the urging pin 45. Referring to FIGS. 13 and 14, the configuration of the intermediate holding members 47 is illustrated. Since the basic configuration of

10 the intermediate holding members 47 is similar to that of the corner holding members 46.

Where the impact absorbing unit 60 is applied to a tool configured to move vertically by a servo motor and provided at its lower end with a sucking pad adapted to pick up an IC, it

15 includes an actuating rod 63 extending upwardly from the upper end of a body 61 of the associated tool, as shown in FIG. 15. In FIG. 15, the pad, which is provided at the lower end of the tool body 61, is denoted by the reference numeral 62. A fixing plate 64 is fitted around the actuating rod 63. The

20 fixing plate 64 has a coupling hole 66 through which the actuating rod 63 extends vertically. A guide bearing 65 is fitted in the coupling hole 66 around the actuating rod 63. A compression coil spring 67 is also fitted around the actuating rod 63 between the upper surface of the tool body 61

25 and the lower surface of the fixing plate 64.

Referring to FIG. 16, the configuration of the sucking pad 62 is illustrated. As shown in FIG. 16, the sucking pad 62 includes a pad body 71 having a vertical outer surface and a stepped central hole 70. A sucking portion 69 is formed at the lower end of the sucking pad 62. The sucking portion 69 has upwardly-inclined surfaces 68.

Where the overload absorbing unit 80 is applied to a tool 81 having a configuration shown in FIG. 17, namely, including a fixed tool body 88, a servo motor 82 fixedly mounted on the fixed tool body 88, a guide bar 83 extending downwardly from the lower end of the fixed tool body 88, and a movable member 85 slidably mounted to the guide bar 83 and provided with a sucking member 84, it includes a cylinder 86 connected to the movable member 85 to vertically move the movable member 85 along the guide bar 83, and an overload absorbing regulator 87 connected to the cylinder 86.

Referring to FIGS. 18 to 25, the configuration of the sucking member pitch adjusting unit 90 is illustrated. The sucking member pitch adjusting unit 90 includes a support bar 92 mounted to the central portion of the tool body denoted by the reference numeral 91 in FIGS. 18 to 22. A rotating cylinder 93 is fixed to the central portion of the support bar 92. As shown in FIG. 24, a rotating rod 94 is fixedly mounted at one end thereof to the shaft of the rotating cylinder 93. The rotating rod 94 is provided at the other end thereof with

a bearing 95. Another support bar 97, which extends vertically, is mounted to the upper end of the tool body 91. A movable member 96 is fixedly mounted to the upper end of the support bar 97 behind the support bar 97. A pair of switches
5 104 are arranged at opposite sides of the movable member 96 while being spaced from the opposite ends of the movable member 96, respectively. A guide groove 98 is defined by the front surface of the support bar 97. The bearing 95 of the rotating rod 94 is received in the guide groove 98. A link
10 mechanism 99 is connected at one end thereof to the lower end of the support bar 97. The other end of the link mechanism 99 is fixed to the tool body 91.

The link mechanism 99 includes a plurality of first links 101 and a plurality of second links 102 connected to the first
15 links 101 in a crossing manner. The sucking members, which is denoted by the reference numeral 100, of the associated tool are fixed to the cross points 103 of the link mechanism 99 where the first and second links 101 and 102 cross.

As shown in FIG. 26, the sorter transfer moving unit 110
20 includes a servo motor 113 arranged at one side of the apparatus body 111. A drive pulley 112 is fixedly mounted to the shaft of the servo motor 113. The fixed shaft, which is denoted by the reference numeral 115, is horizontally spaced apart from the drive pulley 112 of the servo motor 113. In
25 FIG. 26, the driven pulley, which is rotatably mounted to the

fixed shaft 115, is denoted by the reference numeral 114. As mentioned above, the transfer unit mounted to the upper end of the tool and denoted by the reference numeral 117 is provided with a pair of spaced driven pulleys denoted by the reference numerals 118 and 119. In FIG. 26, the tool is denoted by the reference numeral 116. The belt formed with teeth and denoted by the reference numeral 121 is fixed at one end thereof to the body 111 beneath the servo motor 113. The belt 121 extends via the driven roller 118 of the transfer unit 117, the drive pulley 112 of the servo motor 113, the driven pulley 114 of the fixed shaft 115, and the driven roller 119 of the transfer unit 117, in this order. The other end of the belt 121 is fixed to the body 111 beneath the fixed shaft 115.

Alternatively, the sorter transfer moving unit 110 may have a configuration shown in FIG. 30. In this case, the servo motor 113 is mounted to the lower portion of the body 111 at one side of the body 111. The fixed shaft 115 is mounted to the body 111 while being horizontally spaced apart from the servo motor 113. The transfer unit 117 is arranged at a level higher than those of the servo motor 113 and fixed shaft 115. A pair of pulleys are mounted to the transfer unit 117. Pulleys 122 are also mounted to the fixed shaft 115 and servo motor 113, respectively. A belt 124 having no tooth extends via one pulley of the transfer unit 117, the pulley 122 of the servo motor 113, the pulley 122 of the fixed shaft

115, and the other pulley of the transfer unit 117. A tension adjusting pulley 123 is arranged between the servo motor 113 and fixed shaft 115 to tense the belt 123.

Referring to FIGS. 31 to 33, the configuration of the socket opening unit 130 is illustrated. As shown in FIGS. 31 to 33, the socket opening unit 130 includes an actuating plate 135 from which guide rods 134 protrude downwardly. The guide rods 134 of the actuating plate 135 are inserted into coupling holes 133 formed in the upper surface of the DC unit body denoted by the reference numeral 131 at the corners of the DC unit body 131, respectively, when the actuating plate 135 is mounted to the DC unit body 131. The actuating plate 135 is provided with a plurality of insertion holes 136 corresponding to the sockets 132 of the DC unit, respectively. A pair of depressing protrusions 137 are provided on the actuating plate 135 at opposite sides of each insertion hole 136. A pair of cylinders 138 are connected to opposite ends of the actuating plate 135 in such a manner that it moves the actuating plate 135 vertically.

Referring to FIGS. 35 to 38, the configuration of the socket replacing unit 140 is illustrated. The socket replacing unit 140 includes a guide plate 143 mounted on the DC unit body denoted by the reference numeral 141. The guide plate 143 is provided with guide grooves 142. A fixing plate 146, which has openings 145 adapted to expose the sockets of

the DC unit, is fixed to the upper surface of the circuit board denoted by the reference numeral 144 at one side of the circuit board 144. The circuit board 144 has connection terminals 148 at the other side thereof. The fixing plate 146
5 also has an extension 149 and a coupling hole 150 formed at the extension 149. Sockets 147 are directly mounted on the circuit board 144 at positions corresponding to the openings 145 of the fixing plate 146, respectively. The DC unit body 141 is provided at its inner central portion with a coupling
10 hole 151. The fixing plate 146 is inserted along the guide grooves 143 of the guide plate 143 in such a manner that the coupling hole 150 is vertically aligned with the coupling hole 151 of the DC unit body 141. A fixing pin 152 is fitted into the aligned coupling holes 150 and 151. Thus, the circuit
15 board 144 is firmly coupled to the DC unit body 141.

Now, the operation of the sorting apparatus having the above mentioned configuration according to the present invention will be described.

As shown in FIG. 1, a tray, on which IC products are
20 laid, is first loaded on the tray loading unit 5. Thereafter, a board, on which IC products are laid, is loaded on the board loading unit 2.

When the board is loaded on the board loading unit 2, it is fed to the board feeder by the feeding unit. The board is
25 then fed to the Y-table 8 under the condition in which it is

coupled to a connector included in the sorting unit 11. In this state, the board on the Y-table 8 is rotated 90° by the turning/returning unit 7.

That is, when the board is fed to the Y-table 8, it is positioned on the rotating plate 22 mounted on the Y-table 8, At this time, the rotating plate 22 is rotated by the rotor 20 mounted on the central portion of the Y-table 8. The rotation of the rotating plate 22 is smoothly carried out as the bearing 23 mounted to the lower surface of the rotating plate 22 slides along the guide 21 mounted on the Y-table 8.

After the rotating plate 22 rotates 90°, the servo motor 17 drives, thereby rotating the ball screw 18. As a result, the movable member 19 engaged with the ball screw 18 moves, so that the Y-table 8 moves to a process line where the first, second and third tools 12, 13 and 14 operate.

In other words, four IC products, which have completed their test, are fed to the bin pocket 9 or tray unloading unit 10 by the third tool 14 in accordance with their grades. IC products of a poor quality are fed from the bin pocket 9 to the sorting unit 11 by the fourth tool 15.

After the board is empty in accordance with the above feeding operation, the first tool 12 feeds again four IC products from the tray to the DC testing unit 6. At the same time, IC products present in the DC testing unit 6 are fed to the board by the second tool 13.

The IC products fed to the board are in a test-completed state. These test-completed IC products are sorted in accordance with their grades and removed from the board by the third and fourth tools 14 and 15. Thereafter, the first and
5 second tools 12 and 13 operate to insert new IC products, to be tested, into empty portions of the board.

The third tool 14 feeds IC products of a poor quality to the bin pocket 9 whereas it feeds IC products of a good quality to the tray unloading unit 10. The poor IC products
10 received in the bin pocket 9 are fed to trays of the sorting unit 11 selected in accordance with their grades, respectively.

After the sorting of IC products is completed as mentioned above, the Y-table 8 and rotating plate 22 return to
15 their original positions in accordance with operations carried out reversely to the above mentioned operations. At the same time, a new tray and a new board are supplied again from the tray loading unit 5 and board loading unit 2, respectively. In this state, the above operations are repeated.

20 Meanwhile, in the case of the arrangement illustrated in FIGS. 5 and 6, the first tool, a transfer tool 12 feeds IC products from the board loading unit 2 to the DC testing unit 6. After the DC testing unit 6 completes a test for the IC products fed thereto, the third tool, an insert tool 14 feeds
25 the IC products from the DC testing unit 6 to the board unit

33.

In the board unit 33, the IC products are sorted into those of a good quality and those of a poor quality. The fourth tool, a remove tool 15 feeds IC products of a good quality from the board unit 33 to the removal pocket unit 29. These IC products are then fed from the removal pocket unit 29 to the tray-off loader unit 25 by the second tool, a transfer tool 13.

On the other hand, the fifth tool, a sorting tool 34 feeds IC products of a poor quality from the board unit 33 to the DC rejecting unit 30.

The function of the tray holding unit 40 will now be described in detail.

As mentioned above in conjunction with FIGS. 10 to 14, each corner holding member 46 of the tray holding unit 40 includes an urging pin 45 received in the through hole 51, and the compression coil spring 44 arranged around the urging pin 45 in the through hole 51. The compression coil spring 44 serves to urge the urging pin 45 away from the through hole 51. Accordingly, the head of the urging pin 45 always protrudes from the through hole 51. The snap ring 52, which is fitted around the lower end of the urging pin 45, serves to prevent the urging pin 45 from separating from the through hole 51.

The corner holding members 46, each having one urging

pin, are mounted on the feeding unit body 41 at respective corners of the tray holding plate 43. Intermediate holding members 47, each having two urging pins, are mounted on the feeding unit body 41 at positions corresponding respectively to the adjacent side surfaces of the trays laid on the tray holding plate 43.

Where a tray 42 is to be seated on the tray holding plate 43, it is positioned on the tray holding plate 43 in such a manner that its rear end is laid on one of end holding members 48 mounted at the rear end portion of the tray holding plate 43. In this state, the tray 42 is pushed against the urging pin 45 of the end holding member 48 mounted on the front portion of the tray holding plate 43, thereby causing the urging pin 45 to be withdrawn while compressing the compression coil spring 44. As a result, once the tray 42 is seated on the tray supporting portion 49 of the end holding member 48, it is firmly held by the resilience of the compression coil spring 44 applied thereto toward the end holding member 48 via the urging pin 45.

Since each tray 42 seated on the tray holding plate 43 is held by only one holding member, it is easy to mount the tray on the tray holding plate 43 and to separate the tray from the tray holding plate 43. Since the tray 42 is firmly held in the above mentioned manner, it is possible to prevent the tray and IC products thereon from being separated when the feeding

unit moves at a high speed. The compression coil spring 44 also serves to attenuate vibrations of the tray 42 generated during the movement of the feeding unit. Accordingly, it is possible to more effectively prevent the separation of the tray and IC products thereon.

Now, the function of the impact absorbing unit 60 will be described in detail.

When the fixing plate 64 moves downwardly by an operation of the associated servo motor, the pad 62 coupled to the lower end of the tool body 61 moves downwardly and comes into contact with an IC product. As a result, the sucking portion 69 of the pad 62 uniformly depresses the IC product. Since the sucking portion 69 of the pad 62 has a sharp lower end defined by the inclined surfaces 68, impact generated when the sucking portion 69 comes into contact with the IC product is effectively absorbed into the sucking portion 69. In this state, air sucking is carried out through an air sucking hole formed at the central portion of the tool body 61, thereby forming vacuum between the pad 62 and the IC product. As a result, the IC product is held on the lower end of the pad 62.

When overload is applied to the pad 62 during the above operation, the tool body 61 moves upwardly while compressing the compression coil spring 67 arranged between the tool body 61 and the fixing plate 64. As a result, the actuating rod 63 extending upwardly from the tool body 61 moves upwardly along

the guide bearing 65 mounted on the fixing plate 64.

After the IC product is held on the pad 62, the fixing plate 64 moves upwardly by an operation of the servo motor. At the same time, the tool body 61 returns to its original position by the resilience of the compression coil spring 67. Thus, the pad 62 holds the IC product in a horizontal state. Accordingly, it is possible to easily and accurately insert the IC product into the associated socket.

Now, the function of the regulator 85 will be described in detail, in conjunction with FIG. 17.

Where the tool 81 is desired to feed an IC product, it first turns by a desired angle by an operation of the associated motor so that it is arranged in the same direction as the IC product. Thereafter, the movable member 85 moves downwardly by an operation of the cylinder 86 connected to the movable member 85 and comes into contact with the IC product. In this state, the IC product is picked up by the sucking member 84.

When the sucking member 84 has an insufficient width or when the socket opening member of the tool 81 cannot open the socket, it is impossible to pick up the IC product even when the sucking member 84 comes into contact with the IC product as the movable member 85 moves downwardly by the operation of the cylinder 86. In this case, the regulator 87 detects such error. Based on the detection of error, the operator checks

the erroneous sucking member or socket.

Where the socket opening member of the tool 81 cannot open the socket, the associated IC product may be damaged. In this case, the regulator 87 absorbs force applied to the tool 81, thereby protecting the IC product.

The operation of the sucking member pitch adjusting unit 90 will now be described in conjunction with FIGS. 18 to 25.

Referring to FIG. 19, the sucking members 100 of the tool body 91 are in a tray pitch state. Where it is desired to increase the pitch of the sucking members 100 from the tray pitch state of FIG. 19 to a board pitch state, the rotating cylinder 93 first rotates clockwise (in the illustrated case), thereby rotating the rotating rod 94. At this time, the bearing 95 mounted to the outer end of the rotating rod 94 slides downwardly along the guide groove 98 of the support bar 97 while pushing the support bar 97 in the right direction.

As the support bar 97 moves right, the movable member 96 fixedly mounted to the upper end of the support bar 97 behind the support bar 97 moves from its left position corresponding to the left switch 104 to its right position corresponding to the right switch 104. When the movable member 96 reaches its right position, it switches on the right switch 104. When the right switch 104 switches on, the right movement of the support bar 97 is stopped.

As the support bar 97 moves in a desired direction as

mentioned above, the sucking members 100 mounted to the lower end of the support member 97 by the link mechanism 99 move correspondingly. In this case, since the sucking members 100 are coupled to the cross points 103 of the link mechanism 99, they move by a distance corresponding to the movement distance of the cross points 103.

Since the sucking members 100 are coupled to the cross points 103 of the link mechanism 99 which move along a horizontal line, they move horizontally at a fixed level. Accordingly, the sucking members 100 safely pick up IC products.

Where it is desired to adjust the set pitch of the tool, a desired lateral length of the movable bar 96 is calculated. Based on the result of the calculation, the movable bar 96 is replaced with a new one having a desired lateral length. Since the switch-on/off interval of the switches 104 depends on the lateral length of the movable bar 96, it is possible to set a desired pitch of the tool by selecting a desired lateral length of the movable bar 96.

Now, the operation of the sorter transfer moving unit 110 will be described in conjunction with FIGS. 26 and 29.

When the servo motor 113 drives, the drive pulley 112 fixedly mounted to the shaft of the servo motor 113 rotates, so that the belt 121 having teeth 120 engaged with the drive pulley 112 moves left or right around the drive pulley 112 and

the driven pulley 114 rotatably mounted to the fixed shaft 115.

As the belt 121 moves, it pulls the transfer unit 117 in the same direction as the movement direction thereof while rotating the driven rollers 118 and 119. Accordingly, the tool 116 moves in the same direction as the movement direction of the belt 121.

Since the belt 121 is fixed at its opposite ends to the sorter body, it is subjected to tension at its portion extending between one end thereof and the drive pulley 112 via the driven roller 118 of the transfer unit 117 and at its portion extending between the other end thereof and the driven pulley 114 via the driven roller 119 of the transfer unit 117 during the operation of the servo motor 113. By virtue of the tension, the tool 116 moves left or right.

In the case of FIG. 30, the belt 124 moves by a rotation of the pulley 122 resulting from an operation of the servo motor 113. In accordance with the movement of the belt 124, the transfer unit 117 moves, thereby causing the tool 116 to move. At this time, the tension generated when the belt 123 moves is automatically adjusted by the tension adjusting pulley 123 arranged between the servo motor 113 and fixed shaft 115. Accordingly, it is possible to accurately move the tool 116.

The operation of the socket opening unit 130 will now be

described in conjunction with FIGS. 31 to 33.

Where the first tool picks up IC products and feeds them to the DC unit, the socket opening unit 130 (FIG. 31), arranged over the body 131 of the DC unit, operates to open
5 the sockets 132. After the IC products are inserted into the sockets 132, the socket opening unit 130 returns to its original position so that the sockets 132 hold the IC products.

That is, when the first tool reaches the DC unit, the
10 cylinders 138 arranged at the opposite sides of the DC unit body 131 operate to downwardly move the actuating plate 135 arranged above the sockets 132.

As the actuating plate 135 moves downwardly, the depressing protrusions 137 provided on the actuating plate 135
15 at opposite sides of each insertion hole 136 depress the opposite portions of the associated socket 132, thereby opening the socket 132. In this state, the IC products are inserted into the open socket 132.

After the insertion of the IC products by the first tool
20 is completed, the cylinders 138 operating the actuating plate 135 return to their original positions. As a result, the depressing protrusions 137 depressing the socket 132 return to their original positions. At this time, the socket 132 holds the IC products received therein by its resilience.

25 In this state, the IC products held in the socket 132 are

tested. After the test is completed, the second tool moves to the DC unit. The second tool opens the socket and picks up the tested IC products. Since the second tool has depressing protrusions at its lower end, the depressing protrusions automatically depress the sockets when the second tool reaches those sockets, thereby opening the sockets.

Finally, the operation of the socket replacing unit 140, which is used to replace a damaged socket 147 with a new one, will be described in conjunction with FIGS. 35 to 38.

When a damaged socket 147 is to be replaced with a new one, connectors are first separated from the connection terminals of the circuit board 144. Thereafter, the fixing pin 152 coupled to the DC unit body 141 is separated by pulling it up. In this state, the fixing plate 146 fixed to the circuit board 144 is laterally pulled along the guide grooves 142 of the guide plate 143 fixed to the DC unit body 141, so that it is separated from the DC unit body 141.

In this state, it is possible to replace the damaged socket 147 on the circuit board 144 with a new one. After the replacement, the fixing plate 146 is assembled to the DC unit body 141 in accordance with an operation reverse to the above mentioned operation. The assembling of the fixing plate 146 is completed by coupling the fixing pin 152 to the DC unit body 141.

As apparent from the above description, the present

invention provides an automatic multiple sorting apparatus for IC products which has an efficient arrangement of constituting elements thereof capable of eliminating the use of a centering unit. In accordance with the present invention, guides are
5 provided at the socket depressing unit of the DC testing unit, thereby eliminating the use of the centering unit. In particular, both the units for supplying and removing trays are arranged at one side of the body of the sorting apparatus. Accordingly, it is possible for one person to manage the
10 entire machine. Moreover, the sorting apparatus of the present invention has a configuration using a reduced number of tools, thereby achieving a reduction in costs and weight. Since the sorting apparatus can feed and sort four IC products at one time, it is possible to reduce the sorting time.

15 Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying
20 claims.



WHAT IS CLAIMED IS:

1. An automatic multiple sorting apparatus for IC products comprising an apparatus body, a tray or tube type stacker, a pickup unit provided with a plurality of pickup members adapted to pick up IC products from the tray or tube type stacker, a feeding unit adapted to feed the IC products supplied from the pickup unit, a processor adapted to control the feeding unit, a board X-Y-feeder adapted to control X-Y-movements of a burn-in board, an X-Y-Z-feeder adapted to sort the IC products in accordance with grades, further comprising:
 - a board loader and a board unloader arranged at one side end portion of the apparatus body;
 - a direct current (DC) rejecting unit, a tray loading unit and DC testing unit arranged on the apparatus body, in this order, adjacent to the portion of the apparatus body where the board loader and the board unloader are arranged;
 - a Y-table arranged on the apparatus body adjacent to the DC testing unit, the Y-table being provided with a turning/returning unit configured to turn 90°;
 - a bin pocket arranged adjacent to the Y-table;
 - a tray unloading unit arranged adjacent to the bin pocket; and
 - a sorting unit arranged adjacent to the tray unloading unit.



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2. The automatic multiple sorting apparatus according to Claim 1, wherein the feeding unit comprises:

5 a first tool arranged over the DC rejecting unit, the tray loading unit and the DC testing unit in such a manner that it moves horizontally and vertically among the DC rejecting unit, the tray loading unit and the DC testing unit 6 by a servo motor;

10 a second tool arranged over the DC testing unit and the Y-table in such a manner that it moves horizontally and vertically between the DC testing unit and the Y-table;

a third tool arranged over the Y-table and the bin pocket in such a manner that it moves horizontally and vertically between the Y-table and the bin pocket; and

15 a fourth tool arranged over the bin pocket and the sorting unit in such a manner that it moves horizontally and vertically between the bin pocket and the sorting unit.

3. The automatic multiple sorting apparatus according to Claim 1, wherein the turning/returning unit comprises:

20 a pair of spaced guide rails fixedly mounted on the apparatus body, the guide rails serving to support the Y-table;

a servo motor fixed to the apparatus body;

a ball screw rotatably coupled to the servo motor;

25 a movable member engaged with the ball screw and fixedly

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mounted to the Y-table, the movable member serving to move the Y-table along the guide rails;

a rotor centrally mounted on the Y-table;

a circular guide arranged around the rotor;

5 a rotating plate mounted on the rotor and coupled to the guide by bearings; and

board guides mounted on the rotating plate and mounted with sockets, respectively.

10 4. An automatic multiple sorting apparatus for IC products comprising:

a board loader unit arranged on one side end of a body of the apparatus in such a manner that it moves longitudinally and laterally;

15 a tray unloading unit arranged adjacent to the board loader unit;

a tray-off loader unit arranged adjacent to the tray unloading unit;

20 an X-Y table and a tray transfer unit arranged between the tray unloading unit and the tray-off loader unit;

a DC testing unit arranged over the tray transfer unit;

a removal pocket unit arranged over the X-Y table;

25 a DC rejecting tray, a contact rejecting tray and bin rejecting trays arranged, in this order, adjacent to the tray-off loader unit;



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a sorting robot disposed over the trays; and
a feeding unit arranged over the apparatus body and adapted to feed IC products.

- 5 5. The automatic multiple sorting apparatus according to Claim 4, wherein the feeding unit comprises a plurality of tools arranged over the apparatus body, the tools comprising:
- a first tool, a transfer tool adapted to be fed between the tray unloading unit and the DC testing unit;
- 10 a second tool, a transfer tool adapted to be fed between the removal pocket unit and the tray-off loader unit;
- a third tool, an insert tool adapted to be fed between the DC testing unit and a board unit arranged between the DC testing unit and the remove pocket unit;
- 15 a fourth tool, a remove tool adapted to be fed between the board unit and the removal pocket unit; and
- a fifth tool, a sorting tool adapted to be fed between the DC testing unit and a sorting or DC rejecting unit.
- 20 6. The automatic multiple sorting apparatus according to Claim 4, further comprising:
- a reject line and a good line arranged forwardly and rearwardly of a region centrally defined between the tray unloading unit and the tray-off loader unit, respectively.
- 25

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7. The automatic multiple sorting apparatus according to Claim 6, wherein the DC testing unit comprises sockets moving between the good and reject lines.

5 8. The automatic multiple sorting apparatus according to Claim 4, wherein the board loader unit is arranged at a right portion of the apparatus body having a rectangular shape, wherein a head unit is arranged at left side of the board loader unit and horizontally aligned with the board loader,
10 and wherein a reject line and a good line is arranged forwardly and rearwardly of a portion of the apparatus body arranged beneath the head unit, respectively.

 9. The automatic multiple sorting apparatus according to
15 Claim 4, further comprising:

 a tray holding unit provided for the bin rejecting trays to attenuate rolling and pitching movements of the bin rejecting trays;

 an impact absorbing unit provided for each of the tools
20 to damp an impact applied to the associated tool while preventing a pad of the tool from being worn;

 an overload absorbing unit provided for each of the tools to absorb an overload applied to the associated tool;

 a sucking member pitch adjusting unit provided for each
25 of the tools to adjust a pitch of sucking members included in

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the associated tool and adapted to pick up IC products;

a sorter transfer moving unit provided for each of the tools to horizontally move the associated tool;

5 a socket opening unit provided at a DC unit, which has sockets receiving IC products to be tested, the socket opening unit serving to automatically open the sockets and enabling the open sockets to accurately hold the IC products, respectively; and

10 a socket replacing unit adapted to directly mount the sockets of the DC unit to a circuit board and to enable the circuit board to be separable from a body of the DC unit, thereby enabling a simple replacement of the sockets.

15 10. The automatic multiple sorting apparatus according to Claim 9, wherein the tray holding unit comprises:

a tray holding plate mounted on a body of the feeding unit and adapted to hold a plurality of trays thereon;

20 a plurality of corner holding members mounted on the feeding unit body at respective corners of the tray holding plate;

a plurality of intermediate holding members mounted on the feeding unit body at positions respectively corresponding to side surfaces of the trays laid on the tray holding plate; and

25 a plurality of end holding members mounted on the feeding



unit body at positions respectively corresponding to rear ends of the trays laid on the tray holding plate.

11. The automatic multiple sorting apparatus according to
5 Claim 10, wherein each of the corner holding members comprises:

an L-shaped body;

a tray supporting portion protruding inwardly from an
inner surface of the L-shaped body and adapted to support a
10 tray seated thereon;

a stepped through hole formed through one leg of the L-shaped body;

an urging pin received in the through hole, the urging pin having a head at an upper end thereof;

15 a compression coil spring arranged around the urging pin in the through hole and adapted to urge the urging pin away from the through hole; and

a snap ring fitted around a lower end of the urging pin.

20 12. The automatic multiple sorting apparatus according to Claim 9, wherein, in the case in which each of the tools is configured to move vertically by a servo motor and provided at a lower end thereof with a sucking pad adapted to pick up an IC product, the impact absorbing unit comprises:

25 an actuating rod extending upwardly from an upper end of



a body of the associated tool;

a fixing plate slidably fitted around the actuating rod and provided with a coupling hole through which the actuating rod extends vertically;

5 a guide bearing fitted in the coupling hole around the actuating rod; and

a compression coil spring fitted around the actuating rod between an upper surface of the tool body and a lower surface of the fixing plate.

10

13. The automatic multiple sorting apparatus according to Claim 12, wherein the sucking pad comprises:

a pad body having a vertical outer surface;

15 a stepped central hole vertically formed through the pad body; and

a sucking portion formed at a lower end of the sucking pad body, the sucking portion having upwardly-inclined inner and outer surfaces.

20

14. The automatic multiple sorting apparatus according to Claim 9, wherein, in the case in which each of the tools comprises a fixed tool body, a servo motor fixedly mounted on the fixed tool body, a guide bar extending downwardly from the lower end of the fixed tool body, and a movable member

25 slidably mounted to the guide bar and provided with a sucking



member, the overload absorbing unit comprises:

a cylinder connected to the movable member and adapted to vertically move the movable member along the guide bar; and

5 a regulator connected to the cylinder and adapted to absorb an overload applied to the tool and transmitted to the cylinder.

10 15. The automatic multiple sorting apparatus according to Claim 9, wherein the sucking member pitch adjusting unit comprises:

a first support bar mounted to a central portion of a body of the associated tool;

a rotating cylinder fixed to a central portion of the support bar;

15 a rotating rod fixedly mounted at one end thereof to a shaft of the rotating cylinder and provided at the other end thereof with a bearing;

a second support bar horizontally slidably mounted to an upper end of the tool body while extending vertically;

20 a movable member fixedly mounted to an upper end of the second support bar behind the second support bar;

a pair of switches arranged at opposite sides of the movable member while being spaced from opposite ends of the movable member, respectively, the switches serving to control
25 the rotating cylinder;



a guide groove defined by a front surface of the second support bar and adapted to receive the bearing of the rotating rod, thereby causing the second support bar to move horizontally when the rotating rod rotates by an operation of the rotating cylinder; and

a link mechanism connected at one end thereof to a lower end of the second support bar and fixed at the other end thereof to the tool body, the link mechanism holding the sucking members of the tool in such a manner that the pitch of the sucking members varies in accordance with the horizontal movement of the second support bar.

16. The automatic multiple sorting apparatus according to Claim 15, wherein the link mechanism comprises:

a plurality of first links;
a plurality of second links pivotally connected to the first links in a crossing manner;
fixing pins adapted to pivotally connect the first and second links at points where the first and second links cross, the fixing pins holding the sucking members of the associated tool, respectively.

17. The automatic multiple sorting apparatus according to Claim 9, wherein the sorter transfer moving unit comprises:

a servo motor arranged at one side of the apparatus body;



a drive pulley fixedly mounted to a shaft of the servo motor;

a fixed shaft horizontally spaced apart from the drive pulley of the servo motor;

5 a driven pulley rotatably mounted to the fixed shaft;

a transfer unit mounted to an upper end of the associated tool and provided with a pair of spaced driven pulleys; and

a belt provided with teeth at an inner surface thereof, the belt being fixed at one end thereof to the apparatus body
10 beneath the servo motor and at the other end thereof to the apparatus body beneath the fixed shaft while extending via one driven roller of the transfer unit, the drive pulley of the servo motor, the driven pulley of the fixed shaft, and the other driven roller of the transfer unit, in this order.

15

18. The automatic multiple sorting apparatus according to Claim 9, wherein the sorter transfer moving unit comprises:

a servo motor mounted to a lower end of the apparatus body at one side of the apparatus body;

20 a drive pulley fixedly mounted to a shaft of the servo motor;

a fixed shaft horizontally spaced apart from the drive pulley of the servo motor;

a driven pulley rotatably mounted to the fixed shaft;

25 a transfer unit mounted to an upper end of the associated



tool and provided with a pair of spaced driven pulleys, the transfer unit being arranged at a level higher than the servo motor;

5 a belt fixed at both ends thereof to the apparatus body while extending via one driven roller of the transfer unit, the drive pulley of the servo motor, the driven pulley of the fixed shaft, and the other driven roller of the transfer unit, in this order; and

10 a tension adjusting pulley arranged between the servo motor and the fixed shaft to adjust a tension applied to the belt.

19. The automatic multiple sorting apparatus according to Claim 9, wherein the socket opening unit comprises:

15 coupling holes formed in an upper surface of the DC unit body at corners of the DC unit body, respectively;

an actuating plate provided with guide rods extending downwardly from a lower surface of the actuating plate, the guide rods being inserted into the coupling holes when the
20 actuating plate is coupled to the DC unit body;

a plurality of insertion holes corresponding to the sockets of the DC unit, respectively, the insertion holes being formed in an upper surface of the actuating plate;

25 a pair of depressing protrusions provided on the actuating plate at opposite sides of each of the insertion



holes; and

a pair of cylinders connected to opposite ends of the actuating plate in such a manner that it moves the actuating plate vertically.

5

20. The automatic multiple sorting apparatus according to Claim 9, wherein the socket replacing unit comprises:

a guide plate mounted on the DC unit body and provided with guide grooves; and

10 a fixing plate fixed to an upper surface of the circuit board, on which the sockets of the DC unit is directly mounted, at one side of the circuit board and separably inserted into the guide plate along the guide grooves of the guide plate to fix the circuit board to the DC unit, the
15 fixing plate having openings adapted to expose the sockets of the DC unit when the circuit board is fixed to the DC unit.

21. The automatic multiple sorting apparatus according to Claim 20, wherein the socket replacing unit further comprises:

20 an extension extending from an end of the fixing plate opposite to the circuit board;

a first coupling hole formed at the extension;

a second coupling hole formed at an inner central portion of the DC unit body 149, the second coupling hole being
25 vertically aligned with the first coupling hole when the



circuit board is positioned in position on the DC unit; and
a fixing pin inserted in the aligned coupling holes,
thereby firmly coupling the circuit board to the DC unit body.