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SEMICONDUCTOR DEVICE TESTING APPARATUS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

5 The present invention relates to a semiconductor device testing apparatus with which is connected or integrated a semiconductor device transporting and handling apparatus (commonly called handler) for transporting semiconductor devices (such as semiconductor integrated circuits) to test and sort out the tested semiconductor devices on the basis of the test results, and particularly to improvements on that section of the testing apparatus for testing/measuring semiconductor devices under test (commonly called DUT) which have been brought into the test section of the semiconductor device transporting and handling apparatus (which will be called handler hereinafter) by the handler.

2. DESCRIPTION OF THE RELATED ART

A semiconductor device testing apparatus for testing semiconductor devices has often connected or integrated therewith a handler for transporting semiconductor device under test to subject them to predetermined tests and sort out the tested semiconductor devices on the basis of the test results as noted above. For simplicity of description, in the following disclosure will be taken as an example the semiconductor device testing apparatus (commonly referred to as IC tester) for testing semiconductor integrated circuits

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as will be referred to as IC hereinbelow which are typical of semiconductor devices.

Fig. 6 is a schematic side view illustrating an example of the semiconductor device testing apparatus (which will be called IC tester hereinafter) of the type described above. The IC tester comprises a tester proper (which is known as main frame in the art concerned) 11 in which various electrical circuits, power source or supply and the like are mainly accommodated, a handler 12 equipped with an automatic transporting mechanism for transporting ICs, and a test head 13 electrically connected with but constructed separately from the tester proper 11 and mounted in the test section of the handler 12.

ICs under test which have been transported into the test section by the automatic transporting mechanism of the handler 12 are brought into electrical contact with the test head 13 (specifically the IC socket or sockets mounted on the test head 13), and hence electrically connected with the tester proper 11 through the test head 13 and a bundle of cables 14. A test signal having a predetermined pattern as supplied from the tester proper 11 to the test head 13 through the bundle of cables 14 is applied to the ICs under test, and response signals read out from the ICs under test are transmitted to the tester proper 11 through the test head 13 and the bundle of cables 14, thereby to measure the electric characteristics of the ICs.

The test section of the handler is usually disposed in a

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constant temperature chamber (not shown) for giving a predetermined temperature stress to ICs under test to meet the requirement that ICs under test be tested in an atmosphere at a predetermined temperature. In order to permit ICs under test transported into the test section to be electrically contacted with the IC socket mounted in the test head 13, the constant temperature chamber is provided in its bottom wall with an opening in which there is fitted and fixed a mounting fixture (which is commonly called "Hi-fix Base" or "Test Fixture" in the art concerned) for electrically connecting the test head 13 of the IC tester with the test section in the constant temperature chamber of the handler 12.

Accommodated in the test head 13 are mainly a gang of drivers for applying a predetermined pattern of test signals to ICs under test, a gang of comparators CP for determining whether the output signals read out of the ICs under test are a high (H) logic signal or a low (L) logic signal having a predetermined value of voltage, respectively, and a power line, these components and the power line being electrically connected with the tester proper 11 through the cables 14.

Mounted on the top of the test head 13 is a performance board 30, as shown in Fig. 5, on which there is mounted an IC socket 20 with an adapter socket 40' interposed therebetween. Consequently, in the example shown in Fig. 5, the adapter socket 40' constitutes a mounting fixture. Alternatively, the mounting fixture may comprise a socket board spaced a

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predetermined distance upwardly from and mounted to the performance board 30, and an IC socket 20 mounted directly on the socket board. In this latter case, electrical connection between the performance board 30 and the socket board is established by means of connecting means such as connecting boards, cables, wires or the like. It is to be noted that an adapter socket may be interposed between the socket board and the IC socket 20.

As noted above, the bottom wall of the constant temperature chamber of the handler 12 is typically formed with an opening in which the mounting fixture described above is mounted so that the IC socket 20 mounted either on the top of the performance board 30 via the adapter socket 40' or on the socket board may be located at a predetermined position in the test section within the constant temperature chamber, the arrangement being such that ICs 10 under test which have been brought into the test section by the automatic transporting mechanism are put into electrical contact with the IC socket 20 to test the ICs 10 for their electrical characteristics.

Generally, ICs 10 under test, loaded on a tray, are transported into the test section within the constant temperature chamber where the ICs under test are transferred by transport means from the tray onto the IC sockets 20 to be tested for their electrical characteristics. Upon completion of the testing, the tested ICs are transferred by the transport means from the IC sockets 20 onto the tray,

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followed by being carried on the tray out of the constant temperature chamber. The tested ICs are then sorted out based on the data of the test results. It is to be noted here that the tray for transporting ICs 10 under test into the test section may be the same as or different from the tray used to carrying the tested ICs from the test section and out of the constant temperature chamber. Some handlers may be equipped with no constant temperature chamber.

The transport means for transferring ICs 10 under test from the tray onto the IC sockets 20 and/or the transport means for transferring the tested ICs from the IC sockets 20 onto the tray in the test section are provided with carrier head means having attached thereto a contact arm means 91 as shown in Fig. 5. The transport means includes carrier arm means movable in X and Y directions perpendicular to each other in a horizontal plane so that the carrier head means is movable by the transport means in X and Y directions. The contact arm means 91 is movable in a Z direction (upwardly and downwardly as viewed in Fig. 5) perpendicular to the X and Y directions, and has a pick-up head 92 attached thereto at its tip end. The pick-up head 92 may be either of the configuration to attract and grasp ICs by vacuum suction or of the configuration to grasp ICs by mechanical means such as a chuck.

It is thus to be appreciated that the contact arm means 91 is positioned with respect to the X and Y directions by the transport means where the contact arm means 91 is

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vertically moved and is capable of performing the functions of grasping an IC by means of its pick-up head 92, pressing the grasped IC against the IC socket 20, and releasing the grasped IC. It will be obvious that the carrier head means
5 or other mobile means having the contact arm means 91 thereto may be configured to be movable in the Z direction perpendicular to the X and Y directions.

Fig. 2 diagrammatically illustrates the operation of the transport means and the contact arm means 91 in the test
10 section as described above. The transport means is represented by an X direction mobile means 3X which is driven transversely (in left-right directions of the drawing), a Y direction mobile means 3Y which is driven longitudinally (in upward and downward directions of the drawing), and a Z
15 direction mobile means 3Z which is driven in a direction perpendicular to the X and Y directions (in a direction passing through the plane of the drawing). The contact arm means 91 is affixed to the Z direction mobile means 3Z so that the pick-up head 92 mounted to the tip of the contact
20 arm means is positioned at a predetermined position by the X direction mobile means 3X, the Y direction mobile means 3Y and the Z direction mobile means 3Z.

More specifically, Fig. 2 illustrates the configuration in which the Y direction mobile means 3Y is first driven and
25 positioned in the X direction (as shown in the dotted lines in the drawing) by the X direction mobile means 3X, followed by the Z direction mobile means 3Z being driven and

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positioned in the Y direction by the Y direction mobile means 3Y, and finally the contact arm means 91 being driven in the Z direction by the Z direction mobile means 3Z to position the pick-up head 92 in place.

5 ICs 10 under test, loaded on the tray 110, have been transported into the test section 600 where the X direction mobile means 3X, the Y direction mobile means 3Y and the Z direction mobile means 3Z are driven as described above to move the pick-up head 92 of the contact arm means 91 to a
10 position above an IC 10 under test and bring the head into abutment with the IC to grasp it by virtue of vacuum suction or by mechanical means.

Then, the X direction mobile means 3X, the Y direction mobile means 3Y and the Z direction mobile means 3Z are
15 driven in the reverse procedure to transfer the IC 10 under test grasped by the pick-up head 92 to a position above the IC socket 20 disposed in the test section 600 where the Z direction mobile means 3Z is driven to lower the pick-up head 92 to thereby put the IC under test into electrical contact
20 with the IC socket 20. The Z direction mobile means 3Z maintains the IC under test under the pick-up head 92 in abutment (urged or pressed) against the IC socket 20 to ensure electrical contact between the leads of the IC under test and the terminals of the IC socket 20. In this
25 position, a predetermined pattern of test signals is supplied from the tester proper 11 through the test head 13 to the IC socket 20 to be applied to the ICs under test, and response

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signals from the IC under test are transmitted from the test head 13 back to the tester proper 11 to measure the electric characteristics of the IC. Upon completion of the test, the Z direction mobile means 3Z is driven to raise the contact arm means 91 whereby the tested IC as grasped by the pick-up head 92 is moved upwardly. Then, the X direction mobile means 3X and the Y direction mobile means 3Y are driven to transfer the tested IC to a position above a predetermined location in a device sorting and housing tray 210, followed by the Z direction mobile means 3Z being driven to lower the contact arm means 91 to thereby place the IC just above the predetermined location in the device sorting and housing tray 210, whereupon the grasping force of the pick-up head 92 is released to deposit the tested IC into the device sorting and housing tray 210 at the predetermined location.

Referring to Figs. 3 and 4, a specific example of the electrical connection between the performance board 30 and the IC socket 20 will now be described.

As discussed above, IC sockets 20 may be mounted on the performance board 30 of the test head 13 in various manners. The example shown in Figs. 3 and 4 is representative of the arrangement in which IC sockets 20 are mounted on the performance board 30 by means of a mounting fixture 55 (which is commonly known as "Hi-fix Base" or "Test Fixture" as noted above) for electrically connecting the test section in the handler 12 (see Fig. 6) and the test head 13 (see Fig. 6).

The mounting fixture 55 comprises a box-like housing 56

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open at the top, an insulating base board 60 housed in the bottom of the box-like housing 56, and a socket board 40 with an insulating spacer board 50 interposed therebetween. IC sockets 20 are mounted on the socket boards 40. In example
5 shown, on the base board 60 are placed two socket boards 40 on each of which an IC socket 20 is mounted. This is only one illustrative arrangement, however. It is a matter of course that the number of the IC socket 20 may be increased or decreased depending on the configuration of the handler.

10 The socket board 40 and the base board 60 each comprise a multi-layered printed board as shown in Fig. 4. Each socket board 40 is provided with pin connector portions 41 into which the terminal pins 21 of the IC socket 20 are fitted, and conductive plated through holes 43 (through holes plated
15 with conductive material around the peripheral wall of the through holes and over the top and bottom surfaces of the board around the through holes) electrically connected through a conductive layer 42 with the respective pin connector portions 41.

20 Each spacer board 50 is also provided with conductive plated through holes 51 in alignment with the corresponding conductive plated through holes 43 and is formed with an opening 52 underlying the region of the pin connector portions 41 of the socket board 40.

25 The base board 60 is provided with contact pin mounting holes (conductive plated through holes) 61 in which are fitted and secured contact pins 64 which are in turn fitted

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for electrical contact into connector portions provided on the performance board 30, and conductive plated through holes 63 electrically connected through a conductive layer 62 with the respective contact pin mounting holes 61. The through
5 holes 63 are formed through the base board 60 at locations corresponding with the through holes 51 of the spacer board 50 as well as the through holes 43 of the socket board 40.

Resilient connectors 70 and 70' are interposed between the socket board 40 and the spacer board 50 at least in the
10 regions where the through holes 43 and 51, respectively, are formed and between the socket board 40 and the spacer board 50 at least in the regions where the through holes 43 and 51, respectively are formed, respectively. Each of the resilient connectors 70 and 70' may be formed of a sheet of insulating
15 resilient material such as rubber and very thin needle wires 71 embedded in the sheet across the thickness thereof, the needle wires being electrically isolated and relatively closely spaced from each other. Each needle wire 71 has its opposite ends flush with or recessed from the opposite
20 surfaces (top and bottom surfaces) of the resilient sheet such that when the resilient sheet is compressed in the direction of thickness, the opposite ends of the needle wires 71 are exposed to establish electrical connection between the conductors contacted by the top and bottom surfaces of the
25 resilient sheet.

The IC socket 20 is connected with the socket board 40 of the mounting fixture 55 thus constructed, the contact pins 64

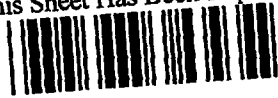
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of the base board 60 is connected with the connector portions of the performance board 30, and then mounting fixture 55 is mounted in the opening of the handler 12 (Fig. 6). It will be appreciated that upon an IC 10 under test being brought
5 into the IC socket 20 thus arranged in the test section of the handler 12, the leads of the IC 10 under test are electrically connected with the connector portions of the performance board 30 through the terminal pins 21 of the IC socket 20, the pin connector portions 41 of the socket board
10 40, the conductive layer 42, the conductive plated through holes 43, the resilient connector 70 (specifically, the needle wires 71), the conductive plated through holes 51 of the spacer board 50, the resilient connector 70' (specifically, the needle wires 71), the conductive plated
15 through holes 63 of the base board 60, the conductive layer 62, the contact pin mounting holes 61 and the contact pins 64. It is noted that contact pins 31 may be secured to the respective connector portions of the performance board 30 and resiliently biased in order to ensure electrical contact.

20 The performance board 30 is constructed of a multi-layered printed board, and the connector portions of the performance board 30 are connected with one ends of the corresponding conductor layers of a wiring pattern (pattern of conductor layers) formed radially in the performance board
25 30. The opposite ends of the conductor layers are connected with the connector terminals 34 attached to the performance board 30 so as to extend downwardly from the bottom surface

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thereof. Connected with these connector terminals 34 are connectors 33 which in turn are connected with connectors 33 from each of which a coaxial cable 35 leads to the tester proper 11 (see Fig. 6).

5 While the conventional example of Figs. 3 and 4 illustrates the arrangement in which the IC socket 20 is mounted on the socket board 40 which is one component of the mounting fixture 55, there is another type of mounting fixture in which the socket board 40 has connected thereto a
10 further adapter socket to which the IC socket 20 is connected, and still another type of mounting fixture in which the IC socket 20 is attached to the top of the performance board 30 with an adapter socket interposed therebetween without using socket board 40.

15 It should be noted that since the mounting fixture 55 shown in Figs. 3 and 4 is configured to be able to be used as an adapter socket as well, it allows for testing various specifications of ICs utilizing the same test head and performance board 30 if the socket board 40, spacer board 50
20 and base board 60 of the mounting fixture 55 are configured so as to match the IC sockets 20 for the various types of ICs to be tested.

Referring back to Fig. 5, in the test section within the constant temperature chamber of the handler, as noted above,
25 an IC 10 under test, grasped by the pick-up head 92 at the tip end of the contact arm means 91, is transported to a position above an IC socket 20 where the contact arm means 91

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is lowered to put the IC 10 under test into electrical contact with the IC socket 20. In this position, a predetermined pattern of test signals is supplied from the tester proper 11 to the IC socket 20 through the test head 13, the performance board 30 and the adapter socket 40' to be applied to the IC under test. Response signals from the IC 10 under test are transmitted through the IC socket 20, the adapter socket 40', the performance board 30 and the test head 13 back to the tester proper 11 to measure the electric characteristics of the IC 10 under test.

It should here be noted, however, that no special provision for electromagnetic shielding is made for the wiring pattern of the performance board 30, IC socket 20, the adapter socket 40' and ICs 10 under test, which components are consequently unprotected against external noise including any noise produced by the handler itself. When one uses the mounting fixture of the type in which an IC socket 20 is mounted on a socket board 40 with or without an adapter socket 40' interposed, the socket board 40 being attached via a spacer to the top of the performance board 30, it is required that the performance board 30 and the socket board 40 be electrically interconnected by means of connecting means such as connecting boards, cables, wires or the like or through the resilient connectors 70, 70', the conductive through holes 43, 51 and 63, etc.. In that case, the connecting means such as connecting boards, cables, wires or the like will also be unprotected against external noise.



When ICs to be tested are analog devices or analog /digital mixed devices and they are to be tested in a high frequency region, then ICs under test, IC sockets, socket boards, adapter sockets, performance board, etc. are highly
5 subject to the influence of external noise if they remain exposed. Should they be affected by external noise, there would occur the serious problem that the accurate testing or measuring of ICs under test might be impossible.

10 SUMMARY OF THE INVENTION

It is an object of the present invention to provide a semiconductor device testing apparatus which is capable of conducting the test on analog devices or analog/digital mixed devices without being subject to the influence of any
15 external noise.

According to the present invention, the foregoing and other objects of the invention are accomplished by providing a semiconductor device testing apparatus having a semiconductor device transporting and handling apparatus
20 connected or integrated therewith for transporting semiconductor devices under test to a test section to bring the semiconductor devices into electrical contact with a socket or sockets disposed in the test section and, upon completion of the test, transporting the tested semiconductor
25 devices out of the test section, in which a shield means is provided on a performance board of a test head, the shield means covering the socket and at least that portion of the



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surface of the performance board to which the socket is attached and its adjoining outer peripheral area.

The shield means comprises a shielding case attached to the performance board such that it covers the socket and at least that portion of the surface of the performance board to which the socket is mounted and its adjoining outer peripheral area, and electrically connected with a ground-potential face of the performance board, and an electrically conductive cover plate attached to a contact arm which forms a component part of the semiconductor device transporting and handling apparatus and which is adapted to grasp and transport a semiconductor device under test in the test section.

The shielding case may be attached on or to the outer periphery of the performance board such that it covers approximately the entire surface of the performance board to which the socket is mounted.

The top wall of the shielding case is formed with an opening through which the contact arm may move into and out of the shielding case. And the shielding case is provided with an electrically conductive, resilient spring contact surrounding the opening mounted thereto. In a preferable embodiment, the spring contact may be an electrically conductive leaf spring.

It is noted that the contact arm is equipped at its tip end with a pick-up head for grasping a semiconductor device, which may be either of the configuration to attract and grasp

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a semiconductor device by vacuum suction or of the configuration to grasp it by mechanical means such as a chuck.

It is preferable that the location where the cover plate is attached to the contact arm be such that when the contact arm is lowered until the semiconductor device under test grasped by the contact arm comes into contact with the socket, the cover plate will press the spring contact downwardly.

When the contact arm is formed of an electrically conductive material, an electrically insulating spacer is interposed between the contact arm and the cover plate.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-sectional view showing the construction of the principal portion of one embodiment of the IC tester according to the present invention;

Fig. 2 is a diagrammatical view illustrating the operation of the transport means and the contact arm means in the test section;

Fig. 3 is a schematic cross-sectional view illustrating the electrical connection between the performance board and the IC socket;

Fig. 4 is an enlarged cross-sectional view of a portion of Fig. 3;

Fig. 5 is a schematic cross-sectional view showing the construction of the principal portion of an example of the

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conventional IC tester according to the present invention;
and

Fig. 6 is a schematic side view illustrating the general arrangement of the IC tester.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic cross-sectional view showing the construction of the principal portion of one embodiment of the IC tester according to the present invention. It is to
10 be understood that those portions or components which correspond to portions or components shown in Fig. 5 are designated by the like reference numerals and will not be discussed again unless needed.

In one embodiment of the present invention, in an IC
15 tester in which an IC socket 20 is mounted via an adapter socket 40' on a performance board 30 of a test head 13, the IC socket 20 being disposed in a test section of a handler such that an IC 10 under test which has been brought into the test section by transport means, not shown, while being
20 grasped by a pick-up head 92 of a contact arm 91 may be put into electrical contact with the IC socket 20 by lowering the contact arm 91 to test the IC for its characteristics, the IC 10 under test, the IC socket 20 and the adapter socket 40', including that surface of the performance board 30 having a
25 wiring pattern exposed are electromagnetically shielded by a shielding case 100 so that the IC 10 under test and other elements, and connecting conductors such as the exposed



wiring pattern and connectors may not be subject to the influence of external noise including any noise generated by the handler itself.

In the embodiment shown in Fig. 1, a shielding case 100
5 having a bottom surface area which is approximately the same as that of the performance board 30 is used. The lower end peripheral edge 101 of the shielding case 100 is electrically connected with a ground-potential face 36 of the performance board 30 around its outer periphery to maintain the shielding
10 case 100 at the ground potential so that the IC 10 under test, the IC socket 20 and the adapter socket 40' and that surface portion of the performance board 30 having a wiring pattern exposed are electromagnetically shielded by the shielding case 100. However, the wiring pattern exposed on
15 the surface of the performance board 30 is typically limited to that portion of the performance board to which the adapter socket 40' is attached and its adjoining outer peripheral area. Accordingly, it will be sufficient if the bottom surface area of the shielding case 100 is large just enough
20 to cover that surface area of the performance board 30 on which the wiring pattern is exposed. It is thus to be appreciated that the IC 10 under test, the IC socket 20, the adapter socket 40' and that surface portion of the performance board 30 on which the wiring pattern is exposed
25 can be electromagnetically shielded by placing a shielding case having such a limited bottom surface area on the performance board 30 with the lower end peripheral edge of

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the shielding case being electrically connected with the ground-potential face 36 of the performance board 30.

For mounting the shielding case 100 to the performance board 30, welding including soldering, screw-fastening, and
5 any other suitable securing means may be adopted depending on the material, shape and construction of the shielding case 100.

The top wall of the shielding case 100 need be formed with an opening 102 through which the contact arm 91 with the
10 pick-up head 92 grasping and carrying an IC under test may move into and out of the shielding case 100. However, providing the opening 102 would possibly allow ingress of external noise into the interior of the shielding case 100 through the opening 102.

15 For this reason, in the illustrated embodiment, the shielding case 100 is provided with a spring contact 103 surrounding the opening 102 and electrically connected with the shielding case while the contact arm 91 has a cover plate 104 attached thereto at an appropriate location thereof, the
20 cover plate 104 being sized to cover the opening 102. The location where the cover plate 104 is attached to the contact arm 91 is such that when the contact arm 91 is lowered until the leads of the IC 10 under test come into proper contact with the terminals of the IC socket 20, the cover plate 104
25 is brought into contact with the spring contact 103 attached to the shielding case 100 to somewhat further press the spring contact 103 downwardly. With this construction, the

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cover plate 104 will have the same ground potential as the potential of the shielding case 100 and the spring contact 103.

The cover plate 104, which forms part of the shield means, is formed of an electrically conductive material. If the contact arm 91 were made of a conductive material, the cover plate 104 would not be at the same potential as that of the shielding case 100 since the potential on the side of the handler would be applied to the cover plate 104 through the contact arm 91. For this reason, in the illustrated embodiment, the cover plate 104 is secured via an insulating spacer 105 to the contact arm 91. As a result, since the cover plate 104 is electrically insulated from the contact arm 91, the spring contact 103 and the shielding case 100 as well as the contact arm 91 are completely isolated from the potential of the contact arm 91.

While practically the IC tester is constructed such that the test head 13 and the handler 12 are maintained at a common ground potential, it is preferable that the two be electrically insulated from each other in view of a situation where there may possibly occur a differential in potential between the two due to some cause or other.

While the embodiment described above is representative of the case in which the IC socket is mounted via the adapter socket 40' on the performance board 30 of the test head 13, it will be evident that in the case where the IC socket is mounted directly on the performance board 30 as well, the IC

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10 under test, the IC socket 20, the adapter socket 40' and that surface portion of the performance board 30 on which the wiring pattern is exposed can likewise be electromagnetically shielded by the shielding case of the configuration similar to that described in connection with the illustrated embodiment.

It is also needless to say that in the case where the IC socket is mounted via an adapter socket or directly without an adapter socket on a socket board which is attached via a spacer to the top of the performance board 30 as well, the IC 10 under test, the IC socket 20, the adapter socket, and the connecting conductors and connectors for electrically connecting the performance board 30 and the socket board can likewise be electromagnetically shielded by the shielding case of the configuration similar to that described in connection with the illustrated embodiment.

It will be understood from the foregoing that the interior space enclosed by the shielding case 100 defines an electromagnetically completely shielded, closed space during the time in which the IC 10 under test is being tested, since the shielding case 100, the spring contact 103 and the cover plate 104 are electrically connected with the ground-potential face of the performance board 30 to be maintained at the ground potential. Hence, the IC 10 under test, the IC socket 20 and the wiring pattern or connecting conductors and connectors exposed on the surface of the performance board 30, or the adapter socket 40', socket board and connecting

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conductors and connectors for electrically connecting the performance board 30 and socket board, all housed in the closed space, are completely shielded from external noise during the process in which the test is being conducted.

5 Consequently, even when ICs to be tested are analog devices or analog/digital mixed devices and they are to be tested in a high frequency region, it is possible to test such ICs under test accurately and measure their electrical characteristics.

10 It should be noted here that when the contact arm 91 is formed of an electrically insulating material such as plastic or the like rather than of an electrically conductive material such as metal, it is not required to interpose the insulating spacer 105 between the contact arm 91 and the
15 cover plate 104.

While the spring contact 103 in the form of a leaf spring is used in the embodiment described above, it is to be understood that any resilient contact may be used as the spring contact 103, provided that it is made of an
20 electrically conductive and resilient material.

In addition, while the embodiment described above illustrates the case where there is a single contact arm 91 and hence only one IC socket mounted on the top of the performance board 30, it will be apparent that similarly
25 configured shield means may be employed with similar functional effects, when a plurality of IC socket are mounted on the top of the performance board 30 with a corresponding



number of contact arms 91 provided.

Moreover, it will be appreciated that the present invention is applicable with equal functional effects to not only the IC tester having integrated therewith the handler of the type in which ICs under test are loaded on a tray and transported into the test section, but also the IC tester having integrated therewith the handler of the type in which ICs under test are individually transported into the test section as by suitable transport means such as IC carriers or by being allowed to glide along a surface by virtue of their own weight, as long as the handler is of the type in which ICs under test are grasped and put into contact with the IC socket by the pick-up-head attached to the contact arm 91.

While the invention has been described in the foregoing discussion as being applied to the IC tester adapted to test ICs which are typical of semiconductor devices, it will be obvious that the invention is also applicable, with similar advantages, to various types of semiconductor device testing apparatus for testing semiconductor devices other than ICs.

As is discussed above, according to the present invention, in a semiconductor device testing apparatus in which a semiconductor device under test is transported into the test section of the handler while grasped by a pick-up head of a contact arm and is, while still remaining grasped by the pick-up head, brought into electrical contact with a socket disposed in the test section by moving the contact arm, the socket and a shielding case covering at least a

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portion of that surface of a performance board of a test head on which the socket is mounted are electrically connected with a ground-potential face of the performance board, while the top wall of the shielding case is formed with an opening
5 through which the contact arm 91 with the pick-up head may move into and out of the shielding case, whereby the semiconductor under test grasped by the pick-up head and brought into electrical contact with the socket, the socket, and at least a portion of the surface of the performance
10 board are confined in a closed space enclosed by the shielding case.

From the foregoing discussion, it will be appreciated that these components and connecting conductors are electromagnetically shielded from the exterior to be free
15 from the influence of any external noise by the shielding case which is at the ground potential. Even if semiconductor devices to be tested are analog devices or analog/digital mixed devices and they are to be tested in a high frequency region, the present invention provides the remarkable
20 advantage that such semiconductor devices under test can be tested accurately and measured for their electrical characteristics under the condition where they are completely shielded from external noise.



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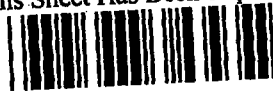
WHAT IS CLAIMED IS:

1. A semiconductor device testing apparatus having a semiconductor device transporting and handling apparatus connected therewith for transporting a semiconductor device under test to a test section to bring the semiconductor device into electrical contact with a socket disposed in said test section and, upon completion of the test, transporting the tested semiconductor device out of said test section, characterized in that:

a shield means is provided on a performance board of a test head, said shield means covering said socket and at least that portion of the surface of said performance board to which said socket is attached and an area adjoining the outer peripheral of that portion.

2. The semiconductor device testing apparatus according to Claim 1, wherein said shield means comprises a shielding case attached to the performance board such that it covers said socket and at least that portion of the surface of said performance board to which said socket is mounted and an area adjoining the outer peripheral of that portion, said shielding case being electrically connected with a ground-potential face of said performance board, and an electrically conductive cover plate attached to a contact arm which forms a component part of the semiconductor device transporting and handling apparatus and which is adapted to grasp and transport a semiconductor device in said test section.

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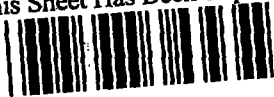
3. The semiconductor device testing apparatus according to Claim 1, wherein said shield means comprises a shielding case attached to the outer periphery of said performance board such that it covers approximately the entire surface of the performance board to which the socket is mounted, said shielding case being electrically connected with a ground-potential face of said performance board, and an electrically conductive cover plate attached to a contact arm which forms a component part of the semiconductor device transporting and handling apparatus and which is adapted to grasp and transport a semiconductor device in said test section.

4. The semiconductor device testing apparatus according to Claim 2, wherein said shielding case is formed through its top wall with an opening through which said contact arm may move into and out of said shielding case, an electrically conductive, resilient contact surrounding said opening being attached to said shielding case.

5. The semiconductor device testing apparatus according to Claim 2, wherein said resilient contact is an electrically conductive leaf spring.

6. The semiconductor device testing apparatus according to Claim 2, wherein said contact arm is equipped at its tip end with a pick-up head for grasping a semiconductor device,

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which may be either of the configuration to attract and grasp the semiconductor device by vacuum suction or of the configuration to grasp it by mechanical means.

7. The semiconductor device testing apparatus according to Claim 3, wherein the location where said cover plate is attached to said contact arm is such that when said contact arm is lowered until the semiconductor device under test grasped by the contact arm comes into contact with said socket, said cover plate will press said resilient contact downwardly.

8. The semiconductor device testing apparatus according to any one of Claims 2 to 7, wherein said contact arm is formed of an electrically conductive material, an electrically insulating spacer being interposed between said contact arm and said cover plate.

9. A semiconductor device testing apparatus having a semiconductor device transporting and handling apparatus connected therewith for transporting a semiconductor device under test to a test section to bring the semiconductor device into electrical contact with a socket disposed in said test section and, upon completion of the test, transporting the tested semiconductor device out of said test section, wherein in said test section, a semiconductor device grasped by a grasp means mounted to said contact arm at its tip end



is brought into electrical contact with the socket disposed in said test section by moving said contact arm which is a component part of the semiconductor device transporting and handling apparatus, characterized in that:

a shielding case is attached to a performance board of a test head, said shielding case covering said socket and at least that portion of the surface of said performance board to which said socket is mounted and an area adjoining the outer peripheral of that portion, said shielding case being electrically connected with a ground-potential face of said performance board; and

an opening is formed through the top wall of the shielding case, through which said contact arm with said grasp means may move into and out of said shielding case.

10. The semiconductor device testing apparatus according to Claim 9, wherein an electrically conductive, resilient contact surrounding said opening is attached to said shielding case, and an electrically conductive cover plate is attached to said contact arm and positioned such that as said contact arm is lowered, said cover plate comes into contact with said resilient contact.

11. The semiconductor device testing apparatus according to Claim 9, wherein said shielding case is attached to the outer periphery of said performance board such that it covers approximately the entire surface of the performance board to

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which the socket is mounted, said shielding case being electrically connected with a ground-potential face of said performance board.

12. The semiconductor device testing apparatus according to Claim 10, wherein said resilient contact is an electrically conductive leaf spring.

13. The semiconductor device testing apparatus according to Claim 9, wherein said contact arm is equipped at its tip end with a pick-up head for grasping a semiconductor device, which may be either of the configuration to attract and grasp the semiconductor device by vacuum suction or of the configuration to grasp it by mechanical means.

14. The semiconductor device testing apparatus according to Claim 10, wherein the location where said cover plate is attached to said contact arm is such that when said contact arm is lowered until the semiconductor device under test grasped by the contact arm comes into contact with said socket, said cover plate will press said resilient contact downwardly.

15. The semiconductor device testing apparatus according to any one of Claims 10 to 14, wherein said contact arm is formed of an electrically conductive material, an electrically insulating spacer being interposed between said

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contact arm and said cover plate.

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ABSTRACT

An IC tester which is capable of conducting the test on analog devices or analog/digital mixed devices without being subject to the influence of any external noise is provided. A shielding case 100 is attached to a performance board 30 of a test head 13 and covers an IC socket 20 disposed in the test section of the handler 12 and at least that portion of the surface of the performance board to which the socket is mounted and an area adjoining the outer peripheral of that portion. The shielding case is formed through its top wall with an opening 102 through which a contact arm 91 with a pick-up head 92 may move into and out of the shielding case. An electrically conductive spring contact 103 surrounding the opening is attached to the shielding case, and an electrically conductive cover plate 104 is attached to the contact arm and positioned such that as the contact arm is lowered, the cover plate comes into contact with the spring contact to slightly press the latter.

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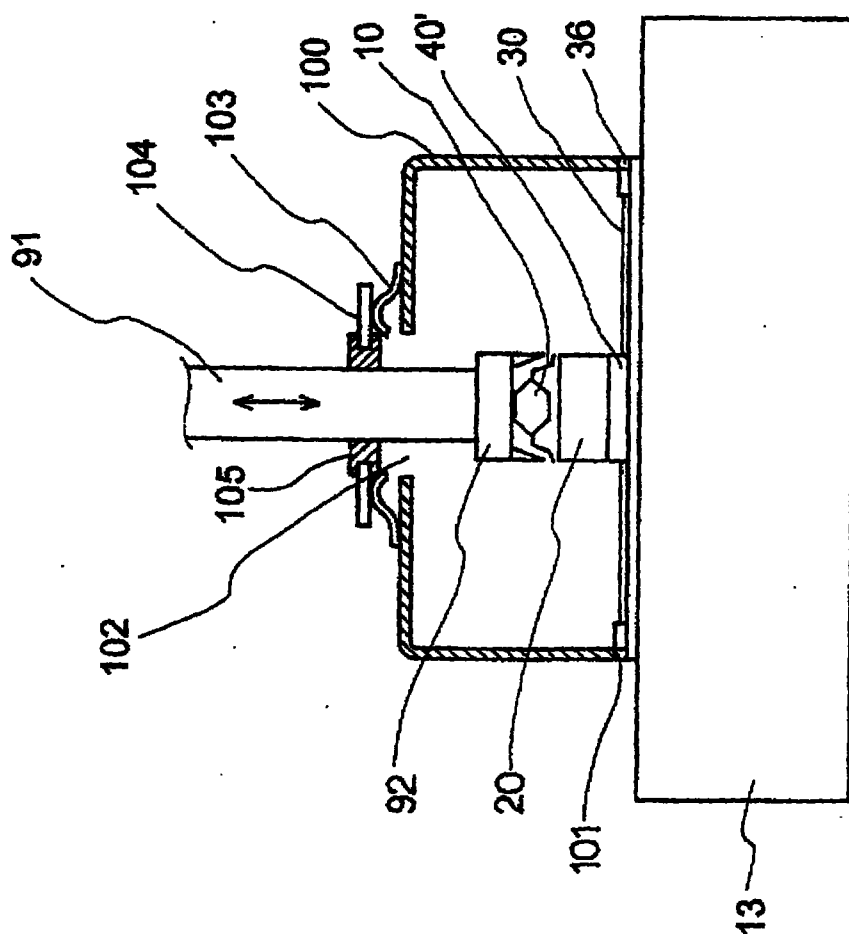


FIG. 1

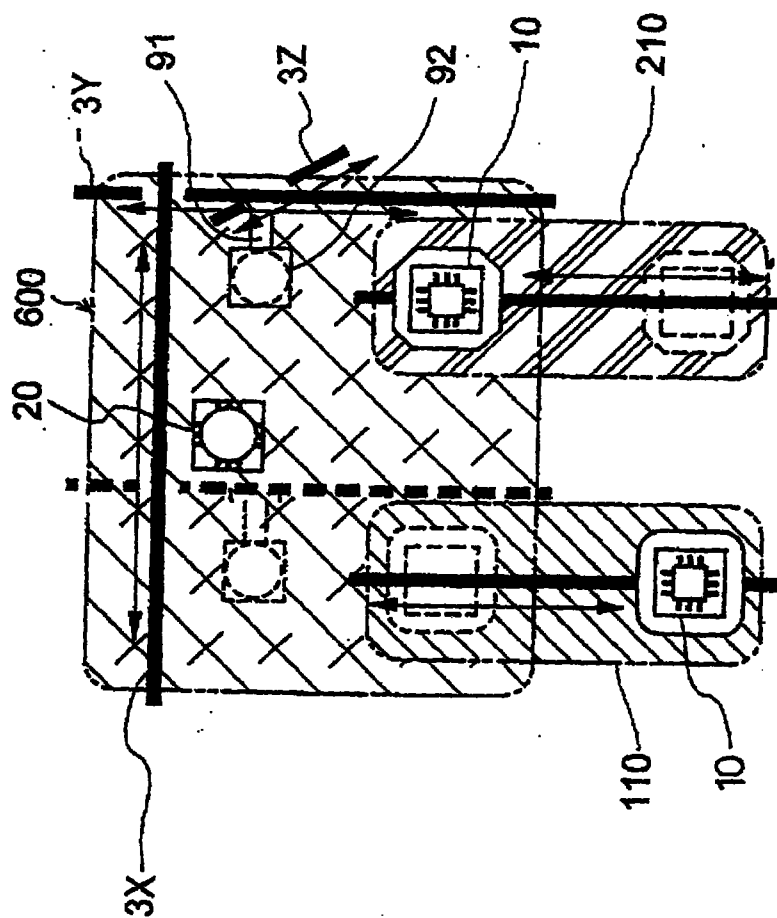
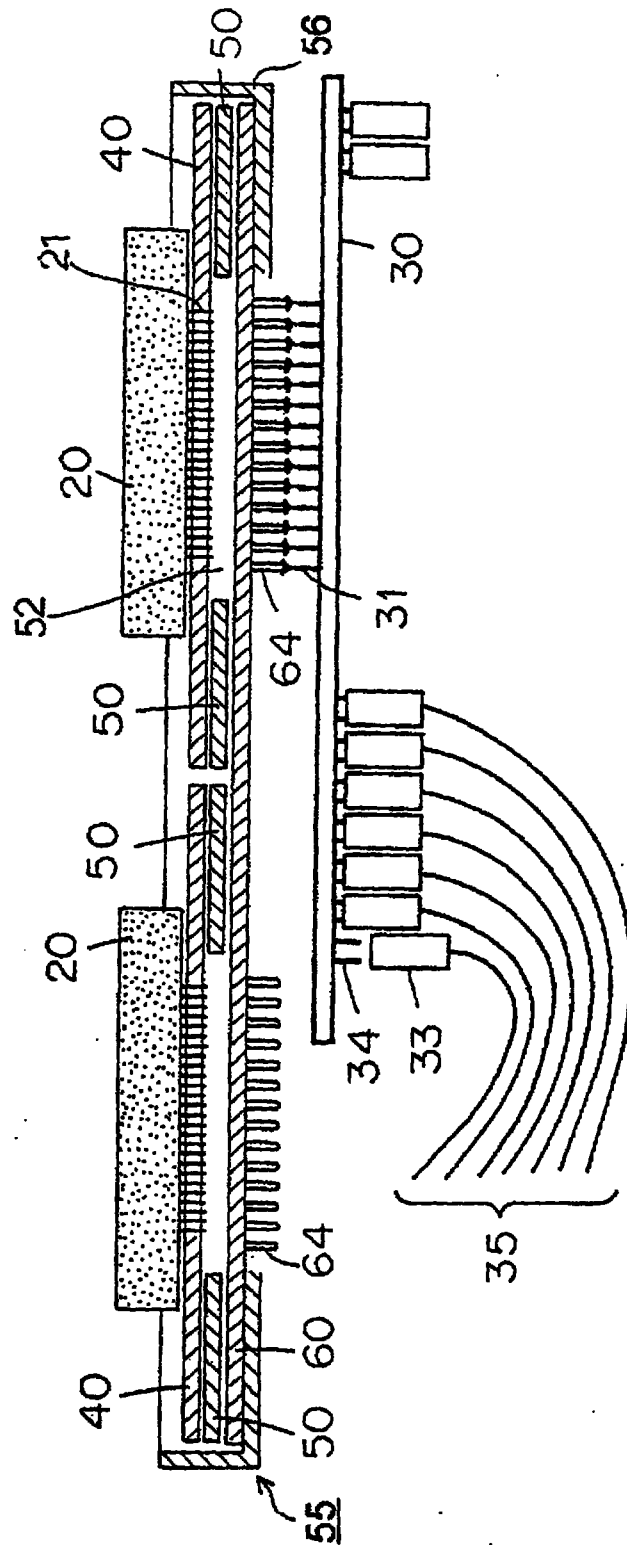


FIG. 2

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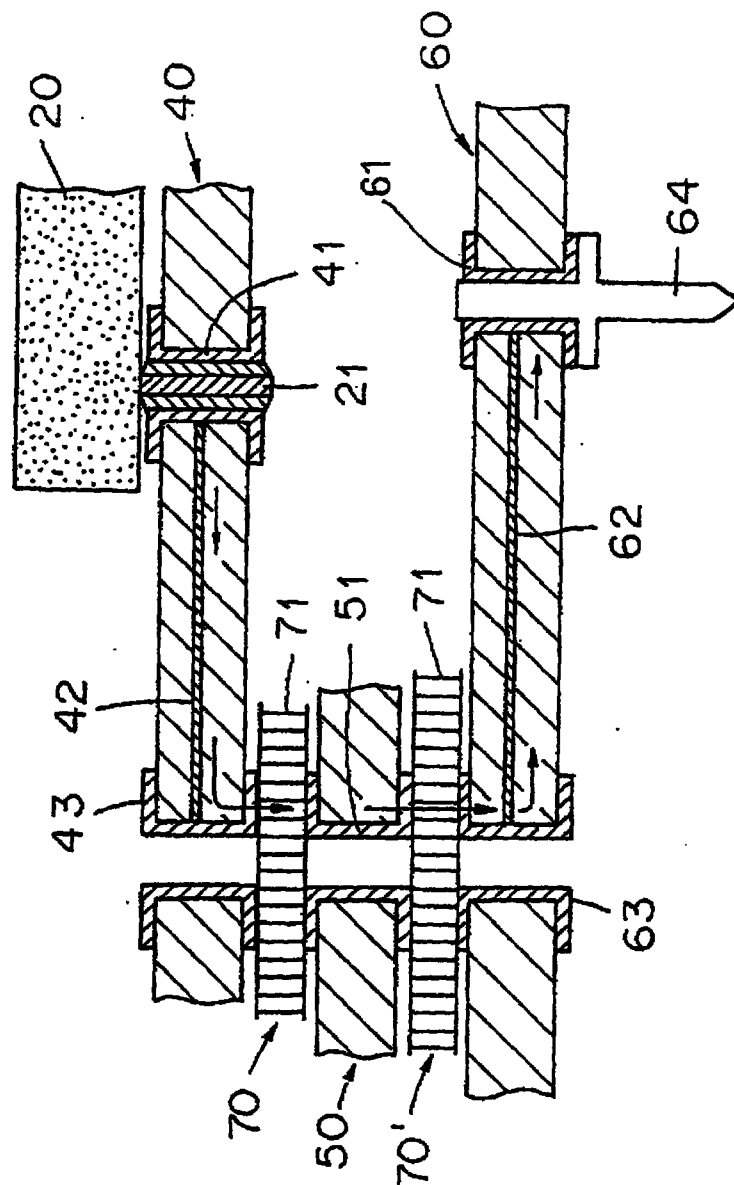


FIG. 4

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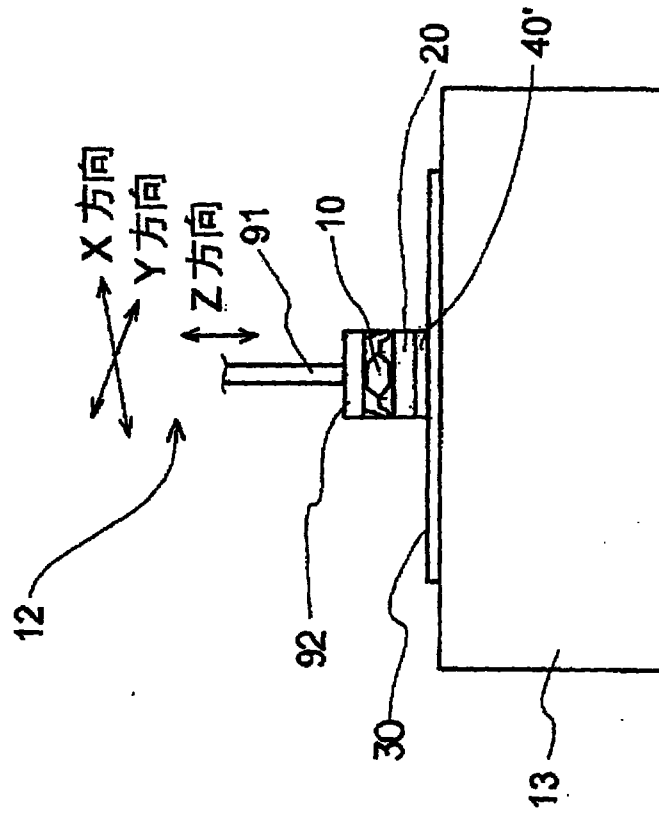


FIG. 5

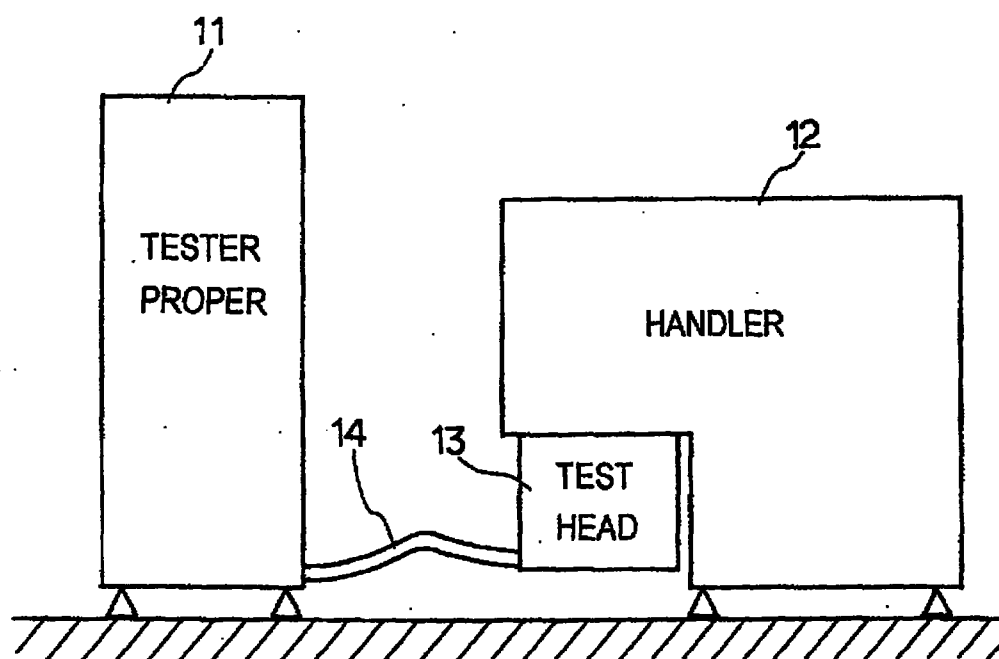
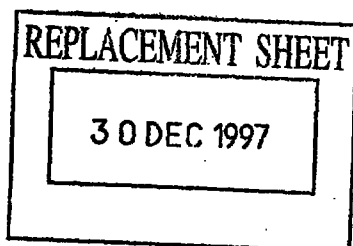


FIG. 6



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☒ Claim(s) : paged ... to paged ... 29

☒ Drawing(s) : paged ... to paged ... 6

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DATE OF RECEIPT 30/12/97

SEMICONDUCTOR DEVICE TESTING APPARATUS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

5 The present invention relates to a semiconductor device testing apparatus with which is connected or integrated a semiconductor device transporting and handling apparatus (commonly called handler) for transporting semiconductor devices (such as semiconductor integrated circuits) to test

10 and sort out the tested semiconductor devices on the basis of the test results, and particularly to improvements on that section of the testing apparatus for testing/measuring semiconductor devices under test (commonly called DUT) which have been brought into the test section of the semiconductor

15 device transporting and handling apparatus (which will be called handler hereinafter) by the handler.

2. DESCRIPTION OF THE RELATED ART

A semiconductor device testing apparatus for testing

20 semiconductor devices has often connected or integrated therewith a handler for transporting semiconductor device under test to subject them to predetermined tests and sort out the tested semiconductor devices on the basis of the test results as noted above. For simplicity of description, in

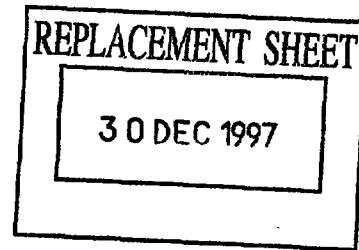
25 the following disclosure will be taken as an example the semiconductor device testing apparatus (commonly referred to as IC tester) for testing semiconductor integrated circuits

as will be referred to as IC hereinbelow which are typical of semiconductor devices.

Fig. 6 is a schematic side view illustrating an example of the semiconductor device testing apparatus (which will be called IC tester hereinafter) of the type described above. The IC tester comprises a tester proper (which is known as main frame in the art concerned) 11 in which various electrical circuits, power source or supply and the like are mainly accommodated, a handler 12 equipped with an automatic transporting mechanism for transporting ICs, and a test head 13 electrically connected with but constructed separately from the tester proper 11 and mounted in the test section of the handler 12.

ICs under test which have been transported into the test section by the automatic transporting mechanism of the handler 12 are brought into electrical contact with the test head 13 (specifically the IC socket or sockets mounted on the test head 13), and hence electrically connected with the tester proper 11 through the test head 13 and a bundle of cables 14. A test signal having a predetermined pattern as supplied from the tester proper 11 to the test head 13 through the bundle of cables 14 is applied to the ICs under test, and response signals read out from the ICs under test are transmitted to the tester proper 11 through the test head 13 and the bundle of cables 14, thereby to measure the electric characteristics of the ICs.

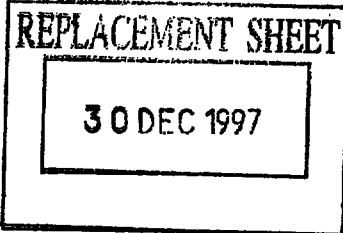
The test section of the handler is usually disposed in a



constant temperature chamber (not shown) for giving a predetermined temperature stress to ICs under test to meet the requirement that ICs under test be tested in an atmosphere at a predetermined temperature. In order to permit ICs under test transported into the test section to be electrically contacted with the IC socket mounted in the test head 13, the constant temperature chamber is provided in its bottom wall with an opening in which there is fitted and fixed a mounting fixture (which is commonly called "Hi-fix Base" or "Test Fixture" in the art concerned) for electrically connecting the test head 13 of the IC tester with the test section in the constant temperature chamber of the handler 12.

Accommodated in the test head 13 are mainly a gang of drivers for applying a predetermined pattern of test signals to ICs under test, a gang of comparators CP for determining whether the output signals read out of the ICs under test are a high (H) logic signal or a low (L) logic signal having a predetermined value of voltage, respectively, and a power line, these components and the power line being electrically connected with the tester proper 11 through the cables 14.

Mounted on the top of the test head 13 is a performance board 30, as shown in Fig. 5, on which there is mounted an IC socket 20 with an adapter socket 40' interposed therebetween. Consequently, in the example shown in Fig. 5, the adapter socket 40' constitutes a mounting fixture. Alternatively, the mounting fixture may comprise a socket board spaced a

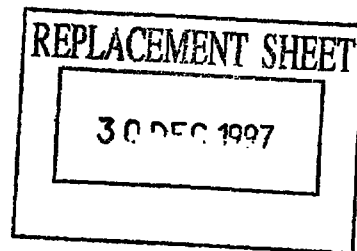


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predetermined distance upwardly from and mounted to the performance board 30, and an IC socket 20 mounted directly on the socket board. In this latter case, electrical connection between the performance board 30 and the socket board is
5 established by means of connecting means such as connecting boards, cables, wires or the like. It is to be noted that an adapter socket may be interposed between the socket board and the IC socket 20.

As noted above, the bottom wall of the constant
10 temperature chamber of the handler 12 is typically formed with an opening in which the mounting fixture described above is mounted so that the IC socket 20 mounted either on the top of the performance board 30 via the adapter socket 40' or on the socket board may be located at a predetermined position
15 in the test section within the constant temperature chamber, the arrangement being such that ICs 10 under test which have been brought into the test section by the automatic transporting mechanism are put into electrical contact with the IC socket 20 to test the ICs 10 for their electrical
20 characteristics.

Generally, ICs 10 under test, loaded on a tray, are transported into the test section within the constant temperature chamber where the ICs under test are transferred by transport means from the tray onto the IC sockets 20 to be
25 tested for their electrical characteristics. Upon completion of the testing, the tested ICs are transferred by the transport means from the IC sockets 20 onto the tray,



followed by being carried on the tray out of the constant temperature chamber. The tested ICs are then sorted out based on the data of the test results. It is to be noted here that the tray for transporting ICs 10 under test into
5 the test section may be the same as or different from the tray used to carrying the tested ICs from the test section and out of the constant temperature chamber. Some handlers may be equipped with no constant temperature chamber.

The transport means for transferring ICs 10 under test
10 from the tray onto the IC sockets 20 and/or the transport means for transferring the tested ICs from the IC sockets 20 onto the tray in the test section are provided with carrier head means having attached thereto a contact arm means 91 as shown in Fig. 5. The transport means includes carrier arm
15 means movable in X and Y directions perpendicular to each other in a horizontal plane so that the carrier head means is movable by the transport means in X and Y directions. The contact arm means 91 is movable in a Z direction (upwardly and downwardly as viewed in Fig. 5) perpendicular to the X
20 and Y directions, and has a pick-up head 92 attached thereto at its tip end. The pick-up head 92 may be either of the configuration to attract and grasp ICs by vacuum suction or of the configuration to grasp ICs by mechanical means such as a chuck.

25 It is thus to be appreciated that the contact arm means 91 is positioned with respect to the X and Y directions by the transport means where the contact arm means 91 is

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vertically moved and is capable of performing the functions of grasping an IC by means of its pick-up head 92, pressing the grasped IC against the IC socket 20, and releasing the grasped IC. It will be obvious that the carrier head means
5 or other mobile means having the contact arm means 91 thereto may be configured to be movable in the Z direction perpendicular to the X and Y directions.

Fig. 2 diagrammatically illustrates the operation of the transport means and the contact arm means 91 in the test
10 section as described above. The transport means is represented by an X direction mobile means 3X which is driven transversely (in left-right directions of the drawing), a Y direction mobile means 3Y which is driven longitudinally (in upward and downward directions of the drawing), and a Z
15 direction mobile means 3Z which is driven in a direction perpendicular to the X and Y directions (in a direction passing through the plane of the drawing). The contact arm means 91 is affixed to the Z direction mobile means 3Z so that the pick-up head 92 mounted to the tip of the contact
20 arm means is positioned at a predetermined position by the X direction mobile means 3X, the Y direction mobile means 3Y and the Z direction mobile means 3Z.

More specifically, Fig. 2 illustrates the configuration in which the Y direction mobile means 3Y is first driven and
25 positioned in the X direction (as shown in the dotted lines in the drawing) by the X direction mobile means 3X, followed by the Z direction mobile means 3Z being driven and

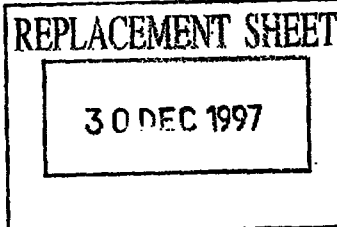
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positioned in the Y direction by the Y direction mobile means 3Y, and finally the contact arm means 91 being driven in the Z direction by the Z direction mobile means 3Z to position the pick-up head 92 in place.

5 ICs 10 under test, loaded on the tray 110, have been transported into the test section 600 where the X direction mobile means 3X, the Y direction mobile means 3Y and the Z direction mobile means 3Z are driven as described above to move the pick-up head 92 of the contact arm means 91 to a
10 position above an IC 10 under test and bring the head into abutment with the IC to grasp it by virtue of vacuum suction or by mechanical means.

Then, the X direction mobile means 3X, the Y direction mobile means 3Y and the Z direction mobile means 3Z are
15 driven in the reverse procedure to transfer the IC 10 under test grasped by the pick-up head 92 to a position above the IC socket 20 disposed in the test section 600 where the Z direction mobile means 3Z is driven to lower the pick-up head 92 to thereby put the IC under test into electrical contact
20 with the IC socket 20. The Z direction mobile means 3Z maintains the IC under test under the pick-up head 92 in abutment (urged or pressed) against the IC socket 20 to ensure electrical contact between the leads of the IC under test and the terminals of the IC socket 20. In this
25 position, a predetermined pattern of test signals is supplied from the tester proper 11 through the test head 13 to the IC socket 20 to be applied to the ICs under test, and response



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signals from the IC under test are transmitted from the test head 13 back to the tester proper 11 to measure the electric characteristics of the IC. Upon completion of the test, the Z direction mobile means 3Z is driven to raise the contact arm means 91 whereby the tested IC as grasped by the pick-up head 92 is moved upwardly. Then, the X direction mobile means 3X and the Y direction mobile means 3Y are driven to transfer the tested IC to a position above a predetermined location in a device sorting and housing tray 210, followed by the Z direction mobile means 3Z being driven to lower the contact arm means 91 to thereby place the IC just above the predetermined location in the device sorting and housing tray 210, whereupon the grasping force of the pick-up head 92 is released to deposit the tested IC into the device sorting and housing tray 210 at the predetermined location.

Referring to Figs. 3 and 4, a specific example of the electrical connection between the performance board 30 and the IC socket 20 will now be described.

As discussed above, IC sockets 20 may be mounted on the performance board 30 of the test head 13 in various manners. The example shown in Figs. 3 and 4 is representative of the arrangement in which IC sockets 20 are mounted on the performance board 30 by means of a mounting fixture 55 (which is commonly known as "Hi-fix Base" or "Test Fixture" as noted above) for electrically connecting the test section in the handler 12 (see Fig. 6) and the test head 13 (see Fig. 6).

The mounting fixture 55 comprises a box-like housing 56

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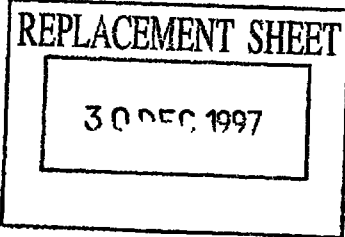
-9-

open at the top, an insulating base board 60 housed in the bottom of the box-like housing 56, and a socket board 40 with an insulating spacer board 50 interposed therebetween. IC sockets 20 are mounted on the socket boards 40. In example
5 shown, on the base board 60 are placed two socket boards 40 on each of which an IC socket 20 is mounted. This is only one illustrative arrangement, however. It is a matter of course that the number of the IC socket 20 may be increased or decreased depending on the configuration of the handler.

10 The socket board 40 and the base board 60 each comprise a multi-layered printed board as shown in Fig. 4. Each socket board 40 is provided with pin connector portions 41 into which the terminal pins 21 of the IC socket 20 are fitted, and conductive plated through holes 43 (through holes plated
15 with conductive material around the peripheral wall of the through holes and over the top and bottom surfaces of the board around the through holes) electrically connected through a conductive layer 42 with the respective pin connector portions 41.

20 Each spacer board 50 is also provided with conductive plated through holes 51 in alignment with the corresponding conductive plated through holes 43 and is formed with an opening 52 underlying the region of the pin connector portions 41 of the socket board 40.

25 The base board 60 is provided with contact pin mounting holes (conductive plated through holes) 61 in which are fitted and secured contact pins 64 which are in turn fitted



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for electrical contact into connector portions provided on the performance board 30, and conductive plated through holes 63 electrically connected through a conductive layer 62 with the respective contact pin mounting holes 61. The through
5 holes 63 are formed through the base board 60 at locations corresponding with the through holes 51 of the spacer board 50 as well as the through holes 43 of the socket board 40.

Resilient connectors 70 and 70' are interposed between the socket board 40 and the spacer board 50 at least in the
10 regions where the through holes 43 and 51, respectively, are formed and between the socket board 40 and the spacer board 50 at least in the regions where the through holes 43 and 51, respectively are formed, respectively. Each of the resilient connectors 70 and 70' may be formed of a sheet of insulating
15 resilient material such as rubber and very thin needle wires 71 embedded in the sheet across the thickness thereof, the needle wires being electrically isolated and relatively closely spaced from each other. Each needle wire 71 has its opposite ends flush with or recessed from the opposite
20 surfaces (top and bottom surfaces) of the resilient sheet such that when the resilient sheet is compressed in the direction of thickness, the opposite ends of the needle wires 71 are exposed to establish electrical connection between the conductors contacted by the top and bottom surfaces of the
25 resilient sheet.

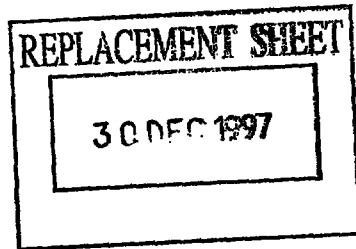
The IC socket 20 is connected with the socket board 40 of the mounting fixture 55 thus constructed, the contact pins 64

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of the base board 60 is connected with the connector portions of the performance board 30, and then mounting fixture 55 is mounted in the opening of the handler 12 (Fig. 6). It will be appreciated that upon an IC 10 under test being brought into the IC socket 20 thus arranged in the test section of the handler 12, the leads of the IC 10 under test are electrically connected with the connector portions of the performance board 30 through the terminal pins 21 of the IC socket 20, the pin connector portions 41 of the socket board 40, the conductive layer 42, the conductive plated through holes 43, the resilient connector 70 (specifically, the needle wires 71), the conductive plated through holes 51 of the spacer board 50, the resilient connector 70' (specifically, the needle wires 71), the conductive plated through holes 63 of the base board 60, the conductive layer 62, the contact pin mounting holes 61 and the contact pins 64. It is noted that contact pins 31 may be secured to the respective connector portions of the performance board 30 and resiliently biased in order to ensure electrical contact.

The performance board 30 is constructed of a multi-layered printed board, and the connector portions of the performance board 30 are connected with one ends of the corresponding conductor layers of a wiring pattern (pattern of conductor layers) formed radially in the performance board 30. The opposite ends of the conductor layers are connected with the connector terminals 34 attached to the performance board 30 so as to extend downwardly from the bottom surface



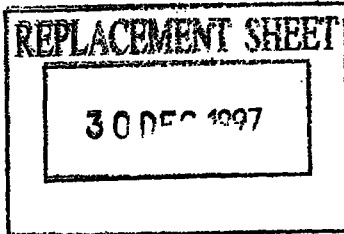
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thereof. Connected with these connector terminals 34 are connectors 33 which in turn are connected with connectors 33 from each of which a coaxial cable 35 leads to the tester proper 11 (see Fig. 6).

5 While the conventional example of Figs. 3 and 4 illustrates the arrangement in which the IC socket 20 is mounted on the socket board 40 which is one component of the mounting fixture 55, there is another type of mounting fixture in which the socket board 40 has connected thereto a
10 further adapter socket to which the IC socket 20 is connected, and still another type of mounting fixture in which the IC socket 20 is attached to the top of the performance board 30 with an adapter socket interposed therebetween without using socket board 40.

15 It should be noted that since the mounting fixture 55 shown in Figs. 3 and 4 is configured to be able to be used as an adapter socket as well, it allows for testing various specifications of ICs utilizing the same test head and performance board 30 if the socket board 40, spacer board 50
20 and base board 60 of the mounting fixture 55 are configured so as to match the IC sockets 20 for the various types of ICs to be tested.

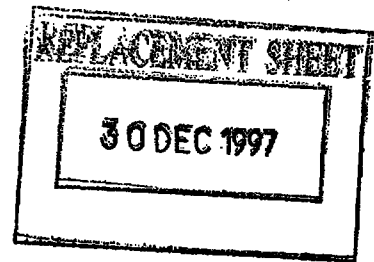
Referring back to Fig. 5, in the test section within the constant temperature chamber of the handler, as noted above,
25 an IC 10 under test, grasped by the pick-up head 92 at the tip end of the contact arm means 91, is transported to a position above an IC socket 20 where the contact arm means 91



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is lowered to put the IC 10 under test into electrical contact with the IC socket 20. In this position, a predetermined pattern of test signals is supplied from the tester proper 11 to the IC socket 20 through the test head 13, the performance board 30 and the adapter socket 40' to be applied to the IC under test. Response signals from the IC 10 under test are transmitted through the IC socket 20, the adapter socket 40', the performance board 30 and the test head 13 back to the tester proper 11 to measure the electric characteristics of the IC 10 under test.

It should here be noted, however, that no special provision for electromagnetic shielding is made for the wiring pattern of the performance board 30, IC socket 20, the adapter socket 40' and ICs 10 under test, which components are consequently unprotected against external noise including any noise produced by the handler itself. When one uses the mounting fixture of the type in which an IC socket 20 is mounted on a socket board 40 with or without an adapter socket 40' interposed, the socket board 40 being attached via a spacer to the top of the performance board 30, it is required that the performance board 30 and the socket board 40 be electrically interconnected by means of connecting means such as connecting boards, cables, wires or the like or through the resilient connectors 70, 70', the conductive through holes 43, 51 and 63, etc.. In that case, the connecting means such as connecting boards, cables, wires or the like will also be unprotected against external noise.

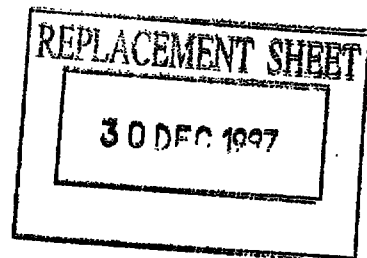


When ICs to be tested are analog devices or analog /digital mixed devices and they are to be tested in a high frequency region, then ICs under test, IC sockets, socket boards, adapter sockets, performance board, etc. are highly
5 subject to the influence of external noise if they remain exposed. Should they be affected by external noise, there would occur the serious problem that the accurate testing or measuring of ICs under test might be impossible.

10 SUMMARY OF THE INVENTION

It is an object of the present invention to provide a semiconductor device testing apparatus which is capable of conducting the test on analog devices or analog/digital mixed devices without being subject to the influence of any
15 external noise.

According to the present invention, the foregoing and other objects of the invention are accomplished by providing a semiconductor device testing apparatus having a semiconductor device transporting and handling apparatus
20 connected or integrated therewith for transporting semiconductor devices under test to a test section to bring the semiconductor devices into electrical contact with a socket or sockets disposed in the test section and, upon completion of the test, transporting the tested semiconductor
25 devices out of the test section, in which a shield means is provided on a performance board of a test head, the shield means covering the socket and at least that portion of the



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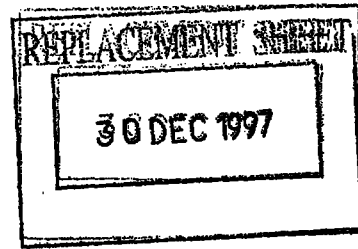
surface of the performance board to which the socket is attached and its adjoining outer peripheral area.

The shield means comprises a shielding case attached to the performance board such that it covers the socket and at least that portion of the surface of the performance board to which the socket is mounted and its adjoining outer peripheral area, and electrically connected with a ground-potential face of the performance board, and an electrically conductive cover plate attached to a contact arm which forms a component part of the semiconductor device transporting and handling apparatus and which is adapted to grasp and transport a semiconductor device under test in the test section.

The shielding case may be attached on or to the outer periphery of the performance board such that it covers approximately the entire surface of the performance board to which the socket is mounted.

The top wall of the shielding case is formed with an opening through which the contact arm may move into and out of the shielding case. And the shielding case is provided with an electrically conductive, resilient spring contact surrounding the opening mounted thereto. In a preferable embodiment, the spring contact may be an electrically conductive leaf spring.

It is noted that the contact arm is equipped at its tip end with a pick-up head for grasping a semiconductor device, which may be either of the configuration to attract and grasp



a semiconductor device by vacuum suction or of the configuration to grasp it by mechanical means such as a chuck.

5 It is preferable that the location where the cover plate is attached to the contact arm be such that when the contact arm is lowered until the semiconductor device under test grasped by the contact arm comes into contact with the socket, the cover plate will press the spring contact downwardly.

10 When the contact arm is formed of an electrically conductive material, an electrically insulating spacer is interposed between the contact arm and the cover plate.

DESCRIPTION OF THE DRAWINGS

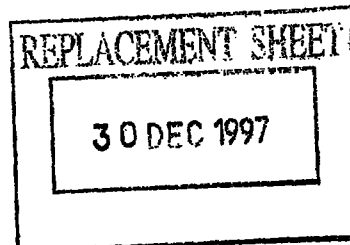
15 Fig. 1 is a schematic cross-sectional view showing the construction of the principal portion of one embodiment of the IC tester according to the present invention;

Fig. 2 is a diagrammatical view illustrating the operation of the transport means and the contact arm means in
20 the test section;

Fig. 3 is a schematic cross-sectional view illustrating the electrical connection between the performance board and the IC socket;

Fig. 4 is an enlarged cross-sectional view of a portion
25 of Fig. 3;

Fig. 5 is a schematic cross-sectional view showing the construction of the principal portion of an example of the



conventional IC tester according to the present invention;
and

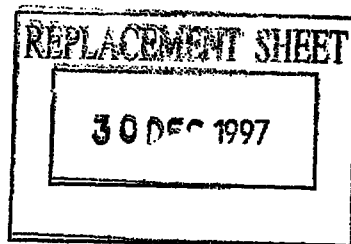
Fig. 6 is a schematic side view illustrating the general arrangement of the IC tester.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic cross-sectional view showing the construction of the principal portion of one embodiment of the IC tester according to the present invention. It is to
10 be understood that those portions or components which correspond to portions or components shown in Fig. 5 are designated by the like reference numerals and will not be discussed again unless needed.

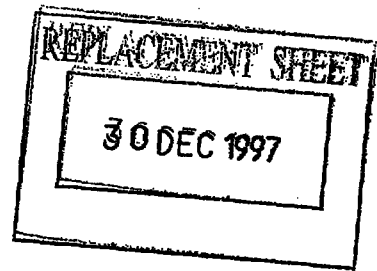
In one embodiment of the present invention, in an IC
15 tester in which an IC socket 20 is mounted via an adapter socket 40' on a performance board 30 of a test head 13, the IC socket 20 being disposed in a test section of a handler such that an IC 10 under test which has been brought into the test section by transport means, not shown, while being
20 grasped by a pick-up head 92 of a contact arm 91 may be put into electrical contact with the IC socket 20 by lowering the contact arm 91 to test the IC for its characteristics, the IC 10 under test, the IC socket 20 and the adapter socket 40', including that surface of the performance board 30 having a
25 wiring pattern exposed are electromagnetically shielded by a shielding case 100 so that the IC 10 under test and other elements, and connecting conductors such as the exposed



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wiring pattern and connectors may not be subject to the influence of external noise including any noise generated by the handler itself.

In the embodiment shown in Fig. 1, a shielding case 100
5 having a bottom surface area which is approximately the same as that of the performance board 30 is used. The lower end peripheral edge 101 of the shielding case 100 is electrically connected with a ground-potential face 36 of the performance board 30 around its outer periphery to maintain the shielding
10 case 100 at the ground potential so that the IC 10 under test, the IC socket 20 and the adapter socket 40' and that surface portion of the performance board 30 having a wiring pattern exposed are electromagnetically shielded by the shielding case 100. However, the wiring pattern exposed on
15 the surface of the performance board 30 is typically limited to that portion of the performance board to which the adapter socket 40' is attached and its adjoining outer peripheral area. Accordingly, it will be sufficient if the bottom surface area of the shielding case 100 is large just enough
20 to cover that surface area of the performance board 30 on which the wiring pattern is exposed. It is thus to be appreciated that the IC 10 under test, the IC socket 20, the adapter socket 40' and that surface portion of the performance board 30 on which the wiring pattern is exposed
25 can be electromagnetically shielded by placing a shielding case having such a limited bottom surface area on the performance board 30 with the lower end peripheral edge of

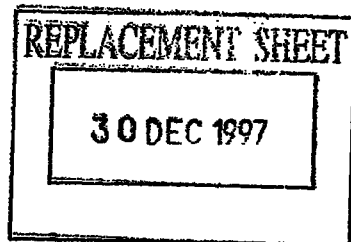


the shielding case being electrically connected with the ground-potential face 36 of the performance board 30.

For mounting the shielding case 100 to the performance board 30, welding including soldering, screw-fastening, and
5 any other suitable securing means may be adopted depending on the material, shape and construction of the shielding case 100.

The top wall of the shielding case 100 need be formed with an opening 102 through which the contact arm 91 with the
10 pick-up head 92 grasping and carrying an IC under test may move into and out of the shielding case 100. However, providing the opening 102 would possibly allow ingress of external noise into the interior of the shielding case 100 through the opening 102.

15 For this reason, in the illustrated embodiment, the shielding case 100 is provided with a spring contact 103 surrounding the opening 102 and electrically connected with the shielding case while the contact arm 91 has a cover plate 104 attached thereto at an appropriate location thereof, the
20 cover plate 104 being sized to cover the opening 102. The location where the cover plate 104 is attached to the contact arm 91 is such that when the contact arm 91 is lowered until the leads of the IC 10 under test come into proper contact with the terminals of the IC socket 20, the cover plate 104
25 is brought into contact with the spring contact 103 attached to the shielding case 100 to somewhat further press the spring contact 103 downwardly. With this construction, the



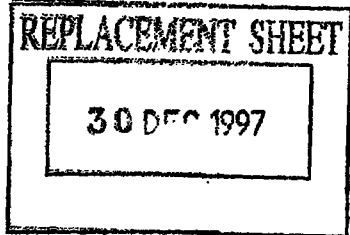
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cover plate 104 will have the same ground potential as the potential of the shielding case 100 and the spring contact 103.

5 The cover plate 104, which forms part of the shield means, is formed of an electrically conductive material. If the contact arm 91 were made of a conductive material, the cover plate 104 would not be at the same potential as that of the shielding case 100 since the potential on the side of the handler would be applied to the cover plate 104 through the
10 contact arm 91. For this reason, in the illustrated embodiment, the cover plate 104 is secured via an insulating spacer 105 to the contact arm 91. As a result, since the cover plate 104 is electrically insulated from the contact arm 91, the spring contact 103 and the shielding case 100 as
15 well as the contact arm 91 are completely isolated from the potential of the contact arm 91.

While practically the IC tester is constructed such that the test head 13 and the handler 12 are maintained at a common ground potential, it is preferable that the two be
20 electrically insulated from each other in view of a situation where there may possibly occur a differential in potential between the two due to some cause or other.

While the embodiment described above is representative of the case in which the IC socket is mounted via the adapter
25 socket 40' on the performance board 30 of the test head 13, it will be evident that in the case where the IC socket is mounted directly on the performance board 30 as well, the IC

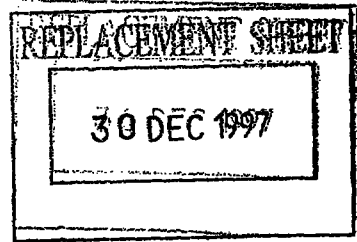


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10 under test, the IC socket 20, the adapter socket 40' and that surface portion of the performance board 30 on which the wiring pattern is exposed can likewise be electromagnetically shielded by the shielding case of the configuration similar to that described in connection with the illustrated embodiment.

It is also needless to say that in the case where the IC socket is mounted via an adapter socket or directly without an adapter socket on a socket board which is attached via a spacer to the top of the performance board 30 as well, the IC 10 under test, the IC socket 20, the adapter socket, and the connecting conductors and connectors for electrically connecting the performance board 30 and the socket board can likewise be electromagnetically shielded by the shielding case of the configuration similar to that described in connection with the illustrated embodiment.

It will be understood from the foregoing that the interior space enclosed by the shielding case 100 defines an electromagnetically completely shielded, closed space during the time in which the IC 10 under test is being tested, since the shielding case 100, the spring contact 103 and the cover plate 104 are electrically connected with the ground-potential face of the performance board 30 to be maintained at the ground potential. Hence, the IC 10 under test, the IC socket 20 and the wiring pattern or connecting conductors and connectors exposed on the surface of the performance board 30, or the adapter socket 40', socket board and connecting



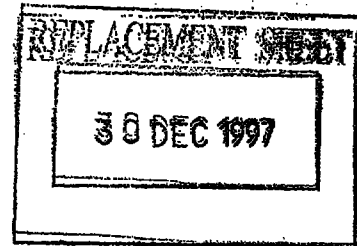
conductors and connectors for electrically connecting the performance board 30 and socket board, all housed in the closed space, are completely shielded from external noise during the process in which the test is being conducted.

5 Consequently, even when ICs to be tested are analog devices or analog/digital mixed devices and they are to be tested in a high frequency region, it is possible to test such ICs under test accurately and measure their electrical characteristics.

10 It should be noted here that when the contact arm 91 is formed of an electrically insulating material such as plastic or the like rather than of an electrically conductive material such as metal, it is not required to interpose the insulating spacer 105 between the contact arm 91 and the
15 cover plate 104.

While the spring contact 103 in the form of a leaf spring is used in the embodiment described above, it is to be understood that any resilient contact may be used as the spring contact 103, provided that it is made of an
20 electrically conductive and resilient material.

In addition, while the embodiment described above illustrates the case where there is a single contact arm 91 and hence only one IC socket mounted on the top of the performance board 30, it will be apparent that similarly
25 configured shield means may be employed with similar functional effects, when a plurality of IC socket are mounted on the top of the performance board 30 with a corresponding

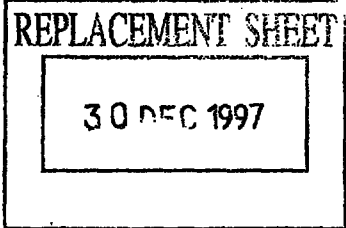


number of contact arms 91 provided.

Moreover, it will be appreciated that the present invention is applicable with equal functional effects to not only the IC tester having integrated therewith the handler of the type in which ICs under test are loaded on a tray and transported into the test section, but also the IC tester having integrated therewith the handler of the type in which ICs under test are individually transported into the test section as by suitable transport means such as IC carriers or by being allowed to glide along a surface by virtue of their own weight, as long as the handler is of the type in which ICs under test are grasped and put into contact with the IC socket by the pick-up-head attached to the contact arm 91.

While the invention has been described in the foregoing discussion as being applied to the IC tester adapted to test ICs which are typical of semiconductor devices, it will be obvious that the invention is also applicable, with similar advantages, to various types of semiconductor device testing apparatus for testing semiconductor devices other than ICs.

As is discussed above, according to the present invention, in a semiconductor device testing apparatus in which a semiconductor device under test is transported into the test section of the handler while grasped by a pick-up head of a contact arm and is, while still remaining grasped by the pick-up head, brought into electrical contact with a socket disposed in the test section by moving the contact arm, the socket and a shielding case covering at least a

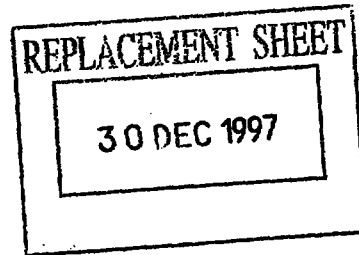


portion of that surface of a performance board of a test head
on which the socket is mounted are electrically connected
with a ground-potential face of the performance board, while
the top wall of the shielding case is formed with an opening
5 through which the contact arm 91 with the pick-up head may
move into and out of the shielding case, whereby the
semiconductor under test grasped by the pick-up head and
brought into electrical contact with the socket, the socket,
and at least a portion of the surface of the performance
10 board are confined in a closed space enclosed by the
shielding case.

From the foregoing discussion, it will be appreciated
that these components and connecting conductors are
electromagnetically shielded from the exterior to be free
15 from the influence of any external noise by the shielding
case which is at the ground potential. Even if semiconductor
devices to be tested are analog devices or analog/digital
mixed devices and they are to be tested in a high frequency
region, the present invention provides the remarkable
20 advantage that such semiconductor devices under test can be
tested accurately and measured for their electrical
characteristics under the condition where they are completely
shielded from external noise.



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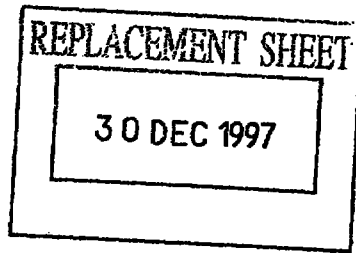


WHAT IS CLAIMED IS:

1. A semiconductor device testing apparatus having a semiconductor device transporting and handling apparatus connected therewith for transporting a semiconductor device under test to a test section to bring the semiconductor device into electrical contact with a socket disposed in said test section and, upon completion of the test, transporting the tested semiconductor device out of said test section, characterized in that:

a shield means is provided on a performance board of a test head, said shield means covering said socket and at least that portion of the surface of said performance board to which said socket is attached and an area adjoining the outer peripheral of that portion.

2. The semiconductor device testing apparatus according to Claim 1, wherein said shield means comprises a shielding case attached to the performance board such that it covers said socket and at least that portion of the surface of said performance board to which said socket is mounted and an area adjoining the outer peripheral of that portion, said shielding case being electrically connected with a ground-potential face of said performance board, and an electrically conductive cover plate attached to a contact arm which forms a component part of the semiconductor device transporting and handling apparatus and which is adapted to grasp and transport a semiconductor device in said test section.

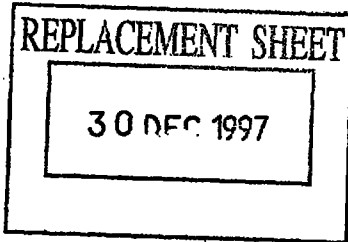


3. The semiconductor device testing apparatus according to Claim 1, wherein said shield means comprises a shielding case attached to the outer periphery of said performance board such that it covers approximately the entire surface of the performance board to which the socket is mounted, said shielding case being electrically connected with a ground-potential face of said performance board, and an electrically conductive cover plate attached to a contact arm which forms a component part of the semiconductor device transporting and handling apparatus and which is adapted to grasp and transport a semiconductor device in said test section.

4. The semiconductor device testing apparatus according to Claim 2, wherein said shielding case is formed through its top wall with an opening through which said contact arm may move into and out of said shielding case, an electrically conductive, resilient contact surrounding said opening being attached to said shielding case.

5. The semiconductor device testing apparatus according to Claim 2, wherein said resilient contact is an electrically conductive leaf spring.

6. The semiconductor device testing apparatus according to Claim 2, wherein said contact arm is equipped at its tip end with a pick-up head for grasping a semiconductor device,



which may be either of the configuration to attract and grasp the semiconductor device by vacuum suction or of the configuration to grasp it by mechanical means.

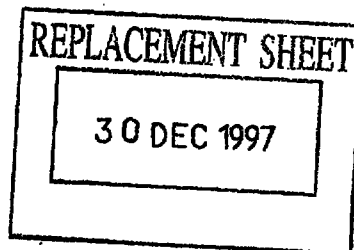
7. The semiconductor device testing apparatus according to Claim 3, wherein the location where said cover plate is attached to said contact arm is such that when said contact arm is lowered until the semiconductor device under test grasped by the contact arm comes into contact with said socket, said cover plate will press said resilient contact downwardly.

8. The semiconductor device testing apparatus according to any one of Claims 2 to 7, wherein said contact arm is formed of an electrically conductive material, an electrically insulating spacer being interposed between said contact arm and said cover plate.

9. A semiconductor device testing apparatus having a semiconductor device transporting and handling apparatus connected therewith for transporting a semiconductor device under test to a test section to bring the semiconductor device into electrical contact with a socket disposed in said test section and, upon completion of the test, transporting the tested semiconductor device out of said test section, wherein in said test section, a semiconductor device grasped by a grasp means mounted to said contact arm at its tip end



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is brought into electrical contact with the socket disposed in said test section by moving said contact arm which is a component part of the semiconductor device transporting and handling apparatus, characterized in that:

a shielding case is attached to a performance board of a test head, said shielding case covering said socket and at least that portion of the surface of said performance board to which said socket is mounted and an area adjoining the outer peripheral of that portion, said shielding case being electrically connected with a ground-potential face of said performance board; and

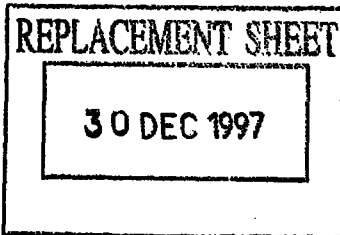
an opening is formed through the top wall of the shielding case, through which said contact arm with said grasp means may move into and out of said shielding case.

10. The semiconductor device testing apparatus according to Claim 9, wherein an electrically conductive, resilient contact surrounding said opening is attached to said shielding case, and an electrically conductive cover plate is attached to said contact arm and positioned such that as said contact arm is lowered, said cover plate comes into contact with said resilient contact.

11. The semiconductor device testing apparatus according to Claim 9, wherein said shielding case is attached to the outer periphery of said performance board such that it covers approximately the entire surface of the performance board to



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which the socket is mounted, said shielding case being electrically connected with a ground-potential face of said performance board.

12. The semiconductor device testing apparatus according to Claim 10, wherein said resilient contact is an electrically conductive leaf spring.

13. The semiconductor device testing apparatus according to Claim 9, wherein said contact arm is equipped at its tip end with a pick-up head for grasping a semiconductor device, which may be either of the configuration to attract and grasp the semiconductor device by vacuum suction or of the configuration to grasp it by mechanical means.

14. The semiconductor device testing apparatus according to Claim 10, wherein the location where said cover plate is attached to said contact arm is such that when said contact arm is lowered until the semiconductor device under test grasped by the contact arm comes into contact with said socket, said cover plate will press said resilient contact downwardly.

15. The semiconductor device testing apparatus according to any one of Claims 10 to 14, wherein said contact arm is formed of an electrically conductive material, an electrically insulating spacer being interposed between said



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contact arm and said cover plate.

REPLACEMENT SHEET

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SEMICONDUCTOR DEVICE TESTING APPARATUS

ABSTRACT

An IC tester which is capable of conducting the test on analog devices or analog/digital mixed devices without being subject to the influence of any external noise is provided. A shielding case 100 is attached to a performance board 30 of a test head 13 and covers an IC socket 20 disposed in the test section of the handler 12 and at least that portion of the surface of the performance board to which the socket is mounted and an area adjoining the outer peripheral of that portion. The shielding case is formed through its top wall with an opening 102 through which a contact arm 91 with a pick-up head 92 may move into and out of the shielding case. An electrically conductive spring contact 103 surrounding the opening is attached to the shielding case, and an electrically conductive cover plate 104 is attached to the contact arm and positioned such that as the contact arm is lowered, the cover plate comes into contact with the spring contact to slightly press the latter.

Figure 1

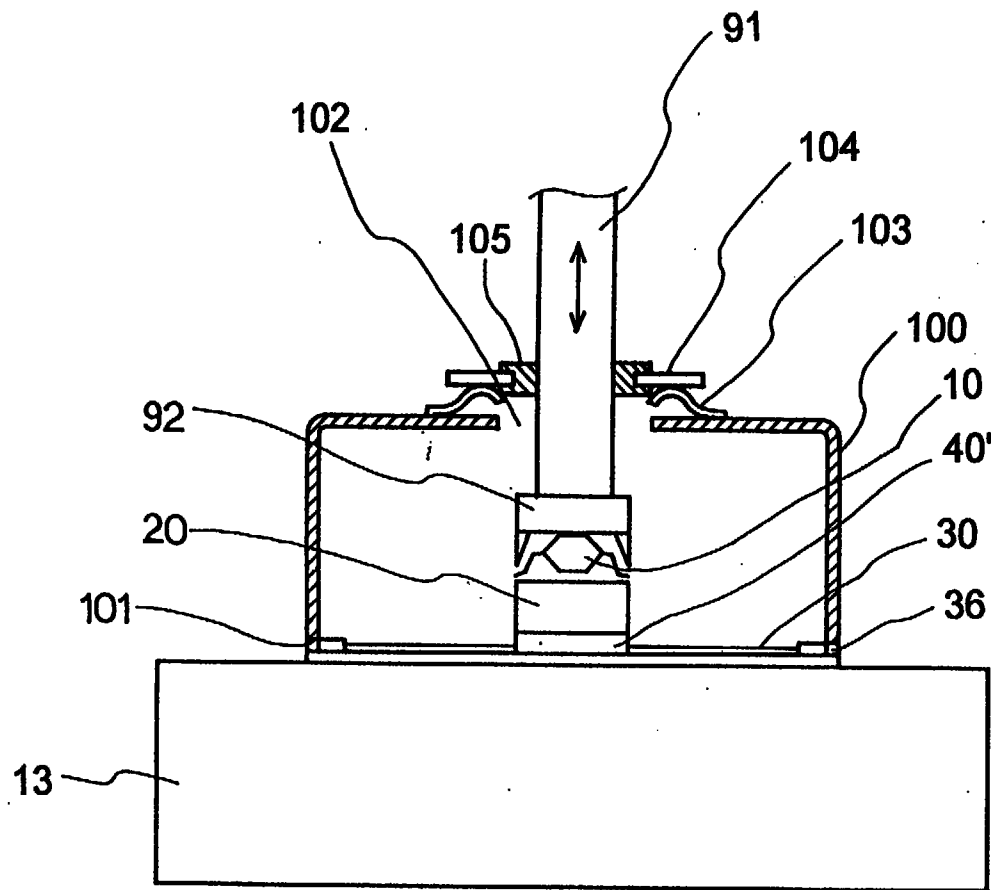
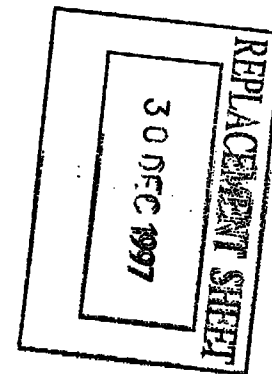


FIG. 1

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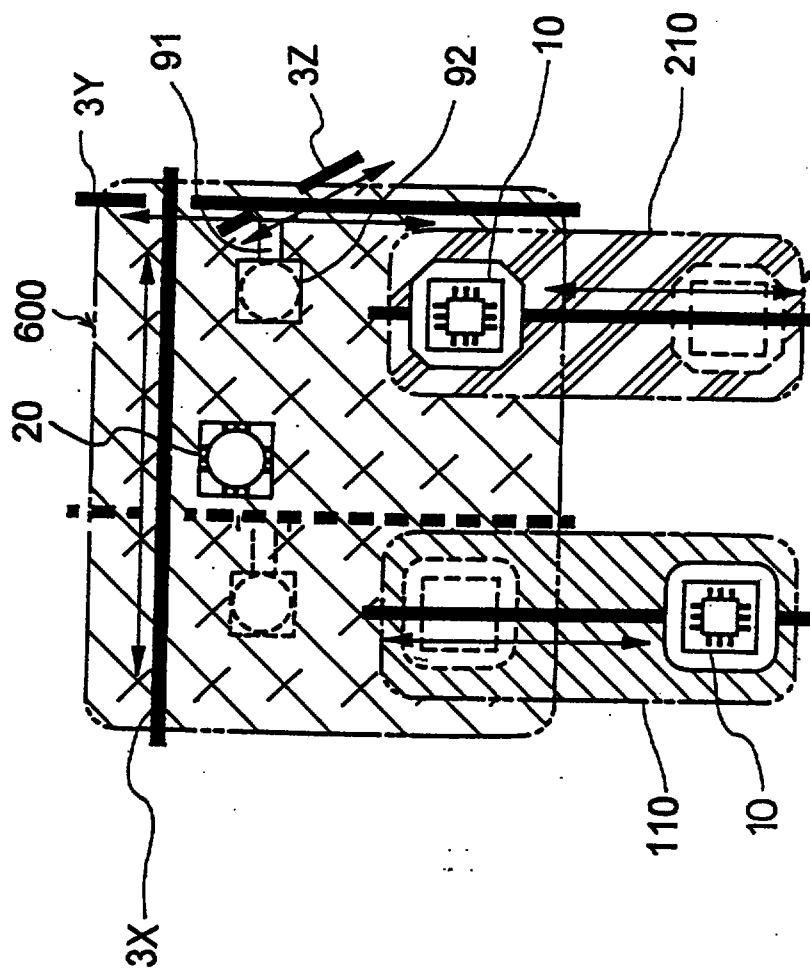


FIG. 2

REPLACEMENT SHEET

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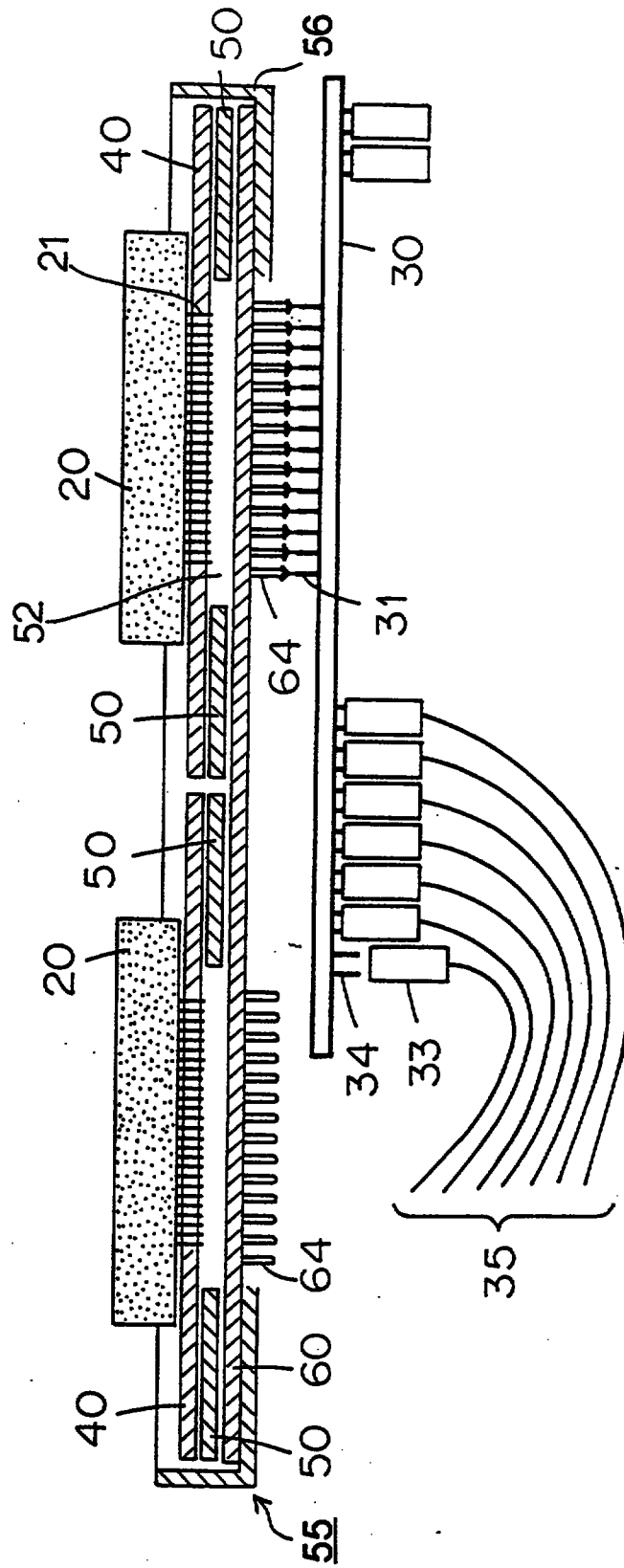


FIG. 3

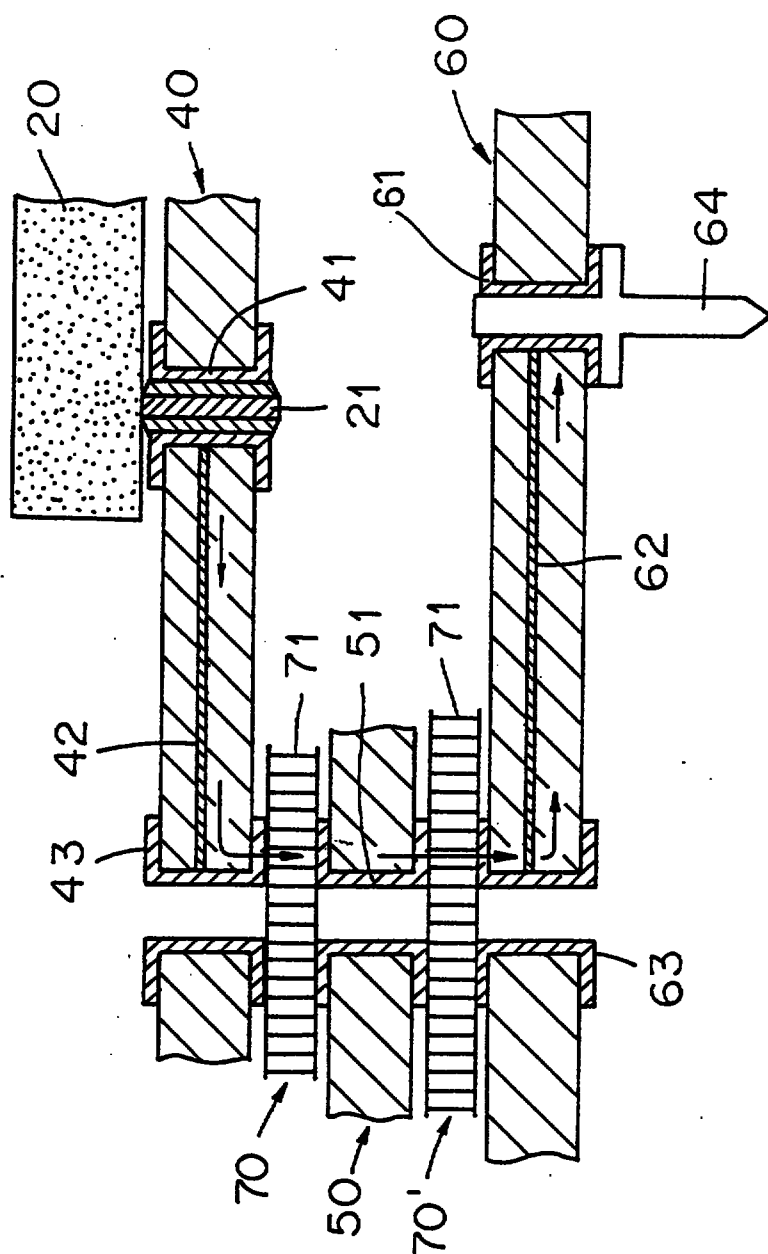


FIG. 4

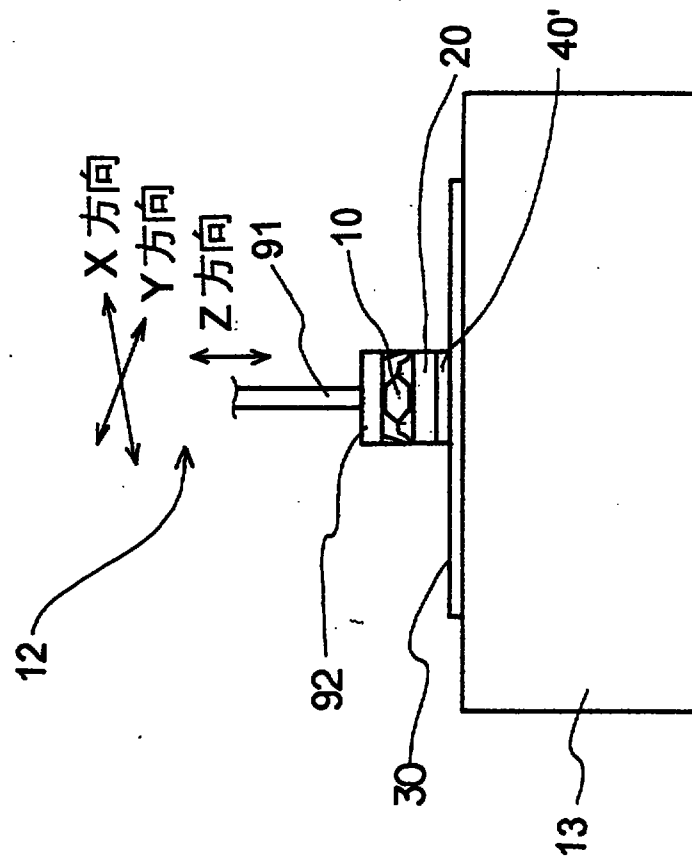
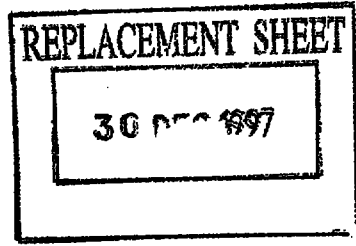


FIG. 5

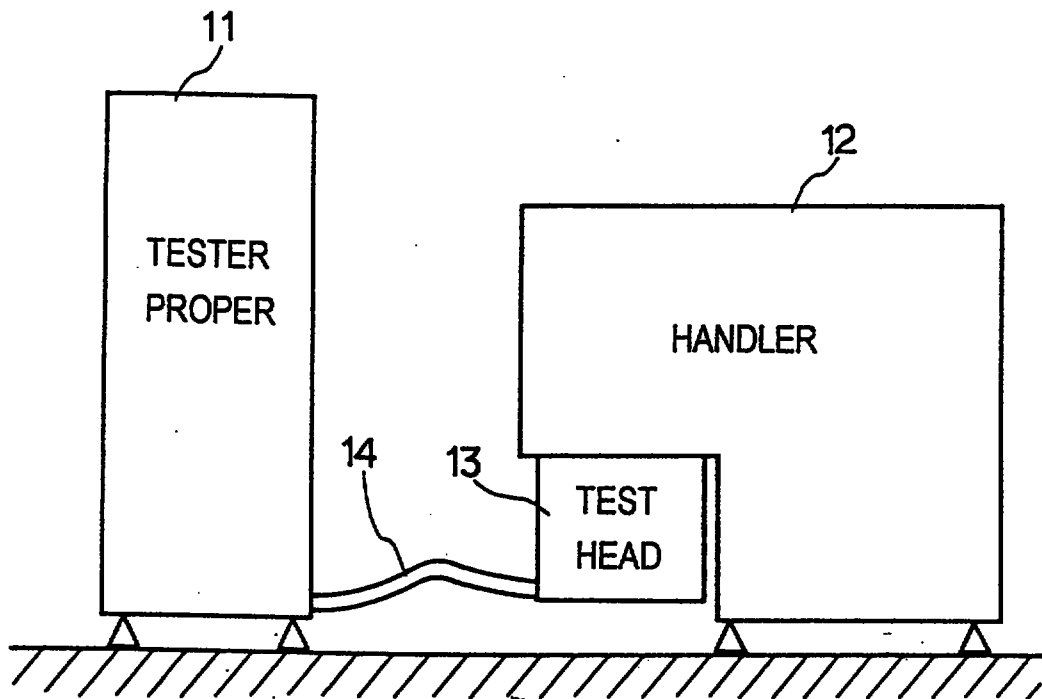
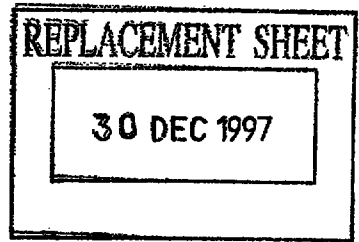


FIG. 6