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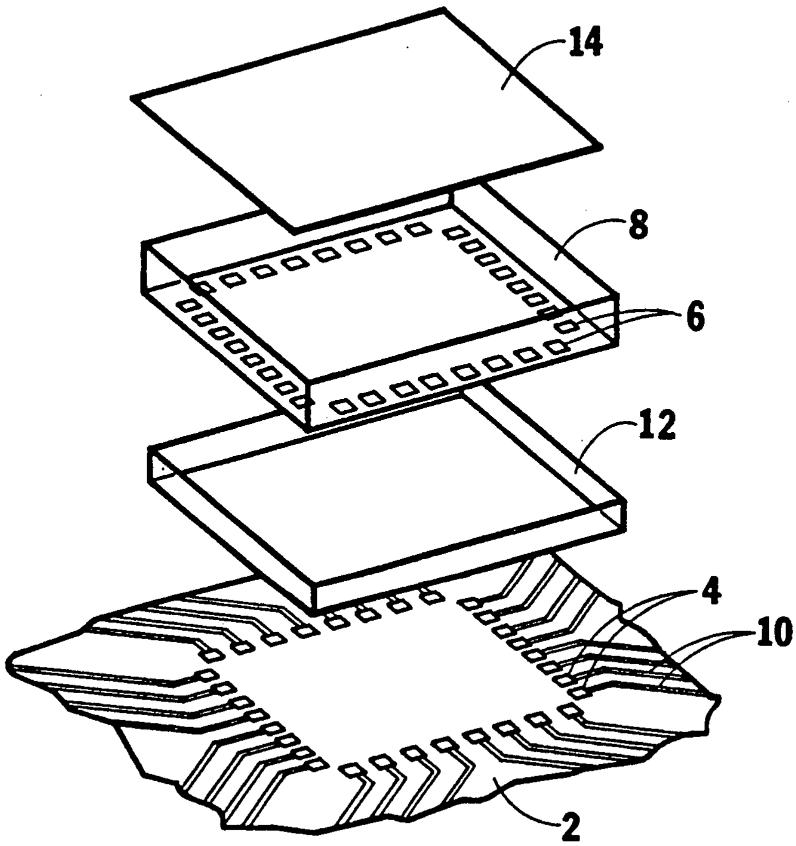
(57) Abstract

Using a Z-axis material (12'), a bare die (36) can be burn-in tested without first packaging the die. Burn-in testing of the bare die has the benefit of saving packaging efforts. For multiple die packages, burn-in testing of the bare die has the benefit that each individual die can be burn-in tested separately from the package.



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METHOD AND APPARATUS FOR BARE DIE BURN-IN AND TEST USING Z-AXIS ELECTRICALLY CONDUCTIVE MATERIAL

Background of the Invention

This invention relates to a method and apparatus for the burn-in testing of dies. During Burn-in testing, a die is heat stressed while electrical signals are sent to a circuit on the die. The heat applied in the burn-in testing accelerates the aging of the die. After the heat stressing, the die is tested for failures.

The burn-in testing typically consists of an infant mortality test or a statistics test. The infant mortality test culls out dies that would fail due to the infant mortality of specific dies. On the other hand, the statistics test produces statistics on the failure rate of dies produced with a circuit design. These statistics are valuable in certifying that the process does not produce too many defective dies.

Prior art burn-in test methods test packaged dies. The dies are permanently packaged by conventional packaging techniques. The package is then placed in an expensive socket in a burn-in board carrier and burn-in tested.

It is expensive to package dies just for a statistics test. Additionally, a failure of any of the dies in an infant mortality test done on a multiple die package will cause the multiple die package to fail the infant mortality test. Such a failure would mean that the entire package including non-defective dies would have to be discarded.

Summary

The present invention is a method and apparatus for performing a bare die burn-in which avoids the above listed problems. An advantage of performing a bare die burn-in is that the dies do not have to be packaged in order to perform the burn-in statistics test of the dies. Additionally, each individual die can be tested for infant mortality failures before the dies are placed into a multi-die package.

The above and other objectives are realized by using an apparatus for use in burn-in testing. This apparatus comprises a base defining a base surface. The base also comprises a plurality of contacts on the base surface. The apparatus further comprises a directionally conductive material on the base surface. The directionally conductive material on the base surface is electrically conductive through paths which are transverse to the base surface but the material is not electrically conductive

through paths parallel to the base surface. The die defines a die surface and comprises a plurality of wire bond pads on the surface. The die surface is located on the directionally conductive material. The contacts are arranged on the base in a manner that each of the wire bond pads is electrically connected to a corresponding contact of the plurality of contacts through one of the electrically conductive paths. The apparatus also comprises circuitry electrically connected to the contacts for supplying electrical signals to the die during burn-in.

Additionally, the above and other objectives are realized by using a method of die burn-in. The method comprises providing a die which defines a die surface, the die having a plurality of wire bond pads on the die surface; providing a base defining a base surface, the base surface having a plurality of contacts; placing a directionally conductive material on the base surface, the directionally conductive material being electrically conductive through paths in the material which are transverse to the base surface, but the material being not electrically conductive through paths in the material parallel to the base surface; aligning the die on top of the directionally conductive material in a manner that each of the wire bond pads are in electrical contact through one of the electrically conductive paths with a corresponding contact of the plurality of contacts and not in electrical contact with any other of the plurality of contacts; and burn-in testing the die.

Brief Description of the Drawings

The above and other features and aspects of the present invention will become more apparent upon reading the following detailed description in conjunction with the accompanying drawings, in which:

Fig. 1 is a partial three-dimensional schematic view of the present invention;

Fig. 2A is a partial cross-sectional view of the present invention (this view is not to scale);

Figure 2B is a partial cross-sectional view of an alternate embodiment of the present invention;

Figure 2C is a partial cross-sectional view of another alternate embodiment of the present invention;

Fig. 3 is a top view of a single die carrier of the present invention;

Fig. 4 is a partial cross-sectional view of the single die carrier shown in Fig. 3; and

Fig. 5 is a three-dimensional view of a multiple die carrier of the present invention.

Detailed Description of the Preferred Embodiment

Fig. 1 is a partial three-dimensional schematic view of the present invention. A base 2 defines a surface including a plurality of contacts 4. These contacts 4 are arranged in a mirror image of the wire bond pads 6 on the surface of die 8.

In the preferred embodiment, the base 2 is constructed of PC board material with the contacts 4 being traces. Wire traces 10 connected to the contacts 4 can be formed on the PC board material. The wire traces 10 connect to external leads or pins as described below.

A directionally conductive material 12 is placed in between the dies 8 and the base 2. This directionally conductive material 12 is conductive in paths which are transverse or not parallel to the base surface. The directionally conductive material can be a Z-axis material. Z-axis material is a material that is conductive one direction, but is not conductive along other directions.

There are two main types of Z-axis material. The first type is a Z-axis film such as that discussed in U.S. Patent 4,695,404 and Reworkable Z-Axis Electrically Conductive Adhesives for Solder Replacement K. Chung et al., I.T.A.D. 1991 Proceedings, pg. 200-211. This Z-axis film comprises conductive particles placed into a normally insulative polymer matrix such that the conductive particles are close together and facilitate current flow. This film can electrically connect the contacts 4 with the wire bond pads 6 on the die 8 so that the die can be burn-in tested. This Z-Axis film is available from A.I. Technology, Inc. of Princeton, New Jersey.

The other type of Z-axis material is a material that comprises a non-conductive elastic substance with embedded metal wires along the Z-axis. In the preferred embodiment, these metal wires are embedded with a pitch of less than around six mils. This material could be "Z-connector" available from Fuji Poly Corporation or could be "tester interposer" available from the JSR Corporation. A benefit of this second type of Z-axis material is that the embedded wires may scratch away some of the oxide formed around the contacts 4 or the wire bond pads 6.

A pressure plate 14 is placed on top of the die 8, directionally conductive material 12, and base 2 so that electrical connections are formed between the contacts 4 and the wire bond pads 6.

Fig. 2A is a partial cross-sectional view of the present invention. This figure is not drawn to scale. Fig. 2A shows that the contact 4a' is electrically connected to a corresponding wire bond pad 6a' by the Z-axis material 12'. The Z-axis material 12' is electrically conductive through paths 15 which are transverse to the base surface. Paths in the Z-axis material 12' parallel to the base surface are not electrically conductive. This means that, for example, the contact 4a' is not electrically connected to the wire bond pad 6b'. Preferably, the conductive paths 15 in the Z-axis material 12' are substantially perpendicular to the surface of base 2'.

As a practical matter, the conductive paths in the base surface do not have to be perfectly perpendicular to the base surface. Figure 2B is a partial cross-sectional view of an alternate embodiment of the present invention. Notice that wire 16 in Z-axis material 12'' is not perfectly perpendicular but the wire 16 still electrically connects wire bond pad 6a'' with contact 4a''. A disadvantage of the embodiment shown in Figure 2B is that the wires must be placed closer together in the Z-axis material than if the wires were substantially perpendicular to the base surface.

Alternatively, the conductive paths could connect wire bond pads and contacts that were not adjacent. Figure 2C is a partial cross-sectional view of another alternate embodiment of the present invention. Wire 18 in Z-axis material 12''' is not perpendicular with respect to the surface on base 2'''. Wire 18 electrically connects wire bond pad 6b''' with contact 4a'''. This alternative embodiment has the disadvantage that it makes aligning the die more difficult.

Looking again at Figure 2A, the Z-axis material 12' does not permanently attach itself to the die surface. For this reason, the die 8' can be removed and the apparatus can be re-used with a different die. This is an advantage over prior art methods which require a permanent wire bond connection to the wire bond pads on the die in order to burn-in test the die. After the burn-in test, the die 8' can be packaged using conventional methods.

Fig. 4 is a partial cross-sectional view of the present invention. This figure shows the base 30. This base defines a cavity 30a and includes a PC board material 30b with contacts 32 such as contact 32a placed on its surface. The base 30 includes a template 30c. The template 30c is used to hold the Z-axis material 34 and the die 36 in place. The Z-axis material 34 is shown as the non-conductive elastic material with embedded wires placed therein. Note that the die 36 includes wire bond pads 38 such as wire bond pad 38a corresponding to the contacts 32. For example, contact 32a is in electrical contact with wire bond pad 38a. The thickness of the die cavity 30a is preferably 80% of the combined thickness of the Z-axis material 34 and the die 36. When the die 36 is placed down into the cavity against the template 30c, the die pads will self-align with the contacts in the die cavity providing that the die orientation is correct. The use of the template 30c ensures that each of the wire bond pads is electrically connected to its corresponding contact through electrically conductive paths in the Z-Axis material 34.

The pressure plate 40 is locked with a locking mechanism 42. The locking mechanism 42 can be four screws which screw down into the pressure plate through to the base, a twist lock mechanism or a hinged plate with a lock. When the pressure plate 40 is locked onto the base 30, the apparatus is ready for the burn-in test. After the burn-in test, the pressure plate 40 can be unlocked, the Z-axis material 34 taken out and the die 36 removed.

Fig. 3 is a top view of the single die carrier showing the traces on the PC board layer. Note that contacts such as contact 50 are connected by traces such as trace 52 to external leads such as external lead 54. The location of the template 30c', the package cavity 30d' and the die cavity 30a' are shown in phantom. The position of the pressure plate 40 is also shown. The carrier 60 is a specially designed package that has an external package body and leads that look the same as one of the commonly used packages, eg. dual-in-line, quad flat pack, and pin grid array packages. The external leads such as external lead 55 can be connected to circuitry 62. The circuitry 62 supplies electrical test signals to the external leads which are connected to the contacts. The contacts are connected through the Z-axis material to the wire bond pads. In this fashion, the circuitry 62 can be used for supplying electrical signals to the die during burn-in. After burn-in, circuitry 62 or other circuitry (not shown) can be used for testing the die.

In the statistics test of the die, the die is heat stressed at a temperature between 125° C to 150° C. The dies are tested after 250 hours, 500 hours, 750 hours and 1,000 hours of operation under heat stress and electrical signal stimulus. These testings produce the required statistics. The infant mortality testing can also be done using the carrier 60.

Fig. 5 is a three-dimensional view of the multiple die carrier of the present invention. This multiple die carrier 70 can be used for a burn-in test of more than one die at a time. The multiple die carrier 70 uses a pressure plate 72 to hold multiple dies such as dies 74 and 76. A single Z-axis layer 78 or multiple Z-axis layers (not shown) could be used to electrically connect the contacts and the wire bond pads. Contacts 86 on the base 80 are a mirror image of corresponding wire bond pads

90 on the die 74. Additionally, contacts 88 on the base 80 are a mirror image of corresponding wire bond pads 91 on the die 76. The base 80 includes templates 81 to keep the dies in alignment.

In the preferred embodiment, connector traces 82 electrically connect contacts 86 with contacts 88. Furthermore, these contacts 86 and 88 are electrically connected to a plug 92 on one side of the base that is electrically connected to the circuitry 84. The circuitry 84 can supply electrical signals to all the dies in the carrier 70 during the burn-in.

In the preferred embodiment, after the burn-in stressing, each of the multiple dies is placed in an individual carrier, such as that shown in figure 3, for testing. The individual carriers are used for testing since the connector traces 82 on the multiple die carrier shown in figure 5 connect together wire bond pads of each of the multiple dies in order to send the same electrical signals to the die during burn-in.

The benefit of using multiple die carriers is that they use less space in the burn-in oven. Single die carriers use two to three times as much space per die in the burn-in oven compared to the multiple die carriers.

The multiple die carriers are not limited to holding only two dies. The carrier 70 could, for example, connect together forty (40) or more dies in the manner described above.

Various details of the implementation and method are merely illustrative of the invention. It will be understood that various changes of details may be within the scope of the invention, which is to be limited only by the appended claims.

WHAT IS CLAIMED IS:

1. An apparatus for use in burn-in testing, said apparatus comprising:

a base defining a base surface, said base comprising a plurality of contacts on said base surface;

a directionally conductive material on said base surface, said material being electrically conductive through paths which are transverse to said base surface but said material being not electrically conductive through paths parallel to said base surface;

a die defining a die surface and comprising a plurality of wire bond pads on said die surface, said die surface being located on said directionally conductive material, wherein said contacts are arranged on said base in a manner that each of said wire bond pads is electrically connected to a corresponding contact of said plurality of contacts through one of said electrically conductive paths; and

circuitry electrically connected to said contacts for supplying electrical signals to said die during burn-in.

2. The apparatus of claim 1, wherein said material is such that each of said wire bond pads is not

in electrical contact with any other of said plurality of contacts, except its corresponding contact.

3. The apparatus of claim 1 wherein said material is such that said material does not permanently attach to said die surface so said die can be removed from said apparatus.

4. The apparatus of claim 3, further comprising a pressure plate pressure plate connected to said base for putting pressure on the die to hold said die surface on said material, said pressure plate being adapted in a manner that the die can be removed from the apparatus.

5. The apparatus of claim 1, wherein said base defines a cavity, said cavity containing said material and portions of said die, and wherein said base includes a template surrounding said cavity for ensuring that each of said wire bond pads is electrically connected to its corresponding contact through one of said electrically conductive paths.

6. The apparatus of claim 1, wherein said material comprises a z-axis film.

7. The apparatus of claim 1, wherein said material comprises a non-conductive elastic substance with embedded metal wires, said metal wires including a wire electrically connecting each of said wire bond pads to its corresponding contact.

8. The apparatus of claim 1, wherein said base further comprises external leads or pads electrically connected to said contacts, said external leads or pads being adapted to connect to said electrical signal supplying circuitry.

9. The apparatus of claim 8, wherein said base comprises a PC board layer and wherein said contacts comprise traces on or in said PC board layer, wherein said traces are electrically connected to said external leads or pads.

10. The apparatus of claim 1, wherein said electrically conductive paths in said material comprise paths that are substantially perpendicular to said base surface.

11. The apparatus of claim 1, wherein said base includes multiple sets of contacts corresponding to wire

bond pads on multiple dies and wherein one pressure plate connected to the base is adapted to contain the multiple dies.

12. A method of die burn-in comprising:

providing a die which defines a die surface, said die having a plurality of wire bond pads on said die surface;

providing a base defining a base surface, said base surface having a plurality of contacts;

placing a directionally conductive material on said base surface, said directionally conductive material being electrically conductive through paths in said material which are transverse to said base surface, but said material not being electrically conductive through paths in said material parallel to said base surface;

aligning said die on top of the directionally conductive material in a manner that each of said wire bond pads are in electrical contact through one of said electrically conductive paths with a corresponding contact of said plurality of contacts and not in electrical contact with any other of said plurality of contacts; and

burn-in testing said die.

13. The method of claim 12, further comprising

removing said die from said material.

14. The method of claim 13, further comprising the step of forming a package with said die.

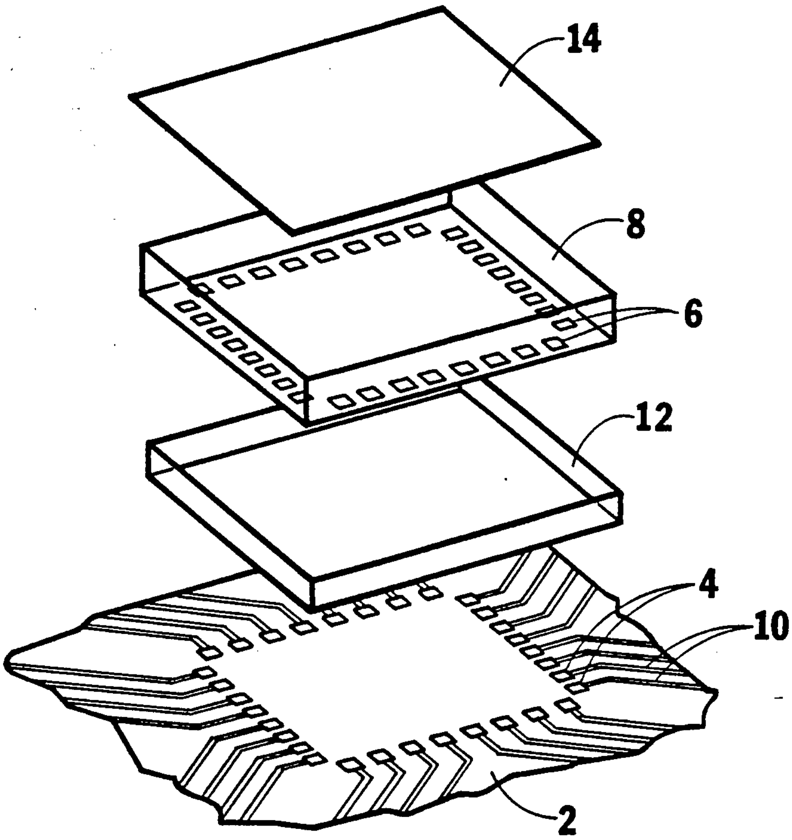

FIG._1.

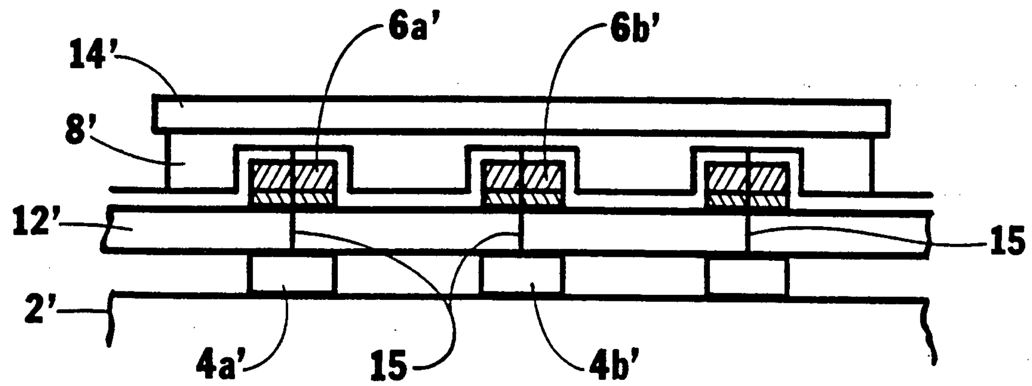

FIG._2A.

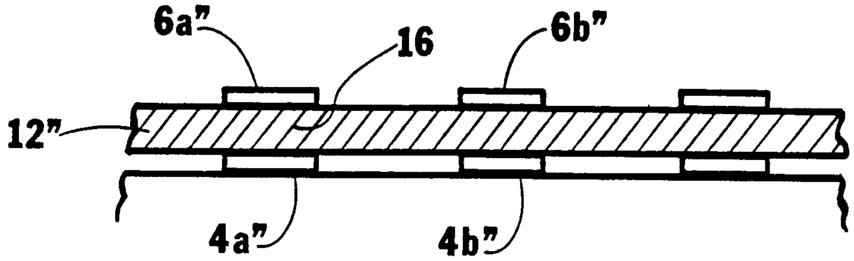

FIG._2B.

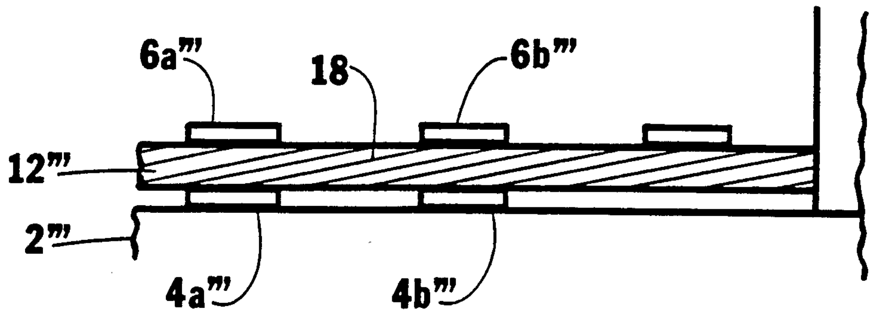

FIG._2C.

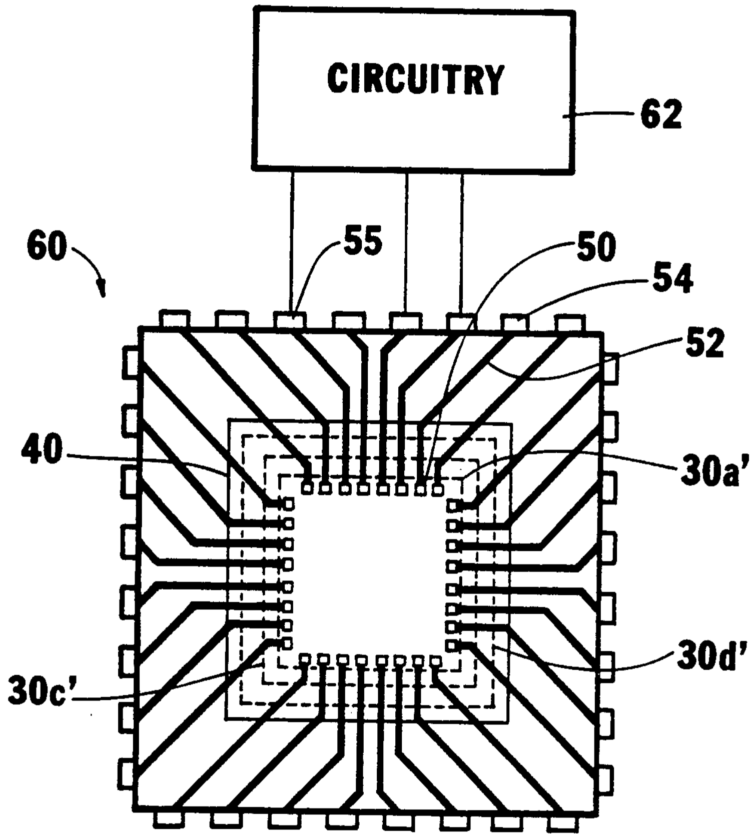
CIRCUITRY
62
60
55
50
54
52
40
30a'
30d'
30c'

FIG. 3.

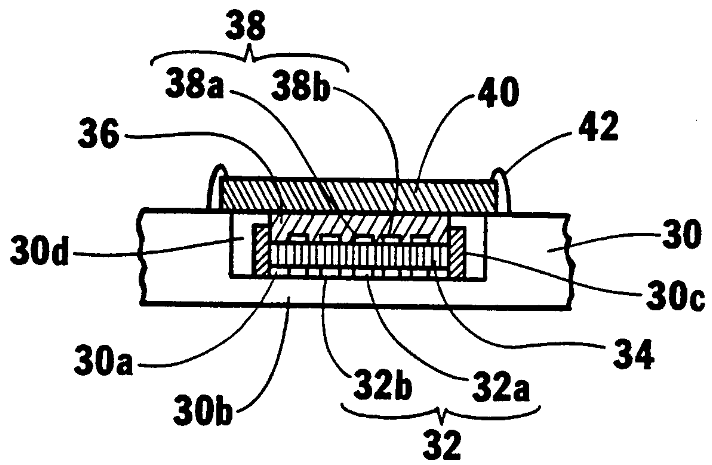
38
38a
38b
40
42
36
30d
30
30c
34
30a
32b
32a
30b
32

FIG. 4.

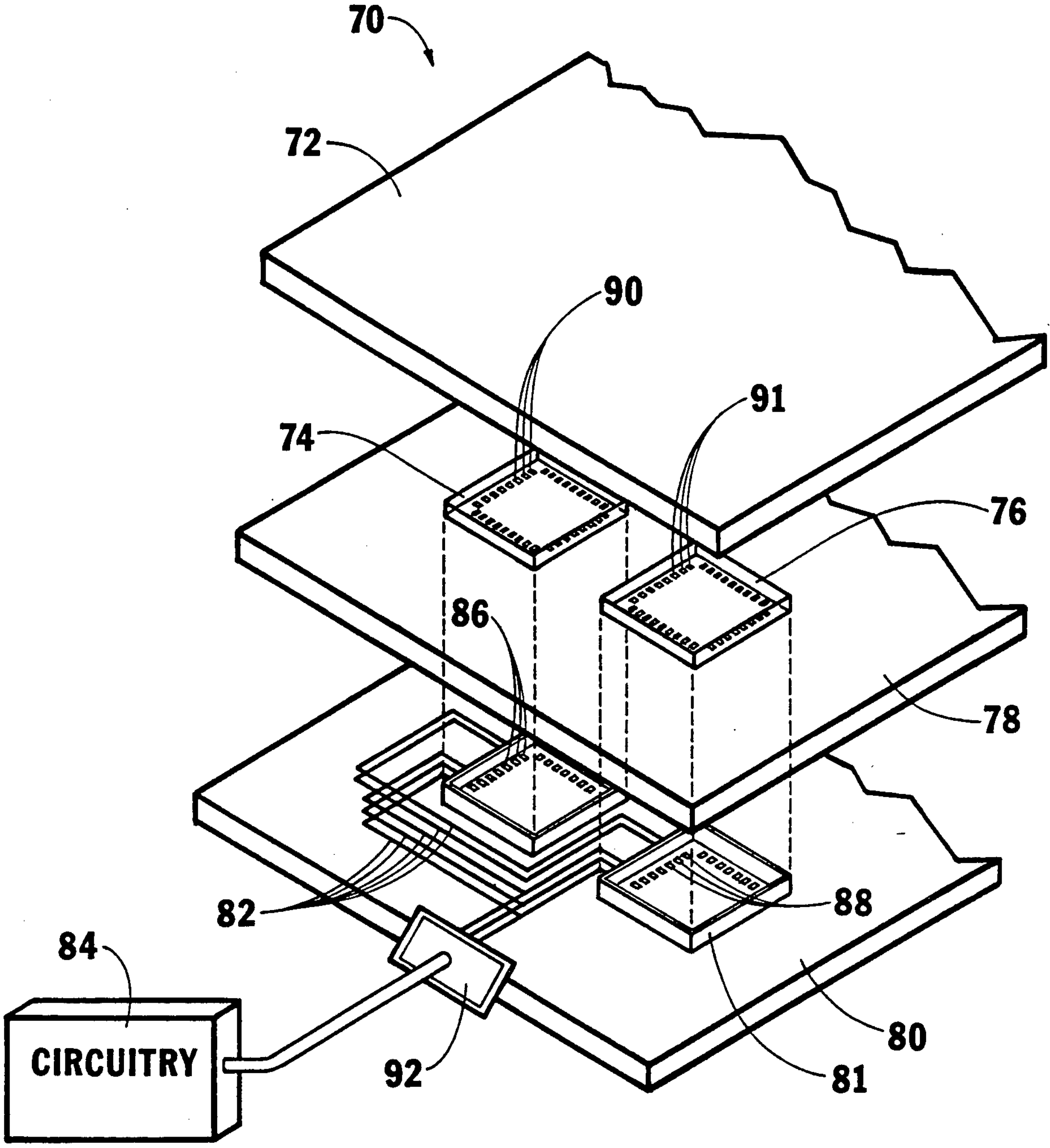

FIG._5.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/01653

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G01R, 1/04
US CL :324/158P
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 324/158F, 158P

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,123,850 (ELDER) 23 June 1992, figure 7 and column 3, lines 33-37 and column 4, line 58 to column 5, lines 10-11.	1-14
X	US, A, 5,176,528 (NIERESCHER et al) 05 January 1993, figure 2 and 6.	1-14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
04 April 1994	JUN 27 1994

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