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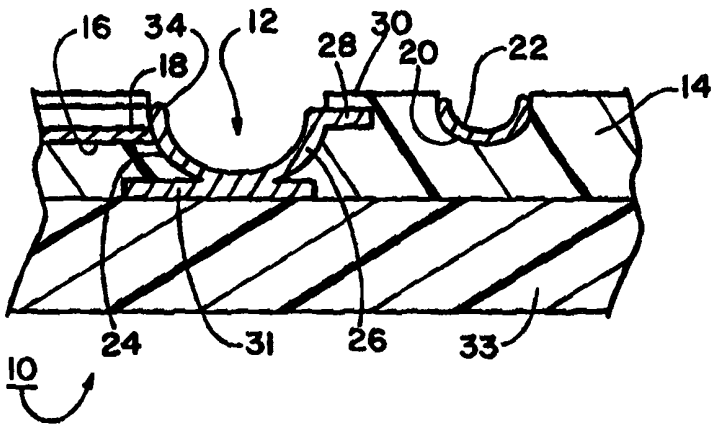
(54) Title: WIRING BOARD CONSTRUCTIONS AND METHODS OF MAKING SAME

(57) Abstract

A wiring board construction (10) includes at least one microvia (12) disposed in a base substrate (14) and includes a deep imprinted cup shaped in the top surface thereof (24). A conductor material is disposed within the recess (26), and has a portion disposed at the bottom thereof. A conductor disposed at a bottom surface of the substrate opposite to the conductor material bottom portion (31) helps to complete an electrically conductive path through the substrate.



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TITLE OF THE INVENTION

WIRING BOARD CONSTRUCTIONS AND METHODS OF MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

Technical Field

The present invention relates in general to wiring board constructions and methods of making them. The invention more particularly relates to methods of making microvias in wiring boards.

Background Art

Plated through holes have been employed in printed wiring boards for establishing electrical connections between the top and bottom sides of the boards. Such plated through holes have also been employed in multiple layer wiring board constructions.

According to the construction of conventional plated through holes, relatively large pads surround the plated through holes according to conventional design techniques, because the plated through holes are created by drilling through the conductor pad and the board. The pad is electrically connected to a conductor trace, and the conventional pads are substantially larger in size than the trace to accommodate any potential layer-to-layer or pattern-to-hole misregistration problems during the construction of the plated through hole. As explained in the book, entitled "Printed Circuit Handbook", Fourth Edition, by Clyde F. Coombs, Jr.,

published by McGraw-Hill, the misregistration is caused principally by the instability and movement of the base laminate substrate during the process of making the printed wiring board or multilayer board.

By having the large pad surrounding the hole, an unwanted and undesirable waste of valuable space on the wiring board results. As stated in the Coombs book, a reduction in the pad diameter from 55 to 25 mils causing a 55% reduction in an area. Such a reduction would double the overall interconnection density. Thus, it is important to reduce the pad diameters. The reduction of the pad diameters would be highly desirable for increasing greatly the wiring capacity of the modern complex printed wiring boards.

Thus, it would be highly desirable to have a new and improved wiring board construction and method of making it to enable through holes to be provided with little or no surrounding pads.

Additionally, the forming of through holes by drilling through the pads individually is time consuming and expensive. Considering the fact that a large number of such through holes are required according to modern manufacturing techniques, it would be highly desirable to enable the individual drilling to be eliminated.

Therefore, the formation of through holes in printed wiring boards and multilayer boards in one operation without the necessity of drilling each one individually would be highly advantageous for cost saving and through put purposes. Also, it would be highly desirable to form the through holes in a highly precise manner to eliminate or greatly reduce the problem of misregistration.

SUMMARY OF THE INVENTION

Therefore, the principal object of the present invention is to provide a new and improved wiring board

construction and method of making it, wherein microvias can be formed simultaneously without individual drilling and with little or no loss in valuable space on the wiring board, thereby to increase the wiring capacity for the board.

Briefly, the above and further objects of the present invention are realized by providing a new and improved wiring board and construction and method of making it to produce wiring board constructions having high density microvias formed without occupying unnecessary space on the board. Surrounding pads are either greatly reduced in size or entirely eliminated. Furthermore, the microvias are all able to be formed simultaneously, without the requirement of expensive individual drilling, and are formed at the same time as the traces on the board.

A wiring board construction includes at least one microvia disposed in a base substrate and includes a deep imprinted recess in the top surface thereof. A conductor material is disposed within the recess, and has a portion disposed at the bottom thereof. A conductor disposed at a bottom surface of the substrate opposite to the conductor material bottom portion helps to complete an electrically conductor path through the substrate to help complete an electrically conductive path through the substrate.

The conductive material can be supplied to the recess by electroplating, metal transfer and/or the addition of a microvia fill material. The substitute can be composed of an imprintable material including either an organic material such as resins and polymers, or an inorganic material such as ceramic material.

BRIEF DESCRIPTION OF DRAWINGS

The above mentioned and other objects and features of this invention and the manner of attaining them will

become apparent, and the invention itself will be best understood by reference to the following description of the embodiments of the invention in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectional diagrammatic fragmentary elevational view of a wiring board construction, which is constructed in accordance with the present invention;

FIG. 1A is an enlarged sectional fragmentary diagrammatic elevational view of the wiring board construction of FIG. 1, illustrating it in the process of being fabricated;

FIG. 2 is a fragmentary plan view of the board of FIG 1;

FIG. 3 is a fragmentary elevational sectional view of a multiple layer wiring board construction, including the wiring board construction of FIG. 1, according to the present invention;

FIG. 4 is a sectional fragmentary elevational view of another multiple layer board construction, which is constructed in accordance with the present invention;

FIG. 5 is a fragmentary plan view of yet another wiring board construction, which is constructed in accordance with the present invention;

FIG. 6 is a sectional fragmentary elevational view of the wiring board construction of FIG. 5.

FIG. 7 is a sectional fragmentary elevational view of a wiring board construction, which is constructed in accordance with the present invention;

FIG. 8 is a fragmentary pictorial diagrammatic view of a standard grid pattern construction, which is constructed in accordance with the present invention;

FIG. 9 is a fragmentary sectional elevational view of the construction of FIG. 8; and

FIG. 10 is a sectional diagrammatic fragmentary elevational view of an interconnect carrier sheet

illustrated in the process of being assemblied in accordance with the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings, and more particularly to FIGS. 1, 1A and 2 thereof, there is shown a wiring board construction 10, which is constructed in accordance with the present invention. The terms "wiring board" as used herein are intended to refer to and to include the terms "printed circuit board."

The wiring board construction 10 includes a microvia 12 formed in the wiring board construction 10 in accordance with the present invention. As seen in FIG. 2, the size of the microvia 12 is substantially smaller than the size of a conventional pad as indicated at 15 which would surround a conventional microvia (not shown), thereby greatly improving wiring density for the wiring board construction 10 as compared with conventional wiring densities.

A conductor shallow groove 16 has a conductor pad 18 or trace electrically connected to the microvia 12. The curved conductor trace 18 is formed in the top substrate 14 in accordance with fabrication methods disclosed in United States patents 5,334,279; 5,390,412 and 5,451,722, which are incorporated herein by reference. A conductor shallow groove 20 having a curved conductor pad 22 forming another trace in the wiring board construction 10 is also formed in the substrate 14 in accordance with the method disclosed in the foregoing patents. In accordance with the methods of the present invention, the microvia 12 and the conductor pads 18 and 22 are all formed simultaneously, and the microvia 12 does not require drilling.

Considering now the microvia 12 in greater detail, the microvia 12 includes a conductor deep recess 24

formed in the top surface of the substrate 14, and has a dished or cup shaped conductor 26 lining the surface of the groove 24. The conductor 26 is generally circular in cross section as indicated in FIG. 2, and includes a side flanged 28 for interconnecting with other conductors as hereinafter described in connection with FIG. 3 of the drawings. A conductor or trace 31 is disposed on the top surface of a bottom substrate 33 and is electrically connected to the bottom portion of the microvia conductor 26.

A rim 34 of the cup shaped conductor 26 is disposed substantially below the surface disposed between adjacent conductors 26 and 22 as indicated in FIG. 1. The solder dam 30 is a portion of the substrate 14 disposed above the top surfaces or rims of the conductors 22 and 26, such as the rim 34 to reduce solder bridging.

The conductor trace 31 can be a pad, which can be square, round or tear drop in configuration.

The microvia 12 is formed by imprint patterning to simultaneously form all of the interconnecting traces in both the X and Y directions (traces 18 and 22), as well as the Z direction (microvia 12).

Referring now to FIG. 1A, according to the method of the present invention, the wiring board construction 10 is made by using a low cost and repeated-use metal imprinting tool 27 to pattern the substrate 14 to form the grooves 16 and 22, and the recess 24, simultaneously. All of this is accomplished without requiring a phototool film, photoresist, imaging, developing or permanent solder mask (not shown).

The metal imprinting tool imprints the entire circuit and microvia pattern simultaneously by compression forming on one or both layers in a conventional printed wiring board laminating press (not

shown) while the interlayers are being laminated. The patterning tool can be made by electroforming, an extremely reliable and inexpensive atom-by-atom electrodeposition process.

Considering now in greater detail the method of making the microvia 12 of the wiring board construction 10 in accordance with the present invention, the cup-shaped recess 24, as well as the U-shaped conductor grooves 16 and 20, are formed simultaneously in the top substrate 14 by imprinting or stamp forming by means of the tool 27 hot-pressed into the top surface of the substrate 14 utilizing the laminating press (not shown). The cup-shaped recess 24 is circular in cross section, and extends substantially through the entire depth of the substrate 14 and extends to the conductor 31 therebelow. Prior to metalizing the recess 24 and the grooves 20 and 24 (FIG. 1), a thin web 25 at the bottom of the recess 24, as best seen in FIG. 1A, is removed.

There are a variety of removal or ablation techniques, which are preferred in accordance with the present invention. For example, a wet-chemical attack can be used. In this regard, the side walls of the recess 24 are etched back before metalizing. Permanganate etchback may be employed, although other etchback materials may also be employed as will become apparent to those skilled in the art. In the case of a substrate which is composed of photosensitive material, a pass through the weakened or diluted developer solution is utilized to remove the web 25.

Another web removal process is performed by abrasive etching. A plurality of nozzles (not shown) disposed above the substrate 14 may be employed, or fluidized bed abrasize ablation. Another technique for web removal is the use of dry etching by use of plasma techniques. Such a technique is inherently clean, and

the dry etching process can be performed non-selectively, without the use of a film or a mask. This technique is possible because the thickness of the web 25 to be removed at the bottom of the microvia 12 is dramatically thinner than the thickness of the entire layer. All areas can be slightly reduced in thickness without adversely altering the final X-Y configuration of the pattern definition.

A further web removal technique is to employ laser cutting techniques. Because the web 35 is very thin, rapid ablation of the web 25 is possible with low wattage lasers, depending upon the wave length used. However, laser ablation is a serial, or small area process, often somewhat slower than the alternatives.

A still further web-removal approach in accordance with the present invention is to employ heat ablation, especially of uncured film. A planar or line-source of heat such as a halogen lamp source (not shown), is positioned in a closely spaced manner to the uncured substrate material, which may be disposed on a moving conveyor (not shown). The thin web 25 is thus heated and reverts from a polymer to a monomer. Although this could also happen on the top surface, removal by a wet chemical method of a tiny portion of all surfaces preserves the pattern, thereby eliminating the need for registration and many other empirical steps otherwise employed in conventional techniques.

Yet another web removal technique according to the present invention is the use of scrubbing by vibration such as by the use of ultrasonic vibrations of the tool plate during or after lamination molding to cause the web 25 to be pushed aside by scrubbing.

An additional technique for web removal is to remove the webs by subjecting them simultaneously to a group of high pressure jets of fluid, such as air,

nitrogen or other gases or liquids. Thus, the jets penetate and break away the webs.

A further approach according to the present invention is to omit the web removal step entirely and replace it with a punch through operation, where a sharp pointed instrument (not shown) severs the web 33 without removing it entirely.

A further approach is to omit the web removal process entirely, and a metal conductor 31 on the surface of the tool and the metal cup-shaped conductor 26 are microwelded together through the thin web 25. In this regard, the conductors 26 and 31 on the surface of the tool have microscopic aspirites which cause a microwelding of the metals together and effectively penetrate the web 25.

In the situation where the web is removed, a blind hole (not shown) is formed in the web 25. Thus, the hole formed in the web 25 is bottomed at the conductor 31, and when the recess 24 is subsequently lined with the conductor 26, the microvia 12 results as indicated in FIG. 1.

After patterning the grooves and recesses as indicated in FIG. 1A, the laminate 14 is then metalized. One metalizing technique is to perform a metal transfer operation as disclosed in detail in U.S. patents 5, 334,279; 5,390,412 and 5,451,722 incorporated herein by reference.

A further technique for applying metal material to the recesses is to coat the recesses with a conductive ink by means of a squeegee.

Another approach is to electroplate the patterned laminate 14. In such an approach, the conductors are added by applying a liquid, non-photoreactive etch resist is applied by a squeegee (not shown). A resist application requires no registration, because the resist

enters the U-shaped grooves and the microvia recesses, precisely in position to shield interior metal from the subsequent etching process. After resist curing, all unprotected metal is removed in a conventional conveyorized etcher (not shown), leaving recessed metal in the pads and traces, as well as the conductor 26 of the microvia 12. Over etching is reduced or eliminated as a result of the present inventive techniques, since only the metal to be removed is exposed, so the etching process is substantially self terminating.

Self-registered dead-on solder dams, such as the solder dam 30, are readily formed between pads, and dam dimensions are precisely controllable according to the methods of the present invention.

Misregistration is reduced or totally eliminated, as all features are formed from the same pressure plate tool.

The substrates, such as the substrate 14 are composed of imprintable materials. The imprintable materials can either be organic or inorganic. The organic materials include resins and polymers. One example is a thermoset, sold under the tradename "HYSOL," made by the Hysol Aerospace Products Division of the Dexter Corporation, having a place of business at 2850 Willow Pass Road, Pittsburgh, California 94563-0031. The "HYSOL" material is an imprintable, nipcast, highly filled, non-tacky laminate which is devoid of long glass fibers. Other organic imprintable materials include thermoplastics, psydosets or psydoplastics, such as polyimides.

Another organic material is an epoxy mold compound, which is a fast curing compound.

The substrates may also include inorganic imprintable materials, including green body technology

referred to as "green tape," and ceramics, such as aluminum and beryllium oxide ceramics.

Referring now to FIG. 3, there is shown a multiple layer wiring board construction 35 having a stair-step microvia 36, which is constructed in accordance with the present invention. The wiring board construction 35 comprises a top or first layer 37 overlying the wiring board construction 10 of FIGS. 1 and 2. A first or top substrate 38 of the layer 37 includes a top conductor recess 39 extending through the substrate 38. A cup-shaped conductor 42 lines the surface of the recess 39 in a similar manner as the conductor 26 lines its recess 24.

In order to form the stair-step microvia 36, the bottom portion of the conductor 42 engages electrically the flange 28 of the conductor 26 of the top substrate 14 of the wiring board construction 10. The multiple layer wiring board construction 35 is made according to the method as described in connection with the construction 10 of FIGS. 1, 1A and 2 of the drawings.

Referring now to FIG. 4, there is shown a multiple layer wiring board construction 44 having a microvia 46 therein, constructed in accordance with the present invention. The multiple layer wiring board construction 44 includes a first or top substrate 48 overlying a second or bottom substrate 50. A deep conductor recess 53 is disposed in the substrate 48 and has a cup-shaped conductor 55 lining the inner surface thereof. A microvia conductive fill material 57 fills the conductor lined recess 53. The recess 53 and the conductor 55 are formed in a similar manner as the respective cup shaped recess 24 and the conductor 26 of FIGS. 1 and 2.

Similarly, the substrate 50 includes a deep conductor cup shaped recess 59 disposed in alignment with the cup shaped recess 53, and has a cup shaped

conductor 62 lining the inner surface thereof. The recess 59 is also filled with a microvia conductive fill material 64. The bottom surface of the upper conductor 53 engages electrically the conductive material 64 within the recess 59 to complete the microvia 46. Advantageously, microvia conductive fill material can be applied by squeegee into the horizontal (X_Y) traces at the same time the microvias are filled.

The construction 44 is made in a similar manner as the construction 10 of FIG. 1.

Referring now to FIGS. 5 and 6, there is shown a wiring board construction 66, which includes a microvia 68 disposed entirely within a curved conductor pad or trace 69 lining a conductor groove 70 within a substrate 71. Thus, in accordance with the present invention, the entire microvia 68 does not occupy any additional space on the substrate 71 beyond the trace 69.

The microvia 68 includes a deep conductor cross recess 73, which is cupshaped and is disposed entirely within the groove 77 of the top surface of the substrate 71. A cup-shaped conductor 75 lines the surface of the recess 73. A conductor 77 (FIG. 6) at the bottom surface of the substrate 71 is disposed in electrical contact with the bottom surface of the cup-shaped conductor 75 in a similar manner as the conductors 26 and 31 are disposed in FIG. 1. The construction 66 is made in accordance with the present invention in a similar manner as the method of making the construction 10 of FIG. 1.

Referring now to FIG. 7, a ball grid ray construction 79 having a microvia 82 in a substrate 83 thereof is constructed in accordance with the present invention and is adapted to be connected electrically to a solder ball 84 at the bottom surface of the substrate 83. A conductor shallow U-shaped groove 86 in the top

surface of the substrate 83 has a curved conductor pad or trace 88 lining the recess 86 and being disposed adjacent to the microvia 82.

The microvia 82 includes a shallow cup-shaped recess 91 having a shallow cup-shaped conductor 93 lining the surface thereof. A deep cup-shaped recess 95 in the underside of the substrate 83 is disposed in axial alignment with the recess 91 in the top surface of the substrate 83. The two recesses are separated by a thin, shallow cup-shaped or dished web 96. A microvia conductive fill material 97 is disposed within the bottom recess 95 and is connected electrically to the conductor 93 due to a microwelding through the web 96 due to aspirites on the conductor 93. In this regard, the aspirites penetrate the thin, shallow dished web 96 into electrical engagement with the conductive fill material 97 to complete the microvia 82.

The method of making the construction 79 is similar to the method of making the construction 10.

Referring now to FIGS. 8 and 9, there is shown a standard grid array 99 having a matrix 100 of microvias, such as a microvia 102. The standard grid ray 99 is disposed in underlying relationship relative to a top or first substrate 104. The matrix 100 of microvias is disposed in a second or bottom substrate 106 of the standard grid ray 99.

The microvias, such as the microvia 102 include a cup-shaped conductor 108 lining a hole or recess 113 in the top surface of the substrate 106. Microvia conductor fill material 115 fills the recess 113 and is disposed in electrical contact with a conductor 111 disposed in the bottom surface of the substrate 104.

A conductor 117 disposed on the underside of the bottom substrate 106 is disposed in electrical contact with the bottom surface of the cup-shaped conductor 108.

Referring now to FIG. 10, there is shown an interconnect carrier sheet 125, which is illustrated being constructed in accordance with the present invention. The sheet 125 includes a substrate 127, which is similar to the substrate 14 of FIG. 1. The interconnect sheet 125 has a group of interconnect devices mounted thereon. The devices include pins, such as the pin 129, and clips (not shown).

In order to fabricate the sheet 125, a pair of tools 132 and 134 having respective recess forming made members 136 and 138 imprint simultaneously a pair of deep cup-shaped circular recesses on the respective top and bottom surface of the substrate 127. The resulting recesses are axially aligned, and are separated by a thin substrate web 143. The web 143 may be removed by a variety of techniques, such as those techniques described in connection with the construction 10 of FIG 1. Alternatively, the web 143 may be removed when the pin 129 is inserted into the recesses to secure it in place as indicated in phantom lines.

While particular embodiments of the present invention have been disclosed, it is to be understood that various different modifications are possible and are contemplated within the true spirit and scope of the appended claims. There is no intention, therefore, of limitations to the exact abstract or disclosure herein presented.

CLAIMS

What is claimed is:

1. A wiring board construction, comprising:

a base substrate; and

means defining at least one microvia being disposed in said substrate and including a deep imprinted cup shaped recess in the top surface thereof, a conductor material being disposed within the recess, said material having a portion being disposed at the bottom of the recess, and a conductor disposed at a bottom surface of said substrate opposite to said conductor material bottom portion to help complete an electrically conductive path through said substrate.

2. A wiring board construction according to claim 1, wherein said substrate is composed of an epoxy composition.

3. A wiring board construction according to claim 2, wherein said epoxy composition is "HYSOL."

4. A method of making a wiring board construction, comprising:

using a substrate;

imprinting a deep cup shaped recess in the top surface of said substrate;

applying conductor material on at least a portion of the surface of said recess, said material including a portion being disposed at the bottom of the recess;

disposing a conductor at a bottom surface of said substrate opposite said conductor material bottom portion to help complete an electrically conductive path through said substrate to help form a microvia in said substrate.

5. A method of making a wiring board construction according to claim 4, further including removing a

substrate web from between the recess and said conductor prior to applying the conductor material.

6. A method of making a wiring board construction according to claim 5, wherein said removing includes wet chemical attacking.

7. A method of making a wiring board construction according to claim 5, wherein said removing includes abrasive etching.

8. A method of making a wiring board construction according to claim 5, wherein said removing includes plasma etching.

9. A method of making a wiring board construction according to claim 5, wherein said removing includes laser cutting.

10. A method of making a wiring board construction according to claim 5 wherein said removing includes heat ablating.

11. A method of making a wiring board construction according to claim 5, wherein said removing includes vibration scrubbing.

12. A method of making a wiring board construction according to claim 5, wherein said removing includes punching through with a sharp instrument.

13. A method of making a wiring board construction according to claim 5, wherein said removing includes directing a jet of fluid against said web to break it apart.

14. A wiring board construction including at least one microvia therein made by a process comprising:

using a substrate;

imprinting a deep cup shaped recess in the top surface of the substrate;

adding a cup shaped conductor material on at least a portion of the recess surface, said material

including a portion being disposed at the bottom of the recess;

disposing a conductor at a bottom surface of said substrate opposite said conductor material bottom portion to help complete an electrically conductive path through said substrate to help form a microvia in said substrate.

15. A wiring board coattachnstruction according to claim 14, wherein said adding conductor material includes.

16. A wiring board construction according to claim 14, electroplating wherein said adding conductor material includes transferring metal.

17. A multiple layer wiring board construction, comprising:

a top substrate;

a deep imprinted cup-shaped recess in the top surface of said top substrate;

conductor material disposed within the recess, said material having a portion being disposed at the bottom of the recess; and

a bottom substrate underlying a bottom surface of said top substrate and having an imprinted cup shaped recess therein and a cup-shaped conductor disposed therein near a top surface thereof opposite to the conductor material bottom portion to help complete an electrically conductive path through the substrate, thereby forcing a microvia through said substrates.

18. A multiple layer wiring board construction according to claim 17, wherein said conductors are electroplated.

19. A multiple layer wiring board construction according to claim 17, wherein said top and bottom substrates are each composed of "HYSOL."

20. A method of making a multiple layer wiring board, comprising:

using a top substrate;

imprinting a deep cup shaped recess in the top surface of said top substrate;

adding a cup shaped conductor material on the surface of said recess, said material having a portion being disposed at the bottom of the recess;

using a bottom substrate having a conductor disposed at a top surface thereof; and

disposing the bottom substrate in underlying relationship with the bottom surface of said top substrate, the bottom surface conductor being positioned opposite to the conductor material bottom portion to help complete an electrically conductive path through said substrate, thereby forming a microvia through said and bottom substrate.

21. A method according to claim 20, further including forming a deep imprinted cup shaped recess in the top surface of said bottom substrate;

disposing the bottom substrate conductor within the recess in said bottom substrate.

22. A method of making a multiple layer wiring board according to claim 21, further using a third substrate having a conductor, disposing the conductor of said third substrate in electrical contact with the conductor of the bottom substrate, thereby forming a microvia through said substrate.

23. A method of making a multiple layer wiring board, according to claim 22, wherein said substrates are each composed of "HYSOL."

24. A wiring board construction, comprising:

an imprintable substrate;

means defining a shallow groove in the top surface thereof;

a conductor disposed within said groove;

means defining a microvia being disposed substantially within said groove and connected electrically to its pad, and including a deep imprinted cup shaped recess disposed entirely within said groove,

imprinted conductor material lining at least a portion of said recess, said material being disposed at the bottom of the recess; and

a conductor disposed at a bottom surface of said substrate opposite to said conductor material bottom portion to help complete an electrically conductive path through said substrate.

25. A wiring board construction according to claim 24, wherein said substrate is composed of an epoxy material.

26. A wiring board construction according to claim 25, wherein said epoxy material is "HYSOL."

27. A wiring board construction according to claim 24, wherein said substrate includes a material selected from the material consisting of resins, polyners, thermosets, thermoplastics, psyclosets, psycloplastics, green body technology and ceramics.

28. A method of making a wiring board construction, comprising:

forming a shallow groove in the top surface of a substrate;

disposing a conductor within said groove;

imprinting a deep cup-shaped recess within said groove;

lining at least a portion of said recess with conductor material, said material being disposed at the bottom of the recess; and

disposing a conductor at a bottom surface of said substrate opposite to said conductor material

bottom portion to help complete an electrically conductive path through said substrate.

29. A standard grid array construction, comprising:

a substrate;

a conductor pad disposed at the bottom surface of said substrate;

a second substrate underlying said first substrate;

means defining a microvia being disposed substantially within said second substrate; and

a third substrate underlying said second substrate, said third substrate having a conductor connected electrically to the microvia within said first and second substrates.

30. A ball grid array, comprising:

a substrate;

a top shallow cup shaped recess in the upper surface of said substrate;

a conductor lining said shallow recess;

a bottom deep cup-shaped recess in the bottom surface of said substrate axially aligned with said top recess; and

conductive means of filling said deep recess.

31. A ball grid array according to claim 30, wherein said conductive means is conductive microvia fill material.

32. A patterning tool for making a wiring board construction having microvias disposed therein, comprising:

means including surfaces for forming deep cup shaped recesses adapted to receive corresponding complementary shaped conductors to form microvias.

33. An interconnect carrier sheet, comprising:

a base substrate;

a top deep cup-shaped imprinted recess, in the top surface of said substrate;

a bottom deep cup-shaped imprinted recess axially aligned with the top recess in the bottom surface of said substrate; and

an interconnect device disposed within the axially aligned recesses.

34. A method of making an interconnect carrier sheet for receiving and supporting a group of interconnect devices, comprising;

using a base substrate;

imprinting a top deep cup-shaped recess in the top surface of the said substrate;

imprinting a bottom deep cup-shaped recess in the bottom surface of said substrate; and

inserting an interconnect device within the axially aligned recess.

35. A method according to claim 34, wherein said interconnect device is a pin, said pin being inserted to penetrate a substrate web interposed between the recess.

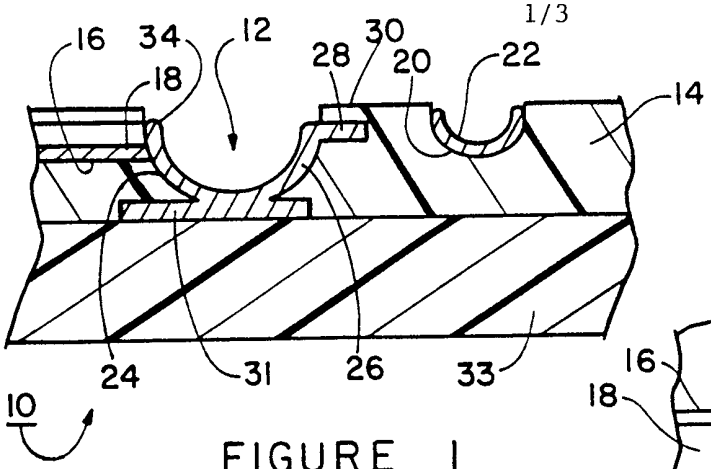

FIGURE 1

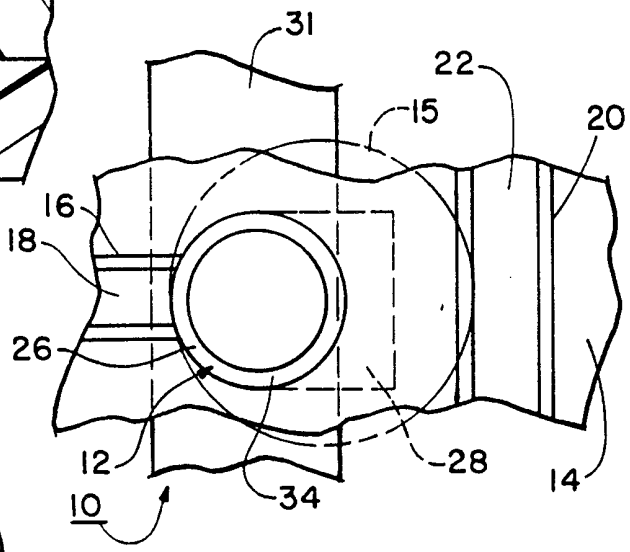

FIGURE 2

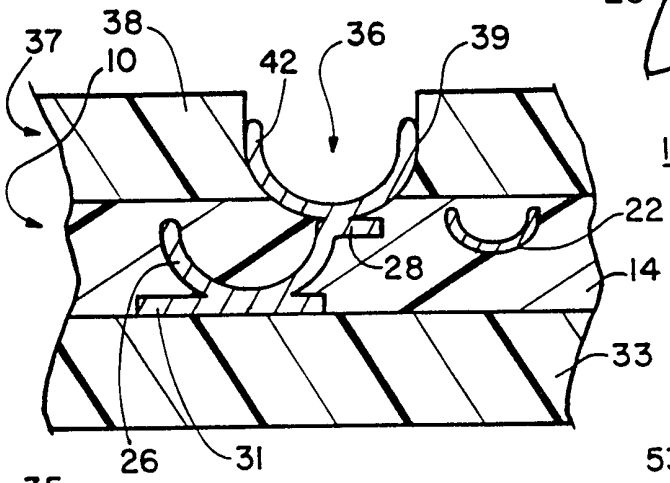

FIGURE 3

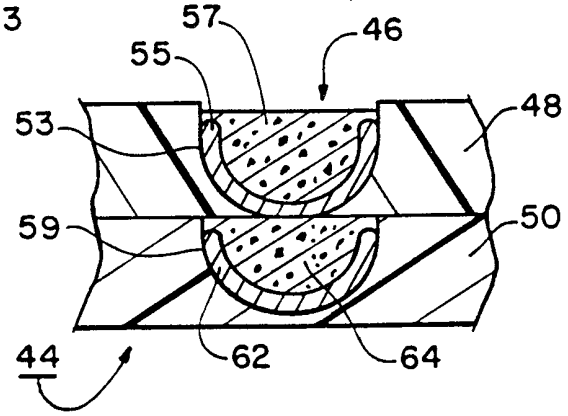

FIGURE 4

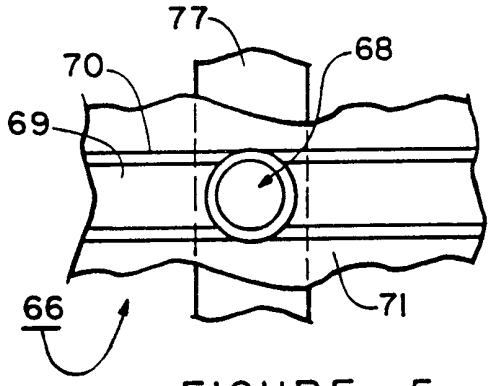

FIGURE 5

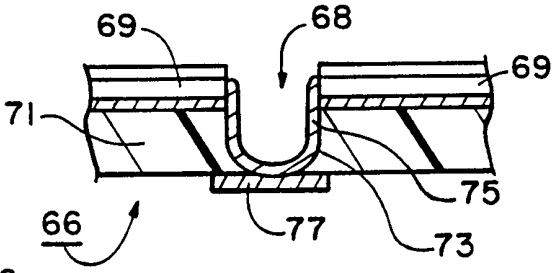

FIGURE 6

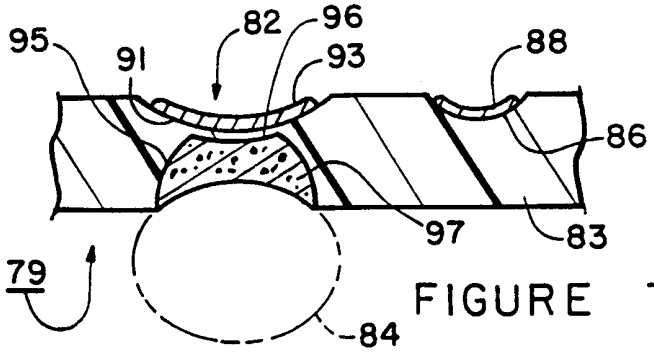

FIGURE 7

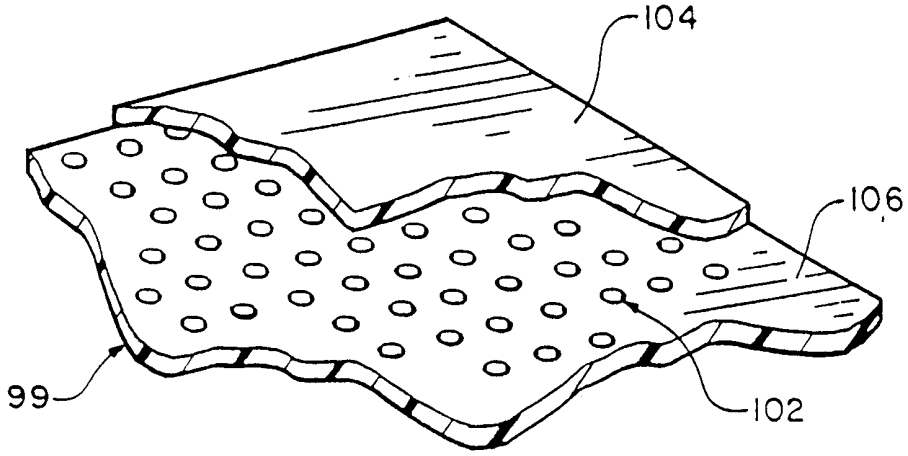

FIGURE 8

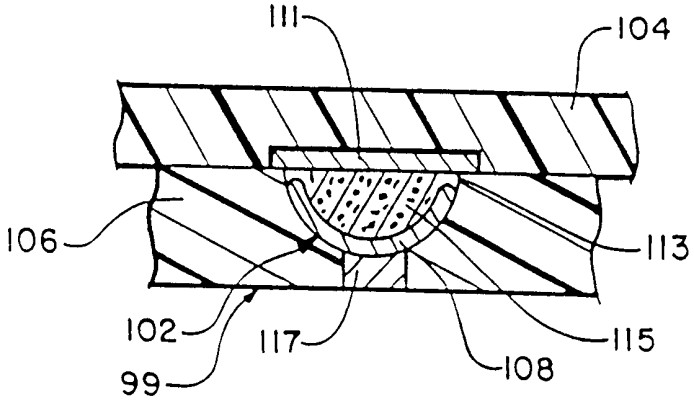

FIGURE 9

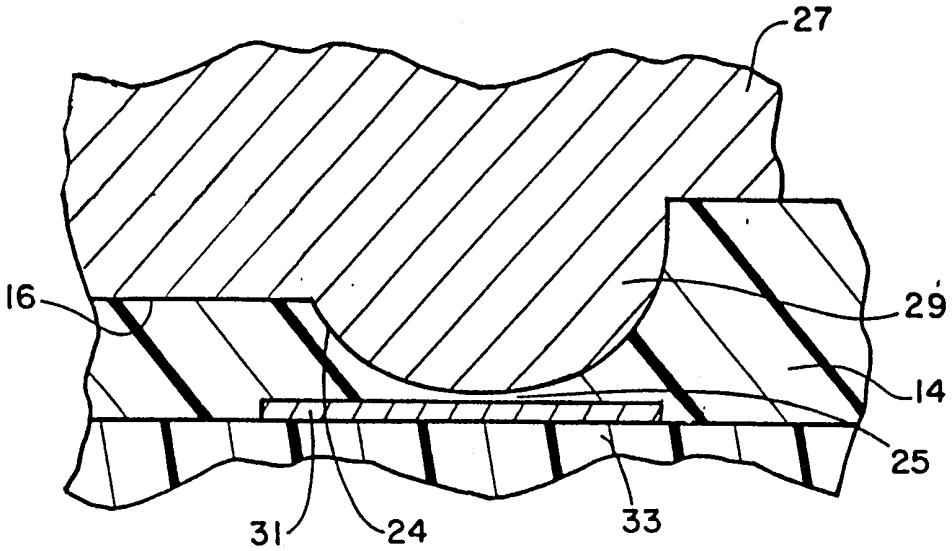

FIGURE 1A

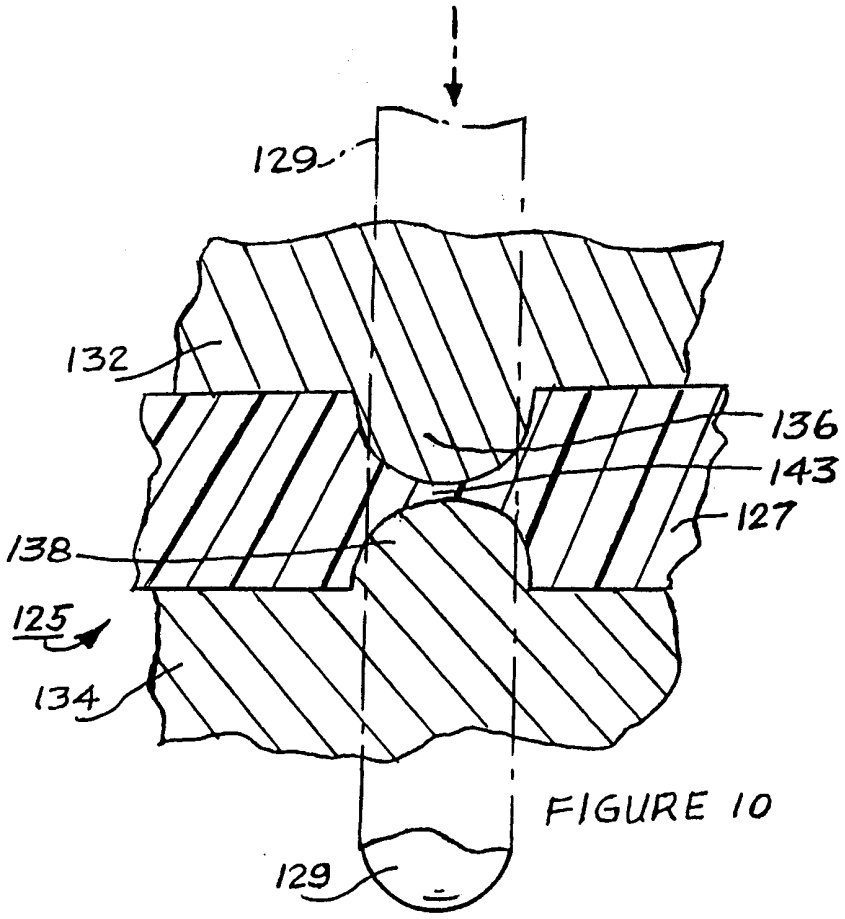

FIGURE 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/21222

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H01R 9/09
US CL : 174/262; 29/852
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. : 174/262, 263, 266; 29/852, 853; 427/97

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Clyde F. Coombs, Jr., Printed Circuits Handbook, 4th Edition, 1995

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, WEST
search terms: via, through hole, substrate, hysol, epoxy, thermoset, printed circuit board, wiring board

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,662,987 A (Mizumoto et al.) 02 September 1997 (02.09.97), Figures 1-19, columns 1-6.	1, 2, 4, 14, 16-18, 20-22, 24-25, 28-29 --- 3, 5-13, 19, 23, 26, 27, 30, 31, 33-35
Y,E	US 5,840,402 A (Roberts et al) 11 November 1998 (11.11.98), col 1., lines 52-55, col 4. lines 47-55.	4, 5, 14
Y,P	US 5,699,613 A (Chong et al) 12 December 1997 (12.12.97), Figures 8, 10.	1, 4, 14, 16-18, 20-22, 24, 28-31 33, 34

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 21 DECEMBER 1998	Date of mailing of the international search report 14 JAN 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer WILLIAM SILVERIO Telephone No. (703) 305-0853

Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/21222

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 5,715,595 A (Kman et al) 10 February 1998 (10.02.98), Figures 1, 2, 7, columns 1, 2.	33-35
A,P	US 5,744,758 A (Takenouchi et al) 28 April 1998 (28.04.98), Figures 1-10, columns 1-12.	1, 4, 14, 16, 17, 20, 21, 22, 24, 28, 29, 33, 34
Y	COOMBS, JR., CLYDE F. Printed Circuits Handbook. 1995. 4th Ed. pages 3.3, 3.7, 3.8, 10.18, 18.1-18.9.	2, 3, 18, 19, 23, 25-27
Y	US 5,487,218 A (Bhatt et al.) 30 January 1996 (30.01.96), Figure 1.	29-35

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/21222

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 15
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claim 15 is clearly incomplete and cannot be understood. The claim reads "A wiring board coattachnstruction according to claim 14, wherein said adding conductor material includes."

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.