(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 341 872 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89304292.9

(51) Int. Cl.4: H01R 23/68

(22) Date of filing: 28.04.89

(30) Priority: 09.05.88 US 191636

(43) Date of publication of application: 15.11.89 Bulletin 89/46

(84) Designated Contracting States: DE FR GB IT NL

(71) Applicant: AMERICAN TELEPHONE AND TELEGRAPH COMPANY
550 Madison Avenue
New York, NY 10022(US)

(72) Inventor: Akkapeddi, Kaushik Sharma
1 Laverne Court
Wharton New Jersey 07885(US)
Inventor: Rhodes, Ronald J.
1414 Fox Place
South Plainfield New Jersey 07080(US)
Inventor: Mantay, Mark K.
145 Wells Street
Westfield New Jersey 07090(US)
Inventor: Winings, Clifford Lawrence
4085 Royale Court
Lee's Summit Missouri 64063(US)

(74) Representative: Johnston, Kenneth Graham et al
AT&T (UK) LTD. AT&T Intellectual Property Division 5 Mornington Road
Woodford Green Essex, IG8 OTU(GB)

(54) High density connectors.

(57) Disclosed are electrical connectors (15) for high density, large area interfaces such as in circuit pack (11) to backplane (12) interconnections. The connectors utilize some means, such as a multilayer structure (40) or flexible circuit (33), to provide electrical connection and 90 degree translation from the circuit pack surface, and a conductive elastomer (18, 19) to provide the connection from such means to the circuit pack and/or backplane surface.

EP 0 341 872 A2

HIGH DENSITY CONNECTORS

Background of the Invention

This invention relates to electrical connectors, such as those which are useful for connecting circuit packs to backplanes.

For large electrical systems, some point in the interconnection hierarchy usually requires electrical connection between conductive elements disposed on orthogonally disposed surfaces. For example, a circuit pack typically includes components mounted to a circuit board and connected to an array of pads at an edge of one or both surfaces of the board. This circuit pack is electrically coupled to terminal pins or an edge-card connector protruding from a backplane surface which is orthogonal to the circuit board surfaces. The connection is typically provided by some form of plug-in connector attached to the circuit board or in the backplane so that each pad on the circuit board is coupled to a corresponding pad or pin on the backplane when the circuit pack is inserted within an appropriate shelf. (See, for example, Harrod, et al "The Fastech™ Integrated Packaging System", Solid State Tech., Vol. 29 No. 6, Pages 107-114 (June 1986).

Such a system has been generally satisfactory. However, future designs will typically require higher density pad arrays with, in some cases, lower crosstalk and lower electrical reflection coefficients than is generally feasible for pin-in-socket type connections. Thus, it is desirable to provide an array of pads on the backplane as well as on the circuit pack and connect them with the shortest possible connector structures. (It will be understood that an array is defined as nxm contact pads where n and m are greater than 1). The short connector structures could conceivably reduce crosstalk and lower the reflection coefficients.

It will be appreciated that connecting high density arrays of pads over a large area presents special problems in terms of aligning the corresponding pads in each array and achieving the proper pressure on each pad to break through any oxide or other insulating layer formed thereon. In a typical system for example, there would be 560 pads on the backplane separated by 0.64mm and covering a total area of approximately $900mm^2$.

Proposals for interconnecting circuit packs and backplanes have included the use of a flexible circuit which connects pads on the circuit pack to a connector which is plugged into a socket on the backplane.(See Young "Flex Header Connector with Ground Plane", IEEE Proceedings of the Electronic Components Conference, pp. 55-62 (October 1986)). Interconnection between pad arrays on circuit packs and backplanes has been suggested using a flexible circuit with raised gold dots to provide pressure for penetrating any oxide formed on the pads (See Howett, "An Advanced Density Interconnect System for Military/Space Applications,"ECSG Proceedings of the Electronic Connector Study Group, pp. 150-166(September 1984). It has also been suggested to connect pads on orthogonal boards with a flexible circuit and a spring mechanism for providing proper compliance (See Murphy et "High Density Impedance Controlled Connectors", Electro 84, Professional Program Session, Record #3, pp. 1-11 (May 1984)). It has been suggested, further, that when flexible circuits are connected to printed circuit boards, a compliant pad made of a material such as an elastomer, can be utilized to provide appropriate compliance (See, U.S. Patent 4,453,795 issued to Moulin, and Mersereau et al "Rogers Solderless System", Proceedings International Electronics Packaging Society pp. 43-53 (1984). Alternative methods for connecting two orthogonally disposed boards have included the use of conductive elastomers (R. Hasan, et al "A New High Density, Low Resistance Elastomeric Composite Connector for Board-To-Board Connection" Tecknit Brochure TR 1007).

It is desirable to provide alternative means for electrically interconnecting high density, large area pad arrays on two orthogonal surfaces.

Summary of the Invention

This and other objects are achieved in accordance with the invention which, in one aspect, is a connector adapted for interconnecting conductive elements on two essentially orthogonal surfaces. The connector comprises an insulating medium with conductive paths disposed from one surface of the insulating medium to another surface of said medium which is essentially orthogonal thereto so that the orthogonal surfaces are adapted for connection to the conducting elements. The connector also includes a layer of compliant, anisotropically conductive material disposed adjacent to the insulating medium on at least one orthogonal surface of the insulating medium which is adapted for connection to the conductive elements.

Brief Description of the Drawing

These and other features of the invention are delineated in detail in the following description. In the drawing:

FIG. 1 is a perspective, partly cut away, and partly schematic view of an interconnection system in accordance with one embodiment of the invention;

FIG. 2 is an enlarged view of a portion of the system of FIG. 1 in accordance with one embodiment of the invention;

FIG. 3 is a view of a portion of the system of FIG. 2 in accordance with the same embodiment;

FIG. 4 is a perspective, partly cut-away view of a portion of the system of FIG. 1 in accordance with a further embodiment of the invention;

FIG. 5 is a top view of a portion of the system of FIG. 1 in accordance with a further embodiment of the invention; and

FIG. 6 is a top cross-sectional view of a portion of the system of FIG. 1 in accordance with a still further embodiment of the invention.

It will be appreciated that, for purposes of illustration, these figures are not necessarily drawn to scale.

Detailed Description

FIG. 1 shows the basic elements of an interconnection system in accordance with the invention. A circuit pack, 10, which includes many electronic components (not shown) mounted on a circuit board, is inserted into a shelf, 11, which includes a backplane 12. The circuit pack includes an array of conductive pads, such as 13, which are coupled to the components. The backplane also includes arrays of conductive pads, such as 14, which correspond in number and location to those on the circuit pack. (In the example shown, two arrays are shown on the backplane to accommodate two circuit packs in the shelf). The pads are typically made of copper having a thickness of approximately 0.05mm with successive layers of nickel and gold plated thereon to thicknesses of 2 microns each.

A connector element, 15, partially broken away in the view of FIG. 1, provides electrical connection between corresponding pads (e.g. 13) on the circuit pack and on the backplane (e.g.14) by providing conductive paths between the orthogonally disposed arrays. Sufficient pressure for mating the pads on the backplane with conductive paths on the surface of the connector element facing the backplane is provided by the combination of a latch, 16, and spring 17, engaged at the other end of the shelf. Because the surfaces of the backplane and circuit pack are not usually flat, a compliant medium is generally needed between those surfaces and the connector element to insure a proper electrical connection. At the same time, it is desirable for the pressure exerted on the pad arrays to penetrate any insulating material on the surface of the pads. These objectives are achieved by including layers of compliant material, 18 and 19, between the connector element, 15, and the pad arrays on the surfaces of the circuit pack and backplane. The compliant material is preferably an elastomer which includes chains of conductive particles of wires extending in a direction orthogonal to the major surfaces of the material to achieve anisotropic electrical conduction in that direction. Materials for providing anisotropic conduction, also referred to as conductive polymer interconnect (CPI), are known generally and are not discussed in great detail. (See, for example, U.S. Patent 4,548,862 issued to Hartman which is incorporated by reference herein). Particularly useful for this application is a material where the elastomer is an RTV silicone insulator and the conductive particles are gold-coated nickel. The compliance of such materials is preferably in the range of 0.25-0.50mm with a pressure of 50 grams/mm^2. If the compliance is too low, an unacceptably high resistance could result, while if it is too high, the conductive particles could buckle. Typical thickness of the layers are 1.3-2.6mm. The layers, 18 and 19, can be attached to the circuit pack and backplane surfaces, respectively, over the pad arrays or attached to the connector element, by means of alignment pins. In this example, layer 19 is attached to the connector 15 by alignment pins 21 and 22. The layer 18 is attached to the circuit pack by alignment pins (not shown). The connector element, 15, is then attached to the circuit pack 10, with layer 18 therebetween, by some type of standard mechanical clamping, such as screws, bolts, rivets or heat stakes (not shown). Alignment pins, 21 and 22, are also provided in the connector element in order to fit within holes, 23 and 24, respectively, in the compliant layer 19 and in the backplane so that the connector element is properly aligned with the pads on the backplane. Similar pins (not shown) may be used to align the connector element with the circuit pack.

One form of the connector element, 15, is illustrated in more detail in FIGS. 2-3 where elements corresponding to those of FIG. 1 are similarly numbered. The connector element includes a support structure 31, made of metal or plastic which is attached to the circuit pack, 10, by mounting screws (not shown). Electrical connection between the pads on the circuit pack (not shown) and pads on the backplane is provided by a flexible circuit member, 33, connected electrically to the surface portion of the circuit pack including the pad array, (by a CPI layer 18) and extending between the CPI layer 19 and the support structure 31 in the area of the backplane pad array. CPI layer 18 is mounted between the flexible circuit 33 and the circuit pack 10, while a stiffener element, 30, is provided on the opposite surface of the circuit pack.

If desired, the circuit pack could be moved to the area behind the support 31 (the surface opposite the backplane) with one end of the flexible circuit contacting one surface of the circuit pack and the other end extending around the support element to contact the opposite surface of the circuit pack. Thus, pads on both major surfaces of the circuit pack can make contact with the backplane pads. For high frequency applications, grounded conductive portions can br provided on the flexible circuit for electrical shielding and/or impedance control of the signal lines.

FIG. 3 illustrates a portion of the flexible circuit member 33. The circuit includes conductive strips, such as 34, formed on the flexible substrate, 35. The strips are typically made of copper with a thickness of the order of 0.05mm, while the substrate is typically polyimide with a thickness of 1.2mm. Each strip extends from a conductive pad, e.g., 36, which makes electrical contact with a corresponding pad on the circuit pack, to a pad, e.g., 37, which is positioned to provide electrical contact to a corresponding pad on the backplane. Electrical contact to the circuit pack and backplane pads is effected by providing via holes, e.g., 38 and 39, in the pad areas which allow the conductive material to extend to the opposite surface of the flexible circuit to form the same pad array on said opposite surface (not shown) for physical and electrical connection to the CPI material (18 and 19).

It will be appreciated that the use of the compliant material may eliminate the need for special raised dots on the flexible circuit pads for penetrating any oxide on the circuit pack or backplane pads, although such dots may be included if desired. (See Howett, cited previously.)

FIG. 4 illustrates a portion of the interconnection system of FIG. 1 in accordance with a further embodiment. Again, similar elements are similarly numbered. Here, electrical connection is made between the pad array (e.g., 13) of the circuit pack, 10, and the pad array (e.g., 14) of the backplane, 12, by means of a multilayer structure 40. The structure can be the standard type of multilayer printed circuit board comprising multiple layers of a dielectric, 41, such as ceramic, epoxy-glass, or photopolymer, with patterns of conductive material, 42, such as copper formed on each level. The conductive patterns at different levels are connected by via holes (e.g., 43) formed through the dielectric layers. (For a more detailed discussion of a multilayer printed circuit board, see, for example, U.S. Patent 3,934,335 issued to Nelson.) The multilayer structure is fabricated at the edge of the circuit pack 10 over the area of the pad array to be connected.

The conductive patterns can be fabricated into any desired form by standard photolithography. Consequently, each level can be formed with strips of metal which correspond in number and position with a particular column of backplane pads. Each strip contacts one of the backplane pads through the CPI layer 19 at the edge of the multilayer structure. Each such strip can then be contacted to a corresponding pad 13 on the circuit pack by means of a metalized via (e.g. 43) extending from that strip through the multilayer structure as shown. Thus, each row of pads on the backplane is connected to a corresponding row of pads on the circuit pack through conductors formed at each level of the multilayer structure. Again, conductors can be formed for ground connection shielding or impedance control in high frequency applications.

If desired, a second multilayer structure (not shown) can also be fabricated on the opposite surface of the circuit pack to connect any array of pads on that surface to another pad array on the backplane (also not shown),

A further embodiment of the invention is illustrated in the portion of the interconnection system shown in FIG. 5 where, again, the same elements are similarly numbered. In this embodiment, connection between the pad arrays on the circuit pack and backplane is provided by a connector 15 which comprises a pair of molded insulating piece parts 50, 51 with a conductive layers (52, 53 and 54, 55 respectively) formed on their major surfaces. The molded piece parts are typically plastic which are formed in the shape indicated to provide the 90 degree translation between the pad arrays. The conductive layers (52-55) are typically made of copper which is plated onto the surfaces in strips which correspond in number and position to the columns of pads to be connected. The molded parts are separated by a spacer element 56, also made of plastic, which may be pinned or bonded to the facing surfaces of the parts (the piece parts are shown slightly separated for the sake of illustration).

The CPI layer 18, is disposed between the molded parts 50 and 51 and the circuit pack 10, to connect conductive layers 52-55 to pads 13. Similarly, CPI layer 19 is disposed between connector 15 and backplane 12. Attachment of connector 15, to the circuit pack 10, is effected by screws or other clamping means (not shown).

FIG. 6 illustrates a still further embodiment of the invention where the connector, 15, is again made from a molded insulating material, 60, such as plastic. Here, however, the conduction paths comprise conductive pins, e.g. 61, which are insert molded into the material. The pins are oriented at an angle of approximately 45 degrees with respect to the surfaces of the molded material adjacent to the CPI layers (18 and 19) to achieve the shortest electrical path between the pad arrays on the circuit pack and backplane. The pins may be flush with or protrude from the faces of the connector, and are plated with gold to produce pads, such as 62 and 63 which correspond to the backplane and circuit pack pad arrays. The connector, 15, is typically made of stacked modules (not shown) which are attached by screws or other clamping means (not shown) to the circuit pack with CPI layer 18 therebetween.

It will be appreciated, therefore, that the invention in its various embodiments includes the use of an insulating medium with conductive paths disposed between two surfaces of the medium which are essentially orthogonal so that connection can be made between orthogonally disposed pad arrays. Such a connector, in combination with a CPI layer adjacent to at least one surface of the insulating medium, permits reliable electrical connection of high density pad arrays. The invention is desirable where the pad arrays comprise at least 20 pads per inch of height (h of FIG. 1) of the circuit pack (8 pads per cm). Typically, a high density system will comprise at least 80 pads per inch (32 pads per cm) and the invention is particularly desirable for such systems. Some of the embodiments may be desirable in systems where lower cross talk and/or lower reflection coefficients are required.

Various additional modifications will become apparent to those skilled in the art. All such variations which basically rely on the teachings through which the invention has advanced the art are properly considered within the scope of the invention.

Claims

1. A connector adapted for interconnecting conducting elements on two substantially orthogonal surfaces comprising: an insulating medium: and conductive paths disposed from one surface of the insulating medium to another surface of said medium which is substantially orthogonal thereto so that said orthogonal surfaces are adapted for connection to said conducting elements;
CHARACTERIZED IN THAT the connector further comprises a layer of compliant, anisotropically conductive material disposed adjacent to the insulating medium on at least one orthogonal surface of the insulating medium which is adapted for connection to the conducting elements.

2. The device according to claim 1 wherein the insulating medium comprises a flexible sheet and the conductive paths comprise conductive strips formed on at least one major surface of said sheet.

3. The device according to claim 1 wherein the insulating medium comprises multiple layers of material and the conductive paths comprise conductive layers disposed between the multiple layers.

4. The device according to claim 1 wherein the insulating medium comprises a molded material and the conductive paths comprise conductive strips formed on at least one surface of the material.

5. The device according to claim 1 wherein the insulating medium comprises a molded material and the conductive paths comprise conductive pins within the material.

6. The device according to claim 5 wherein the pins are situated at an angle of approximately 45 degrees with respect to said surfaces of the medium.

7. The device according to claim 1 wherein the compliant layer comprises an elastomer including chains of conductive particles formed therein from one major surface of said layer to the opposite major surface of said layer.

8. The device according to claim 1 wherein compliant layers are disposed adjacent to both of said orthogonal surfaces of the medium.

9. The device according to claim 1 wherein the conductive paths terminate at the orthogonal surfaces of the insulating medium in an array corresponding to the conducting elements to be connected, and said array comprises at least 8 conductive pads per cm of height of the connector.

10. The device according to claim 3 further comprising holes formed through said layers for connecting conductive layers to one of said orthogonal surfaces of the medium.

11. An electrical interconnection system comprising two orthogonally disposed members with arrays of conductive pads disposed on major surfaces which are essentially orthogonal;
an insulating medium having surfaces mated with said orthogonal surfaces of the members; and
conductive paths disposed from one of said surfaces of the insulating medium to another said surface of the medium so as to provide electrical connection between corresponding pads on the two arrays;
CHARACTERIZED IN THAT said system further comprises a layer of compliant, anisotropically conductive material disposed between at least one surface of the insulating medium and a corresponding member.

12. The system according to claim 11 wherein the arrays of conductive pads comprise at least 8 pads per cm of height of the member.

13. The system according to claim 11 wherein the orthogonally disposed members comprise a backplane and a circuit pack.

14. The system according to claim 13 wherein the compliant material is disposed between the surface of the insulating material and the backplane.

15. The system according to claim 11, wherein the compliant material is disposed between both of said surfaces of the insulating medium and their corresponding members.

16. The system according to claim 13 wherein the insulating medium comprises a flexible sheet and the conductive paths comprise conductive strips formed on at least one major surface of said sheet.

17. The system according to claim 13 wherein the insulating medium comprises multiple layers of material and the conductive paths comprise conductive layers disposed between the multiple layers.

18. The system according to claim 13 wherein the insulating medium comprises a molded material and the conductive paths comprise conductive strips formed on at least one surface of the material.

19. The system according to claim 13 wherein the insulating medium comprises a molded material and the conductive paths comprise conductive pins situated within the material.

20. The system according to claim 13 wherein the compliant layer comprises an elastomer with two major surfaces and chains of conductive particles formed therein between the major surfaces.

FIG. 1

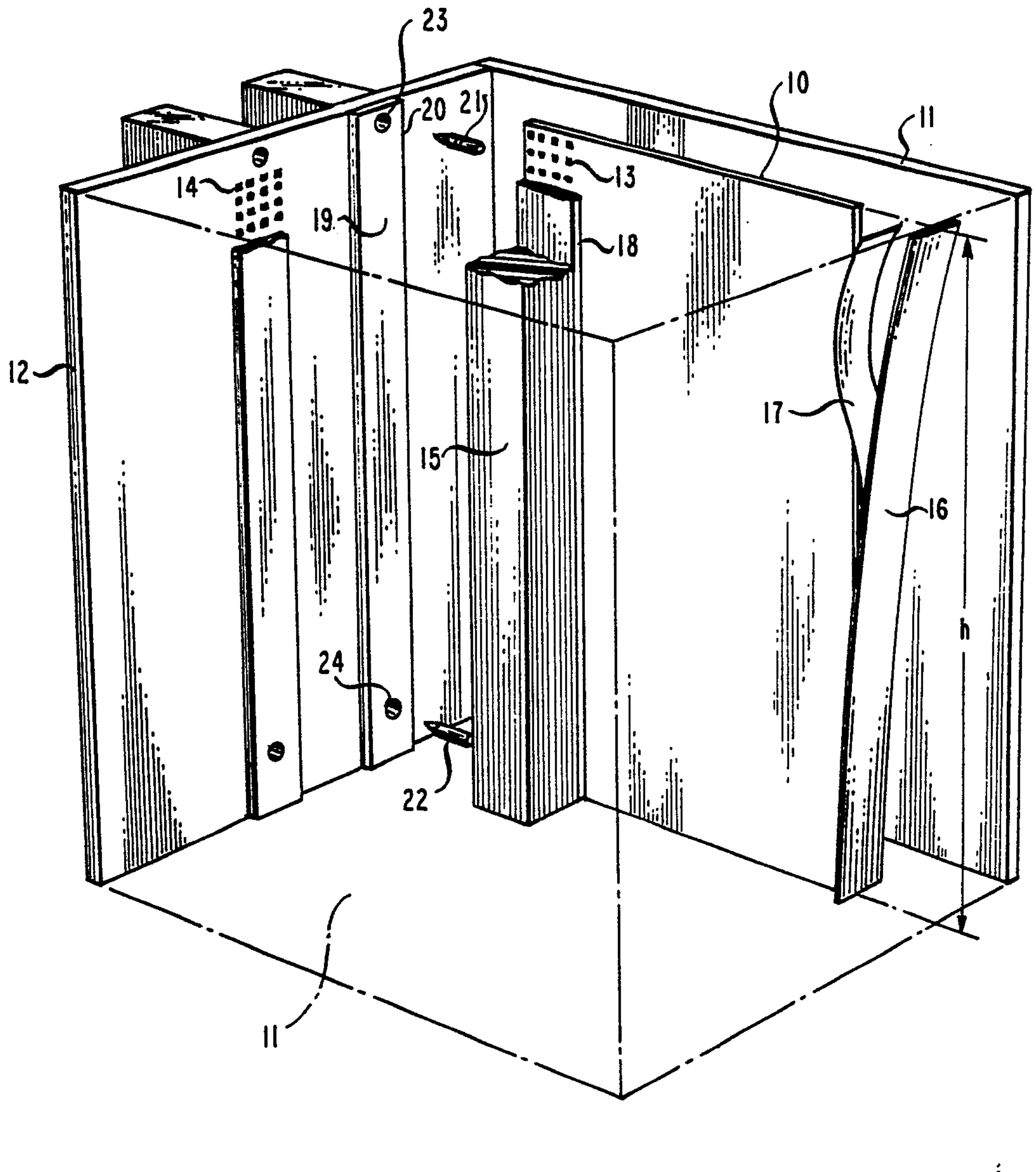
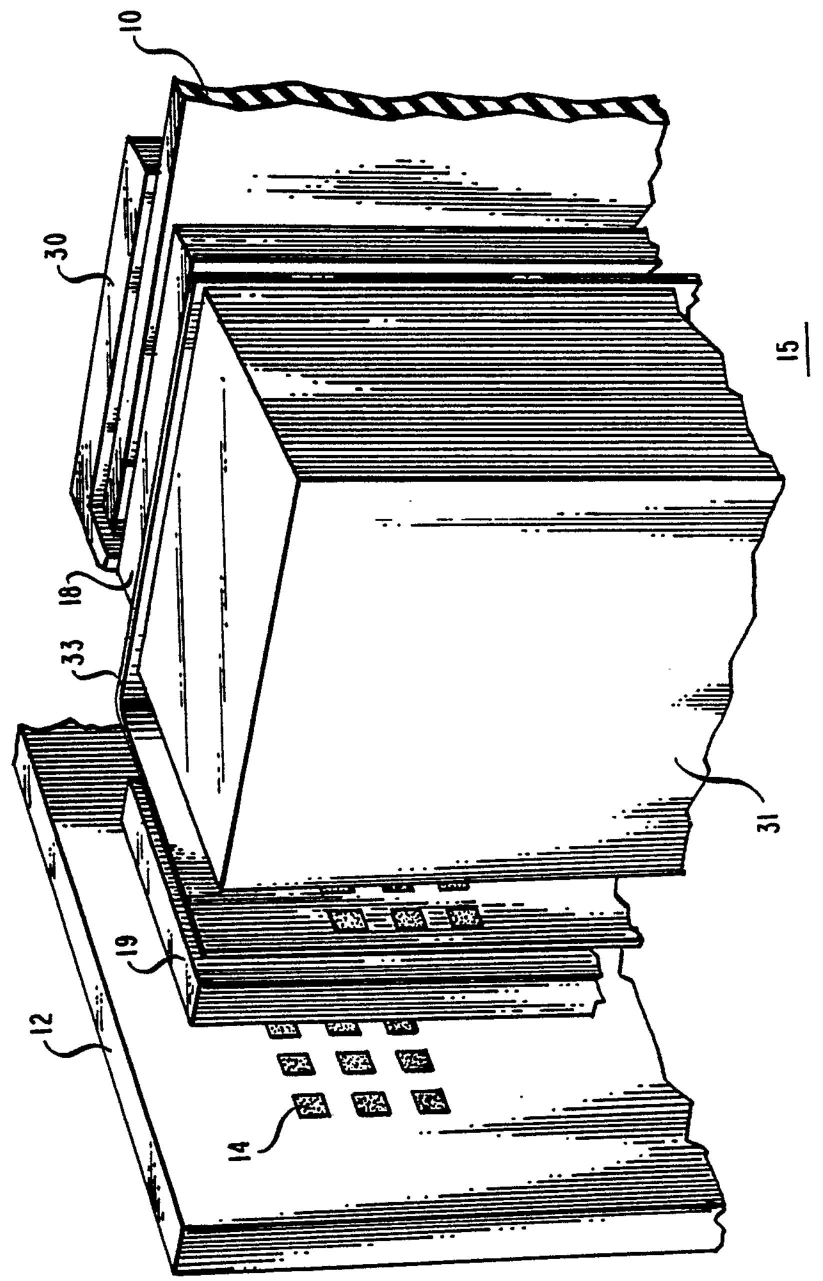


FIG. 2



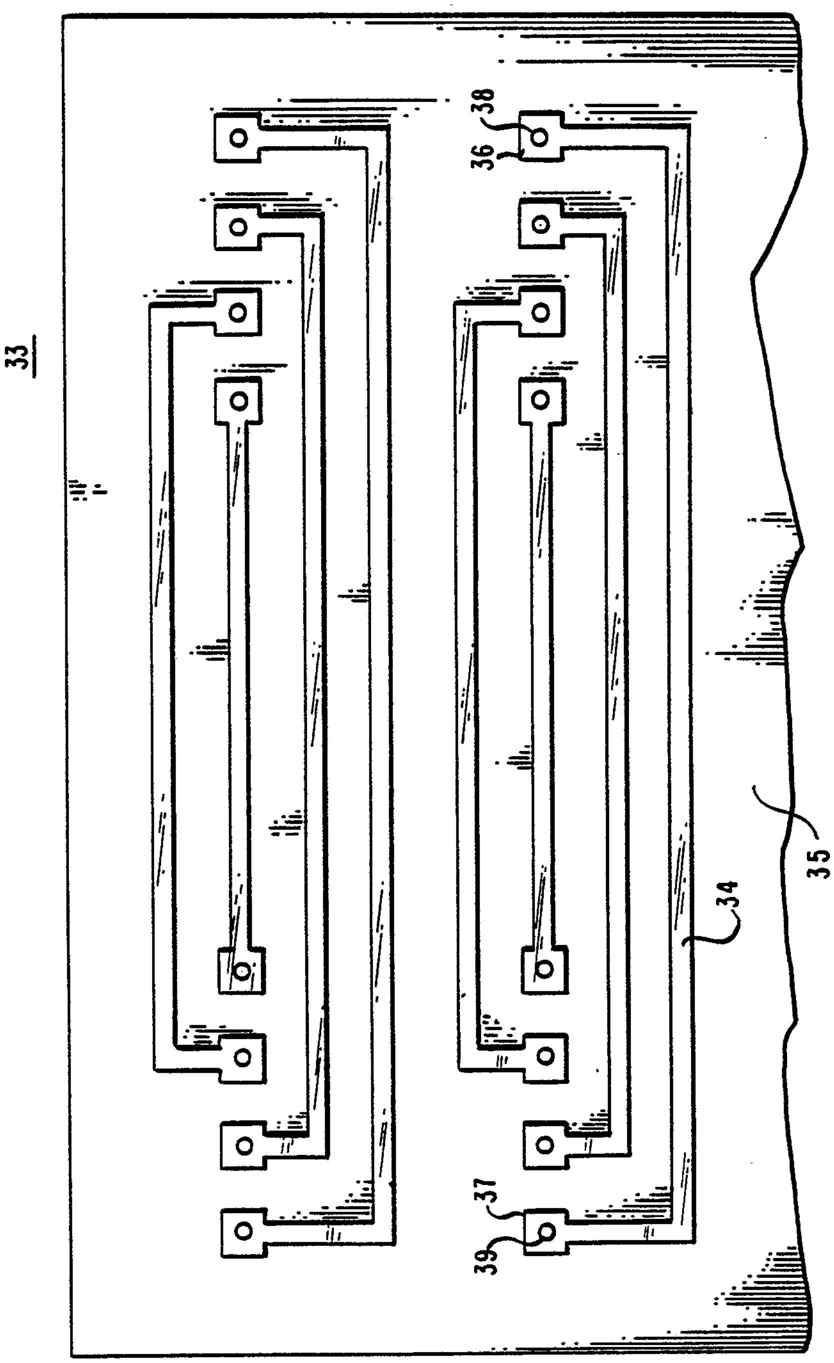
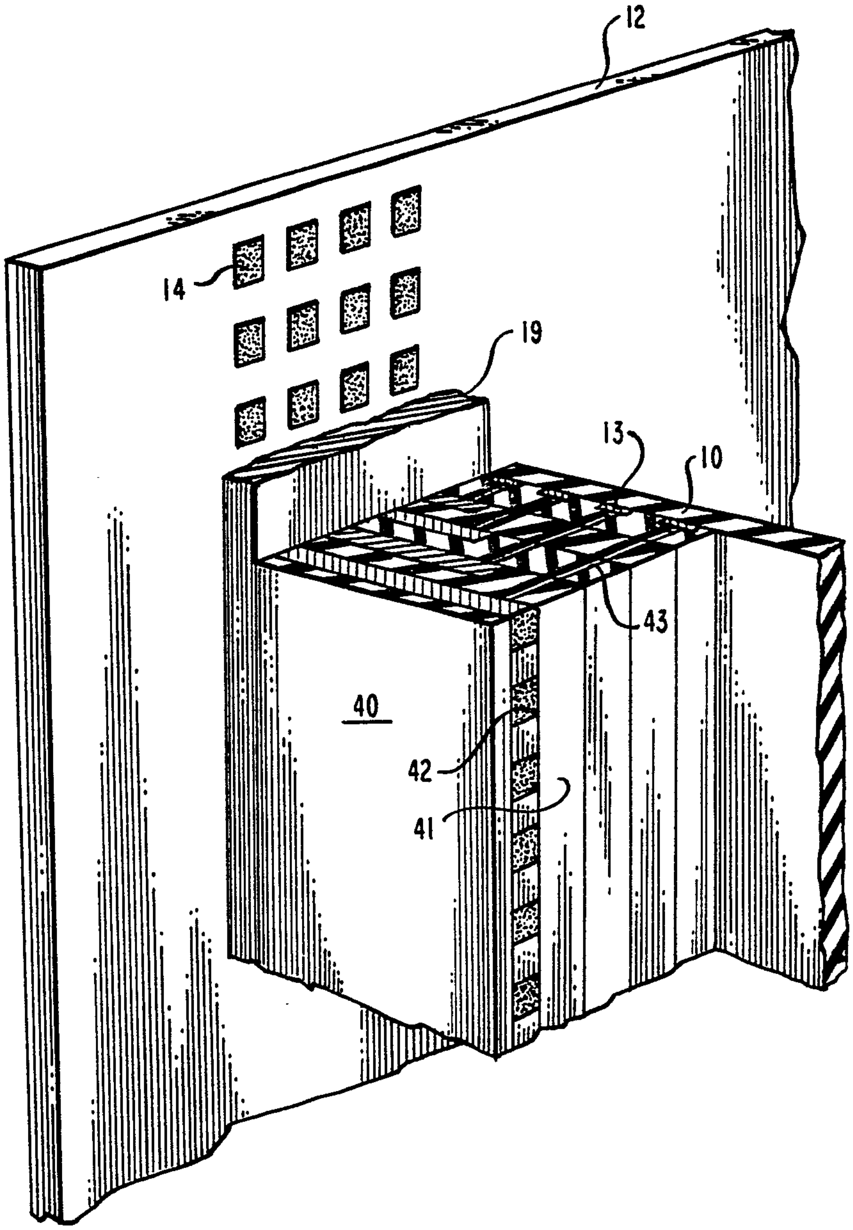


FIG. 3

FIG. 4



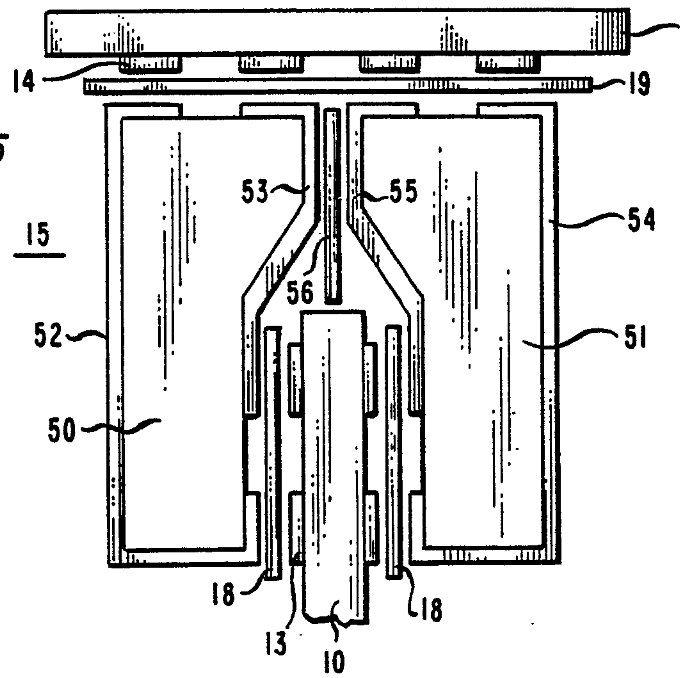
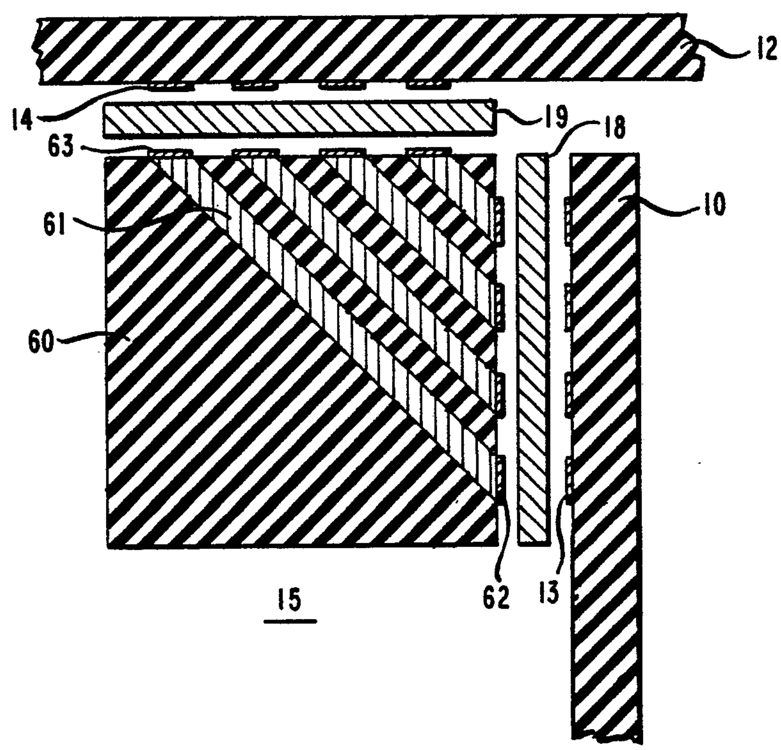

12
14
19
53
55
54
15
56
52
51
50
18
13
10
18

FIG. 5

FIG. 6


12
14
19
18
63
10
61
60
15
62
13