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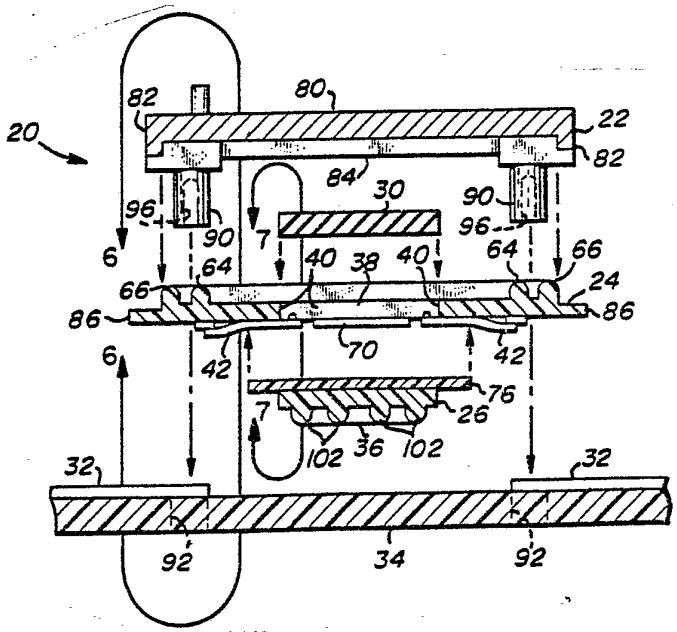
(57) Abstract

The technical field of the invention concerns electronic circuit packaging and interconnecting an electronic circuit chip to a printed circuit board. Commonly, individual wires are attached to the chip pads and to the package pins manually, either by thermocompression or ultrasonic bonding. Such manual methods results in significant cost. The present invention provides a simpler and less costly assembly for and method of connecting an electronic circuit chip (30) to a printed circuit board (34). The assembly (20) includes a pressure connection frame (24) having an aperture (38) for receiving the electronic circuit chip (30), making electrical contact thereto, and also making electrical contact to electrically conductive traces (32) on the printed circuit board (34). The assembly (20) further includes a connection pressure pad (26) which contacts the pressure connection frame (24) about the aperture (38) into which is received the electronic circuit chip (30). The pressure connection frame (24), in which the electronic circuit chip (30) is received and to which the connection pressure pad (26) is secured, is inserted into a cover (22) which is then in turn secured to the printed circuit board (34) to complete the formation of the assembly (20) and the connection of the electronic circuit chip (30) to the printed circuit board (34).



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THE DESCRIPTION

ELECTRONIC CIRCUIT CHIP CONNECTION ASSEMBLY AND METHOD

Technical Field

This invention relates generally to the technical field of electronic circuit packaging and in particular to interconnecting an electronic circuit chip to a printed circuit board.

Background Art

Both monolithic and hybrid integrated circuits, as are well known in the art, require electrical connection to external electrical circuits for their proper operation. Such connections are necessary for supplying power for such circuits' operation, for applying input signals to such circuits, and for transmitting output signals from such circuits to other electrical devices. Such integrated circuits are most frequently fabricated as rectangularly shaped, planar chips. Such chips generally include a number of much smaller rectangularly shaped conductive areas arranged about the periphery of one of the chip's planar surfaces for attaching the required electrical connections. Such electrically conductive areas are frequently referred to in the trade as "pads." As presently most commonly used, the various types of mechanical enclosures in which such integrated electronic circuit chips are packaged include a plurality of electrical conductors adapted to interconnect such chip's pads to corresponding electrical conductors, frequently referred to in the trade as "traces," on a printed circuit board.

The mechanical package most widely used for housing such electronic circuit chips is the dual inline package ("DIP"). Such DIP packages employ parallel rows of pins extending outward from opposite parallel edges of their rectangularly shaped, planar bodies to make connection to the printed circuit board traces. Within the DIP package, a plurality of individual electrical wires respectively interconnect the

electronic circuit chip's pads to such pins. Most commonly, each such individual wire is attached to the electronic circuit chip's pads and to the DIP package pins manually either by thermo-compression bonding or by ultrasonic bonding. The use of such manual methods to establish such interconnections frequently causes that operation to be a significant cost and perhaps even the dominant cost in the high volume manufacture of monolithic integrated circuits.

Recognizing that significant economies might be achieved if it were possible to form all the interconnections between an electronic circuit chip's pads and the pins of a DIP package simultaneously in a single operation, methods and apparatus have been developed which employ a plurality of electrical conductors, specially preformed repetitively at a plurality of individual sites along the length of a metallic tape, for forming such interconnections. In such methods, each site in the metallic tape is first aligned both to the electronic circuit chip's pads and to the DIP package's pins and then all the required interconnections are formed in a single thermo-compression or ultrasonic bonding operation. After an electronic circuit chip is thus connected to the DIP package's pins, the metallic tape is advanced to the next site and a subsequent electronic circuit chip and DIP package are similarly joined. For various reasons, such tape bonding methods have failed to gain wide acceptance within the electronics industry and manual bonding of individual wires presently remains the most widely used method.

In addition to requiring relatively expensive, manual methods for interconnecting the pads of an electronic circuit chip with the pins of a DIP package, such DIP package is not well adapted to attaching the larger and more complicated monolithic integrated circuits to printed circuit boards. Most commonly, a printed circuit board is adapted to receive a DIP package by forming a plurality of holes, plated along their interior walls with copper, through such boards, one such hole for each pin of the DIP package. Further, each such hole is surrounded by an annularly shaped ring of sheet

copper usually on both sides of the printed circuit board. Because of the area occupied by such an annularly shaped ring surrounding each respective hole, monolithic integrated circuits such as those now commonly requiring twenty-four (24) to sixty-eight (68) pins are relatively long in the direction of their parallel rows of pins in comparison to their width between such rows. Consequently, a significant amount of space on a printed circuit board is occupied by such a DIP package solely because of the area required to connect its pins to the printed circuit board.

Further, since in such elongated DIP packages the electrical connections between the circuit chip's pads and the DIP packages' pins located at the ends of such parallel rows is relatively long in comparison with similar connections to pins located about the DIP package's midpoint, such long conductors have relatively higher electrical resistance, increased capacitance, and increased inductance in comparison with the shorter conductors. Such differences in electrical characteristics between the respective pins of such large DIP packages result in impedance differences between the longest and shortest conductors which can upset the timing of signals critical to the proper operation of an electronic circuit chip. Consequently, as a general rule the DIP package is disfavored for electronic circuit chips requiring in excess of forty (40) pins.

Lastly, because the materials most frequently used for mechanically enclosing the electronic circuit chip within the DIP package have relatively low thermal conductivity, and because of the location in which such chips are secured within the cavity provided in such package, the DIP package is poorly adapted for use with circuits dissipating large quantities of heat. Consequently, if a DIP package is to be used for an electronic circuit which dissipates several watts of power, such package must frequently be augmented with additional cooling devices.

While the numerous disadvantages of the DIP package are widely known within the industry and while various alternatives to the DIP package have been proposed and

developed, the DIP package presently remains the most widely used package for electronic circuit chips because of its relatively low cost in comparison with the various alternative packages which have been introduced from time to time thus far.

Disclosure of the Invention

An object of the present invention is to provide a simpler and a less costly assembly for and method of connecting an electronic circuit chip to a printed circuit board.

Another object of the present invention is to provide an assembly for connecting an electronic circuit chip to a printed circuit board which occupies a smaller area on the printed circuit board.

Another object of the present invention is to provide an assembly for connecting an electronic circuit chip to a printed circuit board having more equal electrically conductive lead lengths between the electronic circuit chip and the printed circuit board.

Another object of the present invention is to provide an assembly for connecting an electronic circuit chip to a printed circuit board which is suitable for use with chips requiring a large number of individual connections.

Another object of the present invention is to provide an assembly for connecting an electronic circuit chip to a printed circuit board adapted for dissipating the heat generated within the electronic circuit chip.

Briefly, these and other objects and advantages are accomplished in the preferred embodiment of the present invention by an assembly comprising a pressure connection frame, a connection pressure pad, and a cover adapted to receive the pressure connection frame and the connection pressure pad while such cover is secured to a printed circuit board.

The assembly's pressure connection frame, in its preferred embodiment, is fabricated from a resilient elastomer material and includes an aperture into which an

electronic circuit chip may be inserted. The preferred embodiment of the pressure connection frame further includes a plurality of metallic electrical conductors bonded to one surface of the pressure connection frame. Each such electrical conductor includes one terminal end adapted to form an electrical connection with the electrically conductive pads of an electronic circuit chip and another terminal end adapted to form an electrical connection with the electrically conductive traces of a printed circuit board. The preferred embodiment of the pressure connection frame further includes a pair of raised ribs projecting from a surface thereof which respectively surround the aperture into which the electronic circuit chip may be inserted. Both of these ribs are adapted for contacting an interior surface of the cover when the assembly is formed and the cover is secured to the printed circuit board. When so assembled, the innermost of the raised ribs is compressed to apply a force to the metallic conductors for urging them into contact with the printed circuit board traces. Similarly compressed, the outermost of the raised ribs hermetically seals the electronic circuit chip within the assembly when the rib and the immediately adjacent portions of the pressure connection frame are compressed between the cover and the printed circuit board.

The assembly's connection pressure pad, in its preferred embodiment, includes a resilient portion fabricated from an elastomeric material to which is secured a pressure spreading plate formed from a stiffer material than that of the resilient portion thereof. When forming the assembly, the pressure spreading plate is positioned to contact that surface of the pressure connection frame to which the metallic conductors are bonded and is disposed about the aperture formed in the pressure connection frame into which an electronic circuit chip may be inserted. Thus, when the cover is secured to the printed circuit board, the pressure connection frame and the electronic circuit chip are compressed between the cover and the connection pressure pad which itself is pressed against the printed circuit board.

When so assembled, the force thus applied to the electronic circuit chip urges it into intimate contact with the interior surface of the cover and similarly urges the terminal ends of the pressure connection frame's metallic conductors into intimate contact with the electrically conductive pads of the electronic circuit chip.

The assembly's cover, in its preferred embodiment, is fabricated from a material having a high thermal conductivity, preferrably a metal, and when secured to the printed circuit board is generally electrically insulated from the numerous electrically conductive traces thereof. Thus fabricated and secured, the cover rapidly absorbs heat generated within the electronic circuit chip to facilitate its rapid dissipation into the surrounding atmosphere. In alternative embodiments of the present invention the cover is further adapted to facilitate the dissipation of such heat by inclusion of either cooling fins or of a separate chamber through which a liquid coolant may be circulated.

An advantage of the present invention is that all electrical connections between the electronic circuit chip's electrically conductive pads and the electrically conductive printed circuit board traces are established simultaneously by the metallic electrical conductors bonded to the assembly's pressure connection frame thereby providing a simpler and a less costly assembly for and method of connecting an electronic circuit chip to a printed circuit board.

Another advantage of the present invention is that a smaller area may be occupied by each electrical connection between the metallic electrical conductors of the assembly's pressure connection frame and the electrically conductive printed circuit board traces in comparison with that required for DIP packages thereby permitting a higher areal density of printed circuit board traces and correspondingly reducing the printed circuit board area required for such connections.

Another advantage of the present invention is that, because the area required for the electrical connections between the metallic electrical conductors and the

electrically conductive traces may be reduced, the traces and the metallic conductors may be arranged to have more equal lead lengths in comparison with DIP packages thereby improving the electrical characteristics of the connection between the electronic circuit chip and the printed circuit board, reducing the differences in the electronic characteristics between those numerous connections, and also adapting the assembly for use with electronic circuit chips requiring a large number of interconnections.

Another advantage of the present invention is that, in its preferred embodiment, it provides an assembly for connecting an electronic circuit chip to a printed circuit board which more readily conducts heat away from the electronic circuit chip in comparison with a DIP package and the assembly's various alternative embodiments further provide cooling means which facilitates the rapid dissipation of such heat either into the surrounding atmosphere or into a liquid coolant. These and other features, objects, and advantages will either be discussed or will, no doubt, become apparent to those of ordinary skill in the art after having read the following detailed description of the preferred embodiment as illustrated in the various drawing figures.

Brief Description of the Drawings

FIG. 1 is a partially sectioned, exploded, perspective view of a chip connecting assembly in accordance with the present invention including a cover, an electronic circuit chip, a pressure connection frame, a connection pressure pad, and a printed circuit board;

FIG. 2 is a cross-sectional view of the chip connecting assembly taken along the line 2-2 of FIG. 1 including a cover, an electronic circuit chip, a pressure connection frame, a connection pressure pad, and a printed circuit board;

FIG. 3 is a cross-sectional view showing the assembly of the pressure connection frame of FIG. 2 by depicting the bonding of metallic conductors to a surface of a resilient elastomer about a chip aperture formed therein;

FIG. 4 is a cross-sectional view of a metallic conductor taken along the line 4-4 of FIG. 3;

FIG. 5 is a plan view of the pressure connection frame of FIG. 3 showing alignment of the metallic conductors to the chip aperture thereof;

FIG. 6 is a cross-sectional view of an assembled cover, pressure connection frame, and printed circuit board taken along the line 6-6 of FIG. 2 showing the connection of a metallic conductor with a printed circuit board's trace;

FIG. 7 is a cross-sectional view of an assembled cover, electronic circuit chip, pressure connection frame, connection pressure pad, and printed circuit board taken along the line 7-7 of FIG. 2 showing the connection of a metallic conductor with an electronic circuit chip's pad;

FIG. 8 is a perspective view of the assembled cover, electronic circuit chip, pressure connection frame, connection pressure pad, and printed circuit board of FIG. 1 depicting an alternative embodiment cover adapted for enhanced cooling by the inclusion of cooling fins; and

FIG. 9 is a perspective view of the assembled cover, electronic circuit chip, pressure connection frame, connection pressure pad, and printed circuit board of FIG. 1 depicting an alternative embodiment cover adapted for enhanced cooling by the inclusion of a chamber through which a liquid coolant may be circulated.

Best Modes for Carrying Out the Invention

FIG.s 1, and 2 show an assembly, referred to by the general reference character 20, in accordance with the present invention. The assembly 20 comprises a cover 22, a pressure connection frame 24, and a connection pressure pad 26 for connecting a rectangularly shaped electronic circuit chip 30 to traces 32 of a printed circuit board 34. Both the pressure connection frame 24 and a spring portion 36 of the connection 26 are cast from a resilient elastomer material having a hardness between 20 and 40 durometers such as Dow Corning Sylgard 184. To eliminate the possibility of molding flash, the pressure connection frame 24, as originally cast,

lacks a chip aperture 38. After casting, the aperture 38 is formed in the pressure connection frame 24 by simultaneously cutting it with sharp blades first along two parallel edges 40 of the aperture 38 and subsequently along the remaining two parallel edges 40. Longer blades are used for these two cutting operations than the edges 40 which the operations form in order to overcut the aperture 38 thereby insuring the formation of square corners therein.

The resilient material of the pressure connection frame 24 has bonded to a surface thereof a plurality of metallic electrical conductors 42 as is shown is FIG. 3. The electrical conductors 42 are preformed repetitively at a plurality of individual sites 44 along a length of aluminum tape 46 approximately 19.0 microns thick. The conductors 42 are formed in the metallic tape 46 by first coating both an upper surface 48 and a lower surface 50 with an approximately 25.0 micron thick film 42 comprising a photoresist material in which is suspended a slurry of glass beads having a nominal diameter of approximately 10 microns. The film 52 on the lower surface 50 is then exposed successively at each site 44 with a pattern for the metallic conductors 42 while the upper surface 48 is exposed with a pattern for forming a plated electrical contact 54 respectively at each terminal end of the conductors 42. After the film 52 on the surfaces 48 and 50 has been exposed with the respective patterns by ultraviolet light, it is then developed to provide apertures through which are plated the electrical contacts 54 onto the upper surface 48 of the metallic tape 46 and through which the aluminum material of the tape 46 is subsequently removed by etching to form the metallic conductors 42.

Referring now to FIG. 4, the electrical contact 54 at that end of each metallic conductor 42 which respectively connects to the trace 32 of the printed circuit board 34 is formed in the shape of an elongated oval having a width of approximately 100 microns and a length of between 250 and 500 microns. The contact 54 is formed by first floating the upper surface 48 of the metallic tape 46 on a liquid solution from which is plated a core 58 of silver material. This silver

core 58 of the contact 54 is plated up through the thickness of the film 52 on the upper surface 48 to a thickness of approximately 70 microns. Then, the upper surface 48 of the tape 46 is floated on a liquid solution from which is plated a thin gold outer surface 60 of the contact 54. The preceding plating operations, besides forming the elongated oval electrical contact 54 at the ends of the metallic conductors 42 which connect to the traces 32 of the printed circuit board 34, also simultaneously form similar circular electrical contacts 54 having a similar thickness and a diameter of approximately 35 microns respectively at the opposite end of each metallic conductor 42 for contacting the electronic circuit chip 30.

After plating has been completed, the lower surface 50 of the metallic tape 46 is then floated on a liquid solution which etches away the aluminum material of the tape 46 to form the metallic conductors 42. The pattern used to form the conductors 42 is shaped such that the elongated oval electrical contact 54 for contacting the traces 32 of the printed circuit board projects outward beyond the etched terminal end of the conductor 42 as is shown in FIG. 3. Contrarily, that same pattern leaves the metallic material of the tape 46 totally surrounding the base of the circular electrical contact 54 for contacting the electronic circuit chip 30. Because the film 52 coated onto the upper surface, 48 of the tape 46 almost completely covers its surface except in those locations at which the contacts 54 are plated through that film 52, the metallic conductors 42, formed by etching successive sites 44 along the length of the tape 46, are supported in that location by the film 52 of the upper surface 48 which bridges from the conductors 42 to an outer edge 62 of each site 44.

Having thus formed the metallic conductors 42 at successive sites 44 along the length of the tape 46, the surface of the resilient material of the pressure connection frame 24 to which the metallic conductors are to be bonded is then coated with Dow Corning adhesive 282 diluted 20 to 1. When the pressure connection frame 24 was initially cast, it

was formed with an inner, raised electrical contact rib 64 and an outer, hermetic seal rib 66 which both encircle the chip aperture 38 and project outward from the surface of the frame 24 opposite to that onto which the conductors 42 are to be bonded. Immediately prior to bonding the metallic conductors 42 onto the adhesive coated surface of the pressure connection frame 24, that surface of the frame 24 from which the ribs 64 and 66 project is inserted into an aperture formed to receive such surface in a block of transparent material such as an acrylic resin (not shown). Then such block of material, with the pressure connection frame secured therein, is positioned adjacent to a site 44 in the metallic tape 46 as is shown in FIG. 5.

During the etching process which formed the metallic conductors 42, a registration region 70 was also formed about the center of each site 44. Each registration region 70 includes a plurality of registration tabs 72 shaped to mate with the edges 40 of the chip aperture 38 when the site 44 and the pressure connection frame 24 are in proper registration with each other. When thus registered, the ends of the metallic conductors 42 which contact the electronic circuit chip 30 are properly aligned to the chip aperture. Such registration is achieved by visually aligning the registration tabs 72 with the respective edges 40 of the chip aperture 38. Proper alignment of the ends of the metallic conductors 42 which connect to the traces 32 of the printed circuit board 34 with the pressure connection frame 24 is achieved by mechanically maintaining the transparent block holding the frame 24 in proper alignment with the metallic tape 46 while it is translated to register the edges 40 with the tabs 72. After such registration has been achieved, the site 44 of the metallic tape 46 is contacted to the adhesive coated surface of the pressure connection frame 24 causing the metallic conductors 42 to adhere thereto. When the frame 24 is subsequently moved away from the metallic tape 46, the film 52 on the upper surface 48 thereof, which has previously supported the metallic conductors 42 at the site 44, tears free from the outer edge 62 of the site 44 thus freeing the

conductors 42 from the tape 46. Thus assembled, the pressure connection frame 24 includes a plurality of electrically conductive paths, each such path provided by an individual metallic conductor 42.

In the same manner as the metallic conductors 42 are bonded to the resilient material of the pressure connection frame 24, the spring portion 36 of the connection pressure pad 26 of the assembly 20 is coated with adhesive after which a rectangularly shaped pressure distributing plate 76 is bonded thereto as shown in FIG. 2. The pressure distributing plate 76 is fabricated from sheet mylar material having a thickness between 25.0 and 75.0 microns, and is cut to be larger than the chip aperture 38 formed in the pressure connection frame 24. Further, the surface of the pressure distributing plate 76 opposite to that bonded to the spring portion 36 of the connection pressure pad 26 is also coated with adhesive so it may be bonded to that surface of the pressure connection frame 24 to which the metallic conductors 42 are bonded. Thus, when the pressure distributing plate 76 of the connection pressure pad 26 is properly aligned to the chip aperture 38 and bonded to the pressure connection frame 24, the plate 76 bridges the chip aperture 38 and supports those ends of the metallic conductors 42 projecting thereinto for contacting the electronic circuit chip 30. The thickness of the pressure distributing plate 76 is selected such that it focuses compressive forces onto the contacts 54 of the metallic conductors 42 which contact the electronic circuit chip 30 while being compliant enough to apply such compressive forces essentially equally to each of such contacts 54 regardless of thickness variations among them.

After the pressure distributing plate 76 of the connection pressure pad 26 has been bonded to the pressure connection frame 24 about the chip aperture 38, the electronic circuit chip 30, after being properly oriented with respect to the metallic conductors 42 of the frame 24, is inserted into the aperture 38. Then the pressure connection frame 24 carrying the electronic circuit chip 30 and to which is bonded the connection pressure pad 26 is

inserted into the cover 22.

The rectangularly shaped cover 22 of the assembly 20 is adapted to receive the pressure connection frame 24 carrying the electronic circuit chip 30 and the bonded connection pressure pad 26 by being formed with a chip covering wall 80 surrounded by four side walls 82. The interior surface of the cover 22, formed by the walls 80 and 82, is shaped to receive and to mate with the rib 66 of the pressure connection frame 24. Similarly, the side walls 82 are formed with reliefs 84 for receiving projecting tabs 86 of the frame 24. The interior surfaces of the walls 82 at one corner of the cover 22 are shaped differently from the three other corners of the cover 22 to receive a diagonally shaped key 88 formed by the ribs 64 and 66 of the pressure connection frame 24. This keying of the pressure connection frame 24 to the cover 22 maintains the orientation of the electronic circuit chip 30 within the cover 22.

The cover 22 also includes four projecting pins 90, one such pin 90 being respectively located about each corner thereof. The printed circuit board 34 is fabricated with mating holes 92 for receiving the pins 90. The cover 22 is further formed with a tab 94 projecting from the outer surface of its chip contacting wall 80 for easily establishing the orientation of the electronic circuit chip 30 within the assembly 20. Thus, once the cover 22 is properly oriented with respect to the traces 32 of the printed circuit board 34 by reference to the tab 94, the assembly 20 comprising the cover 22, the pressure connection frame 24 and the connection pressure pad 26 and carrying the electronic circuit chip 30 may be properly positioned on the printed circuit board 34 by inserting the pins 90 into the holes 92. The pins 90 are formed with hollow centers 96 to facilitate securing the cover 22 to the printed circuit board 34 by swaging the ends of the pins 90 which project through the printed circuit board 34 as is shown in FIG. 6.

With the cover 22 of the assembly 20 thus secured to the printed circuit board 34, the elongated oval electrical contact 54, located at that end of each metallic conductor 42

which respectively connects with the traces 32 and as surrounded by the film 42 applied to the upper surface 48 of the metallic tape 46, is urged into contact with a gold surface 98 plated onto the copper material 100 of the trace 32. The force urging such contact 54 into intimate contact with the gold plated surface 98 of the trace 32, which is in the range of 100 to 200 pounds per square inch (69 to 138 newtons per square centimeter), is supplied by the compression of the electrical contact rib 64 against the interior surface of the chip contacting wall 80 of the cover 22. This contact between the elongated oval contact 54 and the gold plated surface 98 of the trace 32 establishes an electrical connection between the trace 32 and the metallic conductor 42. Similarly, the compression of the hermetic seal rib 66 against the walls 80 and 82 of the cover 22 establishes a force, of the same magnitude as that normally used with "O" ring seals, which urges the pressure connection frame 24 into intimate contact with the printed circuit board 34 and the traces 32 located thereon thereby hermetically sealing the electronic circuit chip 30 within the assembly 20 and the printed circuit board 34.

Referring now to FIG. 7, securing the cover 22 of the assembly 20 to the printed circuit board 34 also compresses chip contact pressure ribs 102 projecting outward on the spring portion 36 of the connection pressure pad 26 from its surface opposite to the pressure distributing plate 76 against the surface of the printed circuit board 34. The ribs 102 are formed when the resilient elastomer material of the pressure connection frame is initially cast before the chip aperture 38 is cut thereinto. The force established by compressing the chip contact pressure ribs 102 against the surface of the printed circuit board 34 is applied to the electrical contacts 54 located at the ends of the metallic conductors 42 which contact the electronic circuit chip 30. This force urges each contact 54 into intimate contact with an electrical contact pad 104 located on the surface of the chip 30 with a force in the range of 10,000 to 20,000 pounds per square inch (6,900 to 13,800 newtons per square

centimeter) thereby establishing an electrical connection between such pad 104 and the metallic conductor 42. The formation of an electrical connection between any other portion of the metallic conductor 42 and the circuit chip 30 other than at the electrical contact 54 is prevented by the presence of the glass beads compounded into the material of the film 52. The glass beads in the film 52 provide a mechanically strong, electrically insulating material which selectively coats the surface of the metallic conductors 42 to prevent the formation of unintended electrical connections between the metallic conductors 42 and the electronic circuit chip 30.

The force which urges each electrical contact 54 into intimate contact with the contact pad 104 also urges the chip 30 into intimate contact with the interior surface of the chip contacting wall 80 of the cover 22 thereby establishing a high thermal conductivity path between the chip 30 and the cover 22. The presence of this high thermal conductivity path permits heat generated within the electronic circuit chip 30 to be rapidly transferred to the material of the cover 22.

FIG. 8 shows an alternative embodiment of the assembly 20 of the present invention incorporating an alternative embodiment cover 22'. Those elements common to the assembly 20 carry the same reference numeral distinguished by a prime designation. The alternative embodiment cover 22' further includes a plurality of fins 110 projecting outward from the chip contacting wall 80' to enhance the dissipation of heat from the cover 22' to the surrounding atmosphere. The absence of a fin 110 or a different spacing between a pair of fins 110 provides a reference for establishing the orientation of the electronic circuit chip 30' within the assembly 20' analagously to the tab 94 of the cover 22.

FIG. 9 shows yet another alternative embodiment of the assembly 20 of the present invention incorporating an alternative embodiment cover 22". Those elements common to the assembly 20 also carry the same reference numeral distinguished by a double prime designation. The alternative embodiment cover 22" includes side walls 82" which extend

upward above the chip contacting wall 80" away from the printed circuit board 34". These extended walls 82" are closed by a coolant chamber enclosing wall 120 to establish a hollow coolant chamber 122 within the cover 22". An inlet port 124 and an outlet port 126, formed through that portion of the side walls 82" extending above the chip contacting wall 80" permit a liquid coolant to be circulated through the coolant chamber 122 to facilitate removing heat generated within the electronic circuit chip 30" from the cover 22". The location of the inlet port 124 and the outlet port 126 on the cover 22" may be employed as a reference for establishing the orientation of the electronic circuit chip 30" within the assembly 20" analogously to the tab 94 of the cover 22.

Industrial Applicability

Because of the relative small size of the electrical contact 54 at the end of the metallic conductor 42 which connects to the trace 32 of the printed circuit board 34, and because establishing a connection to the trace 32 does not require forming a plated hole through the printed circuit board 34 nor does it require an annular region of copper surrounding such hole, the present invention reduces the area occupied by connections to the traces 32 thereby permitting them to be placed as close as 0.7 millimeters center to center. Thus, the traces 32 may be located closer to the electronic circuit chip 30 than with the prior art DIP package thereby relatively shortening the lengths of the leads interconnecting the electronic circuit chip 30 to the printed circuit board 34 and also reducing the differences in such lead lengths among the numerous leads.

While the preferred embodiment of the present invention employes resilient elastomer material in fabricating the pressure connection frame 24 and the connection pressure pad 26, the use of such material is necessitated by mechanical variations in the thickness of the various parts of the assembly 20 and in the thickness of the electronic circuit chip 30. If the variations in the thicknesses of these various components were more precisely controlled, it is

possible that a less resilient material could be used in fabricating the pressure connection frame 24 and/or the connection pressure pad 26.

While bonding metallic conductors 42 to a surface of the resilient material of the pressure connection frame 24 is the preferred method for forming a plurality of electrically conductive paths therein, such paths could alternatively be provided by fabricating the pressure connection frame 24 to include properly shaped regions of electrically conductive elastomer material which are electrically insulated from each other and mechanically supported by the remainder of the pressure connection frame which is formed from an electrically insulating elastomer material. If properly shaped, such an "all elastomer" pressure connection frame 24 could incorporate the function of the connection pressure pad 26 for urging the electrically conductive paths into contact with the electronic circuit chip 30 and for urging the electronic circuit chip 30 into intimate contact with the chip contacting wall 80 of the cover 22.

The preferred method of initially establishing the proper orientation of the electronic circuit chip 30 to the pressure connection frame 24 when such chip 30 is a monolithic integrated circuit is to bond an entire wafer (not shown) of such chips to a sheet of adhesive material (not shown) before such wafer is cut into the chips 30. After such dicing operation has been completed thus forming the chips 30, they remain attached to the sheet of adhesive thereby preserving their orientation with respect to the wafer until such time as they are removed from the sheet of adhesive for insertion into the chip aperture 38 of the pressure connection frame 24. The use of such sheet adhesive in combination with the structure of the frame 24 and the cover 22 with their respective inclusion of an orientation preserving structure such as the tab 94 thereby adapts the assembly 20 to semi-automatic or even perhaps fully automatic packaging of such electronic circuit chips 30.

Although the present invention has been described in terms of the presently preferred embodiment, it is to be

understood that such disclosure is purely illustrative and is not to be interpreted as limiting. Consequently, without departing from the spirit and scope of the invention, various alterations, modifications, and/or alternative applications of the invention will, no doubt, be suggested to those skilled in the art after having read the preceding disclosure. Accordingly, it is intended that the following claims be interpreted as encompassing all alterations, modifications, or alternative applications as fall within the true spirit and scope of the invention.

THE CLAIMS

What is claimed is:

1. A chip connecting assembly for connecting an electronic circuit chip to a printed circuit board which comprises:

(a) a pressure connection frame having a chip aperture formed therein for receiving said electronic circuit chip, said pressure connection frame further including a plurality of electrically conductive paths, each such electrically conductive path having a chip contacting terminal located about the chip aperture for contacting said electronic circuit chip when said chip is inserted into the chip aperture, each electrically conductive path further having a printed circuit board contacting terminal for contacting a surface of said printed circuit board when said chip connecting assembly connects said electronic circuit chip to said printed circuit board;

(b) a connection pressure pad for contacting a surface of said pressure connection frame about the chip aperture formed therein, said connection pressure pad being adapted for urging the chip contacting terminal of the electrically conductive paths into contact with said electronic circuit chip when said chip connecting assembly connects said electronic circuit chip to said printed circuit board; and

(c) a cover adapted to be secured to said printed circuit board while enclosing said pressure connection frame together with an electronic circuit chip inserted into the chip aperture formed therein whereby the printed circuit board contacting terminals of the electrically conductive paths are urged into contact with the surface of said printed circuit board, said cover being further adapted to press together said electronic circuit chip, said pressure connection frame, said connection pressure pad, and said printed circuit board when said cover is so secured to said printed circuit board whereby a force is applied to said electronic circuit chip and to said pressure connection frame which force urges the chip contacting terminals of the

electrically conductive paths into contact with said electronic circuit chip.

2. The chip connecting assembly of claim 1 wherein said pressure connection frame is fabricated from a resilient elastomer having a hardness between 20 and 40 durometers.

3. The chip connecting assembly of claim 1 wherein said pressure connection pad includes a portion fabricated from a resilient elastomer having a hardness between 20 and 40 durometers.

4. The chip connecting assembly of claims 1, 2, or 3 wherein said pressure connection frame is formed with a projecting surface located about the printed circuit board contacting terminals of the electrically conductive paths for urging such printed circuit board contacting terminals into intimate contact with the surface of said printed circuit board when said chip cover is secured thereto.

5. The chip connecting assembly of claims 1, 2, or 3 further including means for sealing said electronic circuit chip hermetically within an assembly comprised of said chip pressure connection frame, said chip connection pressure pad, said chip cover, and said printed circuit board.

6. The chip connecting assembly of claim 5 wherein said means for sealing includes a sealing rib projecting from a surface of said pressure connection frame and encircling the chip aperture formed therein, the sealing rib being adapted for compressing said pressure connection frame between an interior surface of said cover and the surface of said printed circuit board when said cover is secured thereto, which compression causes said pressure connection frame to mate with and to form a seal with such compressing surfaces.

7. The chip connecting assembly of claims 1, 2, or 3 wherein the conductive paths of said pressure connection frame are formed by metallic strips bonded to a surface of said pressure connection frame.

8. The chip connecting assembly of claim 7 wherein the metallic strips bonded to the surface of said pressure connection frame forming the conductive paths thereof are selectively coated with a mechanically strong, electrically

insulating material for preventing the formation of unintended electrical contacts between the metallic strips and an electronic circuit chip received into the chip aperture of said pressure connection frame.

9. The chip connecting assembly of claim 7 wherein the metallic strips are bonded to that surface of said pressure connection frame immediately adjacent to the surface of said printed circuit board contacted by the printed circuit board contacting terminals of the conductive paths.

10. The chip connecting assembly of claim 3 wherein said connection pressure pad further includes a pressure distributing plate for contacting said pressure connection frame, the pressure distributing plate being located about the chip aperture formed in said pressure connection frame and intermediate to the resilient material of said connection pressure pad and said pressure connection frame, the pressure distributing plate being formed from a material having a greater stiffness than the material from which said connection pressure pad is fabricated.

11. The chip connecting assembly of claims 1, 2, or 3 wherein said cover is fabricated from a material having a high thermal conductivity, and wherein a surface of said electronic circuit chip may be urged toward an interior surface of said cover whereby a high thermal conductivity path may be established between said electronic circuit chip and said cover.

12. The chip connecting assembly of claim 11 wherein said cover further includes cooling means located adjacent to the surface thereof toward which said electronic circuit chip is urged.

13. A method for connecting an electronic circuit chip to a printed circuit board comprising the operations of:

(a) inserting said electronic circuit chip into a chip aperture formed in a pressure connection frame, said frame further including a plurality of electrically conductive paths, each such electrically conductive path having a chip contacting terminal located about the chip aperture for contacting said electronic circuit chip, each electrically

conductive path further having a printed circuit board contacting terminal for contacting a surface of said printed circuit board;

(b) placing a cover about said pressure connection frame and said electronic circuit chip inserted therein, and securing said cover to said printed circuit board whereby the printed circuit board contacting terminals of the electrically conductive paths are urged into contact with the surface of said printed circuit board, and whereby a force is applied to said connection pressure frame which urges the chip contacting terminals of the electrically conductive paths into contact with said electronic circuit chip.

14. The method of claim 13 further comprising the operation of contacting a connection pressure pad to a surface of said pressure connection frame about the chip aperture into which said electronic circuit chip has been inserted prior to securing said cover to said printed circuit board, said connection pressure pad urging the chip contacting terminals of the electrically conductive paths of said pressure connection frame into contact with said electronic circuit chip.

15. The method of claims 13 or 14 wherein said pressure connection frame is fabricated from a resilient elastomer having a hardness between 20 and 40 durometers.

16. The method of claim 14 wherein said connection pressure pad includes a portion which is fabricated from a resilient elastomer having a hardness between 20 and 40 durometers.

17. The method of claim 13 further comprising the operation of hermetically sealing said electronic circuit chip within an assembly comprised of said pressure connection frame, said cover, and said printed circuit board.

18. The method of claim 14 further comprising the operation of hermetically sealing said electronic circuit chip within an assembly comprised of said pressure connection frame, said pressure connection pad, said cover, and said printed circuit board.

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19. The method of claims 13 or 14 further comprising the operation of bonding metallic strips to a surface of said pressure connection frame to form the electrically conductive paths thereof.

20. The method of claim 19 further comprising the operation of selectively coating the metallic strips as are bonded to a surface of said pressure connection frame to form the electrically conductive paths thereof with a mechanically strong, electrically insulating material for preventing the formation of unintended electrical contacts between the metallic strips and said electronic circuit chip inserted into the chip aperture formed in said pressure connection frame.

21. The method of claims 13 or 14 wherein said cover is fabricated from a material having a high thermal conductivity, the method further comprising the operation of urging said electronic circuit chip toward an interior surface of said cover whereby a high thermal conductivity path is established between said electronic circuit chip and said cover.

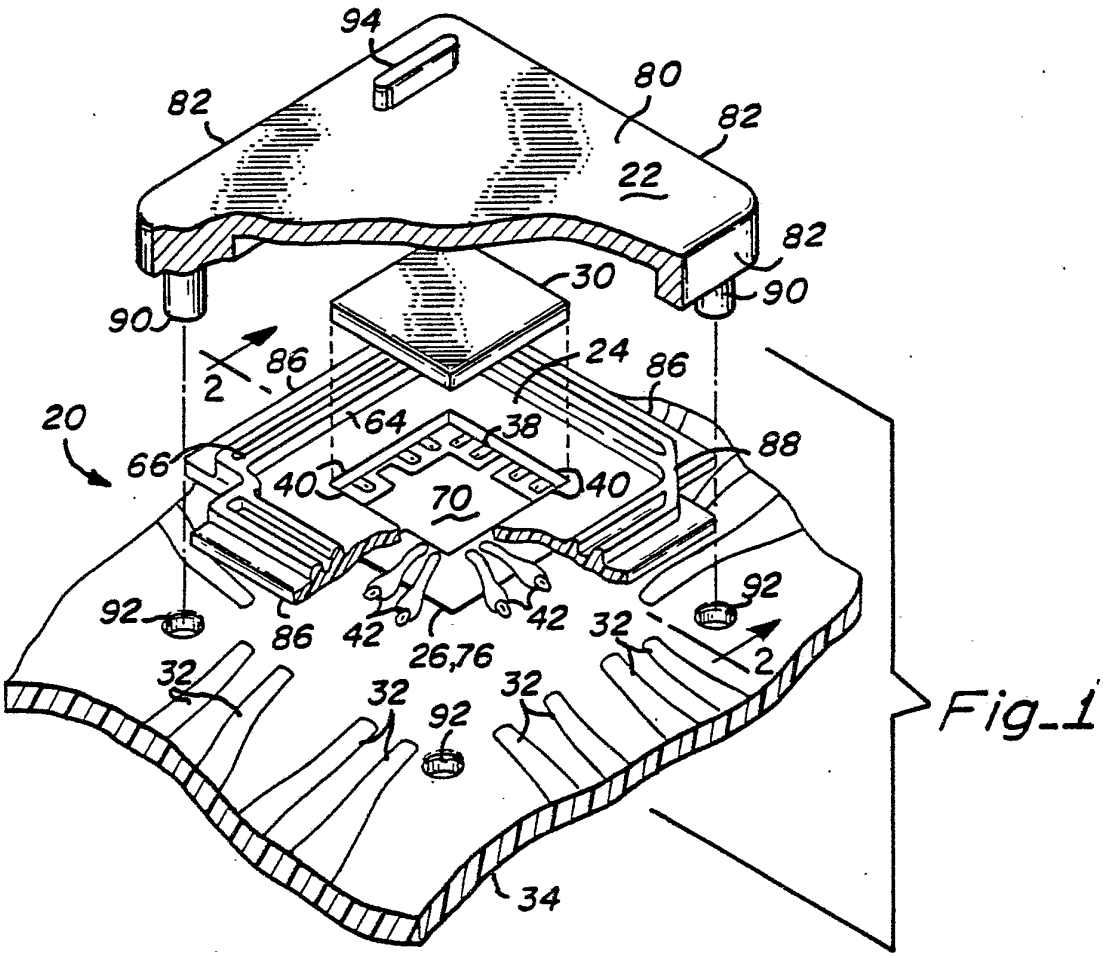

Fig_1

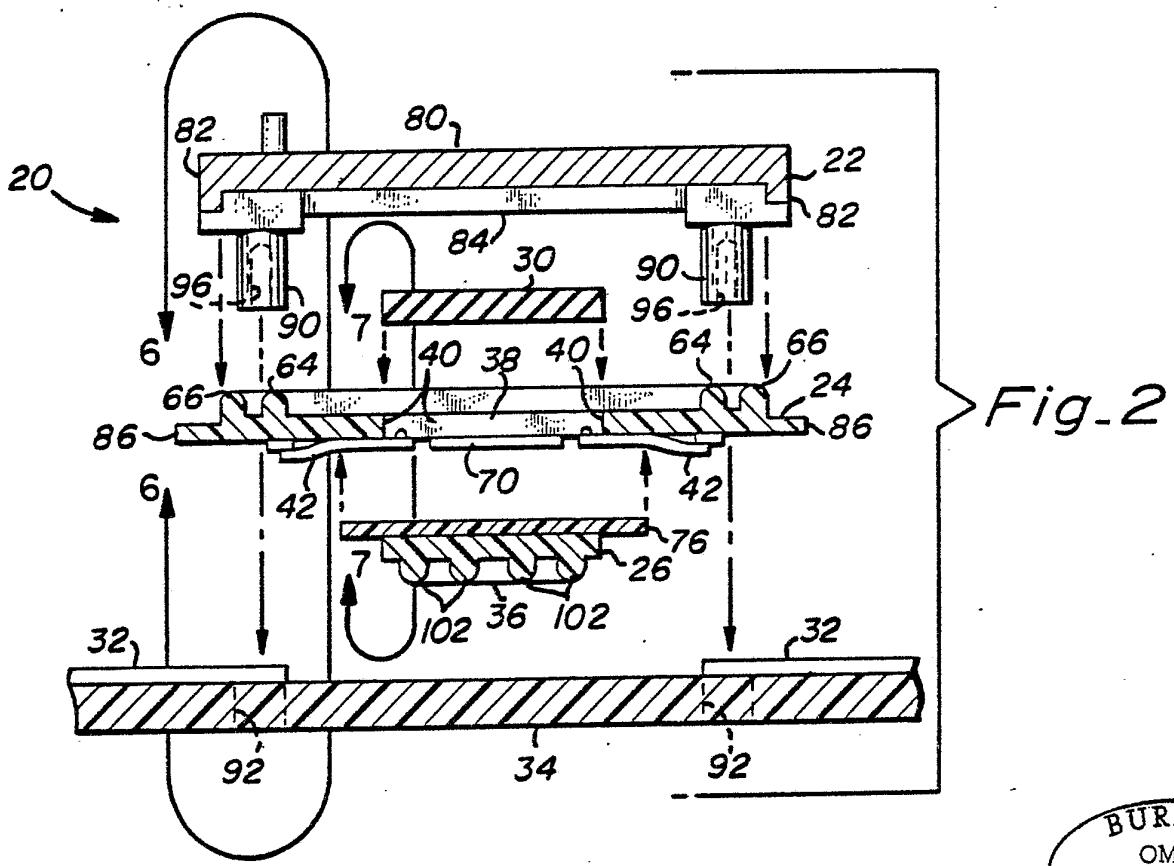

Fig_2

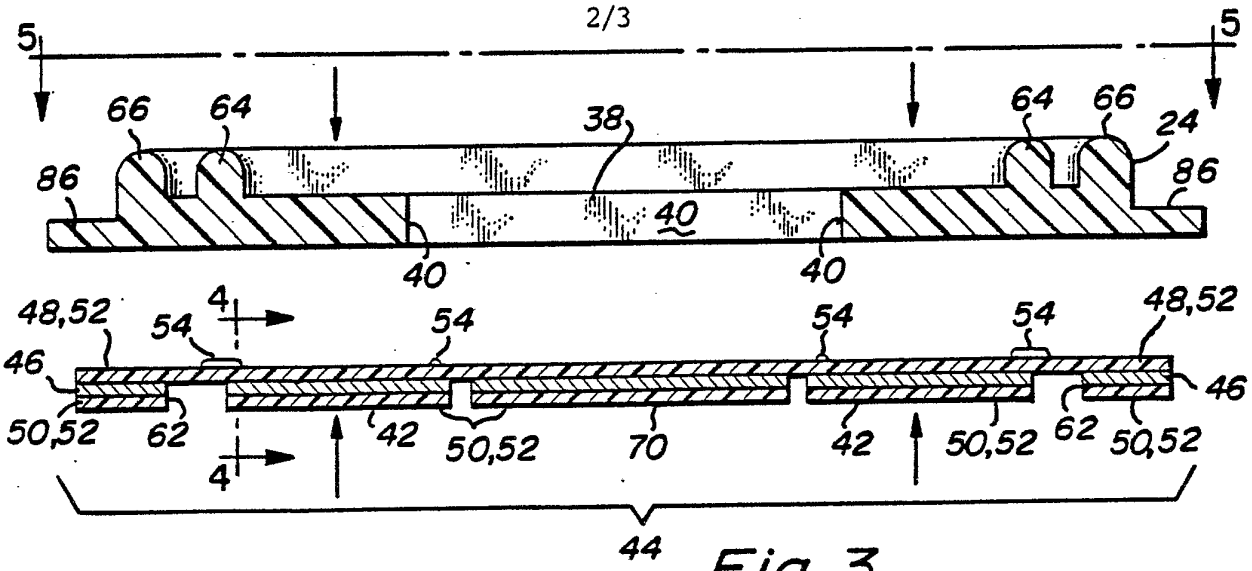

Fig_3

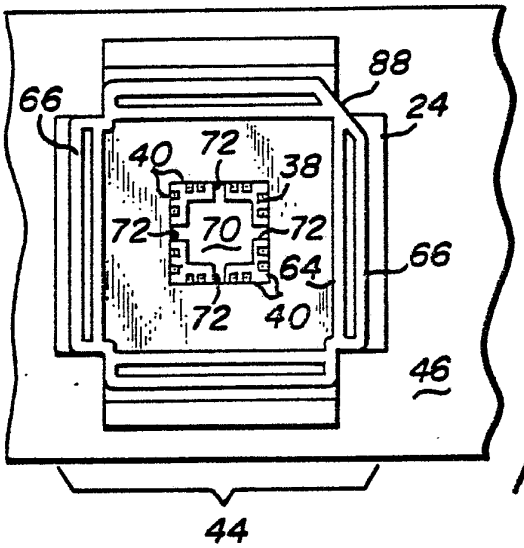

Fig_5

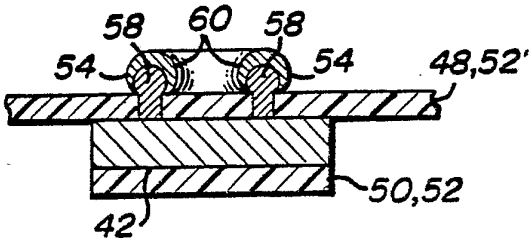

Fig_4

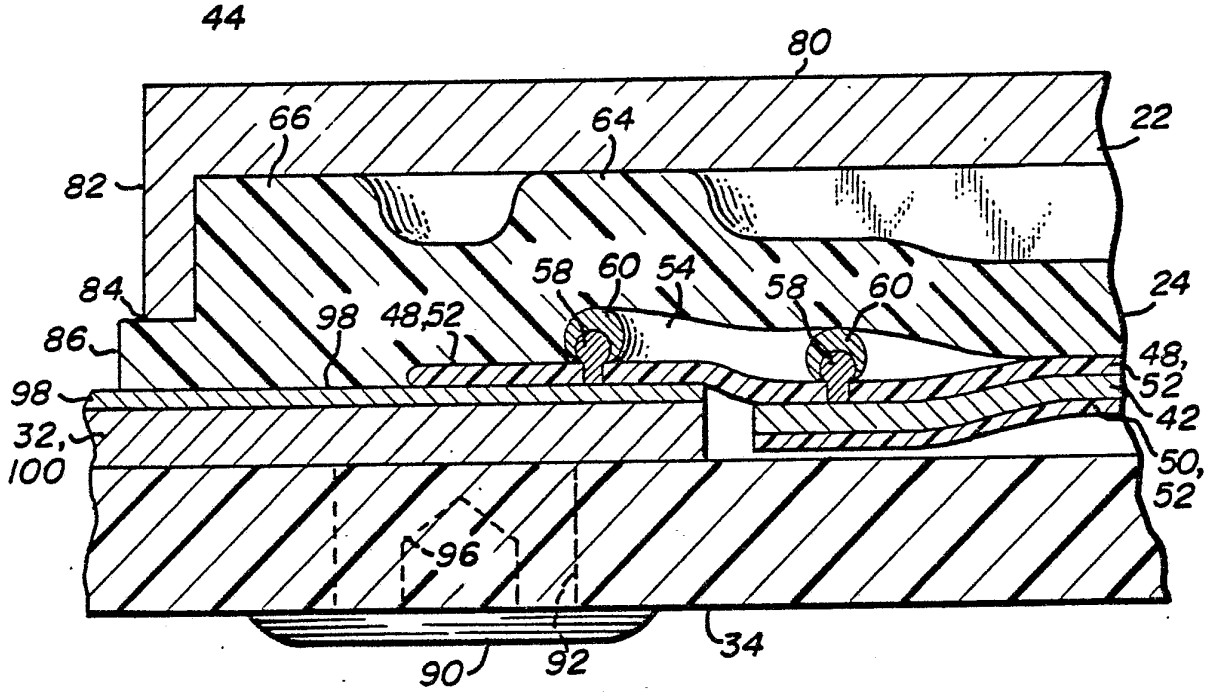

Fig_6

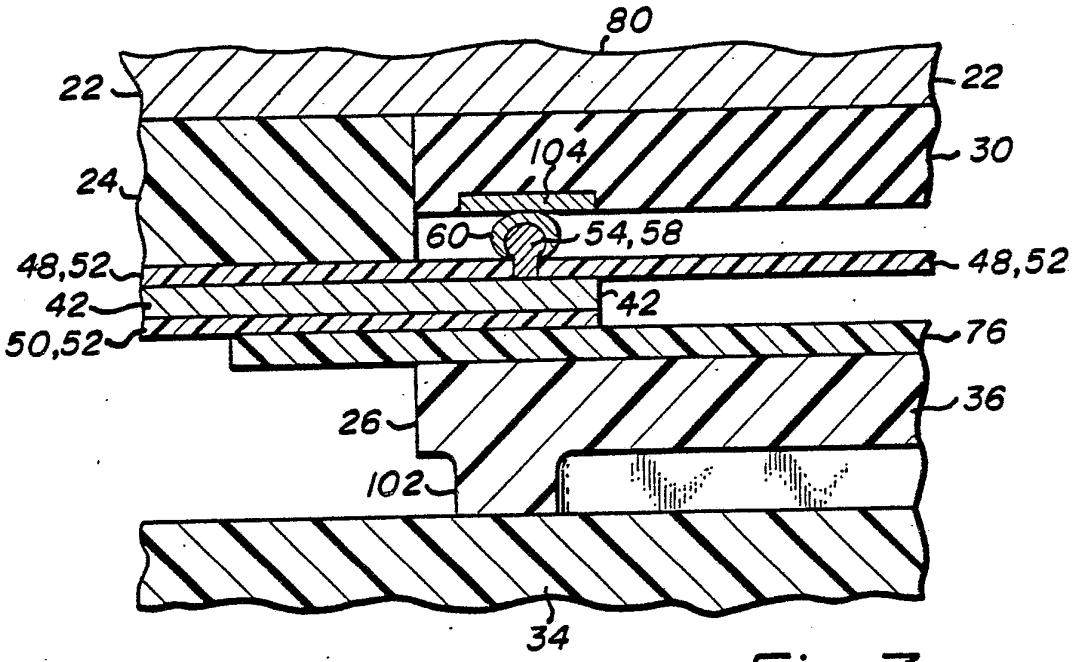

Fig_7

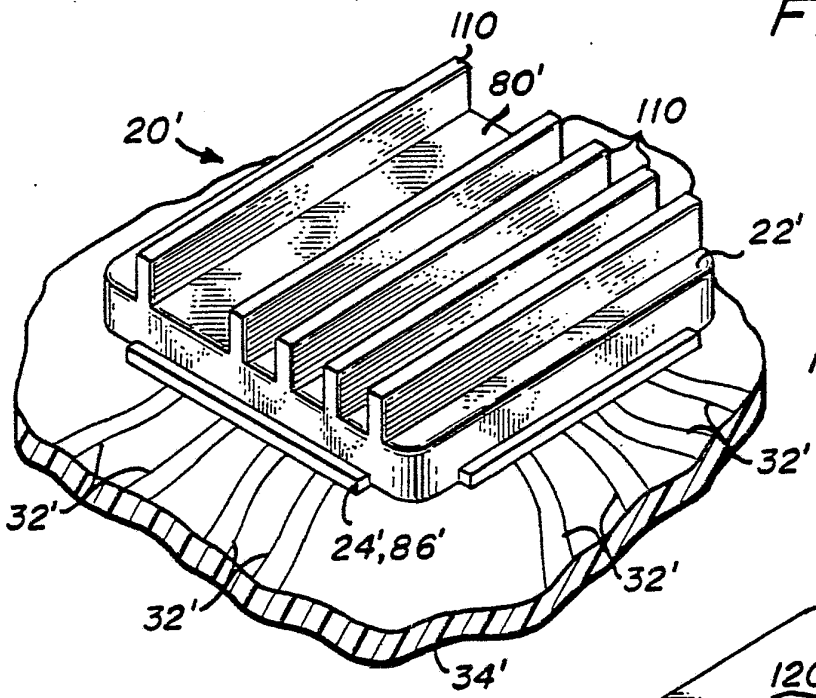

Fig_8

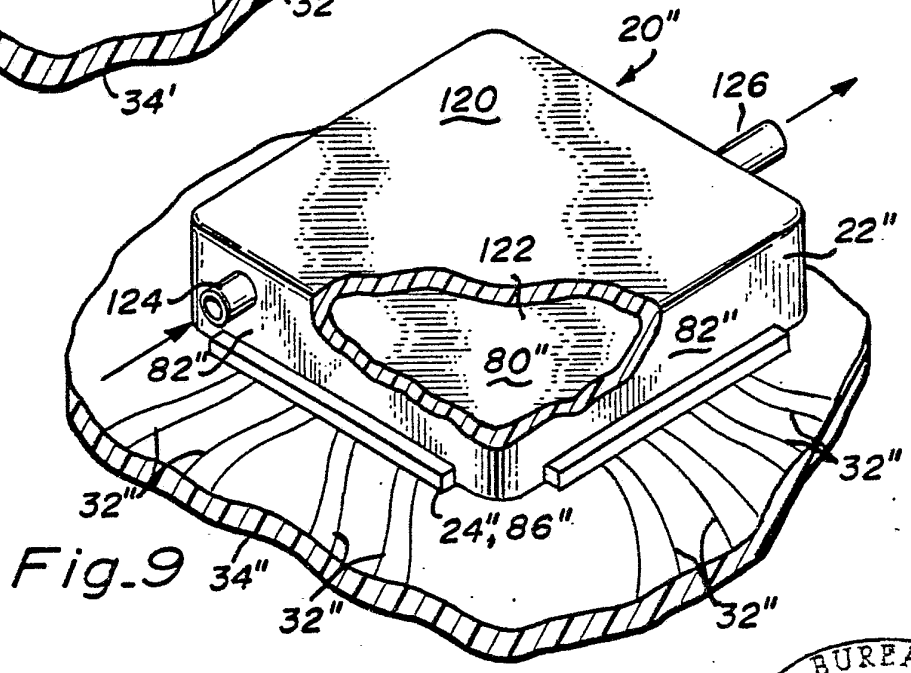

Fig_9

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 82/01584

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.3 H05K 7/20

U.S. Cl. 361/386,400; 357/79.

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	29/832; 174/52 FP; 339/17CF; 357/79,80,81,82; 361/386,395,399,400,403,417,419,429

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US,A, 4,037,270, Published 19 July 1977, Ahmann.	1-4,7-9,13-21
Y	US,A, 3,906,144, Published 16 September 1975, Wiley.	1-21
Y	US,A, 3,911,327, Published 7 October 1975, Murari.	1-21
Y	US,A, 3,689,804, Published 05 September 1972, Ishihama	11-21
Y	US,A, 4,251,852, Published 17 February, 1981, Ecker.	10
A	US,A, 3,480,836, Published 25 November 1969, Aronstein.	1-21

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"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

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"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.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
05 January 1983	18 JAN 1983
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	G. P. Tolin

Form PCT/ISA/210 (second sheet) (October 1981)