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Oyama et al.

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[54] **PRINTED CIRCUIT BOARD**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[3] **H05K 1/14**

[52] **U.S. Cl.** .... **361/412;** 174/138 G; 361/414

[58] **Field of Search** .... 361/412, 414; 174/138 D, 138 E, 138 G

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[57] **ABSTRACT**

In a printed circuit board wherein chip components are mounted in aligned holes provided through two printed substrates stacked over one another, spacer members are interposed between the printed substrates so as to define spaces therebetween around the holes. Since the printed substrates and chip components are movable relative one another due to such spaces, thermal stresses in the joints between the chip components and the printed substrates can be relieved.

6 Claims, 6 Drawing Figures

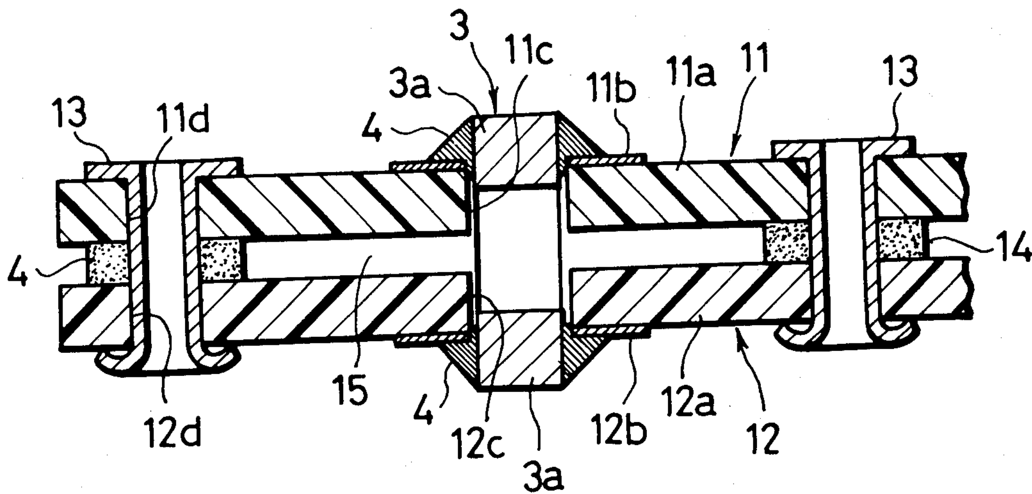


Fig. 1
PRIOR ART

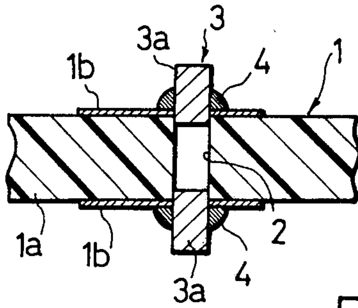


Fig. 2
PRIOR ART

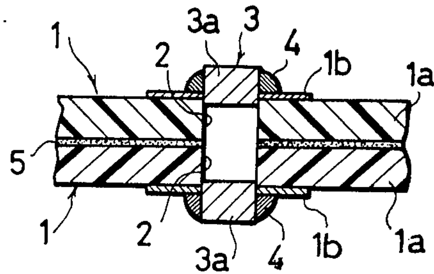


Fig. 3

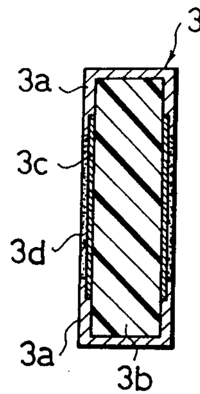


Fig. 4

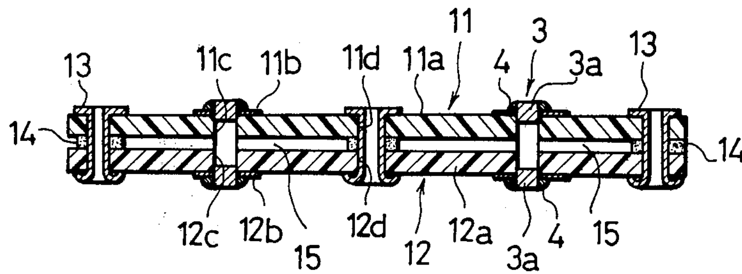


Fig. 5

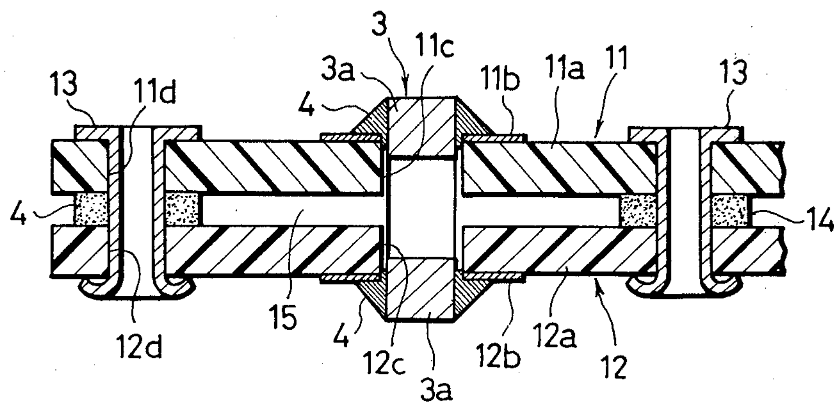
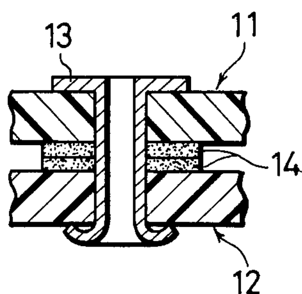


Fig. 6



PRINTED CIRCUIT BOARD

BACKGROUND OF THE INVENTION

The present invention relates to printed circuit boards, and more particularly, to a printed circuit board formed from two printed substrates.

A prior art printed circuit board is as shown in FIG. 1. A printed substrate **1** has conductive foils **1*b*** and **1*b*** formed on both surfaces of a single insulating substrate **1*a*** made of a paper epoxy resin substrate or glass epoxy resin substrate. The substrate **1*a*** is provided with a hole **2** therethrough, and a chip component **3** such as a chip capacitor is inserted through the hole **2**. Electrode portions **3*a*** and **3*a*** at ends of the chip component **3** are soldered to the conductive foils **1*b*** and **1*b***, as shown by numeral **4**.

Another type of circuit board is shown in FIG. 2, wherein printed substrates **1** and **1** each having a conductive foil **1*b*** formed on the outer surface of insulating substrate portion **1*a*** are placed one over the other, and bonded to each other by a binder **5** made of a thermosetting resin. A chip component **3** is inserted into aligned holes **2** provided in both substrate portions **1*a*** and **1*a***. Electrode portions **3*a*** and **3*a*** of the chip component **3** are soldered at **4** to the conductive foils **1*b*** and **1*b***.

In general, the chip component **3** is constructed as shown in FIG. 3. A rod-like or cylindrical insulating body **3*b*** is made of a ceramic material, and its surface has a film **3*c*** of a resistor material or the like formed thereover. The electrode portions **3*a*** and **3*a*** are disposed at both ends of the insulating body **3*b***. An insulating coating **3*d*** is formed so as to cover the film **3*c*** which is located between the electrodes **3*a*** and **3*a***.

When such chip component **3** is inserted in the hole or holes **2** of the printed substrate or substrates **1** and soldered to the conductive foils **1*b*** as illustrated in FIGS. **1** or **2**, the insulating body **3*b*** of the chip component **3** and the insulating substrate **1*a*** of each printed substrate **1** may expand due to thermal effects. After the soldering, they may each shrink due to cooling. Further, when an electric equipment having such a printed circuit board is operated, the insulating body **3*b*** and the insulating substrate portion **1*a*** may repeatedly expand and contract with the rise and fall of the temperature within the electric equipment. The insulating body **3*b*** of a ceramic material and the insulating substrate portion **1*a*** of the paper epoxy resin substrate or the like typically have unequal coefficients of thermal expansion, and the differential thickness of the insulating substrate portion **1*a*** between the expanded and contacted states thereof is several times greater than that of the insulating body **3*b*** in the direction of the hole **2**. For this reason, a stress acts on the soldered joint between the chip component **3** and the printed substrate **1**. The stresses produced by the expansion and contraction of the printed substrate **1** may damage the conductive foil **1*b*** and the electrode portion **3*a*** or cause the conductive foil **1*b*** or the electrode portion **3*a*** to separate from the soldered joint **4**. Such known circuit boards therefore have the disadvantage that the chip componet **3** cannot be connected reliably to circuit patterns on the board.

SUMMARY OF THE INVENTION

An object of the present invention is to eliminate the disadvantage of such known circuit boards by providing a printed circuit board in which a chip component can be connected to conductive patterns reliably over a long term.

According to one aspect of performance of the present invention, there is provided a printed circuit board for mounting chip components comprising first and second printed substrates which are provided with conductive wiring patterns and which are formed with holes for receiving the chip components therein. Printed substrates are stacked and coupled together with spacer members therebetween. The chip components can then be inserted in set holes and soldered to said conductive patterns of said first and second printed substrates.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are fragmentary sectional views of known printed circuit boards,

FIG. **3** is a sectional view of a chip component,

FIG. **4** is a sectional view of a printed circuit board according to the present invention,

FIG. **5** is an enlarged fragmentary sectional view of the printed circuit board shown in FIG. **4**, and

FIG. **6** is a fragmentary sectional view showing another embodiment of the present invention.

PREFERRED EMBODIMENTS OF THE INVENTION

An embodiment of the present invention is shown in FIGS. **4** and **5**. Referring to the figures, numerals **11** and **12** designate first and second printed substrates in which conductive foils or similar conductive wiring patterns **11*b*** and **12*b*** are formed on the outer surfaces of insulating substrate portions **11*a*** and **12*a*** made of paper epoxy resin, glass epoxy resin, or the like. The first and second printed substrates **11** and **12** are respectively formed with holes **11*c*** and **12*c*** for receiving chip components **3** therein, and fitting holes **11*d*** and **12*d*** for receiving coupling members **13** therein. The coupling members **13** for coupling the first and second printed substrates **11** and **12** together are made of eyelets or the like members. Spacer members **14** each of which is made of a polyester film or the like having a thickness of, for example, 0.1 mm to 0.5 mm or so are placed between the two substrates **11** and **12** and extend around respective coupling members.

In assembling the printed circuit boards, the coupling members **13** are first inserted through respective fitting holes **11*d*** of the first printed substrate **11** with the conductive patterns **11*b*** facing outwardly. Subsequently, respective spacer members **14** are fitted on inserted coupling members **13** and the coupling members **13** are then fitted into the respective fitting holes **12*d*** of the second printed substrate **12** with conductive patterns **12*b*** facing outwardly.

Next, the lower ends of the coupling members **13** are caulked to couple the first and second printed substrates **11** and **12**. Under the coupled state, the holes **11*c*** and **12*c*** respectively provided in the first and second printed substrates **11** and **12** are aligned, and a small space **15** is provided between the first and second printed substrates **11** and **12** in the vicinity of the holes **11*c*** and **12*c***.

Thereafter, the chip components **3** are inserted through the holes **11*c*** and **12*c*** of the first and second printed substrates **11** and **12**, and their electrode portions **3*a*** and **3*a*** are respectively soldered to the conductive patterns **11*b*** and **12*b*** as shown at numeral **4**. Thereafter, the printed circuit board is completed.

With the printed circuit board thus constructed, even when the insulating substrate portions **11***a* and **12***a* and the insulating body **3***b* of the chip component **3** have respectively expanded or contracted under thermal stresses during the soldering or with temperature rise and fall inside the electric equipment, they can move relative one another in the direction of the thickness of the insulated substrate portions **11***a* and **12***a* owing to the presence of the spaces **15** between the first and second printed substrates **11** and **12**, and hence, the stresses in the joints between the chip component **3** and the printed substrates **11** and **12** can be relieved.

That is, according the the present invention, the first and second printed substrates **11** and **12** are stacked and coupled through spacer members **14**, and the spaces **15** defined between the first and second printed substrates **11** and **12** around the holes **11***c* and **12***c* for the chip components **3** enable relative movement between the chip component and the printed substrates **11** and **12**. Therefore, even when the printed substrates **11** and **12** have expanded or contracted in the direction of the thickness thereof, they are displaceable owing to the spaces **15**, and the stresses in the joints can be relieved. Accordingly, damage of the conductive patterns **11***b* and **12***b* of the printed substrates **11** and **12** or the electrode portions **3***a* of the chip components **3**, and the separation between the conductive patterns **11***b* and **12***b* and the soldering part **4**, or between the electrode portion **3***a* and the soldering part **4**, can be reduced. The chip components **3** can thus be connected reliably over a long term to the circuit boards.

Although, in the above embodiment, the spacer member **14** had been described as the polyester film, it is a matter of course that a flat member made of any other material may well be employed. Alternatively, the spacer member **14** may be formed as shown in FIG. **6**. In this embodiment, at least one of the opposing surfaces of the first and second printed substrates **11** and **12** is printed or coated with a resin such as solder resist or is formed with a copper foil (conductive foil) by the print-wiring technique to form the spacer member.

What is claimed is:

1. A printed circuit board for mounting chip components, comprising first and second printed substrates stacked over one another and each having conductive wiring patterns formed on the surfaces thereof facing outwardly, said first and second printed substrates having aligned holes extending between respective conductive wiring patterns of each said substrate and receiving therein respective chip components, said chip components having a coefficient of thermal expansion different than that of said first and second printed substrates and being soldered to said wiring patterns, and means including spacer members located between said first and second printed substrates for providing a spacing between said first and second printed substrates around said holes so that thermal stresses developed between said printed substrates and any of said chip components can be relieved by relative movement between said printed substrates to vary said spacing.

2. A printed circuit board for mounting chip components as defined in claim **1**, further comprising coupling members extending through aligned openings in said first and second printed substrates, said coupling members having said spacer members fitted therearound so as to hold said printed substrates in a spaced manner.

3. A printed circuit board for mounting chip components as defined in claim **1**, said spacer members being formed from a polyester film.

4. A printed circuit board for mounting chip components as defined in claim **1**, said spacer members being provided by a layer selected from the group consisting of a resin and a copper foil deposited on at least one of opposing surfaces of said printed substrates, said layer being deposited at areas of said printed substrates remote from any of said holes receiving a chip component so that portions of said printed substrates adjacent said chip components are free to deflect relative thereto to relieve thermal stresses.

5. A printed circuit board for mounting chip components as defined in claim **3**, said polyester film being located at areas of said printed substrate remote from any of said holes receiving a chip component so that portions of said printed substrate adjacent said chip components are free to deflect relative thereto to relieve thermal stresses.

6. A printed circuit board for mounting chip components, comprising first and second printed substrates stacked one over another and each having conductive wiring patterns formed on the surfaces thereof facing outwardly, said first and second printed substrates having aligned holes extending between respective conductive wiring patterns of each said substrate and receiving therein respective chip components, said chip components having a coefficient of thermal expansion different than that of the first and second printed substrates and being soldered to said wiring patterns, and means including spacer members located between said first and second printed substrates at locations remote from any of said holes receiving a chip component for providing a spacing between said first and second printed substrates around said holes so that thermal stresses developed between said printed substrates and any of said chip components can be relieved by deflection of portions of said printed substrates adjacent said chip components.

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