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D E C I S I O N
of 23 July 2002

Case Number: T 0174/99 - 3.4.3

Application Number: 94919395.7

Publication Number: 0702847

IPC: H01L 21/48

Language of the proceedings: EN

Title of invention:
Method for providing electrical interconnections between adjacent circuit board layers of a multi-layer circuit board

Applicant:
MINNESOTA MINING AND MANUFACTURING COMPANY

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54 and 56

Keyword:
"Novelty (yes) (claimed features not directly and unambiguously derivabled from the closest prior art)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

Case Number: T 0174/99 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 23 July 2002

Appellant: MINNESOTA MINING AND MANUFACTURING COMPANY
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 21 August 1998 refusing European patent application No. 94 919 395.7 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: M. Chomentowski
J. H. Van Moer

Summary of Facts and Submissions

I. The European patent application No. 94 91 93 95.7 (Publication No. 0 702 847) was refused by a decision dated 21 August 1998 of the examining division on the ground that the subject-matter of claim 1, concerning a method, was not new having regard to document

D4 = US-A-5 046 238.

Moreover, in the decision it was held that the subject-matter of claim 1 also was not new having regard to any of the documents

D1 = Patent Abstracts of Japan, vol. 16, no. 158 (E-1191), 17 April 1992 & JP-A-04 010 696,

D2 = EP-A-0 543 364, and

D3 = EP-A-0 494 668.

Lack of novelty was also objected against dependent claims and independent device claim 11.

II. Claim 1 forming the basis of the decision read as follows:

"1. A method of making a multi-layer interconnect, comprising:

- forming a first circuit board layer (10) having a via hole (18) extending between a first side to a second side, the via hole (18) extending to a trace metal layer (16) carried on the first side, the via hole (18) carrying a conductive via

material (20) in electrical contact with the trace metal layer (16) and forming a crown exterior to the via hole (18) on the second side of the first circuit board layer (10),

- forming a second circuit board layer (28) having an electrical contact (36, 52) carried on a first side,

- aligning the first circuit board layer (10) with the second circuit board layer (28) wherein the via hole (18) of the first circuit board (10) is substantially aligned with the electrical contact (36, 52) of the second circuit board layer (28), and

- laminating the first circuit board layer (10) to the second circuit board layer (28) wherein the conductive via material (20) of the first circuit board layer (10) electrically contacts the electrical contact (36, 52) of the second circuit board layer (28)."

III. The applicant lodged an appeal against the decision on 2 November 1998 paying the appeal fee on the same day. A statement setting out the grounds of the appeal was filed on 30 December 1998.

IV. At the oral proceedings of 23 July 2002 the appellant (applicant) filed an amended set of claims and amended pages of the description and requested that the decision under appeal be set aside and that a patent be granted with the following patent application documents:

Description:
Pages 2, 4, 7, 10 and 13 as filed;
Page 3b as filed with appellant's letter dated
30 December 1998;
Pages 1, 3, 6, 8, 9 and 12 as filed with applicant's
letter dated 13 January 1998;
Pages 3a, 5, 11 and 14 filed during the oral
proceedings;

Claims:
Nos 1 to 9 filed during the oral proceedings;

Drawings:
Sheets 1/5 to 5/5 as filed.

Claim 1 reads as follows:

"1. A method of making a multi-layer interconnect,
comprising:

- forming a first circuit board layer (10) having a via hole (18) extending between a first side to a second side, the via hole (18) extending to a trace metal layer (12, 16) carried on the first side, the via hole (18) carrying a conductive via material (20) in electrical contact with the trace metal layer (12, 16) and forming a crown exterior to the via hole (18) on the second side of the first circuit board layer (10), **the second side of the first circuit board layer (10) being provided with a layer of insulative adhesive material (24) covering the crown,**

- forming a second circuit board layer (28) having an electrical contact (36, 52) carried on a first side,

- aligning the first circuit board layer (10) with the second circuit board layer (28) [wherein] **the second side of the first circuit board layer (10) facing the first side of the second circuit board layer (28) and wherein** the via hole (18) of the first circuit board (10) is substantially aligned with the electrical contact (36, 52) of the second circuit board layer (28), and

- laminating the first circuit board layer (10) to the second circuit board layer (28) **under heat and pressure** wherein **the insulative adhesive material (24) is displaced from the crown and the crown** electrically contacts the electrical contact (36, 52) of the second circuit board layer (28)."

(Amendments by way of addition and deletion from the text of claim 1 refused in the decision under appeal have been emphasised and put in brackets respectively by the Board.) The expression "the conductive via material (20) of the first circuit board layer (10) electrically contacts ..." in claim 1 forming the basis of the decision has been replaced by "**the crown** electrically contacts ...").

The claims 2 to 9 are dependent claims.

V. The appellant submitted the following arguments in support of his request:

Present claim 1 requires that, prior to lamination, the crown is covered with a layer of insulative adhesive material, and this is not clearly derivable from Figure 4(d) of document D1. Although in this Figure the crowns (5) are shown with their sides covered by the surrounding insulative adhesive layer (6), there is no

indication that the head areas of the crowns (5), which are for electrically contacting the electrical contact of the superposed second circuit board layer, are also covered by the adhesive layer (6) before laminating. Present claim 1 also requires that during lamination the insulative adhesive material is displaced from the crown, and this is not derivable from document D1 either. This document indeed represents the closest prior art. However, its teaching should not be distorted; any other hindsight interpretation of the teaching would be directly rejected by the skilled reader generally knowing that interposed insulative adhesive material would be detrimental to the electrical contact to be obtained.

The other prior art documents D2 to D4 concern methods using interposed insulative adhesive material which is removed from the crown before lamination, so that they do not teach displacing the adhesive material from the crown during lamination.

Therefore, the subject-matter of claim 1 is new.

The measures suggested by the invention are not obvious having regard to the state of the art and they significantly facilitate the manufacturing process since it is very easy to apply the layer of insulative adhesive material over the bump-shaped metal projections so as to provide a bonding. Therefore, the subject-matter of claim 1 involves an inventive step.

Reason for the Decision

1. The appeal is admissible.

2. *Admissibility of the amendments and clarity*

In present claim 1, it is specified that, in the method of making a multi-layer interconnect,

- the second side of the first circuit board layer (10) is provided with a layer of insulative adhesive material (24) covering the crown,
- the second side of the first circuit board layer (10) faces the first side of the second circuit board layer (28), and that,
- laminating the first circuit board layer (10) to the second circuit board layer (28) is done under heat and pressure wherein the insulative adhesive material (24) is displaced from the crown and the crown electrically contacts the contact on the second circuit board layer.

These features are based on the content of the application as filed concerning the aspect of the invention wherein there is an interposed layer of insulative adhesive material which is displaced from the crown during lamination (see claim 1 together with page 4, lines 25 to 36, page 8, line 33 to page 11, line 6 and Figures 9 and 10).

Information relating to methods wherein no insulative adhesive material is disposed over the crown and displaced therefrom during lamination has been deleted, and the present application does not comprise any claim directed at a multi-layer interconnect.

Therefore, the application satisfies the requirement of Article 123(2) EPC that a European patent application may not contain subject-matter extending beyond the content of the application as filed.

Moreover, the Board is satisfied that the claims are clear, concise and are supported by the description in the sense of Article 84 EPC.

3. *Novelty*

3.1 As a preliminary remark, it is to be noted that, as a result of the amendments provided by the appellant by addition of features and by cancellation of the device claims, the findings in the decision under appeal in respect of the independent method and device claims are not relevant any more.

3.2 A method of making a multi-layer interconnect is known from document D1 (see the whole document, together with the Patent Abstract in English and the translation in English of the text of the JP-A-document; see in particular Figure 4(d)). The method comprises:

- forming a first circuit board layer (2) having a via hole (3) extending between a first side to a second side, the via hole (3) extending to a trace metal layer (1) carried on the first side; the via hole (3) carries a conductive via material (4) in electrical contact with the trace metal layer (1) and forms a crown (5) exterior to the via hole (3) on the second side of the first circuit board layer (2); the whole surface of the second side of the first circuit board layer (2) is provided with a layer of adhesive material (6) which, as shown on Figure 4(d), also covers **at least the lateral sides of** the crown (5); taking into account the structures formed by the method and shown in the other Figures of the document, it is directly and unambiguously derivable that the adhesive material (6) is an insulative material;

- forming a second circuit board layer having an electrical contact carried on a first side,

- aligning the first circuit board layer with the second circuit board layer wherein the second side of the first circuit board layer (2) is facing the first side of the second circuit board layer and wherein the via hole (3) of the first circuit board is substantially aligned with the electrical contact of the second circuit board layer, and

- laminating the first circuit board layer (1) to the second circuit board layer under heat and pressure whereby the crown (5) of the first circuit board layer electrically contacts the electrical contact of the second circuit board layer.

Since it is mentioned that during this lamination step air is expelled from the through-holes (3) which are not filled with metal, it is directly and unambiguously derivable that insulative adhesive material (6) is displaced from the first circuit board layer.

3.2.1 The appellant has convincingly argued as follows as to the teaching of document D1:

Present claim 1 requires that, prior to lamination, the crown is covered with an insulative adhesive layer, and this is not clearly derivable from Figure 4(d) of document D1. In this Figure 4(d), the crowns (5) are shown with their sides covered by the surrounding insulative adhesive layer (6). However, there is no unambiguous information that the head areas of the crowns (5), which are for electrically contacting the aligned electrical contact of the second circuit board layer, are also covered by the adhesive layer (6) before laminating.

Moreover, in the known method, during lamination, the insulative adhesive material (6) is indeed displaced for filling the through-holes which have not been filled with metal material. However, since there is no unambiguous information that the head areas of the crown are also covered by the insulative adhesive material, the known method, as it is disclosed in particular in Figure 4(d), cannot fulfill either the further requirement of present claim 1 that the insulative adhesive material is displaced from the crown.

3.3 Another method of making a multi-layer interconnect is known from document D3 (see column 13, line 12 to column 14, line 13, more in particular column 13, lines 12 to 30; Figures 9, 10(A) and 10(B)) wherein a layer (88) of an adhesive is provided to cover entirely the surface of a first circuit board layer (10) including metal bumps (52). However, before aligning and laminating the superposed first and second circuit boards, the layer of adhesive is selectively removed from the areas of the metal bumps (52), i.e., as shown in the Figures, also around the metal bumps (52), so that, when laminating the two circuit boards, the adhesive material (88) is **not** displaced from the bumps (52) or crowns, as required by present claim 1.

A further method of making a multi-layer interconnect is known from document D2 (see column 5, line 47 to column 7, line 57 and Figures 1 to 5, more in particular column 7, lines 19 to 31 and Figures 4(d) and 4(f)) wherein a layer (23) of an adhesive is provided to entirely cover the surface of a first circuit board layer including metal bumps (21). However, before aligning and laminating the superposed first and second circuit boards, the layer (23) of adhesive is selectively removed in the areas (22) of

the metal bumps, i.e., as shown in the Figures, leaving an aperture over the metal bumps (52) corresponding to the shape of the outstanding bumps (11) of the opposite circuit board layer, so that, when laminating the two circuit boards, the adhesive material (23) is not derivable as being displaced from the bumps (21), as required by present claim 1.

Still another method of making a multi-layer interconnect is known from document D4 (see the embodiments illustrated by Figures 1 to 7 and 8 to 12) wherein the crowns (16, 21; 44) are made on facing circuit board layers, and in particular on the facing surfaces thereof or in apertures (16, 42) of the facing surfaces thereof. The crowns (16, 21; 44) are surrounded by insulative adhesive material (14, 40). However, insulative adhesive material covering the crowns, if present before lamination, is removed e.g. by laser etching (see for instance column 4, line 63 to column 5, line 7; Figures 9 and 10), so that, when laminating the two circuit boards together, the adhesive material (23) is not displaced from the crowns (21, 16; 44), as required by present claim 1.

The other prior art documents are less relevant.

3.4 Therefore, the subject-matter of present claim 1 is not comprised in the state of the art and is thus new in the sense of Article 54 EPC.

4. *Inventive step*

4.1 The appellant has convincingly argued as follows:

The closest prior art is represented by document D1. Starting from this known method, it is necessary, to arrive at the method of present claim 1, that, prior to

lamination, the crown, and in particular the head area thereof, is covered with the insulative adhesive layer, and, moreover, that during lamination the insulative adhesive material is also displaced from the crown.

These features are not disclosed by the prior art documents D2 to D4 either, which use between adjacent board layers an intermediate bonding layer with preformed openings or wherein openings are formed "*in situ*".

The objective technical problem addressed by the invention as claimed can therefore be regarded as simplifying the method of lamination of circuit boards as known from document D1.

Indeed, with the benefit of hindsight, it could be argued that the skilled person could derive from the content of document D1 that one of the multiple possible ways of completing the teaching of this document and thus arrive at the structure of Figure 4(d) comprising the crown (5) with its sides covered by the surrounding insulative adhesive material (6) could be to cover the crown with this material and then laminate the adjacent circuit board layers.

However, even if the skilled person would consider such a solution, he would be directly aware that, in spite of lamination and related displacement of the insulative adhesive material, some of it may remain adhered between the head area of the crown and the adjacent contact on the facing circuit board layer thereby deteriorating electrical contact.

The measures suggested by the invention significantly facilitate the manufacturing process since it is very easy to apply the adhesive material over the bump-shaped metal projections so as to provide a bonding.

4.2 As stated in the application (see page 5, lines 1 to 9), the invention enables large volume production of multilayer circuit boards. Indeed, in the claimed method, it is not necessary to use additional method steps for obtaining the head area of the crown free of insulative adhesive material before lamination, as in the methods of documents D2 to D4. Moreover, as set forth here above, a specific method step of displacing insulative adhesive material from the crown during lamination is not directly and unambiguously derivable from document D1 either. According to the application (see page 4, lines 16 to 24), measures are intended for making electrically sound metal to metal bond between the parts. Thus, it is credible that the simplification of the fabrication method obtained by providing the first circuit board layer with a layer of insulative adhesive material covering the crown and, during lamination, displacing the insulative adhesive material from the crown, more than compensates problems which might arise because of remaining insulative adhesive material between the head area of the crown and the aligned contact of the adjacent circuit board layer.

Therefore, in the Board's judgement, the subject-matter of claim 1 involves an inventive step in the sense of Article 56 EPC and, thus, it is patentable in the sense of Article 52(1) EPC.

5. Consequently, a patent can be granted on this basis (Article 97(2) EPC).

Order

For these reasons it is decided:

1. The decision under appeal is set aside.

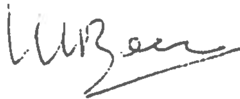
2. The case is remitted to the first instance with the order to grant a patent on the basis of the following patent application documents:

   Description:
   Pages 2, 4, 7, 10 and 13 as filed;
   Page 3b as filed with letter dated 30 December 1998;
   Pages 1, 3, 6, 8, 9 and 12 as filed with letter dated 13 January 1998;
   Pages 3a, 5, 11 and 14 filed during the oral proceedings;

   Claims:
   Nos 1 to 9 filed during the oral proceedings;

   Drawings:
   Sheets 1/5 to 5/5 as filed.

The Registrar:



M. Beer

The Chairman:

R. K. Shukla