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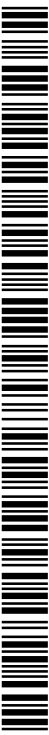
**Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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(54) Title: FLEXIBLE CIRCUIT ASSEMBLY AND METHOD THEREOF

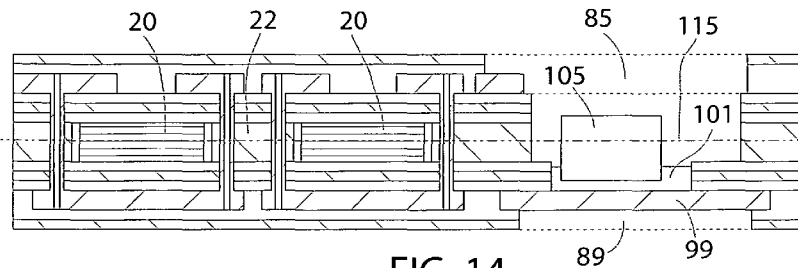


FIG. 14

(57) Abstract: An embedded device (105) is assembled within a flexible circuit assembly (30) with the embedded device mid-plane intentionally located in proximity to the flexible circuit assembly central plane (115) to minimize stress effects on the embedded device. The opening (18), for the embedded device, is enlarged in an intermediate layer (10) to enhance flexibility of the flexible circuit assembly.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/00259

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 29/00 (2012.01)

USPC - 257/181; 257/E23.078

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

USPC: 257/181; 257/E23.078

IPC: H01L 29/00 (2012.01)

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

USPC: 257/181; 257/E23.078

IPC: H01L 29/00 (2012.01) (keyword limited - see search terms below)

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

PatBase (FullText); Google; Google Scholar

SeaTerms: flexible, rigid, circuit, board, substrate, layer, stack, plane, axis, intermediate, intervene, middle, pattern, mask, aperture, hole, via, opening, embed, implant, through, connect, surface, edge, border, heat, thermal, temperature, sink, exchange, bend, fold, offset, cut.

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2011/0117703 A1 (Eckhardt et al.) 19 May 2011 (19.05.2011), entire document, especially abstract, Figs. 1A-1J, 3B, 5, para [0003], [0014], [0027], [0036], [0039], [0040], [0042], [0054], [0056], [0060], [0061]	1-3, 5, 7, 9, 10, 13, 14 ----- 4, 6, 8, 11, 12, 24-31
X --- Y	US 2007/0124916 A1 (Harding) 07 June 2007 (07.06.2007), entire document, especially abstract, Fig. 11, para [0004], [0023], [0029], [0030], [0032], [0041], [0045], [0048], [0050], [0051], [0057]	15-23 ----- 31
Y	US 2010/0072577 A1 (Nuzzo et al.) 25 March 2010 (25.03.2010), entire document, especially abstract, para [0009], [0010], [0123]	4, 25-30
Y	US 2010/0096166 A1 (Fjelstad) 22 April 2010 (22.04.2010), entire document, especially abstract, para [0095], [0096], [0114]	6, 8, 11, 12
Y	DE 4412278 A (Seiler) 12 October 1995 (12.10.1995), entire document, especially Fig 2, 3; col 2	24
A	US 5,444,228 A (Gelus) 22 August 1995 (22.08.1995), entire document, especially fig 3, 4	24
A	US 2007/0108521 A1 (Dekker) 17 May 2007 (17.05.2007), entire document, especially abstract, para [0007], [0020], [0045], [0049], [0050]	1-31
A	US 2010/0091501 A1 (Tan et al.) 15 April 2010 (15.04.2010), entire document, especially abstract, para [0012], [0013], [0035], [0036]	1-31

 Further documents are listed in the continuation of Box C.


\* Special categories of cited documents:

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

"E" earlier application or patent 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 when the document is taken alone

"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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

07 November 2012 (07.11.2012)

Date of mailing of the international search report

28 NOV 2012

Name and mailing address of the ISA/US

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**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/US 12/00259

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

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

- 1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
- 2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
- 3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

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

- 1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
- 2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
- 3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:  
1-31 (Groups I, II, III).
- 4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
  - The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
  - No protest accompanied the payment of additional search fees.

The following claim groups were found:

Group I: Claims 1-14, 25-31

Group II: Claims 15-23

Group III: Claims 24

Group IV: Claims 32-36

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: is drawn to a flexible circuit assembly, having an embedded device, comprising: an intermediate layer having an opening configured for receiving an embedded device, said intermediate layer having a first and second surface, said embedded device having a mid-plane plane; a first structure having a first layer and a second layer, said first layer of said first structure affixed to said first surface of said intermediate layer, said first structure having intervening layers between said first layer and said second layer, said first structure having an opening through said first layer, through said second layer, and through said intervening layers, said opening concurrent with said intermediate layer opening, and configured for embedding said embedded device; and a second structure having a first layer and a second layer, said first layer of said second structure affixed to said second surface of said intermediate layer, said second structure having intervening layers between said first layer and said second layer of said second structure, said second structure having a opening for device target placement through said first layer, through said intervening layers, and terminating at said first layer of said second structure, said opening of said second structure being concurrent with said opening of said intermediate layer opening and said opening of said first structure, said embedded device placed through said opening of said second structure and having a first surface affixed to said first layer of said second structure, said intermediate layer, said first structure, and said second structure in combination, having a predetermined central plane; said mid-plane of said embedded device located in proximity to said central plane of said intermediate layer.

Group II: is drawn to a method of fabricating a laminated inductor core, suitable for embedding in a flexible circuit assembly, comprising the steps of: a) patterning a first magnetic core layer; b) patterning a second magnetic core layer; c) forming said first magnetic core layer; d) forming said second magnetic core layer; e) forming an air gap in said first magnetic core layer; f) forming an air gap in said second magnetic core layer, wherein said air gap in said second magnetic core layer is offset from said air gap in said first magnetic core layer; and g) laminating said first and second magnetic core layers.

Group III: is drawn to a method of further enhancing flexibility in a flexible circuit assembly, comprising the steps of: a) providing a flexible circuit assembly, b) predetermining a plurality of cut lines for said flexible circuit assembly; c) providing a plurality of termination points for said plurality of cut lines; d) cutting said flexible circuit assembly along said each of said predetermined cut lines to corresponding said termination points; and e) separating said flexible circuit assembly along at least one of said cut lines in an expanding manner.

Group IV: is drawn to a circuit for powering a light emitting diode (LED) with an alternating current, comprising: a plurality of light emitting diode pairs coupled in a serial configuration, each of said light emitting diode pairs having a first diode, said first diode having an anode and a cathode, each of said light emitting diode pairs having a second diode, said second diode having an anode and a cathode, wherein said cathode of said first diode is coupled to said anode of said second diode, wherein said cathode of said second diode is coupled to said anode of said first diode; a first light emitting diode pair having an input at a juncture of said first diode anode and said second diode cathode; a second light emitting diode pair have an input at a juncture of said first diode cathode and said second anode cathode, a remainder of said plurality of said light emitting diode pairs coupled between said first light emitting diode pair and said second light emitting diode pair; a transformer having a first output coupled to said input of said first light emitting diode pair and a second output coupled to said input of said second light emitting diode pair; and 30 said transformer having a first input and a second input, said first and second inputs configured for coupling to an alternating current source.

The inventions listed in the abovementioned groups do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Groups I-IV lack unity of invention, because even though the inventions of these groups require the technical feature of a flexible circuit assembly, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2007/0124916 A1 to Harding (07 June 2007), which discloses a flexible circuit assembly (para [0003]) or alternately in view of US 2010/0091501 A1 to Tan et al. (15 April 2010), which discloses a flexible circuit assembly (para [0012], [0013]).

Groups I and II lack unity of invention, because even though the inventions of these groups require the technical feature of an inductor core, these technical features are not special technical features as they do not make a contribution over the prior art in view of US 2007/0124916 A1 to Harding, which discloses an inductor core (abstract; para [0003], [0004]).

Groups I and IV lack unity of invention, because even though the inventions of these groups require the technical feature of an LED device, these technical features are not special technical features as they do not make a contribution over the prior art in view of US 2010/0091501 A1 to Tan et al., which discloses an LED device (para [0012], [0013]).

Groups I-IV therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.