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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/195,392	6841737	2841	9200

OC000000048187243

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 13155 on 06/13/2011

- **Correspondence Address**
- **Maintenance Fee Address**

The address of record for Customer Number 13155 is:

13155
Edwards Neils PLLC
11710 Plaza America Drive, Suite 2000
Reston, VA 20190

PART 1 - ATTORNEY/APPLICANT COPY

page 1 of 1

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/195,392	6841737	2841	9200

OC000000047403606

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 13155 on 04/27/2011

- **Correspondence Address**
- **Maintenance Fee Address**

The address of record for Customer Number 13155 is:

13155
Edwards Neils PLLC
11710 Plaza America Drive, Suite 2000
Reston, VA 20190

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page 1 of 1

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/195,392	6841737	2841	9200

OC000000047377575

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 13155 on 04/26/2011

- **Correspondence Address**
- **Maintenance Fee Address**

The address of record for Customer Number 13155 is:

13155
Edwards Neils PLLC
11710 Plaza America Drive, Suite 2000
Reston, VA 20190

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/195,392	6841737	2841	9200

Correspondence Address / Fee Address Change

The following fields have been set to Customer Number 57362 on 11/18/2005

- Correspondence Address
- Maintenance Fee Address

The address of record for Customer Number 57362 is:
AKERMAN SENTERFITT
801 PENNSYLVANIA AVENUE N.W.
SUITE 600
WASHINGTON,DC 20004

10/195,392

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,841,737 B2
DATED : January 11, 2005
INVENTOR(S) : Makoto Komatsubara et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1,
Line 4, replace "2001-21812" with -- 2001-216812 --.

Column 24,
Line 63, replace "red" with -- wired --.

Signed and Sealed this

Seventeenth Day of May, 2005

Jon W. Dudas

JON W. DUDAS
Director of the United States Patent and Trademark Office

copy

Attorney Docket No.: 71450.00002
Customer No.: 35161

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA et al. — Group Art Unit: 2827

Application No.: 10/195,392 — Examiner: Vigushin, John B.

Patent Number: 6,841,737 B2 — Confirmation No.: 2813

Issued: January 11, 2005

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

CERTIFICATE OF CORRECTION UNDER 37 CFR 1.322

Attention: Certificate of Corrections Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In reviewing the above-identified patent, errors were discovered therein, requiring correction. Pursuant to the provisions of 37 C.F.R. 1.322, please enter the corrections shown in the attached Certification of Correction (PTO/SB/44). The errors are:

1) Claim 7 should read --wired circuit board - - instead of "red circuit board", as originally submitted by Applicants as original Claim 9.

2) Additionally, the serial number of the Japanese application from which the present patent claims priority, was incorrectly identified as serial number 2001-21812 in column 1, line 4. Applicants' preliminary amendment adding paragraph referencing the priority claim to the Japanese Application, identified the serial number of the Japanese Application as 2001-216812.

The PTO/SB/44 attached herewith submits corrections of these two errors.

Patentee respectfully requests issuance of the Certificate of Correction of the referenced patent, and if the Office deems it appropriate, issuance of corrected Letters Patent. Since the errors are the result of Patent Office printing mistakes, no fee is required or submitted.

However, if this is found to the contrary, please charge any shortage in fees in connection with the filing of this paper, including extension of times fees, to Deposit Account number 04-0160 and please credit any excess fees to such account.

Respectfully submitted,

Jean C. Edwards

Jean C. Edwards
Registration No. 41,728

DICKINSON WRIGHT PLLC
1901 L St., N.W.
Suite 800
Washington, D.C. 20036
Telephone: 202/659-6946
Facsimile: 202/659-1559
Date: **March 14, 2005**

DC 71450-2 100468v1

MAR 17 2005

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,841,737 B2

DATED : January 11, 2005

INVENTOR(S) : Makoto KOMATSUBARA, Shigenori MORITA, Tadoa OOKAWA, and Toshio SHINTANI

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column Number 1, Line 4: Replace "2001-21812" with --2001-216812 --.

Column Number 24, Line 63: Replace "red" with -- wired --.

MAILING ADDRESS OF SENDER:

Dickinson Wright, PLLC (Customer Number 35,161)
1901 L Street N.W., Ste. 800
Washington, D.C. 20036

PATENT NO. 6,841,737

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/195,392		2841	28PH

Change of Address/Power of Attorney

The following fields have been set to Customer Number 35161 on

- Correspondence Address
- Maintenance Fee Address

The address of record for Customer Number 35161 is:
DICKINSON WRIGHT PLLC
1901 L. STREET NW
SUITE 800
WASHINGTON, DC 20036

The Practitioners of record for Customer Number 35161 are:

PTO INSTRUCTIONS:

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1) File this Notice in the File Jacket

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Commissioner for Patents
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Alexandria, Virginia 22313-1450

or Fax **(703) 746-4000**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed wh appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

35161 7590 09/09/2004

DICKINSON WRIGHT PLLC
1901 L. STREET NW
SUITE 800
WASHINGTON, DC 20036

OIPE JC174 NOV 1 6 2004 PATENT & TRADEMARK OFFICE

11/17/2004 NNGUYEN2 00000032 10195392

01 FC:1501 1370.00 OP
02 FC:1504 300.00 OP
03 FC:8001 30.00 OP

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Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the Un States Postal Service with sufficient postage for first class mail in an envel addressed to the Mail Stop ISSUE FEE address above, or being facsim transmitted to the USPTO (703) 746-4000, on the date indicated below.

(Depositor's na

(Signat

(D

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

TITLE OF INVENTION: WIRED CIRCUIT BOARD

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	12/09/2004

EXAMINER	ART UNIT	CLASS-SUBCLASS
VIGUSHIN, JOHN B	2841	174-250000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Jean C. Edwards, Esq.
2
3 Dickinson Wright PLLC

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Nitto Denko Corporation

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Osaka, Japan

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Governm

4a. The following fee(s) are enclosed:
☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☒ Advance Order - # of Copies 10

4b. Payment of Fee(s):
☒ A check in the amount of the fee(s) is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized by charge the required fee(s), or credit any overpayment Deposit Account Number 04-1061 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other part interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature Jean C. Edwards Date November 16, 2004

Typed or printed name Jean C. Edwards, Esq. Registration No. 41,728

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to proc an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to comp this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 14 Alexandria, Virginia 22313-1450.

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PTO/SB/21 (09-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/195,392
Filing Date	July 16, 2002
First Named Inventor	Makoto KOMATSUBARA
Art Unit	2841
Examiner Name	John B. Vigushin
Attorney Docket Number	71450.00002
Total Number of Pages in This Submission	

ENCLOSURES *(Check all that apply)*

- [x] Fee Transmittal Form
  - [x] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) ____________
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Part B - Fee(s) Transmittal (PTOL-85)

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Dickinson Wright PLLC		
Signature	Jean C. Edwards		
Printed name	Jean C. Edwards		
Date	November 16, 2004	Reg. No.	41,728

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature			
Typed or printed name		Date	

OIPE JC174
NOV 16 2004
PATENT & TRADEMARK OFFICE

FEE TRANSMITTAL for FY 2005

Effective 10/01/2004. Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 1,700

Complete if Known	
Application Number	10/195,392
Filing Date	July 16, 2002
First Named Inventor	Makoto KOMATSUBARA
Examiner Name	John B. Vigushin
Art Unit	2841
Attorney Docket No.	71450.00002

METHOD OF PAYMENT *(check all that apply)*

☑ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☑ Deposit Account:

Deposit Account Number: 04-1061

Deposit Account Name: Dickinson Wright PLLC

The Director is authorized to: *(check all that apply)*

☐ Charge fee(s) indicated below ☑ Credit any overpayments

☑ Charge any additional fee(s) or any underpayment of fee(s)

☐ Charge fee(s) indicated below, **except for the filing fee**

to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	790	2001	395	Utility filing fee	
1002	350	2002	175	Design filing fee	
1003	550	2003	275	Plant filing fee	
1004	790	2004	395	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($)

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims		-20** =		X		=	
Independent Claims		- 3** =		X		=	
Multiple Dependent						=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	88	2201	44	Independent claims in excess of 3
1203	300	2203	150	Multiple dependent claim, if not paid
1204	88	2204	44	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)

***or number previously paid, if greater; For Reissues, see above*

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	430	2252	215	Extension for reply within second month	
1253	980	2253	490	Extension for reply within third month	
1254	1,530	2254	765	Extension for reply within fourth month	
1255	2,080	2255	1,040	Extension for reply within fifth month	
1401	340	2401	170	Notice of Appeal	
1402	340	2402	170	Filing a brief in support of an appeal	
1403	300	2403	150	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,370	2453	685	Petition to revive - unintentional	
1501	1,370	2501	685	Utility issue fee (or reissue)	1,370
1502	490	2502	245	Design issue fee	
1503	660	2503	330	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	790	2809	395	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	790	2810	395	For each additional invention to be examined (37 CFR 1.129(b))	
1801	790	2801	395	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) ____________ 330

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 1,700

SUBMITTED BY				(Complete *(if applicable)*)	
Name (Print/Type)	Jean C. Edwards	Registration No. (Attorney/Agent)	41,728	*Telephone*	202/659-6946
Signature	Jean C. Edwards			*Date*	November 16, 2004

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

35161 7590 09/09/2004

DICKINSON WRIGHT PLLC
1901 L. STREET NW
SUITE 800
WASHINGTON, DC 20036

EXAMINER	
VIGUSHIN, JOHN B	
ART UNIT	PAPER NUMBER
2841	

DATE MAILED: 09/09/2004

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

TITLE OF INVENTION: WIRED CIRCUIT BOARD

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	12/09/2004

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATEN PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHT THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPO PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM TH MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. TH STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOV REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (O AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WIL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is n claiming SMALL ENTITY status, check box 5a on Part B - Fee Transmittal and pay the PUBLICATION FEE (if required) and 1 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) w your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should completed and an extra copy of the form should be submitted.

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

35161 7590 09/09/2004

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1901 L. STREET NW
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WASHINGTON, DC 20036

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Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the Un States Postal Service with sufficient postage for first class mail in an envel addressed to the Mail Stop ISSUE FEE address above, or being facsim transmitted to the USPTO (703) 746-4000, on the date indicated below.

(Depositor's na

(Signat

(D

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

TITLE OF INVENTION: WIRED CIRCUIT BOARD

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	12/09/2004

EXAMINER	ART UNIT	CLASS-SUBCLASS
VIGUSHIN, JOHN B	2841	174-250000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1____________
   2____________
   3____________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Governm

4a. The following fee(s) are enclosed:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies __________

4b. Payment of Fee(s):
- ❑ A check in the amount of the fee(s) is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The Director is hereby authorized by charge the required fee(s), or credit any overpayment Deposit Account Number __________ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other part interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ____________ Date ____________

Typed or printed name ____________ Registration No. ____________

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

35161 7590 09/09/2004

DICKINSON WRIGHT PLLC
1901 L. STREET NW
SUITE 800
WASHINGTON, DC 20036

EXAMINER	
VIGUSHIN, JOHN B	
ART UNIT	PAPER NUMBER
2841	

DATE MAILED: 09/09/2004

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after t mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a h months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date th determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retriev (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

35161 7590 09/09/2004

DICKINSON WRIGHT PLLC
1901 L. STREET NW
SUITE 800
WASHINGTON, DC 20036

EXAMINER	
VIGUSHIN, JOHN B	

ART UNIT	PAPER NUMBER
2841	

DATE MAILED: 09/09/2004

Notice of Fee Increase on October 1, 2004

If a reply to a "Notice of Allowance and Fee(s) Due" is filed in the Office on or after October 1, 2004, then t amount due will be higher than that set forth in the "Notice of Allowance and Fee(s) Due" because an increase in fe effective on October 1, 2004 is anticipated. See Revision of Patent Fees for Fiscal Year 2005; Proposed Rule, 69 Fe Reg. 25861, 25863, 25864 (May 10, 2004).

The current fee schedule is accessible from WEB site (http://www.uspto.gov/main/howtofees.htm).

If the fee paid is the amount shown on the "Notice of Allowance and Fee(s) Due" but not the correct amount in vie of the fee increase, a "Notice of Pay Balance of Issue Fee" will be mailed to applicant. In order to avoid processi delays associated with mailing of a "Notice of Pay Balance of Issue Fee," if the response to the Notice of Allowan is to be filed on or after October 1, 2004 (or mailed with a certificate of mailing on or after October 1, 2004), t issue fee paid should be the fee that is required at the time the fee is paid. See Manual of Patent Examining Procedu (MPEP), Section 1306 (Eighth Edition, Rev. 2, May 2004). If the issue fee was previously paid, and the response the "Notice of Allowance and Fee(s) Due" includes a request to apply a previously-paid issue fee to the issue f now due, then the difference between the issue fee amount at the time the response is filed and the previously-pa issue fee should be paid. See MPEP Section 1308.01.

Effective October 1, 2004, 37 CFR 1.18 is proposed to be amended by revising paragraphs (a) through (c) to read set forth below. As stated above, the final fee may be a different amount, and applicant should check the WEB s given above when paying the fee.

Section 1.18 Patent post allowance (including issue) fees.

(a) Issue fee for issuing each original or reissue patent, except a design or plant patent:
  By a small entity (Sec. 1.27(a))...................... $670.00
  By other than a small entity......................... $1,340.00
(b) Issue fee for issuing a design patent:
  By a small entity (Sec. 1.27(a))...................... $245.00
  By other than a small entity........................... $490.00
(c) Issue fee for issuing a plant patent:
  By a small entity (Sec. 1.27(a))...................... $325.00
  By other than a small entity........................... $650.00

Questions relating to issue and publication fee payments should be directed to the Customer Service Center of t Office of Patent Publication at (703) 305-8283.

Notice of Allowability	**Application No.** 10/195,392	**Applicant(s)** KOMATSUBARA ET AL.	
	Examiner John B. Vigushin	**Art Unit** 2841	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *20 August 2004*.
2. ☒ The allowed claim(s) is/are *2-6,8 and 9 (renumbered as Claims 1-7, respectively)*.
3. ☒ The drawings filed on *20 February 2004* are accepted by the Examiner.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

John B. Vigushin
John B. Vigushin
Primary Examiner
Art Unit: 2841

Attorney Docket No.: 71450.00002
Customer No.: 35161

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA et al. — Group Art Unit: 2827

Application No.: 10/195,392 — Examiner: Vigushin, John B.

Confirmation No.: 2813

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

OK to ENTER — 09/02/04

AMENDMENT UNDER 37 C.F.R. § 1.116

MAIL STOP AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INTRODUCTORY REMARKS

Sir:

In response to the Final Office Action dated May 21, 2004, please amend the above-identified application as follows:

Issue Classification

Application No.	Applicant(s)	
10/195,392	KOMATSUBARA ET AL.	
Examiner	**Art Unit**	
John B. Vigushin	2841	

ISSUE CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)							
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)						
174	250	174	255	257	258				

INTERNATIONAL CLASSIFICATION				
H	0	5	K	7/06
				/
				/
				/
				/

(Assistant Examiner) (Date)

9/

(Legal Instruments Examiner) (Date)

John B. Vigushin
September 02, 2004

(Primary Examiner) (Date)

Total Claims Allowed: 7

O.G. Print Claim(s)	O.G. Print Fig.
1	1(a),(b)

☐ **Claims renumbered in the same order as presented by applicant** ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		31		61		91		121		151		181
1	2		32		62		92		122		152		182
2	3		33		63		93		123		153		183
3	4		34		64		94		124		154		184
4	5		35		65		95		125		155		185
5	6		36		66		96		126		156		186
	7		37		67		97		127		157		187
6	8		38		68		98		128		158		188
7	9		39		69		99		129		159		189
	10		40		70		100		130		160		190
	11		41		71		101		131		161		191
	12		42		72		102		132		162		192
	13		43		73		103		133		163		193
	14		44		74		104		134		164		194
	15		45		75		105		135		165		195
	16		46		76		106		136		166		196
	17		47		77		107		137		167		197
	18		48		78		108		138		168		198
	19		49		79		109		139		169		199
	20		50		80		110		140		170		200
	21		51		81		111		141		171		201
	22		52		82		112		142		172		202
	23		53		83		113		143		173		203
	24		54		84		114		144		174		204
	25		55		85		115		145		175		205
	26		56		86		116		146		176		206
	27		57		87		117		147		177		207
	28		58		88		118		148		178		208
	29		59		89		119		149		179		209
	30		60		90		120		150		180		210

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BIBDATASHEET

Bib Data Sheet

CONFIRMATION NO. 2813

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/195,392	07/16/2002 RULE	~~361~~ 174	2841	30015280.0001

APPLICANTS

Makoto Komatsubara, Osaka, JAPAN;

Shigenori Morita, Osaka, JAPAN;
Tadao Ookawa, Osaka, JAPAN;Toshio Shintani, Osaka, JAPAN;

** CONTINUING DATA ************************* NONE JBV

** FOREIGN APPLICATIONS ******************** JBV
JAPAN 2001-216812 07/17/2001

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 09/17/2002

Foreign Priority claimed / 35 USC 119 (a-d) conditions met / Verified and Acknowledged	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☒ yes ☐ no 35 USC 119 (a-d) conditions met ☒ yes ☐ no ☒ Met after Allowance Verified and Acknowledged: Examiner's Signature ____ Initials JBV	JAPAN	15	~~8~~ 7	~~6~~ 4

ADDRESS
35161
DICKINSON WRIGHT PLLC
1901 L. STREET NW
SUITE 800
WASHINGTON , DC
20036

TITLE
Wired circuit board

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
992	No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ____________ ☐ Credit

Search Notes	Application No. 10/195,392	Applicant(s) KOMATSUBARA ET AL.	
	Examiner John B. Vigushin	Art Unit 2841	

SEARCHED

Class	Subclass	Date	Examiner
361	749-751	6/15/2003	JBV
174	254	6/15/2003	JBV
Search	Updated	11/24/2003	JBV
174	250	11/24/2003	JBV
	255-258		
	261		
Search	Updated	5/19/2004	JBV

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner
174	**250, 255,**	9/2/2004	**JBV**
	257, 258		

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
EAST Text Search (see print-out)	6/15/2003	JBV
EAST Text Search (see print-out)	11/24/2003	JBV
EAST Text Search (see print-out)	5/19/2004	JBV

PATENT APPLICATION FEE DETERMINATION RECORD Effective October 1, 2003	Application or Docket Number 10/195392

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20=	*
INDEPENDENT CLAIMS	minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 9	Minus	** 20	=
Independent	* 6	Minus	*** 6	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

8-20-04

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 7	Minus	** 20	= —
Independent	* 4	Minus	*** 6	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev 10/03)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

CLAIMS ONLY

Application Number	Filing Date
10/195392	
Applicant(s)	

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT 8-20-04		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1			—	—		
2			1			
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Total Depend			3			
Total Claims			7			

CLAIMS	*		*		*	
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Total Indep						
Total Depend						
Total Claims						

OIPE JC25 AUG 2 0 2004 PATENT & TRADEMARK OFFICE

IFW AF

PTO/SB/21 (02-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/195,392
Filing Date	July 16, 2002
First Named Inventor	Makoto KOMATSUBARA
Art Unit	2827
Examiner Name	Vigushin, John B.
Attorney Docket Number	71450.00002
Total Number of Pages in This Submission	6

ENCLOSURES *(Check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [x] Amendment/Reply
  - [x] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) ____________
- [ ] After Allowance communication to Technology Center (TC)
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [ ] Other Enclosure(s) (please Identify below):

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	Jean C. Edwards, Esq., Reg. No. 41,728 Dickinson Wright PLLC 1901 L Street, NW, Suite 800, WDC 20036
Signature	Jean C. Edwards
Date	August 20, 2004

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Typed or printed name			
Signature		Date	

Attorney Docket No.: 71450.00002
Customer No.: 35161

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA et al.

Group Art Unit: 2827

Application No.: 10/195,392

Examiner: Vigushin, John B.

Confirmation No.: 2813

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

AMENDMENT UNDER 37 C.F.R. § 1.116

MAIL STOP AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INTRODUCTORY REMARKS

Sir:

In response to the Final Office Action dated May 21, 2004, please amend the above-identified application as follows:

AMENDMENTS TO THE CLAIMS:

1. (Canceled)

2. (Previously Presented) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at the ends of the opening in crossing areas where ends of the opening and the conductive pattern cross each other.

3. (Original) The wired circuit board according to Claim 2, wherein the wired circuit board is a suspension board with circuit.

4. (Previously Presented) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other.

5. (Previously Presented) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other.

6. (Original) The wired circuit board according to Claim 5, wherein the wired circuit board is a suspension board with circuit.

7. (Canceled)

8. (Previously Presented) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal

supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least one of the first insulating layer and the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern cross each other.

9. (Original) The wired circuit board according to Claim 8, wherein the wired circuit board is a suspension board with circuit.

REMARKS

Claims 2-9 are presently pending in the application. Claims 2-6, 8 and 9 are allowed, and Claims 1 and 7 have been canceled without prejudice or disclaimer. Reconsideration and allowance of all claims are respectfully requested.

The Examiner has finally rejected Claims 1 and 7 under 35 U.S.C. §102(b) as being anticipated by Iwayama et al.

Although the Applicants disagree with the Examiner's characterization of the claims, in order to move prosecution forward, Claims 1 and 7 have been canceled without prejudice or disclaimer.

Accordingly, the application is in form for allowance and such action is hereby solicited.

If the Examiner believes that there is any issue which could be resolved by a telephone or personal interview, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Applicants hereby petition for any extension of time which may be required to maintain the pendency of this case, and any required fee for such an extension is to be charged to Deposit Account No. 04-1061.

Respectfully submitted,

Jean C. Edwards

Jean C. Edwards
Registration No. 41,728

DICKINSON WRIGHT PLLC
1901 L St., N.W.
Suite 800
Washington, D.C. 20036
Telephone: 202/659-6946
Facsimile: 202/659-1559
Date: **August 20, 2004**

DC 71450-2 95711

UNITED STATES PATENT AND TRADEMARK OFFICE

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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

35161 7590 05/21/2004

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SUITE 800
WASHINGTON, DC 20036

EXAMINER	
VIGUSHIN, JOHN B	
ART UNIT	PAPER NUMBER
2827	

DATE MAILED: 05/21/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/195,392	KOMATSUBARA ET AL.
	Examiner	Art Unit
	John B. Vigushin	2827

-- The MAILING DATE of this communication appears on the cover sheet with the correspondenc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 February 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *2-6,8 and 9* is/are allowed.

6)☒ Claim(s) *1 and 7* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *20 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☐ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4)☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: _____.

DETAILED ACTION

1. The present Office Action is responsive to Applicant's Amendment filed February 20, 2004. The Examiner acknowledges the amendments to Claims 1 and 7. Claims 1-9 remain pending in the instant amended Application.

2. The Examiner further acknowledges the receipt of the corrected Formal Drawings, filed February 20, 2004, which have been approved by the Examiner.

3. The Examiner further acknowledges the receipt of the verified translation of priority document JP 2001-216812 which has been reviewed by the Examiner and which perfects the claim to foreign priority of the above-cited document having the official filing date of July 17, 2001.

4. The Examiner further acknowledges the Applicant's statement, bridging pp. 7-8 in the Remarks section of the above-cited instant Amendment, that the 35 USC § 102(e)/103(c) Yamato et al. reference (US 6,388,201 B2) and the instant Application were owned by the same assignee at the time the invention was made, in accordance with MPEP § 706.02(l)(1) and § 706.02(l)(2). Therefore, the Examiner's 35 USC § 103(a) rejections, in the previous Office Action of November 28, 2003, of Applicant's Claims 2, 3, 8 and 9 using Yamato et al. have been withdrawn.

5. The Examiner further acknowledges that the perfection of foreign priority, as indicated in section 3, above, precludes a 35 USC § 102(e) lack of novelty rejection based on the above-cited Yamato et al. reference (US 6,388,201 B2).

References Based On Prior Art

6. The following references were relied upon for the rejections hereinbelow:

Iwayama et al. (US 5,446,245)*

*Already made of record in the instant Application.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1 and 7 are rejected under 35 U.S.C. 102(b) as being anticipated by Iwayama et al.

A) As to Claim 1, Iwayama et al. discloses, in Figs. 1, 2 and 3C: a wired circuit board comprising a first insulating layer 4, a conductive pattern 2 (i.e., pattern 2 including protruding terminal portion 2A) formed on the first insulating layer 4, a second insulating layer 1 formed on conductive pattern 2, and an opening (corresponding to element 12 in Fig. 1 and corresponding to aperture 8 in mask 9 in Fig. 3C) formed at the same position of the conductive pattern 2, for allowing the first insulating layer 4 and the second insulating layer 1 to open <u>at the same position</u> (Fig. 1), so as to form a terminal portion 2A in which front and back sides of the conductive pattern 2 at terminal portion 2A are exposed <u>at the same position</u> (col.2: 59-col.3: 4), wherein first insulating layer 4 has reinforcing portions 6 for reinforcing the conductive pattern 2 (at terminal portion

2A), formed at ends of the opening 8 in crossing areas where ends of the opening 8 and conductive pattern 2 cross each other (col.2: 37-41). *Examiner's Note*: It is clear from Fig. 1, col.2: 34-41 and col.2: 59-col.3: 11 of Iwayama et al. that the first and second insulating layers are open **at the same position**. Also, the limitation "front and back sides of the conductive pattern are exposed at the same position" **does not preclude each of the subportions 6 of terminals 2A from being covered, i.e., reinforced, by extensions of the insulating layer 4**, as disclosed in Iwayama et al. (Figs. 1 and 2; col.2: 35-41), because the Applicant's claim recitation, "front and back sides," is broad enough to be met by the **remaining uncovered** subportions of terminal portions 2A, in Iwayama et al., that have their front and back sides exposed **at the same position** with respect to the opening 12 in layers 1 and 4, and **at the same position** with respect to the two exposed sides of each of the **remaining uncovered** subportions of the terminals 2A.

B) As to Claim 7, Iwayama et al. discloses, in Figs. 1, 2 and 3C: a wired circuit board comprising a first insulating layer 4, a conductive pattern 2 (i.e., pattern 2 including protruding terminal portion 2A) formed on the first insulating layer 4, a second insulating layer 1 formed on conductive pattern 2, and an opening (corresponding to element 12 in Fig. 1 and corresponding to aperture 8 in mask 9 in Fig. 3C) formed at the same position of the conductive pattern 2, for allowing the first insulating layer 4 and the second insulating layer 1 to open at the same position (Fig. 1), so as to form a terminal portion 2A in which front and back sides of the conductive pattern 2 at terminal portion 2A are exposed at the same position (col.2: 59-col.3: 4), wherein first insulating layer 4 has projections 6 projecting from ends of the opening 8 onto terminal portions 2A of the conductive pattern 2 in the opening 8 in the crossing area where ends of the opening 8 and conductive pattern 2 cross each other (col.2: 37-41). *Examiner's Note*: It is clear from Fig. 1, col.2: 34-41 and col.2: 59-col.3: 11 of Iwayama et al. that the first and second insulating layers are open **at the same position**. Also, the limitation "front and back sides of the conductive pattern are exposed at the same position" **does not preclude each of the subportions 6 of terminals 2A from being covered, i.e., reinforced, by extensions of the insulating layer 4**, as disclosed in Iwayama et al. (Figs. 1 and 2; col.2: 35-41), because the Applicant's claim recitation, "front and back sides," is broad enough to be met by the **remaining uncovered** subportions of terminal portions 2A, in Iwayama et al., that have their front and back sides exposed **at the same position** with respect to the opening 12 in layers 1 and 4, and **at the same position** with respect to the two exposed sides of each of the **remaining uncovered** subportions of the terminals 2A.

Allowable Subject Matter

9. Claims 2-6 and 8-9 have been allowed.

10. The following is a statement of reasons for the indication of allowable subject matter:

As to Claims 2-3, patentability resides in *the first insulating layer formed on a metal supporting layer, wherein the metal supporting layer has an opening corresponding to the openings formed in the first and second insulating layers,* *respectively, for exposing the terminal portion of the conductive pattern*, in combination with the other limitations of base Claim 2.

As to Claim 4, patentability resides in the limitation wherein *the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other*, in combination with the other limitations of the claim.

As to Claims 5-6, patentability resides, at least in part, in *the first insulating layer formed on a metal supporting layer, wherein the metal supporting layer has an opening corresponding to the openings formed in the first and second insulating layers, respectively, for exposing the terminal portion of the conductive pattern*, in combination with the other limitations of base Claim 5.

As to Claims 8-9, patentability resides in *the first insulating layer formed on a metal supporting layer, wherein the metal supporting layer has an opening corresponding to the openings formed in the first and second insulating layers, respectively, for exposing the terminal portion of the conductive pattern*, in combination with the other limitations of base Claim 8.

Response to Arguments

11. Applicant's arguments, filed in the instant Amendment of February 20, 2004, regarding the Examiner's 35 USC § 102(b) rejection of Claims 1 and 7 over Iwayama et al. have been fully considered but they are not persuasive.

As explained in the rejections above, the added claim language, "at the same position," regarding the opening of the first and second layers and regarding exposed front and back sides of the conductive pattern is not sufficient to overcome the structure disclosed by Iwayama et al.

Conclusion

12. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to John B. Vigushin whose telephone number is 571-272-1936. The examiner can normally be reached on 8:30AM-5:00PM Mo-Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamand Cuneo can be reached on 571-272-1957. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

John B. Vigushin

John B. Vigushin
Primary Examiner
Art Unit 2827

jbv
May 19, 2004

Search Notes	Application No. 10/195,392	Applicant(s) KOMATSUBARA ET AL.
	Examiner John B. Vigushin	Art Unit 2827

SEARCHED

Class	Subclass	Date	Examiner
361	749-751	6/15/2003	JBV
174	254	6/15/2003	JBV
Search	Updated	11/24/2003	JBV
174	250,	11/24/2003	JBV
	255-258,		
	261		
Search	Updated	5/19/2004	JBV

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
EAST Text Search (see print-out)	6/15/2003	JBV
EAST Text Search (see print-out)	11/24/2003	JBV
EAST Text Search (see print-out)	5/19/2004	JBV

U.S. Patent and Trademark Office

Part of Paper No. 0504

	L #	Hits	Search Text	DBs
1	L1	999	(361/749-751).ccls.	USPAT; US-PGPUB
2	L2	4698	(174/250,254-258,261).ccls.	USPAT; US-PGPUB
3	L3	5313	1 2	USPAT; US-PGPUB
4	L4	288	3 and @pd>=20031107	USPAT; US-PGPUB
5	L5	113	4 and (reinforc$6 strength$5)	USPAT; US-PGPUB
6	L6	53	5 and (opening$1 aperture$1 cut$1out$1)	USPAT; US-PGPUB
7	L7	3	("4942452" | "6169253" | "6441316").PN.	USPAT
8	L8	60	5 n t 6	USPAT; US-PGPUB

	L #	Hits	S arch Text	DBs
9	L9	175	4 n t 5	USPAT; US-PGPUB
10	L10	36	9 and (taper$3 widen$3 narrow$3)	USPAT; US-PGPUB
11	L11	98	9 and (expose$1 exposing)	USPAT; US-PGPUB
12	L12	112	10 11	USPAT; US-PGPUB
13	L13	4	("3978375" | "5699235" | "5777851" | "6373720").PN.	USPAT

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2003

Application or Docket Number: 10/195392

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20=	*
INDEPENDENT CLAIMS	minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 9	Minus	** 20	= /
Independent	* 6	Minus	*** 6	= /
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE		OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	/
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev 10/03) Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

10/195392

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PATENT & TRADEMARK OFFICE

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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/195,392
Filing Date	July 16, 2002
First Named Inventor	Makoto Komatsubara
Art Unit	2827
Examiner Name	John B. Vigushin
Attorney Docket Number	71450.0002

Total Number of Pages in This Submission: 93

ENCLOSURES *(Check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [x] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [x] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) ______
- [ ] After Allowance communication to Technology Center (TC)
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Verification of Translation of Priority Document and Assignment of U.S. Patent Appl. No. 09/866,813

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	Jean C. Edwards, Reg. No. 41,728
Signature	Jean C. Edwards
Date	February 20, 2004

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Typed or printed name			
Signature		Date	

Attorney Docket No.: 71450.0002
Customer No.: 35161

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: 2827

Application No.: 10/195,392

Examiner: John B. Vigushin

Filed: July 16, 2002

Confirmation No.: 2813

For: WIRED CIRCUIT BOARD

AMENDMENT UNDER 37 C.F.R. § 1.111

MAIL STOP – NON FEE AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INTRODUCTORY REMARKS

Sir:

In response to the Non-Final Office Action dated November 28, 2003, Paper No. 1103, please amend the above-identified application as follows:

AMENDMENTS TO THE DRAWINGS:

The Formal Drawings, Figs. 1-21, have been amended to correct for improper margins, and to correct the orientation of the label of Fig. 9 with respect to the drawing, in response to the Official Drafsperson's PTO-948 Form dated November 14, 2003. Fifteen (15) Replacement Sheets of Corrected Formal Drawings Figs. 1-21 are attached herewith which should overcome the Official Draftsperson's objections.

AMENDMENTS TO THE CLAIMS:

1. (Currently amended) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open at the same position, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed at the same position,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern cross each other.

2. (Previously presented) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at the ends of the opening in crossing areas where ends of the opening and the conductive pattern cross each other.

3. (Original) The wired circuit board according to Claim 2, wherein the wired circuit board is a suspension board with circuit.

4. (Previously presented) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other.

5. (Previously presented) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other.

6. (Original) The wired circuit board according to Claim 5, wherein the wired circuit board is a suspension board with circuit.

7. (Currently amended) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open at the same position, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed at the same position,

wherein at least one of the first insulating layer and the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing area where the ends of the opening and the conductive pattern cross each other.

8. (Previously presented) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least one of the first insulating layer and the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern cross each other.

9. (Original) The wired circuit board according to Claim 8, wherein the wired circuit board is a suspension board with circuit.

REMARKS

Claims 1-9 are presently pending in the application. Reconsideration and allowance of all claims are respectfully requested in view of the following remarks.

The Official Draftsperson has objected to the drawings as filed on July 16, 2002, due to improper margins and improper orientation of the label of Fig. 9 with respect to the drawing, as shown by the PTO-948 Form. Fifteen (15) Replacement Sheets of Corrected Formal Drawings Figs. 1-21 are attached hereith which should overcome the Official Draftsperson's objections.

The Examiner has rejected Claims 1 and 7 under 35 U.S.C. §102(b) as being anticipated by Iwayama et al. The Examiner has also rejected Claims 2, 3, 8 and 9 under 35 U.S.C. §103(a) as being obvious over Iwayama et al. in view of Yamato et al.

However, the Examiner has found Claims 4 and 5-6 allowable "if rewritten into independent form including all of the limitations of the base claim and any intervening claims". The Applicants respectfully point out to the Examiner that Claims 4-5 are in independent form, and Claim 6 depends from independent Claim 5. Thus, Claims 4-6 should stand allowed.

Claim 1 has been amended to further define the position of the opening with respect to the insulating layers and the conductive pattern.

For the following reasons, the prior art rejections are respectfully traversed.

The Applicants respectfully submit that Iwayama et al. do not teach or suggest a wired circuit board including an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open <u>at the same position</u>, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed <u>at a same position</u>, as recited in amended Claims 1 and 7, and wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed <u>at ends of the opening in crossing areas</u> where ends of the opening and the conductive pattern cross each other, as recited in Claim 1.

Rather, Iwayama et al. disclose an opening (aperture 12) where the first insulating layer (insulating film 4) and second insulating layer (insulating base member 1) open at different positions with respect to the conductive pattern (circuit wiring pattern 2) (see Fig. 2); and where the terminal portion is formed such that the front and back sides of the conductive pattern 2 are exposed at different positions (see Fig. 2).

Further, with respect to Claim 1, Iwayama et al. disclose a first insulating layer 4 which has a reinforcing portion 6 which reinforces the conductive pattern (protruding conductor 2A) within the opening 12 (see Fig. 2), rather than at ends of the opening 12 in crossing areas wherein ends of the opening 12 and the conductive pattern 2 cross each other.

However, the present invention in Figs. 1-2, includes a first insulating layer 12 and second insulating layer 14 which open at the same position (i.e., opening 17 (18)) with respect to the conductive pattern 13; where the terminal portion 16 is formed such that the front and back sides of the conductive pattern 13 are exposed at the same position (17 (18)).

Further, the present invention discloses in Figs. 1-2, a first insulating layer 12 which has a reinforcing portion (i.e., at widened portion 22) which reinforces the conductive pattern 13 at ends of the opening 17 (18) in crossing areas 21 wherein ends of the opening 17 (18) and the conductive pattern 13 cross each other.

Accordingly, Iwayama et al. do not anticipate, nor or obvious over, Claims 1 and 7 of the present invention, and the rejection of Claims 1 and 7 under 35 U.S.C. §102(b) should be withdrawn.

With respect to the rejection of Claims 2, 3, 8, and 9 over the combination of the Iwayama et al. and Yamato et al. references, since the Yamato et al. reference is a 35 U.S.C. §102(e)/103 reference, the Applicants respectfully invoke the provisions of 35 U.S.C. §103(c), asserting that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person – namely, Nitto Denko Corporation (see MPEP 706.02(1)(1) and (2), and 35 U.S.C. §103(c)).

As evidence thereof, the Applicants respectfully submit concurrently herewith, a copy of the Assignment document for the Yamato et al. reference, which shows that at the time of the present invention, the subject matter of the reference and the claimed invention were commonly owned by Nitto Denko Corporation. Since the Yamato et al. reference no longer stands as prior art based on 35 U.S.C. §102(e)/103 with respect to the present application, the Examiner's rejection of Claims 2, 3, 8, and 9 over the combination of the Iwayama et al. and Yamato et al. references must fail.

Further, in the event that the Examiner should return a 35 U.S.C. §102(a) rejection of the present claims over Yamato et al., asserting that the publication date of Yamato et al. of January 8, 2002 is prior to the U.S. filing date of the present application (i.e., July 16, 2002), the Applicants respectfully submit concurrently herewith, a verified translation of priority document JP 2001-216812, dated July 17, 2001, and which was submitted August 7, 2002, which will overcome this potentially applied rejection.

Accordingly, Claims 2, 3, 8, and 9 should now be allowed.

If the Examiner believes that there is any issue which could be resolved by a telephone or personal interview, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Applicant hereby petitions for any extension of time which may be required to maintain the pendency of this application, and any required fee for such an extension is to be charged to Deposit Account No. 04-1061.

Respectfully submitted,

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Registration No. 41,728

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Telephone: 202/659-6946
Facsimile: 202/659-1559
Date: February 20, 2004
DC 71450-2 90197

Attorney Docket No.: 71450.0002
Customer No.: 35161

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: 2827

Application No.: 10/195,392

Examiner: John B. Vigushin

Filed: July 16, 2002

Confirmation No.: 2813

For: WIRED CIRCUIT BOARD

SUBMISSION OF CORRECTED FORMAL DRAWINGS

ATTN: OFFICIAL DRAFTSPERSON
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Please find attached fifteen (15) replacement sheets of corrected formal drawings of Figures 1-21, which now includes the proper orientation of the label of Figure 9 and the corrected margins for the figures, as requested by the Examiner. These replacement drawings should overcome the Official Draftperson's objections. The Examiner is respectfully requested to acknowledge receipt of these replacement drawings.

Respectfully submitted,

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Telephone: 202/659-6946
Facsimile: 202/659-1559
Date: February 20, 2004
DC 71450-2 91496

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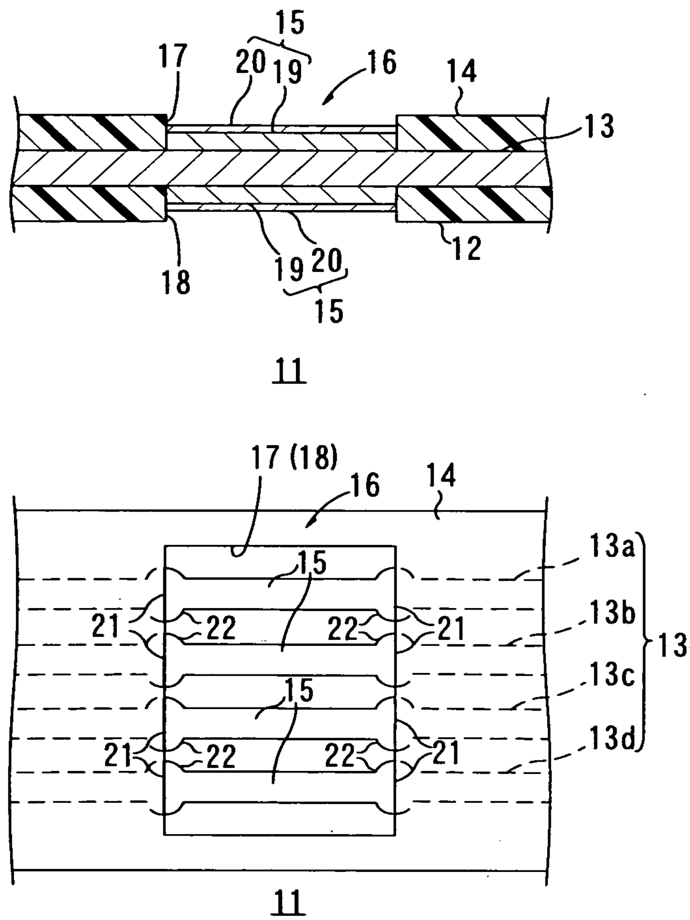
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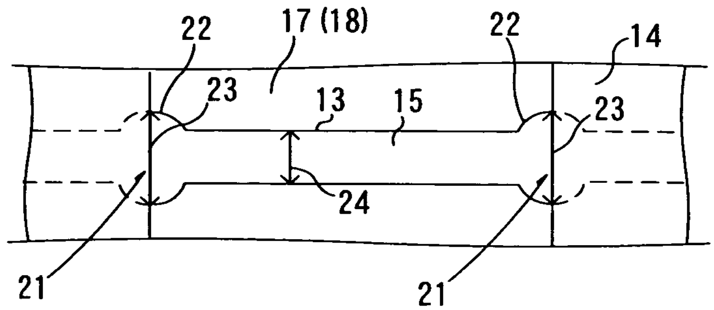
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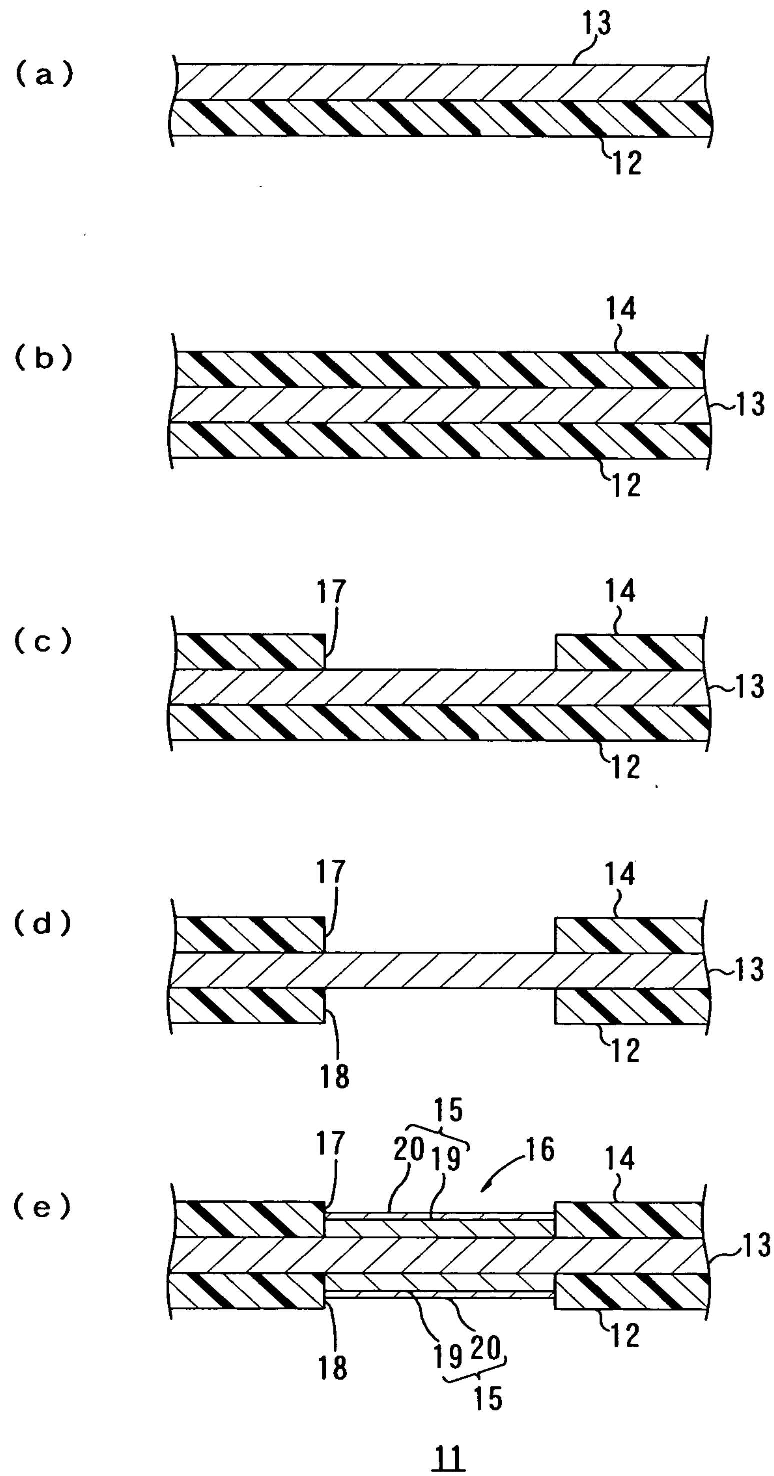
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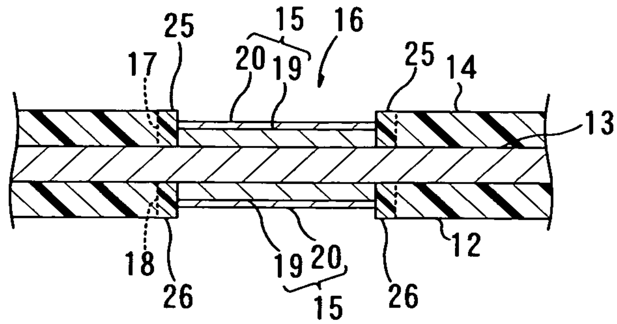
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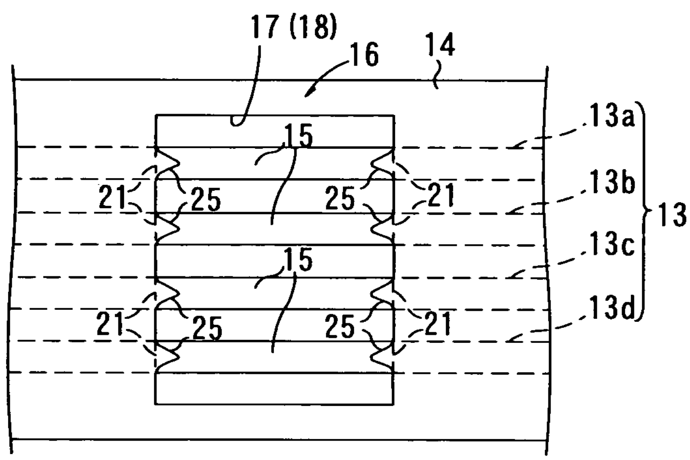
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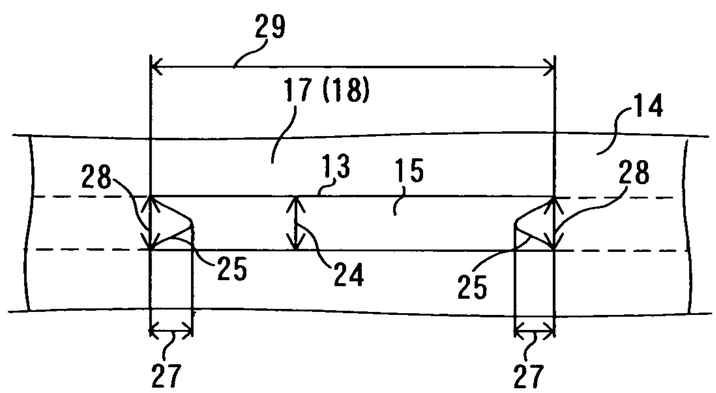
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FIG. 6

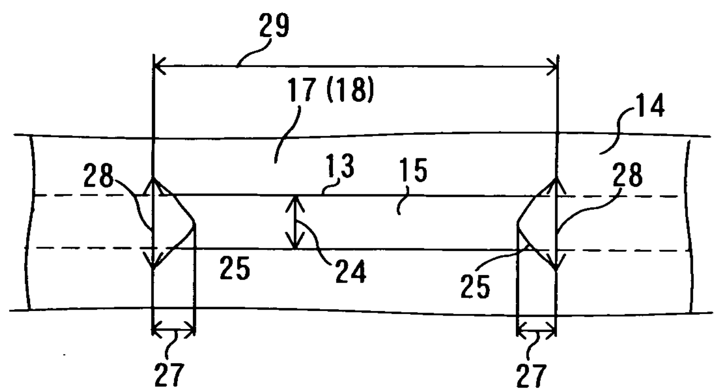
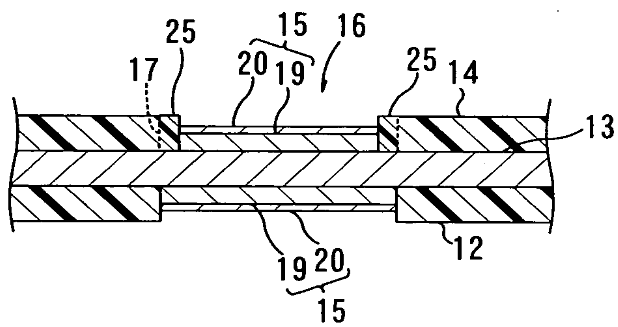


FIG. 7



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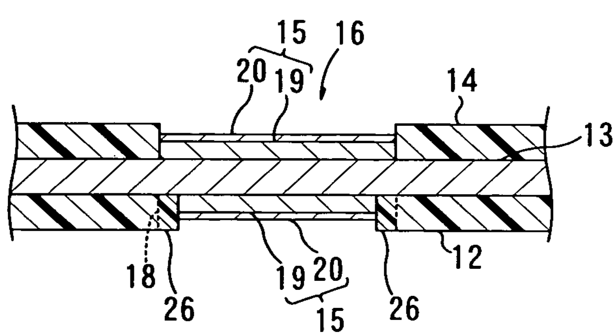

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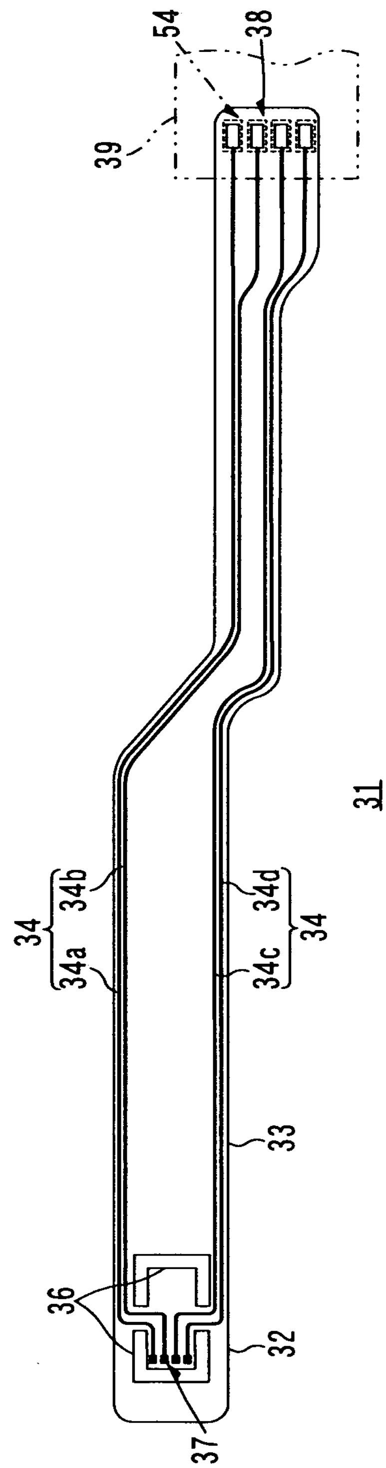

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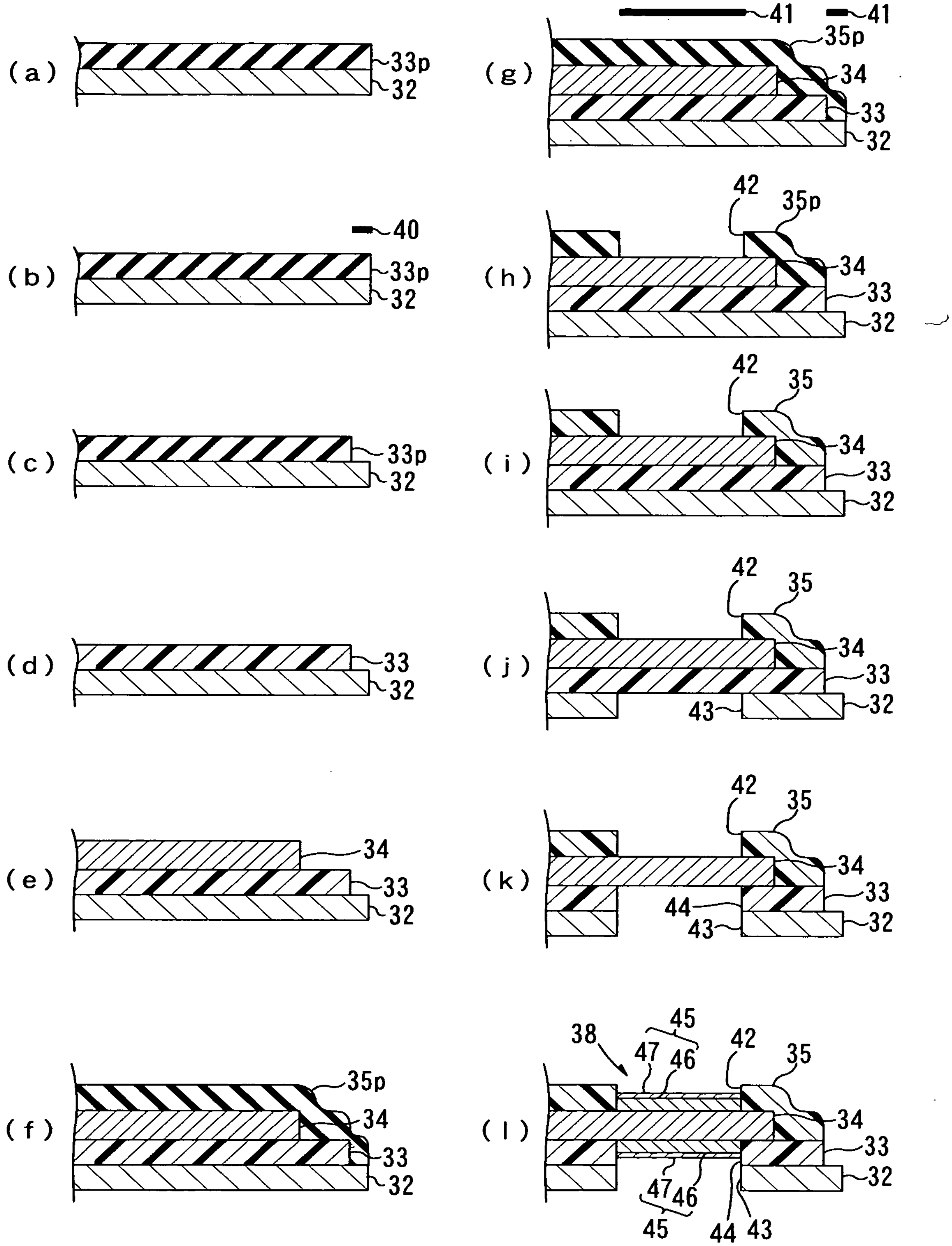
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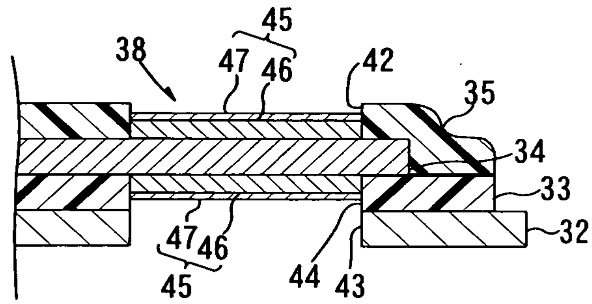
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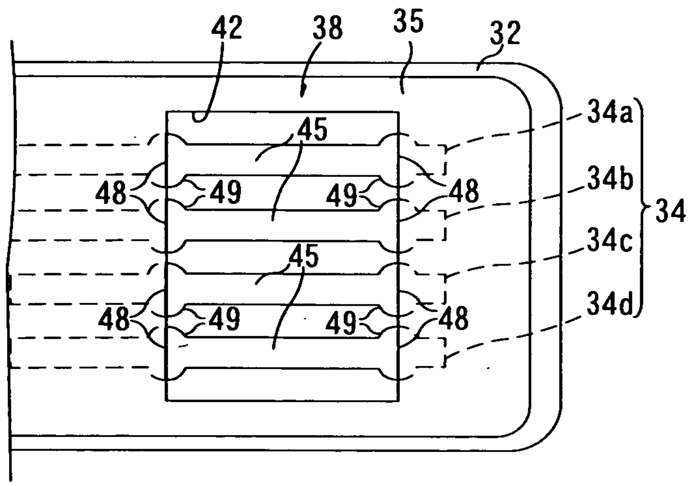
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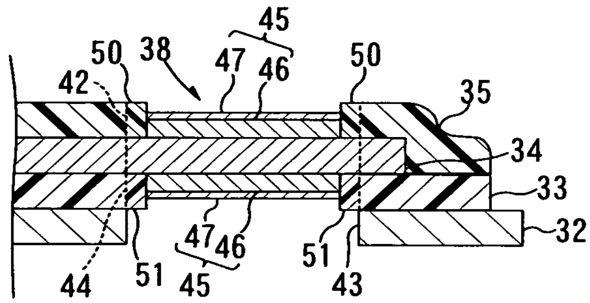
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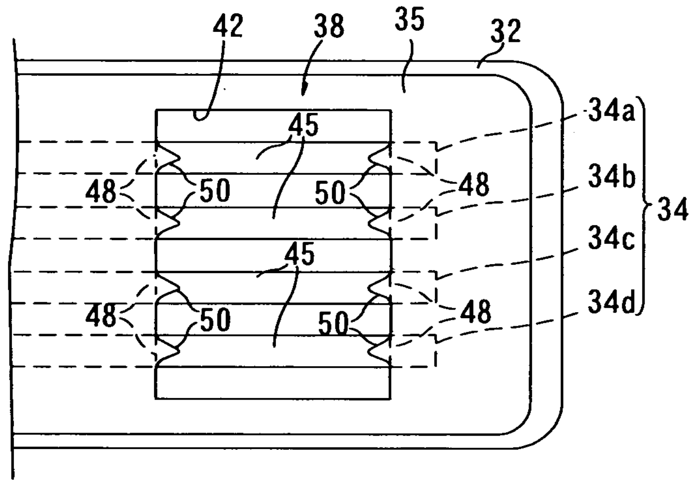
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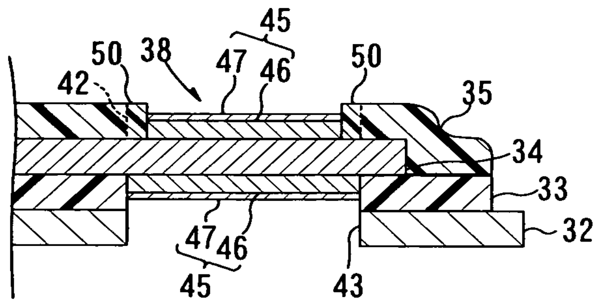
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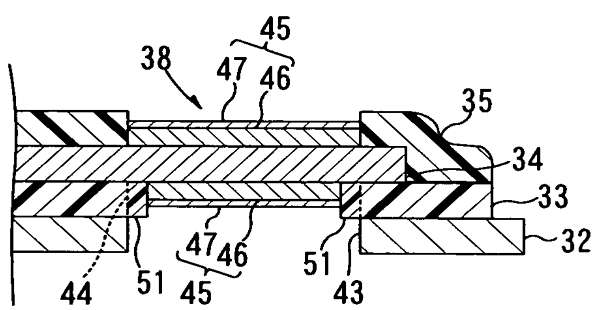
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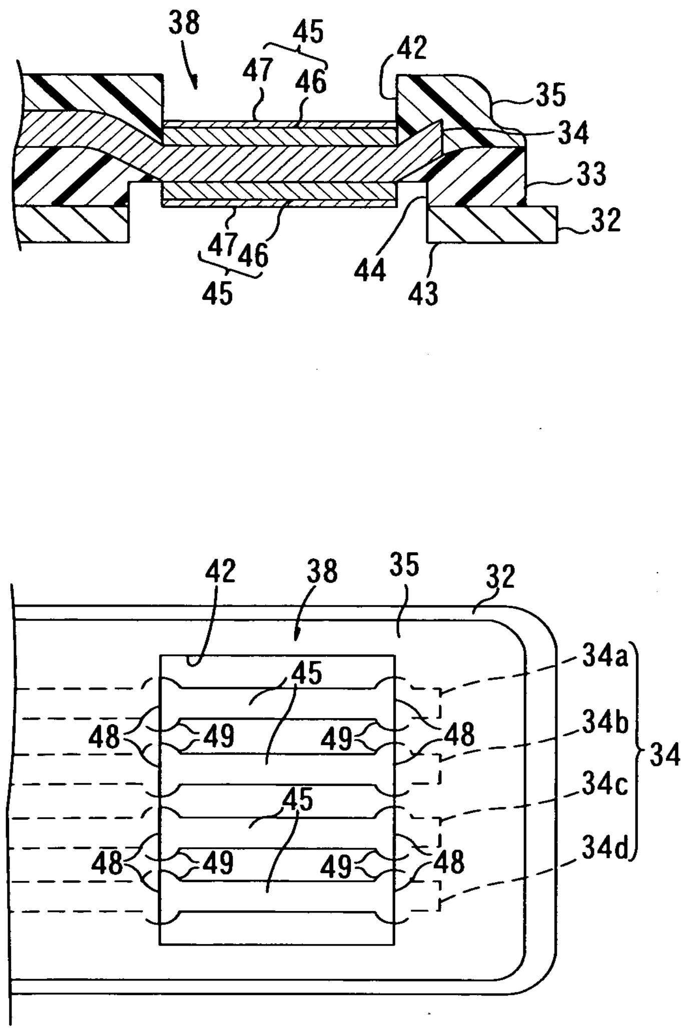
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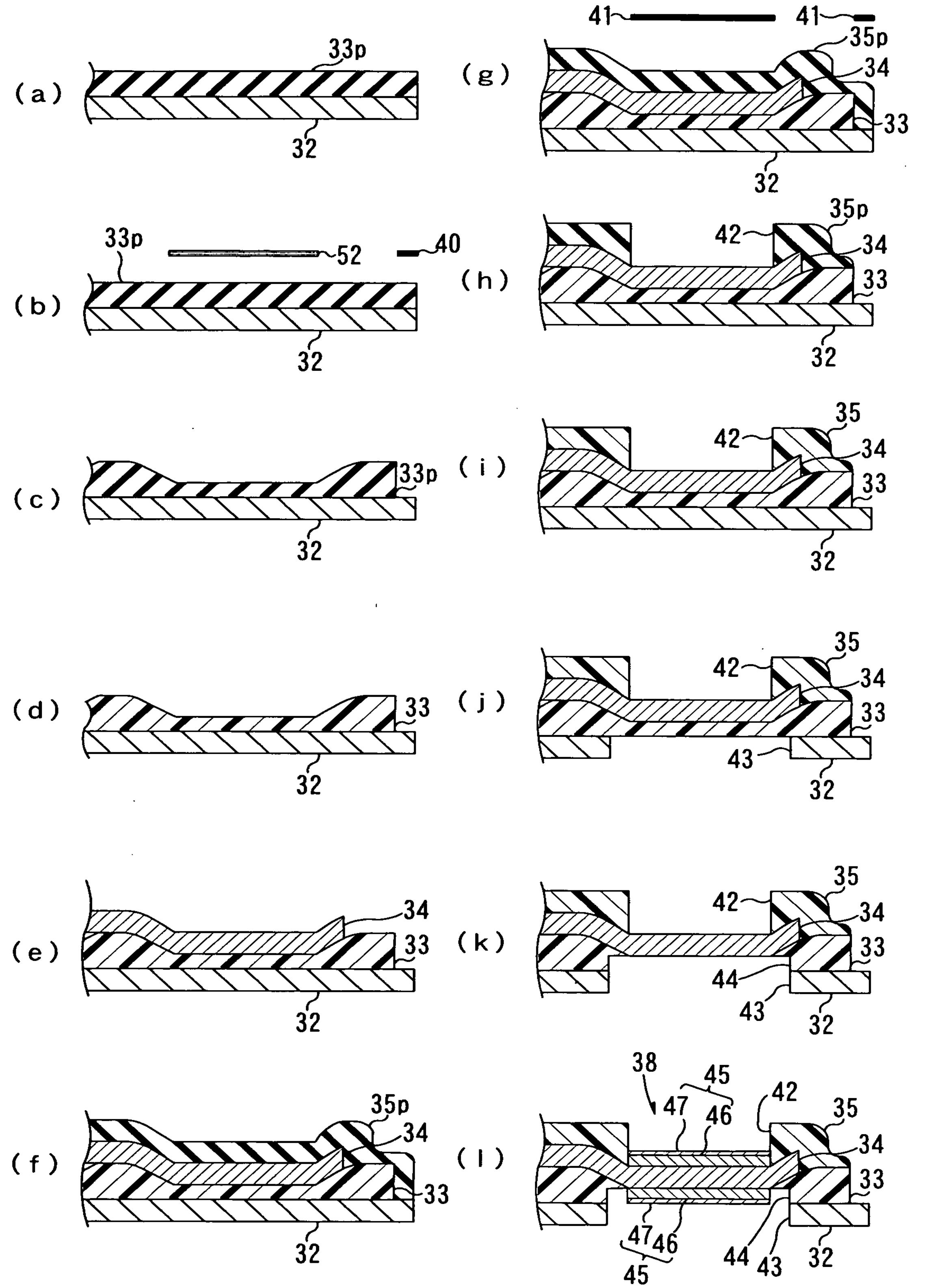
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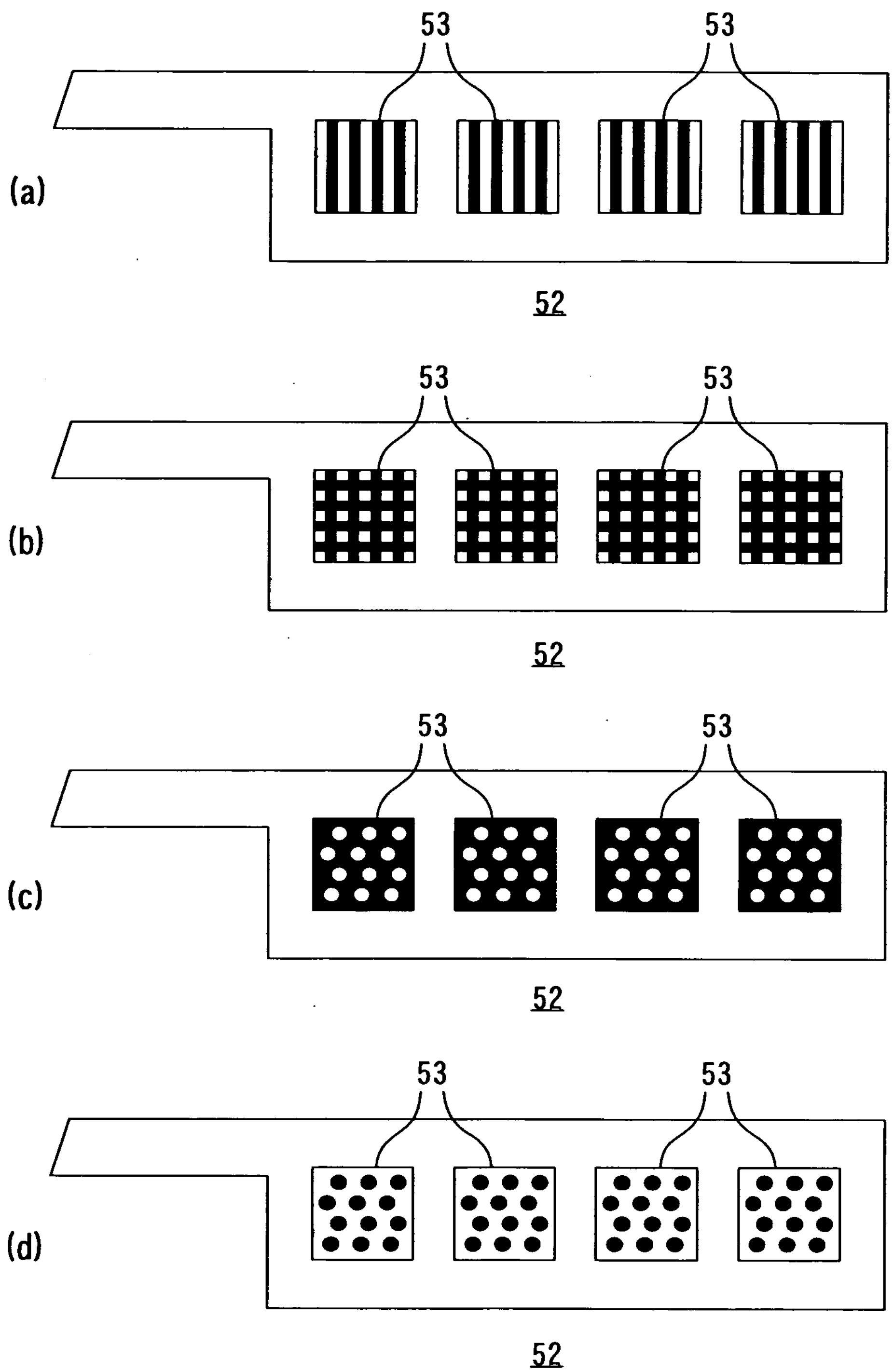

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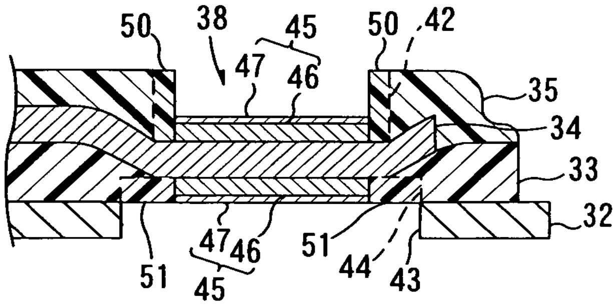
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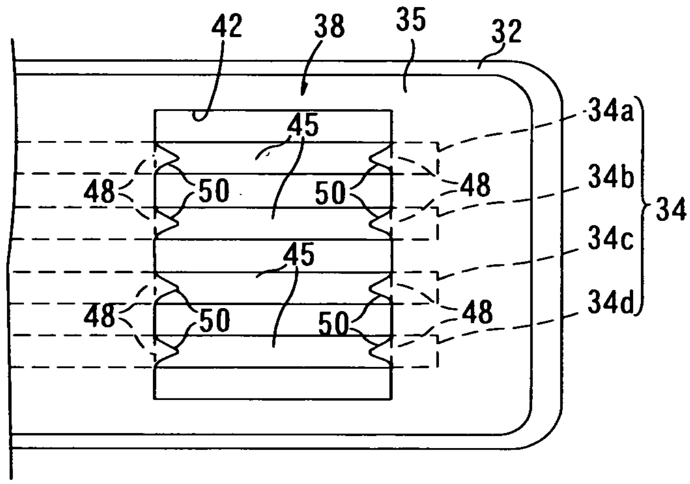
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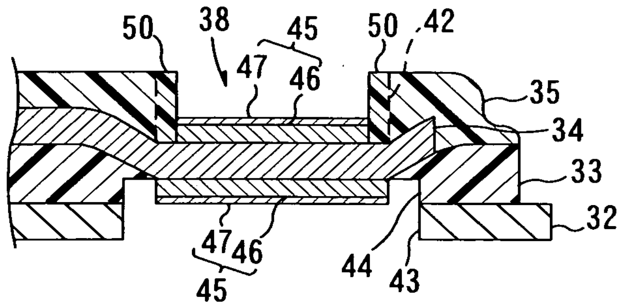
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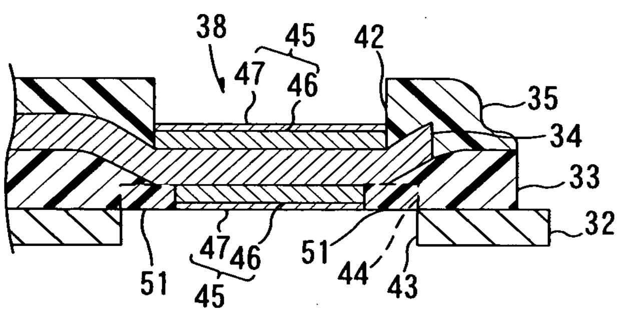
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F I G. 2 1

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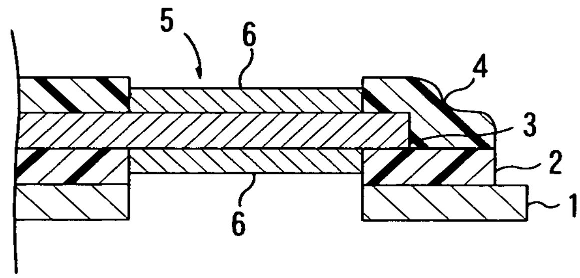

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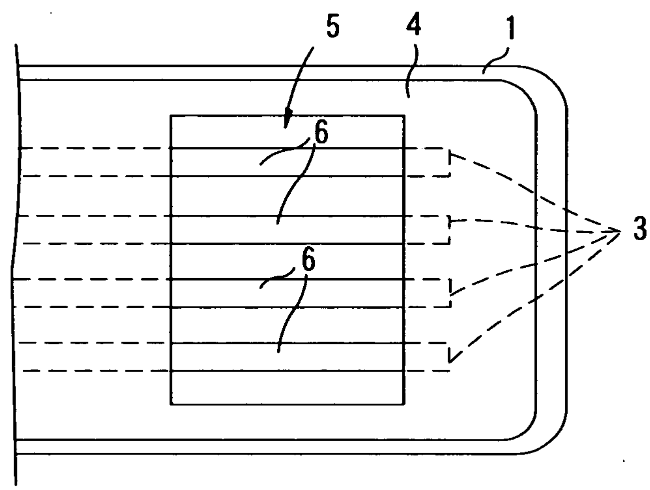

FEB 2 0 2004

Attorney Docket No.: 71450.0002
Customer No.: 35161

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: 2827

Application No.: 10/195,392

Examiner: John B. Vigushin

Filed: July 16, 2002

Confirmation No.: 2813

For: WIRED CIRCUIT BOARD

SUBMISSION OF VERIFICATION OF TRANSLATION OF

PRIORITY DOCUMENT JP 2001-216812

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Please find attached a verification of translation of the priority document JP 2001-216812, filed July 17, 2001, for the above-identified application. The Examiner is respectfully requested to acknowledge receipt of this verified translation.

Respectfully submitted,

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Facsimile: 202/659-1559
Date: February 20, 2004
DC 71450-2 91498

VERIFICATION OF TRANSLATION

I, Hiroyuki OKAMOTO, c/o Okamoto International Patent Attorneys Office, of Kawaramachi NK Building, 8-5, Kawaramachi 4-chome, Chuo-ku, Osaka, Japan

do hereby solemnly and sincerely declare that I am well acquainted with both Japanese and English languages and that the following is a true translation of the certified document of

Japanese Patent Application No.2001-216812

into English to the best of my knowledge and belief.

I also hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: February 12th, 2004

Signature: Hiroyuki Okamoto

Hiroyuki Okamoto

【Document Name】 Application for Patent

【Reference Number】 101076

【Filing Date】 July 17, 2001

【Addressed to】 The Director-General of Patent Office

【International Patent Classification】 H05K 1/11

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【Name】 Toshio SHINTANI

【Application for Patent】

【Identification Number】 000003964

【Name】 NITTO DENKO CORPORATION

【Representative】 Masamichi TAKEMOTO

【Agent】

【Identification Number】 100103517

【Patent Attorney】

【Name】 Hiroyuki OKAMOTO

【Phone Number】 06-4706-1366

【Prepayment of Filing Fees】

【Prepayment Account Book Number】 045702

【Payment Amount】 ¥21,000.-

【List of Submission】

【Name of Submission】 Specification 1

【Name of Submission】 Drawings 1

【Name of Submission】 Abstract 1

【Request of Proof】 Yes

【Document Name】 Specification

【Title of the Invention】 Wired Circuit Board

【Claim】

【Claim 1】 A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【Claim 2】 A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【Claim 3】A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【Claim 4】 A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【Claim 5】 A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing area where the ends of the opening and the conductive pattern are crossed each other.

【Claim 6】 A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

【Claim 7】 The wired circuit board according to any one of Claims 1-6, wherein the wired circuit board is a suspension board with circuit.

【Detailed Description of the Invention】

【0001】

【Technical Field to Which the Invention Belongs】

The present invention relates to a wired circuit board and, more particularly, to a wired circuit board suitably used for a suspension board with circuit.

【0002】

【Prior Art】

The wired circuit boards used for electronic/electric equipments are usually provided with terminal portions to connect with external connecting terminals.

【0003】

In recent years, the so-called "flying lead" in which the terminal portions are formed on both sides of the conductive pattern, rather than in only either side thereof, is being in widespread use in order to meet the demand for electronic/electric equipment to have increasingly higher density and reduced size. It is known, for example, in suspension board with circuit used for a hard disk drive that the terminals are provided in the form of flying lead.

【0004】

To be more specific, the suspension board with circuit comprises a supporting board 1 of stainless steel foil, a base layer 2 of an insulating material formed on the supporting board 1, a conductive pattern 3 formed on the base layer 2 in the form of a specified circuit pattern, and a cover layer 4 of an insulating material, for covering the conductive pattern 3, as shown in FIG. 21. The terminal portions 5 provided in the form of the flying lead are formed on both sides of the conductive pattern 3 in the following manner. The cover layer 4 is opened to expose a front side of the conductive pattern 3, while also the supporting board 1 and the base layer 2 are opened to expose a back side of the conductive pattern 3. If necessary, metal plated layers 6 are formed on the both sides of the thus exposed conductive pattern 3 by nickel/gold plating and the like.

【0005】

Thereafter, these terminal portions formed as the flying lead are bonded to external connecting terminals by applying supersonic vibration thereto by use of a bonding tool and the like.

【0006】

【Problems To Be Solved By the Invention】

In this terminal portion formed as the flying lead, since the both sides of the conductive pattern are exposed, the supersonic vibration is easily transmitted to the terminals. This is suitable for the bonding using the supersonic vibration: on the other hand, this provides the disadvantage that the conductive pattern exposed at both sides thereof is weak in physical strength and is subject to stress concentration at edge portions of the openings in the base layer and cover layer, to cause disconnection of the conductive pattern with ease.

【0007】

It is the object of the invention to provide a new wired circuit board having a terminal portion formed as a flying lead in which both sides of a conductive pattern are exposed that can provide enhanced strength of the conductive pattern by simple construction to effectively prevent occurrence of disconnection of the conductive pattern.

【0008】

【Means For Solving the Problems】

To accomplish the object mentioned above, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【0009】

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0010]

In the wired circuit boards mentioned above, since at least any one of the first insulating layer, the second insulating layer and the conductive pattern has the reinforcing portions for reinforcing the conductive pattern formed at the ends of the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0011]

In addition, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【0012】

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

【0013】

In the wired circuit boards mentioned above, since the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to the extending direction of the conductive pattern in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

【0014】

Further, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

【0015】

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

【0016】

In the wired circuit boards mentioned above, since the first insulating layer and/or the second insulating layer have projections projecting from the ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

【0017】

The wired circuit board of the present invention can provide high bonding reliability so that the wired circuit board can be used as the suspension board with circuit, even when formed as the flying lead in which both sides of the conductive pattern are exposed.

【0018】

【Embodiments of the Invention】

Referring to FIG. 1, there is shown an embodiment of a wired circuit board of the present invention. FIG. 1(a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and FIG. 1(b) is a plan view of the terminal portion of the same. In FIG. 1(a), the wired circuit board 11 comprises a base layer 12 formed as a first insulating layer of insulating material, a conductive pattern 13 formed on the base layer 12 in the form of a specified wired circuit pattern, and a cover layer 14 formed as a second insulating layer of insulating material on the conductive pattern 13. The conductive pattern 13 is provided in the form of a plurality of lines of wires 13a, 13b, 13c and 13d arrayed in parallel with each other with spaced at a predetermined interval, as shown in FIG. 1(b).

【0019】

The insulating materials of the base layer 12 and the cover layer 14 that may be used include, for example, synthetic resins, such as polyimide resin, acrylic resin, polyether nitrile resin, polyether sulfonic resin, polyethylene terephthalate resin, polyethylene naphthalate resin and polyvinyl chloride resin. Polyimide resin is preferably used.

【0020】

The base layer 12 and the cover layer 14 usually have thickness of 1-30μm, or preferably 2-20μm.

【0021】

The conductive materials used for the conductive pattern 13 include, for example, copper, nickel, gold, solder or alloys thereof. Copper is preferably used. The conductive pattern 13 usually has thickness of 2-30μm, or preferably 5-20μm.

【0022】

This wired circuit board 11 is formed in the following way. First, as shown in FIG. 3(a), the conductive pattern 13 is formed on the base layer 12 formed in a film-like form, in the form of the specified wired circuit pattern by a known patterning process, such as a subtracting process, an additive process and a semi-additive process. Then, as shown in FIG. 3(b), the base layer 12 is covered with the cover layer 14 in a known method, for example, by adhesive bonding a film-like resin to the conductive pattern 13 or by applying a photosensitive resin to the conductive pattern 13 and then curing that resin.

[0023]

In the wired circuit board 11 thus formed, as shown in FIG. 1(a), the cover layer 14 is opened to expose a front side of the conductive pattern 13 and also the base layer 12 is opened to expose a back side of the conductive pattern 13 in such a manner that the exposed front side of the conductive pattern 13 and the exposed back side of the same correspond in position to each other so as to expose the both sides of the conductive pattern 13. Then, on the both sides of the exposed conductive pattern 13, metal plating layers 15 are formed thereby forming the terminal portion 16 in the form of the flying lead.

[0024]

This terminal portion 16 is formed in the following manner. First, a cover-side opening 17 is formed in the cover layer 14 in a portion thereof in which the terminal portion 16 is to be formed, in a known method, such as drilling, laser machining, etching and patterning of photosensitive resin, as shown in FIG. 3(c). Likewise, a base-side opening 18 is formed in the base layer 12 in a portion thereof corresponding to the cover-side opening 17, in a known method, such as drilling, laser machining, etching and patterning of photosensitive resin, as shown in FIG. 3(d). The cover-side opening 17 and the base-side opening 18 are opened into a rectangular shape to cover all the lines of wire 13a, 13b, 13c and 13d.

【0025】

As shown in FIG. 3(e), the metal plating layers 15 are formed by plating on both sides of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

【0026】

No particular limitation is imposed on the plating method used for forming the metal plated layer 15. The metal plating layer 15 may be formed by either of electrolysis plating and electroless plating. Also, no particular limitation is imposed on the metals used for the plating. Known metals may be used for the plating. It is preferable that the electrolysis nickel plating and the electrolysis gold plating are performed in sequence so that a gold plated layer 20 is formed on a nickel plated layer 19. The nickel plated layer 19 and the gold plated layer 20 each have thickness of the order of 1-5μm.

【0027】

The wired circuit board 11 has the terminal portion 16 in the form of the flying lead. In the terminal portion 16, widened portions 22 as reinforcing portions which extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 13 are provided in the conductive pattern 13 in crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other, as shown in FIG. 1(b).

[0028]

To be more specific, the widened portions 22 are formed in the respective lines of wire 13a, 13b, 13c and 13d at positions thereof which correspond to the crossing areas 21 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d. The widened portions 22 are formed in such a generally round shape as to protrude widthwise from the lines of wire 13a, 13b, 13c and 13d.

[0029]

As shown in FIG. 2, each widened portion 22 is arranged, with its generally outer half portion embedded in the cover layer 14/base layer 12 and its generally inner half portion exposed in the cover-side opening 17/ base-side opening 18, when a maximum widthwise length 23 between the adjacent lines of wire is defined as a boundary between the outer half portion and the inner half portion. Thus, the terminals 16 are formed in such a dumbbell shape that the lines of wire 13a, 13b, 13c and 13d are protruded widthwise at both ends thereof in the cover-side opening 17/the base-side opening 18.

[0030]

Each widened portion 22 is so formed that the maximum widthwise length 23 is 1.1-4 times, or preferably 2-3 times, as longer as a usual line width 24 of the lines of wire 13a, 13b, 13c and 13d exposed outside in the cover-side opening 17/base-side opening 18. To be more specific, a widthwise part of widened portion 22 at the maximum widthwise length 23 is 20-1,000μm in length and a lengthwise part of the widened portion 22 extending in a longitudinal direction of the lines of wire 13a, 13b, 13c and 13d is 50-500μm in length.

【0031】

The widened portions 22 may be formed in any shape other than the generally round shape, as long as they are shaped to protrude widthwise and have widths larger than the usual width. For example, the widened portion 22 may be formed in rectangle.

【0032】

The terminal portion 16 having this widened portion 22 can be formed in the processes given below. The widened portions 22 are formed with the patterning of the wired circuit pattern in the process of forming the conductive pattern 13. Then, in the processes of FIG. 3(c) and (d), the cover layer 14 and the base layer 12 are each opened so that the maximum widthwise length 23 of the widened portion 22 can be within the crossing areas 21 and thereby the cover-side opening 17 and the base-side opening 18 are formed. Thereafter, in the process shown in FIG. 3(e), the metal plated layer 15 is formed on each side of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

【0033】

In this formation of the wired circuit board 11, since the widened portions 22 widened in the widthwise direction of the conductive pattern 13 are formed in the conductive pattern 13 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive pattern 13 are crossed each other, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

【0034】

In addition, the wired circuit board 11 may be formed so that the terminal portion 16 presented in the form of this flying lead can have cover-side projections 25 formed as the reinforcing portions and base-side projections 26 formed as the reinforcing portions, as shown in FIG. 4. Specifically, the cover-side projections 25 are formed to project from the ends of the cover-side opening 17 onto the conductive pattern 13 in the cover-side opening 17 in the cover layer 14 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other. The base-side projections 26 are formed to project from the ends of the base-side opening 18 onto the conductive pattern 13 in the base-side opening 18 in the base layer 12 in the crossing areas 21.

【0035】

To be more specific, the cover-side projections 25 and the base-side projections 26 are formed in the respective lines of wire 13a, 13b, 13c and 13d at positions thereof which correspond to the crossing areas 21 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d, as shown in FIG. 4(b). These projections 25, 26 are formed in a convex shape projecting inwardly from the ends of the cover-side opening 17 and the base-side opening 18 along the extending direction of the lines of wire 13a, 13b, 13c and 13d, respectively.

【0036】

The cover-side projections 25 and the base-side projections 26 are overlapped with the lines of wire 13a, 13b, 13c and 13d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 17/base-side opening 18, respectively. As a result of this, the terminal portions 16 are so formed that the lines of wire 13a, 13b, 13c and 13d can be covered with the cover-side projections 25 and the base-side projections 26 at opposite ends thereof in the cover-side opening 17 and the base-side opening 18.

【0037】

The cover-side projections 25 and the base-side projections 26 are formed to project at projection length 27 of one-fourth to one-thirtieth, or preferably one-fifth to one-twentieth, to a line length 29 of each of the lines of wire 13a, 13b, 13c and 13d exposed in the cover-side opening 17 and the base-side opening 18, as shown in FIG. 5. To be more specific, each of the cover-side projections 25 and the base-side projections 26 has a basal width 28 of 5-20μm slightly smaller than a line width 24 of lines of wire 13a, 13b, 13c and 13d at the ends of the cover-side opening 17/the base-side opening 18. The cover-side projections 25 and the base-side projections 26 are projected inwardly in a taped manner at a projection length 27 of 5-250μm and are formed in a generally triangle whose top is located at a widthwise center of lines of wire 13a, 13b, 13c and 13d.

【0038】

The shape of the cover-side projections 25 and the base-side projections 26 is not limited to the one shown in FIG. 5, as long as those projections have such a shape as to overlap with the lines of wire 13a, 13b, 13c and 13d along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d. For example, as shown in FIG. 6, the cover-side projections 25 and the base-side projections 26 may be formed to project toward the inside thereof in a tapered manner from the ends of the cover-side opening 17/the base-side opening 18, with the basal width 28 slightly larger than the line width 24 of the lines of wire 13a, 13b, 13c and 13d. Further, those projections 25, 26 may be formed in such a rectangular shape as to overlap with the lines of wire 13a, 13b, 13c and 13d along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d, without limiting to the generally triangle shape.

【0039】

The terminal portions 16 having these cover-side projections 25 and the base-side projections 26 are formed as follows. In the process of FIG. 3(c), the cover layer 14 is opened in such a manner as to form the cover-side projections 25 to thereby produce the cover-side opening 17. In the process of FIG. 3(d), the base layer 12 is opened in such a manner as to form the base-side projections 26 to thereby produce the base-side opening 18. Thereafter, in the process of FIG. 3(e), the metal plated layer 15 is formed on each side of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

【0040】

In this formation of the wired circuit board 11, since the cover-side projections 25 and the base-side projections 26 are formed in the cover layer 14 and the base layer 12 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other, so as to project from the ends of the cover-side opening 17/the base-side opening 18 onto the conductive pattern 13 in the cover-side opening 17 and the base-side opening 18, respectively, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

【0041】

It is to be noted that in the wired circuit board 11, both of cover-side projections 25 and the base-side projections 26 are not necessarily required. For example, only the cover-side projections 25 may be formed, as shown in FIG. 7. Alternatively, only the base-side projections 26 may be formed, as shown in FIG. 8.

【0042】

Further, modification may be made of the invention by forming the widened portions 22 in the conductive pattern 13 and also forming the cover-side projections 25 in the cover layer 14 and/or forming the base-side projections 26 in the base layer 12, though not shown.

【0043】

The wired circuit board 11 having these terminal portions 16 is particularly preferably applicable to a suspension board with circuit.

【0044】

Referring to FIG. 9, there is shown a perspective view of a suspension board with circuit presented as an embodiment of the wired circuit board of the present invention. The suspension board with circuit 31 mounts thereon a magnetic head of a hard disk driver (not shown) and suspends the magnetic head while holding a minute interval between the magnetic head and a magnetic disk against airflow generated when the magnetic head and the magnetic disk run relative to each other. The suspension board with circuit has the lines of wire 34a, 34b, 34c, 34d, integrally formed in the form of a specified wired circuit pattern, for connecting the magnetic head and a read/write board 39 formed as an external circuit.

【0045】

In FIG. 9, the suspension board with circuit 31 has a base layer 33, as a first insulating layer of insulating material, which is formed on a supporting board 32 extending longitudinally as a metal supporting layer. A conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, and a cover layer 35 (not shown) is formed on the conductive pattern 34 as a second insulating layer of insulating material. The conductive pattern 34 is provided in the form of the plurality of lines of wire 34a, 34b, 34c and 34d arrayed in parallel with spaced at a predetermined interval.

【0046】

Gimbals 36 for fitting the magnetic head therein are formed in the supporting board 32 by cutting out the supporting board 32 at a front end portion thereof. At the front end portion of the supporting board 32, magnetic head connecting terminals 37 are formed to connect between the magnetic head and the lines of wire 34a, 34b, 34c and 34d. At the rear end portion of the supporting board 32, external-side connecting terminals 38 as the terminals are formed to connect between the read/write board 39 and the lines of wire 34a, 34b, 34c and 34d. The external-side connecting terminals 38 are formed in the ends of the lines of wire 34a, 34b, 34c and 34d, to correspond to each of the read/write terminals 54.

【0047】

This suspension board with circuit 31 can be formed in the following processes. First, the supporting board 32 is prepared and the base layer 33 is formed on the supporting board 32 in the form of the specified pattern, as shown in FIG. 10(a)-(d). A metal foil or a metal sheet is preferably used as the supporting board 32. For example, stainless steel, 42 alloy and the like are preferably used. The supporting board 32 used preferably has thickness of 10-60μm, or further preferably 15-30μm, and width of 50-500mm, or further preferably 125-300mm.

【0048】

Insulating material used for forming the base layer 33 is not limited to any particular insulating material. The insulating materials that may be used include, for example, synthetic resins such as polyimide resin, acrylic resin, polyether nitrile resin, polyether sulfonic resin, polyethylene terephthalate resin, polyethylene naphthalate resin and polyvinyl chloride resin. Of these synthetic resins, a photosensitive resin is preferably used as the base layer. A photosensitive polyimide resin is further preferably used.

【0049】

Then, for example when the base layer 33 is formed in the specified pattern on the supporting board 32 by using photosensitive polyimide resin, liquid solution of precursor of the photosensitive polyimide resin is applied to the whole area of the supporting board 32 prepared first, and then is dried, for example, at 60-150℃, to form a coating 33p of the precursor of the photosensitive polyimide resin, as shown in FIG. 10(a).

【0050】

Then, the coating 33p is exposed to light through a photomask 40, as shown in FIG. 10(b). If required, the exposed part is heated to a specified temperature. Thereafter, the coating 33p is developed to form the coating 33p into a specified pattern, as shown in FIG. 10(c). Preferably, radiation irradiated for the exposure has an exposure wavelength in the range of 300-450nm, or preferably 350-420nm. An integrated quantity of exposure light is preferably in the range of 100-1,000mJ/cm^2, or further preferably 200-700mJ/cm^2. Further, when the exposed part of the coating 33p irradiated is heated, for example, at a temperature in the range of not less than 130℃ to less than 150℃, it is solubilized (positive type) for the next processing procedure (development), while on the other hand, when heated, for example, at a temperature in the range of not less than 150℃ to not more than 180℃, it is non-solubilized (negative type) for the next processing procedure (development). The development can be performed by any known method, such as a dipping process and a spraying process, by using a known developing solution such as alkaline developer. Preferably, the manufacturing method uses the negative type to produce the circuit pattern. Illustrated in FIG. 10 is an embodiment using the process steps of negative type for patterning the circuit.

【0051】

As shown in FIG. 10(d), the coating 33p of the precursor of the polyimide resin thus patterned is finally heated, for example, to 250℃ or more to be cured (imidized), whereby the base layer 33 of polyimide resin is formed in the specified pattern. The base layer 33 thus formed have a thickness in the range of e.g. 2-30μm, or preferably 5-20μm.

【0052】

Sequentially, the conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, as shown in FIG. 10(e). The conductive materials that may be used for forming the conductive pattern 34 include metals, such as copper, nickel, gold, solder or alloys thereof. Copper is preferably used. To form the conductive pattern 34 in the specified wired circuit pattern, the conductive pattern 34 may be formed on the base layer 33 in the specified wired circuit pattern in any known patterning process, such as the subtracting process, the additive process and the semi-additive process. In this method, the semi-additive process is preferably used.

【0053】

The conductive pattern 34 thus formed is in the form of a pattern formed by the plurality of lines of wire 34a, 34b, 34c and 34d which are spaced from each other in parallel with a given interval, as mentioned above. The conductive pattern 34 has a thickness in the range of e.g. 2-30μm, or preferably 5-20μm. The lines of wire 34a, 34b, 34c and 34d have a line width in the range of e.g. 10-500μm, or preferably 30-200μm. The interval (space width) between the adjacent lines of wire 34a, 34b, 34c and 34d is in the range of e.g. 10-500μm, or preferably 30-200μm.

【0054】

Sequentially, the conductive pattern 34 is covered with the cover layer 35 of insulating material, as shown in FIG. 10(f)-(i). The same insulating material as the insulating material of the base layer 35 is used for forming the cover layer 35. Preferably, photosensitive polyimide resin is used therefor.

【0055】

For example when the cover layer 35 is formed by using the photosensitive polyimide resin, liquid solution of precursor of the photosensitive polyimide resin is applied to the whole area of the supporting board 32 and the base layer 33, first, and then is dried at a temperature in the range of e.g. 60-150℃, in the same manner as in the patterning of the base layer 33, to form a coating 35p of the precursor of the photosensitive polyimide resin, as shown in FIG. 10(f). Then, the coating 35p is exposed to light through the photomask 41, as shown in FIG. 10(g). If required, the exposed part is heated to a certain temperature. Thereafter, the coating 35p is developed to be patterned so that the conductive pattern 34 can be covered with the coating 35p, as shown in FIG. 10(h).

【0056】

In the patterning of the coating 35p, the photomasks 41 are placed to confront the areas where the external-side connecting terminals 38 are formed, so that the front side of the conductive pattern 34 can be exposed from the coating 35p to form the cover-side opening 42. To be more specific, the coating 35p is opened so that the cover-side opening 42 can be formed in such a rectangle shape as to include the lines of wire 34a, 34b, 34c and 34d, so as to provide the external-side connecting terminals 38 in the form of the flying lead, as mentioned later.

【0057】

The coating 35p can be exposed to light and developed under the same condition as the condition for exposing and developing the base layer 33. Shown in FIG. 10 is the patterning in which the coating 35p is patterned in the negative type in the same manner as in the case of the base layer 33.

【0058】

As shown in FIG. 10(i), the coating 35p of the precursor of the polyimide resin thus patterned is finally heated, for example, to 250℃ or more to be cured (imidized), whereby the cover layer 35 made of polyimide resin is formed on the conductive pattern 34. The cover layer 35 has a thickness in the range of e.g. 1-30μm, or preferably 2-5μm.

【0059】

Before the cover layer 35 is formed on the conductive pattern 34, the conductive pattern 34 may be protected by a thin film of rigid nickel by nickel plating.

【0060】

In the suspension board with circuit 31 thus formed, the external-side connecting terminals 38 are presented in the form of the flying lead exposed at both sides of the conductive pattern 34, as shown in FIG. 10(j)-(l).

【0061】

The external-side connecting terminals 38 are presented in the form of the terminals exposed at both sides of the conductive pattern 34 in the following processes. First, as shown in FIG. 10(j), supporting-board-side openings 43 are formed in the supporting board 32 at portions thereof where the external-side connecting terminals 38 are formed or at portions thereof corresponding to the cover-side openings 42 of the cover layer 35, so that the base layer 33 can be exposed. The supporting-board-side openings 43 can be formed by any known method. For example, after all area of the supporting board 32 but the areas of the same corresponding to the supporting-board-side openings 43 are subjected to masking, they are chemically etched.

【0062】

Sequentially, as shown in FIG. 10(k), base-side openings 44 are formed in the base layer 33 exposed in the supporting-board-side openings 43 of the supporting board 32, so as to expose the conductive pattern 34. Though the base-side openings 44 can be formed by a known method, the base-side openings 44 are preferably formed by etching or by plasma etching, in particular. The etching enables a portion of the base layer 33 to be precisely cut from the exposed surface of the base layer 33 to the back side of the conductive pattern 34.

【0063】

In the plasma etching, the supporting board 32 can be used as the mask to etch the entire base layer 33 exposed in the supporting-board-side openings 43 of the supporting board 32. For example, after the sample is disposed between opposed electrodes in an atmosphere in which a prescribed gas is filled in therebetween, high-frequency plasma is produced therebetween. The prescribed gases that may be used include, for example, He, Ne, Ar, Xe, Kr, N_2, O_2, CF_4 and NF_3. Of these gases, Ar, O_2, CF_4 and NF_3 are preferably used. These gases may be used in mixture in a prescribed proportion. The gas pressure (degree of vacuum) is in the range of 0.5-200Pa, or preferably 10-100Pa. Cited as the conditions required for producing the high-frequency plasma are the frequency in the range of e.g. 10kHz-20MKz, or preferably 10kHz-100kHz, and the power required for the plasma etching in the range of e.g. 0.5-10W/cm^2, or preferably 1-5W/cm^2. The frequency in the range of 10kHz-100kHz can make it easy to match with a plasma etching device (tune for resistances). In these atmospheric conditions, the sample is disposed on the electrodes whose temperature is controlled to e.g. 0-120℃, or preferably 10-80℃, and is etched for the time required for the base layer 33 to be etched to a predetermined thickness.

【0064】

Since the base-side openings 44 of the base layer 33 thus formed are formed by using the supporting board 32 as the mask, they can be formed in the same size and shape as the supporting-board-side openings 43 of the supporting board 32.

【0065】

Thereafter, as shown in FIG. 10(l), metal plated layers 45 are simultaneously formed by plating on both sides of the conductive pattern 34 thus exposed. The metal plated layers 45 can be formed by using either the electrolysis plating or the electroless plating, without any particular limitation. Also, the plating can be formed by using any known metal, without any particular limitation. Preferably, the electrolysis nickel plating and the electrolysis gold plating are sequentially performed to form a gold plated layer 47 on a nickel plated layer 46. Preferably, the nickel plated layer 46 and the gold plated layer 47 both have a thickness in the range of about 1-5μm. As a result of this, the external-side connecting terminals 38 are formed with the conductive pattern exposed at both sides thereof.

【0066】

As shown in FIG. 11, in the external-side connecting terminals 38 of the suspension board with circuit 31, widened portions 49 as reinforcing portions extending in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 34 are provided in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other, as is the case with the wired circuit board 11.

【0067】

To be more specific, the widened portions 49 are formed in the respective lines of wire 34a, 34b, 34c and 34d at positions thereof which correspond to the crossing areas 48 (two areas per each line of wire) and arranged with space from each other along the longitudinal directions of the lines of wire 34a, 34b, 34c and 34d. The widened portions 49 are formed in such a generally round shape as to protrude widthwise from the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 11(b). Each widened portion 49 is arranged, with its generally outer half portion embedded in the cover layer 35/base layer 33 and its generally inner half portion exposed in the cover-side opening 42, the base-side opening 44 and the supporting-board-side opening 43, when a maximum widthwise length between the adjacent lines of wire is defined as a boundary between the outer half portion and the inner half portion, as is the case with widened portions 22 of the wired circuit board 11. Thus, the external-side connecting terminals 38 are formed in such a dumbbell shape that the lines of wire 34a, 34b, 34c and 34d are protruded widthwise at both ends thereof in the cover-side opening 42, the base-side opening 44 and the supporting-board-side opening 43.

【0068】

The widened portions 49 may be made identical in the maximum widthwise length and the longitudinal length extending along the extending direction of the conductive pattern 34 with the widened portions 22 of the wired circuit board 11 mentioned above. Also, the widened portions 49 may be formed in any shape other than the generally round shape, as long as they are shaped to protrude widthwise and have widths larger than the usual width. For example, the widened portion 49 may be formed in rectangle.

[0069]

The external-side connecting terminals 38 having these widened portions 49 can be formed in the processes given below. The widened portions 49 are formed with the patterning of the wired circuit pattern in the process of forming the conductive pattern 34. Then, in the processes of FIG. 10(h) and (k), the cover layer 35, the supporting board 32 and the base layer 33 are each opened so that the maximum widthwise length of the widened portion 49 can be within the crossing areas 48 and thereby the cover-side opening 42, the supporting-board-side opening 43 and the base-side opening 44 are formed. Thereafter, in the process shown in FIG. 10(i), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44/supporting-board-side opening 43.

[0070]

In this formation of the suspension board with circuit 31, since the widened portions 49 widened in the widthwise direction of the conductive pattern 34 are formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 are crossed each other, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing further improved connection reliability.

[0071]

In addition, the suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of this flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 12. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

[0072]

To be more specific, the cover-side projections 50 and the base-side projections 51 are formed in the lines of wire 34a, 34b, 34c and 34d at positions thereof corresponding to the crossing areas 48, two for each, with spaced from each other along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 12(b). These projections are formed in a convex shape projecting inwardly from the ends of the cover-side opening 42 and the base-side opening 44 along the extending direction of the lines of wire 34a, 34b, 34c and 34d, respectively. The cover-side projections 50 and the base-side projections 51 are overlapped with the lines of wire 34a, 34b, 34c and 34d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 42/base-side opening 44, respectively. As a result of this, the external-side connecting terminals 38 are so formed that the lines of wire 34a, 34b, 34c and 34d can be covered with the cover-side projections 50 and the base-side projections 51 at opposite ends thereof in the cover-side opening 42 and the base-side opening 44.

[0073]

The cover-side projections 50 and the base-side projections 51 may be made identical in projection length and basal width with the cover-side projections 25 and the base-side projections 26 of the wired circuit board 11. Also, the shape of the cover-side projections 50 and the base-side projections 51 is not limited to the one shown in FIG. 12(b), as long as those projections have such a shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d. For example, the cover-side projections 50 and the base-side projections 51 may be formed to project toward the inside thereof in a tapered manner, with the basal width slightly larger than the line width of the lines of wire 34a, 34b, 34c and 34d. Further, those projections 50, 51 may be formed in such a rectangular shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, without limiting to the generally triangle shape.

[0074]

The external-side connecting terminals 38 having these cover-side projections 50 and the base-side projections 51 can be formed as follows. In the processes FIG. 10(g)-(i), the cover layer 35 is opened in such a manner as to form the cover-side projections 50 to thereby produce the cover-side opening 42. In the process of FIG. 10(k), the base layer 33 is opened in such a manner as to form the base-side projections 50 to thereby produce the base-side opening 44. Thereafter, in the process of FIG. 10(l), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44.

【0075】

In this formation of the suspension board with circuit 31, since the cover-side projections 50 and the base-side projections 51 are formed at the cover layer 35 and the base layer 33 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive patterns 43 are crossed each other, so as to project from the ends of the cover-side opening 42/the base-side opening 44 onto the conductive pattern 34 in the cover-side opening 42 and the base-side opening 44, respectively, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing improved connection reliability.

【0076】

It is to be noted that in the suspension board with circuit 31, both of cover-side projections 50 and the base-side projections 51 are not necessarily required. For example, only the cover-side projections 50 may be formed, as shown in FIG. 13. Alternatively, only the base-side projections 51 may be formed, as shown in FIG. 14.

【0077】

Further, modification may be made of the invention by forming the widened portions 49 in the conductive pattern 34 and also forming the cover-side projections 50 in the cover layer 35 and/or forming the base-side projections 51 in the base layer 33, though not shown.

【0078】

In this suspension board with circuit 31, the external-side connecting terminals 38 may be formed in such a manner that the conductive pattern 34 is depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 at its portions corresponding to the external-side connecting terminals 38 and also the base-side opening 44 and the supporting-board-side opening 43 are made larger than the areas in which the metal plated layers 45 are formed, as shown in FIG. 15(a). In the external-side connecting terminals 38 thus formed, the widened portion 49 may be formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 are crossed each other, as shown in FIG. 12(b).

【0079】

This suspension board with circuit 31 can be formed in the processes shown in FIG. 16, for example. First, the coating 33p of the liquid solution of precursor of the photosensitive polyimide resin is formed on the previously prepared supporting board 32 in the same manner as in the above, as shown in FIG. 16(a). Then, as shown in FIG. 16(b), in the process of exposing the coating 33p to light, in addition to the photomasks 40 that permit no irradiated light to transmit through the masks, photomasks 52 that permit the irradiated light to partially transmit through the masks (average transmittance ratio in the range of 1-99%) are placed to confront the areas for the external-side connecting terminals 38 to be formed in the coating 33p. Then, the coating 33p is exposed to light through the photomask 52, such that the area in the coating 33p in which the external-side connecting terminals 38 is to be formed is exposed to a smaller amount of light exposure than an amount of light exposure to the remaining areas of the coating 33p. Sequentially, the coating is developed and cured, as mentioned above. As a result of this, the areas of the base layer 33 in which the external-side connecting terminals 38 is to be formed is made smaller in thickness than the remaining areas of the base layer 33, as shown in FIG. 16(c) and (d).

【0080】

The photomasks 52 may be formed in the following manner. For example, a semi-translucent part of the front surface of the photomask 52 is finely roughened so that components of irregular reflection on the front surface of the photomask 52 can be increased to reduce components of the transmitted light in that part. Or, an irradiated light absorbing film is stuck on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that semi-translucent part can be reduced. Or, a pattern having a light transmiting area and a light shielding area is formed on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that part can be reduced.

[0081]

Further, in the case of the photomask 52 comprising a thin metal film forming a light-shielding pattern thereon, a thin metal film smaller in thickness than the thin metal film of the photomask 52 may be formed on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that semi-translucent part can be reduced. In other words, this photomask 52 can be formed in the following manner: A photomask 52 with no thin metal film formed in the semi-translucent part thereof (a conventional photomask) is formed. After a resist is formed on that photomask 52 so that only the semi-translucent part can be exposed, a thin metal film made of e.g. chromium smaller in thickness than the above-mentioned thin metal film is formed on the photomask 52 by vapor deposition or by plating and, thereafter, the resist is peeled.

[0082]

Of these photomasks 52, the photomasks 52 each having the semi-translucent part 53 on which the pattern of the light transmiting area and the light shielding area is formed as shown in FIG. 17 are preferably used. These photomasks 52 are each made of a sheet of glass, such as quartz glass or soda glass, of thickness of 2-5mm. The thin metal film formed on the semi-translucent part 53 of the photomask 52 made of the glass is patterned so that the light transmission ratio (transmissivity) in the semi-translucent part 53 of the glass can be reduced more than in the remaining parts of the glass. The pattern of the thin metal film can be formed, for example, by the process that after a thin metal film made of e.g. chromium is formed on the whole area of the glass by vapor deposition or by plating, the thin metal film is patterned by use of laser or electron beam. To be more specific, the pattern of the semi-translucent part 53 is preferably presented in the form of a repeat pattern in which the light transmitting portions and the light shielding portions being alternately arranged at a not more than 6 μm pitch (width of the light transmitting portion and the light shielding portion) and of which averaged transmittance ratio is not more than 80% or preferably not more than 50%. For example, a striped pattern having the average transmission ratio of about 50% as shown in FIG. 17(a); a latticed pattern having the average transmission ratio of about 25% as shown in FIG. 17(b); a circular staggered pattern having the average transmission ratio of about 25% as shown in FIG. 17(c); and a circular staggered pattern having the average transmission ratio of about 70% as shown in FIG. 17(d) are preferably used.

【0083】

While the patterning is provided in the negative type in the embodiment mentioned above, the patterning can be provided in the positive type as well. For example when the patterning is provided in the positive type, the photomask 52 may be so structured that the transmission ratio of irradiated light in the semi-translucent part of the photomask can be increased more than in the remaining parts of the photomask.

【0084】

The base layer 33 thus formed has a thickness in the range of e.g. 2-30μm, or preferably in the range of 5-20μm. The base layer 33 usually has a thickness of about 10μm. The area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has a thickness of usually 80% or less of the thickness of the remaining areas. For example, that area of the base layer 33 preferably has thickness of not more than 8μm, or further preferably not more than 5μm. Suppose that the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has thickness of 8μm or less, when the remaining areas have a usual thickness of 10μm, the time required for the opening to be formed in the later stage can be shortened to the extent corresponding to 2μm.

【0085】

The area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has a lower limit of thickness or a minimum thickness to serve as a barrier layer against the conductive pattern 34 when the supporting board 32 is opened. For example, the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed can have e.g. 3μm, or further about 1μm, as the minimum thickness. Accordingly, the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed preferably has a thickness in the range of 0.1-8μm or further preferably 1.0-5μm.

【0086】

Sequentially, the conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern in the same manner as in the above, as shown in FIG. 16(e). Since the areas of the base layer 33 on which the external-side connecting terminals 38 are to be formed are made smaller in thickness than the remaining areas of the base layer 33, the conductive pattern 34 is formed so that its portions on which metal plated layers 45 are formed in the later stage are depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 to an extent corresponding to the reduced thickness. In this formation of the conductive pattern 34, the widened portions 49 are formed simultaneously with the patterning of the wired circuit pattern.

[0087]

Sequentially, as shown in FIG. 16(f)-(i), the conductive pattern 34 is covered with the cover layer 35 in the same manner as in the above. Then, the cover-side opening 42 is formed in the area of the conductive pattern 34 in which the external-side connecting terminal 38 is to be formed so that the maximum lengths of the widened portions 49 are placed in the crossing areas 48. Thereafter, the supporting-board-side opening 43 is formed to be larger than the area of the supporting board 32 corresponding to the cover-side opening 42, as shown in FIG. 16(j). Then, the base-side opening 44 is formed in the base layer 33 exposed in the supporting-board-side opening 43 so that the maximum lengths of the widened portions 49 are placed in the crossing areas 48, as shown in FIG. 16(k). Thereafter, the metal plated layers 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and in the base-side opening 44/ supporting-board-side opening 43, as shown in FIG. 16(l). The metal plated layer 45 thus formed is positioned with a certain space between its periphery and the peripheries of the base-side opening 44 and supporting-board-side opening 43.

[0088]

When the suspension board with circuit 31 is produced in this method, the base layer 33 is formed to have smaller thickness at the base-side opening 44 for exposing the conductive pattern 34 than at the remaining portions of the base layer 33 in the process of forming the base layer 33. Consequently, when the base layer 33 is etched in the process of forming the external-side connecting terminals 38, as shown in FIG. 16(k), the etching time required for the conductive pattern 34 to be exposed can be shortened to an extent corresponding to the difference between the reduced thickness of the base layer 33 at the opening portions 31 and the thickness of the remaining portions. This enables the conductive pattern 34 to be exposed in a short time, and as such can provide improved efficiency in producing the external-side connecting terminals 38 in the form of the flying lead exposed at both sides thereof.

[0089]

In this formation, since the base-side opening 44 and the supporting-board-side opening 43 are formed to be larger than the exposed portion of the conductive pattern 34, a certain space is left between the periphery of the metal plated layer 45 and the peripheries of the base-side opening 44 and supporting-board-side opening 43. This can produce the effect that for example when the metal plated layer 45 is increased in thickness for improvement in connection reliability, the metal plated layer 45 and the supporting board 32 can be prevented from contacting with each other. This can surely prevent occurrence of a short circuit from the contact between the metal plated layer 45 and the supporting board 32, thus providing improved connection reliability and voltage proof property of the suspension board with circuit 32.

【0090】

In the suspension board with circuit 31, the interval formed between the periphery of the metal plated layer 45 and the periphery of the supporting-board-side opening 43 is preferably at least 1μm, or preferably in the order of 2-100μm.

【0091】

Further, in this formation, since the area of the conductive pattern 34 in which the metal plated layer 45 is formed is so formed as to be depressed toward the supporting board 32, the distance from the front side of the supporting board 32 to the front side of the metal plated layer 45 is shortened to an extent corresponding to the depression with respect to the remaining areas of the conductive pattern 34 and, as a result of this, the metal plated layers 45 are placed closer to the outside of the supporting board 32 to that extent. This can produce the effect that for example when the external-side connecting terminals 38 are connected with read/write terminals 54 of the read/write board 39 in such a manner that the read/write terminals 54 are laid over the metal plated layers 45 and are bonded to each other by applying supersonic vibration of the bonding tool, the pressure bonding can be well ensured, thus providing further improved connection reliability.

【0092】

In the suspension board with circuit 31 thus formed, the thicknesswise interval formed between the front side of the metal plated layers 45 and the interface between the base layer 33 and the supporting board 32 is preferably ±6μm, or further preferably ±2μm.

【0093】

This suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of the flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 18. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing area 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

【0094】

To be more specific, the cover-side projections 50 and the base-side projections 51 are formed in the respective lines of wire 34a, 34b, 34c and 34d at positions thereof corresponding to the crossing areas 48 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 18(b). These projections are formed in a convex shape projecting inwardly from the ends of the cover-side opening 42 and the base-side opening 44 along the extending direction of the lines of wire 34a, 34b, 34c and 34d, respectively. The cover-side projections 50 and the base-side projections 51 are overlapped with the lines of wire 34a, 34b, 34c and 34d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 42/base-side opening 44, respectively. As a result of this, the external-side connecting terminals 38 are so formed that the lines of wire 34a, 34b, 34c and 34d can be covered with the cover-side projections 50 and the base-side projections 51 at opposite ends thereof in the cover-side opening 42 and the base-side opening 44.

【0095】

The cover-side projections 50 and the base-side projections 51 may be made identical in projection length and basal width with the cover-side projections 25 and the base-side projections 26 of the wired circuit board 11 mentioned above. Also, the shape of the cover-side projections 50 and the base-side projections 51 is not limited to the one shown in FIG. 18(b), as long as those projections have such a shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d. For example, the cover-side projections 50 and the base-side projections 51 may be formed to project toward the inside thereof in a tapered manner, with the basal width slightly larger than the line width of the lines of wire 34a, 34b, 34c and 34d. Further, those projections 50, 51 may be formed in such a rectangular shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, without limiting to the generally triangle shape.

【0096】

In the suspension board with circuit 31 shown in FIG. 18, the base-side opening 44 is formed to be larger in area than the cover-side opening 42, so that the base-side projection 51 is formed to be larger in length than the cover-side projection 50 to that extent corresponding to the difference in area between the base-side opening 44 and the cover-side opening 42, as shown in FIG. 18(a).

【0097】

The external-side connecting terminals 38 having these cover-side projections 50 and the base-side projections 51 are formed as follows. In the process of FIG. 16(g)-(i), the cover layer 35 is opened in such a manner as to form the cover-side projections 50 to thereby produce the cover-side opening 42. In the process of FIG. 16(k), the base layer 33 is opened in such a manner as to form the base-side projections 50 to thereby produce the base-side opening 44. Thereafter, in the process of FIG. 16(l), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44.

【0098】

It is to be noted that in the suspension board with circuit 31 as well, both of cover-side projections 50 and the base-side projections 51 are not necessarily required, as is the case with the above. For example, only the cover-side projections 50 may be formed, as shown in FIG. 19. Alternatively, only the base-side projections 51 may be formed, as shown in

FIG. 20.

【0099】

Further, modification may be made of the invention by forming the widened portions 49 in the conductive pattern 34 and also forming the cover-side projections 50 in the cover layer 35 and/or forming the base-side projections 51 in the base layer 33, though not shown.

【0100】

Although the external-side connecting terminals 38 provided in the form of the flying lead have been exclusively discussed above, this suspension board with circuit 31 includes magnetic-head-side connecting terminals 37 provided in the form of the flying lead identical with the external-side connecting terminals 38.

【0101】

【Examples】

While in the following, the present invention will be described in further detail with reference to Examples, the present invention is not limited to any Examples.

【0102】

Example 1

A liquid solution of precursor of photosensitive polyimide resin was applied on the stainless steel foil (SUS304 H-TA) having thickness of 20μm so that after dried, it could have a thickness of 24μm and then dried at 130℃ to thereby form a coating of the precursor of the photosensitive polyimide resin (Cf. FIG. 16(a)). Sequentially, the coating was exposed to light (405nm, 1,500mJ/cm^2) through a photomask (Cf. FIG. 16(b)). The exposed part of the coating was heated to 180℃ and then developed by using an alkaline developer, whereby the coating was patterned with the negative imaging (Cf. FIG. 16(c)). Sequentially, the patterned coating of the precursor of the photosensitive polyimide resin was heated at 350℃ to be cured (imidized), whereby a base layer made of polyimide resin of thickness of 10μm was formed in the specified pattern (Cf. FIG. 16(d)).

【0103】

In forming the base layer, the photomask of metal film having a latticed repeat pattern in which the light transmitting portions and the light shielding portions are alternately arranged at a not more than 6μm pitch (which corresponds to the photomask 52 having the average transmission ratio of about 25% shown in FIG. 17(b)), was positioned over the coating at its portion which is to be opened in the later stage and at which an external-side connecting terminals are to be formed. Then, the coating was exposed to light through the photomask, so that the amount of light exposure in the portion of the coating at which the external-side connecting terminals are to be formed could be reduced more than the amount of light exposure in the remaining portions of the coating (Cf. FIG. 16(b)). As a result of this, after the coating was developed and cured, the base layer having a thickness of 2μm at portions thereof at which the external-side connecting terminals are to be formed and a thickness of 10μm at the remaining portions thereof was obtained (Cf. FIG. 16(d)).

【0104】

Sequentially, a thin chrome film of thickness of 300Å and a thin copper film having thickness of 700Å were formed in sequence on the whole area of the stainless steel foil and the base layer by a sputtering deposition process. Thereafter, a plating resist having an opposite pattern to the specified wired circuit pattern was formed by use of a dry film resist, and a conductive pattern having the specified wired circuit pattern was formed in the part of the base layer where the plating resist was not formed, in the semi-additive method using the electrolysis copper plating (Cf. FIG. 16(e)). As a result of the base layer being formed to be smaller in thickness at its part at which the external-side connecting terminals are to be formed than at its remaining parts, the conductive pattern thus formed had, at its part at which the external-side connecting terminals are to be formed, concave portions depressed toward the stainless steel foil from the remaining portions of the conductive pattern with respect to the thickness direction by about 8 μm. The conductive pattern was formed to have thickness of 10 μm and have the wired pattern formed by four lines of wire each having width of 110 μm and spaced from each other in parallel at interval of 200 μm.

【0105】

Further, generally round widened portions (Cf. FIG. 15(b)), which were widened in the widthwise direction substantially orthogonal to the extending direction of the lines of wire and had the maximum widthwise length of 230 μm and the longitudinal length of 100 μm, were formed in the respective lines of wire in crossing areas where the ends of the cover-side opening/the base-side opening and the lines of wire are crossed each other, two for each line of wire.

【0106】

Thereafter, the plating resist was removed by chemical etching and then the thin chromium film and the thin copper film on which the plating resist had been formed were removed by chemical etching.

【0107】

Sequentially, a rigid, thin nickel film having thickness of 0.1μm was formed on the surface of the conductive pattern and the surface of the stainless steel foil by the electroless nickel plating. Thereafter, a liquid solution of a precursor of the photosensitive polyimide resin was applied on the thin nickel film and the base layer and then heated at 130℃ to thereby form a coating of the precursor of the photosensitive polyimide resin (Cf. FIG. 16(f)). Sequentially, the coating was exposed to light (405nm, 1,500mJ/cm^2) through the photomask (Cf. FIG. 16(g)). The exposed part of the coating was heated to 180℃ and then developed by using an alkaline developer, whereby the coating was patterned so that the conductive layer could be covered with the coating (Cf. FIG. 16(h)). Sequentially, the patterned coating of the precursor of photosensitive polyimide resin was heated at 350℃ to be cured (imidized), whereby the cover layer comprising polyimide resin of thickness of 3μm was formed on the conductive layer (FIG. 16(i)).

【0108】

It is to be noted that in forming the cover layer, the cover-side openings were formed in the cover layer so that when the cover layer was patterned, the thin nickel film on the conductive pattern at its part at which the external-side connecting terminals are to be formed could be exposed.

【0109】

Sequentially, the external-side connecting terminals were formed in the state in which their both sides were exposed. First, the supporting-board-side openings larger than the cover-side openings were formed in the stainless steel foil at its portions corresponding to the cover-side openings so that the base layer could be exposed (Cf. FIG. 16(j)). The supporting-board-side openings were formed in the process that after all of the areas of the stainless steel foil, except the areas in which the supporting-board-side openings are to be formed, were subjected to masking, the stainless steel foil was subjected to the chemical etching. At the same time as the formation of the supporting-board-side openings, the gimbals were cut into a predetermined shape by the chemical etching.

【0110】

Sequentially, the thin nickel film as was exposed in the cover-side openings was peeled and the thin nickel film formed on the stainless steel foil was peeled.

【0111】

Then, the base layer exposed in the supporting-board-side openings of stainless steel foil were opened and thereby the base-side openings were formed to expose the ground formed on the back side of the conductive pattern (Cf. FIG. 16(k)). The base-side openings were formed by the plasma etching. In the plasma etching, with the stainless steel foil as the mask, the entire base layer exposed in the supporting-board-side openings of the stainless steel foil was etched for about 2 minutes in the conditions of: the mixed gas of CF_4 and O_2 (CF_4/O_2 =20/80) used as the gas filled; the gas pressure (degree of vacuum) of 25Pa; the frequency of 13.5MHz; and the power required for the plasma etching of 2,500W.

【0112】

The base-side openings thus formed were formed in the same size and shape as the supporting-board-side openings, and the space of about 50μm was defined between the periphery of the ground exposed in the base-side openings and the periphery of the base-side opening/supporting-board-side opening.

【0113】

Thereafter, the ground exposed in the base-side openings were peeled to expose the back side of the conductive pattern. Sequentially, the metal plated layers were formed by performing the electrolysis nickel plating and the electrolysis gold plating being alternately, so that the nickel plated layers having thickness of 2μm and the gold plated layer having thickness of 1μm were formed on the both sides of the conductive pattern thus exposed (FIG. 16(l)).

【0114】

The metal plated layers on the back side of the conductive pattern thus formed left the thicknesswise interval of $\pm$2μm between the front side of the metal plated layers and the interface between the base layer and the stainless steel foil and also left the interval of 47μm between the periphery of the metal plated layer and the periphery of the base-side opening/the supporting-board-side opening.

【0115】

After these processes, the suspension board with circuit was obtained in which the external connecting terminals were presented in the form of the flying lead of the conductive pattern in which the widened portions were formed in the lines of wire, respectively (Cf. FIG. 15).

【0116】

Example 2

The suspension board with circuit having the external-side connecting terminals produced in the form of the flying lead of the conductive pattern whose lines of wire were covered with the base-side projections at their exposed ends was produced (FIG. 20) in the same operation as in Example 1, except that instead of forming the widened portions in the lines of wire of the conductive pattern, the base-side projections of generally triangle as viewed from the top having the basal width of 110μm and the projection length of 200μm were formed in the base layer in the crossing areas (two areas per each line of wire) where the ends of the base-side opening and the lines of wire are crossed each other, so as to project from the ends of the base-side opening onto the conductive pattern in the base-side opening in the process of opening the base layer to form the base-side openings (Cf. FIG. 16(k)).

【0117】

Comparative Example 1

Except that no widened portions were formed in the lines of wire of the conductive pattern, the suspension board with circuit having the external-side connecting terminals presented in the form of the flying lead was produced (Cf. FIG. 21) in the same operation as in Example 1.

【0118】

Evaluation

After being bonded to the external terminals comprising gold pads by applying supersonic vibration thereto by use of the bonding tool, the external-side connecting terminals of the suspension boards with circuit obtained in Examples 1 and 2 and Comparative Example 1 were put to the peel tests to measure the bonding strength.

【0119】

The test results are shown in Table 1 given below. It should be noted that all destructions occured in the conductive patterns of the suspension boards with circuit of Examples 1 and 2 took place in the areas where the conductive pattern was covered with the cover layer and the base layer.

【0120】

【Table 1】

	Example 1	Example 2	Comparative Example 1
Bonding strength in peel test (mN)	540	590	490

【Effects of the Invention】

As mentioned above, according to the wired circuit board of the present invention, since at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern is subject to stress concentration at exposed portions thereof at ends of the opening in the process of bonding the terminal portions and the external connecting terminals by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved connection reliability.

【0121】

Hence, even when the wired circuit board of the present invention is produced in the form of the flying lead in which both sides of the conductive pattern are exposed, it can be suitably used as the suspension board with circuit with high connection reliability.

【Brief Description of the Drawings】

FIG. 1 shows an embodiment of a wired circuit board (wherein a widened portion is formed) of the present invention: (a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and (b) is a plan view of the terminal portion of the same.

FIG. 2 is an enlarged plan view of FIG. 1(b).

FIG. 3 illustrates the production processes of a wired circuit board shown in FIG. 1:

(a) shows the step of forming a conductive pattern on a base layer;

(b) shows the step of forming a base layer on the conductive pattern;

(c) shows the step of forming a cover-side opening on the cover layer at a portion thereof at which terminals are to be formed;

(d) shows the step of forming a base-side opening on the base layer at a portion thereof at which terminals are to be formed; and

(e) shows the step of forming a metal plated layer on each of front and back sides of the conductive pattern exposed in the cover-side opening and the base-side opening.

FIG. 4 shows another embodiment of the wired circuit board (wherein a cover-side projection and a base-side projection are formed) of the present invention: (a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and (b) is a plan view of the terminal portion of the same.

FIG. 5 is an enlarged view of the plan view shown in FIG. 4(b).

FIG. 6 is an enlarged view of the plane view of another embodiment shown in FIG. 4(b).

FIG. 7 shows in section a principal portion of another embodiment (only the cover-side projection is formed) of the wired circuit board shown in FIG. 4(a).

FIG. 8 shows in section a principal portion of still another embodiment (only the base-side projection is formed) of the wired circuit board shown in FIG. 4(a).

FIG. 9 is a plan view of a suspension board with circuit presented as one embodiment of the wired circuit board of the present invention.

FIG. 10 illustrates the production processes of the suspension board with circuit shown in FIG. 9:

(a) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on a supporting board;

(b) shows the step of exposing the coating to light through a photomask;

(c) shows the step of developing the coating to form it into a predetermined pattern;

(d) shows the step of curing the patterned coating to form the base layer,

(e) shows the step of forming a conductive pattern on the base layer;

(f) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on the conductive pattern;

(g) shows the step of exposing the coating to light through a photomask;

(h) shows the step of developing the coating to form it into a predetermined pattern;

(i) shows the step of curing the patterned coating to form the cover layer;

(j) shows the step of opening the supporting board at portions thereof at which the external-side connecting terminals are formed;

(k) shows the step of opening the base layer at portions thereof at which the external-side connecting terminals are formed; and

(l) shows the step of forming a metal plated layer on each side of the exposed conductive pattern.

FIG. 11 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein a widened portion is formed) of the present invention: (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 12 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein a cover-side projection and a base-side projection are formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 13 shows in section a principal portion of another embodiment (only the cover-side projection is formed) of the suspension board with circuit shown in FIG. 12(a).

FIG. 14 shows in section a principal portion of still another embodiment (only the base-side projection is formed) of the suspension board with circuit shown in FIG. 12(a).

FIG. 15 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein the conductive pattern has a concave form and a widened portion is formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 16 illustrates the production processes of the suspension board with circuit shown in FIG. 15:

(a) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on a supporting board;

(b) shows the step of exposing the coating to light through a photomask;

(c) shows the step of developing the coating to form it into a predetermined pattern;

(d) shows the step of curing the patterned coating to form the base layer,

(e) shows the step of forming a conductive pattern on the base layer;

(f) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on the conductive pattern;

(g) shows the step of exposing the coating to light through a photomask;

(h) shows the step of developing the coating to form it into a predetermined pattern;

(i) shows the step of curing the patterned coating to form the cover layer;

(j) shows the step of opening the supporting board at portions thereof at which the external-side connecting terminals are formed;

(k) shows the step of opening the base layer at portions thereof at which the external-side connecting terminals are formed; and

(l) shows the step of forming a metal plated layer on each side of the exposed conductive pattern.

FIG. 17 is a schematic plan view of an embodiment of a photomask used for exposing the coating to light in the step of FIG. 16(b):

(a) shows a semi-translucent striped pattern having an average transmission ratio of about 50%;

(b) shows a semi-translucent latticed pattern having an average transmission ratio of about 25%;

(c) shows a semi-translucent circular staggered pattern having an average transmission ratio of about 25%; and

(d) shows a semi-translucent circular staggered pattern having an average transmission ratio of about 70%.

FIG. 18 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein the conductive pattern has a concave form and a cover-side projection and a base-side projection are formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 19 shows in section a principal part of another embodiment of a suspension board with circuit shown in FIG. 18(a) (wherein only the cover-side projection is formed).

FIG. 20 shows in section a principal part of still another embodiment of a suspension board with circuit shown in FIG. 18(a) (wherein only the base-side projection is formed).

FIG. 21 shows a conventional suspension board with circuit: (a) is a sectional view of a principal portion of a terminal of the suspension board with circuit; and (b) is a plan view of the terminal of the same.

[Description of Reference Numerals]

11	Wired circuit board
12	Base layer
13	Conductive pattern
14	Cover layer
16	Terminal portion
17	Cover-side opening
18	Base-side opening
21	Crossing area
22	Widened portion
25	Cover-side projection
26	Base-side projection

31	Suspension board with circuit
32	Supporting board
33	Base layer
34	Conductive pattern
35	Cover layer
38	External-side connecting terminal
42	Cover-side opening
43	Supporting-board-side opening
44	Base-side opening
48	Crossing area
49	Widened portion
50	Cover-side projection
51	Base-side projection

【Document Name】 Abstract of Disclosure

【Abstract】

【Object】To provide a wired circuit board having a terminal portion formed as a flying lead that can provide enhanced strength of the conductive pattern, both sides of which are exposed, by simple construction to effectively prevent disconnection of the conductive pattern.

【Solving Means】 The wired circuit board 11 having the terminal portion 16 formed as the flying lead in which the both sides of the conductive pattern 34 are exposed includes, in crossing areas 21 where ends of a cover-side opening 17 and ends of a base-side opening 18 and the conductive pattern 13 are crossed each other, (i) widened portions 22 formed in the conductive pattern 13 or (ii) cover-side projections 25 and base-side projections 26 formed in the cover layer 35 and the base layer 33, respectively.

【Selective Drawing】 FIG. 1

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

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ART UNIT	**PAPER NUMBER**
2827	

DATE MAILED: 11/28/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	10/195,392	KOMATSUBARA ET AL.
	Examiner	Art Unit
	John B. Vigushin	2827

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondenc address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 August 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3 and 7-9* is/are rejected.

7)☒ Claim(s) *4-6* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .

4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: .

DETAILED ACTION

1. The present Office Action is responsive to Applicant's amended Response filed August 25, 2003. The Examiner acknowledges the amendments to Claims 1, 2, 4, 5, 7 and 8 that correct various minor informalities. Claims 1-9 remain pending in the instant amended Application.

References Based On Prior Art

2. The following references were relied upon for the rejections hereinbelow:

Iwayama et al. (US 5,446,245) Yamato et al. (US 6,388,201 B2)*

*Already made of record in the instant Application.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1 and 7 are rejected under 35 U.S.C. 102(b) as being anticipated by Iwayama et al.

A) As to Claim 1, Iwayama et al. discloses, in Figs. 1, 2 and 3C: a wired circuit board comprising a first insulating layer 4, a conductive pattern 2 (i.e., pattern 2 including protruding terminal portion 2A) formed on the first insulating layer 4, a second insulating layer 1 formed on conductive pattern 2, and an opening (corresponding to element 12 in Fig. 1 and corresponding to aperture 8 in mask 9 in Fig. 3C) formed at the same position of the conductive pattern 2, for allowing the first insulating layer 4 and the second insulating layer to open, so as to form a terminal portion 2A in which the front and back sides of the conductive pattern 2 at terminal portion 2A are exposed (col.2: 59-col.3: 4), wherein first insulating layer 4 has reinforcing portions 6 for reinforcing the conductive pattern 2 (at terminal portion 2A), formed at ends of the opening 8 in crossing areas where ends of the opening 8 and conductive pattern 2 cross each other (col.2: 37-41).

B) As to Claim 7, Iwayama et al. discloses, in Figs. 1, 2 and 3C: a wired circuit board comprising a first insulating layer 4, a conductive pattern 2 (i.e., pattern 2 including protruding terminal portion 2A) formed on the first insulating layer 4, a second insulating layer 1 formed on conductive pattern 2, and an opening (corresponding to element 12 in Fig. 1 and corresponding to aperture 8 in mask 9 in Fig. 3C) formed at the same position of the conductive pattern 2, for allowing the first insulating layer 4 and the second insulating layer to open, so as to form a terminal portion 2A in which the front and back sides of the conductive pattern 2 at terminal portion 2A are exposed (col.2: 59-col.3: 4), wherein first insulating layer 4 has projections 6 projecting from ends of the opening 8 onto terminal portions 2A of the conductive pattern 2 in the opening 8 in the crossing area where ends of the opening 8 and conductive pattern 2 cross each other (col.2: 37-41).

Claim Rej ctions - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 2, 3, 8 and 9 are rejected under 35 U.S.C. 103(a) as being obvious over Iwayama et al. in view of Yamato et al.

The applied reference has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(l)(1) and § 706.02(l)(2).

A) As to Claim 2:

I. Iwayama et al. discloses, in Figs. 1, 2 and 3C: a wired circuit board comprising a first insulating layer 4, a conductive pattern 2 (i.e., pattern 2 including protruding terminal portion 2A) formed on the first insulating layer 4, a second insulating layer 1 formed on conductive pattern 2, and an opening (corresponding to element 12 in Fig. 1 and corresponding to aperture 8 in mask 9 in Fig. 3C) formed at the same position of the conductive pattern 2, for allowing the first insulating layer 4 and the second insulating layer to open, so as to form a terminal portion 2A in which the front and back sides of the conductive pattern 2 at terminal portion 2A are exposed (col.2: 59-col.3: 4), wherein first insulating layer 4 has reinforcing portions 6 for reinforcing the conductive pattern 2 (at terminal portion 2A), formed at ends of the opening 8 in crossing areas where ends of the opening 8 and conductive pattern 2 cross each other (col.2: 37-41).

II. Iwayama et al. further teaches that the wired circuit board is a thin-film polyimide circuit (col.1: 9-13; col.2: 11-27 and 31-32) but does not teach that first insulating layer 4 is formed on a metal supporting layer, wherein the metal supporting layer has an opening corresponding to the openings formed in the first and second insulating layers 4 and 1, respectively, for exposing the terminal portion 2A of conductive pattern 2.

III. Yamato et al. discloses, in Fig. 13, a thin-film (Fig. 1; col.16: 5-28) wired circuit board, structurally similar to that of Imayama et al., but further including a metal supporting layer 12 for providing structural support to the thin circuit, and also comprising a first insulating layer 13 (polyimide material: col.5: 21-29) formed on the metal supporting layer 12, a conductive pattern 14 (with plated layers 19), a second insulating layer 18 (polyimide material: col.10: 18-22) and an opening (comprising aperture 35 in first layer 13, aperture 33 in second layer 18 and aperture 34 in metal supporting layer 12) for exposing the terminal portion 36 of conductive pattern 14.

IV. Since both Iwayama et al. and Yamato et al. both teach thin-film polyimide wired circuit boards with exposed terminal portions and Yamato et al. further teaches a metal supporting layer for applications wherein the thin-film circuit board requires structural support (i.e., a "stiffener" for supporting the thin-film wiring board), then the use of a metal supporting layer as a stiffener for the thin-film wiring board, in applications wherein such mechanical support is required to ensure functional reliability of the thin-film circuit board, and the inclusion of an aperture in the metal supporting layer, corresponding to the apertures of the first and second insulating layers, for forming the openings that expose the terminal portions of the conductive pattern, would have been readily recognized for applications of the thin-film wired circuit board in the pertinent art of Iwayama et al.

V. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further include a metal supporting ("stiffening") layer with an aperture for exposing the terminal portion of the conductive pattern in order to provide mechanical support to the thin-film structure of the wiring board and thereby ensure the functional reliability of the wiring board in various applications.

B) As to Claim 3:

I. Iwayama et al. et al. is silent as to any particular application of the thin-film wiring board, as modified--with the metal supporting layer including the terminal exposing aperture--by Yamato et al. However, Yamato et al. further teaches that the thin-film wiring board--including the apertured metal supporting layer--is a suspension board with circuit 11 (Fig. 1) used, for example, for a hard disk drive (col.1: 10-17; col.4: 22-34).

II. Since Iwayama et al., as modified by Yamato et al., teaches the wiring board structure of base Claim 2, then the application of that structure as a suspension board with circuit for a hard disk drive, as taught by Yamato et al., would have been readily recognized in the pertinent art of modified Iwayama et al.

III. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the wiring board structure of modified Iwayama et al. as a suspension board with circuit 11 for a hard disk drive, as taught by Yamato et al., as at least one application of the thin-film wiring board of modified Iwayama et al.

C) As to Claim 8:

I. Iwayama et al. discloses, in Figs. 1, 2 and 3C: a wired circuit board comprising a first insulating layer 4, a conductive pattern 2 (i.e., pattern 2 including protruding terminal portion 2A) formed on the first insulating layer 4, a second insulating layer 1 formed on conductive pattern 2, and an opening (corresponding to element 12 in Fig. 1 and corresponding to aperture 8 in mask 9 in Fig. 3C) formed at the same position of the conductive pattern 2, for allowing the first insulating layer 4 and the second insulating layer to open, so as to form a terminal portion 2A in which the front and back sides of the conductive pattern 2 at terminal portion 2A are exposed (col.2: 59-col.3: 4), wherein first insulating layer 4 has projections 6 projecting from ends of the opening 8 onto terminal portions 2A of the conductive pattern 2 in the opening 8 in the crossing area where ends of the opening 8 and conductive pattern 2 cross each other (col.2: 37-41).

II. Iwayama et al. further teaches that the wired circuit board is a thin-film polyimide circuit (col.1: 9-13; col.2: 11-27 and 31-32) but does not teach that first insulating layer 4 is formed on a metal supporting layer, wherein the metal supporting layer has an opening corresponding to the openings formed in the first and second insulating layers 4 and 1, respectively, for exposing the terminal portion 2A of conductive pattern 2.

III. Yamato et al. discloses, in Fig. 13, a thin-film (Fig. 1; col.16: 5-28) wired circuit board, structurally similar to that of Imayama et al., but further including a metal supporting layer 12 for providing structural support to the thin circuit, and also comprising a first insulating layer 13 (polyimide material: col.5: 21-29) formed on the metal supporting layer 12, a conductive pattern 14 (with plated layers 19), a second insulating layer 18 (polyimide material: col.10: 18-22) and an opening (comprising aperture 35 in first layer 13, aperture 33 in second layer 18 and aperture 34 in metal supporting layer 12) for exposing the terminal portion 36 of conductive pattern 14.

IV. Since both Iwayama et al. and Yamato et al. both teach thin-film polyimide wired circuit boards with exposed terminal portions and Yamato et al. further teaches a metal supporting layer for applications wherein the thin-film circuit board requires structural support (i.e., a "stiffener" for supporting the thin-film wiring board), then the use of a metal supporting layer as a stiffener for the thin-film wiring board, in applications wherein such mechanical support is required to ensure functional reliability of the thin-film circuit board, and the inclusion of an aperture in the metal supporting layer, corresponding to the apertures of the first and second insulating layers, for forming the openings that expose the terminal portions of the conductive pattern, would have been readily recognized for applications of the thin-film wired circuit board in the pertinent art of Iwayama et al.

V. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further include a metal supporting ("stiffening") layer with an aperture for exposing the terminal portion of the conductive pattern in order to provide mechanical support to the thin-film structure of the wiring board and thereby ensure the functional reliability of the wiring board in various applications.

D) As to Claim 9:

I. Iwayama et al. et al. is silent as to any particular application of the thin-film wiring board, as modified--with the metal supporting layer including the terminal exposing aperture--by Yamato et al. However, Yamato et al. further teaches that the thin-film wiring board--including the apertured metal supporting layer--is a suspension board with circuit 11 (Fig. 1) used, for example, for a hard disk drive (col.1: 10-17; col.4: 22-34).

II. Since Iwayama et al., as modified by Yamato et al., teaches the wiring board structure of base Claim 2, then the application of that structure as a suspension board with circuit for a hard disk drive, as taught by Yamato et al., would have been readily recognized in the pertinent art of modified Iwayama et al.

III. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the wiring board structure of modified Iwayama et al. as a suspension board with circuit for a hard disk drive, as taught by Yamato et al., as at least one application of the thin-film wiring board of modified Iwayama et al.

Allowable Subject Matter

7. Claims 4 and 5-6 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

8. The following is a statement of reasons for the indication of allowable subject matter:

As to Claims 4 and 5-6, patentability resides in the limitation wherein *the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other*, in combination with the other limitations of independent Claims 4 and 5.

9. As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

Response to Arguments

10. Applicant's arguments (see instant Amendment, pp.15-17, filed August 25, 2003) with respect to the rejection(s)of claim(s) 1-3 and 7-9 under 35 USC § 102(e) as being anticipated by Yamato et al. (US 6,388,201 B2) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Iwayama et al. (Claims 1 and 7) and Iwayama et al. in view of Yamato et al. (Claims 2, 3, 8 and 9). Accordingly, the present Office Action has been made NON-FINAL.

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ohkawa et al. (US 6,399,899 B1) discloses all of the limitations of Claims 4 and 5-6 including that *the conductive pattern has widened portions 35 formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern* 14 (Figs. 16-18) but does not teach that *the widened portions 35 extend orthogonally to an extending direction of the conductive pattern 14* ***in crossing areas where ends of the opening 32 and th conductive pattern 14 cross each oth r*** (see Fig. 18 wherein the widened portions 35 extend orthogonally to an extending direction of the conductive pattern 14 **in the interior region of the opening 32** and not in the crossing areas where **ends of the opening 32 and the conductive patt rn 14 cross each other**).

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to John B. Vigushin whose telephone number is 703-308-1205 (Crystal City campus) and 571-272-1936 (Carlisle campus). The examiner can normally be reached on 8:30AM-5:00PM Mo-Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamand Cuneo can be reached on 703-308-1233 (Crystal City campus) and 571-272-1957 (Carlisle campus). The fax phone number for the organization where this application or proceeding is assigned is 703-308-7382.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

John B. Vigushin
John B. Vigushin
Primary Examiner
Art Unit 2827

jbv
November 24, 2003

Notice of References Cit d	Application/Control No. 10/195,392	Applicant(s)/Patent Under Reexamination KOMATSUBARA ET AL.	
	Examiner John B. Vigushin	Art Unit 2827	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-6,399,899 B1	06-2002	Ohkawa et al.	174/261
	B	US-5,446,245	08-1995	Iwayama et al.	174/261
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001) **Notice of References Cited** Part of Paper No. 1103

Form PTO-948 (Rev. 03/03)
Application No. 10/195,392

U.S. DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

The drawing(s) filed (insert date) 07/16/02 are:

A. ____ approved by the Draftsperson under 37 CFR 1.84 or 1.152.

B. ✓ objected to by the Draftsperson under 37 CFR 1.84 or 1.152 for the reasons indicated below. Corrected drawings are required.

1. DRAWINGS. 37 CFR 1.84(a): Acceptable categories of drawings: Black ink or Color (3 sets required).
Color drawings are not acceptable until petition is granted. Fig(s) ____
___ Pencil and non black ink not permitted. Fig(s) ____

2. PHOTOGRAPHS. 37 CFR 1.84(b)
___ 1 full-tone set is required. Fig(s) ____
___ Photographs may not be mounted. 37 CFR 1.84(e)
___ Photographs must meet paper size requirements of of 37 CFR 1.84(f). Fig(s) ____
___ Poor quality (half-tone). Fig(s) ____

3. TYPE OF PAPER. 37 CFR 1.84(e)
___ Paper not flexible, strong, white, and durable. Fig(s) ____
___ Erasures, alterations, overwritings, interlineations, folds, copy machine marks not accepted. Fig(s) ____

4. SIZE OF PAPER. 37 CFR 1.84(f): Acceptable sizes:
21.0 cm by 29.7 cm (DIN size A4) or
21.6cm by 27.9cm (8 1/2x 11 inches)
___ All drawing sheets not the same size. Sheet(s) ____
___ Drawings sheets not an acceptable size. Fig(s) ____

5. MARGINS. 37 CFR 1.84(g): Acceptable margins:
Top 2.5 cm Left 2.5 cm Right 1.5 cm Bottom 1.0 cm
Margins not acceptable. Fig(s) 1-21
___ Top (T) ✓ Left (L)
___ Right (R) ___ Bottom (B)

6. VIEWS. 37 CFR 1.84(h)
REMINDER: Specification may require revision to correspond to drawing changes, e.g., if Fig. 1 is changed to Fig. 1A, Fig 1B and Fig. 1C, etc., the specification, at the Brief Description of the Drawings, must likewise be changed.
___ Views not labeled separately or properly. Fig(s) ____

7. SECTIONAL VIEWS. 37 CFR 1.84(h)(3)
___ Sectional designation should be noted with Arabic or Roman numbers. Fig(s) ____

8. ARRANGEMENT OF VIEWS. 37 CFR 1.84(i)
Words do not appear on a horizontal, left-to-right fashion when page is either upright or turned so that the top becomes the right side, except for graphs. Fig(s) ____

9. SCALE. 37 CFR 1.84(k)
___ Scale not large enough to show mechanism without crowding when drawing is reduced in size to two-thirds in reproduction. Fig(s) ____

10. CHARACTER OF LINES, NUMBERS, & LETTERS. 37 CFR 1.84(l)
___ Lines, numbers & letters not uniformly thick and well defined, clean, durable, and black (poor line quality). Fig(s) ____

11. SHADING. 37 CFR 1.84(m)
___ Solid black areas pale. Fig(s) ____
___ Solid black shading not permitted. Fig(s) ____

12. NUMBERS, LETTERS, & REFERENCE CHARACTERS. 37 CFR 1.84(p)
___ Numbers and reference characters not plain and legible. Fig(s) ____
___ Figure legends are poor. Fig(s) ____
✓ Numbers and reference characters not oriented in the same direction as the view. 37 CFR 1.84(p)(1) Fig(s) 9
___ English alphabet not used. 37 CFR 1.84(p)(2) Fig(s) ____
___ Numbers, letters and reference characters must be at least 32 cm (1/8 inch) in height. 37 CFR 1.84(p)(3). Fig(s) ____

13. LEAD LINES. 37 CFR 1.84(q)
___ Lead lines missing. Fig(s) ____

14. NUMBERING OF SHEETS OF DRAWINGS. 37 CFR 1.84(t)
___ Sheets not numbered consecutively, and in Arabic numerals beginning with number 1. Sheet(s) ____

15. NUMBERING OF VIEWS. 37 CFR 1.84(u)
___ Views not numbered consecutively, and in Arabic numerals, beginning with number 1. Fig(s) ____

16. DESIGN DRAWINGS. 37 CFR 1.152
___ Surface shading shown not appropriate. Fig(s) ____
___ Solid black surface shading is not permitted except when used to represent the color black as well as color contrast. Fig(s) ____

COMMENTS:

Reviewer LAM

Date 11/14/03

If you have questions, call (703) 305-8404.

Attachment to Paper No. 1103

Search Notes	Application No.	Applicant(s)	
	10/195,392	KOMATSUBARA ET AL.	
	Examiner	Art Unit	
	John B. Vigushin	2827	

SEARCHED

Class	Subclass	Date	Examiner
361	749-751	6/15/2003	JBV
174	254	6/15/2003	JBV
Search	Updated	11/24/2003	JBV
174	250,	11/24/2003	JBV
	255-258,		
	261		

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
EAST Text Search (see print-out)	6/15/2003	JBV
EAST Text Search (see print-out)	11/24/2003	JBV

U.S. Patent and Trademark Office

Part of Paper No. 1103

	L #	Hits	Sear h T xt	DB
1	L1	972	(361/749,750,751).ccls.	USPAT; US-PGPUB
2	L2	754	174/254.ccls.	USPAT; US-PGPUB
3	L3	1469	1 2	USPAT; US-PGPUB
4	L4	52	3 and @pd>=20030601	USPAT; US-PGPUB
5	L5	11	4 and reinforc$5	USPAT; US-PGPUB
6	L6	41	4 not 5	USPAT; US-PGPUB
7	L7	13	6 and (taper$3 widen$3 narrow$3)	USPAT; US-PGPUB

	L #	Hit	arch Text	DBs
8	L8	100	("3436604" | "3727064" | "3746934" | "3772776" | "4103318" | "4288841" | "4398235" | "4406508" | "4437235" | "4587596" | "4696525" | "4733461" | "4821007" | "4823234" | "4833568" | "4862249" | "4884237" | "4891789" | "4911643" | "4953060" | "4956694" | "4983533" | "5012323" | "5016138" | "5034350" | "5041015" | "5099393" | "5104820" | "5138430" | "5159434" | "5198888" | "5222014" | "5241454" | "5247423" | "5252857" | "5259770" | "5262927" | "5279029" | "5281852" | "5311401" | "5313097" | "5343075" | "5347428" | "5375041" | "5377077" | "5394010" | "5402006" | "5420751" | "5438224" | "5446620" | "5455740" | "5475920" | "5477082" | "5479318" | "5484959" | "5493476" | "5499160" | "5514907" | "5523619" | "5541812" | "5543664" | "5561591" | "5566051" | "5572065"	USPAT
9	L9	28	6 not 7	USPAT; US-PGPUB

	L #	Hits	Sear h Text	DB
10	L10	3320	(174/250,256,257,258,261).ccls.	USPAT; US-PGPUB
11	L11	1175	10 and (reinforc$6 strength$5)	USPAT; US-PGPUB
12	L12	493	11 and (aperture$1 opening$1)	USPAT; US-PGPUB
13	L13	162	12 and (taper$3 widen$3 narrow$3)	USPAT; US-PGPUB
14	L14	331	12 not 13	USPAT; US-PGPUB
15	L15	4	("5844753" | "5857257" | "6184479" | "6217987").PN.	USPAT
16	L16	0	6399899.URPN.	USPAT
17	L17	2	("4357750" | "4631820").PN.	USPAT
18	L18	1	5446245.URPN.	USPAT
19	L19	5	("4931134" | "4978830" | "5065506" | "5088008" | "5278385").PN.	USPAT

	L #	Hit	Search T xt	DBs
20	L20	5	5444188.URPN.	USPAT
21	L21	6	("3610811" | "4493952" | "4883920" | "5010448" | "5025348" | "5130768").PN.	USPAT
22	L22	4	5252781.URPN.	USPAT
23	L23	4	5252781.URPN.	USPAT
24	L24	682	11 not 12	USPAT; US-PGPUB
25	L25	372	24 and (expose$1 exposing)	USPAT; US-PGPUB
26	L26	310	24 not 25	USPAT; US-PGPUB
27	L27	91	26 and support$3	USPAT; US-PGPUB
28	L28	219	26 not 27	USPAT; US-PGPUB

	L #	Hit	Search Text	DBs
29	L29	486	3 and (reinforc$6 strength$5)	USPAT; US-PGPUB
30	L30	360	29 not (12 24)	USPAT; US-PGPUB
31	L31	983	3 not (12 24 30)	USPAT; US-PGPUB
32	L32	372	31 and (aperture$1 opening$1)	USPAT; US-PGPUB
33	L33	190	32 and (expose$1 exposing)	USPAT; US-PGPUB
34	L34	182	32 not 33	USPAT; US-PGPUB
35	L35	100	34 and support$3	USPAT; US-PGPUB

	L #	Hit	Search T xt	DB
36	L36	82	34 not 35	USPAT; US-PGPUB
37	L37	1196	174/255.ccls.	USPAT; US-PGPUB
38	L38	889	37 not (12 24 30 32)	USPAT; US-PGPUB
39	L39	321	38 and (aperture$1 opening$1)	USPAT; US-PGPUB
40	L40	200	38 and (reinforc$6 strength$5)	USPAT; US-PGPUB
41	L41	97	39 and 40	USPAT; US-PGPUB
42	L42	103	40 not 41	USPAT; US-PGPUB

	L #	Hits	S arch Text	DB
43	L43	224	39 not 40	USPAT; US-PGPUB
44	L44	224	43 not 42	USPAT; US-PGPUB
45	L45	224	43 not 41	USPAT; US-PGPUB
46	L46	118	(3 10 37) and suspension	USPAT; US-PGPUB

Application or Docket Number

10/195392

PATENT APPLICATION FEE DETERMINATION RECORD

Effective January 1, 2003

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20=	*
INDEPENDENT CLAIMS	minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	$375	OR	BASIC FEE	$750
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 9	Minus	** 20	—
Independent	* 6	Minus	*** 6	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT FEE		OR	TOTAL ADDIT FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. [illegible]) Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

OIPE JC 41 AUG 2 5 2003 PATENT & TRADEMARK OFFICE

Please type a plus sign (+) inside this box ⟶ [+]

Approved for use through 05/31/2003. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/195,392
Filing Date	July 16, 2002
First Named Inventor	Makoto Komatsubara
Group Art Unit	2841
Examiner Name	John B. Vigushin
Attorney Docket Number	30015280.0001

Total Number of Pages in This Submission: 18

ENCLOSURES *(check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [x] Amendment / Response
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Assignment Papers *(for an Application)*
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] After Allowance Communication to Group
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- [ ] Proprietary Information
- [ ] Status Letter
- [ ] Other Enclosure(s) *(please identify below)*:

Remarks

RECEIVED AUG 26 2003 TECHNOLOGY CENTER 2800

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm *or* Individual name	Jean C. Edwards
Signature	Jean C. Edwards
Date	August 25, 2003

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on this date: ______

Typed or printed name			
Signature		Date	

Attorney Docket No.: 30015280.0001
Customer No.: 26263

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: 2841

U.S. Application No.: 10/195,392

Examiner: John B. Vigushin

Confirmation No.: 2813

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

AMENDMENT UNDER 37 C.F.R. § 1.111

MAIL STOP NON-FEE AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

INTRODUCTORY REMARKS

In response to the Non-Final Office Action dated June 18, 2003, Paper No. 0603, please amend the above-identified application as follows:

AMENDMENTS TO THE SPECIFICATION:

Page 1, the second paragraph was amended as follows:

The wired circuit boards used for electronic/electric ~~equipments~~ equipment are usually provided with terminal portions to connect with external connecting terminals.

Page 1, the third paragraph was amended as follows:

In recent years, the so-called "flying lead" in which the terminal portions are formed on both sides of the conductive pattern, rather than in only either side thereof, is ~~being~~ in widespread use in order to meet the demand for electronic/electric equipment to have increasingly higher density and reduced size. It is known, for example, in a suspension board with circuit used for a hard disk drive that the terminals are provided in the form of flying lead.

Page 2, the second full paragraph was amended as follows:

In this terminal portion formed as the flying lead, since the both sides of the conductive pattern are exposed, the supersonic vibration is easily transmitted to the terminals. This is suitable for the bonding using the supersonic vibration: on the other hand, this provides the disadvantage that the conductive pattern exposed at both sides thereof is weak in physical strength and is subject to stress concentration at edge portions of the openings in the base layer and cover layer, to cause easy disconnection of the conductive pattern ~~with ease~~.

Beginning at page 2, replace the "SUMMARY OF THE INVENTION" section, continuing to page 7, with the following new "SUMMARY OF THE INVENTION" section:

It is the object of the invention to provide a new wired circuit board having a terminal portion formed as a flying lead in which both sides of a conductive pattern are exposed that can provide enhanced strength of the conductive pattern by simple construction to effectively prevent the occurrence of disconnection of the conductive pattern.

The present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

In the wired circuit boards mentioned above, since at least any one of the first insulating layer, the second insulating layer and the conductive pattern has the reinforcing portions for reinforcing the conductive pattern formed at the ends of the opening in the crossing areas where the ends of the opening and the conductive pattern ~~are crossed~~ cross each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example, when the conductive pattern, both sides of which are exposed, is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

In addition, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

In the wired circuit boards mentioned above, since the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to the extending direction of the conductive pattern in the crossing areas where the ends of the opening and the conductive pattern ~~are~~

~~crossed~~ cross each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

Further, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

In the wired circuit boards mentioned above, since the first insulating layer and/or the second insulating layer have projections projecting from the ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern ~~are crossed~~ cross each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

The wired circuit board of the present invention can provide high bonding reliability so that the wired circuit board can be used as the suspension board with circuit, even when formed as the flying lead in which both sides of the conductive pattern are exposed.

Page 16, the first full paragraph was amended as follows:

The wired circuit board 11 has the terminal portion 16 in the form of the flying lead. In the terminal portion 16, widened portions 22 as reinforcing portions which extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 13 are provided in the conductive pattern 13 in crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 ~~are crossed~~ cross each other, as shown in FIG. 1(b).

Page 18, the first full paragraph was amended as follows:

In this formation of the wired circuit board 11, since the widened portions 22 widened in the widthwise direction of the conductive pattern 13 are formed in the conductive pattern 13 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive pattern

13 are crossed each other, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 ~~are~~ is subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

Page 23, the first full paragraph was amended as follows:

In FIG. 9, the suspension board with circuit 31 has a base layer 33, as a first insulating layer of insulating material, which is formed on a supporting board 32 extending longitudinally as a metal supporting layer. A conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, and a cover layer 35 (~~not shown~~ see Fig. 10) is formed on the conductive pattern 34 as a second insulating layer of insulating material. The conductive pattern 34 is provided in the form of the plurality of lines of wire 34a, 34b, 34c and 34d arrayed in parallel with spaced at a predetermined interval.

Page 55, the third full paragraph was amended as follows:

Sequentially, the conductive pattern 34 is covered with the cover layer 35 of insulating material, as shown in FIG. 10(f)-(i). The same insulating material as the insulating material of the base layer ~~35~~ 33 is used for forming the cover layer 35. Preferably, photosensitive polyimide resin is used therefor.

Page 31, the first full paragraph was amended as follows:

As shown in FIG. 11, in the external-side connecting terminals 38 of the suspension board with circuit 31, widened portions 49 as reinforcing portions extending in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 34 are provided in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 ~~are crossed~~ cross each other, as is the case with the wired circuit board 11.

Page 35, the second full paragraph, continuing to page 36, was amended as follows:

In this formation of the suspension board with circuit 31, since the cover-side projections 50 and the base-side projections 51 are formed at the cover layer 35 and the base layer 33 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive patterns 43 ~~are crossed~~ cross each other, so as to project from the ends of the cover-side opening 42/the base-side opening 44 onto the conductive pattern 34 in the cover-side opening 42 and the base-side opening 44, respectively, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 ~~are~~ is subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing improved connection reliability.

Page 36, the third full paragraph, continuing to page 37, was amended as follows:

In this suspension board with circuit 31, the external-side connecting terminals 38 may be formed in such a manner that the conductive pattern 34 is depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 at its portions corresponding to the external-side connecting terminals 38 and also the base-side opening 44 and the supporting-board-side opening 43 are made larger than the areas in which the metal plated layers 45 are formed, as shown in FIG. 15(a). In the external-side connecting terminals 38 thus formed, the widened portion 49 may be formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 ~~are crossed~~ cross each other, as shown in FIG. 12(b).

Page 44, the second full paragraph was amended as follows:

This suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of the flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 18. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing area 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 ~~are crossed~~ cross each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

Page 53, the third full paragraph was amended as follows:

The suspension board with circuit having the external-side connecting terminals produced in the form of the flying lead of the conductive pattern whose lines of wire were covered with the base-side projections at their exposed ends was produced (FIG. 20) in the same operation as in Example 1, except that instead of forming the widened portions in the lines of wire of the conductive pattern, the base-side projections of generally triangle as viewed from the top having the basal width of 110μm and the projection length of 200μm were formed in the base layer in the crossing areas (two areas per each line of wire) where the ends of the base-side opening and the lines of wire ~~are crossed~~ cross each other, so as to project from the ends of the base-side opening onto the conductive pattern in the base-side opening in the process of opening the base layer to form the base-side openings (Cf. FIG. 16(k)).

AMENDMENTS TO THE CLAIMS:

1. (Currently amended) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

2. (Currently amended) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

3. (Original) The wired circuit board according to Claim 2, wherein the wired circuit board is a suspension board with circuit.

4. (Currently amended) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

5. (Currently amended) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

6. (Original) The wired circuit board according to Claim 5, wherein the wired circuit board is a suspension board with circuit.

7. (Currently amended) A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating

layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least one of the first insulating layer ~~and/or~~ and the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing area where the ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

8. (Currently amended) A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least one of the first insulating layer ~~and/or~~ and the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern ~~are crossed~~ cross each other.

9. (Original) The wired circuit board according to Claim 8, wherein the wired circuit board is a suspension board with circuit.

AMENDMENTS TO THE ABSTRACT OF THE DISCLOSURE:

A wired circuit board having a terminal portion formed as a flying lead that can provide enhanced strength of the conductive pattern, both sides of which are exposed, by simple construction to effectively prevent disconnection of the conductive pattern. The wired circuit board having the terminal portion formed as the flying lead in which the both sides of the conductive pattern are exposed includes, in crossing areas where ends of a cover-side opening and ends of a base-side opening and the conductive pattern ~~are crossed~~ cross each other, (i) the widened portions formed in the conductive pattern or (ii) cover-side projections and base-side projections formed in the cover layer and the base layer, respectively.

REMARKS

Claims 1-9 are presently pending in the application. Reconsideration and allowance of all claims are respectfully requested in view of the following remarks.

The Examiner has objected to Claims 1-9 due to informalities. The claims have been amended to obviate any informalities noted by the Examiner.

The Examiner has rejected Claims 1-3 and 7-9 under 35 U.S.C. §102(e) as being anticipated by Yamato et al. (USP 6,388,201 B2).

However, the Examiner has stated that Claims 4, 5 and 6 would be allowable if rewritten or amended to overcome the informalities set forth in the Office Action. Since Claims 4-6 have been amended to overcome any informalities noted by the Examiner, Claims 4-6 should stand allowed.

With respect to Claims 1-3 and 7-9, for the following reasons, the prior art rejection is respectfully traversed.

The Applicants respectfully submit that Yamato et al. do not teach or suggest a wired circuit board wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern cross each other, as recited in Claims 1 and 2.

Rather, Yamato et al. are completely silent with respect to this feature, and the Examiner is "reading into" the reference to assert there are such "reinforcing portions". In particular, there is no mention in the specification, or top view of the board 12, which would show such "reinforcing portions". Further, the portions the Examiner refer to in Yamato et al. as the "reinforcing portions", designated by "a" in Fig. 2, are portions of the base layer 13 that remain after opening 35 is etched (see col. 11, lines 17-30). Thus, the portion of base layer 13 designated as "a" is not a "reinforcing portion", but rather a remainder portion after etching, and would not reinforce the conductive layer 14. Thus, the Examiner is incorrect that "reinforcing portions" are inherent in the Yamato et al. reference.

However, in the present invention, as shown in Fig. 1, widened portions 22 are the reinforcing portions which reinforce the conductive pattern 13 at the area where the opening and conductive patterns cross each other. On the other hand, the "a" shown in Fig. 2 of the cited reference does not have any structure which may reinforce the specific portion such as the above-mentioned crossed portion, because "a" of Fig. 2 of Yamato et al. has the same structure (shape) when viewed from the thickness direction of the paper (i.e., when viewed from the direction perpendicular to the sectional view of Fig. 2).

Accordingly, Claims 1 and 2 are not anticipated by Yamato et al., and the rejection of Claims 1 and 2 under 35 U.S.C. §102(e) should be withdrawn.

Further, since Claim 3 depends from Claim 2, it is also patentably distinguishable over Yamato et al. for the reasons cited above with respect to Claim 2.

With respect to Claims 7 and 8, the Applicants respectfully submit that Yamato et al. do not teach or suggest a wired circuit board wherein at least one of the first insulating layer and the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing area where the ends of the opening and the conductive pattern cross each other.

Rather, Yamato et al. are completely silent with respect to this feature, and similarly with the reinforcing portions above, the Examiner is "reading into" the reference to assert there are such "projecting portions". In particular, there is no mention in the specification, or top view of the board 12, which would show such "projecting portions". Thus, the Examiner can not assert that it is inherent that "projecting portions" are present, since only side views are shown of the base layer 13 and the crossing area at the opening 35 where the base layer 13 and the conductive layer 14 cross one another, and it is not apparent that projecting portions project across the opening 35 onto the conductive layer 14.

Rather, as stated above, rather than projecting portions 25 being formed across the conductive layer 14 as in the present invention, Yamato et al. disclose forming base layer 13 such that a portion was etched away to form opening 35 (see Fig. 6(c)). However, the portion of base layer 13 designated as "a" is not a "projecting portion", but rather a remainder portion after etching. Thus, the Examiner is incorrect that "projecting portions" are inherent in the Yamato et al. reference.

Accordingly, Claims 7 and 8 are not anticipated by Yamato et al., and the rejection of Claims 7 and 8 under 35 U.S.C. §102(e) should be withdrawn.

Further, since Claim 9 depends from Claim 8, it is also patentably distinguishable over Yamato et al. for the reasons cited above with respect to Claim 8.

If the Examiner believes that there is any issue which could be resolved by a telephone or personal interview, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Applicants hereby petition for any extension of time which may be required to maintain the pendency of this case, and any required fee for such an extension is to be charged to Deposit Account No. 19-3140.

Respectfully submitted,

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/195,392	07/16/2002	Makoto Komatsubara	30015280.0001	2813

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EXAMINER	
VIGUSHIN, JOHN B	
ART UNIT	**PAPER NUMBER**
2827	

DATE MAILED: 06/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No.	Applicant(s)	
	10/195,392	KOMATSUBARA ET AL.	
	Examiner	Art Unit	
	John B. Vigushin	2827	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 July 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3 and 7-9* is/are rejected.

7)☒ Claim(s) *4-6* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Objections

1. Claims 1-9 are objected to because of the following informalities:

As to Claims 1 and 2, the last two lines: "are crossed" should be changed to --cross--.

As to Claims 4, 5, 7 and 8, the last line: "are crossed" should be changed to --cross--.

Claims 3, 6 and 9 depend from rejected base claims and therefore inherit the defects in those base claims.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1-3 and 7-9 are rejected under 35 U.S.C. 102(e) as being anticipated by Yamato et al. (US 6,388,201 B2).

The applied reference has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

As to Claim 1, Yamato et al. discloses, in Figs. 2 and 6e: a first insulating layer 13; a conductive pattern 14 on first insulating layer 13; a second insulating layer 18 formed on conductive pattern 14; an opening 34/35 (i.e., comprising openings 34 and 35) and an opening 33 formed at the same position of conductive pattern 14, for allowing first and second insulating layers 13 and 33, respectively, to open, so as to form a terminal portion in which front and back sides of conductive pattern 14 are exposed (Figs. 2 and 6e); first insulating layer 13 has reinforcing portions (i.e., the portions of layer 13 that have length **a** and abut the sides of the region of pattern 14 having plating 19; Figs. 2 and 6e) for inherently reinforcing conductive pattern 14 at ends of the opening 34/35 in crossing areas where ends of opening 34/35 and conductive pattern 14 cross each other.

As to Claim 2, Yamato et al. discloses, in Figs. 2 and 6e: a metal supporting layer 12; a first insulating layer 13 formed on metal supporting layer 12; a conductive pattern 14 on first insulating layer 13; a second insulating layer 18 formed on conductive pattern 14; an opening 34/35 (i.e., comprising openings 34 and 35) and an opening 33 formed at the same position of conductive pattern 14, for allowing metal supporting layer 12 and first and second insulating layers 13 and 33 to open, so as to form a terminal portion in which front and back sides of conductive pattern 14 are exposed (Figs. 2 and 6e); first insulating layer 13 has reinforcing portions (i.e., the portions of layer 13 have length **a** and abut the sides of the region of pattern 14 having plating 19; Figs. 2 and 6e) for inherently reinforcing conductive pattern 14 at ends of the opening 34/35 in crossing areas where ends of opening 34/35 and conductive pattern 14 cross each other.

As to Claim 3, the wired circuit board is a suspension board 12 with circuit (Figs. 1 and 2; col.4: 35-40).

As to Claim 7, Yamato et al. discloses, in Figs. 2 and 6e: a first insulating layer 13; a conductive pattern 14 on first insulating layer 13; a second insulating layer 18 formed on conductive pattern 14; an opening 34/35 (i.e., comprising openings 34 and 35) and an opening 33 formed at the same position of conductive pattern 14, for allowing first and second insulating layers 13 and 33, respectively, to open, so as to form a terminal portion in which front and back sides of conductive pattern 14 are exposed (Figs. 2 and 6e); first insulating layer 13 has projections (i.e., the portions of layer 13 having length **a**; Fig. 2) projecting from ends of opening 34/35 onto the conductive pattern 14 in the opening 34/35 in the crossing areas where the ends of opening 34/35 and conductive pattern 14 cross each other (Fig. 2).

As to Claim 8, Yamato et al. discloses, in Figs. 2 and 6e: a metal supporting layer 12; a first insulating layer 13 formed on metal supporting layer 12; a conductive pattern 14 on first insulating layer 13; a second insulating layer 18 formed on conductive pattern 14; an opening 34/35 (i.e., comprising openings 34 and 35) and an opening 33 formed at the same position of conductive pattern 14, for allowing metal supporting layer 12 and first and second insulating layers 13 and 33 to open, so as to form a terminal portion in which front and back sides of conductive pattern 14 are exposed (Figs. 2 and 6e); first insulating layer 13 has projections (i.e., the portions of layer 13 having length **a**; Fig. 2) projecting from ends of opening 34/35 onto the conductive pattern 14 in the opening 34/35 in the crossing areas where the ends of opening 34/35 and conductive pattern 14 cross each other (Fig. 2).

As to Claim 9, the wired circuit board is a suspension board 12 with circuit (Figs. 1 and 2; col.4: 35-40).

Allowable Subject Matter

4. Claims 4 and 5-6 would be allowable if rewritten or amended to overcome the objection(s) set forth, above, in section 1 of this Office action.

5. The following is a statement of reasons for the indication of allowable subject matter:

As to Claims 4 and 5-6, patentability resides in the limitation wherein *the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern cross each other*, in combination with the other limitations of independent Claims 4 and 5.

6. As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Kilby et al. (US 3,711,626) discloses a wiring board with openings 77 that expose conductive pattern 79 (Fig. 14).

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to John B. Vigushin whose telephone number is 703-308-1205. The examiner can normally be reached on 8:30AM-5:00PM Mo-Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David L. Talbott can be reached on 703-305-9883. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7382 for regular communications and 703-308-7382 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

John B. Vigushin
John B. Vigushin
Examiner
Art Unit 2827

jbv
June 15, 2003

Notice of References Cited	Application/Control No. 10/195,392	Applicant(s)/Patent Under Reexamination KOMATSUBARA ET AL.	
	Examiner John B. Vigushin	Art Unit 2827	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-6,388,201 B2	05-2002	Yamato et al.	174/255
	B	US-3,711,626	01-1973	Kilby et al.	174/251
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	**Application No.**	**Applicant(s)**	
	10/195,392	KOMATSUBARA ET AL.	
	Examiner	**Art Unit**	
	John B. Vigushin	2827	

SEARCHED			
Class	Subclass	Date	Examiner
361	749-751	6/15/2003	JBV
174	254	6/15/2003	JBV

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
East Text Search (see print-out)	6/15/2003	JBV

# Index of Claims	Application No.	Applicant(s)
	10/195,392	KOMATSUBARA ET AL.
	Examiner	**Art Unit**
	John B. Vigushin	2827

·	Rejected	—	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim		Date
Final	Original	6/15/03
	1	√
	2	√
	3	√
	4	O
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	6	O
	7	√
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U.S. Patent and Trademark Office Part of Paper No. 0603

	L #	Hits	Search Text	DBs
1	L1	942	(361/749,750,751).ccls.	USPAT; US-PGPUB
2	L2	730	174/254.ccls.	USPAT; US-PGPUB
3	L3	1420	1 2	USPAT; US-PGPUB
4	L4	232	3 and reinforc$5	USPAT; US-PGPUB
5	L5	76	3 and (widen$3 taper$3)	USPAT; US-PGPUB
6	L6	53	5 not 4	USPAT; US-PGPUB
7	L7	486	3 and width	USPAT; US-PGPUB

	L #	Hits	Search Text	DBs
8	L8	343	7 not (4 6)	USPAT; US-PGPUB
9	L9	695	3 and (opening$1 aperture$1 via$1hole$1 vias)	USPAT; US-PGPUB
10	L10	322	9 not (4 6 8)	USPAT; US-PGPUB

A 10-[illegible]6-02 Receipt #2

PTO/SB/21 (08-00)

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Approved for use through 10/31/2002. OMB 0651-0031
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/195,392
Filing Date	July 16, 2002
First Named Inventor	Makoto Komatsubara
Group Art Unit	2841
Examiner Name	Not yet assigned
Attorney Docket Number	30015280.0001

Total Number of Pages in This Submission: 3

ENCLOSURES *(check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment / Response
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Assignment Papers *(for an Application)*
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s)
- [ ] After Allowance Communication to Group
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) *(please identify below)*:

  Request for Corrected Filing Receipt

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm *or* Individual name	Jean C. Edwards
Signature	Jean C. Edwards
Date	October 8, 2002

30412
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Attorney Docket No.: 30015280.0001
Customer No.: 30412

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: 2841

U.S. Application No.: 10/195,392

Examiner: Not yet assigned

Confirmation No.: 2813

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

REQUEST FOR CORRECTED FILING RECEIPT

Office of Initial Patent Examination's
Filing Receipt Corrections
Assistant Commissioner for Patents and Trademarks
Washington, D.C. 20231

Sir:

Attached is a copy of the Filing Receipt for the above-identified application, for which the following correction is requested:

Applicants: [Tadeo] Tadao Ookawa, Osaka, Japan

The requested correction is marked in red. A Corrected Filing Receipt is requested.

Respectfully submitted,

Jean C. Edwards

Jean C. Edwards
Registration No. 41,728

Sonnenschein Nath & Rosenthal
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Washington, D.C. 20005
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Facsimile: 202/408-6399
Date: October 8, 2002
25055601\V1

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WASHINGTON, D.C. 20231
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APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
10/195,392	07/16/2002	2841	992	30015280.0001	15	9	6

CONFIRMATION NO. 2813

FILING RECEIPT

OC000000008804512

30412
SONNENSCHEIN NATH & ROSENTHAL
1301 K STREET NW, SUITE 600
EAST TOWER
WASHINGTON, DC 20005

Date Mailed: 09/18/2002

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Filing Receipt Corrections, facsimile number 703-746-9195. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Makoto Komatsubara, Osaka, JAPAN;
Shigenori Morita, Osaka, JAPAN;
Tadao Tadeo Ookawa, Osaka, JAPAN;
Toshio Shintani, Osaka, JAPAN;

Domestic Priority data as claimed by applicant

Foreign Applications

JAPAN 2001-216812 07/17/2001

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Non-Publication Request: No

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Title

Wired circuit board

0280

PTO/SB/21 (08-00)

Approved for use through 10/31/2002. OMB 0651-0031

U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Group Art Unit	Not yet assigned
Examiner Name	Not yet assigned
Attorney Docket Number	30015280.0001

Total Number of Pages in This Submission: 64

ENCLOSURES *(check all that apply)*

- [ ] Fee Transmittal Form
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- [ ] Amendment / Response
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [x] Certified Copy of Priority Document- (Japanese Priority Document Number 2001-216812)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Assignment Papers *(for an Application)*
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
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- [ ] After Allowance Communication to Group
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- [ ] Proprietary Information
- [ ] Status Letter
- [ ] Other Enclosure(s) *(please identify below)*:

Remarks

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Firm *or* Individual name	Jean C. Edwards
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Attorney Docket No.: 30015280.0001
Customer No.: 30412

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: Not yet assigned

U.S. Application No.: 10/195,392

Examiner: Not yet assigned

Confirmation No.: Not yet assigned

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

SUBMISSION OF PRIORITY DOCUMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please find enclosed Priority Document number 2001-216812, filed July 17, 2001 in the Japan Patent Office, from which the above-identified application claims priority. The Examiner is respectfully requested to acknowledge receipt of the Priority Document.

Respectfully submitted,

Jean C. Edwards

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Date: August 7, 2002
25052665\V1

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別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed with this Office

出願年月日
Date of Application:　　２００１年　７月１７日

出願番号
Application Number:　　特願２００１－２１６８１２

[ST.10/C]:　　[ＪＰ２００１－２１６８１２]

出願人
Applicant(s):　　日東電工株式会社

２００２年　７月　２日

特許庁長官
Commissioner,
Japan Patent Office　　及川耕造

出証番号　出証特２００２－３０５２６６３

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【整理番号】　101076
【提出日】　平成13年 7月17日
【あて先】　特許庁長官殿
【国際特許分類】　H05K　1/11
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【納付金額】　21,000円

【提出物件の目録】

【物件名】　明細書　1

【物件名】　図面　1

【物件名】　要約書　1

【プルーフの要否】　要

【書類名】　　明細書

【発明の名称】　配線回路基板

【特許請求の範囲】

【請求項１】　第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記第１絶縁層および前記第２絶縁層が開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、

前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層、前記第２絶縁層および前記導体パターンの少なくともいずれかには、前記開口部の端縁部における前記導体パターンを補強するための補強部が形成されていることを特徴とする、配線回路基板。

【請求項２】　金属支持層の上に第１絶縁層が形成され、前記第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記金属支持層および前記第１絶縁層と、前記第２絶縁層とが開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、

前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層、前記第２絶縁層および前記導体パターンの少なくともいずれかには、前記開口部の端縁部における前記導体パターンを補強するための補強部が形成されていることを特徴とする、配線回路基板。

【請求項３】　第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記第１絶縁層および前記第２絶縁層が開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、

前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記導体パターンには、前記導体パターンが延びる方向と実質的に直交する幅方向に

広がる幅広部が形成されていることを特徴とする、配線回路基板。

【請求項４】　金属支持層の上に第１絶縁層が形成され、前記第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記金属支持層および前記第１絶縁層と、前記第２絶縁層とが開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、

前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記導体パターンには、前記導体パターンが延びる方向と実質的に直交する幅方向に広がる幅広部が形成されていることを特徴とする、配線回路基板。

【請求項５】　第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記第１絶縁層および前記第２絶縁層が開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、

前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層および／または前記第２絶縁層には、前記開口部の端縁部から前記開口部内の前記導体パターンの上に突出する突出部が形成されていることを特徴とする、配線回路基板。

【請求項６】　金属支持層の上に第１絶縁層が形成され、前記第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記金属支持層および前記第１絶縁層と、前記第２絶縁層とが開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、

前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層および／または前記第２絶縁層には、前記開口部の端縁部から前記開口部内の前記導体パターンの上に突出する突出部が形成されていることを特徴とする、配線回路基板。

【請求項７】　前記配線回路基板が、回路付サスペンション基板であることを特徴とする、請求項１～６のいずれかに記載の配線回路基板。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】

本発明は、配線回路基板、詳しくは、回路付サスペンション基板として好適に用いられる、配線回路基板に関する。

【０００２】

【従来の技術】

電子・電気機器などに用いられる配線回路基板には、通常、外部端子と接続するための端子部が形成されている。

【０００３】

このような端子部として、近年、電子・電気機器の高密度化および小型化に対応すべく、導体パターンの片面だけではなく、その導体パターンの両面に形成されるいわゆるフライングリードが普及しつつあり、例えば、ハードディスクドライブに用いられる回路付サスペンション基板などにおいては、端子部をフライングリードとして形成することが知られている。

【０００４】

より具体的には、回路付サスペンション基板は、例えば、図２１に示すように、ステンレス箔からなる支持基板１と、その支持基板１の上に形成される絶縁体からなるベース層２と、そのベース層２の上に、所定の配線回路パターンとして形成される導体パターン３と、その導体パターン３を被覆する絶縁体からなるカバー層４とを備えており、フライングリードとして形成される端子部５は、カバー層４が開口形成されることにより導体パターン３の表面を露出させるとともに、支持基板１およびベース層２を開口させることにより、導体パターン３の裏面を露出させ、その露出された導体パターン３の両面に、必要により、ニッケル／金めっきなどにより、金属めっき層６を形成することにより形成されている。

【０００５】

そして、このようなフライングリードとして形成される端子部は、例えば、ボ

ンディングツールなどを用いて、超音波振動を加えることにより、外部端子と接続される。

【０００６】

【発明が解決しようとする課題】

しかし、このようなフライングリードとして形成される端子部では、導体パターンの両面が露出しているので、超音波が伝達されやすく、超音波振動による接合には適している反面、物理的強度が弱く、ベース層およびカバー層の開口部の端縁部において、両面が露出する導体パターンに応力が集中して断線しやすいという不具合がある。

【０００７】

本発明は、このような不具合に鑑みなされたもので、その目的とするところは、簡易な構成により、端子部をフライングリードとして形成し、両面が露出される導体パターンの強度を確保して、その導体パターンの断線を有効に防止することのできる配線回路基板を提供することにある。

【０００８】

【課題を解決するための手段】

上記目的を達成するために、本発明は、第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記第１絶縁層および前記第２絶縁層が開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層、前記第２絶縁層および前記導体パターンの少なくともいずれかには、前記開口部の端縁部における前記導体パターンを補強するための補強部が形成されていることを特徴としている。

【０００９】

また、本発明は、金属支持層の上に第１絶縁層が形成され、前記第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記金属支持層および前記第１絶縁層と、前記第２絶縁層とが開口される開口部が形成されることにより、前記導

体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層、前記第２絶縁層および前記導体パターンの少なくともいずれかには、前記開口部の端縁部における前記導体パターンを補強するための補強部が形成されている、配線回路基板を含んでいる。

【００１０】

上記の配線回路基板によれば、開口部の端縁部と導体パターンとの交差部分において、第１絶縁層、第２絶縁層および導体パターンの少なくともいずれかに、開口部の端縁部における導体パターンを補強するための補強部が形成されているので、その開口部の端縁部における導体パターンの物理的強度を補強することができる。そのため、たとえば、その端子部と外部端子とをボンディングツールにより超音波振動を加えて接続するような場合において、開口部の端縁部において両面が露出する導体パターンに応力が集中しても、その導体パターンの断線を有効に防止することができ、接続信頼性を向上させることができる。

【００１１】

また、本発明は、第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記第１絶縁層および前記第２絶縁層が開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記導体パターンには、前記導体パターンが延びる方向と実質的に直交する幅方向に広がる幅広部が形成されている、配線回路基板を含んでいる。

【００１２】

また、本発明は、金属支持層の上に第１絶縁層が形成され、前記第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記金属支持層および前記第１絶縁層と、前記第２絶縁層とが開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、前記開口部の端縁部と前記導体パターンとが交差する交差部分において

、前記導体パターンには、前記導体パターンが延びる方向と実質的に直交する幅方向に広がる幅広部が形成されている、配線回路基板を含んでいる。

【００１３】

上記の配線回路基板によれば、開口部の端縁部と導体パターンとの交差部分において、導体パターンには、その導体パターンが延びる方向と実質的に直交する幅方向に広がる幅広部が形成されているので、その開口部の端縁部における導体パターンの物理的強度を補強することができる。そのため、たとえば、その端子部と外部端子とをボンディングツールにより超音波振動を加えて接続するような場合において、開口部の端縁部において両面が露出する導体パターンに応力が集中しても、その導体パターンの断線を有効に防止することができ、接続信頼性を向上させることができる。

【００１４】

また、本発明は、第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記第１絶縁層および前記第２絶縁層が開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層および／または前記第２絶縁層には、前記開口部の端縁部から前記開口部内の前記導体パターンの上に突出する突出部が形成されている、配線回路基板を含んでいる。

【００１５】

また、本発明は、金属支持層の上に第１絶縁層が形成され、前記第１絶縁層の上に導体パターンが形成され、前記導体パターンの上に第２絶縁層が形成されており、前記導体パターンの同じ位置において、前記金属支持層および前記第１絶縁層と、前記第２絶縁層とが開口される開口部が形成されることにより、前記導体パターンの表面および裏面が露出する端子部が形成されている配線回路基板であって、前記開口部の端縁部と前記導体パターンとが交差する交差部分において、前記第１絶縁層および／または前記第２絶縁層には、前記開口部の端縁部から前記開口部内の前記導体パターンの上に突出する突出部が形成されている、配線

回路基板を含んでいる。

【００１６】

上記の配線回路基板によれば、開口部の端縁部と導体パターンとの交差部分において、第１絶縁層および／または第２絶縁層には、開口部の端縁部から開口部内の導体パターンの上に突出する突出部が形成されているので、その開口部の端縁部における導体パターンの物理的強度を補強することができる。そのため、たとえば、その端子部と外部端子とをボンディングツールにより超音波振動を加えて接続するような場合において、開口部の端縁部において両面が露出する導体パターンに応力が集中しても、その導体パターンの断線を有効に防止することができ、接続信頼性を向上させることができる。

【００１７】

そして、上記した本発明の前記配線回路基板は、導体パターンの両面が露出するいわゆるフライングリードとして形成しても、接続信頼性が高く、回路付サスペンション基板として好適に用いることができる。

【００１８】

【発明の実施の形態】

図１は、本発明の配線回路基板の一実施形態であって、（ａ）は、その端子部における要部断面図、（ｂ）は、その端子部における平面図である。図１（ａ）において、この配線回路基板１１は、絶縁体からなる第１絶縁層としてのベース層１２の上に、所定の配線回路パターンとして形成される導体パターン１３が形成され、その導体パターン１３の上に、絶縁体からなる第２絶縁層としてのカバー層１４が形成されている。なお、導体パターン１３は、図１（ｂ）に示すように、互いに所定の間隔を隔てて平行状に配置される複数の配線１３ａ、１３ｂ、１３ｃおよび１３ｄとして形成されている。

【００１９】

ベース層１２およびカバー層１４の絶縁体としては、例えば、ポリイミド樹脂、アクリル樹脂、ポリエーテルニトリル樹脂、ポリエーテルスルホン樹脂、ポリエチレンテレフタレート樹脂、ポリエチレンナフタレート樹脂、ポリ塩化ビニル樹脂などの合成樹脂が用いられ、好ましくは、ポリイミド樹脂が用いられる。

【００２０】

また、ベース層１２およびカバー層１４の厚みは、通常、１～３０μm、好ましくは、２～２０μmである。

【００２１】

また、導体パターン１３を形成する導体としては、例えば、銅、ニッケル、金、はんだ、またはこれらの合金などが用いられ、好ましくは、銅が用いられる。また、導体パターン１３の厚みは、通常、２～３０μm、好ましくは、５～２０μmである。

【００２２】

そして、このような配線回路基板１１は、図３（ａ）に示すように、まず、フィルム状に形成されたベース層１２の上に、サブトラクティブ法、アディティブ法、セミアディティブ法などの公知のパターンニング法によって、所定の配線回路パターンとして導体パターン１３を形成し、次いで、図３（ｂ）に示すように、その導体パターン１３の上に、例えば、フィルム状樹脂の接着、または、感光性樹脂の塗布および硬化などの公知の方法によって、ベース層１４が被覆されることによって、形成されている。

【００２３】

そして、この配線回路基板１１では、図１（ａ）に示すように、導体パターン１３の同じ位置において、カバー層１４を開口して導体パターン１３の表面を露出させるとともに、ベース層１２を開口して導体パターン１３の裏面を露出させることにより、導体パターン１３の表面および裏面を露出させ、その露出した導体パターン１３の両面に金属めっき層１５をそれぞれ形成することにより、フライングリードとして端子部１６が形成されている。

【００２４】

このような端子部１６は、図３（ｃ）に示すように、まず、カバー層１４における端子部１６が形成される部分に、ドリル穿孔、レーザ加工、エッチング、感光性樹脂のパターンニングなど公知の方法によってカバー側開口部１７を開口形成するとともに、図３（ｄ）に示すように、そのカバー側開口部１７に対向するベース層１２の部分に、同じく、ドリル穿孔、レーザ加工、エッチング、感光性

樹脂のパターンニングなど公知の方法によってベース側開口部１８を開口形成する。なお、このカバー側開口部１７およびベース側開口部１８は、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄを含むような矩形状に開口形成される。

【００２５】

そして、図３（ｅ）に示すように、これらカバー側開口部１７内およびベース側開口部１８内に露出した導体パターン１３の表面および裏面に、めっきにより金属めっき層１５を形成することによって、形成することができる。

【００２６】

金属めっき層１５の形成は、特に制限されず、電解めっきおよび無電解めっきのいずれの方法を用いてもよく、また、めっきに用いる金属も、特に制限されず、公知の金属を用いることができる。好ましくは、電解ニッケルめっきと電解金めっきとを順次行なうことにより、ニッケルめっき層１９の上に金めっき層２０を形成する。なお、ニッケルめっき層１９および金めっき層２０の厚さは、いずれも、１～５μｍ程度であることが好ましい。

【００２７】

そして、この配線回路基板１１では、図１（ｂ）に示すように、このようなフライングリードとして形成される端子部１６において、カバー側開口部１７およびベース側開口部１８の端縁部と導体パターン１３とが交差する交差部分２１における導体パターン１３には、その導体パターン１３が延びる方向と実質的に直交する幅方向に広がる補強部としての幅広部２２が形成されている。

【００２８】

より具体的には、この幅広部２２は、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄにおける長手方向に沿って所定の間隔を隔てて交差部分２１に対向する位置にそれぞれ（２つ）形成され、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄにおける幅方向に膨出するようなほぼ円形に形成されている。

【００２９】

各幅広部２２は、図２に示すように、その幅方向の最長部分２３を境として、ほぼ外側半分がカバー層１４およびベース層１２に埋設されるとともに、ほぼ内側半分がカバー側開口部１７およびベース側開口部１８において露出するように

配置されている。これによって、端子部１６は、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄがカバー側開口部１７内およびベース側開口部１８内の両側端部において幅方向に膨出するダンベル形状としてそれぞれ形成される。

【００３０】

また、各幅広部２２は、その幅方向の最長部分２３が、カバー側開口部１７およびベース側開口部１８において露出している各配線１３ａ、１３ｂ、１３ｃおよび１３ｄの通常のライン幅２４に対して、１．１～４倍、好ましくは、２～３倍として形成されており、より具体的には、その幅方向の最長部分２３の長さが、２０～１０００μｍで、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄが延びる方向に沿う長手方向の長さが、５０～５００μｍで形成されている。

【００３１】

なお、各幅広部２２の形状は、その幅方向に膨出するような形状であって、通常の幅よりも広く形成されていれば、特にほぼ円形に限定されることはなく、例えば、矩形状などであってもよい。

【００３２】

そして、このような幅広部２２を有する端子部１６は、上記した導体パターン１３の形成において、幅広部２２を配線回路パターンのパターンニングとともに形成しておき、図３（ｃ）および（ｄ）に示す工程において、カバー層１４およびベース層１２を、その幅広部２２の最長部分２３が交差部分２１に配置されるように開口することによってカバー側開口部１７およびベース側開口部１８を形成した後、図３（ｅ）に示す工程において、それらカバー側開口部１７内およびベース側開口部１８内において露出する導体パターン１３の両面に金属めっき層１５を形成することにより、形成すればよい。

【００３３】

このような配線回路基板１１によれば、カバー側開口部１７およびベース側開口部１８の端縁部と導体パターン１３とが交差する交差部分２１における導体パターン１３には、その導体パターン１３の幅方向に広がる幅広部２２が形成されているので、そのカバー側開口部１７およびベース側開口部１８の端縁部における導体パターン１３の物理的強度を補強することができる。そのため、たとえば

、その端子部１６と外部端子とをボンディングツールにより超音波振動を加えて接続するような場合において、カバー側開口部１７およびベース側開口部１８の端縁部において両面が露出する導体パターン１３に応力が集中しても、その導体パターン１３の断線を有効に防止することができ、接続信頼性を向上させることができる。

【００３４】

また、この配線回路基板１１においては、図４に示すように、このようなフライングリードとして形成される端子部１６において、カバー側開口部１７およびベース側開口部１８の端縁部と導体パターン１３とが交差する交差部分２１におけるカバー層１４に、カバー側開口部１７の端縁部からカバー側開口部１７内の導体パターン１３の上に突出する補強部としてのカバー側突出部２５を形成するとともに、交差部分２１におけるベース層１２にも、ベース側開口部１８の端縁部からベース側開口部１８内の導体パターン１３の上に突出する補強部としてのベース側突出部２６を形成してもよい。

【００３５】

より具体的には、これらカバー側突出部２５およびベース側突出部２６は、図４（ｂ）に示すように、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄにおける長手方向に沿って所定の間隔を隔てて交差部分２１に対向する位置にそれぞれ（２つ）形成され、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄが延びる方向に沿ってカバー側開口部１７およびベース側開口部１８の端縁部から内側にそれぞれ突出する凸状に形成されている。

【００３６】

各カバー側突出部２５および各ベース側突出部２６は、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄに重なり、カバー側開口部１７およびベース側開口部１８の内側に向かって、次第にその重なりが少なくなるような先細状（平面視略三角形状）に形成されており、これによって、端子部１６は、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄがカバー側開口部１７内およびベース側開口部１８内の両側端部において、各カバー側突出部２５および各ベース側突出部２６によって被覆されるような形状に形成される。

【００３７】

また、各カバー側突出部２５および各ベース側突出部２６は、図５に示すように、カバー側開口部１７およびベース側開口部１８において露出している各配線１３ａ、１３ｂ、１３ｃおよび１３ｄのライン長さ２９に対して、４～３０分の１、好ましくは、５～２０分の１の突出長さ２７で突出形成されており、より具体的には、カバー側開口部１７およびベース側開口部１８の端縁部において、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄのライン幅２４よりもやや狭い５～２５０μｍの基幅２８で、その内側に向かって先細状に、５～２５０μｍの突出長さ２７で突出され、その先端部が各配線１３ａ、１３ｂ、１３ｃおよび１３ｄの幅方向中央部に配置されるような略三角形状に形成されている。

【００３８】

なお、各カバー側突出部２５および各ベース側突出部２６は、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄが延びる長手方向に重なって突出するような形状であれば、図５に示すような形状に限定されることはなく、例えば、図６に示すように、カバー側開口部１７およびベース側開口部１８の端縁部において、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄのライン幅２４よりもやや広い基幅２８で、その内側に向かって先細状に突出形成されていてもよく、さらには、略三角形状に形成しなくても、例えば、各配線１３ａ、１３ｂ、１３ｃおよび１３ｄが延びる長手方向に重なる矩形状に形成してもよい。

【００３９】

そして、このようなカバー側突出部２５およびベース側突出部２６を有する端子部１６は、図３（ｃ）に示す工程において、カバー側突出部２５が形成されるようにカバー層１４を開口してカバー側開口部１７を形成するとともに、図３（ｄ）に示す工程において、ベース側突出部２６が形成されるようにベース層１２を開口してベース側開口部１８を形成した後、図３（ｅ）に示す工程において、それらカバー側開口部１７内およびベース側開口部１８内において露出する導体パターン１３の両面に金属めっき層１５を形成することにより、形成すればよい。

【００４０】

このような配線回路基板１１によれば、カバー側開口部１７およびベース側開口部１８の端縁部と導体パターン１３とが交差する交差部分２１におけるカバー層１４およびベース層１２には、カバー側開口部１７およびベース側開口部１８の端縁部からカバー側開口部１７内およびベース側開口部１８内の導体パターン１３の上に突出するカバー側突出部２５およびベース側突出部２６がそれぞれ形成されているので、そのカバー側開口部１７およびベース側開口部１８の端縁部における導体パターン１３の物理的強度を補強することができる。そのため、たとえば、その端子部１６と外部端子とをボンディングツールにより超音波振動を加えて接続するような場合において、カバー側開口部１７およびベース側開口部１８の端縁部において両面が露出する導体パターン１３に応力が集中しても、その導体パターン１３の断線を有効に防止することができ、接続信頼性を向上させることができる。

【００４１】

なお、この配線回路基板１１においては、必ずしも、各カバー側突出部２５および各ベース側突出部２６の両方を形成せずとも、例えば、図７に示すように、カバー側突出部２５のみを形成してもよく、また、例えば、図８に示すように、ベース側突出部２６のみを形成してもよい。

【００４２】

さらには、図示しないが、上記したように、導体パターン１３に幅広部２２を形成するとともに、カバー層１４にはカバー側突出部２５を、および／または、ベース層１２にはベース側突出部２６を形成してもよい。

【００４３】

そして、このような端子部１６を有する配線回路基板１１は、とりわけ、回路付サスペンション基板に、好適に適用することができる。

【００４４】

図９は、本発明の配線回路基板の一実施形態としての回路付サスペンション基板を示す斜視図である。この回路付サスペンション基板３１は、ハードディスクドライブの磁気ヘッド（図示せず）を実装して、その磁気ヘッドを、磁気ヘッドと磁気ディスクとが相対的に走行する時の空気流に抗して、磁気ディスクとの間

に微小な間隔を保持しながら支持するものであり、磁気ヘッドと、外部の回路としてのリード・ライト基板３９とを接続するための配線３４ａ、３４ｂ、３４ｃおよび３４ｄが、所定の配線回路パターンとして一体的に形成されている。

【００４５】

図９において、この回路付サスペンション基板３１は、長手方向に延びる金属支持層としての支持基板３２の上に、絶縁体からなる第１絶縁層としてのベース層３３が形成されており、そのベース層３３の上に、所定の配線回路パターンとして導体パターン３４が形成され、その導体パターン３４の上に、絶縁体からなる第２絶縁層としてのカバー層３５（図示せず）が形成されている。なお、導体パターン３４は、互いに所定の間隔を隔てて平行状に配置される複数の配線３４ａ、３４ｂ、３４ｃおよび３４ｄとして形成されている。

【００４６】

支持基板３２の先端部には、その支持基板３２を切り込むことによって、磁気ヘッドを実装するためのジンバル３６が形成されている。また、その支持基板３２の先端部には、磁気ヘッドと各配線３４ａ、３４ｂ、３４ｃおよび３４ｄとを接続するための磁気ヘッド側接続端子３７が形成されるとともに、支持基板３２の後端部には、リード・ライト基板３９と各配線３４ａ、３４ｂ、３４ｃおよび３４ｄとを接続するための端子部としての外部側接続端子３８が形成されている。この外部側接続端子３８は、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄの端部において、各リードライト端子５４に対応してそれぞれ形成されている。

【００４７】

そして、このような回路付サスペンション基板３１は、次のようにして形成することができる。すなわち、まず、図１０（ａ）～（ｄ）に示すように、支持基板３２を用意して、その支持基板３２の上に、所定のパターンでベース層３３を形成する。支持基板３２としては、金属箔または金属薄板を用いることが好ましく、例えば、ステンレス、４２アロイなどが好ましく用いられる。また、その厚さが、１０～６０μｍ、さらには、１５～３０μｍ、その幅が、５０～５００ｍｍ、さらには、１２５～３００ｍｍのものが好ましく用いられる。

【００４８】

また、ベース層３３を形成するための絶縁体としては、特に制限されず、例えば、ポリイミド樹脂、アクリル樹脂、ポリエーテルニトリル樹脂、ポリエーテルスルホン樹脂、ポリエチレンテレフタレート樹脂、ポリエチレンナフタレート樹脂、ポリ塩化ビニル樹脂などの合成樹脂が用いられる。これらのうち、感光性樹脂が好ましく用いられ、感光性ポリイミド樹脂がさらに好ましく用いられる。

【００４９】

そして、例えば、感光性ポリイミド樹脂を用いて、支持基板３２の上に、所定のパターンでベース層３３を形成する場合には、まず、図１０（ａ）に示すように、予め用意された支持基板３２の上に、感光性ポリイミド樹脂前駆体の溶液を、その支持基板１２の全面に塗布した後、例えば、６０～１５０℃で乾燥することにより、感光性ポリイミド樹脂前駆体の皮膜３３ｐを形成する。

【００５０】

次に、図１０（ｂ）に示すように、その皮膜３３ｐを、フォトマスク４０を介して露光させ、必要により露光部分を所定の温度に加熱した後、図１０（ｃ）に示すように、現像することにより、皮膜３３ｐを所定のパターンとする。なお、露光のための照射光は、その露光波長が、３００～４５０ｎｍ、さらには、３５０～４２０ｎｍであることが好ましく、その露光積算光量が、１００～１０００ｍＪ／ｃｍ^2、さらには、２００～７００ｍＪ／ｃｍ^{2}であることが好ましい。また、照射された皮膜３３ｐの露光部分は、例えば、１３０℃以上１５０℃未満で加熱することにより、次の現像処理において可溶化（ポジ型）し、また、例えば、１５０℃以上１８０℃以下で加熱することにより、次の現像処理において不溶化（ネガ型）する。また、現像は、例えば、アルカリ現像液などの公知の現像液を用いて、浸漬法やスプレー法などの公知の方法により行なえばよい。なお、この方法においては、ネガ型でパターンを得ることが好ましく、図１０においては、ネガ型でパターンニングする態様として示されている。

【００５１】

次いで、図１０（ｄ）に示すように、このようにしてパターン化されたポリイミド樹脂前駆体の皮膜３３ｐを、例えば、最終的に２５０℃以上に加熱することによって、硬化（イミド化）させ、これによって、ポリイミド樹脂からなるベー

ス層３３を所定のパターンで形成する。なお、このようにして形成されるベース層３３の厚さは、例えば、２～３０μm、好ましくは、５～２０μmである。

【００５２】

次いで、図１０（ｅ）に示すように、ベース層３３の上に、導体パターン３４を、所定の配線回路パターンとして形成する。導体パターン３４を形成するための導体としては、例えば、銅、ニッケル、金、はんだ、またはこれらの合金などの金属が用いられ、好ましくは、銅が用いられる。所定の配線回路パターンで導体パターン３４を形成するには、ベース層３３の表面に、導体パターン３４を、例えば、サブトラクティブ法、アディティブ法、セミアディティブ法などの公知のパターンニング法によって、所定の配線回路パターンとして形成すればよく、この方法においては、セミアディティブ法が好ましく用いられる。

【００５３】

このようにして形成される導体パターン３４は、上記したように、互いに所定の間隔を隔てて平行状に配置される複数の配線３４ａ、３４ｂ、３４ｃおよび３４ｄのパターンであって、その厚さは、例えば、２～３０μm、好ましくは、５～２０μmであり、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄのライン幅は、例えば、１０～５００μm、好ましくは、３０～２００μmであり、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄ間の間隔（スペース幅）は、例えば、１０～５００μm、好ましくは、３０～２００μmである。

【００５４】

次いで、図１０（ｆ）～（ｉ）に示すように、導体パターン３４を、絶縁体からなるカバー層３５により被覆する。カバー層３５を形成するための絶縁体としては、ベース層３５と同様の絶縁体が用いられ、好ましくは、感光性ポリイミド樹脂が用いられる。

【００５５】

そして、例えば、感光性ポリイミド樹脂を用いて、カバー層３５を形成するには、図１０（ｆ）に示すように、まず、支持基板３２およびベース層３３の全面に、感光性ポリイミド樹脂前駆体の溶液を塗布した後、ベース層３３のパターンニングと同様に、例えば、６０～１５０℃で乾燥することにより、感光性ポリイ

ミド樹脂前駆体の皮膜３５ｐを形成し、次に、図１０（ｇ）に示すように、その皮膜３５ｐを、フォトマスク４１を介して露光させ、必要により露光部分を所定の温度に加熱した後、図１０（ｈ）に示すように、現像することにより、皮膜３５ｐによって、導体パターン３４が被覆されるようにパターン化する。

【００５６】

なお、このパターン化において、外部側接続端子３８が形成される部分には、導体パターン３４の表面が露出するように、その外部側接続端子３８が形成される部分にフォトマスク４１を対向配置して、カバー側開口部４２が形成されるようにする。より具体的には、このカバー側開口部４２は、後述するように外部側接続端子３８をフライングリードとして形成するために、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄを含むような矩形状に開口形成される。

【００５７】

また、この露光および現像の条件は、ベース層３３を露光および現像する条件と同様の条件でよく、図１０においては、ベース層３３と同様に、ネガ型でパターンニングする態様として示されている。

【００５８】

そして、このようにしてパターン化されたポリイミド樹脂前駆体の皮膜３５ｐを、図１０（ｉ）に示すように、例えば、最終的に２５０℃以上に加熱することによって、硬化（イミド化）させ、これによって、ポリイミド樹脂からなるカバー層３５を、導体パターン３４の上に形成する。なお、カバー層３５の厚さは、例えば、１～３０μｍ、好ましくは、２～５μｍである。

【００５９】

また、このカバー層３５を形成する前に、予め導体パターン３４を、ニッケルめっきによって硬質ニッケルの薄膜で保護するようにしておいてもよい。

【００６０】

そして、このようにして形成される回路付サスペンション基板３１では、図１０（ｊ）～（ｌ）に示すように、外部側接続端子３８が、導体パターン３４の両面が露出するフライングリードとして形成されている。

【００６１】

すなわち、外部側接続端子３８を、導体パターン３４の両面が露出した端子として形成するには、まず、図１０（ｊ）に示すように、支持基板３２における外部側接続端子３８が形成される部分、すなわち、カバー層３５のカバー側開口部４２に対向する部分にベース層３３が露出するように支持基板側開口部４３を形成する。この支持基板側開口部４３の形成は、公知の方法でよく、例えば、支持基板３２における支持基板側開口部４３を形成する部分以外をすべてマスキングした後に、化学エッチングすればよい。

【００６２】

次いで、図１０（ｋ）に示すように、支持基板３２の支持基板側開口部４３内において露出しているベース層３３に、導体パターン３４が露出するようにベース側開口部４４を形成する。このベース側開口部４４の形成は、公知の方法でよいが、エッチング、とりわけ、プラズマエッチングにより形成することが好ましい。エッチングによれば、ベース層３３の露出面から、導体パターン３４の裏面までの間のベース層３３を、正確に削ることができる。

【００６３】

このプラズマエッチングでは、支持基板３２をマスクとして、その支持基板３２の支持基板側開口部４３に露出するベース層３３の全体をエッチングすればよく、例えば、所定のガスを封入した雰囲気下で対向電極間に、サンプルを配置して、高周波プラズマを発生させるようにする。所定のガスとしては、例えば、Ｈｅ、Ｎｅ、Ａｒ、Ｘｅ、Ｋｒ、N_2、O_2、CF_4、NF_3などが用いられる。好ましくは、Ａｒ、O_2、CF_4、NF_3が用いられる。これらのガスは、所定の割合で混合して用いてもよい。また、そのガス圧（真空度）は、例えば、０．５～２００Ｐａ、好ましくは、１０～１００Ｐａである。また、高周波プラズマを発生させる条件としては、周波数が、例えば、１０ｋＨｚ～２０ＭＨｚ、好ましくは、１０ｋＨｚ～１００ｋＨｚであり、処理電力が、例えば、０．５～１０W/cm^2、好ましくは、１～５W/cm^2である。周波数が１０ｋＨｚ～１００ｋＨｚであると、プラズマエッチング装置のマッチング（抵抗値のチューニング）がとりやすくなる。そして、このような雰囲気条件下において、例えば、０～１２０℃、好ましくは、１０～８０℃に温度管理された電極上にサンプルを配

置して、ベース層３３をエッチングする厚さに相当する所定の時間処理すればよい。

【００６４】

そして、このようにして形成されるベース層３３のベース側開口部４４は、支持基板３２をマスクとして形成されるので、支持基板３２の支持基板側開口部４３と同じ大きさおよび形で開口形成される。

【００６５】

その後、図１０（１）に示すように、このように露出している導体パターン３４の両面に、金属めっき層４５を、めっきにより同時に形成する。金属めっき層４５の形成は、特に制限されず、電解めっきおよび無電解めっきのいずれの方法を用いてもよく、また、めっきに用いる金属も、特に制限されず、公知の金属を用いることができる。好ましくは、電解ニッケルめっきと電解金めっきとを順次行なうことにより、ニッケルめっき層４６の上に金めっき層４７を形成する。なお、ニッケルめっき層４６および金めっき層４７の厚さは、いずれも、１～５μｍ程度であることが好ましい。これによって、外部側接続端子３８が、両面が露出した状態で形成される。

【００６６】

そして、この回路付サスペンション基板３１の外部側接続端子３８では、上記した配線回路基板１１と同様に、図１１に示すように、カバー側開口部４２およびベース側開口部４４の端縁部と導体パターン３４とが交差する交差部分４８における導体パターン３４に、その導体パターン３４が延びる方向と実質的に直交する幅方向に広がる補強部としての幅広部４９が形成されている。

【００６７】

より具体的には、この幅広部４９は、図１１（ｂ）に示すように、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄにおける長手方向に沿って所定の間隔を隔てて交差部分４８に対向する位置にそれぞれ（２つ）形成され、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄにおける幅方向に膨出するようなほぼ円形に形成されている。各幅広部４９は、上記した配線回路基板１１の幅広部２２と同様に、その幅方向の最長部分を境として、ほぼ外側半分がカバー層３５およびベース層３３

に埋設されるとともに、ほぼ内側半分がカバー側開口部４２、ベース側開口部４４および支持基板側開口部４３において露出するように配置されている。これによって、外部側接続端子３８は、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄがカバー側開口部４２内と、ベース側開口部４４内および支持基板側開口部４３内との両側端部において幅方向に膨出するダンベル形状としてそれぞれ形成される。

【００６８】

なお、各幅広部４９における幅方向の最長部分の長さや導体パターン３４が延びる方向に沿う長手方向の長さは、上記した配線回路基板１１の幅広部２２と同様でよく、また、その形状も、その幅方向に膨出するような形状であって、通常の幅よりも広く形成されていれば、特にほぼ円形に限定されることはなく、例えば、矩形状などであってもよい。

【００６９】

そして、このような幅広部４９を有する外部側接続端子３８は、上記した導体パターン３４の形成において、幅広部４９を配線回路パターンのパターンニングとともに形成しておき、図１０（ｈ）～（ｋ）に示す工程において、カバー層３５、支持基板３２およびベース層３３を、その幅広部４９の最長部分が交差部分４８に配置されるように開口することによってカバー側開口部４２、支持基板側開口部４３およびベース側開口部４４を形成した後、図１０（ｉ）に示す工程において、それらカバー側開口部４２内と、ベース側開口部４４内および支持基板側開口部４３内とにおいて露出する導体パターン３４の両面に金属めっき層４５を形成することにより、形成すればよい。

【００７０】

このような回路付サスペンション基板３１によれば、カバー側開口部４２およびベース側開口部４４の端縁部と導体パターン３４とが交差する交差部分４８における導体パターン３４には、その導体パターン３４の幅方向に広がる幅広部４９が形成されているので、そのカバー側開口部４２およびベース側開口部４４の端縁部における導体パターン３４の物理的強度を補強することができる。そのため、たとえば、その外部側接続端子３８とリードライト端子５４とをボンディン

グツールにより超音波振動を加えて接続するような場合において、カバー側開口部４２およびベース側開口部４４の端縁部において両面が露出する導体パターン３４に応力が集中しても、その導体パターン３４の断線を有効に防止することができ、接続信頼性を向上させることができる。

【００７１】

また、この回路付サスペンション基板３１においては、図１２に示すように、このようなフライングリードとして形成される外部側接続端子３８において、カバー側開口部４２およびベース側開口部４４の端縁部と導体パターン３４とが交差する交差部分４８におけるカバー層３５に、カバー側開口部４２の端縁部からカバー側開口部４２内の導体パターン３４の上に突出する補強部としてのカバー側突出部５０を形成するとともに、交差部分４８におけるベース層３３にも、ベース側開口部４４の端縁部からベース側開口部４４内の導体パターン３４の上に突出する補強部としてのベース側突出部５１を形成してもよい。

【００７２】

より具体的には、これらカバー側突出部５０およびベース側突出部５１は、図１２（ｂ）に示すように、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄにおける長手方向に沿って所定の間隔を隔てて交差部分４８に対向する位置にそれぞれ（２つ）形成され、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄが延びる方向に沿ってカバー側開口部４２およびベース側開口部４４の端縁部から内側にそれぞれ突出する凸状に形成されている。各カバー側突出部５０および各ベース側突出部５１は、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄに重なり、カバー側開口部４２およびベース側開口部４４の内側に向かって、次第にその重なりが少なくなるような先細状（平面視略三角形状）に形成されており、これによって、外部側接続端子３８は、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄがカバー側開口部４２内およびベース側開口部４４内の両側端部において、各カバー側突出部５０および各ベース側突出部５１によって被覆されるような形状に形成される。

【００７３】

なお、各カバー側突出部５０および各ベース側突出部５１における突出長さや基幅は、上記した配線回路基板１１のカバー側突出部２５およびベース側突出部

２６と同様でよく、また、その形状も、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄが延びる長手方向に重なって突出するような形状であれば、図１２（ｂ）に示すような形状に限定されることはなく、例えば、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄのライン幅よりもやや広い基幅で、その内側に向かって先細状に突出形成されていてもよく、さらには、略三角形状に形成しなくても、例えば、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄが延びる長手方向に重なる矩形状に形成してもよい。

【００７４】

そして、このようなカバー側突出部５０およびベース側突出部５１を有する外部側接続端子３８は、図１０（ｇ）～（ｉ）に示す工程において、カバー側突出部５０が形成されるようにカバー層３５を開口してカバー側開口部４２を形成するとともに、図１０（ｋ）に示す工程において、ベース側突出部５０が形成されるようにベース層３３を開口してベース側開口部４４を形成した後、図１０（ｌ）に示す工程において、それらカバー側開口部４２内およびベース側開口部４４内において露出する導体パターン３４の両面に金属めっき層４５を形成することにより、形成すればよい。

【００７５】

このような回路付サスペンション基板３１によれば、カバー側開口部４２およびベース側開口部４４の端縁部と導体パターン４３とが交差する交差部分４８におけるカバー層３５およびベース層３３には、カバー側開口部４２およびベース側開口部４４の端縁部からカバー側開口部４２内およびベース側開口部４４内の導体パターン３４の上に突出するカバー側突出部５０およびベース側突出部５１がそれぞれ形成されているので、そのカバー側開口部４２およびベース側開口部４４の端縁部における導体パターン３４の物理的強度を補強することができる。そのため、たとえば、その外部側接続端子３８とリードライト端子５４とをボンディングツールにより超音波振動を加えて接続するような場合において、カバー側開口部４２およびベース側開口部４４の端縁部において両面が露出する導体パターン３４に応力が集中しても、その導体パターン３４の断線を有効に防止することができ、接続信頼性を向上させることができる。

【００７６】

なお、この回路付サスペンション基板３１においては、必ずしも、各カバー側突出部５０および各ベース側突出部５１の両方を形成せずとも、例えば、図１３に示すように、カバー側突出部５０のみを形成してもよく、また、例えば、図１４に示すように、ベース側突出部５１のみを形成してもよい。

【００７７】

さらには、図示しないが、上記したように、導体パターン３４に幅広部４９を形成するとともに、カバー層３５にはカバー側突出部５０を、および／または、ベース層３３にはベース側突出部５１を形成してもよい。

【００７８】

また、この回路付サスペンション基板３１では、図１５（ａ）に示すように、導体パターン３４における外部側接続端子３８が形成される部分を、他の部分に対して支持基板３２側に凹むように形成するとともに、ベース側開口部４４および支持基板側開口部４３を、金属めっき層４５が形成される部分よりも大きく開口形成するようにして、外部側接続端子３８を形成してもよく、そのようにして形成される外部側接続端子３８において、図１２（ｂ）に示すように、カバー側開口部４２およびベース側開口部４４の端縁部と導体パターン３４とが交差する交差部分４８における導体パターン３４に、幅広部４９が形成されるようにしてもよい。

【００７９】

すなわち、このような回路付サスペンション基板３１は、例えば、図１６（ａ）に示すように、予め用意された支持基板３２上に、上記と同様にして、感光性ポリイミド樹脂前駆体の皮膜３３ｐを形成した後、図１６（ｂ）に示すように、皮膜３３ｐを露光する工程において、照射光を全く透過しないフォトマスク４０とは別に、照射光を半透過（平均透過率１～９９％の範囲）するフォトマスク５２を、皮膜３３ｐにおける外部側接続端子３８が形成される部分に対向配置して、そのフォトマスク５２を介して皮膜３３ｐを露光させて、皮膜３３ｐにおける外部側接続端子３８が形成される部分を、他の部分に対してより少ない露光量で露光させ、次いで、図１６（ｃ）および（ｄ）に示すように、上記と同様に、現

像および硬化させることにより、外部側接続端子３８が形成される部分が他の部分よりも厚さの薄いベース層３３を形成する。

【００８０】

なお、このようなフォトマスク５２は、例えば、フォトマスク５２における半透過部分の表面を微細に荒らすことにより、その表面での乱反射成分を増加させて、その部分における透過光成分を減少させるように構成するか、あるいは、例えば、フォトマスク５２における半透過部分の表面に、照射光を吸収するフィルムを貼着して、その半透過部分における透過光成分を減少させるように構成するか、あるいは、例えば、フォトマスク５２における半透過部分の表面に、光透過部分および遮光部分のパターンを形成して、その部分における透過光成分を減少させるように構成すればよい。

【００８１】

さらに、例えば、金属薄膜の遮光パターンが形成されているフォトマスク５２において、半透過部分の表面に、その金属薄膜よりも厚みの薄い金属薄膜を形成して、その半透過部分における透過光成分を減少させるように構成してもよい。すなわち、このようなフォトマスク５２は、例えば、半透過部分には、金属薄膜が形成されていないフォトマスク５２（従来のフォトマスク）を形成し、次いで、その半透過部分のみが露出するように、そのフォトマスク５２の上にレジストを形成して、上記の金属薄膜より厚みが薄いクロムなどの金属薄膜を蒸着またはめっきにより形成し、その後、レジストを剥離することにより形成することができる。

【００８２】

これらのうちでは、例えば、図１７に示すように、フォトマスク５２における半透過部分５３の表面に、光透過部分および遮光部分のパターンを形成することが好ましい。すなわち、このようなフォトマスク５２は、例えば、厚さ２～５ｍｍの石英ガラスやソーダガラスなどの板状のガラスからなり、そのガラスにおける半透過部分５３に、透過率がその他の部分の透過率よりも低減するような金属薄膜のパターンが、例えば、まず、ガラスの全面にクロムなどの金属薄膜を蒸着またはめっきした後、その金属薄膜をレーザーや電子ビームなどを用いてパター

ン化することにより形成されている。より具体的には、このような半透過部分５３のパターンは、好ましくは、６μｍ以下のピッチ（各光透過部分および各遮光部分の幅）において、その平均透過率が８０％以下、さらには、５０％以下の繰り返しパターンとして形成されることが好ましく、図１７（ａ）に示すように、縞状のパターンで平均透過率が約５０％のもの、図１７（ｂ）に示すように、格子状のパターンで平均透過率が約２５％のもの、図１７（ｃ）に示すように、円形千鳥状のパターンで平均透過率が約２５％のもの、図１７（ｄ）に示すように、円形千鳥状で平均透過率が約７０％のものなどが用いられる。

【００８３】

なお、上記においては、ネガ型でパターンニングしているが、例えば、ポジ型でパターンニングするには、フォトマスク５２を、半透過部分の照射光の透過率を、その他の部分の照射光の透過率よりも増加させるように構成すればよい。

【００８４】

このようにして形成されるベース層３３の厚さは、例えば、２～３０μｍ、好ましくは、５～２０μｍであり、通常、１０μｍ程度である。そして、ベース層３３における外部側接続端子３８が形成される部分の厚さは、通常、その他の部分の厚みの８０％以下であり、例えば、８μｍ以下、さらには、５μｍ以下であることが好ましい。厚さが８μｍ以下であると、上記したように、他の部分の厚さが、通常１０μｍである場合には、２μｍ分について、後の工程において、開口に要する時間の短縮を図ることができる。

【００８５】

なお、ベース層３３における外部側接続端子３８が形成される部分の厚さの下限は、支持基板３２を開口する時に導体パターン３４のバリヤ層として作用し得る最低限の厚さでよく、例えば、３μｍ、さらには、１μｍ程度でよい。したがって、ベース層３３における外部側接続端子３８が形成される部分の厚さは、例えば、０．１～８μｍ、さらには、１．０～５μｍであることが好ましい。

【００８６】

次いで、図１６（ｅ）に示すように、このベース層３３の上に、上記と同様に、所定の配線回路パターンとして導体パターン３４を形成すれば、導体パターン

３４は、ベース層３３における外部側接続端子３８が形成される部分が、ベース層３３における他の部分よりも薄く形成されていることから、その上に形成される部分、すなわち、後の工程において金属めっき層４５が形成される部分が、導体パターン３４における他の部分に対して、支持基板３２側にその薄くなった厚さ分凹むように形成される。なお、このような導体パターン３４の形成においては、幅広部４９を配線回路パターンのパターンニングとともに形成する。

【００８７】

次いで、図１６（ｆ）～（ｉ）に示すように、上記と同様に、導体パターン３４を、カバー層３５により被覆するとともに、外部側接続端子３８が形成される部分であって、幅広部４９の最長部分が交差部分４８に配置されるようにカバー側開口部４２を形成した後、図１６（ｊ）に示すように、支持基板側開口部４３を、支持基板３２におけるカバー側開口部４２に対向する部分よりも大きくなるように形成するとともに、図１６（ｋ）に示すように、支持基板側開口部４３内において露出しているベース層３３に、幅広部４９の最長部分が交差部分４８に配置されるようにベース側開口部４４を形成する。その後、図１６（ｉ）に示すように、それらカバー側開口部４２内と、ベース側開口部４４内および支持基板側開口部４３内とにおいて露出する導体パターン３４の両面に金属めっき層４５を形成する。このようにして形成された金属めっき層４５は、その金属めっき層４５の周端縁と、ベース側開口部４４および支持基板側開口部４３の周端縁との間に、所定の間隔が隔てられる。

【００８８】

このような方法により回路付サスペンション基板３１を製造すると、ベース層３３を形成する工程において、導体パターン３４を露出させるためのベース側開口部４４の厚さをベース層３３における他の部分の厚さよりも薄く形成するので、外部側接続端子３８を形成する工程において、図１６（ｋ）に示すように、ベース層３３をエッチングする時には、他の部分の厚さよりも薄くなっている分、導体パターン３４を露出させるためのエッチング時間を短縮することができる。そのため、導体パターン３４を短時間で露出させることができ、外部側接続端子３８を、両面が露出するフライングリードとして効率よく形成することができる

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【００８９】

また、このように形成すれば、ベース側開口部４４および支持基板側開口部４３が、導体パターン３４の露出部分よりも大きく開口形成されているので、金属めっき層４５の周端縁と、ベース側開口部４４および支持基板側開口部４３の周端縁との間には、所定の間隔が設けられる。そのため、例えば、接続信頼性を向上させるべく金属めっき層４５を厚く形成しても、金属めっき層４５と支持基板３２とが接触することがなく、金属めっき層４５と支持基板３２との間の接触による短絡を確実に防止することができる。そのため、回路付サスペンション基板３２の接続信頼性および耐電圧特性の向上を図ることができる。

【００９０】

なお、この回路付サスペンション基板３１においては、金属めっき層４５の周端縁と支持基板側開口部４３の周端縁との間の間隔を、少なくとも１μｍ以上、好ましくは、２～１００μｍ程度として形成することが好ましい。

【００９１】

また、このように形成すれば、導体パターン３４における金属めっき層４５が形成される部分が、支持基板３２側に凹むように形成されるので、支持基板３２の表面から金属めっき層４５の表面までの距離が、他の部分に対して凹んだ分だけ短くなり、金属めっき層４５が、その分、支持基板３２の外側よりに配置される。そのため、例えば、リード・ライト基板３９のリードライト端子５４との接続において、金属めっき層４５にリードライト端子５４を重ね合わせて、ボンディングツールにより超音波振動を加えて接続するような場合においては、良好な圧着性を確保することができ、接続信頼性をより一層向上させることができる。

【００９２】

なお、この回路付サスペンション基板３１においては、金属めっき層４５の表面と、ベース層３３および支持基板３２の界面との間の厚さ方向における間隔が、±６μｍ、さらには、±２μｍとなるように形成することが好ましい。

【００９３】

また、この回路付サスペンション基板３１においては、図１８に示すように、

このようなフライングリードとして形成される外部側接続端子３８において、カバー側開口部４２およびベース側開口部４４の端縁部と導体パターン３４とが交差する交差部分４８におけるカバー層３５に、上記と同様に、カバー側開口部４２の端縁部からカバー側開口部４２内の導体パターン３４の上に突出する補強部としてのカバー側突出部５０を形成するとともに、交差部分４８におけるベース層３３にも、ベース側開口部４４の端縁部からベース側開口部４４内の導体パターン３４の上に突出する補強部としてのベース側突出部５１を形成してもよい。

【００９４】

より具体的には、これらカバー側突出部５０およびベース側突出部５１は、図１８（ｂ）に示すように、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄにおける長手方向に沿って所定の間隔を隔てて交差部分４８に対向する位置にそれぞれ（２つ）形成され、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄが延びる方向に沿ってカバー側開口部４２およびベース側開口部４４の端縁部から内側にそれぞれ突出する凸状に形成されている。各カバー側突出部５０および各ベース側突出部５１は、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄに重なり、カバー側開口部４２およびベース側開口部４４の内側に向かって、次第にその重なりが少なくなるような先細状（平面視略三角形状）に形成されており、これによって、外部側接続端子３８は、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄがカバー側開口部４２内およびベース側開口部４４内の両側端部において、各カバー側突出部５０および各ベース側突出部５１によって被覆されるような形状に形成される。

【００９５】

なお、各カバー側突出部５０および各ベース側突出部５１における突出長さや基幅は、上記した配線回路基板１１のカバー側突出部２５およびベース側突出部２６と同様でよく、また、その形状も、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄが延びる長手方向に重なって突出するような形状であれば、図１８（ｂ）に示すような形状に限定されることはなく、例えば、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄのライン幅よりもやや広い基幅で、その内側に向かって先細状に突出形成されていてもよく、さらには、略三角形状に形成しなくても、例えば、各配線３４ａ、３４ｂ、３４ｃおよび３４ｄが延びる長手方向に重なる矩形状に

形成してもよい。

【００９６】

なお、図１８に示す回路付サスペンション基板３１では、カバー側開口部４２の開口面積に対して、ベース側開口部４４の開口面積が広く形成されているため、図１８（ａ）に示すように、カバー側突出部５０に対してベース側突出部５１が、その分、突出長さが長くなるように形成される。

【００９７】

そして、このようなカバー側突出部５０およびベース側突出部５１を有する外部側接続端子３８は、図１６（ｇ）～（ｉ）に示す工程において、カバー側突出部５０が形成されるようにカバー層３５を開口してカバー側開口部４２を形成するとともに、図１６（ｋ）に示す工程において、ベース側突出部５０が形成されるようにベース層３３を開口してベース側開口部４４を形成した後、図１６（ｌ）に示す工程において、それらカバー側開口部４２内およびベース側開口部４４内において露出する導体パターン３４の両面に金属めっき層４５を形成することにより、形成すればよい。

【００９８】

なお、この回路付サスペンション基板３１においても、上記と同様に、必ずしも、各カバー側突出部５０および各ベース側突出部５１の両方を形成せずとも、例えば、図１９に示すように、カバー側突出部５０のみを形成してもよく、また、例えば、図２０に示すように、ベース側突出部５１のみを形成してもよい。

【００９９】

さらには、図示しないが、上記したように、導体パターン３４に幅広部４９を形成するとともに、カバー層３５にはカバー側突出部５０を、および／または、ベース層３３にはベース側突出部５１を形成してもよい。

【０１００】

なお、以上の説明においては、外部側接続端子３８をフライングリードとして形成する場合について説明したが、この回路付サスペンション基板３１においては、磁気ヘッド側接続端子３７も、外部側接続端子３８と同様のフライングリードとして形成されている。

【０１０１】

【実施例】

以下に実施例を示し、本発明をさらに具体的に説明するが、本発明は、何ら実施例に限定されることはない。

【０１０２】

実施例１

厚さ２０μmのステンレス箔（ＳＵＳ３０４　Ｈ－ＴＡ）の上に、感光性ポリイミド樹脂前駆体の溶液を、乾燥後の厚さが２４μmとなるように塗布した後、１３０℃で乾燥することにより、感光性ポリイミド樹脂前駆体の皮膜を形成した（図１６（ａ）参照）。次いで、皮膜を、フォトマスクを介して露光（４０５ｎｍ、１５００ｍＪ／ｃｍ^2）させ（図１６（ｂ）参照）、露光部分を１８０℃に加熱した後、アルカリ現像液を用いて現像することにより、その皮膜をネガ型の画像でパターン化した（図１６（ｃ）参照）。次いで、パターン化された感光性ポリイミド樹脂前駆体の皮膜を、３５０℃で加熱して、硬化（イミド化）させ、これによって、厚さ１０μmのポリイミド樹脂からなるベース層を所定のパターンで形成した（図１６（ｄ）参照）。

【０１０３】

また、このベース層の形成においては、露光する時に、光透過部分および遮光部分が、６μm以下のピッチで金属薄膜の格子状の繰り返しパターンとして形成されているフォトマスク（図１７（ｂ）に示す、平均透過率が約２５％フォトマスク５２に相当する。）を、皮膜において、後の工程において開口され、外部側接続端子が形成される部分の上に配置して、このフォトマスクを介して皮膜を露光させて、皮膜における外部側接続端子が形成される部分の露光量が、他の部分の露光量よりも低減するように露光させた（図１６（ｂ）参照）。そのため、これを現像および硬化させた後においては、ベース層における他の部分の厚さが１０μmであるところ、その外部側接続端子が形成される部分の厚さを２μmとして形成することができた（図１６（ｄ）参照）。

【０１０４】

次いで、ステンレス箔およびベース層の全面に、下地として、厚さ３００Åの

クロム薄膜と厚さ７００Åの銅薄膜とをスパッタ蒸着法によって順次形成した後、所定の配線パターンと逆パターンのめっきレジストを、ドライフィルムレジストを用いて形成し、そして、電解銅めっきにより、ベース層におけるめっきレジストが形成されていない部分に、所定の配線パターンの導体パターンを、セミアディティブ法により形成した（図１６（ｅ）参照）。このようにして形成された導体パターンは、ベース層における外部側接続端子が形成される部分が、ベース層における他の部分よりも薄く形成されているので、導体パターンにおける外部側接続端子が形成される部分が、導体パターンにおける他の部分に対して、ステンレス箔側に、厚さ方向において約８μｍ凹むようにして形成された。なお、この導体パターンの厚さは１０μｍで、そのパターンを、各配線の幅１１０μｍ、各配線間の間隔が２００μｍの、互いに所定の間隔を隔てて平行状に配置される４本の配線パターンとして形成した。

【０１０５】

さらに、各配線には、次に開口形成するカバー開口部およびベース側開口部の端縁部との交差部分（各配線について２箇所）において、各配線が延びる方向と実質的に直交する幅方向に広がる略円形の幅広部（図１５（ｂ）参照）を、幅方向の最長部分の長さ２３０μｍで、長手方向の長さ１００μｍで形成した。

【０１０６】

その後、めっきレジストを、化学エッチングによって除去した後、めっきレジストが形成されていたクロム薄膜および銅薄膜を、化学エッチングにより除去した。

【０１０７】

次いで、導体パターンの表面、および、ステンレス箔の表面に、無電解ニッケルめっきによって、厚さ０．１μｍの硬質のニッケル薄膜を形成した後、ニッケル薄膜およびベース層の上に、感光性ポリイミド樹脂前駆体の溶液を塗布した後、１３０℃で加熱することにより、感光性ポリイミド樹脂前駆体の皮膜を形成した（図１６（ｆ）参照）。次いで、皮膜をフォトマスクを介して露光（４０５ｎｍ、１５００ｍＪ／ｃｍ^2）させ（図１６（ｇ）参照）、露光部分を１８０℃に加熱した後、アルカリ現像液を用いて現像することにより、この皮膜によって導

体層が被覆されるようにパターン化した（図１６（ｈ）参照）。次いで、パターン化された感光性ポリイミド樹脂前駆体の皮膜を、３５０℃で加熱して、硬化（イミド化）させ、これによって、厚さ３μｍのポリイミド樹脂からなるカバー層を、導体層の上に形成した（図１６（ｉ）参照）。

【０１０８】

なお、このカバー層の形成においては、パターン化する時に、導体パターンにおける外部側接続端子が形成される部分のニッケル薄膜が露出するようにカバー側開口部を形成した。

【０１０９】

次いで、外部側接続端子を、両面が露出する状態で形成した。すなわち、まず、ステンレス箔におけるカバー側開口部に対向する部分に、ベース層が露出するように、そのカバー側開口部よりも大きな支持基板側開口部を形成した（図１６（ｊ）参照）。この支持基板側開口部は、ステンレス箔における支持基板側開口部を形成する部分以外をすべてマスキングした後に、化学エッチングすることにより形成した。なお、この支持基板側開口部の形成と同時に、化学エッチングによりジンバルを所定の形状に切り抜いた。

【０１１０】

次いで、カバー側開口部内に露出しているニッケル薄膜を剥離するとともに、ステンレス箔の上に形成されているニッケル薄膜を剥離した。

【０１１１】

そして、ステンレス箔の支持基板側開口部内において露出しているベース層を開口して、導体パターンの裏面に形成される下地が露出するようにベース側開口部を形成した（図１６（ｋ）参照）。このベース側開口部は、プラズマエッチングにより形成した。プラズマエッチングでは、ステンレス箔をマスクとして、そのステンレス箔の支持基板側開口部に露出するベース層全体を、封入ガスとして、CF_4とO_2との混合ガス（CF_4／O_2＝２０／８０）を用い、ガス圧（真空度）２５Ｐａ、周波数１３．５ＭＨｚ、処理電力２５００Ｗの条件下において、約２分間処理した。

【０１１２】

このようにして形成されるベース側開口部は、支持基板側開口部と同じ大きさおよび形で形成され、ベース側開口部に露出する下地の周端縁と、ベース側開口部および支持基板側開口部の周端縁との間には、約５０μｍの間隔が設けられた。

【０１１３】

その後、ベース側開口部に露出する下地を剥離することによって、導体パターンの裏面を露出させた。次いで、このように露出している導体パターンの両面に、金属めっき層を、電解ニッケルめっきと電解金めっきとを順次行なって、厚さ２μｍのニッケルめっき層および厚さ１μｍの金めっき層を形成することによって形成した（図１６（ｌ）参照）。

【０１１４】

このようにして形成された裏面側の金属めっき層は、その表面が、ベース層とステンレス箔との界面に対して、厚さ方向で、±２μｍで形成され、かつ、その金属めっき層の周端縁と、ベース側開口部および支持基板側開口部の周端縁との間に、４７μｍの間隔が隔てられるように形成された。

【０１１５】

これによって、各配線に幅広部が形成される導体パターンのフライングリードとして、外部側接続端子が形成されている回路付サスペンション基板を得た（図１５参照）。

【０１１６】

実施例２

導体パターンの各配線に幅広部を形成することに代えて、ベース層を開口形成してベース側開口部を形成する工程（図１６（ｋ）参照）において、各配線との交差部分（各配線について２箇所）において、ベース層に、ベース側開口部の端縁部からベース側開口部内の導体パターンの上に突出する平面視略三角形状のベース側突出部を、基幅１１０μｍおよび突出長さ２００μｍで形成した以外は、実施例１と同様の操作により、各配線の露出端部がベース側突出部によって被覆されている導体パターンのフライングリードとして、外部側接続端子が形成されている回路付サスペンション基板を得た（図２０参照）。

【０１１７】

比較例１

導体パターンの各配線に幅広部を形成しない以外は、実施例１と同様の操作により、フライングリードとして外部側接続端子が形成されている回路付サスペンション基板を得た（図２１参照）。

【０１１８】

評価

実施例１、２および比較例１で得られた回路付サスペンション基板の外部側接続端子を、金パッドからなる外部端子に、ボンディングツールを用いて超音波振動を加えて接続した後、ピール剥離試験を行ない、接続強度を測定した。

【０１１９】

その結果を、表１に示す。なお、実施例１および２の回路付サスペンション基板については、導体パターンの破壊は、いずれもカバー層およびベース層に被覆されている部分で生じた。

【０１２０】

【表１】

	実施例1	実施例2	比較例1
ピール剥離試験強度（mN）	540	590	490

【発明の効果】

以上述べたように、本発明の配線回路基板によれば、開口部の端縁部と導体パターンとの交差部分において、第１絶縁層、第２絶縁層および導体パターンの少なくともいずれかに、開口部の端縁部における導体パターンを補強するための補強部が形成されているので、その開口部の端縁部における導体パターンの物理的強度を補強することができる。そのため、たとえば、その端子部と外部端子とをボンディングツールにより超音波振動を加えて接続するような場合において、開

口部の端縁部において両面が露出する導体パターンに応力が集中しても、その導体パターンの断線を有効に防止することができ、接続信頼性を向上させることができる。

【０１２１】

そのため、本発明の配線回路基板は、導体パターンの両面が露出するいわゆるフライングリードとして形成しても、接続信頼性が高く、回路付サスペンション基板として好適に用いることができる。

【図面の簡単な説明】

【図１】

本発明の配線回路基板の一実施形態（幅広部が形成される態様）であって、（ａ）は、その端子部における要部断面図、（ｂ）は、その端子部における平面図である。

【図２】

図１（ｂ）に示す平面図の拡大図である。

【図３】

図１に示す配線回路基板の製造方法を示す工程図であって、
（ａ）は、ベース層の上に導体パターンを形成する工程、
（ｂ）は、導体パターンの上に、ベース層を形成する工程、
（ｃ）は、カバー層における端子部が形成される部分にカバー側開口部を開口形成する工程、
（ｄ）は、ベース層における端子部が形成される部分にベース側開口部を開口形成する工程、
（ｅ）は、カバー側開口部内およびベース側開口部内に露出した導体パターンの表面および裏面に金属めっき層を形成する工程
を示す。

【図４】

本発明の配線回路基板の他の実施形態（カバー側突出部およびベース側突出部が形成される態様）であって、（ａ）は、その端子部における要部断面図、（ｂ）は、その端子部における平面図である。

【図５】

図４（ｂ）に示す平面図の拡大図である。

【図６】

図４（ｂ）に示す平面図の他の実施形態の拡大図である。

【図７】

図４（ａ）に示す配線回路基板の他の実施形態（カバー側突出部のみが形成されている態様）を示す要部断面図である。

【図８】

図４（ａ）に示す配線回路基板の他の実施形態（ベース側突出部のみが形成されている態様）を示す要部断面図である。

【図９】

本発明の配線回路基板の一実施形態としての回路付サスペンション基板の平面図である。

【図１０】

図９に示す回路付サスペンション基板の製造方法を示す工程図であって、
（ａ）は、支持基板の上に感光性ポリイミド樹脂前駆体の皮膜を形成する工程、
（ｂ）は、その皮膜をフォトマスクを介して露光させる工程、
（ｃ）は、その皮膜を現像することにより所定のパターンとする工程、
（ｄ）は、パターン化された皮膜を硬化させてベース層を形成する工程、
（ｅ）は、ベース層の上に導体パターンを形成する工程、
（ｆ）は、導体パターンの上に感光性ポリイミド樹脂前駆体の皮膜を形成する工程、
（ｇ）は、その皮膜をフォトマスクを介して露光させる工程、
（ｈ）は、その皮膜を現像することにより所定のパターンとする工程、
（ｉ）は、パターン化された皮膜を硬化させてカバー層を形成する工程、
（ｊ）は、支持基板における外部側接続端子が形成される部分を開口する工程、
（ｋ）は、ベース層における外部側接続端子が形成される部分を開口する工程、
（ｌ）は、露出している導体パターンの両面に金属めっき層を形成する工程
を示す。

【図１１】

図９に示す回路付サスペンション基板の一実施形態（幅広部が形成される態様）であって、（ａ）は、その外部側接続端子における要部断面図、（ｂ）は、その外部側接続端子における平面図である。

【図１２】

図９に示す回路付サスペンション基板の一実施形態（カバー側突出部およびベース側突出部が形成される態様）であって、（ａ）は、その外部側接続端子における要部断面図、（ｂ）は、その外部側接続端子における平面図である。

【図１３】

図１２（ａ）に示す回路付サスペンション基板の他の実施形態（カバー側突出部のみが形成されている態様）を示す要部断面図である。

【図１４】

図１２（ａ）に示す回路付サスペンション基板の他の実施形態（ベース側突出部のみが形成されている態様）を示す要部断面図である。

【図１５】

図９に示す回路付サスペンション基板の一実施形態（導体パターンが凹状で、かつ、幅広部が形成される態様）であって、（ａ）は、その外部側接続端子における要部断面図、（ｂ）は、その外部側接続端子における平面図である。

【図１６】

図１５に示す回路付サスペンション基板の製造方法を示す工程図であって、
（ａ）は、支持基板の上に感光性ポリイミド樹脂前駆体の皮膜を形成する工程、
（ｂ）は、その皮膜をフォトマスクを介して露光させる工程、
（ｃ）は、その皮膜を現像することにより所定のパターンとする工程、
（ｄ）は、パターン化された皮膜を硬化させてベース層を形成する工程、
（ｅ）は、ベース層の上に導体パターンを形成する工程、
（ｆ）は、導体パターンの上に感光性ポリイミド樹脂前駆体の皮膜を形成する工程、
（ｇ）は、その皮膜をフォトマスクを介して露光させる工程、
（ｈ）は、その皮膜を現像することにより所定のパターンとする工程、

（ｉ）は、パターン化された皮膜を硬化させてカバー層を形成する工程、
（ｊ）は、支持基板における外部側接続端子が形成される部分を開口する工程、
（ｋ）は、ベース層における外部側接続端子が形成される部分を開口する工程、
（ｌ）は、露出している導体パターンの両面に金属めっき層を形成する工程
を示す。

【図１７】

図１６（ｂ）において、皮膜を露光させるために用いるフォトマスクの一実施形態の概略平面図であって、
（ａ）は、半透過部が縞状のパターンで平均透過率が約５０％のもの、
（ｂ）は、半透過部が格子状のパターンで平均透過率が約２５％のもの、
（ｃ）は、半透過部が円形千鳥状のパターンで平均透過率が約２５％のもの、
（ｄ）は、半透過部が円形千鳥状のパターンで平均透過率が約７０％のもの、
をそれぞれ示す。

【図１８】

図９に示す回路付サスペンション基板の一実施形態（導体パターンが凹状で、かつ、カバー側突出部およびベース側突出部が形成される態様）であって、（ａ）は、その外部側接続端子における要部断面図、（ｂ）は、その外部側接続端子における平面図である。

【図１９】

図１８（ａ）に示す回路付サスペンション基板の他の実施形態（ベース側突出部のみが形成されている態様）を示す要部断面図である。

【図２０】

図１８（ａ）に示す回路付サスペンション基板の他の実施形態（ベース側突出部のみが形成されている態様）を示す要部断面図である。

【図２１】

従来の回路付サスペンション基板であって、（ａ）は、その端子部における要部断面図、（ｂ）は、その端子部における平面図である。

【符号の説明】

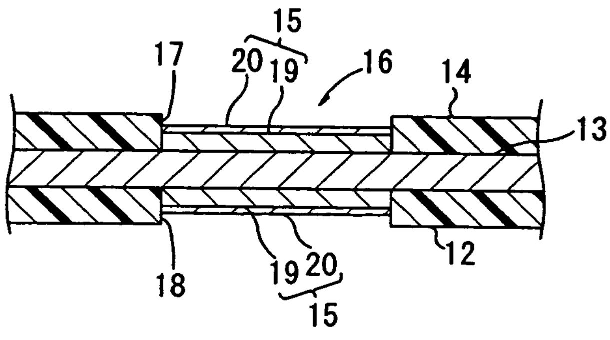
１１　　配線回路基板

１２	ベース層
１３	導体パターン
１４	カバー層
１６	端子部
１７	カバー側開口部
１８	ベース側開口部
２１	交差部分
２２	幅広部
２５	カバー側突出部
２６	ベース側突出部
３１	回路付サスペンション基板
３２	支持基板
３３	ベース層
３４	導体パターン
３５	カバー層
３８	外部側接続端子部
４２	カバー側開口部
４３	支持基板側開口部
４４	ベース側開口部
４８	交差部分
４９	幅広部
５０	カバー側突出部
５１	ベース側突出部

【書類名】　　　　図面

【図１】

（ａ）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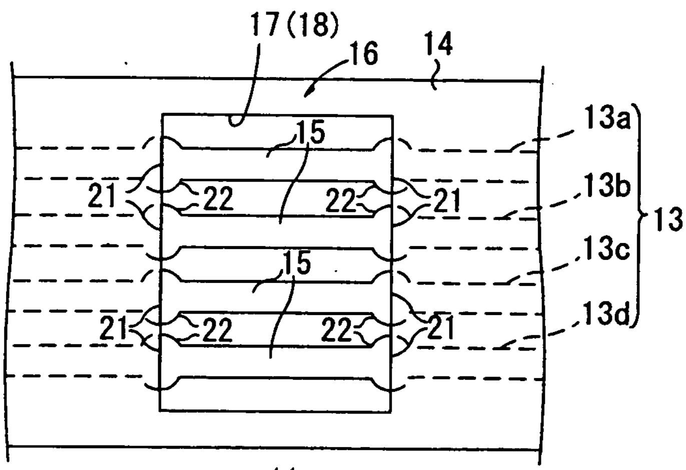
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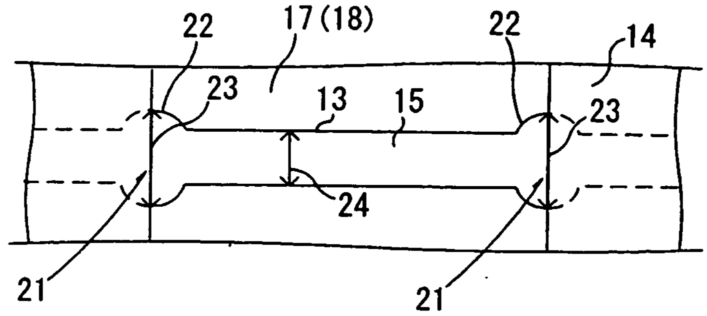
【図２】



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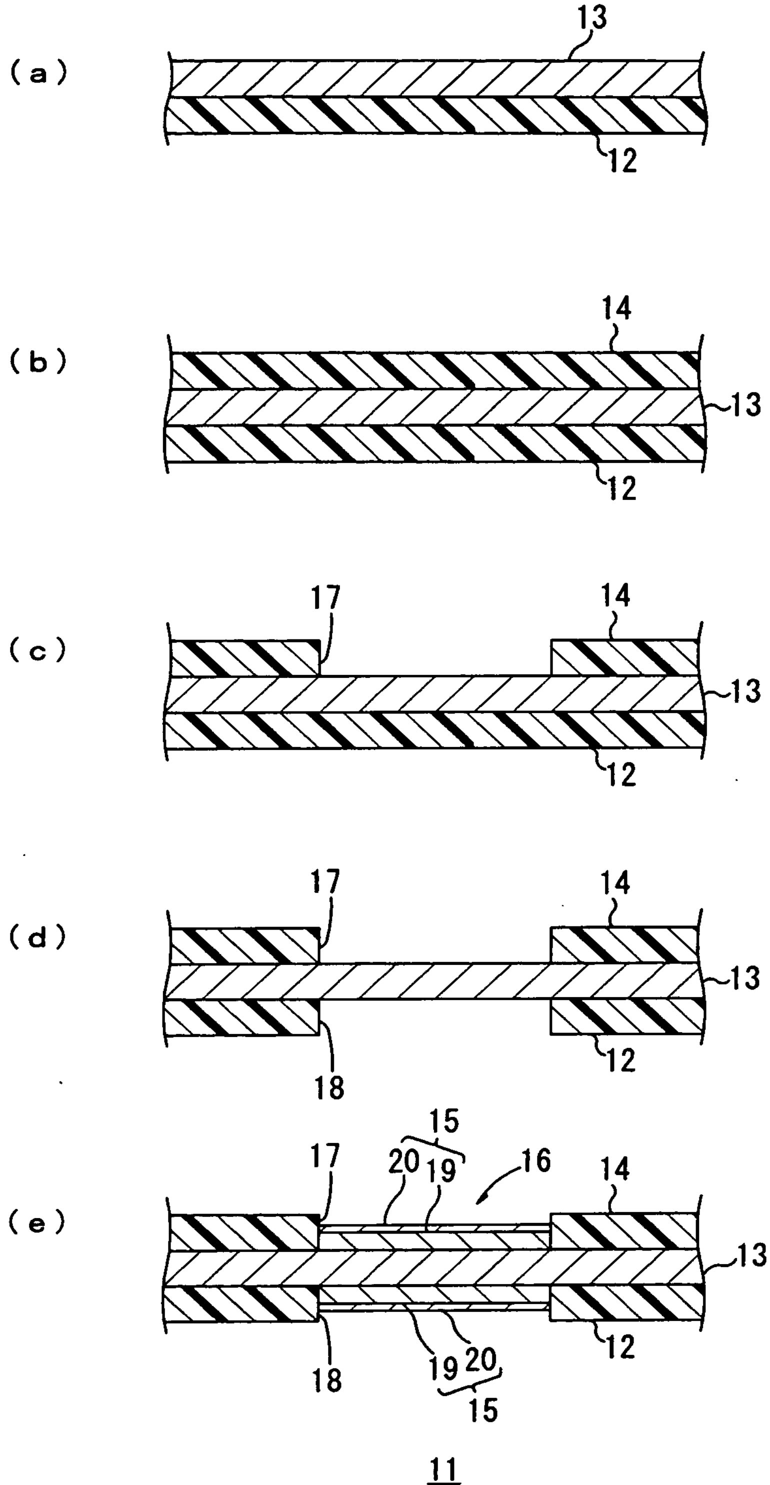
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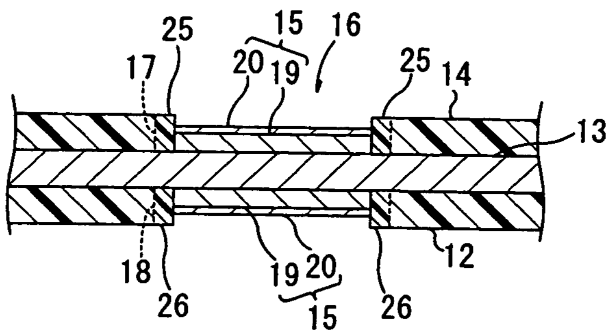
【図４】

（ａ）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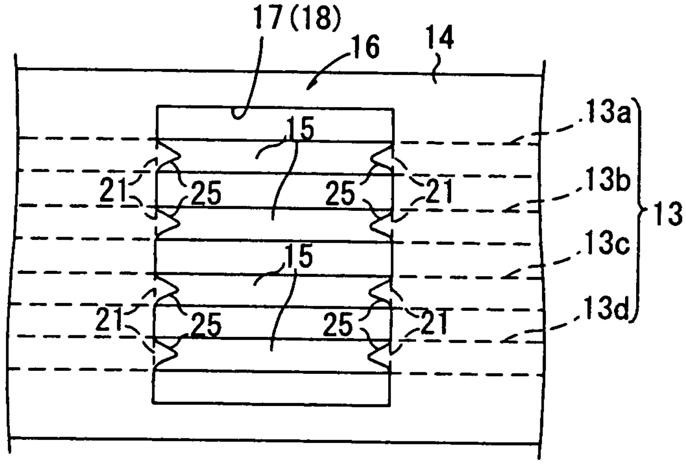
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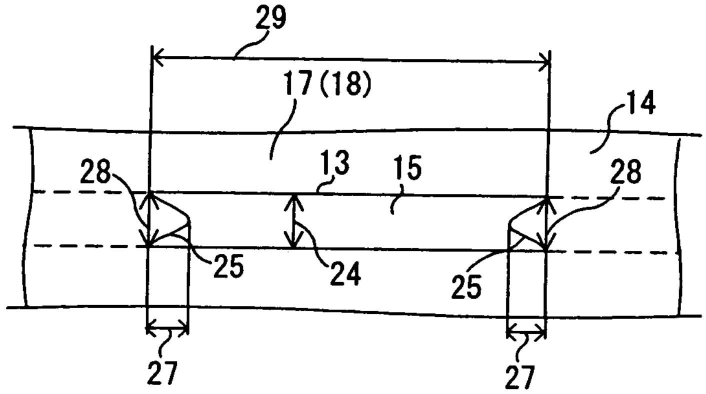
【図５】



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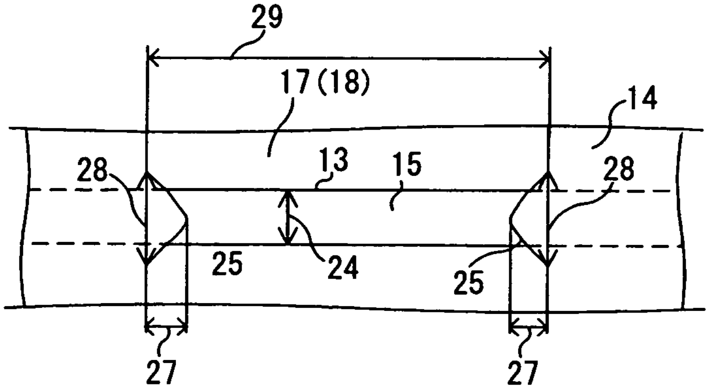
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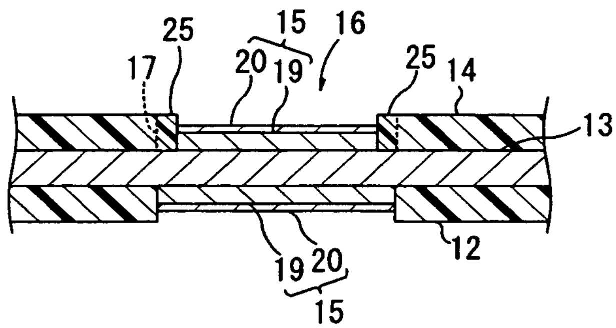
【図７】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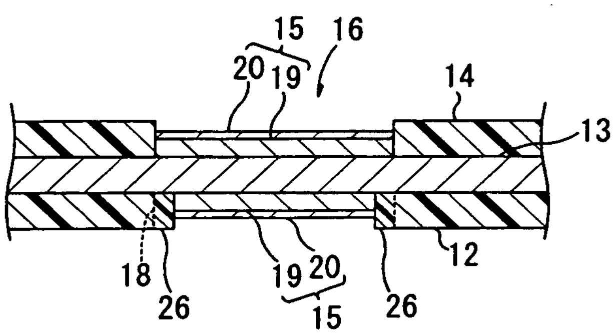
【図８】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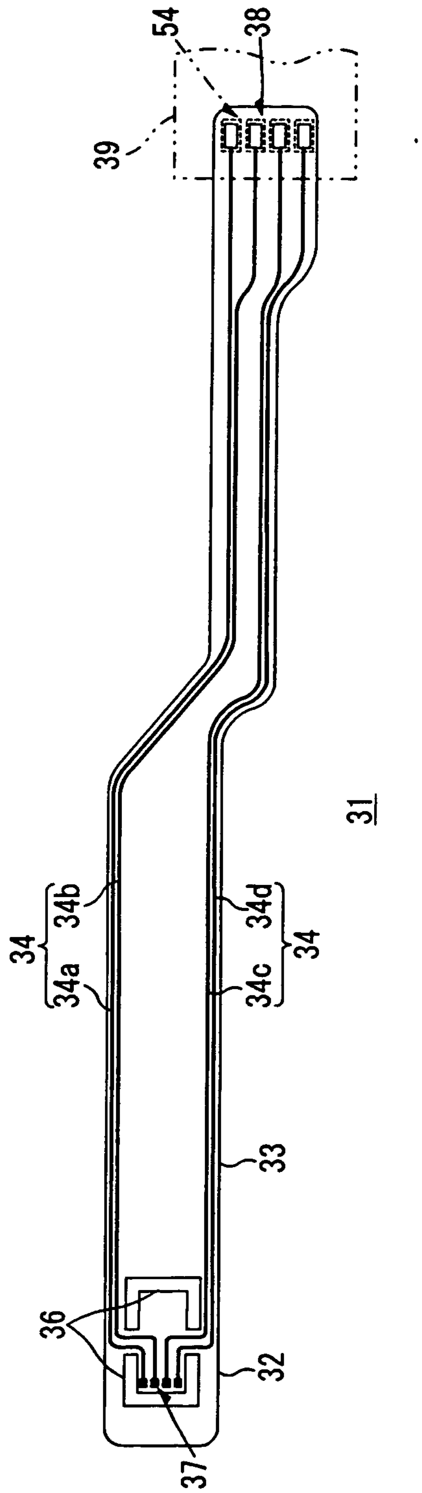
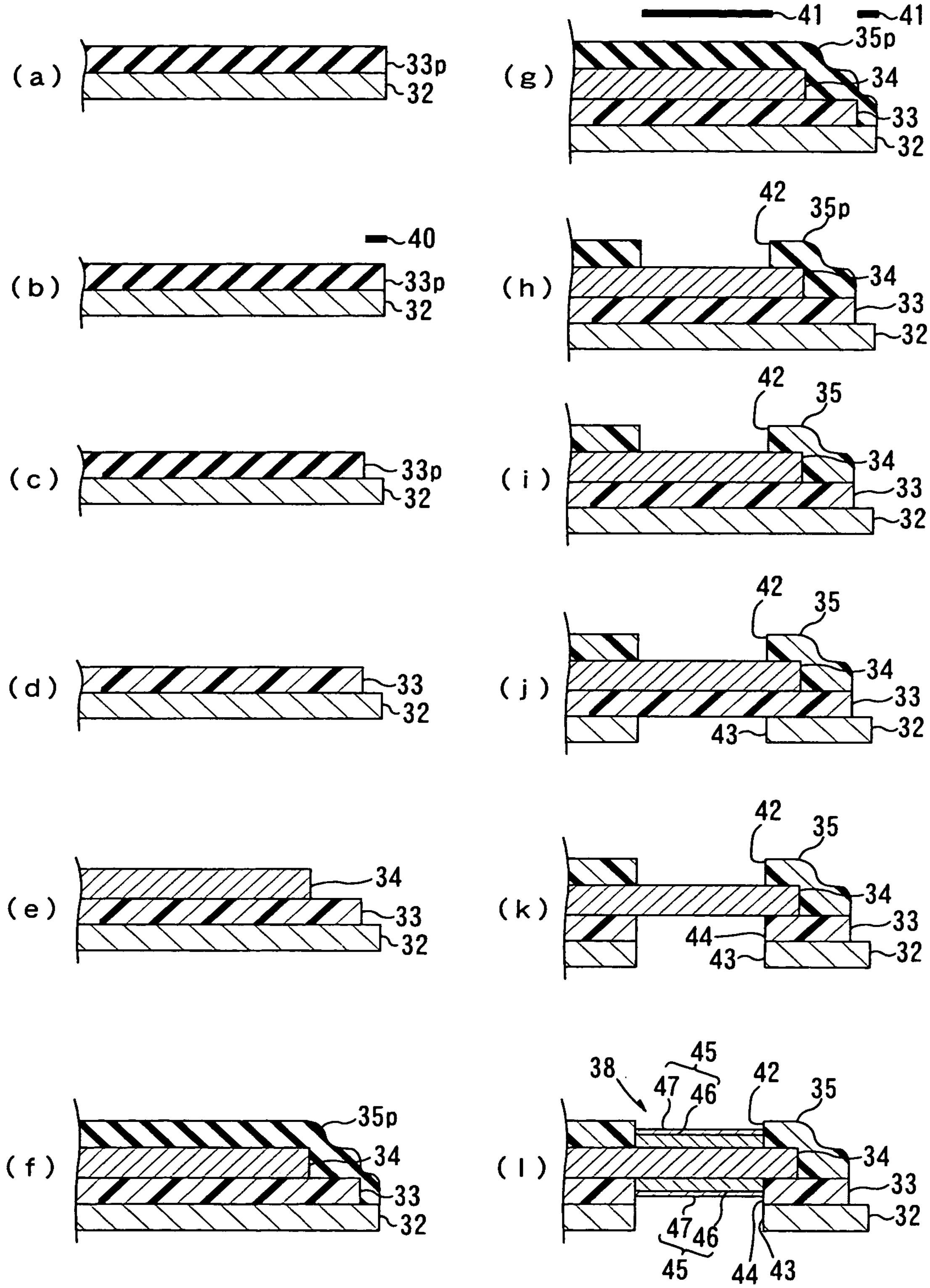
【図９】



【図１０】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【図１１】

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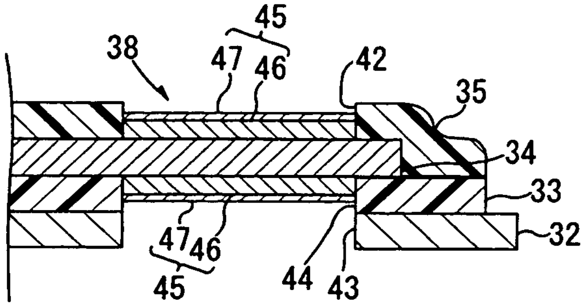
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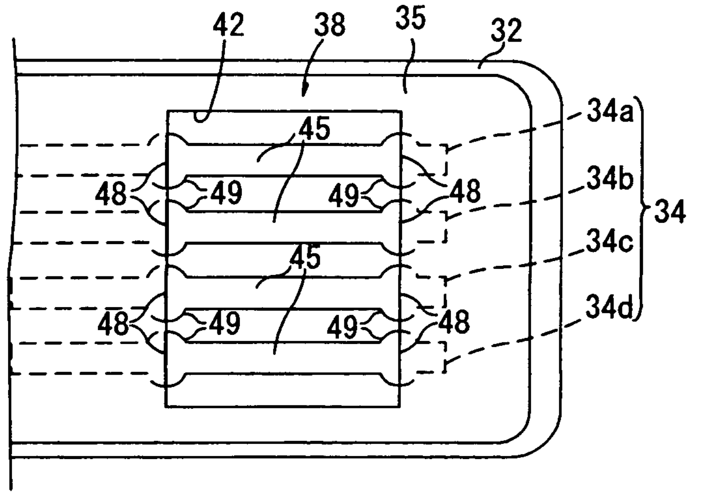
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【図１２】

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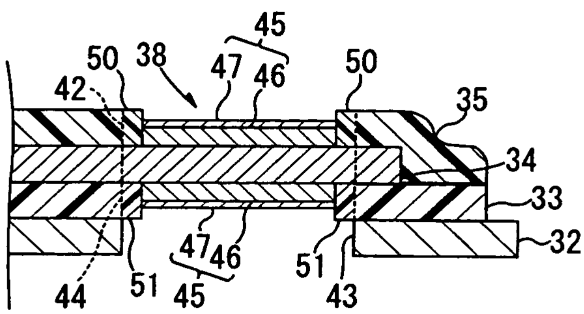
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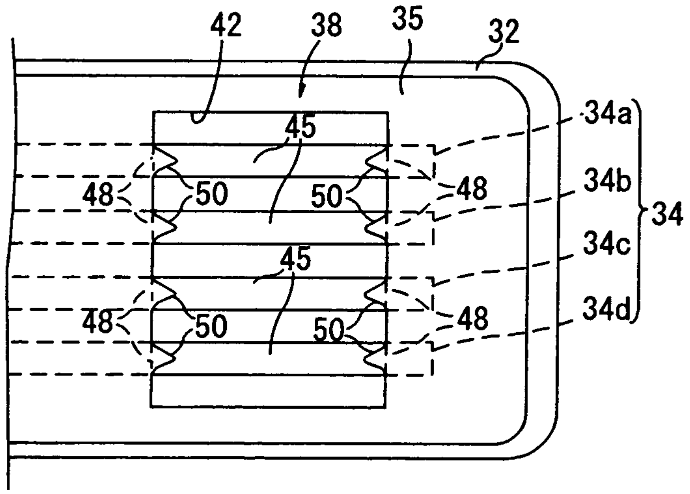
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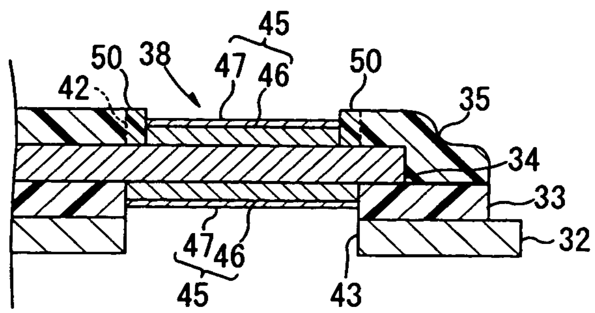
【図１３】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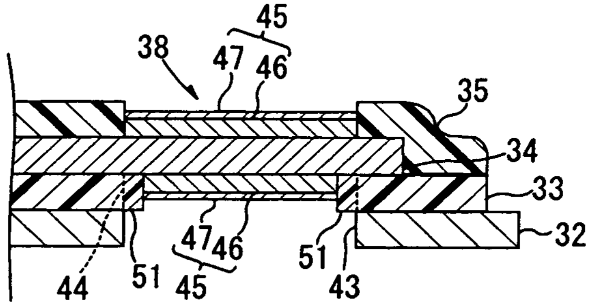
【図１４】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【図１５】

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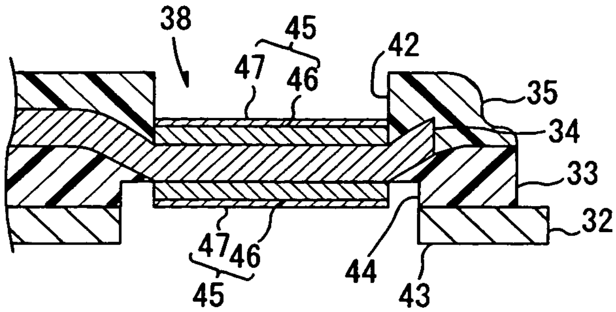

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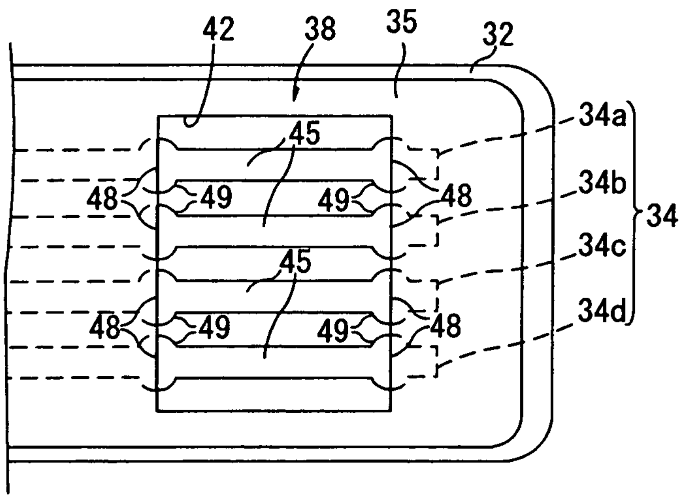
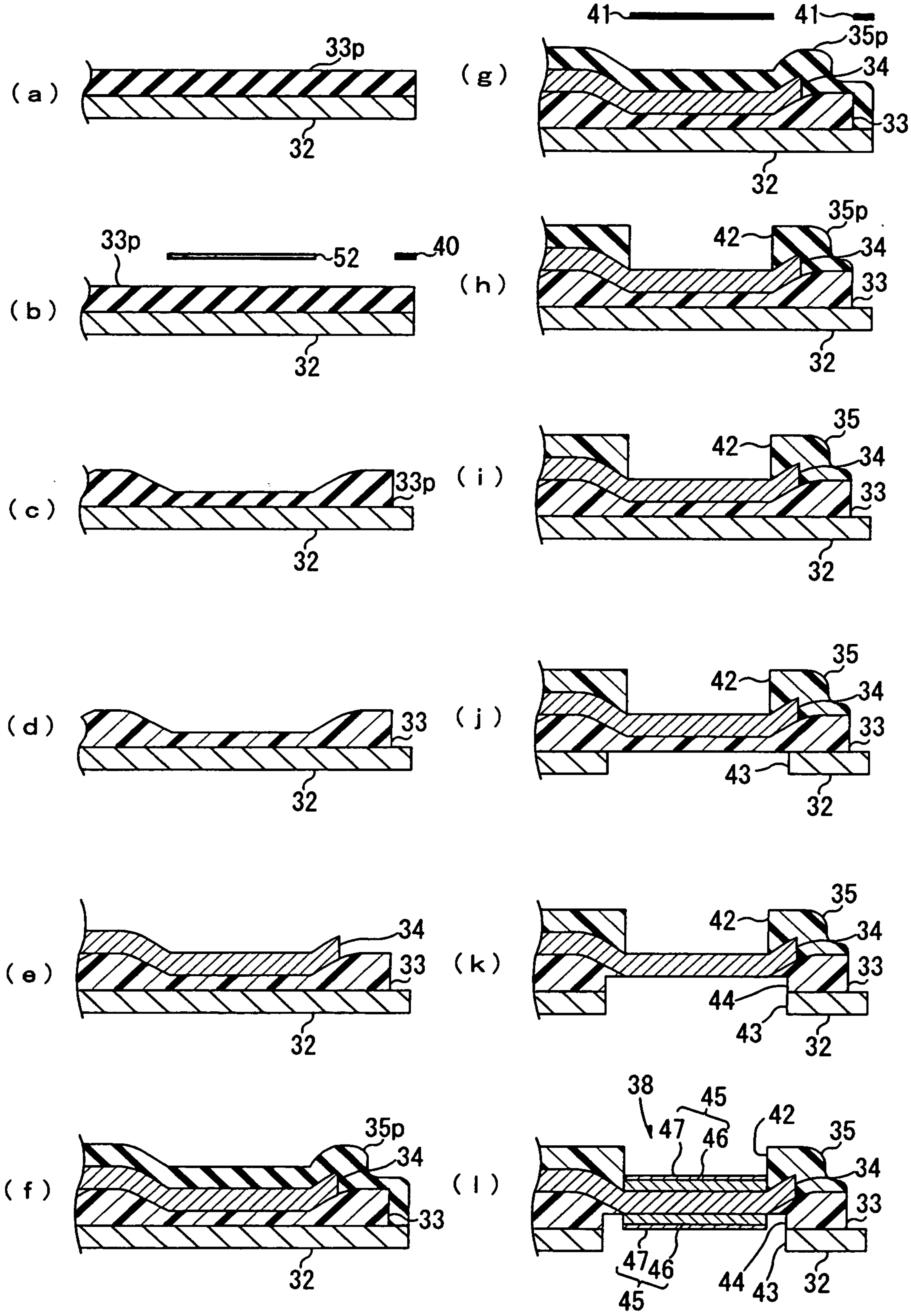


 出証特２００２－３０５２６６３

【図１６】



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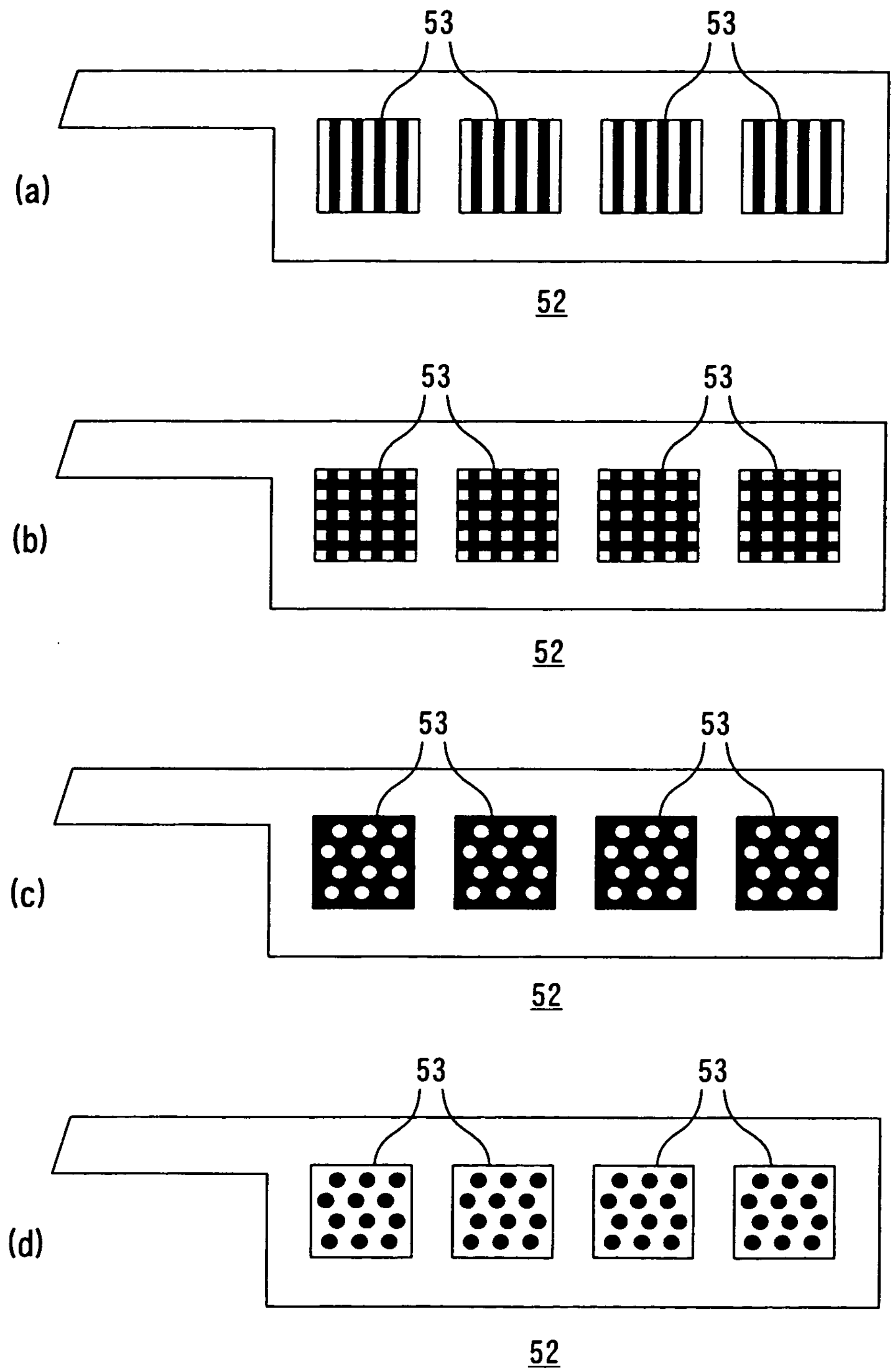
【図１７】



【図１８】

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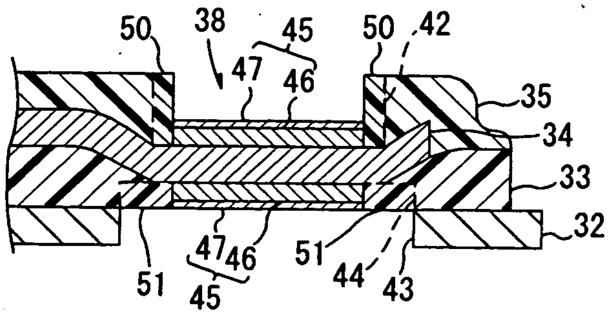
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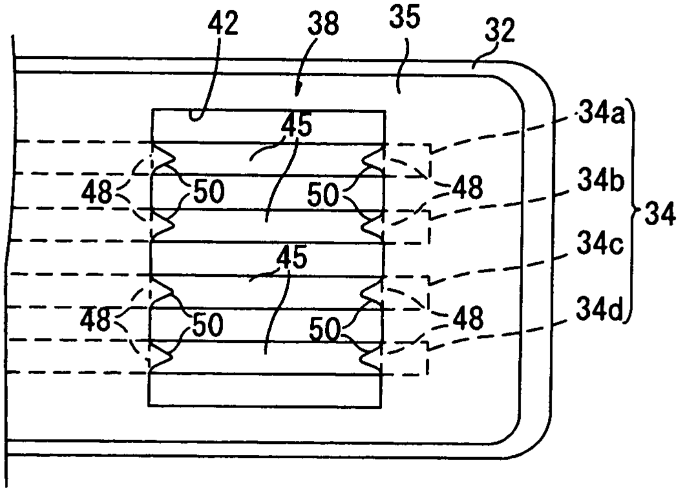
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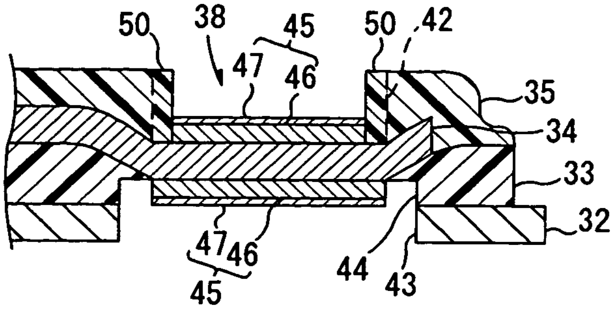
【図１９】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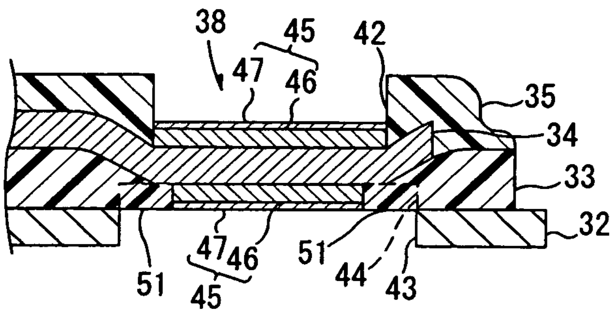
【図２０】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【図２１】

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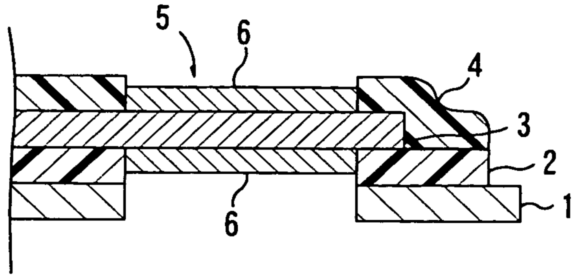

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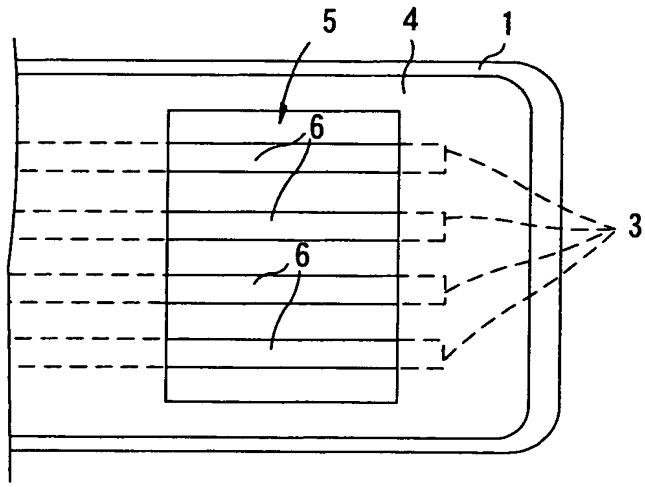


【書類名】　　要約書

【要約】

【課題】　簡易な構成により、端子部をフライングリードとして形成し、両面が露出される導体パターンの強度を確保して、その導体パターンの断線を有効に防止することのできる配線回路基板を提供すること。

【解決手段】　導体パターン３４の両面が露出するフライングリードとして形成されている端子部１６を有する配線回路基板１１において、端子部１６におけるカバー側開口部１７およびベース側開口部１８の端縁部と導体パターン１３とが交差する交差部分２１において、導体パターン１３に幅広部２２を形成するか、あるいは、カバー層３５およびベース層３３にカバー側突出部２５およびベース側突出部２６を形成する。

【選択図】　　図１

出 願 人 履 歴 情 報

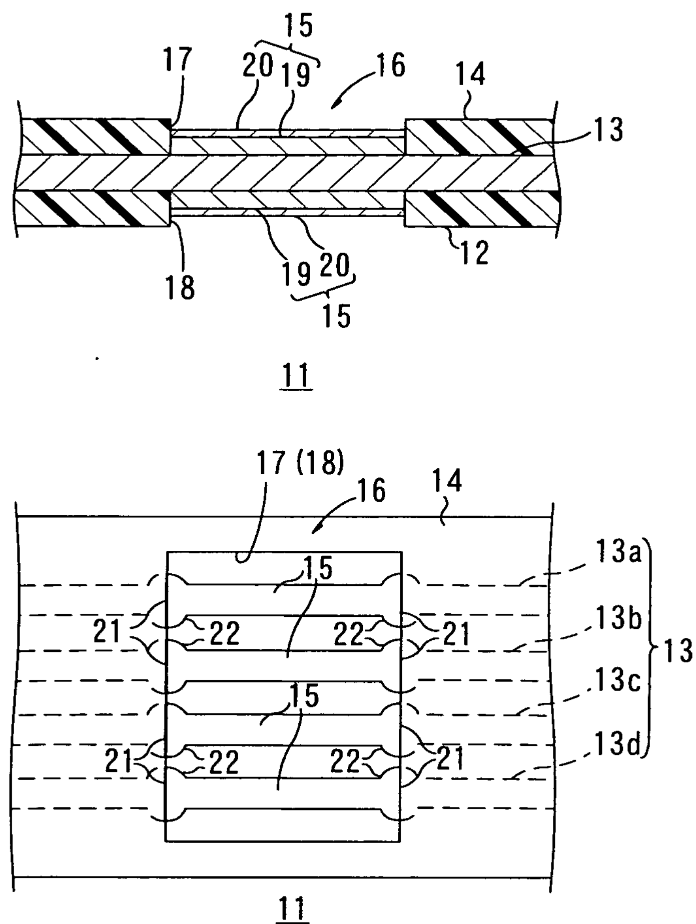
識別番号　　　　〔０００００３９６４〕

１．変更年月日　　１９９０年　８月３１日
　　［変更理由］　新規登録
　　　　住　所　　大阪府茨木市下穂積１丁目１番２号
　　　　氏　名　　日東電工株式会社

F I G. 1

(a)

(b)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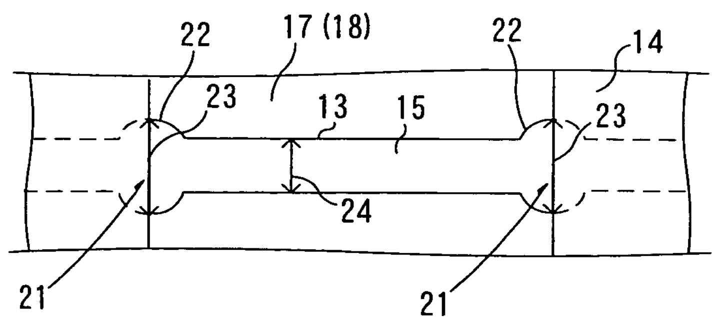
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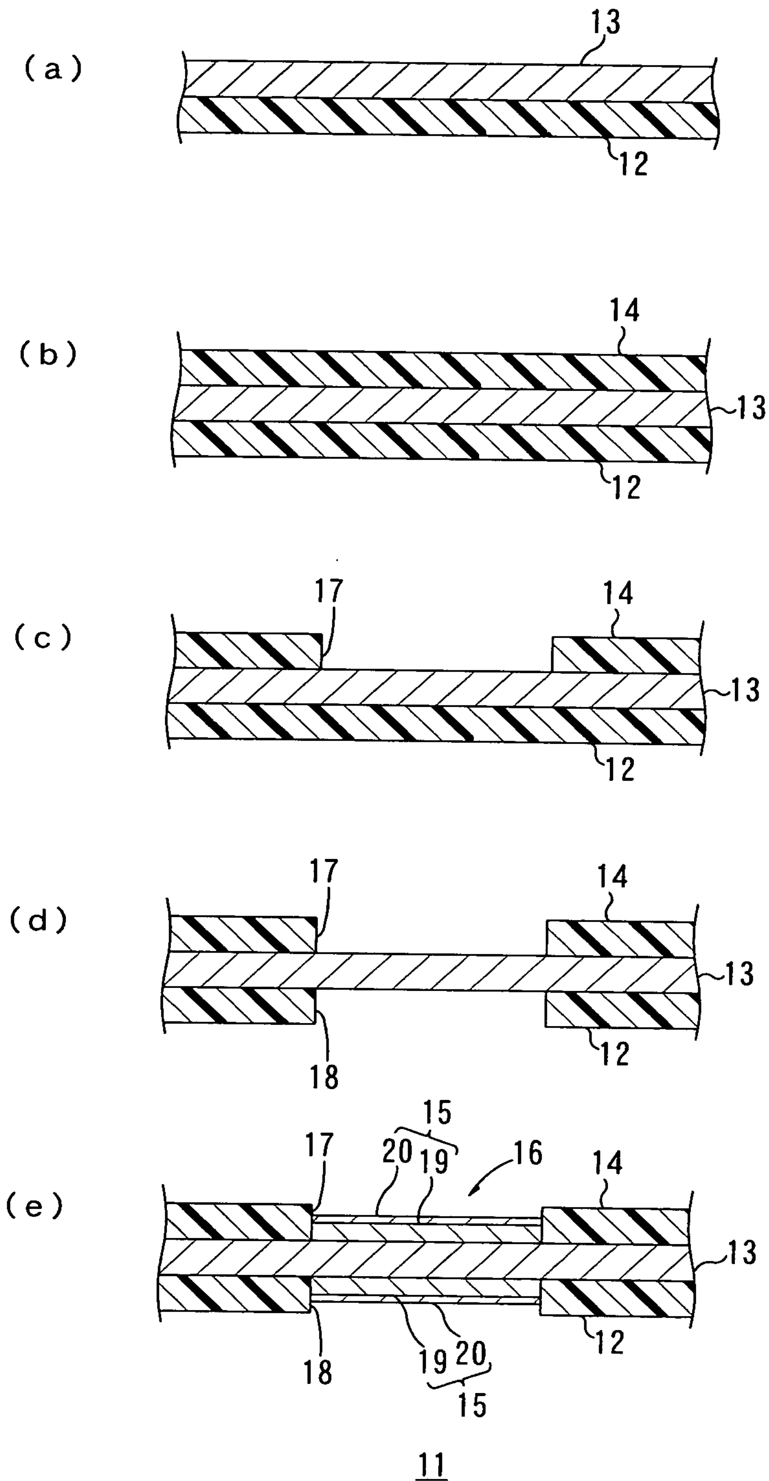
F I G. 3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F I G. 4

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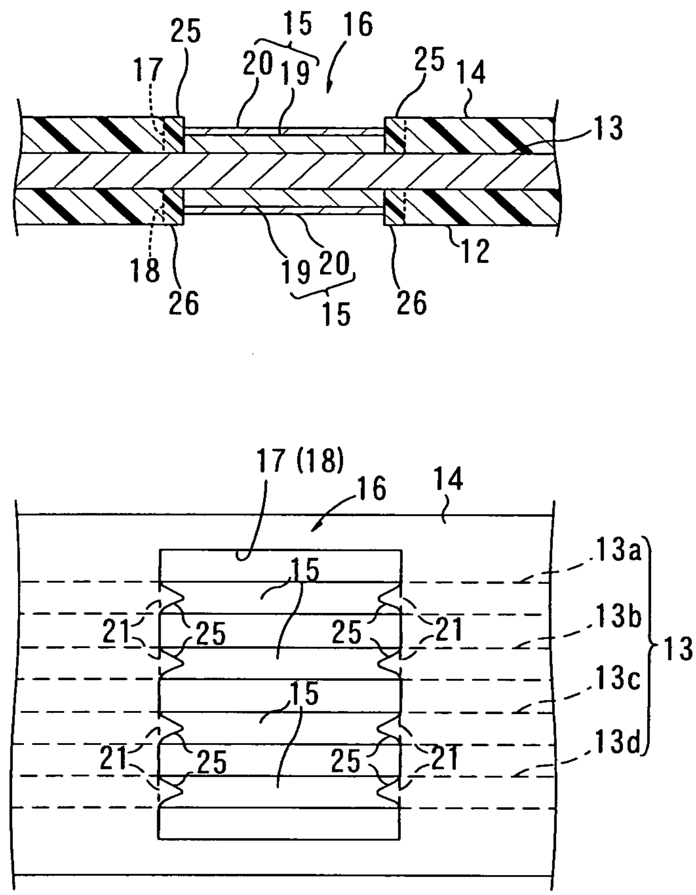
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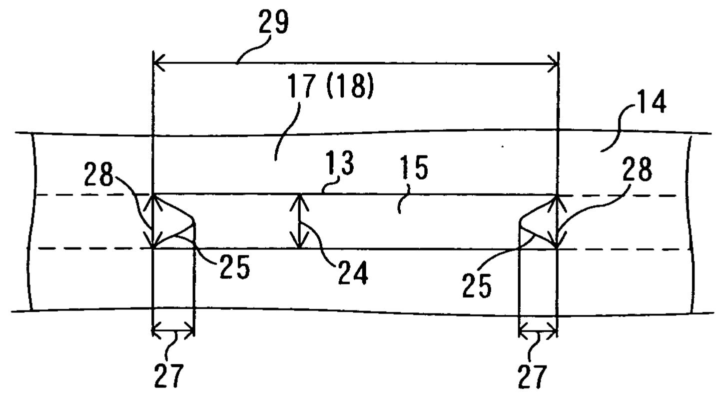
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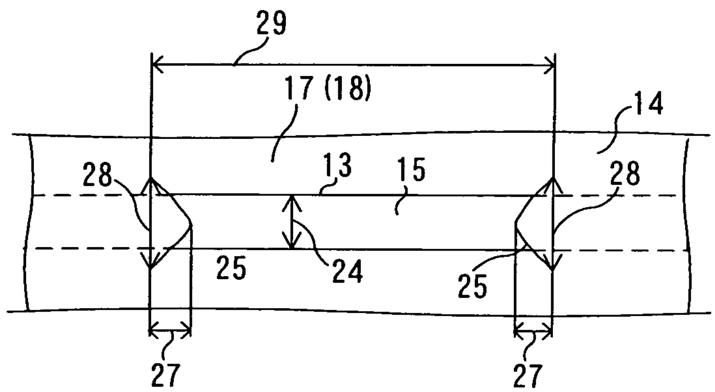
F I G. 6



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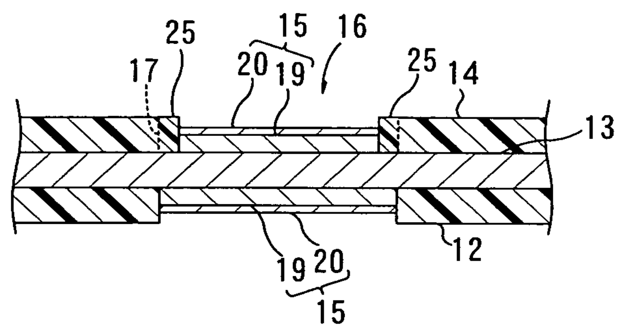
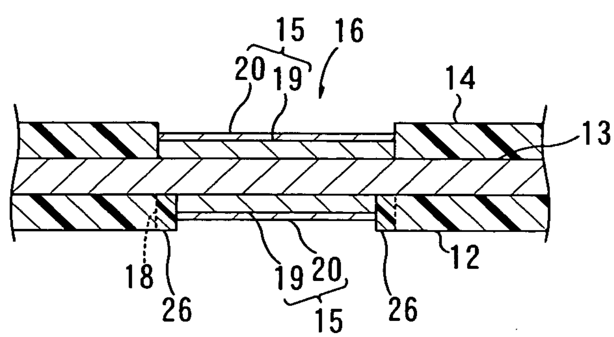


F I G. 8



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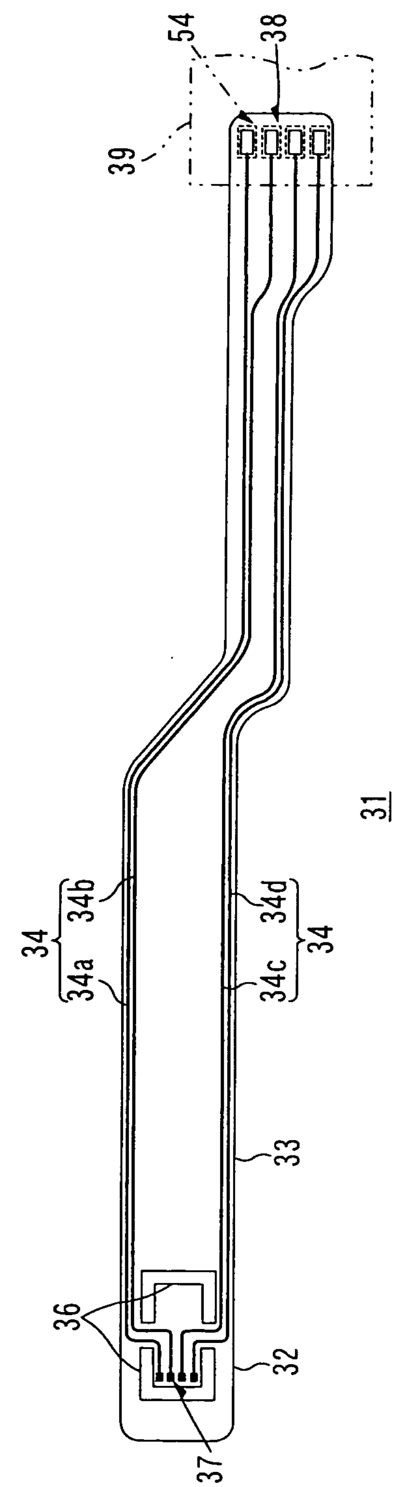

Inventors: Makoto KOMATSUBARA, et al.
Title: WIRED CIRCUIT BOARD
Filing Date: July 16, 2002
Atty. Docket No.: 30015280.0001
Sheet 6 of 15

FIG. 10

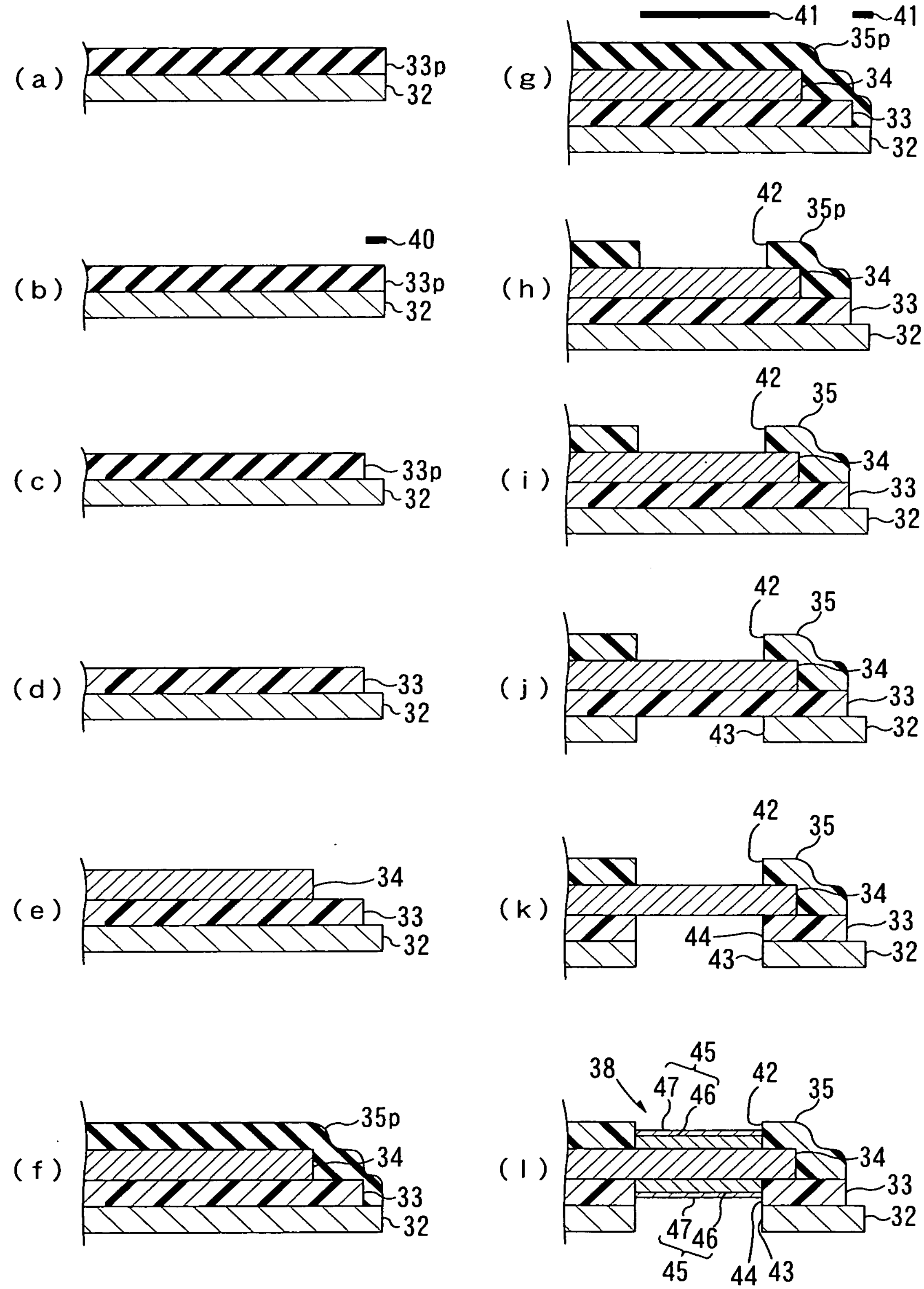

FIG. 11

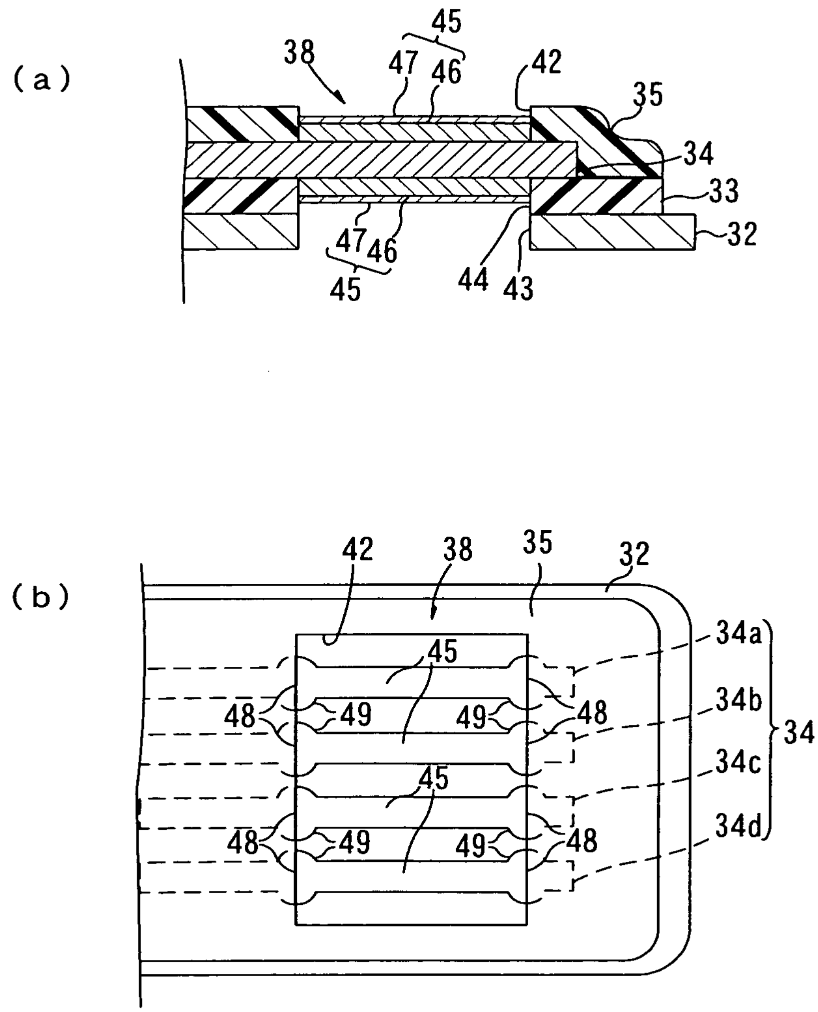
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FIG. 12

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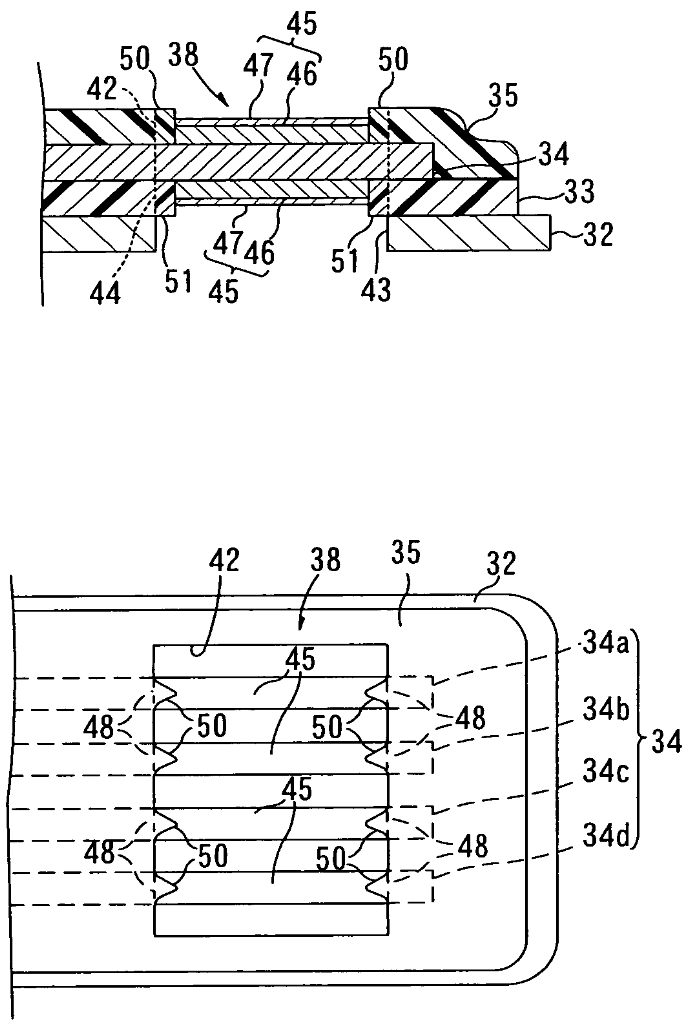

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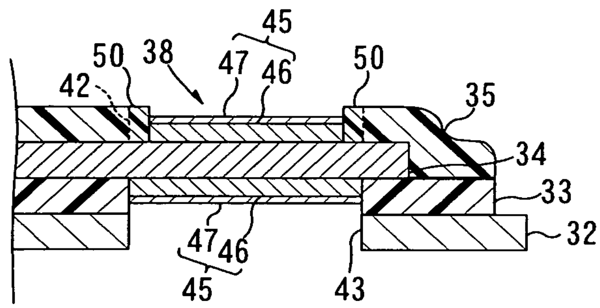
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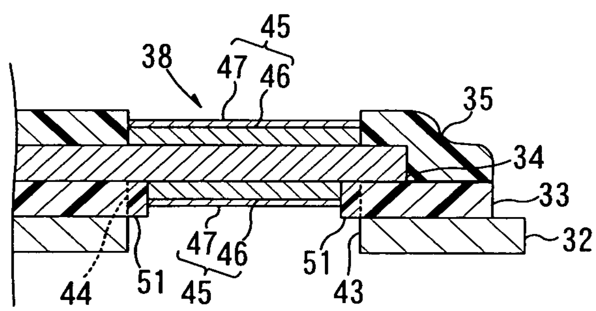
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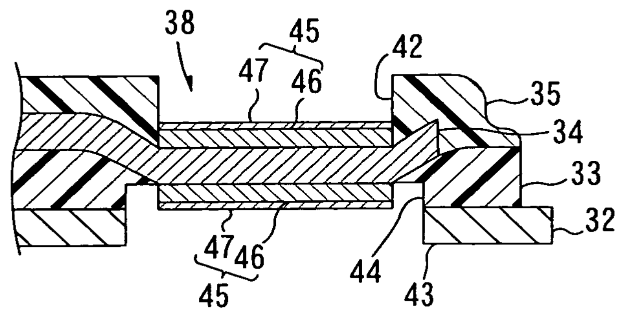
FIG. 15

(a)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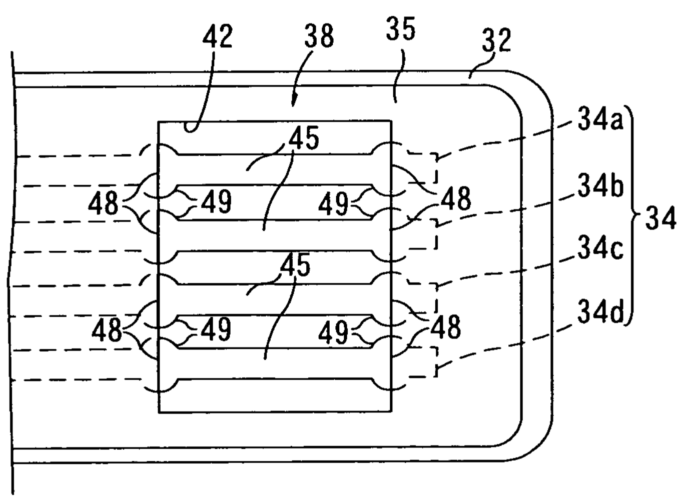
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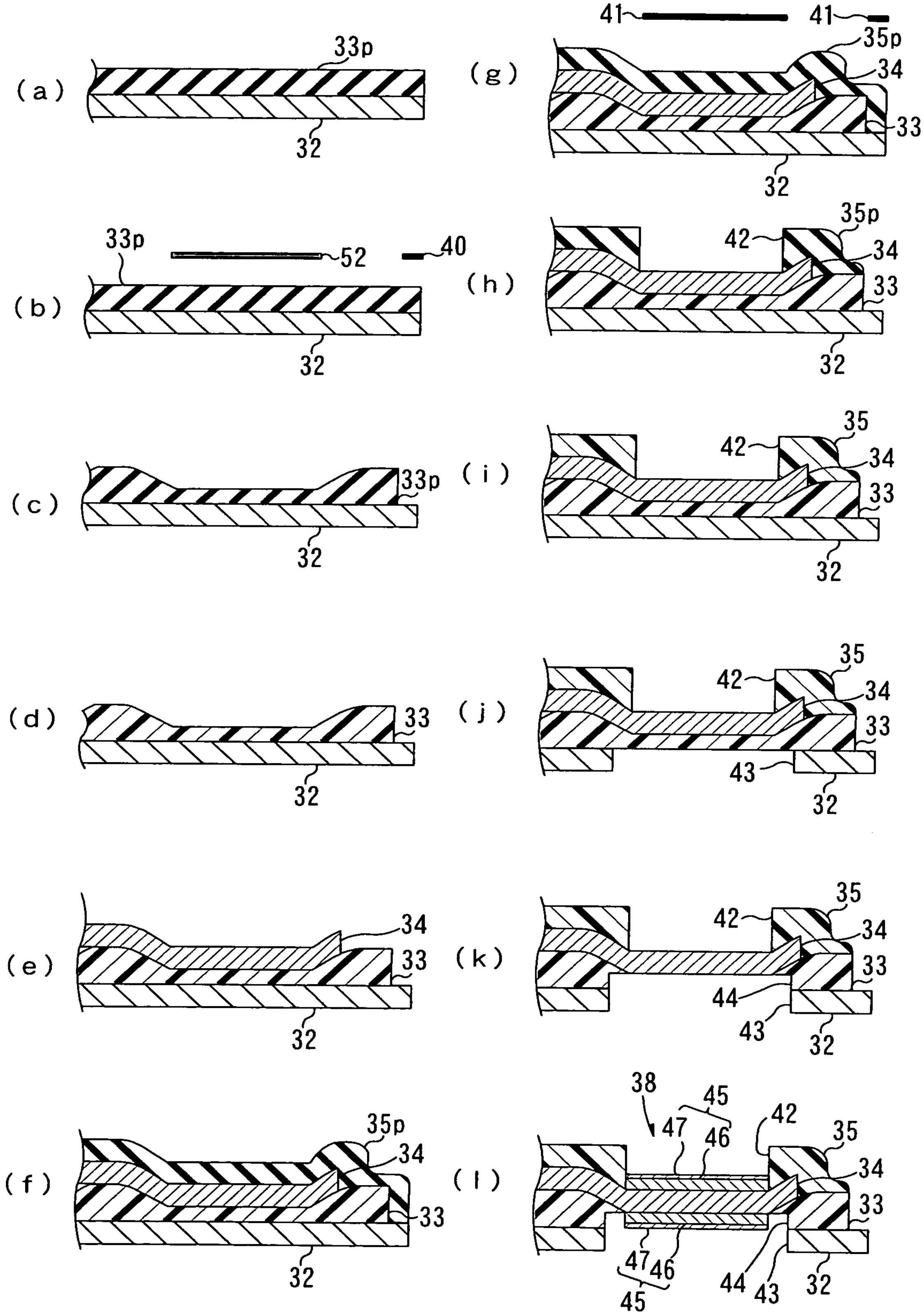
FIG. 16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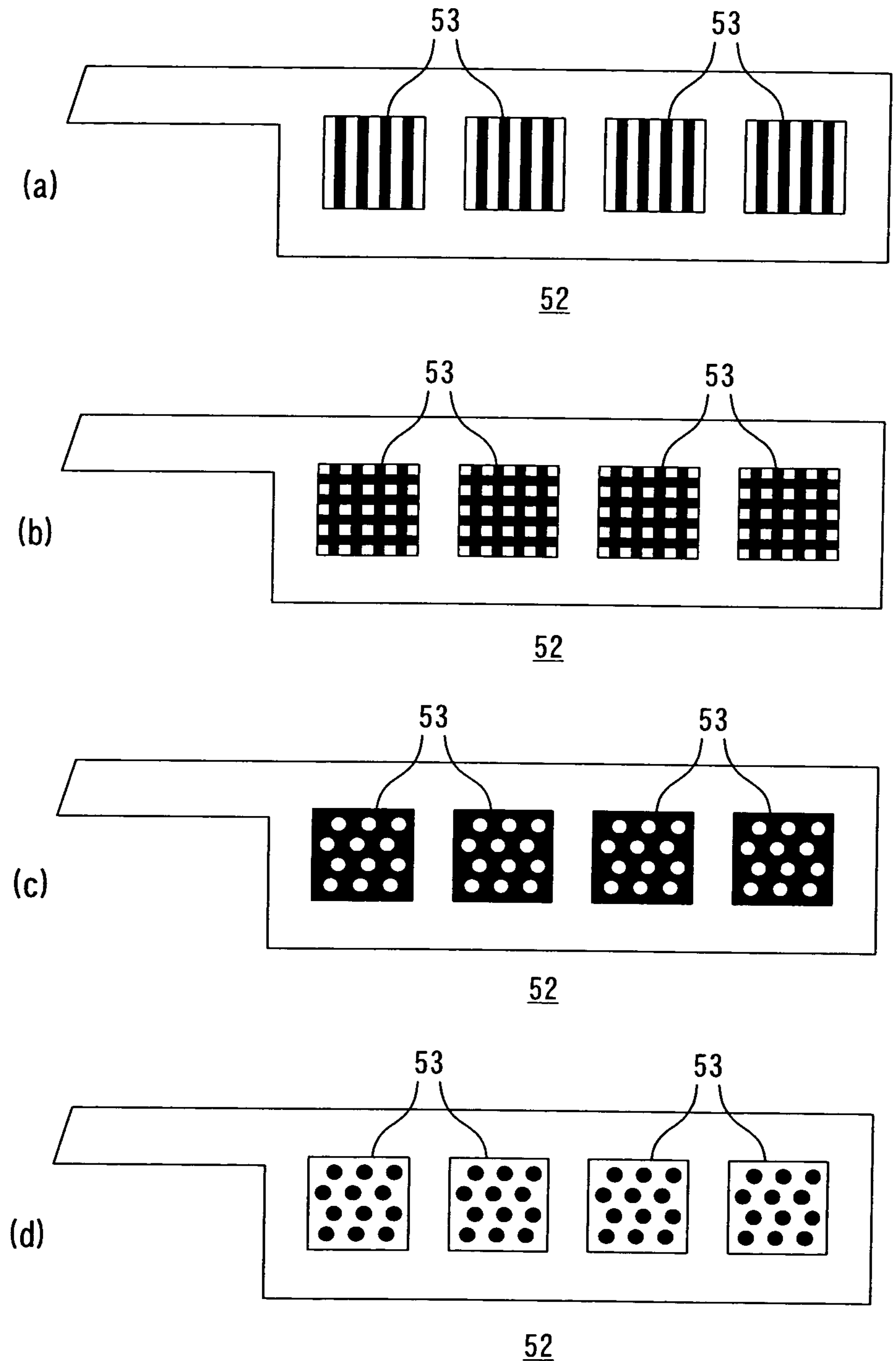
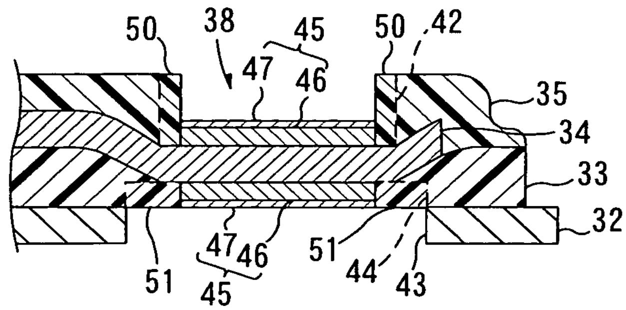


FIG. 18

(a)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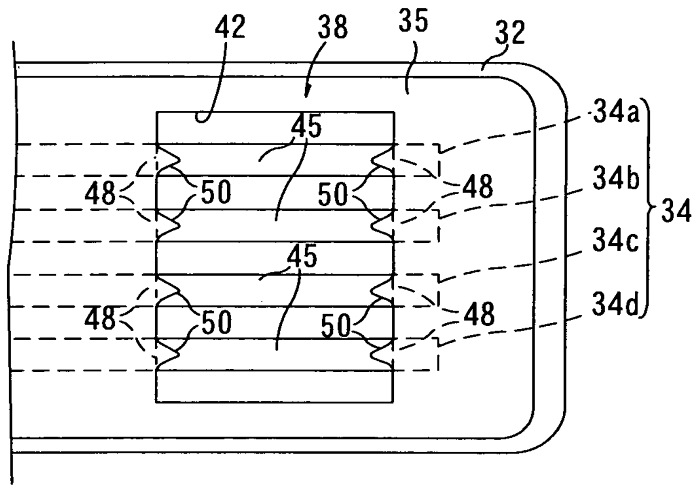
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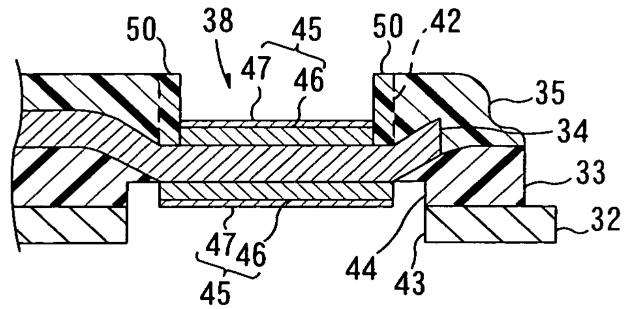
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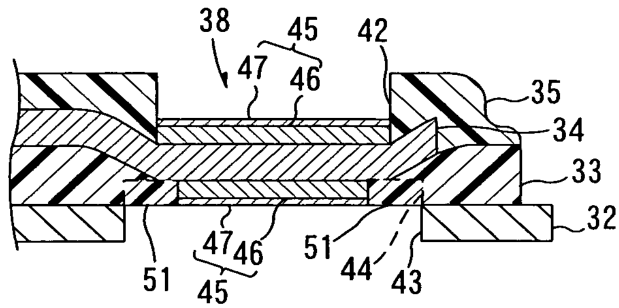
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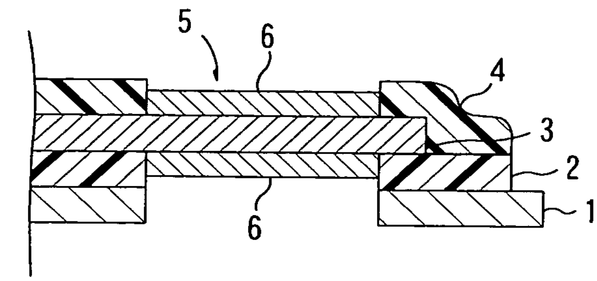

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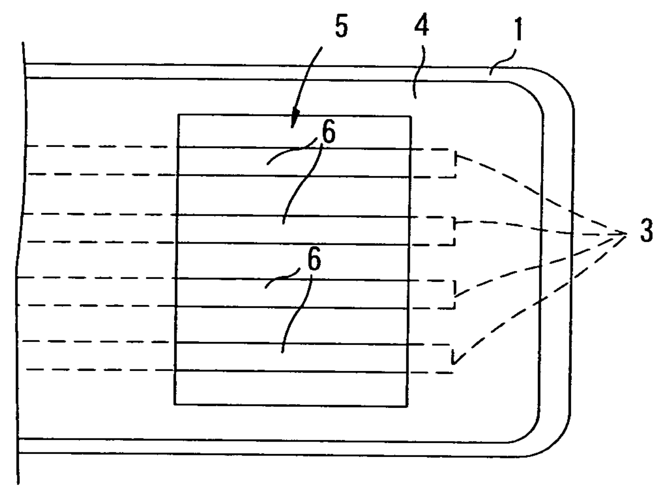

PRIOR ART

PATENT APPLICATION SERIAL NO. ______________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

07/19/2002 WABRHAM1 00000083 10195392

01 FC:101	740.00 OP
02 FC:102	252.00 OP

PTO-1556
(5/87)

*U.S. Government Printing Office: 2001 — 481-697/59173

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PTO/SB/05 (03-01)
Approved[illegible] through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark [illegible]: U.S. DEPARTMENT OF COMMERCE

JC853 U.S. PTO 07/16/02

JC971 U.S. PTO 10/195392 07/16/02

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. 1.53(b))

Attorney Docket No.	30015280.0001
First Inventor	Makoto Komatsubara
Title	WIRED CIRCUIT BOARD
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)
   (Submit an original and a duplicate for fee processing)
2. ☐ Applicant claims small entity status. See 37 CFR 1.27.
3. ☒ Specification [*Total Pages* 60]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. ☒ Drawing(s) (*35 U.S.C.113*) [*Total Sheets* 15]
5. Oath or Declaration [*Total Pages* 4]
   a. ☒ Newly executed (original or copy)
   b. ☐ Copy from a prior application (37 CFR 1.63 (d))
   (for a continuation/divisional with Box 18 completed)
   i. ☐ DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☐ Application Data Sheet. See 37 CFR 1.76
7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program *(Appendix)*
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
   i. ☐ CD-ROM or CD-R (2 copies); or
   ii. ☐ paper
   c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATIONS PARTS

9. ☒ Assignment Papers (cover sheet & document(s))
10. ☐ 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* ☐ Power of Attorney
11. ☐ English Translation Document *(if applicable)*
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☒ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: _____ /

Prior application information: Examiner _____ *Group / Art Unit:*

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

☒ *Customer Number or Bar Code Label* *(Insert Customer No. or Attach bar code label here)* 30412 PATENT TRADEMARK OFFICE or ☐ *Correspondence address below*

Name					
Address					
City		*State*		*Zip Code*	
Country		*Telephone*		*Fax*	

Name (Print/Type)	Jean C. Edwards	*Registration No. (Attorney/Agent)*	41,728
Signature	Jean C. Edwards	*Date*	July 16, 2002

Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Tradema[...]ce: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1[...]persons are required to respond to a collection of information[...]t displays a valid OMB control number.

FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision.

Complete if Known	
Application Number	Not yet assigned
Filing Date	July 16, 2002
First Named Inventor	Makoto Komatsubara
Examiner Name	Not yet assigned
Group / Art Unit	Not yet assigned
Attorney Docket No.	30015280.0001

TOTAL AMOUNT OF PAYMENT ($) 1032

METHOD OF PAYMENT (check one)

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number: 19-3140

Deposit Account Name: SONNENSCHEIN NATH & ROSENTHAL

☒ Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

☐ Applicant claims small entity status. See 37 CFR 1.27

2. ☒ Payment Enclosed:

☒ Check ☐ Credit card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	740	201	370	Utility filing fee	740
106	330	206	165	Design filing fee	
107	510	207	255	Plant filing fee	
108	740	208	370	Reissue filing fee	
114	160	214	80	Provisional filling fee	

SUBTOTAL (1) ($)740

2. EXTRA CLAIM FEES

				Extra Claims		Fee from below		Fee Paid
Total Claims	9	-20	=	0	X	0	=	0
Independent Claims	6	-3	=	3	X	84	=	252
Multiple Dependent					X		=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 252

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	920	217	460	Extension for reply within third month	
118	1,440	218	720	Extension for reply within fourth month	
128	1,960	228	980	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing a brief in support of an appeal	
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive – unavoidable	
141	1,280	241	640	Petition to revive – unintentional	
142	1,280	242	640	Utility issue fee (or reissue)	
143	460	243	230	Design issue fee	
144	620	244	310	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR 1.17 (q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	40
146	740	246	370	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	740	249	370	For each additional invention to be examined (37 CFR § 1.129(b))	
179	740	279	370	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 40

SUBMITTED BY			Complete *(if applicable)*		
Name (Print/Type)	Jean C. Edwards	*Registration No. Attorney/Agent)*	41,728	*Telephone*	202/408-6428
Signature	Jean C. Edwards			*Date*	July 16, 2002

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Attorney Docket No.: 30015280.0001
Customer No.: 30412

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: Not yet assigned

U.S. Application No.: Not yet assigned

Examiner: Not yet assigned

Confirmation No.: Not yet assigned

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

PRELIMINARY AMENDMENT

Commissioner for Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application, please amend the application as follows:

IN THE SPECIFICATION:

Page 1, prior to paragraph 1, please add the following new paragraph:

The present invention claims priority from Japanese Patent Application Serial No. 2001-216812, filed July 17, 2001, which is herein incorporated by reference.

REMARKS

Entry of this Preliminary Amendment prior to examination of the above-identified application is respectfully requested.

The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment, to Deposit Account No. 19-3140.

Respectfully submitted,

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Date: July 16, 2002
25051547\V1

APPENDIX I

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Page 1, prior to paragraph 1, the following new paragraph was added:

The present invention claims priority from Japanese Patent Application Serial No. 2001-216812, filed July 17, 2001, which is herein incorporated by reference.

WIRED CIRCUIT BOARD

BACKGROUND OF THE INVENTION

[0001]

Field of the Invention

The present invention relates to a wired circuit board and, more particularly, to a wired circuit board suitably used for a suspension board with circuit.

[0002]

Description of the Prior Art

The wired circuit boards used for electronic/electric equipments are usually provided with terminal portions to connect with external connecting terminals.

[0003]

In recent years, the so-called "flying lead" in which the terminal portions are formed on both sides of the conductive pattern, rather than in only either side thereof, is being in widespread use in order to meet the demand for electronic/electric equipment to have increasingly higher density and reduced size. It is known, for example, in suspension board with circuit used for a hard disk drive that the terminals are provided in the form of flying lead.

[0004]

To be more specific, the suspension board with circuit comprises a supporting board 1 of stainless steel foil, a base layer 2 of an insulating material formed on the supporting board 1, a conductive pattern 3 formed on the base layer 2 in the form of a specified circuit pattern, and a cover layer 4 of an insulating material, for covering the conductive pattern 3, as shown in FIG. 21. The terminal portions 5 provided in the form of the flying lead are formed on both sides of the conductive pattern 3 in the following manner. The cover layer 4 is opened to expose a front side of the conductive pattern 3, while also the supporting board 1 and the base layer 2 are opened to expose a back side of the conductive pattern 3. If necessary, metal plated layers 6 are formed on the both sides of the thus exposed conductive pattern 3 by nickel/gold plating and the like.

[0005]

Thereafter, these terminal portions formed as the flying lead are bonded to external connecting terminals by applying supersonic vibration thereto by use of a bonding tool and the like.

[0006]

In this terminal portion formed as the flying lead, since the both sides of the conductive pattern are exposed, the supersonic vibration is easily transmitted to the terminals. This is suitable for the bonding using the supersonic vibration: on the other hand, this provides the disadvantage that the conductive pattern exposed at both sides thereof is weak in physical strength and is subject to stress concentration at edge portions of the openings in the base layer and cover layer, to cause disconnection of the conductive pattern with ease.

[0007]

SUMMARY OF THE INVENTION

It is the object of the invention to provide a new wired circuit board having a terminal portion formed as a flying lead in which both sides of a conductive pattern are exposed that can provide enhanced strength of the conductive pattern by simple construction to effectively prevent occurrence of disconnection of the conductive pattern.

[0008]

The present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0009]

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0010]

In the wired circuit boards mentioned above, since at least any one of the first insulating layer, the second insulating layer and the conductive pattern has the reinforcing portions for reinforcing the conductive pattern formed at the ends of the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0011]

In addition, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0012]

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0013]

In the wired circuit boards mentioned above, since the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to the extending direction of the conductive pattern in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0014]

Further, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

[0015]

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

[0016]

In the wired circuit boards mentioned above, since the first insulating layer and/or the second insulating layer have projections projecting from the ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0017]

The wired circuit board of the present invention can provide high bonding reliability so that the wired circuit board can be used as the suspension board with circuit, even when formed as the flying lead in which both sides of the conductive pattern are exposed.

[0018]

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 shows an embodiment of a wired circuit board (wherein a widened portion is formed) of the present invention: (a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and (b) is a plan view of the terminal portion of the same.

FIG. 2 is an enlarged plan view of FIG. 1(b).

FIG. 3 illustrates the production processes of a wired circuit board shown in FIG. 1:

(a) shows the step of forming a conductive pattern on a base layer;

(b) shows the step of forming a base layer on the conductive pattern;

(c) shows the step of forming a cover-side opening on the cover layer at a portion thereof at which terminals are to be formed;

(d) shows the step of forming a base-side opening on the base layer at a portion thereof at which terminals are to be formed; and

(e) shows the step of forming a metal plated layer on each of front and back sides of the conductive pattern exposed in the cover-side opening and the base-side opening.

FIG. 4 shows another embodiment of the wired circuit board (wherein a cover-side projection and a base-side projection are formed) of the present invention: (a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and (b) is a plan view of the terminal portion of the same.

FIG. 5 is an enlarged view of the plan view shown in FIG. 4(b).

FIG. 6 is an enlarged view of the plane view of another embodiment shown in FIG. 4(b).

FIG. 7 shows in section a principal portion of another embodiment (only the cover-side projection is formed) of the wired circuit board shown in FIG. 4(a).

FIG. 8 shows in section a principal portion of still another embodiment (only the base-side projection is formed) of the wired circuit board shown in FIG. 4(a).

FIG. 9 is a plan view of a suspension board with circuit presented as one embodiment of the wired circuit board of the present invention.

FIG. 10 illustrates the production processes of the suspension board with circuit shown in FIG. 9:

(a) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on a supporting board;

(b) shows the step of exposing the coating to light through a photomask;

(c) shows the step of developing the coating to form it into a predetermined pattern;

(d) shows the step of curing the patterned coating to form the base layer,

(e) shows the step of forming a conductive pattern on the base layer;

(f) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on the conductive pattern;

(g) shows the step of exposing the coating to light through a photomask;

(h) shows the step of developing the coating to form it into a predetermined pattern;

(i) shows the step of curing the patterned coating to form the cover layer;

(j) shows the step of opening the supporting board at portions thereof at which the external-side connecting terminals are formed;

(k) shows the step of opening the base layer at portions thereof at which the external-side connecting terminals are formed; and

(l) shows the step of forming a metal plated layer on each side of the exposed conductive pattern.

FIG. 11 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein a widened portion is formed) of the present invention: (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 12 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein a cover-side projection and a base-side projection are formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 13 shows in section a principal portion of another embodiment (only the cover-side projection is formed) of the suspension board with circuit shown in FIG. 12(a).

FIG. 14 shows in section a principal portion of still another embodiment (only the base-side projection is formed) of the suspension board with circuit shown in FIG. 12(a).

FIG. 15 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein the conductive pattern has a concave form and a widened portion is formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 16 illustrates the production processes of the suspension board with circuit shown in FIG. 15:

(a) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on a supporting board;

(b) shows the step of exposing the coating to light through a photomask;

(c) shows the step of developing the coating to form it into a predetermined pattern;

(d) shows the step of curing the patterned coating to form the base layer,

(e) shows the step of forming a conductive pattern on the base layer;

(f) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on the conductive pattern;

(g) shows the step of exposing the coating to light through a photomask;

(h) shows the step of developing the coating to form it into a predetermined pattern;

(i) shows the step of curing the patterned coating to form the cover layer;

(j) shows the step of opening the supporting board at portions thereof at which the external-side connecting terminals are formed;

(k) shows the step of opening the base layer at portions thereof at which the external-side connecting terminals are formed; and

(l) shows the step of forming a metal plated layer on each side of the exposed conductive pattern.

FIG. 17 is a schematic plan view of an embodiment of a photomask used for exposing the coating to light in the step of FIG. 16(b):

(a) shows a semi-translucent striped pattern having an average transmission ratio of about 50%;

(b) shows a semi-translucent latticed pattern having an average transmission ratio of about 25%;

(c) shows a semi-translucent circular staggered pattern having an average transmission ratio of about 25%; and

(d) shows a semi-translucent circular staggered pattern having an average transmission ratio of about 70%.

FIG. 18 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein the conductive pattern has a concave form and a cover-side projection and a base-side projection are formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 19 shows in section a principal part of another embodiment of a suspension board with circuit shown in FIG. 18(a) (wherein only the cover-side projection is formed).

FIG. 20 shows in section a principal part of still another embodiment of a suspension board with circuit shown in FIG. 18(a) (wherein only the base-side projection is formed).

FIG. 21 shows a conventional suspension board with circuit: (a) is a sectional view of a principal portion of a terminal of the suspension board with circuit; and (b) is a plan view of the terminal of the same.

[0019]

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown an embodiment of a wired circuit board of the present invention. FIG. 1(a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and FIG. 1(b) is a plan view of the terminal portion of the same. In FIG. 1(a), the wired circuit board 11 comprises a base layer 12 formed as a first insulating layer of insulating material, a conductive pattern 13 formed on the base layer 12 in the form of a specified wired circuit pattern, and a cover layer 14 formed as a second insulating layer of insulating material on the conductive pattern 13. The conductive pattern 13 is provided in the form of a plurality of lines of wires 13a, 13b, 13c and 13d arrayed in parallel with each other with spaced at a predetermined interval, as shown in FIG. 1(b).

[0020]

The insulating materials of the base layer 12 and the cover layer 14 that may be used include, for example, synthetic resins, such as polyimide resin, acrylic resin, polyether nitrile resin, polyether sulfonic resin, polyethylene terephthalate resin, polyethylene naphthalate resin and polyvinyl chloride resin. Polyimide resin is preferably used.

[0021]

The base layer 12 and the cover layer 14 usually have thickness of 1-30μm, or preferably 2-20μm.

[0022]

The conductive materials used for the conductive pattern 13 include, for example, copper, nickel, gold, solder or alloys thereof. Copper is preferably used. The conductive pattern 13 usually has thickness of 2-30μm, or preferably 5-20μm.

[0023]

This wired circuit board 11 is formed in the following way. First, as shown in FIG. 3(a), the conductive pattern 13 is formed on the base layer 12 formed in a film-like form, in the form of the specified wired circuit pattern by a known patterning process, such as a subtracting process, an additive process and a semi-additive process. Then, as shown in FIG. 3(b), the base layer 12 is covered with the cover layer 14 in a known method, for example, by adhesive bonding a film-like resin to the conductive pattern 13 or by applying a photosensitive resin to the conductive pattern 13 and then curing that resin.

[0024]

In the wired circuit board 11 thus formed, as shown in FIG. 1(a), the cover layer 14 is opened to expose a front side of the conductive pattern 13 and also the base layer 12 is opened to expose a back side of the conductive pattern 13 in such a manner that the exposed front side of the conductive pattern 13 and the exposed back side of the same correspond in position to each other so as to expose the both sides of the conductive pattern 13. Then, on the both sides of the exposed conductive pattern 13, metal plating layers 15 are formed thereby forming the terminal portion 16 in the form of the flying lead.

[0025]

This terminal portion 16 is formed in the following manner. First, a cover-side opening 17 is formed in the cover layer 14 in a portion thereof in which the terminal portion 16 is to be formed, in a known method, such as drilling, laser machining, etching and patterning of photosensitive resin, as shown in FIG. 3(c). Likewise, a base-side opening 18 is formed in the base layer 12 in a portion thereof corresponding to the cover-side opening 17, in a known method, such as drilling, laser machining, etching and patterning of photosensitive resin, as shown in FIG. 3(d). The cover-side opening 17 and the base-side opening 18 are opened into a rectangular shape to cover all the lines of wire 13a, 13b, 13c and 13d.

[0026]

As shown in FIG. 3(e), the metal plating layers 15 are formed by plating on both sides of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

[0027]

No particular limitation is imposed on the plating method used for forming the metal plated layer 15. The metal plating layer 15 may be formed by either of electrolysis plating and electroless plating. Also, no particular limitation is imposed on the metals used for the plating. Known metals may be used for the plating. It is preferable that the electrolysis nickel plating and the electrolysis gold plating are performed in sequence so that a gold plated layer 20 is formed on a nickel plated layer 19. The nickel plated layer 19 and the gold plated layer 20 each have thickness of the order of 1-5μm.

[0028]

The wired circuit board 11 has the terminal portion 16 in the form of the flying lead. In the terminal portion 16, widened portions 22 as reinforcing portions which extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 13 are provided in the conductive pattern 13 in crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other, as shown in FIG. 1(b).

[0029]

To be more specific, the widened portions 22 are formed in the respective lines of wire 13a, 13b, 13c and 13d at positions thereof which correspond to the crossing areas 21 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d. The widened portions 22 are formed in such a generally round shape as to protrude widthwise from the lines of wire 13a, 13b, 13c and 13d.

[0030]

As shown in FIG. 2, each widened portion 22 is arranged, with its generally outer half portion embedded in the cover layer 14/base layer 12 and its generally inner half portion exposed in the cover-side opening 17/ base-side opening 18, when a maximum widthwise length 23 between the adjacent lines of wire is defined as a boundary between the outer half portion and the inner half portion. Thus, the terminals 16 are formed in such a dumbbell shape that the lines of wire 13a, 13b, 13c and 13d are protruded widthwise at both ends thereof in the cover-side opening 17/the base-side opening 18.

[0031]

Each widened portion 22 is so formed that the maximum widthwise length 23 is 1.1-4 times, or preferably 2-3 times, as longer as a usual line width 24 of the lines of wire 13a, 13b, 13c and 13d exposed outside in the cover-side opening 17/base-side opening 18. To be more specific, a widthwise part of widened portion 22 at the maximum widthwise length 23 is 20-1,000μm in length and a lengthwise part of the widened portion 22 extending in a longitudinal direction of the lines of wire 13a, 13b, 13c and 13d is 50-500μm in length.

[0032]

The widened portions 22 may be formed in any shape other than the generally round shape, as long as they are shaped to protrude widthwise and have widths larger than the usual width. For example, the widened portion 22 may be formed in rectangle.

[0033]

The terminal portion 16 having this widened portion 22 can be formed in the processes given below. The widened portions 22 are formed with the patterning of the wired circuit pattern in the process of forming the conductive pattern 13. Then, in the processes of FIG. 3(c) and (d), the cover layer 14 and the base layer 12 are each opened so that the maximum widthwise length 23 of the widened portion 22 can be within the crossing areas 21 and thereby the cover-side opening 17 and the base-side opening

18 are formed. Thereafter, in the process shown in FIG. 3(e), the metal plated layer 15 is formed on each side of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

[0034]

In this formation of the wired circuit board 11, since the widened portions 22 widened in the widthwise direction of the conductive pattern 13 are formed in the conductive pattern 13 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive pattern 13 are crossed each other, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

[0035]

In addition, the wired circuit board 11 may be formed so that the terminal portion 16 presented in the form of this flying lead can have cover-side projections 25 formed as the reinforcing portions and base-side projections 26 formed as the reinforcing portions, as shown in FIG. 4. Specifically, the cover-side projections 25 are formed to project from the ends of the cover-side opening 17 onto the conductive pattern 13 in the cover-side opening 17 in the cover layer 14 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other. The base-side projections 26 are formed to project from the ends of the base-side opening 18 onto the conductive pattern 13 in the base-side opening 18 in the base layer 12 in the crossing areas 21.

[0036]

To be more specific, the cover-side projections 25 and the base-side projections 26 are formed in the respective lines of wire 13a, 13b, 13c and 13d at positions thereof which correspond to the crossing areas 21 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d, as shown in FIG. 4(b). These projections 25, 26 are formed in a convex shape projecting inwardly from the ends of the cover-side opening 17 and the base-side opening 18 along the extending direction of the lines of wire 13a, 13b, 13c and 13d, respectively.

[0037]

The cover-side projections 25 and the base-side projections 26 are overlapped with the lines of wire 13a, 13b, 13c and 13d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 17/base-side opening 18, respectively. As a result of this, the terminal portions 16 are so formed that the lines of wire 13a, 13b, 13c and 13d can be covered with the cover-side projections 25 and the base-side projections 26 at opposite ends thereof in the cover-side opening 17 and the base-side opening 18.

[0038]

The cover-side projections 25 and the base-side projections 26 are formed to project at projection length 27 of one-fourth to one-thirtieth, or preferably one-fifth to one-twentieth, to a line length 29 of each of the lines of wire 13a, 13b, 13c and 13d exposed in the cover-side opening 17 and the base-side opening 18, as shown in FIG. 5. To be more specific, each of the cover-side projections 25 and the base-side projections 26 has a basal width 28 of 5-20μm slightly smaller than a line width 24 of lines of wire 13a, 13b, 13c and 13d at the ends of the cover-side opening 17/the base-side opening 18. The cover-side projections 25 and the base-side projections 26 are projected inwardly in a taped manner at a projection length 27 of 5-250μm and are formed in a generally triangle whose top is located at a widthwise center of lines of wire 13a, 13b, 13c and 13d.

[0039]

The shape of the cover-side projections 25 and the base-side projections 26 is not limited to the one shown in FIG. 5, as long as those projections have such a shape as to overlap with the lines of wire 13a, 13b, 13c and 13d along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d. For example, as shown in FIG. 6, the cover-side projections 25 and the base-side projections 26 may be formed to project toward the inside thereof in a tapered manner from the ends of the cover-side opening 17/the base-side opening 18, with the basal width 28 slightly larger than the line width 24 of the lines of wire 13a, 13b, 13c and 13d. Further, those projections 25, 26 may be formed in such a rectangular shape as to overlap with the lines of wire 13a, 13b, 13c and 13d along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d, without limiting to the generally triangle shape.

[0040]

The terminal portions 16 having these cover-side projections 25 and the base-side projections 26 are formed as follows. In the process of FIG. 3(c), the cover layer 14 is opened in such a manner as to form the cover-side projections 25 to thereby produce the cover-side opening 17. In the process of FIG. 3(d), the base layer 12 is opened in such a manner as to form the base-side projections 26 to thereby produce the base-side opening 18. Thereafter, in the process of FIG. 3(e), the metal plated layer 15 is formed on each side of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

[0041]

In this formation of the wired circuit board 11, since the cover-side projections 25 and the base-side projections 26 are formed in the cover layer 14 and the base layer 12 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other, so as to project from the ends of the cover-side opening 17/the base-side opening 18 onto the conductive pattern 13 in the cover-side opening 17 and the base-side opening 18, respectively, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

[0042]

It is to be noted that in the wired circuit board 11, both of cover-side projections 25 and the base-side projections 26 are not necessarily required. For example, only the cover-side projections 25 may be formed, as shown in FIG. 7. Alternatively, only the base-side projections 26 may be formed, as shown in FIG. 8.

[0043]

Further, modification may be made of the invention by forming the widened portions 22 in the conductive pattern 13 and also forming the cover-side projections 25 in the cover layer 14 and/or forming the base-side projections 26 in the base layer 12, though not shown.

[0044]

The wired circuit board 11 having these terminal portions 16 is particularly preferably applicable to a suspension board with circuit.

[0045]

Referring to FIG. 9, there is shown a perspective view of a suspension board with circuit presented as an embodiment of the wired circuit board of the present invention. The suspension board with circuit 31 mounts thereon a magnetic head of a hard disk driver (not shown) and suspends the magnetic head while holding a minute interval between the magnetic head and a magnetic disk against airflow generated when the magnetic head and the magnetic disk run relative to each other. The suspension board with circuit has the lines of wire 34a, 34b, 34c, 34d, integrally formed in the form of a specified wired circuit pattern, for connecting the magnetic head and a read/write board 39 formed as an external circuit.

[0046]

In FIG. 9, the suspension board with circuit 31 has a base layer 33, as a first insulating layer of insulating material, which is formed on a supporting board 32 extending longitudinally as a metal supporting layer. A conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, and a cover layer 35 (not shown) is formed on the conductive pattern 34 as a second insulating layer of insulating material. The conductive pattern 34 is provided in the form of the plurality of lines of wire 34a, 34b, 34c and 34d arrayed in parallel with spaced at a predetermined interval.

[0047]

Gimbals 36 for fitting the magnetic head therein are formed in the supporting board 32 by cutting out the supporting board 32 at a front end portion thereof. At the front end portion of the supporting board 32, magnetic head connecting terminals 37 are formed to connect between the magnetic head and the lines of wire 34a, 34b, 34c and 34d. At the rear end portion of the supporting board 32, external-side connecting terminals 38 as the terminals are formed to connect between the read/write board 39 and the lines of wire 34a, 34b, 34c and 34d. The external-side connecting terminals 38 are formed in the ends of the lines of wire 34a, 34b, 34c and 34d, to correspond to each of the read/write terminals 54.

[0048]

This suspension board with circuit 31 can be formed in the following processes. First, the supporting board 32 is prepared and the base layer 33 is formed on the supporting board 32 in the form of the specified pattern, as shown in FIG. 10(a)-(d). A metal foil or a metal sheet is preferably used as the supporting board 32. For example, stainless steel, 42 alloy and the like are preferably used. The supporting board 32 used preferably has thickness of 10-60μm, or further preferably 15-30μm, and width of 50-500mm, or further preferably 125-300mm.

[0049]

Insulating material used for forming the base layer 33 is not limited to any particular insulating material. The insulating materials that may be used include, for example, synthetic resins such as polyimide resin, acrylic resin, polyether nitrile resin, polyether sulfonic resin, polyethylene terephthalate resin, polyethylene naphthalate resin and polyvinyl chloride resin. Of these synthetic resins, a photosensitive resin is preferably used as the base layer. A photosensitive polyimide resin is further preferably used.

[0050]

Then, for example when the base layer 33 is formed in the specified pattern on the supporting board 32 by using photosensitive polyimide resin, liquid solution of precursor of the photosensitive polyimide resin is applied to the whole area of the supporting board 32 prepared first, and then is dried, for example, at 60-150℃, to form a coating 33p of the precursor of the photosensitive polyimide resin, as shown in FIG. 10(a).

[0051]

Then, the coating 33p is exposed to light through a photomask 40, as shown in FIG. 10(b). If required, the exposed part is heated to a specified temperature. Thereafter, the coating 33p is developed to form the coating 33p into a specified pattern, as shown in FIG. 10(c). Preferably, radiation irradiated for the exposure has an exposure wavelength in the range of 300-450nm, or preferably 350-420nm. An integrated quantity of exposure light is preferably in the range of 100-1,000mJ/cm², or further preferably 200-700mJ/cm². Further, when the exposed part of the coating 33p irradiated is heated, for example, at a temperature in the range of not less than 130℃ to less than 150℃, it is solubilized (positive type) for the next processing procedure (development), while on the other hand, when heated, for example, at a temperature in the range of not less than 150℃ to not more than 180℃, it is non-solubilized (negative type) for the next processing procedure (development). The development can be performed by any known method, such as a dipping process and a spraying process, by using a known developing solution such as alkaline developer. Preferably, the manufacturing method uses the negative type to produce the circuit pattern. Illustrated in FIG. 10 is an embodiment using the process steps of negative type for patterning the circuit.

[0052]

As shown in FIG. 10(d), the coating 33p of the precursor of the polyimide resin thus patterned is finally heated, for example, to 250℃ or more to be cured (imidized), whereby the base layer 33 of polyimide resin is formed in the specified pattern. The base layer 33 thus formed have a thickness in the range of e.g. 2-30μm, or preferably 5-20μm.

[0053]

Sequentially, the conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, as shown in FIG. 10(e). The conductive materials that may be used for forming the conductive pattern 34 include metals, such as copper, nickel, gold, solder or alloys thereof. Copper is preferably used. To form the conductive pattern 34 in the specified wired circuit pattern, the conductive pattern 34 may be formed on the base layer 33 in the specified wired circuit pattern in any known patterning process, such as the subtracting process, the additive process and the semi-additive process. In this method, the semi-additive process is preferably used.

[0054]

The conductive pattern 34 thus formed is in the form of a pattern formed by the plurality of lines of wire 34a, 34b, 34c and 34d which are spaced from each other in parallel with a given interval, as mentioned above. The conductive pattern 34 has a thickness in the range of e.g. 2-30μm, or preferably 5-20μm. The lines of wire 34a, 34b, 34c and 34d have a line width in the range of e.g. 10-500μm, or preferably 30-200μm. The interval (space width) between the adjacent lines of wire 34a, 34b, 34c and 34d is in the range of e.g. 10-500μm, or preferably 30-200μm.

[0055]

Sequentially, the conductive pattern 34 is covered with the cover layer 35 of insulating material, as shown in FIG. 10(f)-(i). The same insulating material as the insulating material of the base layer 35 is used for forming the cover layer 35. Preferably, photosensitive polyimide resin is used therefor.

[0056]

For example when the cover layer 35 is formed by using the photosensitive polyimide resin, liquid solution of precursor of the photosensitive polyimide resin is applied to the whole area of the supporting board 32 and the base layer 33, first, and then is dried at a temperature in the range of e.g. 60-150℃, in the same manner as in the patterning of the base layer 33, to form a coating 35p of the precursor of the photosensitive polyimide resin, as shown in FIG. 10(f). Then, the coating 35p is exposed to light through the photomask 41, as shown in FIG. 10(g). If required, the exposed part is heated to a certain temperature. Thereafter, the coating 35p is developed to be patterned so that the conductive pattern 34 can be covered with the coating 35p, as shown in FIG. 10(h).

[0057]

In the patterning of the coating 35p, the photomasks 41 are placed to confront the areas where the external-side connecting terminals 38 are formed, so that the front side of the conductive pattern 34 can be exposed from the coating 35p to form the cover-side opening 42. To be more specific, the coating 35p is opened so that the cover-side opening 42 can be formed in such a rectangle shape as to include the lines of wire 34a, 34b, 34c and 34d, so as to provide the external-side connecting terminals 38 in the form of the flying lead, as mentioned later.

[0058]

The coating 35p can be exposed to light and developed under the same condition as the condition for exposing and developing the base layer 33.

Shown in FIG. 10 is the patterning in which the coating 35p is patterned in the negative type in the same manner as in the case of the base layer 33.

[0059]

As shown in FIG. 10(i), the coating 35p of the precursor of the polyimide resin thus patterned is finally heated, for example, to 250℃ or more to be cured (imidized), whereby the cover layer 35 made of polyimide resin is formed on the conductive pattern 34. The cover layer 35 has a thickness in the range of e.g. 1-30μm, or preferably 2-5μm.

[0060]

Before the cover layer 35 is formed on the conductive pattern 34, the conductive pattern 34 may be protected by a thin film of rigid nickel by nickel plating.

[0061]

In the suspension board with circuit 31 thus formed, the external-side connecting terminals 38 are presented in the form of the flying lead exposed at both sides of the conductive pattern 34, as shown in FIG. 10(j)-(l).

[0062]

The external-side connecting terminals 38 are presented in the form of the terminals exposed at both sides of the conductive pattern 34 in the following processes. First, as shown in FIG. 10(j), supporting-board-side openings 43 are formed in the supporting board 32 at portions thereof where the external-side connecting terminals 38 are formed or at portions thereof corresponding to the cover-side openings 42 of the cover layer 35, so that the base layer 33 can be exposed. The supporting-board-side openings 43 can be formed by any known method. For example, after all area of the supporting board 32 but the areas of the same corresponding to the supporting-board-side openings 43 are subjected to masking, they are chemically etched.

[0063]

Sequentially, as shown in FIG. 10(k), base-side openings 44 are formed in the base layer 33 exposed in the supporting-board-side openings 43 of the supporting board 32, so as to expose the conductive pattern 34. Though the base-side openings 44 can be formed by a known method, the base-side openings 44 are preferably formed by etching or by plasma etching, in particular. The etching enables a portion of the base layer 33 to be precisely cut from the exposed surface of the base layer 33 to the back side of the conductive pattern 34.

[0064]

In the plasma etching, the supporting board 32 can be used as the mask to etch the entire base layer 33 exposed in the supporting-board-side openings 43 of the supporting board 32. For example, after the sample is disposed between opposed electrodes in an atmosphere in which a prescribed gas is filled in therebetween, high-frequency plasma is produced therebetween. The prescribed gases that may be used include, for example, He, Ne, Ar, Xe, Kr, N_2, O_2, CF_4 and NF_3. Of these gases, Ar, O_2, CF_4 and NF_3 are preferably used. These gases may be used in mixture in a prescribed proportion. The gas pressure (degree of vacuum) is in the range of 0.5-200Pa, or preferably 10-100Pa. Cited as the conditions required for producing the high-frequency plasma are the frequency in the range of e.g. 10kHz-20MKz, or preferably 10kHz-100kHz, and the power required for the plasma etching in the range of e.g. 0.5-10W/cm^2, or preferably 1-5W/cm^2. The frequency in the range of 10kHz-100kHz can make it easy to match with a plasma etching device (tune for resistances). In these atmospheric conditions, the sample is disposed on the electrodes whose temperature is controlled to e.g. 0-120℃, or preferably 10-80℃, and is etched for the time required for the base layer 33 to be etched to a predetermined thickness.

[0065]

Since the base-side openings 44 of the base layer 33 thus formed are formed by using the supporting board 32 as the mask, they can be formed in the same size and shape as the supporting-board-side openings 43 of the supporting board 32.

[0066]

Thereafter, as shown in FIG. 10(l), metal plated layers 45 are simultaneously formed by plating on both sides of the conductive pattern 34 thus exposed. The metal plated layers 45 can be formed by using either the electrolysis plating or the electroless plating, without any particular limitation. Also, the plating can be formed by using any known metal, without any particular limitation. Preferably, the electrolysis nickel plating and the electrolysis gold plating are sequentially performed to form a gold plated layer 47 on a nickel plated layer 46. Preferably, the nickel plated layer 46 and the gold plated layer 47 both have a thickness in the range of about 1-5μm. As a result of this, the external-side connecting terminals 38 are formed with the conductive pattern exposed at both sides thereof.

[0067]

As shown in FIG. 11, in the external-side connecting terminals 38 of the suspension board with circuit 31, widened portions 49 as reinforcing portions extending in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 34 are provided in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other, as is the case with the wired circuit board 11.

[0068]

To be more specific, the widened portions 49 are formed in the respective lines of wire 34a, 34b, 34c and 34d at positions thereof which correspond to the crossing areas 48 (two areas per each line of wire) and arranged with space from each other along the longitudinal directions of the lines of wire 34a, 34b, 34c and 34d. The widened portions 49 are formed in such a generally round shape as to protrude widthwise from the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 11(b). Each widened portion 49 is arranged, with its generally outer half portion embedded in the cover layer 35/base layer 33 and its generally inner half portion exposed in the cover-side opening 42, the base-side opening 44 and the supporting-board-side opening 43, when a maximum widthwise length between the adjacent lines of wire is defined as a boundary between the outer half portion and the inner half portion, as is the case with widened portions 22 of the wired circuit board 11. Thus, the external-side connecting terminals 38 are formed in such a dumbbell shape that the lines of wire 34a, 34b, 34c and 34d are protruded widthwise at both ends thereof in the cover-side opening 42, the base-side opening 44 and the supporting-board-side opening 43.

[0069]

The widened portions 49 may be made identical in the maximum widthwise length and the longitudinal length extending along the extending direction of the conductive pattern 34 with the widened portions 22 of the wired circuit board 11 mentioned above. Also, the widened portions 49 may be formed in any shape other than the generally round shape, as long as they are shaped to protrude widthwise and have widths larger than the usual width. For example, the widened portion 49 may be formed in rectangle.

[0070]

The external-side connecting terminals 38 having these widened portions 49 can be formed in the processes given below. The widened portions 49 are formed with the patterning of the wired circuit pattern in the process of forming the conductive pattern 34. Then, in the processes of FIG. 10(h) and (k), the cover layer 35, the supporting board 32 and the base layer 33 are each opened so that the maximum widthwise length of the widened portion 49 can be within the crossing areas 48 and thereby the cover-side opening 42, the supporting-board-side opening 43 and the base-side opening 44 are formed. Thereafter, in the process shown in FIG. 10(i), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44/supporting-board-side opening 43.

[0071]

In this formation of the suspension board with circuit 31, since the widened portions 49 widened in the widthwise direction of the conductive pattern 34 are formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 are crossed each other, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing further improved connection reliability.

[0072]

In addition, the suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of this flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 12. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

[0073]

To be more specific, the cover-side projections 50 and the base-side projections 51 are formed in the lines of wire 34a, 34b, 34c and 34d at positions thereof corresponding to the crossing areas 48, two for each, with spaced from each other along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 12(b). These projections are formed in a convex shape projecting inwardly from the ends of the cover-side opening 42 and the base-side opening 44 along the extending direction of the lines of wire 34a, 34b, 34c and 34d, respectively. The cover-side projections 50 and the base-side projections 51 are overlapped with the lines of wire 34a, 34b, 34c and 34d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 42/base-side opening 44, respectively. As a result of this, the external-side connecting terminals 38 are so formed that the lines of wire 34a, 34b, 34c and 34d can be covered with the cover-side projections 50 and the base-side projections 51 at opposite ends thereof in the cover-side opening 42 and the base-side opening 44.

[0074]

The cover-side projections 50 and the base-side projections 51 may be made identical in projection length and basal width with the cover-side projections 25 and the base-side projections 26 of the wired circuit board 11. Also, the shape of the cover-side projections 50 and the base-side projections 51 is not limited to the one shown in FIG. 12(b), as long as those projections have such a shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d. For example, the cover-side projections 50 and the base-side projections 51 may be formed to project toward the inside thereof in a tapered manner, with the basal width slightly larger than the line width of the lines of wire 34a, 34b, 34c and 34d. Further, those projections 50, 51 may be formed in such a rectangular shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, without limiting to the generally triangle shape.

[0075]

The external-side connecting terminals 38 having these cover-side projections 50 and the base-side projections 51 can be formed as follows. In the processes FIG. 10(g)-(i), the cover layer 35 is opened in such a manner as to form the cover-side projections 50 to thereby produce the cover-side opening 42. In the process of FIG. 10(k), the base layer 33 is opened in such a manner as to form the base-side projections 50 to thereby produce the base-side opening 44. Thereafter, in the process of FIG. 10(l), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44.

[0076]

In this formation of the suspension board with circuit 31, since the cover-side projections 50 and the base-side projections 51 are formed at the cover layer 35 and the base layer 33 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive patterns 43 are crossed each other, so as to project from the ends of the cover-side opening 42/the base-side opening 44 onto the conductive pattern

34 in the cover-side opening 42 and the base-side opening 44, respectively, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing improved connection reliability.

[0077]

It is to be noted that in the suspension board with circuit 31, both of cover-side projections 50 and the base-side projections 51 are not necessarily required. For example, only the cover-side projections 50 may be formed, as shown in FIG. 13. Alternatively, only the base-side projections 51 may be formed, as shown in FIG. 14.

[0078]

Further, modification may be made of the invention by forming the widened portions 49 in the conductive pattern 34 and also forming the cover-side projections 50 in the cover layer 35 and/or forming the base-side projections 51 in the base layer 33, though not shown.

[0079]

In this suspension board with circuit 31, the external-side connecting terminals 38 may be formed in such a manner that the conductive pattern 34 is depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 at its portions corresponding to the external-side connecting terminals 38 and also the base-side opening 44 and the supporting-board-side opening 43 are made larger than the areas in which the metal plated layers 45 are formed, as shown in FIG. 15(a). In the external-side connecting terminals 38 thus formed, the widened portion 49 may be formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 are crossed each other, as shown in FIG. 12(b).

[0080]

This suspension board with circuit 31 can be formed in the processes shown in FIG. 16, for example. First, the coating 33p of the liquid solution of precursor of the photosensitive polyimide resin is formed on the previously prepared supporting board 32 in the same manner as in the above, as shown in FIG. 16(a). Then, as shown in FIG. 16(b), in the process of exposing the coating 33p to light, in addition to the photomasks 40 that permit no irradiated light to transmit through the masks, photomasks 52 that permit the irradiated light to partially transmit through the masks (average transmittance ratio in the range of 1-99%) are placed to confront the areas for the external-side connecting terminals 38 to be formed in the coating 33p. Then, the coating 33p is exposed to light through the photomask 52, such that the area in the coating 33p in which the external-side connecting terminals 38 is to be formed is exposed to a smaller amount of light exposure than an amount of light exposure to the remaining areas of the coating 33p. Sequentially, the coating is developed and cured, as mentioned above. As a result of this, the areas of the base layer 33 in which the external-side connecting terminals 38 is to be formed is made smaller in thickness than the remaining areas of the base layer 33, as shown in FIG. 16(c) and (d).

[0081]

The photomasks 52 may be formed in the following manner. For example, a semi-translucent part of the front surface of the photomask 52 is finely roughened so that components of irregular reflection on the front surface of the photomask 52 can be increased to reduce components of the transmitted light in that part. Or, an irradiated light absorbing film is stuck on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that semi-translucent part can be reduced. Or, a pattern having a light transmiting area and a light shielding area is formed on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that part can be reduced.

[0082]

Further, in the case of the photomask 52 comprising a thin metal film forming a light-shielding pattern thereon, a thin metal film smaller in thickness than the thin metal film of the photomask 52 may be formed on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that semi-translucent part can be reduced. In other words, this photomask 52 can be formed in the following manner: A photomask 52 with no thin metal film formed in the semi-translucent part thereof (a conventional photomask) is formed. After a resist is formed on that photomask 52 so that only the semi-translucent part can be exposed, a thin metal film made of e.g. chromium smaller in thickness than the above-mentioned thin metal film is formed on the photomask 52 by vapor deposition or by plating and, thereafter, the resist is peeled.

[0083]

Of these photomasks 52, the photomasks 52 each having the semi-translucent part 53 on which the pattern of the light transmiting area and the light shielding area is formed as shown in FIG. 17 are preferably used. These photomasks 52 are each made of a sheet of glass, such as quartz glass or soda glass, of thickness of 2-5mm. The thin metal film formed on the semi-translucent part 53 of the photomask 52 made of the glass is patterned so that the light transmission ratio (transmissivity) in the semi-translucent part 53 of the glass can be reduced more than in the remaining parts of the glass. The pattern of the thin metal film can be formed, for example, by the process that after a thin metal film made of e.g. chromium is formed on the whole area of the glass by vapor deposition or by plating, the thin metal film is patterned by use of laser or electron beam. To be more specific, the pattern of the semi-translucent part 53 is preferably presented in the form of a repeat pattern in which the light transmitting portions and the light shielding portions being alternately arranged at a not more than 6 μ m pitch (width of the light transmitting portion and the light shielding portion) and of which averaged transmittance ratio is not more than 80% or preferably not more than 50%. For example, a striped pattern having the average transmission ratio of about 50% as shown in FIG. 17(a); a latticed pattern having the average transmission ratio of about 25% as shown in FIG. 17(b); a circular staggered pattern having the average transmission ratio of about

25% as shown in FIG. 17(c); and a circular staggered pattern having the average transmission ratio of about 70% as shown in FIG. 17(d) are preferably used.

[0084]

While the patterning is provided in the negative type in the embodiment mentioned above, the patterning can be provided in the positive type as well. For example when the patterning is provided in the positive type, the photomask 52 may be so structured that the transmission ratio of irradiated light in the semi-translucent part of the photomask can be increased more than in the remaining parts of the photomask.

[0085]

The base layer 33 thus formed has a thickness in the range of e.g. 2-30μm, or preferably in the range of 5-20μm. The base layer 33 usually has a thickness of about 10μm. The area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has a thickness of usually 80% or less of the thickness of the remaining areas. For example, that area of the base layer 33 preferably has thickness of not more than 8μm, or further preferably not more than 5μm. Suppose that the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has thickness of 8μm or less, when the remaining areas have a usual thickness of 10μm, the time required for the opening to be formed in the later stage can be shortened to the extent corresponding to 2μm.

[0086]

The area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has a lower limit of thickness or a minimum thickness to serve as a barrier layer against the conductive pattern 34 when the supporting board 32 is opened. For example, the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed can have e.g. 3μm, or further about 1μm, as the minimum thickness. Accordingly, the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed preferably has a thickness in the range of 0.1-8μm or further preferably 1.0-5μm.

[0087]

Sequentially, the conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern in the same manner as in the above, as shown in FIG. 16(e). Since the areas of the base layer 33 on which the external-side connecting terminals 38 are to be formed are made smaller in thickness than the remaining areas of the base layer 33, the conductive pattern 34 is formed so that its portions on which metal plated layers 45 are formed in the later stage are depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 to an extent corresponding to the reduced thickness. In this formation of the conductive pattern 34, the widened portions 49 are formed simultaneously with the patterning of the wired circuit pattern.

[0088]

Sequentially, as shown in FIG. 16(f)-(i), the conductive pattern 34 is covered with the cover layer 35 in the same manner as in the above. Then, the cover-side opening 42 is formed in the area of the conductive pattern 34 in which the external-side connecting terminal 38 is to be formed so that the maximum lengths of the widened portions 49 are placed in the crossing areas 48. Thereafter, the supporting-board-side opening 43 is formed to be larger than the area of the supporting board 32 corresponding to the cover-side opening 42, as shown in FIG. 16(j). Then, the base-side opening 44 is formed in the base layer 33 exposed in the supporting-board-side opening 43 so that the maximum lengths of the widened portions 49 are placed in the crossing areas 48, as shown in FIG. 16(k). Thereafter, the metal plated layers 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and in the base-side opening 44/ supporting-board-side opening 43, as shown in FIG. 16(l). The metal plated layer 45 thus formed is positioned with a certain space between its periphery and the peripheries of the base-side opening 44 and supporting-board-side opening 43.

[0089]

When the suspension board with circuit 31 is produced in this method, the base layer 33 is formed to have smaller thickness at the base-side opening 44 for exposing the conductive pattern 34 than at the remaining portions of the base layer 33 in the process of forming the base layer 33. Consequently, when the base layer 33 is etched in the process of forming the external-side connecting terminals 38, as shown in FIG. 16(k), the etching time required for the conductive pattern 34 to be exposed can be shortened to an extent corresponding to the difference between the reduced thickness of the base layer 33 at the opening portions 31 and the thickness of the remaining portions. This enables the conductive pattern 34 to be exposed in a short time, and as such can provide improved efficiency in producing the external-side connecting terminals 38 in the form of the flying lead exposed at both sides thereof.

[0090]

In this formation, since the base-side opening 44 and the supporting-board-side opening 43 are formed to be larger than the exposed portion of the conductive pattern 34, a certain space is left between the periphery of the metal plated layer 45 and the peripheries of the base-side opening 44 and supporting-board-side opening 43. This can produce the effect that for example when the metal plated layer 45 is increased in thickness for improvement in connection reliability, the metal plated layer 45 and the supporting board 32 can be prevented from contacting with each other. This can surely prevent occurrence of a short circuit from the contact between the metal plated layer 45 and the supporting board 32, thus providing improved connection reliability and voltage proof property of the suspension board with circuit 32.

[0091]

In the suspension board with circuit 31, the interval formed between the periphery of the metal plated layer 45 and the periphery of the supporting-board-side opening 43 is preferably at least 1μm, or preferably in the order of 2-100μm.

[0092]

Further, in this formation, since the area of the conductive pattern 34 in which the metal plated layer 45 is formed is so formed as to be depressed toward the supporting board 32, the distance from the front side of the supporting board 32 to the front side of the metal plated layer 45 is shortened to an extent corresponding to the depression with respect to the remaining areas of the conductive pattern 34 and, as a result of this, the metal plated layers 45 are placed closer to the outside of the supporting board 32 to that extent. This can produce the effect that for example when the external-side connecting terminals 38 are connected with read/write terminals 54 of the read/write board 39 in such a manner that the read/write terminals 54 are laid over the metal plated layers 45 and are bonded to each other by applying supersonic vibration of the bonding tool, the pressure bonding can be well ensured, thus providing further improved connection reliability.

[0093]

In the suspension board with circuit 31 thus formed, the thicknesswise interval formed between the front side of the metal plated layers 45 and the interface between the base layer 33 and the supporting board 32 is preferably $\pm 6\mu m$, or further preferably $\pm 2\mu m$.

[0094]

This suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of the flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 18. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing area 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

[0095]

To be more specific, the cover-side projections 50 and the base-side projections 51 are formed in the respective lines of wire 34a, 34b, 34c and 34d at positions thereof corresponding to the crossing areas 48 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 18(b). These projections are formed in a convex shape projecting inwardly from the ends of the cover-side opening 42 and the base-side opening 44 along the extending direction of the lines of wire 34a, 34b, 34c and 34d, respectively. The cover-side projections 50 and the base-side projections 51 are overlapped with the lines of wire 34a, 34b, 34c and 34d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 42/base-side opening 44, respectively. As a result of this, the external-side connecting terminals 38 are so formed that the lines of wire 34a, 34b, 34c and 34d can be covered with the cover-side projections 50 and the base-side projections 51 at opposite ends thereof in the cover-side opening 42 and the base-side opening 44.

[0096]

The cover-side projections 50 and the base-side projections 51 may be made identical in projection length and basal width with the cover-side projections 25 and the base-side projections 26 of the wired circuit board 11 mentioned above. Also, the shape of the cover-side projections 50 and the base-side projections 51 is not limited to the one shown in FIG. 18(b), as long as those projections have such a shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d. For example, the cover-side projections 50 and the base-side projections 51 may be formed to project toward the inside thereof in a tapered manner, with the basal width slightly larger than the line width of the lines of wire 34a, 34b, 34c and 34d. Further, those projections 50, 51 may be formed in such a rectangular shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, without limiting to the generally triangle shape.

[0097]

In the suspension board with circuit 31 shown in FIG. 18, the base-side opening 44 is formed to be larger in area than the cover-side opening 42, so that the base-side projection 51 is formed to be larger in length than the cover-side projection 50 to that extent corresponding to the difference in area between the base-side opening 44 and the cover-side opening 42, as shown in FIG. 18(a).

[0098]

The external-side connecting terminals 38 having these cover-side projections 50 and the base-side projections 51 are formed as follows. In the process of FIG. 16(g)-(i), the cover layer 35 is opened in such a manner as to form the cover-side projections 50 to thereby produce the cover-side opening 42. In the process of FIG. 16(k), the base layer 33 is opened in such a manner as to form the base-side projections 50 to thereby produce the base-side opening 44. Thereafter, in the process of FIG. 16(l), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44.

[0099]

It is to be noted that in the suspension board with circuit 31 as well, both of cover-side projections 50 and the base-side projections 51 are not necessarily required, as is the case with the above. For example, only the cover-side projections 50 may be formed, as shown in FIG. 19. Alternatively, only the base-side projections 51 may be formed, as shown in FIG. 20.

[0100]

Further, modification may be made of the invention by forming the widened portions 49 in the conductive pattern 34 and also forming the cover-side projections 50 in the cover layer 35 and/or forming the base-side projections 51 in the base layer 33, though not shown.

[0101]

Although the external-side connecting terminals 38 provided in the form of the flying lead have been exclusively discussed above, this suspension board with circuit 31 includes magnetic-head-side connecting terminals 37 provided in the form of the flying lead identical with the external-side connecting terminals 38.

[0102]

EXAMPLES

While in the following, the present invention will be described in further detail with reference to Examples, the present invention is not limited to any Examples.

[0103]

EXAMPLE 1

A liquid solution of precursor of photosensitive polyimide resin was applied on the stainless steel foil (SUS304 H-TA) having thickness of 20μm so that after dried, it could have a thickness of 24μm and then dried at 130℃ to thereby form a coating of the precursor of the photosensitive polyimide resin (Cf. FIG. 16(a)). Sequentially, the coating was exposed to light (405nm, 1,500mJ/cm^2) through a photomask (Cf. FIG. 16(b)). The exposed part of the coating was heated to 180℃ and then developed by using an alkaline developer, whereby the coating was patterned with the negative imaging (Cf. FIG. 16(c)). Sequentially, the patterned coating of the precursor of the photosensitive polyimide resin was heated at 350℃ to be cured (imidized), whereby a base layer made of polyimide resin of thickness of 10μm was formed in the specified pattern (Cf. FIG. 16(d)).

[0104]

In forming the base layer, the photomask of metal film having a latticed repeat pattern in which the light transmitting portions and the light shielding portions are alternately arranged at a not more than 6μm pitch (which corresponds to the photomask 52 having the average transmission ratio of about 25% shown in FIG. 17(b)), was positioned over the coating at its portion which is to be opened in the later stage and at which an external-side connecting terminals are to be formed. Then, the coating was exposed to light through the photomask, so that the amount of light exposure in the portion of the coating at which the external-side connecting terminals are to be formed could be reduced more than the amount of light exposure in the remaining portions of the coating (Cf. FIG. 16(b)). As a result of this, after the coating was developed and cured, the base layer having a thickness of 2μm at portions thereof at which the external-side connecting terminals are to be formed and a thickness of 10μm at the remaining portions thereof was obtained (Cf. FIG. 16(d)).

[0105]

Sequentially, a thin chrome film of thickness of 300Å and a thin copper film having thickness of 700Å were formed in sequence on the whole area of the stainless steel foil and the base layer by a sputtering deposition process. Thereafter, a plating resist having an opposite pattern to the specified wired circuit pattern was formed by use of a dry film resist, and a conductive pattern having the specified wired circuit pattern was formed in the part of the base layer where the plating resist was not formed, in the semi-additive method using the electrolysis copper plating (Cf. FIG. 16(e)). As a result of the base layer being formed to be smaller in thickness at its part at which the external-side connecting terminals are to be formed than at its remaining parts, the conductive pattern thus formed had, at its part at which the external-side connecting terminals are to be formed, concave portions depressed toward the stainless steel foil from the remaining portions of the conductive pattern with respect to the thickness direction by about 8μm. The conductive pattern was formed to have thickness of 10μm and have the wired pattern formed by four lines of wire each having width of 110μm and spaced from each other in parallel at interval of 200μm.

[0106]

Further, generally round widened portions (Cf. FIG. 15(b)), which were widened in the widthwise direction substantially orthogonal to the extending direction of the lines of wire and had the maximum widthwise length of 230μm and the longitudinal length of 100μm, were formed in the respective lines of wire in crossing areas where the ends of the cover-side opening/the base-side opening and the lines of wire are crossed each other, two for each line of wire.

[0107]

Thereafter, the plating resist was removed by chemical etching and then the thin chromium film and the thin copper film on which the plating resist had been formed were removed by chemical etching.

[0108]

Sequentially, a rigid, thin nickel film having thickness of 0.1μm was formed on the surface of the conductive pattern and the surface of the stainless steel foil by the electroless nickel plating. Thereafter, a liquid solution of a precursor of the photosensitive polyimide resin was applied on the thin nickel film and the base layer and then heated at 130℃ to thereby form a coating of the precursor of the photosensitive polyimide resin (Cf. FIG. 16(f)). Sequentially, the coating was exposed to light (405nm, 1,500mJ/cm^2) through the photomask (Cf. FIG. 16(g)). The exposed part of the coating was heated to 180℃ and then developed by using an alkaline developer, whereby the coating was patterned so that the conductive layer could be covered with the coating (Cf. FIG. 16(h)). Sequentially, the patterned coating of the precursor of photosensitive polyimide resin was heated at 350℃ to be cured (imidized), whereby the cover layer comprising polyimide resin of thickness of 3μm was formed on the conductive layer (FIG. 16(i)).

[0109]

It is to be noted that in forming the cover layer, the cover-side openings were formed in the cover layer so that when the cover layer was patterned, the thin nickel film on the conductive pattern at its part at which the external-side connecting terminals are to be formed could be exposed.

[0110]

Sequentially, the external-side connecting terminals were formed in the state in which their both sides were exposed. First, the supporting-board-side openings larger than the cover-side openings were formed in the stainless steel foil at its portions corresponding to the cover-side openings so that the base layer could be exposed (Cf. FIG. 16(j)). The supporting-board-side openings were formed in the process that after all of the areas of the stainless steel foil, except the areas in which the supporting-board-side openings are to be formed, were subjected to masking, the stainless steel foil was subjected to the chemical etching. At the same time as the formation of the supporting-board-side openings, the gimbals were cut into a predetermined shape by the chemical etching.

[0111]

Sequentially, the thin nickel film as was exposed in the cover-side openings was peeled and the thin nickel film formed on the stainless steel foil was peeled.

[0112]

Then, the base layer exposed in the supporting-board-side openings of stainless steel foil were opened and thereby the base-side openings were formed to expose the ground formed on the back side of the conductive pattern (Cf. FIG. 16(k)). The base-side openings were formed by the plasma etching. In the plasma etching, with the stainless steel foil as the mask, the entire base layer exposed in the supporting-board-side openings of the stainless steel foil was etched for about 2 minutes in the conditions of: the mixed gas of CF_4 and O_2 (CF_4/O_2 =20/80) used as the gas filled; the gas pressure (degree of vacuum) of 25Pa; the frequency of 13.5MHz; and the power required for the plasma etching of 2,500W.

[0113]

The base-side openings thus formed were formed in the same size and shape as the supporting-board-side openings, and the space of about 50 μm was defined between the periphery of the ground exposed in the base-side openings and the periphery of the base-side opening/supporting-board-side opening.

[0114]

Thereafter, the ground exposed in the base-side openings were peeled to expose the back side of the conductive pattern. Sequentially, the metal plated layers were formed by performing the electrolysis nickel plating and the electrolysis gold plating being alternately, so that the nickel plated layers having thickness of 2 μm and the gold plated layer having thickness of 1 μm were formed on the both sides of the conductive pattern thus exposed (FIG. 16(l)).

[0115]

The metal plated layers on the back side of the conductive pattern thus formed left the thicknesswise interval of ±2μm between the front side of the metal plated layers and the interface between the base layer and the stainless steel foil and also left the interval of 47μm between the periphery of the metal plated layer and the periphery of the base-side opening/the supporting-board-side opening.

[0116]

After these processes, the suspension board with circuit was obtained in which the external connecting terminals were presented in the form of the flying lead of the conductive pattern in which the widened portions were formed in the lines of wire, respectively (Cf. FIG. 15).

[0117]

EXAMPLE 2

The suspension board with circuit having the external-side connecting terminals produced in the form of the flying lead of the conductive pattern whose lines of wire were covered with the base-side projections at their exposed ends was produced (FIG. 20) in the same operation as in Example 1, except that instead of forming the widened portions in the lines of wire of the conductive pattern, the base-side projections of generally triangle as viewed from the top having the basal width of 110μm and the projection length of 200μm were formed in the base layer in the crossing areas (two areas per each line of wire) where the ends of the base-side opening and the lines of wire are crossed each other, so as to project from the ends of the base-side opening onto the conductive pattern in the base-side opening in the process of opening the base layer to form the base-side openings (Cf. FIG.

16(k)).

[0118]

COMPARATIVE EXAMPLE 1

Except that no widened portions were formed in the lines of wire of the conductive pattern, the suspension board with circuit having the external-side connecting terminals presented in the form of the flying lead was produced (Cf. FIG. 21) in the same operation as in Example 1.

[0119]

EVALUATION

After being bonded to the external terminals comprising gold pads by applying supersonic vibration thereto by use of the bonding tool, the external-side connecting terminals of the suspension boards with circuit obtained in Examples 1 and 2 and Comparative Example 1 were put to the peel tests to measure the bonding strength.

[0120]

The test results are shown in Table 1 given below. It should be noted that all destructions occured in the conductive patterns of the suspension boards with circuit of Examples 1 and 2 took place in the areas where the conductive pattern was covered with the cover layer and the base layer.

[0121]

Table 1

	Example 1	Example 2	Comparative Example 1
Bonding strength in peel test (mN)	540	590	490

[0122]

While illustrative embodiments of the present invention are provided in the above description, such is for illustrative purpose only and is not to be construed restrictively. Modification and variation of the present invention that will be obvious to those skilled in the art is to be covered by the following claims.

WHAT IS CLAIMED IS:

1. A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

2. A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

3. The wired circuit board according to Claim 2, wherein the wired circuit board is a suspension board with circuit.

4. A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

5. A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

6. The wired circuit board according to Claim 5, wherein the wired circuit board is a suspension board with circuit.

7. A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing area where the ends of the opening and the conductive pattern are crossed each other.

8. A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

9. The wired circuit board according to Claim 8, wherein the wired circuit

board is a suspension board with circuit.

ABSTRACT OF THE DISCLOSURE

A wired circuit board having a terminal portion formed as a flying lead that can provide enhanced strength of the conductive pattern, both sides of which are exposed, by simple construction to effectively prevent disconnection of the conductive pattern. The wired circuit board having the terminal portion formed as the flying lead in which the both sides of the conductive pattern are exposed includes, in crossing areas where ends of a cover-side opening and ends of a base-side opening and the conductive pattern are crossed each other, (i) the widened portions formed in the conductive pattern or (ii) cover-side projections and base-side projections formed in the cover layer and the base layer, respectively.

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Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

私は、以下に記名された発明者として、ここに下記の通り宣言する：

As a below named inventor, I hereby declare that:

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My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

WIRED CIRCUIT BOARD

上記発明の明細書はここに添付されているが、下記の欄がチェックされている場合は、この限りでない：

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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第３７編規則１．５６に定義されている、特許性について重要な情報を開示する義務があることを認める。

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私は、ここに、以下に記載した外国での特許出願または発明者証の出願、或いは米国以外の少なくとも一国を指定している米国法典第35編第365条 (a)によるＰＣＴ国際出願について、同第１１９条 (a) -(d) 項又は第３６５条 (b) 項に基づいて優先権を主張するとともに、優先権を主張する本出願の出願日よりも前の出願日を有する外国での特許出願または発明者証の出願、或いはＰＣＴ国際出願については、いかなる出願も、下記の枠内をチェックすることにより示した。

I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application for which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number)（番号）	(Country)（国名）	(Day/Month/Year Filed)（出願日／月／年）	Priority Not Claimed 優先権主張なし
2001-216812	Japan	17th / July / 2001	☐
			☐

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I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)（出願番号）	(Filing Date)（出願日）	(Application No.)（出願番号）	(Filling Date)（出願日）

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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filling date of the prior application and the national or PCT International filing date of application.

(Application No.)（出願番号）	(Filing Date)（出願日）	(Status: Patented, Pending, Abandoned)（現況：特許許可、係属中、放棄）

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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国籍	Citizenship
郵便の宛先	Post office address
第六の共同発明者の氏名（該当する場合）	Full name of sixth joint inventor, if any
同第六発明者の署名 日付	Sixth inventor's signature Date
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PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number
30015280-0001

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	9	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	9 minus 20=	* 0
INDEPENDENT CLAIMS	6 minus 3 =	* 3
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

SMALL ENTITY RATE	SMALL ENTITY FEE		OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=		OR	X$18=	
X42=		OR	X84=	252.00
+140=		OR	+280=	
TOTAL		OR	TOTAL	992.00

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE		OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 8/01) U.S. Government Printing Office: 2001 — 484-484/59268 Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

101195392 .071602

Please type a plus sign (+) inside this box → +

PTO/SB/05 (03-01)
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JC853 U.S. PTO 07/16/02

JC971 U.S. PTO 10/195392 07/16/02

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. 1.53(b))

Attorney Docket No.	30015280 0001
First Inventor	Makoto Komatsubara
Title	WIRED CIRCUIT BOARD
Express Mail Label No	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)
   (Submit an original and a duplicate for fee processing)
2. ☐ Applicant claims small entity status. See 37 CFR 1.27.
3. ☒ Specification [Total Pages 60]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. ☒ Drawing(s) (35 U.S.C.113) [Total Sheets 15]
5. Oath or Declaration [Total Pages 4]
   a. ☒ Newly executed (original or copy)
   b. ☐ Copy from a prior application (37 CFR 1.63 (d))
   (for a continuation/divisional with Box 18 completed)
   i ☐ DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1 63(d)(2) and 1 33(b)
6. ☐ Application Data Sheet. See 37 CFR 1.76
7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission
   (if applicable, all necessary)
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
   i. ☐ CD-ROM or CD-R (2 copies); or
   ii. ☐ paper
   c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATIONS PARTS

9. ☒ Assignment Papers (cover sheet & document(s))
10. ☐ 37 C.F.R §3.73(b) Statement (when there is an assignee) ☐ Power of Attorney
11. ☐ English Translation Document (if applicable)
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☒ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1 76*

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No _____ /

Prior application information Examiner _____ Group / Art Unit

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

☒ *Customer Number or Bar Code Label* (Insert Customer No or Attach bar code label here) or ☐ *Correspondence address below*

30412
PATENT TRADEMARK OFFICE

Name					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

Name (Print/Type)	Jean C. Edwards	Registration No. (Attorney/Agent)	41,728
Signature	Jean C. Edwards	Date	July 16, 2002

Burden Hour Statement This form is estimated to take 0 2 hours to complete Time will vary depending upon the needs of the individual case Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U S Patent and Trademark Office, Washington, DC 20231 DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS SEND TO Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision

TOTAL AMOUNT OF PAYMENT ($) 1032

Complete if Known	
Application Number	Not yet assigned
Filing Date	July 16, 2002
First Named Inventor	Makoto Komatsubara
Examiner Name	Not yet assigned
Group / Art Unit	Not yet assigned
Attorney Docket No	30015280 0001

METHOD OF PAYMENT (check one)

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to

Deposit Account Number: 19-3140

Deposit Account Name: SONNENSCHEIN NATH & ROSENTHAL

☒ Charge Any Additional Fee Required Under 37 CFR 1 16 and 1 17

☐ Applicant claims small entity status See 37 CFR 1 27

2. ☒ Payment Enclosed.

☒ Check ☐ Credit card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	740	201	370	Utility filing fee	740
106	330	206	165	Design filing fee	
107	510	207	255	Plant filing fee	
108	740	208	370	Reissue filing fee	
114	160	214	80	Provisional filling fee	

SUBTOTAL (1) ($)740

2. EXTRA CLAIM FEES

				Extra Claims		Fee from below		Fee Paid
Total Claims	9	-20	=	0	X	0	=	0
Independent Claims	6	-3	=	3	X	84	=	252
Multiple Dependent					X		=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 252

**or number previously paid, if greater, For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	920	217	460	Extension for reply within third month	
118	1,440	218	720	Extension for reply within fourth month	
128	1,960	228	980	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing a brief in support of an appeal	
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive – unavoidable	
141	1,280	241	640	Petition to revive – unintentional	
142	1,280	242	640	Utility issue fee (or reissue)	
143	460	243	230	Design issue fee	
144	620	244	310	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR 1 17 (q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	40
146	740	246	370	Filing a submission after final rejection (37 CFR § 1 129(a))	
149	740	249	370	For each additional invention to be examined (37 CFR § 1 129(b))	
179	740	279	370	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 40

SUBMITTED BY

				Complete (if applicable)	
Name (Print/Type)	Jean C Edwards	*Registration No Attorney/Agent)*	41,728	*Telephone*	202/408-6428
Signature	Jean C. Edwards			*Date*	July 16, 2002

Attorney Docket No . 30015280.0001
Customer No.: 30412

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Makoto KOMATSUBARA, et al.

Group Art Unit: Not yet assigned

U.S. Application No.: Not yet assigned

Examiner: Not yet assigned

Confirmation No.: Not yet assigned

Filed: July 16, 2002

For: WIRED CIRCUIT BOARD

PRELIMINARY AMENDMENT

Commissioner for Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application, please amend the application as follows:

IN THE SPECIFICATION:

Page 1, prior to paragraph 1, please add the following new paragraph:

The present invention claims priority from Japanese Patent Application Serial No. 2001-216812, filed July 17, 2001, which is herein incorporated by reference.

REMARKS

Entry of this Preliminary Amendment prior to examination of the above-identified application is respectfully requested.

The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment, to Deposit Account No. 19-3140.

Respectfully submitted,

Jean C. Edwards

Jean C. Edwards
Registration No. 41,728

Sonnenschein Nath & Rosenthal
1301 K St., N.W.
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Date: July 16, 2002
25051547\V1

APPENDIX I

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Page 1, prior to paragraph 1, the following new paragraph was added:

The present invention claims priority from Japanese Patent Application Serial No. 2001-216812, filed July 17, 2001, which is herein incorporated by reference.

WIRED CIRCUIT BOARD

BACKGROUND OF THE INVENTION

[0001]

Field of the Invention

The present invention relates to a wired circuit board and, more particularly, to a wired circuit board suitably used for a suspension board with circuit.

[0002]

Description of the Prior Art

The wired circuit boards used for electronic/electric equipments are usually provided with terminal portions to connect with external connecting terminals.

[0003]

In recent years, the so-called "flying lead" in which the terminal portions are formed on both sides of the conductive pattern, rather than in only either side thereof, is being in widespread use in order to meet the demand for electronic/electric equipment to have increasingly higher density and reduced size. It is known, for example, in suspension board with circuit used for a hard disk drive that the terminals are provided in the form of flying lead.

[0004]

To be more specific, the suspension board with circuit comprises a supporting board 1 of stainless steel foil, a base layer 2 of an insulating material formed on the supporting board 1, a conductive pattern 3 formed on the base layer 2 in the form of a specified circuit pattern, and a cover layer 4 of an insulating material, for covering the conductive pattern 3, as shown in FIG. 21. The terminal portions 5 provided in the form of the flying lead are formed on both sides of the conductive pattern 3 in the following manner. The cover layer 4 is opened to expose a front side of the conductive pattern 3, while also the supporting board 1 and the base layer 2 are opened to expose a back side of the conductive pattern 3. If necessary, metal plated layers 6 are formed on the both sides of the thus exposed conductive pattern 3 by nickel/gold plating and the like.

[0005]

Thereafter, these terminal portions formed as the flying lead are bonded to external connecting terminals by applying supersonic vibration thereto by use of a bonding tool and the like.

[0006]

In this terminal portion formed as the flying lead, since the both sides of the conductive pattern are exposed, the supersonic vibration is easily transmitted to the terminals. This is suitable for the bonding using the supersonic vibration: on the other hand, this provides the disadvantage that the conductive pattern exposed at both sides thereof is weak in physical strength and is subject to stress concentration at edge portions of the openings in the base layer and cover layer, to cause disconnection of the conductive pattern with ease.

[0007]

SUMMARY OF THE INVENTION

It is the object of the invention to provide a new wired circuit board having a terminal portion formed as a flying lead in which both sides of a conductive pattern are exposed that can provide enhanced strength of the conductive pattern by simple construction to effectively prevent occurrence of disconnection of the conductive pattern.

[0008]

The present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0009]

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0010]

In the wired circuit boards mentioned above, since at least any one of the first insulating layer, the second insulating layer and the conductive pattern has the reinforcing portions for reinforcing the conductive pattern formed at the ends of the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0011]

In addition, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0012]

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

[0013]

In the wired circuit boards mentioned above, since the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to the extending direction of the conductive pattern in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0014]

Further, the present invention provides a wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

[0015]

Also, the present invention provides a wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed, wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

[0016]

In the wired circuit boards mentioned above, since the first insulating layer and/or the second insulating layer have projections projecting from the ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other, the physical strength of the conductive pattern at the ends of the opening can be reinforced. This can produce the effect that for example when the conductive pattern both sides of which are exposed is subject to stress concentration at the end portions of the opening in the process of bonding the terminal portion and the external connecting terminal by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern can be effectively prevented, thus providing improved bonding reliability.

[0017]

The wired circuit board of the present invention can provide high bonding reliability so that the wired circuit board can be used as the suspension board with circuit, even when formed as the flying lead in which both sides of the conductive pattern are exposed.

[0018]

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 shows an embodiment of a wired circuit board (wherein a widened portion is formed) of the present invention: (a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and (b) is a plan view of the terminal portion of the same.

FIG. 2 is an enlarged plan view of FIG. 1(b).

FIG. 3 illustrates the production processes of a wired circuit board shown in FIG. 1:

(a) shows the step of forming a conductive pattern on a base layer;

(b) shows the step of forming a base layer on the conductive pattern;

(c) shows the step of forming a cover-side opening on the cover layer at a portion thereof at which terminals are to be formed;

(d) shows the step of forming a base-side opening on the base layer at a portion thereof at which terminals are to be formed; and

(e) shows the step of forming a metal plated layer on each of front and back sides of the conductive pattern exposed in the cover-side opening and the base-side opening.

FIG. 4 shows another embodiment of the wired circuit board (wherein a cover-side projection and a base-side projection are formed) of the present invention: (a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and (b) is a plan view of the terminal portion of the same.

FIG. 5 is an enlarged view of the plan view shown in FIG. 4(b).

FIG. 6 is an enlarged view of the plane view of another embodiment shown in FIG. 4(b).

FIG. 7 shows in section a principal portion of another embodiment (only the cover-side projection is formed) of the wired circuit board shown in FIG. 4(a).

FIG. 8 shows in section a principal portion of still another embodiment (only the base-side projection is formed) of the wired circuit board shown in FIG. 4(a).

FIG. 9 is a plan view of a suspension board with circuit presented as one embodiment of the wired circuit board of the present invention.

FIG. 10 illustrates the production processes of the suspension board with circuit shown in FIG. 9:

(a) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on a supporting board;

(b) shows the step of exposing the coating to light through a photomask;

(c) shows the step of developing the coating to form it into a predetermined pattern;

(d) shows the step of curing the patterned coating to form the base layer,

(e) shows the step of forming a conductive pattern on the base layer;

(f) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on the conductive pattern;

(g) shows the step of exposing the coating to light through a photomask;

(h) shows the step of developing the coating to form it into a predetermined pattern;

(i) shows the step of curing the patterned coating to form the cover layer;

(j) shows the step of opening the supporting board at portions thereof at which the external-side connecting terminals are formed;

(k) shows the step of opening the base layer at portions thereof at which the external-side connecting terminals are formed; and

(l) shows the step of forming a metal plated layer on each side of the exposed conductive pattern.

FIG. 11 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein a widened portion is formed) of the present invention: (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 12 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein a cover-side projection and a base-side projection are formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 13 shows in section a principal portion of another embodiment (only the cover-side projection is formed) of the suspension board with circuit shown in FIG. 12(a).

FIG. 14 shows in section a principal portion of still another embodiment (only the base-side projection is formed) of the suspension board with circuit shown in FIG. 12(a).

FIG. 15 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein the conductive pattern has a concave form and a widened portion is formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 16 illustrates the production processes of the suspension board with circuit shown in FIG. 15:

(a) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on a supporting board;

(b) shows the step of exposing the coating to light through a photomask;

(c) shows the step of developing the coating to form it into a predetermined pattern;

(d) shows the step of curing the patterned coating to form the base layer,

(e) shows the step of forming a conductive pattern on the base layer;

(f) shows the step of forming a coating of a precursor of a photosensitive polyimide resin on the conductive pattern;

(g) shows the step of exposing the coating to light through a photomask;

(h) shows the step of developing the coating to form it into a predetermined pattern;

(i) shows the step of curing the patterned coating to form the cover layer;

(j) shows the step of opening the supporting board at portions thereof at which the external-side connecting terminals are formed;

(k) shows the step of opening the base layer at portions thereof at which the external-side connecting terminals are formed; and

(l) shows the step of forming a metal plated layer on each side of the exposed conductive pattern.

FIG. 17 is a schematic plan view of an embodiment of a photomask used for exposing the coating to light in the step of FIG. 16(b):

(a) shows a semi-translucent striped pattern having an average transmission ratio of about 50%;

(b) shows a semi-translucent latticed pattern having an average transmission ratio of about 25%;

(c) shows a semi-translucent circular staggered pattern having an average transmission ratio of about 25%; and

(d) shows a semi-translucent circular staggered pattern having an average transmission ratio of about 70%.

FIG. 18 shows an embodiment of a suspension board with circuit shown in FIG. 9 (wherein the conductive pattern has a concave form and a cover-side projection and a base-side projection are formed): (a) is a sectional view of a principal portion of an external-side connecting terminal of the suspension board with circuit; and (b) is a plan view of the external-side connecting terminal of the same.

FIG. 19 shows in section a principal part of another embodiment of a suspension board with circuit shown in FIG. 18(a) (wherein only the cover-side projection is formed).

FIG. 20 shows in section a principal part of still another embodiment of a suspension board with circuit shown in FIG. 18(a) (wherein only the base-side projection is formed).

FIG. 21 shows a conventional suspension board with circuit: (a) is a sectional view of a principal portion of a terminal of the suspension board with circuit; and (b) is a plan view of the terminal of the same.

[0019]

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown an embodiment of a wired circuit board of the present invention. FIG. 1(a) is a sectional view of a principal portion of a terminal portion of the wired circuit board; and FIG. 1(b) is a plan view of the terminal portion of the same. In FIG. 1(a), the wired circuit board 11 comprises a base layer 12 formed as a first insulating layer of insulating material, a conductive pattern 13 formed on the base layer 12 in the form of a specified wired circuit pattern, and a cover layer 14 formed as a second insulating layer of insulating material on the conductive pattern 13. The conductive pattern 13 is provided in the form of a plurality of lines of wires 13a, 13b, 13c and 13d arrayed in parallel with each other with spaced at a predetermined interval, as shown in FIG. 1(b).

[0020]

The insulating materials of the base layer 12 and the cover layer 14 that may be used include, for example, synthetic resins, such as polyimide resin, acrylic resin, polyether nitrile resin, polyether sulfonic resin, polyethylene terephthalate resin, polyethylene naphthalate resin and polyvinyl chloride resin. Polyimide resin is preferably used.

[0021]

The base layer 12 and the cover layer 14 usually have thickness of 1-30μm, or preferably 2-20μm.

[0022]

The conductive materials used for the conductive pattern 13 include, for example, copper, nickel, gold, solder or alloys thereof. Copper is preferably used. The conductive pattern 13 usually has thickness of 2-30μm, or preferably 5-20μm.

[0023]

This wired circuit board 11 is formed in the following way. First, as shown in FIG. 3(a), the conductive pattern 13 is formed on the base layer 12 formed in a film-like form, in the form of the specified wired circuit pattern by a known patterning process, such as a subtracting process, an additive process and a semi-additive process. Then, as shown in FIG. 3(b), the base layer 12 is covered with the cover layer 14 in a known method, for example, by adhesive bonding a film-like resin to the conductive pattern 13 or by applying a photosensitive resin to the conductive pattern 13 and then curing that resin.

[0024]

In the wired circuit board 11 thus formed, as shown in FIG. 1(a), the cover layer 14 is opened to expose a front side of the conductive pattern 13 and also the base layer 12 is opened to expose a back side of the conductive pattern 13 in such a manner that the exposed front side of the conductive pattern 13 and the exposed back side of the same correspond in position to each other so as to expose the both sides of the conductive pattern 13. Then, on the both sides of the exposed conductive pattern 13, metal plating layers 15 are formed thereby forming the terminal portion 16 in the form of the flying lead.

[0025]

This terminal portion 16 is formed in the following manner. First, a cover-side opening 17 is formed in the cover layer 14 in a portion thereof in which the terminal portion 16 is to be formed, in a known method, such as drilling, laser machining, etching and patterning of photosensitive resin, as shown in FIG. 3(c). Likewise, a base-side opening 18 is formed in the base layer 12 in a portion thereof corresponding to the cover-side opening 17, in a known method, such as drilling, laser machining, etching and patterning of photosensitive resin, as shown in FIG. 3(d). The cover-side opening 17 and the base-side opening 18 are opened into a rectangular shape to cover all the lines of wire 13a, 13b, 13c and 13d.

[0026]

As shown in FIG. 3(e), the metal plating layers 15 are formed by plating on both sides of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

[0027]

No particular limitation is imposed on the plating method used for forming the metal plated layer 15. The metal plating layer 15 may be formed by either of electrolysis plating and electroless plating. Also, no particular limitation is imposed on the metals used for the plating. Known metals may be used for the plating. It is preferable that the electrolysis nickel plating and the electrolysis gold plating are performed in sequence so that a gold plated layer 20 is formed on a nickel plated layer 19. The nickel plated layer 19 and the gold plated layer 20 each have thickness of the order of 1-5μm.

[0028]

The wired circuit board 11 has the terminal portion 16 in the form of the flying lead. In the terminal portion 16, widened portions 22 as reinforcing portions which extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 13 are provided in the conductive pattern 13 in crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other, as shown in FIG. 1(b).

[0029]

To be more specific, the widened portions 22 are formed in the respective lines of wire 13a, 13b, 13c and 13d at positions thereof which correspond to the crossing areas 21 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d. The widened portions 22 are formed in such a generally round shape as to protrude widthwise from the lines of wire 13a, 13b, 13c and 13d.

[0030]

As shown in FIG. 2, each widened portion 22 is arranged, with its generally outer half portion embedded in the cover layer 14/base layer 12 and its generally inner half portion exposed in the cover-side opening 17/ base-side opening 18, when a maximum widthwise length 23 between the adjacent lines of wire is defined as a boundary between the outer half portion and the inner half portion. Thus, the terminals 16 are formed in such a dumbbell shape that the lines of wire 13a, 13b, 13c and 13d are protruded widthwise at both ends thereof in the cover-side opening 17/the base-side opening 18.

[0031]

Each widened portion 22 is so formed that the maximum widthwise length 23 is 1.1-4 times, or preferably 2-3 times, as longer as a usual line width 24 of the lines of wire 13a, 13b, 13c and 13d exposed outside in the cover-side opening 17/base-side opening 18. To be more specific, a widthwise part of widened portion 22 at the maximum widthwise length 23 is 20-1,000μm in length and a lengthwise part of the widened portion 22 extending in a longitudinal direction of the lines of wire 13a, 13b, 13c and 13d is 50-500μm in length.

[0032]

The widened portions 22 may be formed in any shape other than the generally round shape, as long as they are shaped to protrude widthwise and have widths larger than the usual width. For example, the widened portion 22 may be formed in rectangle.

[0033]

The terminal portion 16 having this widened portion 22 can be formed in the processes given below. The widened portions 22 are formed with the patterning of the wired circuit pattern in the process of forming the conductive pattern 13. Then, in the processes of FIG. 3(c) and (d), the cover layer 14 and the base layer 12 are each opened so that the maximum widthwise length 23 of the widened portion 22 can be within the crossing areas 21 and thereby the cover-side opening 17 and the base-side opening

18 are formed. Thereafter, in the process shown in FIG. 3(e), the metal plated layer 15 is formed on each side of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

[0034]

In this formation of the wired circuit board 11, since the widened portions 22 widened in the widthwise direction of the conductive pattern 13 are formed in the conductive pattern 13 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive pattern 13 are crossed each other, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of a bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

[0035]

In addition, the wired circuit board 11 may be formed so that the terminal portion 16 presented in the form of this flying lead can have cover-side projections 25 formed as the reinforcing portions and base-side projections 26 formed as the reinforcing portions, as shown in FIG. 4. Specifically, the cover-side projections 25 are formed to project from the ends of the cover-side opening 17 onto the conductive pattern 13 in the cover-side opening 17 in the cover layer 14 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other. The base-side projections 26 are formed to project from the ends of the base-side opening 18 onto the conductive pattern 13 in the base-side opening 18 in the base layer 12 in the crossing areas 21.

[0036]

To be more specific, the cover-side projections 25 and the base-side projections 26 are formed in the respective lines of wire 13a, 13b, 13c and 13d at positions thereof which correspond to the crossing areas 21 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d, as shown in FIG. 4(b). These projections 25, 26 are formed in a convex shape projecting inwardly from the ends of the cover-side opening 17 and the base-side opening 18 along the extending direction of the lines of wire 13a, 13b, 13c and 13d, respectively.

[0037]

The cover-side projections 25 and the base-side projections 26 are overlapped with the lines of wire 13a, 13b, 13c and 13d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 17/base-side opening 18, respectively. As a result of this, the terminal portions 16 are so formed that the lines of wire 13a, 13b, 13c and 13d can be covered with the cover-side projections 25 and the base-side projections 26 at opposite ends thereof in the cover-side opening 17 and the base-side opening 18.

[0038]

The cover-side projections 25 and the base-side projections 26 are formed to project at projection length 27 of one-fourth to one-thirtieth, or preferably one-fifth to one-twentieth, to a line length 29 of each of the lines of wire 13a, 13b, 13c and 13d exposed in the cover-side opening 17 and the base-side opening 18, as shown in FIG. 5. To be more specific, each of the cover-side projections 25 and the base-side projections 26 has a basal width 28 of 5-20μm slightly smaller than a line width 24 of lines of wire 13a, 13b, 13c and 13d at the ends of the cover-side opening 17/the base-side opening 18. The cover-side projections 25 and the base-side projections 26 are projected inwardly in a taped manner at a projection length 27 of 5-250μm and are formed in a generally triangle whose top is located at a widthwise center of lines of wire 13a, 13b, 13c and 13d.

[0039]

The shape of the cover-side projections 25 and the base-side projections 26 is not limited to the one shown in FIG. 5, as long as those projections have such a shape as to overlap with the lines of wire 13a, 13b, 13c and 13d along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d. For example, as shown in FIG. 6, the cover-side projections 25 and the base-side projections 26 may be formed to project toward the inside thereof in a tapered manner from the ends of the cover-side opening 17/the base-side opening 18, with the basal width 28 slightly larger than the line width 24 of the lines of wire 13a, 13b, 13c and 13d. Further, those projections 25, 26 may be formed in such a rectangular shape as to overlap with the lines of wire 13a, 13b, 13c and 13d along the longitudinal direction of the lines of wire 13a, 13b, 13c and 13d, without limiting to the generally triangle shape.

[0040]

The terminal portions 16 having these cover-side projections 25 and the base-side projections 26 are formed as follows. In the process of FIG. 3(c), the cover layer 14 is opened in such a manner as to form the cover-side projections 25 to thereby produce the cover-side opening 17. In the process of FIG. 3(d), the base layer 12 is opened in such a manner as to form the base-side projections 26 to thereby produce the base-side opening 18. Thereafter, in the process of FIG. 3(e), the metal plated layer 15 is formed on each side of the conductive pattern 13 exposed in the cover-side opening 17 and the base-side opening 18.

[0041]

In this formation of the wired circuit board 11, since the cover-side projections 25 and the base-side projections 26 are formed in the cover layer 14 and the base layer 12 in the crossing areas 21 where the ends of the cover-side opening 17/the base-side opening 18 and the conductive patterns 13 are crossed each other, so as to project from the ends of the cover-side opening 17/the base-side opening 18 onto the conductive pattern 13 in the cover-side opening 17 and the base-side opening 18, respectively, the physical strength of the conductive pattern 13 at the ends of the cover-side opening 17 and at the ends of the base-side opening 18 can be reinforced. This can produce the effect that for example when the conductive pattern 13 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 17 and base-side opening 18 in the process of bonding the terminal portions 16 and the external connecting terminals by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 13 can be effectively prevented, thus providing improved connection reliability.

[0042]

It is to be noted that in the wired circuit board 11, both of cover-side projections 25 and the base-side projections 26 are not necessarily required. For example, only the cover-side projections 25 may be formed, as shown in FIG. 7. Alternatively, only the base-side projections 26 may be formed, as shown in FIG. 8.

[0043]

Further, modification may be made of the invention by forming the widened portions 22 in the conductive pattern 13 and also forming the cover-side projections 25 in the cover layer 14 and/or forming the base-side projections 26 in the base layer 12, though not shown.

[0044]

The wired circuit board 11 having these terminal portions 16 is particularly preferably applicable to a suspension board with circuit.

[0045]

Referring to FIG. 9, there is shown a perspective view of a suspension board with circuit presented as an embodiment of the wired circuit board of the present invention. The suspension board with circuit 31 mounts thereon a magnetic head of a hard disk driver (not shown) and suspends the magnetic head while holding a minute interval between the magnetic head and a magnetic disk against airflow generated when the magnetic head and the magnetic disk run relative to each other. The suspension board with circuit has the lines of wire 34a, 34b, 34c, 34d, integrally formed in the form of a specified wired circuit pattern, for connecting the magnetic head and a read/write board 39 formed as an external circuit.

[0046]

In FIG. 9, the suspension board with circuit 31 has a base layer 33, as a first insulating layer of insulating material, which is formed on a supporting board 32 extending longitudinally as a metal supporting layer. A conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, and a cover layer 35 (not shown) is formed on the conductive pattern 34 as a second insulating layer of insulating material. The conductive pattern 34 is provided in the form of the plurality of lines of wire 34a, 34b, 34c and 34d arrayed in parallel with spaced at a predetermined interval.

[0047]

Gimbals 36 for fitting the magnetic head therein are formed in the supporting board 32 by cutting out the supporting board 32 at a front end portion thereof. At the front end portion of the supporting board 32, magnetic head connecting terminals 37 are formed to connect between the magnetic head and the lines of wire 34a, 34b, 34c and 34d. At the rear end portion of the supporting board 32, external-side connecting terminals 38 as the terminals are formed to connect between the read/write board 39 and the lines of wire 34a, 34b, 34c and 34d. The external-side connecting terminals 38 are formed in the ends of the lines of wire 34a, 34b, 34c and 34d, to correspond to each of the read/write terminals 54.

[0048]

This suspension board with circuit 31 can be formed in the following processes. First, the supporting board 32 is prepared and the base layer 33 is formed on the supporting board 32 in the form of the specified pattern, as shown in FIG. 10(a)-(d). A metal foil or a metal sheet is preferably used as the supporting board 32. For example, stainless steel, 42 alloy and the like are preferably used. The supporting board 32 used preferably has thickness of 10-60μm, or further preferably 15-30μm, and width of 50-500mm, or further preferably 125-300mm.

[0049]

Insulating material used for forming the base layer 33 is not limited to any particular insulating material. The insulating materials that may be used include, for example, synthetic resins such as polyimide resin, acrylic resin, polyether nitrile resin, polyether sulfonic resin, polyethylene terephthalate resin, polyethylene naphthalate resin and polyvinyl chloride resin. Of these synthetic resins, a photosensitive resin is preferably used as the base layer. A photosensitive polyimide resin is further preferably used.

[0050]

Then, for example when the base layer 33 is formed in the specified pattern on the supporting board 32 by using photosensitive polyimide resin, liquid solution of precursor of the photosensitive polyimide resin is applied to the whole area of the supporting board 32 prepared first, and then is dried, for example, at 60-150℃, to form a coating 33p of the precursor of the photosensitive polyimide resin, as shown in FIG. 10(a).

[0051]

Then, the coating 33p is exposed to light through a photomask 40, as shown in FIG. 10(b). If required, the exposed part is heated to a specified temperature. Thereafter, the coating 33p is developed to form the coating 33p into a specified pattern, as shown in FIG. 10(c). Preferably, radiation irradiated for the exposure has an exposure wavelength in the range of 300-450nm, or preferably 350-420nm. An integrated quantity of exposure light is preferably in the range of 100-1,000mJ/cm^2, or further preferably 200-700mJ/cm^2. Further, when the exposed part of the coating 33p irradiated is heated, for example, at a temperature in the range of not less than 130℃ to less than 150℃, it is solubilized (positive type) for the next processing procedure (development), while on the other hand, when heated, for example, at a temperature in the range of not less than 150℃ to not more than 180℃, it is non-solubilized (negative type) for the next processing procedure (development). The development can be performed by any known method, such as a dipping process and a spraying process, by using a known developing solution such as alkaline developer. Preferably, the manufacturing method uses the negative type to produce the circuit pattern. Illustrated in FIG. 10 is an embodiment using the process steps of negative type for patterning the circuit.

[0052]

As shown in FIG. 10(d), the coating 33p of the precursor of the polyimide resin thus patterned is finally heated, for example, to 250℃ or more to be cured (imidized), whereby the base layer 33 of polyimide resin is formed in the specified pattern. The base layer 33 thus formed have a thickness in the range of e.g. 2-30μm, or preferably 5-20μm.

[0053]

Sequentially, the conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern, as shown in FIG. 10(e). The conductive materials that may be used for forming the conductive pattern 34 include metals, such as copper, nickel, gold, solder or alloys thereof. Copper is preferably used. To form the conductive pattern 34 in the specified wired circuit pattern, the conductive pattern 34 may be formed on the base layer 33 in the specified wired circuit pattern in any known patterning process, such as the subtracting process, the additive process and the semi-additive process. In this method, the semi-additive process is preferably used.

[0054]

The conductive pattern 34 thus formed is in the form of a pattern formed by the plurality of lines of wire 34a, 34b, 34c and 34d which are spaced from each other in parallel with a given interval, as mentioned above. The conductive pattern 34 has a thickness in the range of e.g. 2-30μm, or preferably 5-20μm. The lines of wire 34a, 34b, 34c and 34d have a line width in the range of e.g. 10-500μm, or preferably 30-200μm. The interval (space width) between the adjacent lines of wire 34a, 34b, 34c and 34d is in the range of e.g. 10-500μm, or preferably 30-200μm.

[0055]

Sequentially, the conductive pattern 34 is covered with the cover layer 35 of insulating material, as shown in FIG. 10(f)-(i). The same insulating material as the insulating material of the base layer 35 is used for forming the cover layer 35. Preferably, photosensitive polyimide resin is used therefor.

[0056]

For example when the cover layer 35 is formed by using the photosensitive polyimide resin, liquid solution of precursor of the photosensitive polyimide resin is applied to the whole area of the supporting board 32 and the base layer 33, first, and then is dried at a temperature in the range of e.g. 60-150℃, in the same manner as in the patterning of the base layer 33, to form a coating 35p of the precursor of the photosensitive polyimide resin, as shown in FIG. 10(f). Then, the coating 35p is exposed to light through the photomask 41, as shown in FIG. 10(g). If required, the exposed part is heated to a certain temperature. Thereafter, the coating 35p is developed to be patterned so that the conductive pattern 34 can be covered with the coating 35p, as shown in FIG. 10(h).

[0057]

In the patterning of the coating 35p, the photomasks 41 are placed to confront the areas where the external-side connecting terminals 38 are formed, so that the front side of the conductive pattern 34 can be exposed from the coating 35p to form the cover-side opening 42. To be more specific, the coating 35p is opened so that the cover-side opening 42 can be formed in such a rectangle shape as to include the lines of wire 34a, 34b, 34c and 34d, so as to provide the external-side connecting terminals 38 in the form of the flying lead, as mentioned later.

[0058]

The coating 35p can be exposed to light and developed under the same condition as the condition for exposing and developing the base layer 33.

Shown in FIG. 10 is the patterning in which the coating 35p is patterned in the negative type in the same manner as in the case of the base layer 33.

[0059]

As shown in FIG. 10(i), the coating 35p of the precursor of the polyimide resin thus patterned is finally heated, for example, to 250℃ or more to be cured (imidized), whereby the cover layer 35 made of polyimide resin is formed on the conductive pattern 34. The cover layer 35 has a thickness in the range of e.g. 1-30μm, or preferably 2-5μm.

[0060]

Before the cover layer 35 is formed on the conductive pattern 34, the conductive pattern 34 may be protected by a thin film of rigid nickel by nickel plating.

[0061]

In the suspension board with circuit 31 thus formed, the external-side connecting terminals 38 are presented in the form of the flying lead exposed at both sides of the conductive pattern 34, as shown in FIG. 10(j)-(l).

[0062]

The external-side connecting terminals 38 are presented in the form of the terminals exposed at both sides of the conductive pattern 34 in the following processes. First, as shown in FIG. 10(j), supporting-board-side openings 43 are formed in the supporting board 32 at portions thereof where the external-side connecting terminals 38 are formed or at portions thereof corresponding to the cover-side openings 42 of the cover layer 35, so that the base layer 33 can be exposed. The supporting-board-side openings 43 can be formed by any known method. For example, after all area of the supporting board 32 but the areas of the same corresponding to the supporting-board-side openings 43 are subjected to masking, they are chemically etched.

[0063]

Sequentially, as shown in FIG. 10(k), base-side openings 44 are formed in the base layer 33 exposed in the supporting-board-side openings 43 of the supporting board 32, so as to expose the conductive pattern 34. Though the base-side openings 44 can be formed by a known method, the base-side openings 44 are preferably formed by etching or by plasma etching, in particular. The etching enables a portion of the base layer 33 to be precisely cut from the exposed surface of the base layer 33 to the back side of the conductive pattern 34.

[0064]

In the plasma etching, the supporting board 32 can be used as the mask to etch the entire base layer 33 exposed in the supporting-board-side openings 43 of the supporting board 32. For example, after the sample is disposed between opposed electrodes in an atmosphere in which a prescribed gas is filled in therebetween, high-frequency plasma is produced therebetween. The prescribed gases that may be used include, for example, He, Ne, Ar, Xe, Kr, N_2, O_2, CF_4 and NF_3. Of these gases, Ar, O_2, CF_4 and NF_3 are preferably used. These gases may be used in mixture in a prescribed proportion. The gas pressure (degree of vacuum) is in the range of 0.5-200Pa, or preferably 10-100Pa. Cited as the conditions required for producing the high-frequency plasma are the frequency in the range of e.g. 10kHz-20MKz, or preferably 10kHz-100kHz, and the power required for the plasma etching in the range of e.g. 0.5-10W/cm^2, or preferably 1-5W/cm^2. The frequency in the range of 10kHz-100kHz can make it easy to match with a plasma etching device (tune for resistances). In these atmospheric conditions, the sample is disposed on the electrodes whose temperature is controlled to e.g. 0-120℃, or preferably 10-80℃, and is etched for the time required for the base layer 33 to be etched to a predetermined thickness.

[0065]

Since the base-side openings 44 of the base layer 33 thus formed are formed by using the supporting board 32 as the mask, they can be formed in the same size and shape as the supporting-board-side openings 43 of the supporting board 32.

[0066]

Thereafter, as shown in FIG. 10(l), metal plated layers 45 are simultaneously formed by plating on both sides of the conductive pattern 34 thus exposed. The metal plated layers 45 can be formed by using either the electrolysis plating or the electroless plating, without any particular limitation. Also, the plating can be formed by using any known metal, without any particular limitation. Preferably, the electrolysis nickel plating and the electrolysis gold plating are sequentially performed to form a gold plated layer 47 on a nickel plated layer 46. Preferably, the nickel plated layer 46 and the gold plated layer 47 both have a thickness in the range of about 1-5μm. As a result of this, the external-side connecting terminals 38 are formed with the conductive pattern exposed at both sides thereof.

[0067]

As shown in FIG. 11, in the external-side connecting terminals 38 of the suspension board with circuit 31, widened portions 49 as reinforcing portions extending in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern 34 are provided in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other, as is the case with the wired circuit board 11.

[0068]

To be more specific, the widened portions 49 are formed in the respective lines of wire 34a, 34b, 34c and 34d at positions thereof which correspond to the crossing areas 48 (two areas per each line of wire) and arranged with space from each other along the longitudinal directions of the lines of wire 34a, 34b, 34c and 34d. The widened portions 49 are formed in such a generally round shape as to protrude widthwise from the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 11(b). Each widened portion 49 is arranged, with its generally outer half portion embedded in the cover layer 35/base layer 33 and its generally inner half portion exposed in the cover-side opening 42, the base-side opening 44 and the supporting-board-side opening 43, when a maximum widthwise length between the adjacent lines of wire is defined as a boundary between the outer half portion and the inner half portion, as is the case with widened portions 22 of the wired circuit board 11. Thus, the external-side connecting terminals 38 are formed in such a dumbbell shape that the lines of wire 34a, 34b, 34c and 34d are protruded widthwise at both ends thereof in the cover-side opening 42, the base-side opening 44 and the supporting-board-side opening 43.

[0069]

The widened portions 49 may be made identical in the maximum widthwise length and the longitudinal length extending along the extending direction of the conductive pattern 34 with the widened portions 22 of the wired circuit board 11 mentioned above. Also, the widened portions 49 may be formed in any shape other than the generally round shape, as long as they are shaped to protrude widthwise and have widths larger than the usual width. For example, the widened portion 49 may be formed in rectangle.

[0070]

The external-side connecting terminals 38 having these widened portions 49 can be formed in the processes given below. The widened portions 49 are formed with the patterning of the wired circuit pattern in the process of forming the conductive pattern 34. Then, in the processes of FIG. 10(h) and (k), the cover layer 35, the supporting board 32 and the base layer 33 are each opened so that the maximum widthwise length of the widened portion 49 can be within the crossing areas 48 and thereby the cover-side opening 42, the supporting-board-side opening 43 and the base-side opening 44 are formed. Thereafter, in the process shown in FIG. 10(i), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44/supporting-board-side opening 43.

[0071]

In this formation of the suspension board with circuit 31, since the widened portions 49 widened in the widthwise direction of the conductive pattern 34 are formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 are crossed each other, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing further improved connection reliability.

[0072]

In addition, the suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of this flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 12. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing areas 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

[0073]

To be more specific, the cover-side projections 50 and the base-side projections 51 are formed in the lines of wire 34a, 34b, 34c and 34d at positions thereof corresponding to the crossing areas 48, two for each, with spaced from each other along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 12(b). These projections are formed in a convex shape projecting inwardly from the ends of the cover-side opening 42 and the base-side opening 44 along the extending direction of the lines of wire 34a, 34b, 34c and 34d, respectively. The cover-side projections 50 and the base-side projections 51 are overlapped with the lines of wire 34a, 34b, 34c and 34d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 42/base-side opening 44, respectively. As a result of this, the external-side connecting terminals 38 are so formed that the lines of wire 34a, 34b, 34c and 34d can be covered with the cover-side projections 50 and the base-side projections 51 at opposite ends thereof in the cover-side opening 42 and the base-side opening 44.

[0074]

The cover-side projections 50 and the base-side projections 51 may be made identical in projection length and basal width with the cover-side projections 25 and the base-side projections 26 of the wired circuit board 11. Also, the shape of the cover-side projections 50 and the base-side projections 51 is not limited to the one shown in FIG. 12(b), as long as those projections have such a shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d. For example, the cover-side projections 50 and the base-side projections 51 may be formed to project toward the inside thereof in a tapered manner, with the basal width slightly larger than the line width of the lines of wire 34a, 34b, 34c and 34d. Further, those projections 50, 51 may be formed in such a rectangular shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, without limiting to the generally triangle shape.

[0075]

The external-side connecting terminals 38 having these cover-side projections 50 and the base-side projections 51 can be formed as follows. In the processes FIG. 10(g)-(i), the cover layer 35 is opened in such a manner as to form the cover-side projections 50 to thereby produce the cover-side opening 42. In the process of FIG. 10(k), the base layer 33 is opened in such a manner as to form the base-side projections 50 to thereby produce the base-side opening 44. Thereafter, in the process of FIG. 10(l), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44.

[0076]

In this formation of the suspension board with circuit 31, since the cover-side projections 50 and the base-side projections 51 are formed at the cover layer 35 and the base layer 33 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive patterns 43 are crossed each other, so as to project from the ends of the cover-side opening 42/the base-side opening 44 onto the conductive pattern

34 in the cover-side opening 42 and the base-side opening 44, respectively, the physical strength of the conductive pattern 34 at the ends of the cover-side opening 42 and at the ends of the base-side opening 44 can be reinforced. This can produce the effect that for example when the conductive pattern 34 are subject to stress concentration at exposed portions thereof at ends of the cover-side opening 42 and base-side opening 44 in the process of bonding the external-side connecting terminals 38 and the read/write terminals 54 by applying supersonic vibration of the bonding tool, the disconnection of the conductive pattern 34 can be effectively prevented, thus providing improved connection reliability.

[0077]

It is to be noted that in the suspension board with circuit 31, both of cover-side projections 50 and the base-side projections 51 are not necessarily required. For example, only the cover-side projections 50 may be formed, as shown in FIG. 13. Alternatively, only the base-side projections 51 may be formed, as shown in FIG. 14.

[0078]

Further, modification may be made of the invention by forming the widened portions 49 in the conductive pattern 34 and also forming the cover-side projections 50 in the cover layer 35 and/or forming the base-side projections 51 in the base layer 33, though not shown.

[0079]

In this suspension board with circuit 31, the external-side connecting terminals 38 may be formed in such a manner that the conductive pattern 34 is depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 at its portions corresponding to the external-side connecting terminals 38 and also the base-side opening 44 and the supporting-board-side opening 43 are made larger than the areas in which the metal plated layers 45 are formed, as shown in FIG. 15(a). In the external-side connecting terminals 38 thus formed, the widened portion 49 may be formed in the conductive pattern 34 in the crossing areas 48 where the ends of the cover-side opening 42/base-side opening 44 and the conductive pattern 34 are crossed each other, as shown in FIG. 12(b).

[0080]

This suspension board with circuit 31 can be formed in the processes shown in FIG. 16, for example. First, the coating 33p of the liquid solution of precursor of the photosensitive polyimide resin is formed on the previously prepared supporting board 32 in the same manner as in the above, as shown in FIG. 16(a). Then, as shown in FIG. 16(b), in the process of exposing the coating 33p to light, in addition to the photomasks 40 that permit no irradiated light to transmit through the masks, photomasks 52 that permit the irradiated light to partially transmit through the masks (average transmittance ratio in the range of 1-99%) are placed to confront the areas for the external-side connecting terminals 38 to be formed in the coating 33p. Then, the coating 33p is exposed to light through the photomask 52, such that the area in the coating 33p in which the external-side connecting terminals 38 is to be formed is exposed to a smaller amount of light exposure than an amount of light exposure to the remaining areas of the coating 33p. Sequentially, the coating is developed and cured, as mentioned above. As a result of this, the areas of the base layer 33 in which the external-side connecting terminals 38 is to be formed is made smaller in thickness than the remaining areas of the base layer 33, as shown in FIG. 16(c) and (d).

[0081]

The photomasks 52 may be formed in the following manner. For example, a semi-translucent part of the front surface of the photomask 52 is finely roughened so that components of irregular reflection on the front surface of the photomask 52 can be increased to reduce components of the transmitted light in that part. Or, an irradiated light absorbing film is stuck on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that semi-translucent part can be reduced. Or, a pattern having a light transmiting area and a light shielding area is formed on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that part can be reduced.

[0082]

Further, in the case of the photomask 52 comprising a thin metal film forming a light-shielding pattern thereon, a thin metal film smaller in thickness than the thin metal film of the photomask 52 may be formed on the semi-translucent part of the photomask 52 so that the components of the transmitted light in that semi-translucent part can be reduced. In other words, this photomask 52 can be formed in the following manner: A photomask 52 with no thin metal film formed in the semi-translucent part thereof (a conventional photomask) is formed. After a resist is formed on that photomask 52 so that only the semi-translucent part can be exposed, a thin metal film made of e.g. chromium smaller in thickness than the above-mentioned thin metal film is formed on the photomask 52 by vapor deposition or by plating and, thereafter, the resist is peeled.

[0083]

Of these photomasks 52, the photomasks 52 each having the semi-translucent part 53 on which the pattern of the light transmiting area and the light shielding area is formed as shown in FIG. 17 are preferably used. These photomasks 52 are each made of a sheet of glass, such as quartz glass or soda glass, of thickness of 2-5mm. The thin metal film formed on the semi-translucent part 53 of the photomask 52 made of the glass is patterned so that the light transmission ratio (transmissivity) in the semi-translucent part 53 of the glass can be reduced more than in the remaining parts of the glass. The pattern of the thin metal film can be formed, for example, by the process that after a thin metal film made of e.g. chromium is formed on the whole area of the glass by vapor deposition or by plating, the thin metal film is patterned by use of laser or electron beam. To be more specific, the pattern of the semi-translucent part 53 is preferably presented in the form of a repeat pattern in which the light transmitting portions and the light shielding portions being alternately arranged at a not more than 6 μm pitch (width of the light transmitting portion and the light shielding portion) and of which averaged transmittance ratio is not more than 80% or preferably not more than 50%. For example, a striped pattern having the average transmission ratio of about 50% as shown in FIG. 17(a); a latticed pattern having the average transmission ratio of about 25% as shown in FIG. 17(b); a circular staggered pattern having the average transmission ratio of about

25% as shown in FIG. 17(c); and a circular staggered pattern having the average transmission ratio of about 70% as shown in FIG. 17(d) are preferably used.

[0084]

While the patterning is provided in the negative type in the embodiment mentioned above, the patterning can be provided in the positive type as well. For example when the patterning is provided in the positive type, the photomask 52 may be so structured that the transmission ratio of irradiated light in the semi-translucent part of the photomask can be increased more than in the remaining parts of the photomask.

[0085]

The base layer 33 thus formed has a thickness in the range of e.g. 2-30μm, or preferably in the range of 5-20μm. The base layer 33 usually has a thickness of about 10μm. The area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has a thickness of usually 80% or less of the thickness of the remaining areas. For example, that area of the base layer 33 preferably has thickness of not more than 8μm, or further preferably not more than 5μm. Suppose that the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has thickness of 8μm or less, when the remaining areas have a usual thickness of 10μm, the time required for the opening to be formed in the later stage can be shortened to the extent corresponding to 2μm.

[0086]

The area of the base layer 33 in which the external-side connecting terminals 38 are to be formed has a lower limit of thickness or a minimum thickness to serve as a barrier layer against the conductive pattern 34 when the supporting board 32 is opened. For example, the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed can have e.g. 3μm, or further about 1μm, as the minimum thickness. Accordingly, the area of the base layer 33 in which the external-side connecting terminals 38 are to be formed preferably has a thickness in the range of 0.1-8μm or further preferably 1.0-5μm.

[0087]

Sequentially, the conductive pattern 34 is formed on the base layer 33 in the form of a specified wired circuit pattern in the same manner as in the above, as shown in FIG. 16(e). Since the areas of the base layer 33 on which the external-side connecting terminals 38 are to be formed are made smaller in thickness than the remaining areas of the base layer 33, the conductive pattern 34 is formed so that its portions on which metal plated layers 45 are formed in the later stage are depressed toward the supporting board 32 with respect to the remaining portions of the conductive pattern 34 to an extent corresponding to the reduced thickness. In this formation of the conductive pattern 34, the widened portions 49 are formed simultaneously with the patterning of the wired circuit pattern.

[0088]

Sequentially, as shown in FIG. 16(f)-(i), the conductive pattern 34 is covered with the cover layer 35 in the same manner as in the above. Then, the cover-side opening 42 is formed in the area of the conductive pattern 34 in which the external-side connecting terminal 38 is to be formed so that the maximum lengths of the widened portions 49 are placed in the crossing areas 48. Thereafter, the supporting-board-side opening 43 is formed to be larger than the area of the supporting board 32 corresponding to the cover-side opening 42, as shown in FIG. 16(j). Then, the base-side opening 44 is formed in the base layer 33 exposed in the supporting-board-side opening 43 so that the maximum lengths of the widened portions 49 are placed in the crossing areas 48, as shown in FIG. 16(k). Thereafter, the metal plated layers 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and in the base-side opening 44/ supporting-board-side opening 43, as shown in FIG. 16(l). The metal plated layer 45 thus formed is positioned with a certain space between its periphery and the peripheries of the base-side opening 44 and supporting-board-side opening 43.

[0089]

When the suspension board with circuit 31 is produced in this method, the base layer 33 is formed to have smaller thickness at the base-side opening 44 for exposing the conductive pattern 34 than at the remaining portions of the base layer 33 in the process of forming the base layer 33. Consequently, when the base layer 33 is etched in the process of forming the external-side connecting terminals 38, as shown in FIG. 16(k), the etching time required for the conductive pattern 34 to be exposed can be shortened to an extent corresponding to the difference between the reduced thickness of the base layer 33 at the opening portions 31 and the thickness of the remaining portions. This enables the conductive pattern 34 to be exposed in a short time, and as such can provide improved efficiency in producing the external-side connecting terminals 38 in the form of the flying lead exposed at both sides thereof.

[0090]

In this formation, since the base-side opening 44 and the supporting-board-side opening 43 are formed to be larger than the exposed portion of the conductive pattern 34, a certain space is left between the periphery of the metal plated layer 45 and the peripheries of the base-side opening 44 and supporting-board-side opening 43. This can produce the effect that for example when the metal plated layer 45 is increased in thickness for improvement in connection reliability, the metal plated layer 45 and the supporting board 32 can be prevented from contacting with each other. This can surely prevent occurrence of a short circuit from the contact between the metal plated layer 45 and the supporting board 32, thus providing improved connection reliability and voltage proof property of the suspension board with circuit 32.

[0091]

In the suspension board with circuit 31, the interval formed between the periphery of the metal plated layer 45 and the periphery of the supporting-board-side opening 43 is preferably at least 1μm, or preferably in the order of 2-100μm.

[0092]

Further, in this formation, since the area of the conductive pattern 34 in which the metal plated layer 45 is formed is so formed as to be depressed toward the supporting board 32, the distance from the front side of the supporting board 32 to the front side of the metal plated layer 45 is shortened to an extent corresponding to the depression with respect to the remaining areas of the conductive pattern 34 and, as a result of this, the metal plated layers 45 are placed closer to the outside of the supporting board 32 to that extent. This can produce the effect that for example when the external-side connecting terminals 38 are connected with read/write terminals 54 of the read/write board 39 in such a manner that the read/write terminals 54 are laid over the metal plated layers 45 and are bonded to each other by applying supersonic vibration of the bonding tool, the pressure bonding can be well ensured, thus providing further improved connection reliability.

[0093]

In the suspension board with circuit 31 thus formed, the thicknesswise interval formed between the front side of the metal plated layers 45 and the interface between the base layer 33 and the supporting board 32 is preferably $\pm 6\mu m$, or further preferably $\pm 2\mu m$.

[0094]

This suspension board with circuit 31 may be formed so that the external-side connecting terminals 38 presented in the form of the flying lead can have cover-side projections 50 formed as the reinforcing portions and base-side projections 51 formed as the reinforcing portions, as shown in FIG. 18. Specifically, the cover-side projections 50 are formed to project from the ends of the cover-side opening 42 onto the conductive pattern 34 in the cover-side opening 42 in the cover layer 35 in the crossing area 48 where the ends of the cover-side opening 42/the base-side opening 44 and the conductive patterns 34 are crossed each other. The base-side projections 51 are formed to project from the ends of the base-side opening 44 onto the conductive pattern 34 in the base-side opening 44 in the base layer 33 in the crossing areas 48.

[0095]

To be more specific, the cover-side projections 50 and the base-side projections 51 are formed in the respective lines of wire 34a, 34b, 34c and 34d at positions thereof corresponding to the crossing areas 48 (two areas per each line of wire) and arranged with space from each other along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, as shown in FIG. 18(b). These projections are formed in a convex shape projecting inwardly from the ends of the cover-side opening 42 and the base-side opening 44 along the extending direction of the lines of wire 34a, 34b, 34c and 34d, respectively. The cover-side projections 50 and the base-side projections 51 are overlapped with the lines of wire 34a, 34b, 34c and 34d and are so tapered (shaped generally in triangle as viewed from the top) that the overlap can gradually reduce toward the inside of the cover-side opening 42/base-side opening 44, respectively. As a result of this, the external-side connecting terminals 38 are so formed that the lines of wire 34a, 34b, 34c and 34d can be covered with the cover-side projections 50 and the base-side projections 51 at opposite ends thereof in the cover-side opening 42 and the base-side opening 44.

[0096]

The cover-side projections 50 and the base-side projections 51 may be made identical in projection length and basal width with the cover-side projections 25 and the base-side projections 26 of the wired circuit board 11 mentioned above. Also, the shape of the cover-side projections 50 and the base-side projections 51 is not limited to the one shown in FIG. 18(b), as long as those projections have such a shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d. For example, the cover-side projections 50 and the base-side projections 51 may be formed to project toward the inside thereof in a tapered manner, with the basal width slightly larger than the line width of the lines of wire 34a, 34b, 34c and 34d. Further, those projections 50, 51 may be formed in such a rectangular shape as to overlap with the lines of wire 34a, 34b, 34c and 34d along the longitudinal direction of the lines of wire 34a, 34b, 34c and 34d, without limiting to the generally triangle shape.

[0097]

In the suspension board with circuit 31 shown in FIG. 18, the base-side opening 44 is formed to be larger in area than the cover-side opening 42, so that the base-side projection 51 is formed to be larger in length than the cover-side projection 50 to that extent corresponding to the difference in area between the base-side opening 44 and the cover-side opening 42, as shown in FIG. 18(a).

[0098]

The external-side connecting terminals 38 having these cover-side projections 50 and the base-side projections 51 are formed as follows. In the process of FIG. 16(g)-(i), the cover layer 35 is opened in such a manner as to form the cover-side projections 50 to thereby produce the cover-side opening 42. In the process of FIG. 16(k), the base layer 33 is opened in such a manner as to form the base-side projections 50 to thereby produce the base-side opening 44. Thereafter, in the process of FIG. 16(l), the metal plated layer 45 is formed on each side of the conductive pattern 34 exposed in the cover-side opening 42 and the base-side opening 44.

[0099]

It is to be noted that in the suspension board with circuit 31 as well, both of cover-side projections 50 and the base-side projections 51 are not necessarily required, as is the case with the above. For example, only the cover-side projections 50 may be formed, as shown in FIG. 19. Alternatively, only the base-side projections 51 may be formed, as shown in FIG. 20.

[0100]

Further, modification may be made of the invention by forming the widened portions 49 in the conductive pattern 34 and also forming the cover-side projections 50 in the cover layer 35 and/or forming the base-side projections 51 in the base layer 33, though not shown.

[0101]

Although the external-side connecting terminals 38 provided in the form of the flying lead have been exclusively discussed above, this suspension board with circuit 31 includes magnetic-head-side connecting terminals 37 provided in the form of the flying lead identical with the external-side connecting terminals 38.

[0102]

EXAMPLES

While in the following, the present invention will be described in further detail with reference to Examples, the present invention is not limited to any Examples.

[0103]

EXAMPLE 1

A liquid solution of precursor of photosensitive polyimide resin was applied on the stainless steel foil (SUS304 H-TA) having thickness of 20μm so that after dried, it could have a thickness of 24μm and then dried at 130℃ to thereby form a coating of the precursor of the photosensitive polyimide resin (Cf. FIG. 16(a)). Sequentially, the coating was exposed to light (405nm, 1,500mJ/cm^2) through a photomask (Cf. FIG. 16(b)). The exposed part of the coating was heated to 180℃ and then developed by using an alkaline developer, whereby the coating was patterned with the negative imaging (Cf. FIG. 16(c)). Sequentially, the patterned coating of the precursor of the photosensitive polyimide resin was heated at 350℃ to be cured (imidized), whereby a base layer made of polyimide resin of thickness of 10μm was formed in the specified pattern (Cf. FIG. 16(d)).

[0104]

In forming the base layer, the photomask of metal film having a latticed repeat pattern in which the light transmitting portions and the light shielding portions are alternately arranged at a not more than 6μm pitch (which corresponds to the photomask 52 having the average transmission ratio of about 25% shown in FIG. 17(b)), was positioned over the coating at its portion which is to be opened in the later stage and at which an external-side connecting terminals are to be formed. Then, the coating was exposed to light through the photomask, so that the amount of light exposure in the portion of the coating at which the external-side connecting terminals are to be formed could be reduced more than the amount of light exposure in the remaining portions of the coating (Cf. FIG. 16(b)). As a result of this, after the coating was developed and cured, the base layer having a thickness of 2μm at portions thereof at which the external-side connecting terminals are to be formed and a thickness of 10μm at the remaining portions thereof was obtained (Cf. FIG. 16(d)).

[0105]

Sequentially, a thin chrome film of thickness of 300Å and a thin copper film having thickness of 700Å were formed in sequence on the whole area of the stainless steel foil and the base layer by a sputtering deposition process. Thereafter, a plating resist having an opposite pattern to the specified wired circuit pattern was formed by use of a dry film resist, and a conductive pattern having the specified wired circuit pattern was formed in the part of the base layer where the plating resist was not formed, in the semi-additive method using the electrolysis copper plating (Cf. FIG. 16(e)). As a result of the base layer being formed to be smaller in thickness at its part at which the external-side connecting terminals are to be formed than at its remaining parts, the conductive pattern thus formed had, at its part at which the external-side connecting terminals are to be formed, concave portions depressed toward the stainless steel foil from the remaining portions of the conductive pattern with respect to the thickness direction by about 8μm. The conductive pattern was formed to have thickness of 10μm and have the wired pattern formed by four lines of wire each having width of 110μm and spaced from each other in parallel at interval of 200μm.

[0106]

Further, generally round widened portions (Cf. FIG. 15(b)), which were widened in the widthwise direction substantially orthogonal to the extending direction of the lines of wire and had the maximum widthwise length of 230 μm and the longitudinal length of 100 μm, were formed in the respective lines of wire in crossing areas where the ends of the cover-side opening/the base-side opening and the lines of wire are crossed each other, two for each line of wire.

[0107]

Thereafter, the plating resist was removed by chemical etching and then the thin chromium film and the thin copper film on which the plating resist had been formed were removed by chemical etching.

[0108]

Sequentially, a rigid, thin nickel film having thickness of 0.1μm was formed on the surface of the conductive pattern and the surface of the stainless steel foil by the electroless nickel plating. Thereafter, a liquid solution of a precursor of the photosensitive polyimide resin was applied on the thin nickel film and the base layer and then heated at 130℃ to thereby form a coating of the precursor of the photosensitive polyimide resin (Cf. FIG. 16(f)). Sequentially, the coating was exposed to light (405nm, 1,500mJ/cm^2) through the photomask (Cf. FIG. 16(g)). The exposed part of the coating was heated to 180℃ and then developed by using an alkaline developer, whereby the coating was patterned so that the conductive layer could be covered with the coating (Cf. FIG. 16(h)). Sequentially, the patterned coating of the precursor of photosensitive polyimide resin was heated at 350℃ to be cured (imidized), whereby the cover layer comprising polyimide resin of thickness of 3μm was formed on the conductive layer (FIG. 16(i)).

[0109]

It is to be noted that in forming the cover layer, the cover-side openings were formed in the cover layer so that when the cover layer was patterned, the thin nickel film on the conductive pattern at its part at which the external-side connecting terminals are to be formed could be exposed.

[0110]

Sequentially, the external-side connecting terminals were formed in the state in which their both sides were exposed. First, the supporting-board-side openings larger than the cover-side openings were formed in the stainless steel foil at its portions corresponding to the cover-side openings so that the base layer could be exposed (Cf. FIG. 16(j)). The supporting-board-side openings were formed in the process that after all of the areas of the stainless steel foil, except the areas in which the supporting-board-side openings are to be formed, were subjected to masking, the stainless steel foil was subjected to the chemical etching. At the same time as the formation of the supporting-board-side openings, the gimbals were cut into a predetermined shape by the chemical etching.

[0111]

Sequentially, the thin nickel film as was exposed in the cover-side openings was peeled and the thin nickel film formed on the stainless steel foil was peeled.

[0112]

Then, the base layer exposed in the supporting-board-side openings of stainless steel foil were opened and thereby the base-side openings were formed to expose the ground formed on the back side of the conductive pattern (Cf. FIG. 16(k)). The base-side openings were formed by the plasma etching. In the plasma etching, with the stainless steel foil as the mask, the entire base layer exposed in the supporting-board-side openings of the stainless steel foil was etched for about 2 minutes in the conditions of: the mixed gas of CF_4 and O_2 (CF_4/O_2 =20/80) used as the gas filled; the gas pressure (degree of vacuum) of 25Pa; the frequency of 13.5MHz; and the power required for the plasma etching of 2,500W.

[0113]

The base-side openings thus formed were formed in the same size and shape as the supporting-board-side openings, and the space of about 50 μm was defined between the periphery of the ground exposed in the base-side openings and the periphery of the base-side opening/supporting-board-side opening.

[0114]

Thereafter, the ground exposed in the base-side openings were peeled to expose the back side of the conductive pattern. Sequentially, the metal plated layers were formed by performing the electrolysis nickel plating and the electrolysis gold plating being alternately, so that the nickel plated layers having thickness of 2 μm and the gold plated layer having thickness of 1 μm were formed on the both sides of the conductive pattern thus exposed (FIG. 16(l)).

[0115]

The metal plated layers on the back side of the conductive pattern thus formed left the thicknesswise interval of ±2μm between the front side of the metal plated layers and the interface between the base layer and the stainless steel foil and also left the interval of 47μm between the periphery of the metal plated layer and the periphery of the base-side opening/the supporting-board-side opening.

[0116]

After these processes, the suspension board with circuit was obtained in which the external connecting terminals were presented in the form of the flying lead of the conductive pattern in which the widened portions were formed in the lines of wire, respectively (Cf. FIG. 15).

[0117]

EXAMPLE 2

The suspension board with circuit having the external-side connecting terminals produced in the form of the flying lead of the conductive pattern whose lines of wire were covered with the base-side projections at their exposed ends was produced (FIG. 20) in the same operation as in Example 1, except that instead of forming the widened portions in the lines of wire of the conductive pattern, the base-side projections of generally triangle as viewed from the top having the basal width of 110μm and the projection length of 200μm were formed in the base layer in the crossing areas (two areas per each line of wire) where the ends of the base-side opening and the lines of wire are crossed each other, so as to project from the ends of the base-side opening onto the conductive pattern in the base-side opening in the process of opening the base layer to form the base-side openings (Cf. FIG.

16(k)).

[0118]

COMPARATIVE EXAMPLE 1

Except that no widened portions were formed in the lines of wire of the conductive pattern, the suspension board with circuit having the external-side connecting terminals presented in the form of the flying lead was produced (Cf. FIG. 21) in the same operation as in Example 1.

[0119]

EVALUATION

After being bonded to the external terminals comprising gold pads by applying supersonic vibration thereto by use of the bonding tool, the external-side connecting terminals of the suspension boards with circuit obtained in Examples 1 and 2 and Comparative Example 1 were put to the peel tests to measure the bonding strength.

[0120]

The test results are shown in Table 1 given below. It should be noted that all destructions occured in the conductive patterns of the suspension boards with circuit of Examples 1 and 2 took place in the areas where the conductive pattern was covered with the cover layer and the base layer.

[0121]

Table 1

	Example 1	Example 2	Comparative Example 1
Bonding strength in peel test (mN)	540	590	490

[0122]

While illustrative embodiments of the present invention are provided in the above description, such is for illustrative purpose only and is not to be construed restrictively. Modification and variation of the present invention that will be obvious to those skilled in the art is to be covered by the following claims.

WHAT IS CLAIMED IS:

1. A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

2. A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein at least any one of the first insulating layer, the second insulating layer and the conductive pattern has reinforcing portions for reinforcing the conductive pattern formed at ends of the opening in crossing areas where ends of the opening and the conductive pattern are crossed each other.

3. The wired circuit board according to Claim 2, wherein the wired circuit board is a suspension board with circuit.

4. A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

5. A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the conductive pattern has widened portions formed to extend in a widthwise direction substantially orthogonal to an extending direction of the conductive pattern in crossing areas where ends of the opening and the conductive pattern are crossed each other.

6. The wired circuit board according to Claim 5, wherein the wired circuit board is a suspension board with circuit.

7. A wired circuit board comprising a first insulating layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the first insulating layer and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing area where the ends of the opening and the conductive pattern are crossed each other.

8. A wired circuit board comprising a metal supporting layer, a first insulating layer formed on the metal supporting layer, a conductive pattern formed on the first insulating layer, a second insulating layer formed on the conductive pattern, and an opening, formed at the same position of the conductive pattern, for allowing the metal supporting layer and the first insulating layer, and the second insulating layer to open, so as to form a terminal portion in which front and back sides of the conductive pattern are exposed,

wherein the first insulating layer and/or the second insulating layer have projections projecting from ends of the opening onto the conductive pattern in the opening in the crossing areas where the ends of the opening and the conductive pattern are crossed each other.

9. The wired circuit board according to Claim 8, wherein the wired circuit

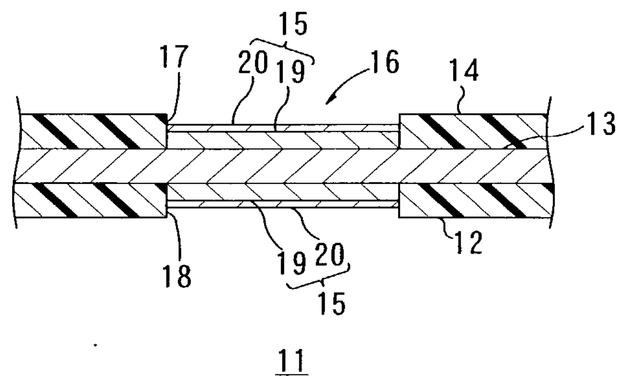
board is a suspension board with circuit.

ABSTRACT OF THE DISCLOSURE

A wired circuit board having a terminal portion formed as a flying lead that can provide enhanced strength of the conductive pattern, both sides of which are exposed, by simple construction to effectively prevent disconnection of the conductive pattern. The wired circuit board having the terminal portion formed as the flying lead in which the both sides of the conductive pattern are exposed includes, in crossing areas where ends of a cover-side opening and ends of a base-side opening and the conductive pattern are crossed each other, (i) the widened portions formed in the conductive pattern or (ii) cover-side projections and base-side projections formed in the cover layer and the base layer, respectively.

FIG. 1

(a)


15
17
20
19
16
14
13
12
18
19
20
15
11

(b)

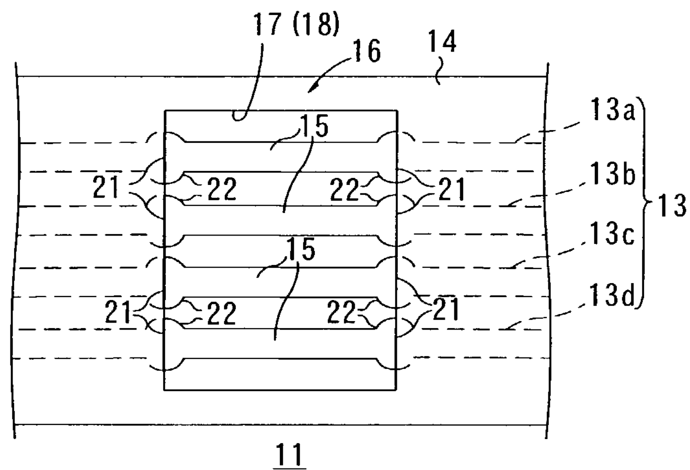

17 (18)
16
14
13a
15
13b
21
22
22
21
13
13c
15
13d
21
22
22
21
11

FIG. 2

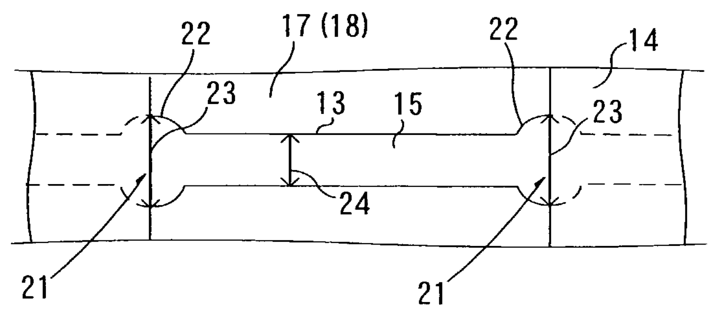

22
17 (18)
22
14
23
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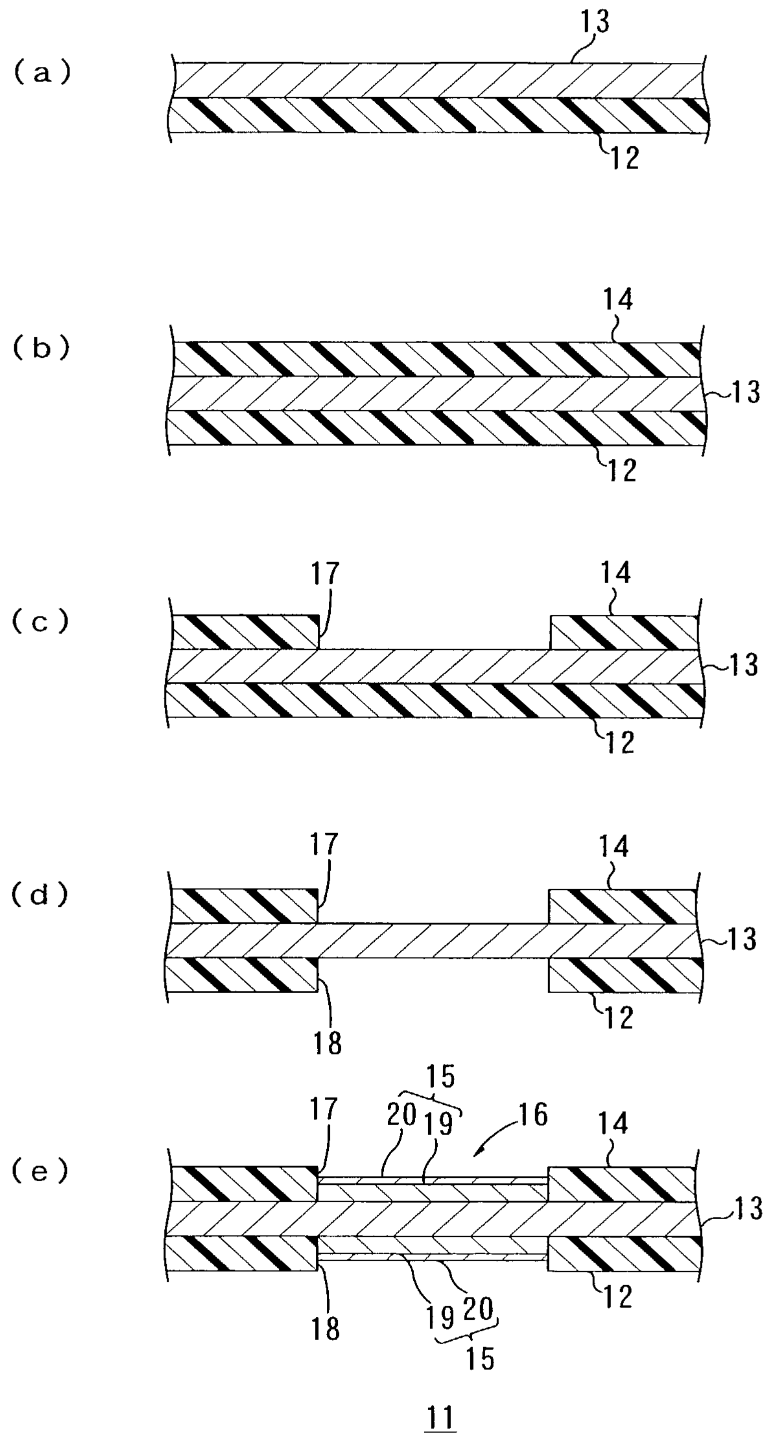
FIG. 3


(a)
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(b)
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(c)
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(e)
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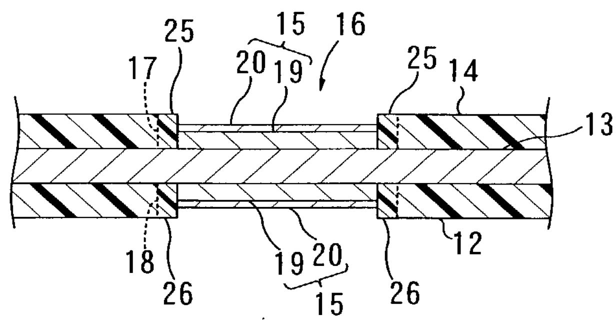
F I G. 4

(a)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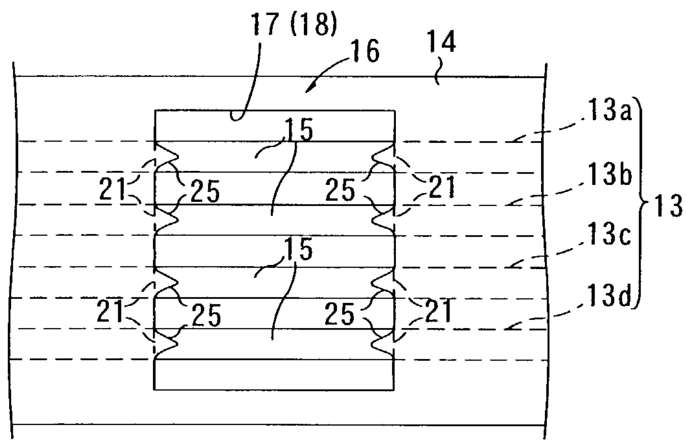
(b)


17 (18)
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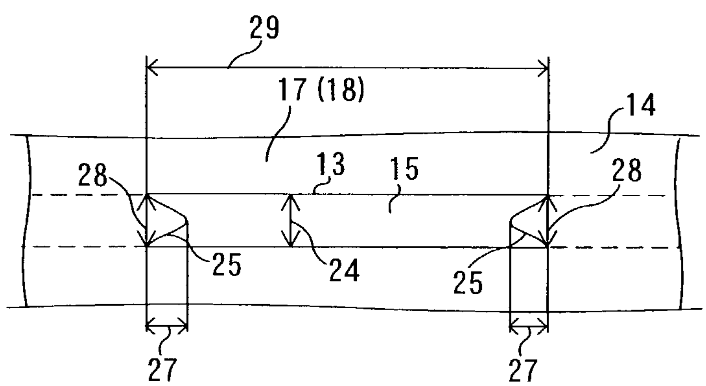
F I G. 5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17 (18)
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FIG. 6

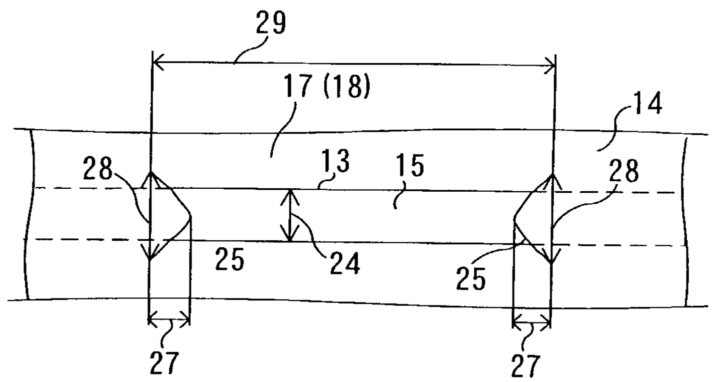


FIG. 7

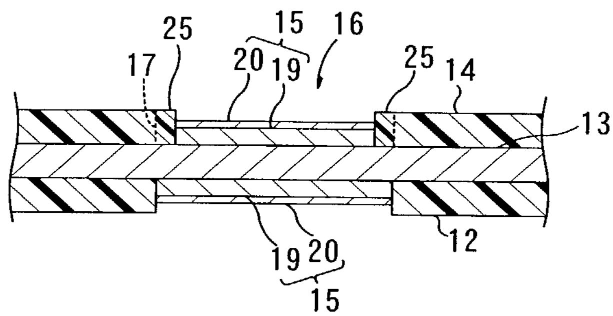
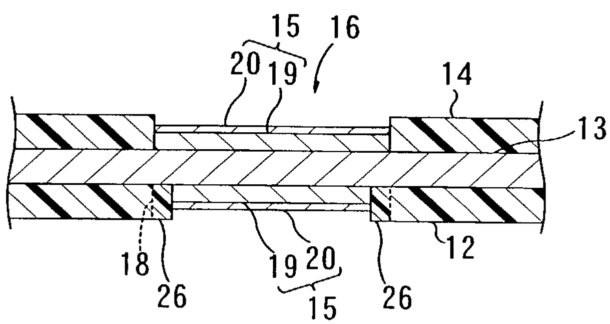
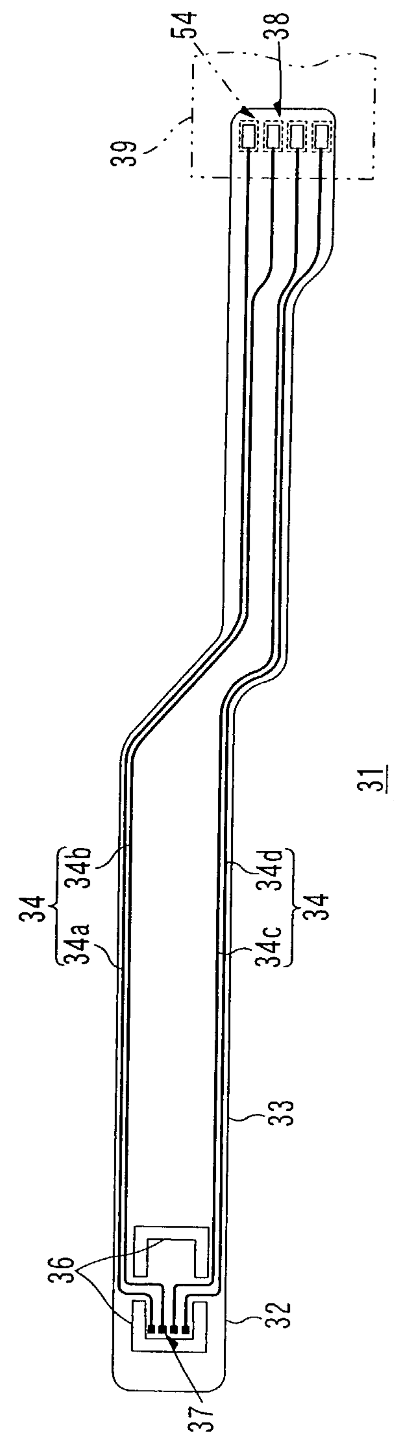


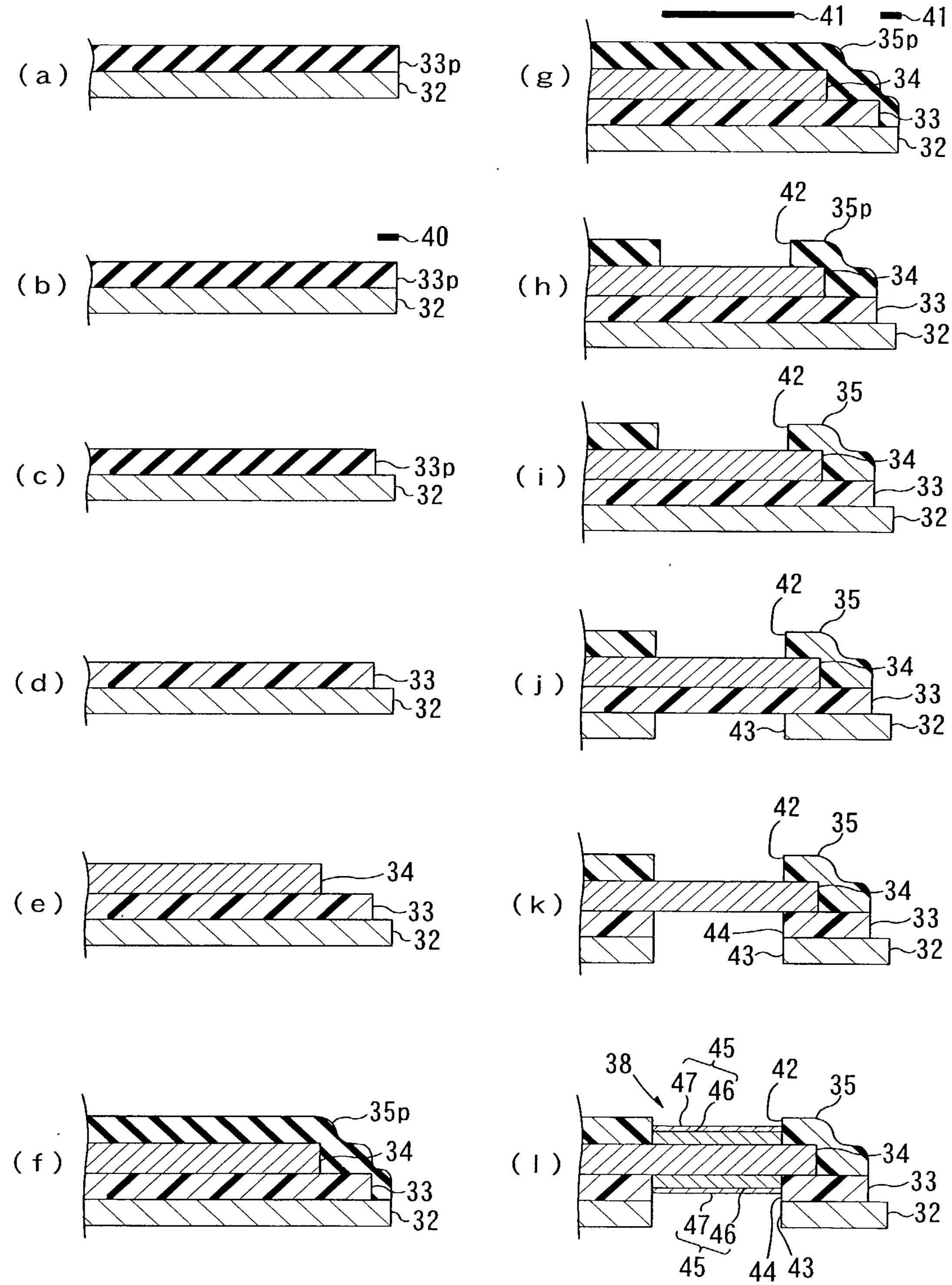
FIG. 8



F I G. 9



F I G. 1 0


(a)
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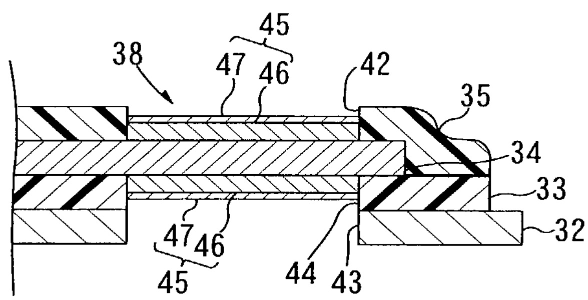
F I G. 1 1

(a)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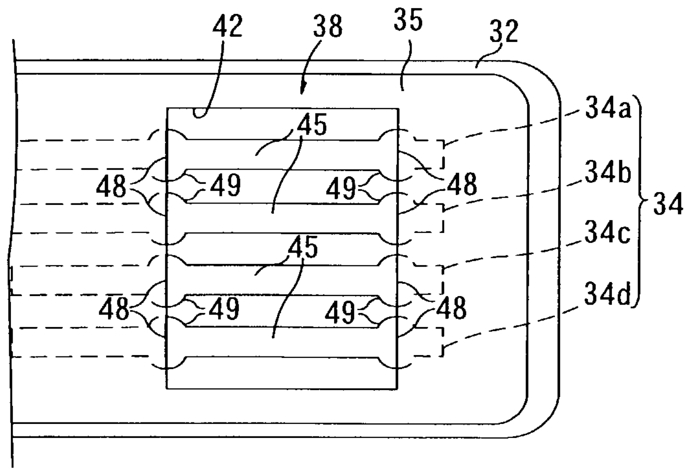
(b)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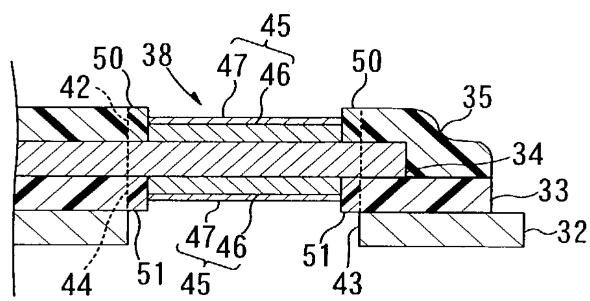
F I G. 1 2

(a)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(b)

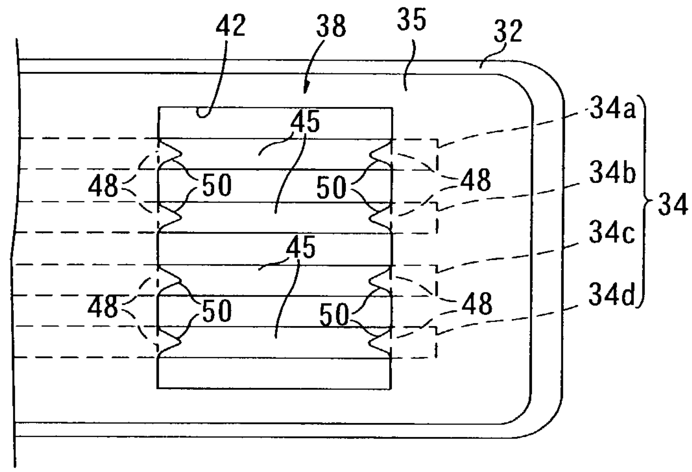
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FIG. 13

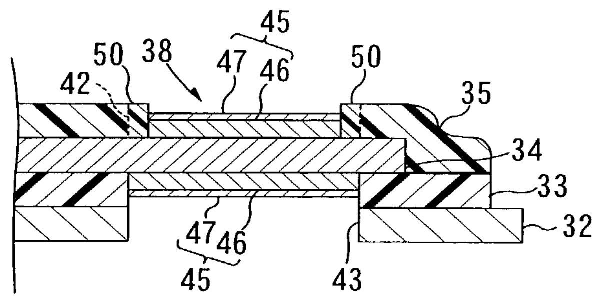
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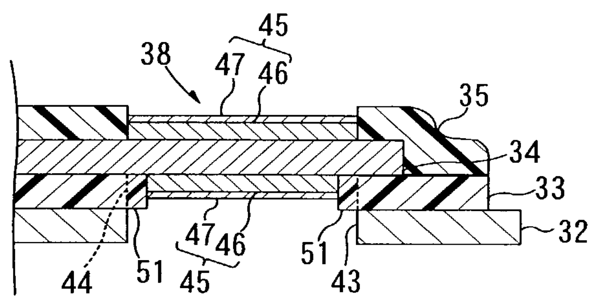
FIG. 14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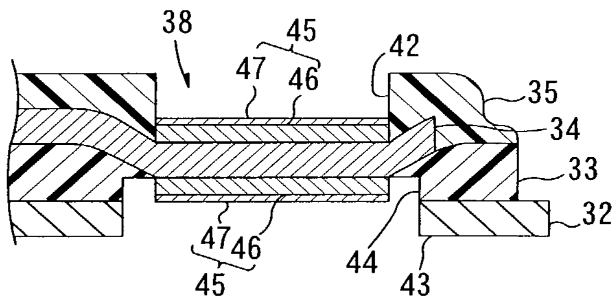
F I G. 1 5

(a)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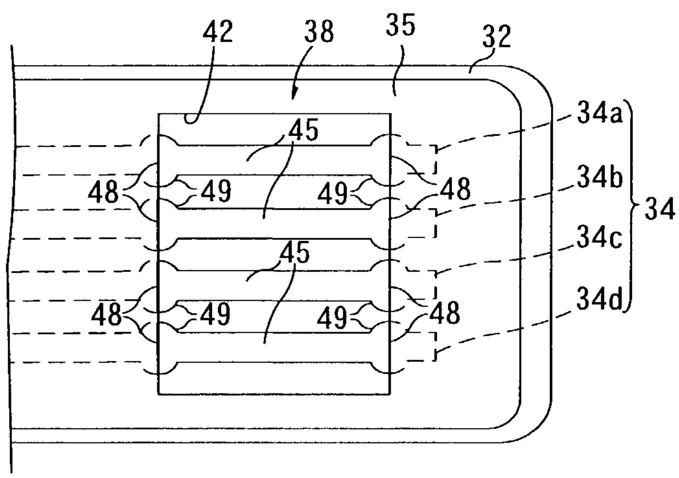
(b)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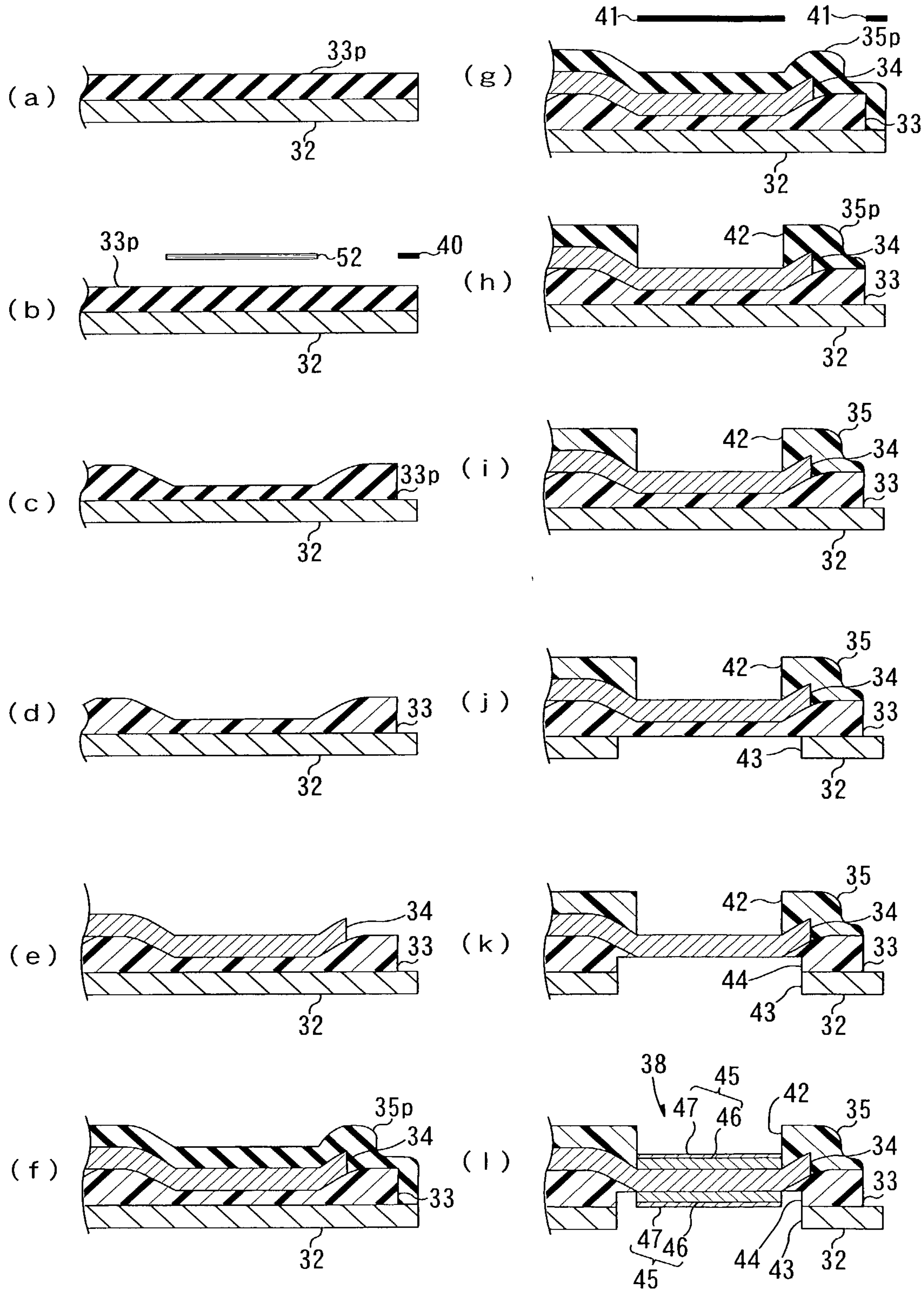
F I G. 1 6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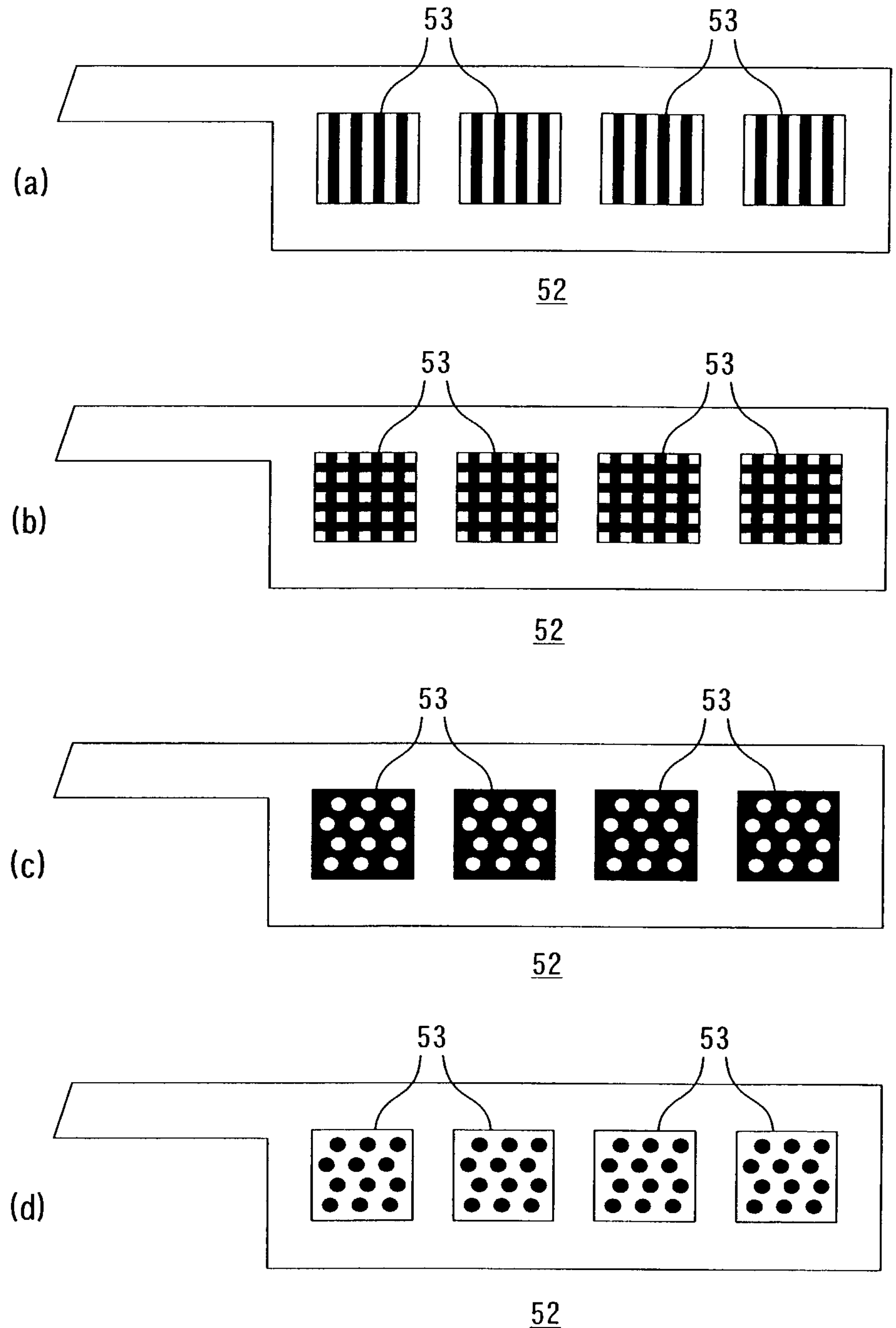
F I G. 1 7



F I G. 1 8

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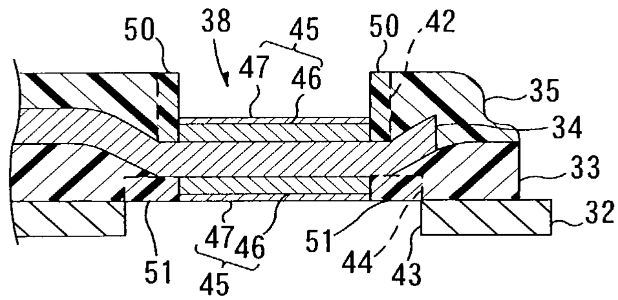
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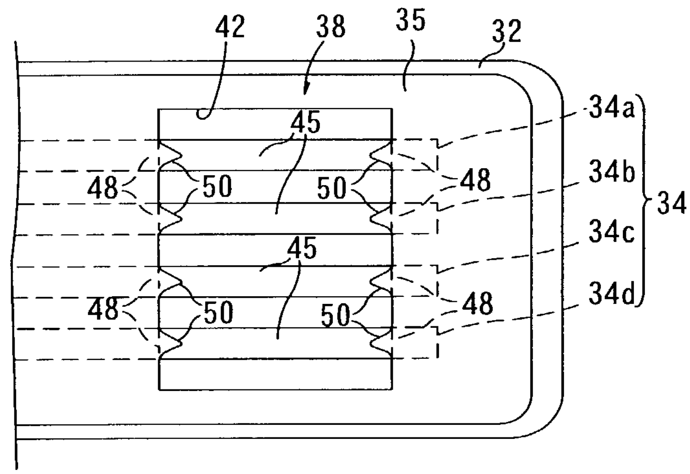
(b)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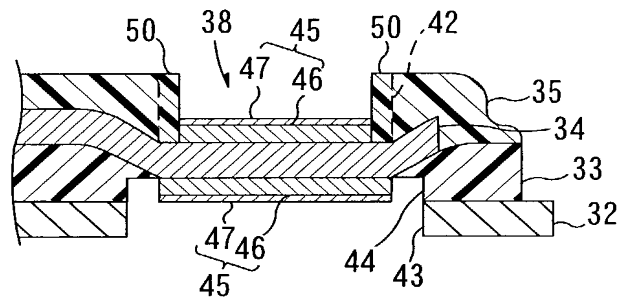
F I G. 1 9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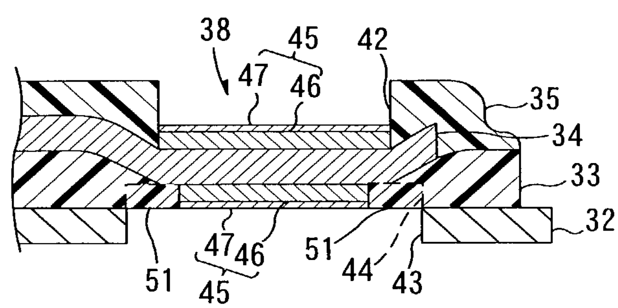
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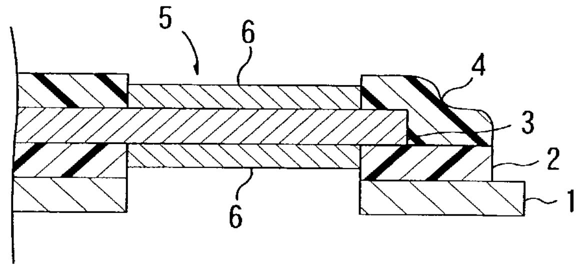
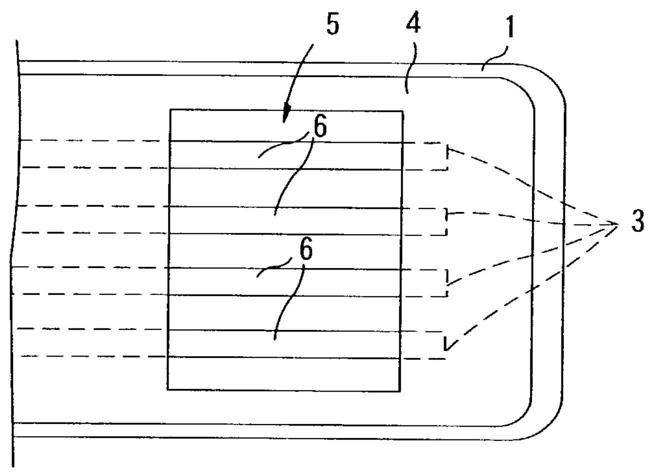
(a)



(b)



PRIOR ART

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As a below named inventor, I hereby declare that

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My residence post office address and citizenship are as stated next to my name.

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

WIRED CIRCUIT BOARD

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the specification of which is attached hereto unless the following box is checked:

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この出願の米国出願番号またはＰＣＴ国際出願番号は、
＿＿＿＿＿＿ であり、且つ
＿＿＿＿＿＿ の日に補正された出願（該当する場合）

☐ was filed on ＿＿＿＿＿＿
as United States Application Number or
PCT International Application Number
＿＿＿＿＿＿ and was amended on
＿＿＿＿＿＿ (if applicable)

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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above

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I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56

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Patent and Trademark Office, U S DEPARTMENT OF COMMERCE

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I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filling date before that of the application for which priority is claimed

Prior Foreign Application(s)
外国での先行出願

			Priority Not Claimed 優先権主張なし
2001-216812	Japan	17th / July / 2001	☐
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) （出願日／月／年）	
			☐
(Number) （番号）	(Country) （国名）	(Day/Month/Year Filed) （出願日／月／年）	

私は、ここに、下記のいかなる米国仮特許出願についても、その米国法典第35編119条(e)項の利益を主張する。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application No) （出願番号）	(Filing Date) （出願日）	(Application No) （出願番号）	(Filing Date) （出願日）

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(Application No) （出願番号）	(Filing Date) （出願日）	(Status: Patented, Pending, Abandoned) （現況：特許許可、係属中、放棄）
(Application No.) （出願番号）	(Filing Date) （出願日）	(Status: Patented, Pending, Abandoned) （現況：特許許可、係属中、放棄）

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

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直通電話連絡先：（氏名及び電話番号）	Direct Telephone Calls to: (name and telephone number)
唯一または第一発明者氏名	Full name of sole or first inventor Makoto KOMATSUBARA
発明者の署名 日付	Inventor's signature Date Makoto Komatsubara 9th/July/2002
住所	Residence Osaka, Japan
国籍	Citizenship Japanese
郵便の宛先	Post Office Address c/o Nitto Denko Corporation of 1-2, Shimo-hozumi 1-chome, Ibaraki-shi, Osaka 567-8680, Japan
第二共同発明者がいる場合、その氏名	Full name of second joint inventor, if any Shigenori MORITA
第二共同発明者の署名 日付	Second inventor's signature Date Shigenori Morita 9th/July/2002
住所	Residence Osaka, Japan
国籍	Citizenship Japanese
郵便の宛先	Post Office Address c/o Nitto Denko Corporation of 1-2, Shimo-hozumi 1-chome, Ibaraki-shi, Osaka 567-8680, Japan
（第三以下の共同発明者についても同様に記載し、署名をすること）	(Supply similar information and signature for third and subsequent joint inventors.)

902007US

第三の共同発明者の氏名（該当する場合）	Full name of third joint inventor, if any Tadao OOKAWA
同第三発明者の署名　日付	Third inventor's signature　Date Tadao Ookawa　9th/July/2002
住所	Residence Osaka, Japan
国籍	Citizenship Japanese
郵便の宛先	Post office address c/o Nitto Denko Corporation of 1-2, Shimo-hozumi 1-chome,
	Ibaraki-shi, Osaka 567-8680, Japan
第四の共同発明者の氏名（該当する場合）	Full name of fourth joint inventor, if any Toshio SHINTANI
同第四発明者の署名　日付	Fourth inventor's signature　Date Toshio Shintani　9th/July/2002
住所	Residence Osaka, Japan
国籍	Citizenship Japanese
郵便の宛先	Post office address c/o Nitto Denko Corporation of 1-2, Shimo-hozumi 1-chome,
	Ibaraki-shi, Osaka 567-8680, Japan
第五の共同発明者の氏名（該当する場合）	Full name of fifth joint inventor, if any
同第五発明者の署名　日付	Fifth inventor's signature　Date
住所	Residence
国籍	Citizenship
郵便の宛先	Post office address
第六の共同発明者の氏名（該当する場合）	Full name of sixth joint inventor, if any
同第六発明者の署名　日付	Sixth inventor's signature　Date
住所	Residence
国籍	Citizenship
郵便の宛先	Post office address