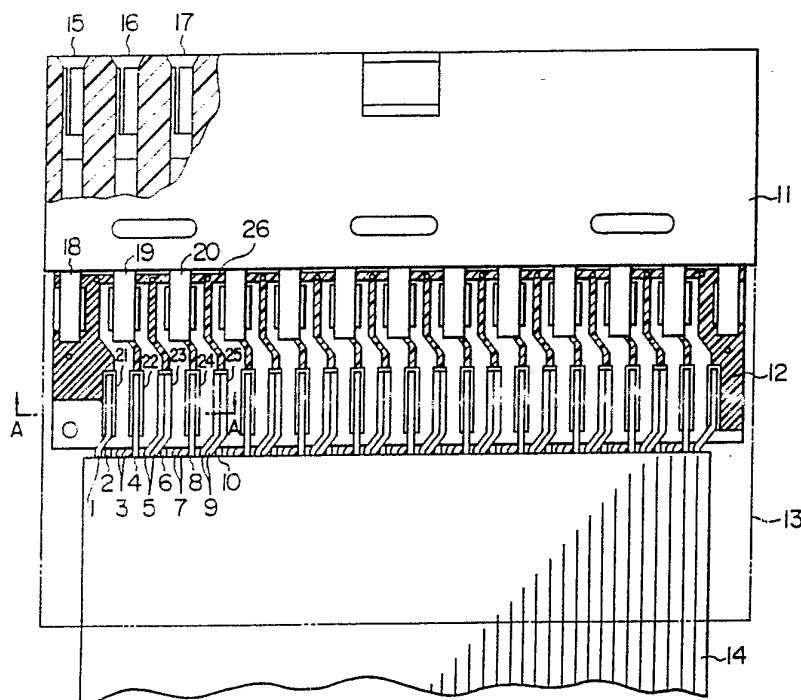




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(21) International Application Number: PCT/US91/05931 (22) International Filing Date: 19 August 1991 (19.08.91) (30) Priority data: 1/90444 29 August 1990 (29.08.90) JP (71) Applicant (for all designated States except US): MINNESOTA MINING AND MANUFACTURING COMPANY [US/US]; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). (72) Inventors; and (75) Inventors/Applicants (for US only) : SUGAWARA, Naoto [JP/JP]; 4-11-3-202, Segamihara, Kanagawa pref. 229 (JP). INAOKA, Seiji [JP/JP]; 2-1-6, Shimo-Renjaku, Mitaka City, Tokyo 181 (JP).		(74) Agents: BARNES, John, C. et al.; Minnesota Mining and Manufacturing Company, Post Office Box 33427, Saint Paul, MN 55133-3427 (US). (81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), KR, LU (European patent), NL (European patent), SE (European patent), US. Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: CONNECTOR FOR HIGH-SPEED SIGNAL TRANSMISSION CABLE



(57) Abstract

A connector for terminating high-speed signal transmission cables, which utilizes a substrate with first signal pad portions and second grounding pad portions. A cable is terminated by terminating alternately, the signal lines and ground lines on each side of the substrate to the first and second pad portions respectively, such that a signal line is connected adjacent a ground line and the pad on the substrate opposite each first pad portion is a second pad portion.

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⁺ Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

5 CONNECTOR FOR HIGH-SPEED SIGNAL TRANSMISSION CABLE

Background of the InventionField of the Invention

10 This invention relates to a connector for a flat cable, and in particular, to a connector for high-speed signal transmission cables.

Description of Prior Art

15 In a connector for high-speed signal transmission cables of prior art, as shown in Fig. 7, signal lead lines 91, 93, 95, 97 of a cable portion 110 are disposed between grounding lead lines 90 and 92; 92 and 94; 94 and 96; 96 and 98; respectively. These signal
20 lead lines are connected with pad portions 84, 85, which are connected with tail portions 81, 82 arranged on one of two surfaces of a substrate 100, while the above-mentioned grounding lead lines 90, 92, 94, 96, 98 are connected with a common grounding plate 120, which is connected with a
25 tail portion 80 arranged on the other one of the two surfaces of the substrate 100 (refer to Fig. 8).

In a connector for high-speed signal transmission cables of prior art, when viewed in detail, the signal lead lines 91, 93, 95 are arranged in parallel
30 with each other at small intervals as shown in Fig. 8. Therefore, there rises a problem that cross-talks are caused among these signal lead lines.

The purpose of the present invention is to solve the above-mentioned problem of the prior art connector and
35 to provide a connector for high-speed signal transmission cables which has a simple structure and suffers very little cross-talk.

Summary of the Invention

40 The connector of the present invention, for high-speed signal transmission cables, comprises first pad portions connected to signal connection terminals and

second pad portions connected to grounding connection terminals. The first pad portions and the second pad portions are spaced and arranged alternately on each of two surfaces of a substrate so that the position of any of the first pad portions on one of the two surfaces of the substrate is substantially aligned with the position of one of the second pad portions on the other of the two surfaces of the substrate.

Further, a connector for high-speed signal transmission cables according to the present invention comprises a cable portion having signal lead lines and grounding lead lines; and a common grounding plate disposed substantially at the end of the cable. The signal lead lines and the grounding lead lines are connected respectively to the first pad portions and the common grounding plate. The common grounding plate has an extension connected to the second pad portion.

Description of the Drawing

Fig. 1 is a partly sectional plan view of a connector according to a first embodiment of the present invention,

Fig. 2 is a side view of a part of the connector shown in Fig. 1,

Fig. 3 is a partly sectional plan view of a connector according to a second embodiment of the present invention,

Fig. 4 is a side view of a part of the connector shown in Fig. 3,

Fig. 5 is a sectional view taken on line A-A of Fig. 1,

Fig. 6 is a sectional view taken on line B-B of Fig. 3,

Fig. 7 is a partly sectional plan view of a connector of a prior art,

Fig. 8 is a sectional view taken on line C-C of Fig. 7.

Detailed Description of Several Presently Preferred Embodiments

Referring to the attached drawings, an embodiment of a connector for high-speed signal transmission cables according to the present invention will be described below.

Fig. 1 is a plan view partly in section of the first embodiment, in which an insulation cover portion 13 covering a region from conductive tail portions 18, 19, 20 to the tip portion of a cable portion 14 is removed.

A plurality of conductive connection terminals 15, 16, 17 are, for example, disposed inside of an insulation cover portion 11 made of synthetic resin such as PTFE. The tail portions 18, 19, 20 are arranged on a substrate 12 fixed to the insulation cover portion 11 separately from each other at substantially equal intervals, and are connected with the connection terminals 15, 16, 17, respectively.

Further, the tail portions have first pad portions 22, 24 and second pad portions 21, 23, 25, these pad portions being connected with lead lines 1 - 10 of the cable portion 14, respectively. These pad portions are also made of conductive material, and are arranged on the substrate 12 separately from each other at substantially equal intervals.

Each of the above-mentioned signal lead lines of the cable portion 14 are, similarly in prior art, adapted to be put between grounding lead lines, for example, the signal lead line 8 is disposed between the grounding lead lines 7, 9.

In this embodiment, the most leftward lead line 1 is used for grounding, and a group of the three lead lines 2, 3, 3 is arranged on the lower surface of the substrate 12 rightwards adjacent to the lead line 1 and connected with the respective pads on the substrate. Further, the next group of the three lead lines 4, 5, 5 extend on the upper surface of the substrate and are connected with the pad portions 22, 23, on the substrate,

respectively. The most leftward lead line 4 of the group of three lines is a signal lead line and the remaining two lines 5, 5 are grounding lead lines. The grounding lead lines 5, 5 are arranged so as to lie upon the pad portion 23 (second pad portion) and connected the pad portion 23, which is connected with the grounding tail portion 18 through a connection portion 21. The other grounding lead lines 9, 9 are also connected with the grounding tail portion 18 through the pad portion 25 (second pad portion) and the connection portion 26.

Fig. 2 is a side view showing a region near the tip portions of the pad portion and the cable portion on the substrate.

Fig. 3 shows a second embodiment of the present invention, which uses a common grounding plate 35.

The insulation cover portion 31, the connection terminals (not shown), the conductive tail portions 36, 37, 38, the conductive first pad portion 41, 43, the conductive second pad portions 40, 42, 44, the substrate 32, and the cable portions 34 have the same structures as in the first embodiment, and the insulation cover 33 is removed.

The above-mentioned grounding plate 35 is located near the front edge portion of the cable portion 34, and connected with the same. The grounding lead lines 52, 55, 57, 59 of the cable portion 34 are bent as being grouped into pairs of lines, and are connected with the grounding plate 35. The signal lead lines 53, 58 of the cable portion are placed upon and are connected with the first pad portions 41, 43, which are connected with the signal tail portions 37, 38, respectively.

Further, the paired grounding lead lines 55 and 59 are bent to place every other pair towards the lower surface of the substrate and they are connected with a second common grounding plate 35 (not shown).

Extensions 70 extending from the common grounding plate 35 are placed upon and connected with the second pad portions 40, 42, 44, which are connected with

the grounding tail portion 36 through a connection portion 39. At positions located on the surface of the substrate opposite to that for the signal lead lines 53, 58 of the cable portion 34 and corresponding to the positions of these signal lines are arranged grounding extensions extending from the grounding plate 35, which extensions are connected with the second pad portions. Referring to Fig. 4, the extensions 70 extending from the grounding plate 35, are placed upon and connected with the lead line 51 (56 and 60 are not shown) extending from the cable portion 34.

In a conventional connector for high-speed signal transmission cables, as shown in Fig. 8, on one surface of a substrate 100 are arranged signal lead lines at substantially equal intervals, while on the other surface are arranged grounding lead lines. On the upper surface of the substrate 40 are arranged pad portions 83, 84, 85 each having a breadth "p", to which are connected signal lead lines 91, 93, 95. Namely, the interval between the signal lead lines is "p".

To the contrary, in a connector according to the present invention, as shown in Figs. 5 and 6 corresponding to embodiments of the present invention, on one surface of the substrate are alternatively arranged signal lead lines and grounding lead lines, and on the other surface of the substrate are arranged signal lead lines oppositely to the grounding lead lines on the one surface, while grounding lead lines are arranged oppositely to the signal lead lines on the one surface. In consequence, assuming the substrate thickness as "t", the distance between adjacent signal lead lines is

$$(p^2 + t^2)^{1/2}$$

and the ratio of cross-talk noise N in the prior art to that in the present invention is

$$(p/(p^2 + t^2)^{1/2})$$

As a concrete example, in case of 0.8 mm thickness "t" of the substrate made of glass epoxy resins, 1.27 mm intervals of the coaxial flat cables, 1 n sec of

pulse rise time, 1 V of pulse breadth, and 1 m of cable length, the following experimental result has been obtained:

5	prior art	present invention	reducing ratio
10	cross talk nozzle N (mV)	13.4	9.2
		69%	

Although the ratio should be deduced theoretically to 84%, the actual ratio is as large as 69%. This difference is considerably great, and exceeds possible error limit in measurement. The reason for this great difference is that signal lead lines are, as shown in Figs. 5 and 6, arranged so as to be surrounded by grounding lead lines.

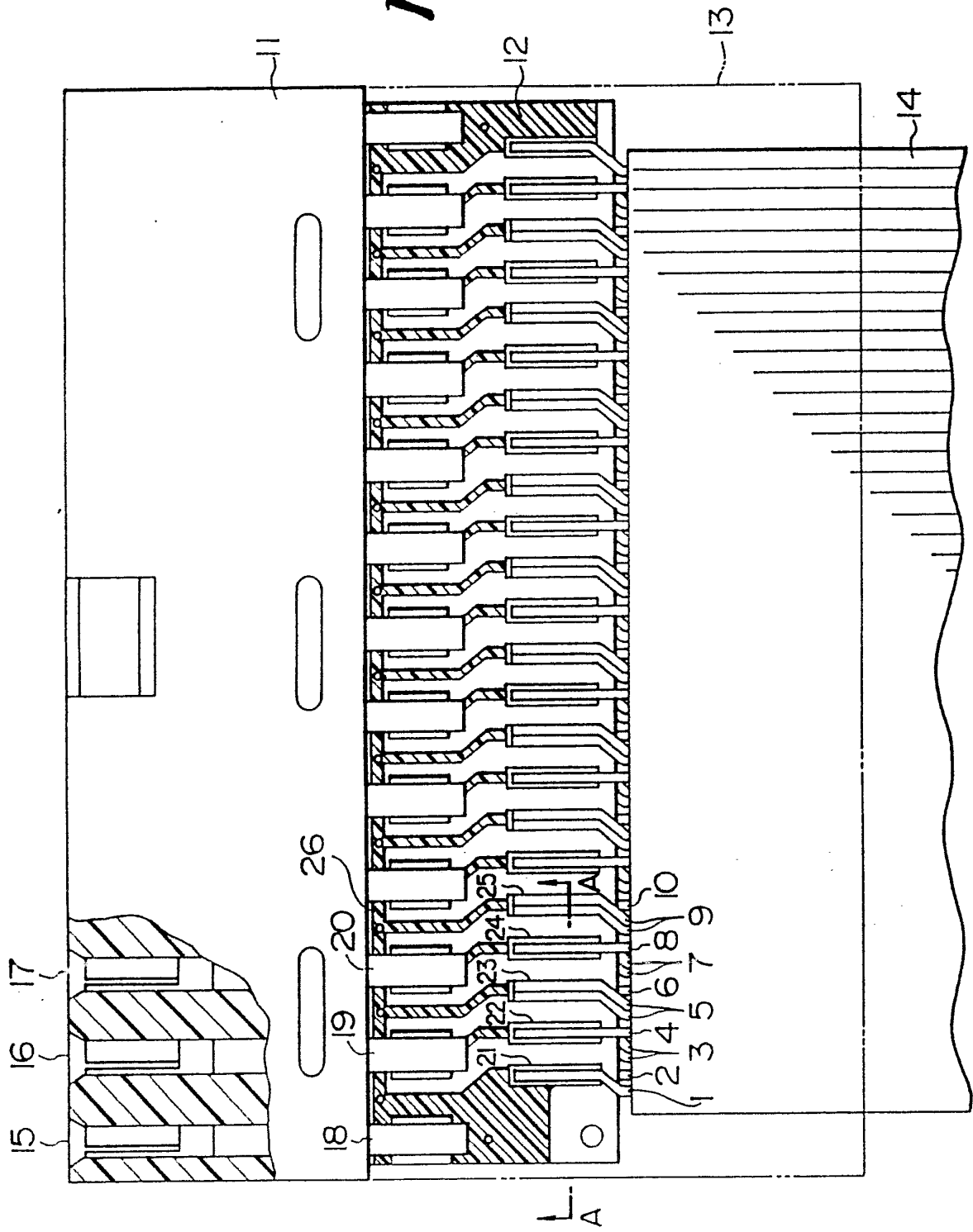
The present invention provides a connector for high-speed signal transmission cables having a very simple structure and decreased cross-talk noises.

In the present invention, since distances between adjacent signal pad portions on each surface of a substrate, namely between adjacent lead lines connected respectively to the signal pad portions are widened, any cross-talk between them is decreased. Further, each of the lead lines connected to the signal pad portions is surrounded along the longitudinal direction thereof by lead lines connected to the grounding pad portions.

Claims:

1. A connector for high-speed signal transmission cable comprising: an insulative substrate having first pad portions connected to signal connection terminals and second pad portions connected to grounding connection terminals, said first pad portions and said second pad portions being spaced and arranged alternately on each of two surfaces of said substrate so that the position of any of the first pad portions on one of said two surfaces of said substrate is substantially aligned with the position of one of said second pad portions on the other of said two surfaces of said substrate.
2. A connector for high-speed signal transmission cable according to Claim 1, further comprising: a cable portion having signal lead lines and grounding lead lines; and a common grounding plate disposed substantially at the end of said cable; said signal lead lines and said grounding lead lines being connected respectively to said first pad portions and said common grounding plate; said common grounding plate having an extension connected to said second pad portions.

Fig. 1



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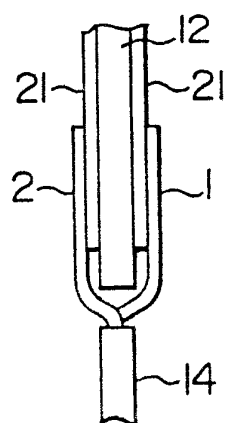
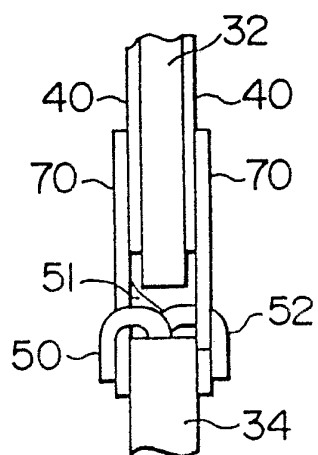
Fig. 2*Fig. 4*

Fig. 5

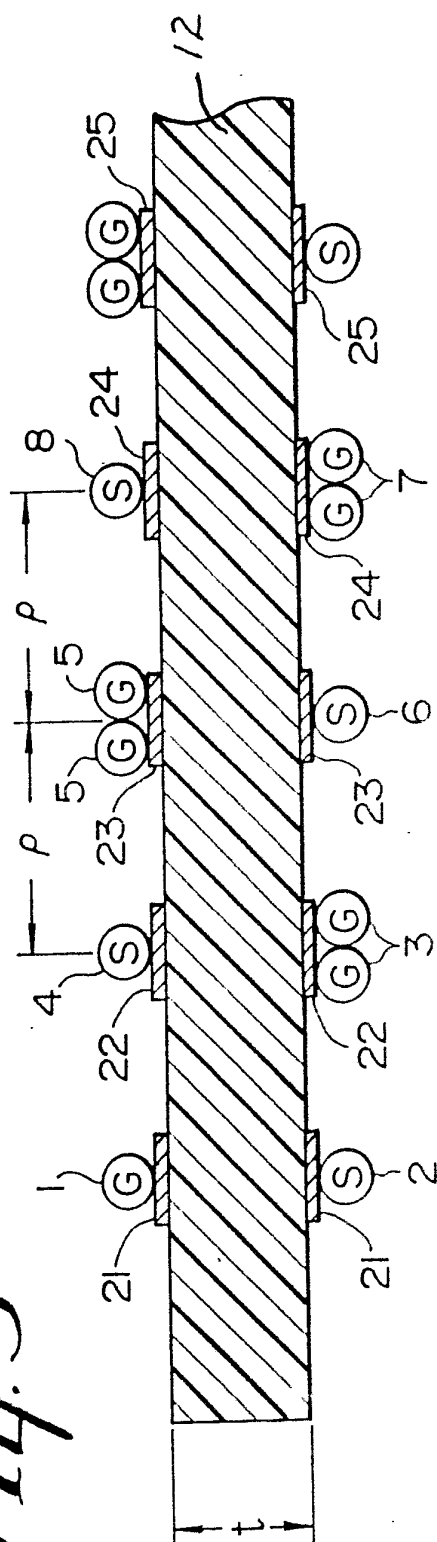


Fig. 6

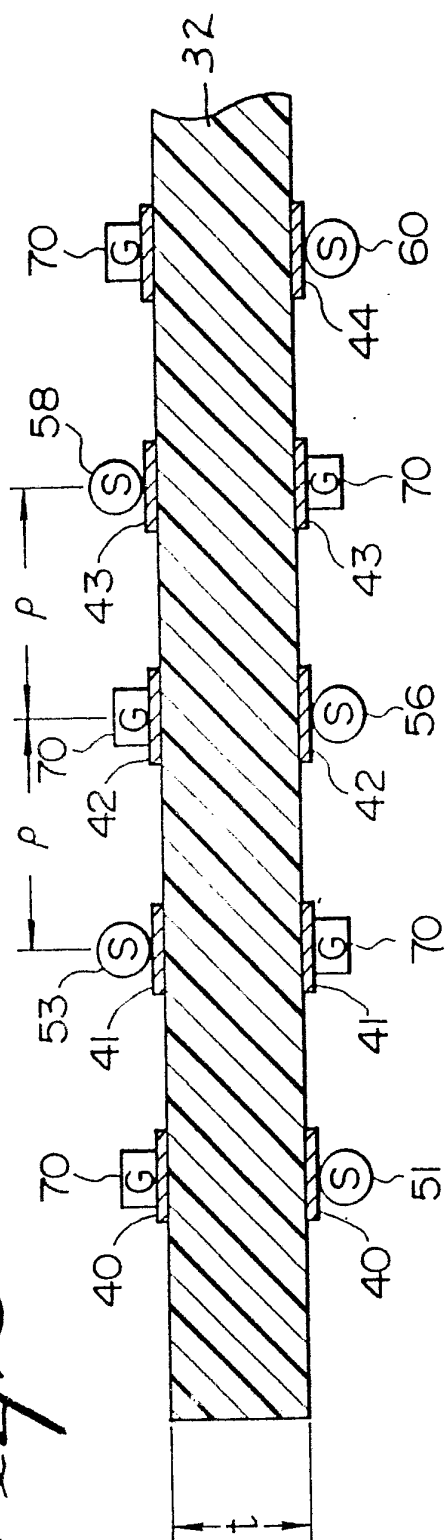


Fig. 7

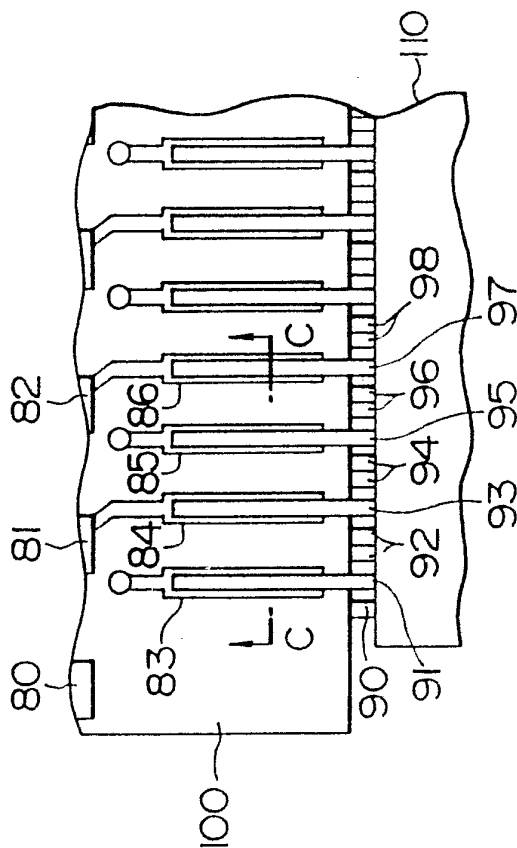
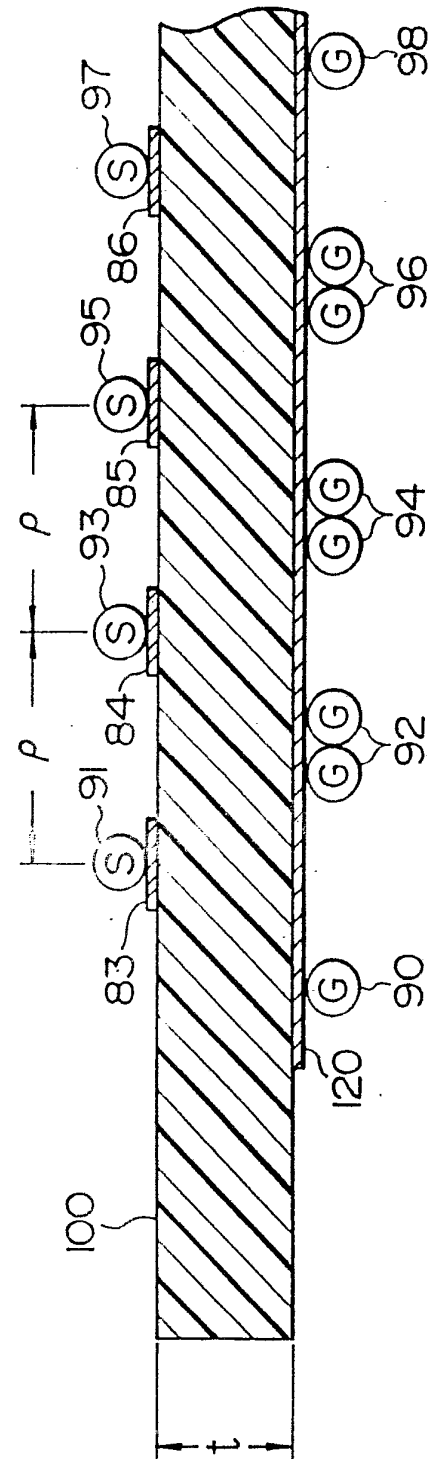
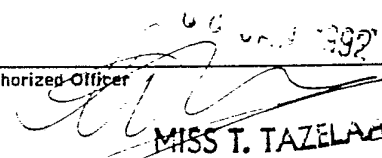
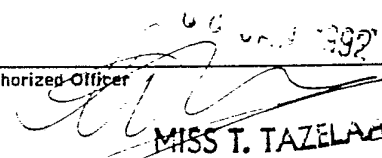
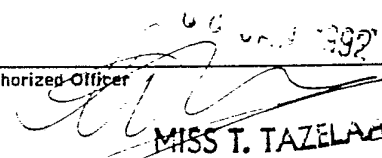


Fig. 8



INTERNATIONAL SEARCH REPORT

International Application No PCT/US 91/05931

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: H 01 R 9/07, 23/66														
II. FIELDS SEARCHED Minimum Documentation Searched⁷ <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <td style="width: 25%; padding: 5px;">Classification System</td> <td style="padding: 5px;">Classification Symbols</td> </tr> <tr> <td style="padding: 5px; height: 40px; vertical-align: bottom;">IPC5</td> <td style="padding: 5px; height: 40px; vertical-align: bottom;">H 01 R</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸			Classification System	Classification Symbols	IPC5	H 01 R								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <th style="width: 10%; padding: 5px;">Category *</th> <th style="width: 70%; padding: 5px;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 20%; padding: 5px;">Relevant to Claim No.¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">EP, A2, 0299487 (MINNESOTA MINING AND MANUFACTURING COMPANY) 18 January 1989, see column 1, line 24 - column 5, line 20 -- </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,2</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 4624515 (R.W. BRUSH JR ET AL) 25 November 1986, see column 2, line 60 - column 5, line 57 -- </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 4871319 (D.A. BABOW) 3 October 1989, see column 3, line 44 - column 4, line 34 -- </td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,2</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	Y	EP, A2, 0299487 (MINNESOTA MINING AND MANUFACTURING COMPANY) 18 January 1989, see column 1, line 24 - column 5, line 20 --	1,2	Y	US, A, 4624515 (R.W. BRUSH JR ET AL) 25 November 1986, see column 2, line 60 - column 5, line 57 --	1	Y	US, A, 4871319 (D.A. BABOW) 3 October 1989, see column 3, line 44 - column 4, line 34 --	1,2
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<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top; border: none;"> * Special categories of cited documents:¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 50%; vertical-align: top; border: none;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family </td> </tr> </table>			* Special categories of cited documents:¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family										
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IV. CERTIFICATION <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <td style="width: 50%; padding: 5px;"> Date of the Actual Completion of the International Search 20th December 1991 </td> <td style="width: 50%; padding: 5px;"> Date of Mailing of this International Search Report 66 DEC 1991 </td> </tr> <tr> <td style="padding: 5px;"> International Searching Authority EUROPEAN PATENT OFFICE </td> <td style="padding: 5px;"> Signature of Authorized Officer  MISS T. TAZELAAR </td> </tr> </table>			Date of the Actual Completion of the International Search 20th December 1991	Date of Mailing of this International Search Report 66 DEC 1991	International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer  MISS T. TAZELAAR								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	EP, A2, 0261905 (ELCO CORPORATION) 30 March 1988, see column 4, line 18 - line 53 --	2
A	US, A, 4602830 (J.L. LOCKARD) 29 July 1986, see abstract -- -----	1,2

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/US 91/05931**

SA 51613

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 31/10/91
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0299487	18/01/89	JP-A- 1031361	01/02/89
US-A- 4624515	25/11/86	NONE	
US-A- 4871319	03/10/89	JP-A- 2244570	28/09/90
EP-A2- 0261905	30/03/88	JP-A- 63080492 US-A- 4920642	11/04/88 01/05/90
US-A- 4602830	29/07/86	EP-A- 0195050 JP-T- 62500480 WO-A- 86/01946	24/09/86 26/02/87 27/03/86

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