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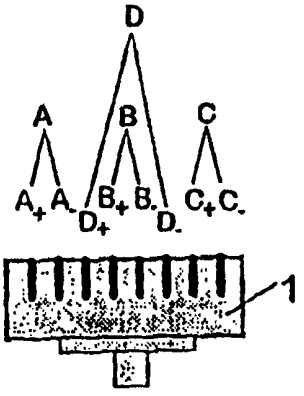
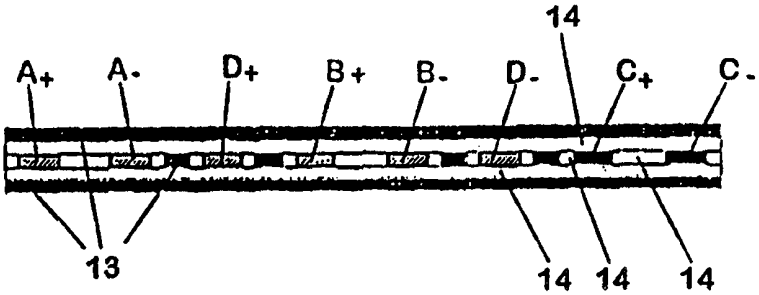
(54) Title: A METHOD OF REDUCING HIGH FREQUENCY COUPLING BETWEEN PAIRS OF CONDUCTORS IN A CONNECTOR, AND A CONNECTOR FOR TRANSFERRING DIFFERENTIAL SIGNALS

(57) Abstract

In order to reduce high frequency signal coupling between conductors in pairs in connectors (1, 2), said conductors consisting of connecting conductors in pairs (A_+, A_-; B_+, B_-; C_+, C_-; D_+, D_-), which are embedded in a dielectric (14), and contact springs, two layers are provided on the sides of the contact springs which are not to touch other contact springs, the first layer being a dielectric, the second layer being an electrically conductive shield (13). Furthermore, the dielectric, which surrounds the connecting conductors, is partially replaced by electrically conductive shields. A reduction in signal coupling between two sets of conductors in pairs may be obtained hereby.





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A method of reducing high frequency coupling between pairs of conductors in a connector, and a connector for transferring differential signals

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The invention relates to a method of reducing undesired high frequency signal coupling in a connector which is used for the transfer of balanced signals through several conductors in pairs, said connector having connecting conductors to connect contact springs and terminals, said pairs of connecting conductors being arranged in a dielectric.

Connectors of the above-mentioned type are usually used in the transmission of data at high rates. These connectors consist of terminals at one end which may be connected to a cable, a printed circuit board or the like. A connecting element extends from the terminals, consisting of a number of conductors in pairs which may be arranged in a dielectric. A plurality of contact springs corresponding to the plurality of connecting conductors is arranged at the opposite end of the conductors. The contact springs are intended to make contact with another connector. As the contact springs are usually very closely spaced, it is inevitable that a certain coupling occurs between the conductors in pairs, understood in the way that when data are transferred through the conductors, they will cause so-called crosstalk, which means that signals from one set of conductors may be recognized in reduced form in another set of conductors. Further, there will be a certain coupling between the conductors in the connecting element itself.

With the ever increasing miniaturization of connectors for use in the transfer of data, the distances between the conductors in the connectors get smaller, which means

that the coupling between the conductors in pairs gets even more pronounced.

The patent literature describes many different ways of eliminating crosstalk between pairs of electrical conductors in connectors of the above-mentioned type, and even though the prior art approaches have succeeded in providing a good reduction, further reduction of crosstalk is still needed.

Accordingly, an object of the invention is to provide a method and a connector by means of which the reduction of crosstalk between pairs of conductors in a connector is even stronger than the reduction obtainable by the prior art.

The object of the invention is achieved by a method of the type defined in the introductory portion of claim 1 which is characterized in that at least some of the pairs of contact springs are coated by a dielectric, and that the dielectric is coated with a shielding material.

Noise contributions from other pairs of the conductors in the connector will hereby be reduced optimally.

To enhance the effect of the reduction additionally, the method may be characterized in that all free surfaces of the contact springs are coated with 2 layers consisting of a layer of dielectric material on whose surfaces a layer of electrically shielding material is applied, as stated in claim 2.

To ensure the noise reduction between the pairs of conductors in the connector additionally, it is an advantage, as stated in claim 4, that an electrical shield is

provided on each side of a pair of connecting conductors in substitution for a portion of the dielectric.

The combination of shield/dielectric gives a better reduction of undesirable signal transfer between the pairs of conductors than if there is just a dielectric around the connecting conductors.

As mentioned, the invention also relates to a connector which, as stated in claim 5, may be of the male or female plug type for the transfer of differential signals through several conductors in pairs, said connector having connecting conductors to connect contact springs and terminals, said connecting conductors being arranged in a dielectric.

The connector is characterized in that a dielectric layer is provided on the upper side of at least some of the contact springs, and that an electrical shield is additionally provided on the upper side of the dielectric layer.

This provides a connector in which the crosstalk between the pairs of connectors may be reduced considerably even at very high rates.

To reduce crosstalk in the connector additionally, all the sides of the contact springs which do not make electrical contact with a connected connector may be coated with a dielectric, which is additionally coated with a conductive shield, as stated in claim 6.

As stated in claim 7, it is an advantage that electrical shields are provided in parts of the dielectric of the connecting conductors.

The combination of dielectric and electrically conductive shields gives a greater immunity between the pairs.

Particularly expediently, as stated in claim 8, the electrical conductors are embedded on each side of the dielectric of a pair of the connecting conductors.

It is ensured hereby that signals in a pair of signals are shielded very strongly from surrounding other pairs of signals, even when they are physically very close to each other.

Finally, as stated in claim 9, it is an advantage if the entire surface of the dielectrics positioned to the greatest extent possible around all the connecting conductors is coated with an electrically conductive shield.

This provides the maximum reduction in crosstalk between the pairs of electrical conductors and reduction in interference from external signals.

The invention will now be explained more fully with reference to an example shown in the drawing, in which

fig. 1 shows an ordinary plug connection in which two connectors are connected to their respective cables,

fig. 2 shows a typical structure of conductors in pairs in a connector, e.g. a connector as shown in fig. 1,

fig. 3 shows an equivalent circuit diagram of the electrical conditions in the reduction of crosstalk in a connector,

fig. 4 schematically shows the conductors whose crosstalk is preferably to be reduced most,

fig. 5 shows the connecting conductor constructed with the constructive features according to the invention,

fig. 6 in more detail shows another embodiment of the connecting conductor in cross-section constructed with the constructive features according to the invention,

fig. 7 shows the contact springs with the constructive features according to the invention, and

fig. 8 shows an alternative embodiment of the structure of the contact spring part.

Fig. 1 shows two connectors which are designated 1 and 2, respectively. These connectors 1, 2 each have a cable 3 connected at their ends, and contact springs are provided at their opposite ends for connection of the two connectors 1 and 2.

Fig. 2 shows a connector 1 having eight conductors which consist of four pairs of conductors. These pairs of conductors are used for transferring balanced differential signals. To facilitate the understanding of the invention, the two poles of the pair of conductors A are designated A_+ and A_- in fig. 2. Similarly, the other pairs of conductors are designated B_+, B_-, C_+, C_-, and D_+, D_-. It is noted that the pair of conductors D is spaced more from each other than the other pairs of conductors, as the pair of conductors B has poles which are positioned within the two poles of the pair of conductors D.

Fig. 3 shows an equivalent circuit diagram, with the measures which have been taken in order to reduce cross-talk between pairs of conductors.

In the figure, 6 designates an area which schematically shows how terminals, which may e.g. be terminals for connection to a printed circuit board, are interconnected by capacitors 9 with a view to reducing crosstalk between the individual conductors in the terminal area. This is shown by a technique known per se, which will therefore not be explained more fully here.

7 designates an area which illustrates reduction of crosstalk in the connecting conductor area of a connector. By way of example, it is schematically shown at 10, 11 and 12 how reduction of crosstalk between pairs of conductors in the area 7 is provided, as 10, 11 and 12 symbolize the constructive features according to the invention for reducing crosstalk in the area 7.

Fig. 3 additionally shows an area 8 which illustrates how reduction of crosstalk between the individual conductors in a connector in the contact spring area is provided, here shown schematically by the reference numeral 13.

Fig. 4 shows the structure of pairs of connectors in a connector as shown in figs. 1 and 2. These pairs of connectors are intended to transfer data at high rates. The rates are not necessarily the same for all the pairs of conductors.

Fig. 5 shows the connecting conductors which are embedded in a dielectric designated 14. As will additionally be seen in fig. 4, 13 designates electrical shields which, as shown in the figure, are arranged between the pairs of conductors as well as on the upper side and the lower side of the dielectric positioned above and below the conductors. This results in a strong shielding in the connecting conductor area by means of common earth between the conductors in pairs.

In fig. 6, 15 designates a dielectric in a connecting conductor area in a connector. As will be seen, the pairs of conductors A_+, A_-..., D_+, D_- recur in this figure. The dielectric 15 is divided and defined by several metallized surfaces, shown at the reference numeral 18. Additionally, a co-extensive metal foil 16 is provided on the outer side of the surface 18, and may also be provided on the lower side, but not shown in fig. 6. The subareas of the divided dielectric are shown in fig. 6 at the reference numerals 15A, 15B, 15C, 15D and 15E. As will be seen, the pair of conductors A_+, A is defined by a metallized subarea 15A, except at the small areas shown at 21 and 22, which are necessary to avoid short-circuits between the metallized surfaces 15B, etc., of the respective areas, since short-circuits may cause an increase in crosstalk. As will additionally be seen, a conductor or a pair of conductors is arranged in each of the areas 15A, 15B, 15C, 15D and 15E, and this conductor or pair of conductors is protected against mutual interference in the form of crosstalk because of the provision of the metallized surfaces. In other words, the crosstalk between e.g. the pair of conductors B_+, B_- and D_- or D_+ is reduced.

Fig. 7 schematically shows how the pairs of conductors in the contact spring area are shielded. This takes place by coating one side of the conductor with a dielectric 14 on whose surface a conductor material 13 has additionally been applied.

The opposite end of the connector is used for making contact with a conductor in another connector.

Fig. 8 shows an alternative embodiment for the implementation of the principles of the invention according to

fig. 7, the difference with respect to the embodiment in fig. 7 being that also a shield 13 is arranged on the sides of the dielectric which adjoins the conductors A-D.

Although the principles of the invention have been explained in connection with a connector having four pairs of conductors, nothing, of course, prevents the principles of the invention from being used in connection with other types of conductors where the conductors may be positioned in another manner than shown in the figures. For example, the conductors may be staggered with respect to each other, and moreover connectors having pairs of conductors formed by more than four conductors are conceivable.

Patent Claims:

1. A method of reducing undesirable high frequency signal coupling in a connector (1, 2) which is used for the transfer of balanced signals through several conductors in pairs (A_+, A_-; B_+, B_-; C_+, C_-; D_+, D_-), said connector having connecting conductors to connect contact springs and terminals, said pairs of connecting conductors being arranged in a dielectric (14), characterized in that at least some of the contact spring parts of the pairs are coated with a dielectric (14), and that the dielectric is coated with an electrically shielding material (13).

2. A method according to claim 1, characterized in that all free surfaces of the contact springs are coated with 2 layers consisting of a layer of dielectric material (14) on whose surfaces a layer of electrically shielding material is applied.

3. A method according to claim 1 or 2, characterized in that at least parts of the dielectric in some of the pairs in the connecting conductors are replaced by an electrical shield (13) which is incorporated as common earth.

4. A method according to claim 3, characterized in that an electrical shield is provided on each side of a pair of connecting conductors in substitution for dielectric.

5. A connector (1, 2) of the male or female plug type for the transfer of differential signals through several conductors in pairs (A_+, A_-; B_+, B_-; C_+, C_-; D_+, D_-), said connector having connecting conductors to connect contact

springs and terminals, sad connecting conductors being arranged in a dielectric, c h a r a c t e r i z e d in that a dielectric layer (14) is provided on the upper side of at least some of the contact springs, and that an electrical shield (13) is additionally provided on the upper side of the dielectric layer.

6. A connector according to claim 5, c h a r a c t e r - i z e d in that all the sides of the contact springs which do not make electrical contact with a connected connector are coated with a dielectric, which is additionally coated with an electrically conductive shield.

7. A connector according to claim 5, c h a r a c t e r - i z e d in that electrical shields are provided in parts of the dielectric of the connecting conductors.

8. A connector according to claim 7, c h a r a c t e r - i z e d in that the electrical shields are embedded on each side of the dielectric of a pair of the connecting conductors.

9. A connector according to any one of claims 5-8, c h a r a c t e r i z e d in that the entire surface of the dielectrics positioned above and below all the connecting conductors is coated with an electrically conductive shield.

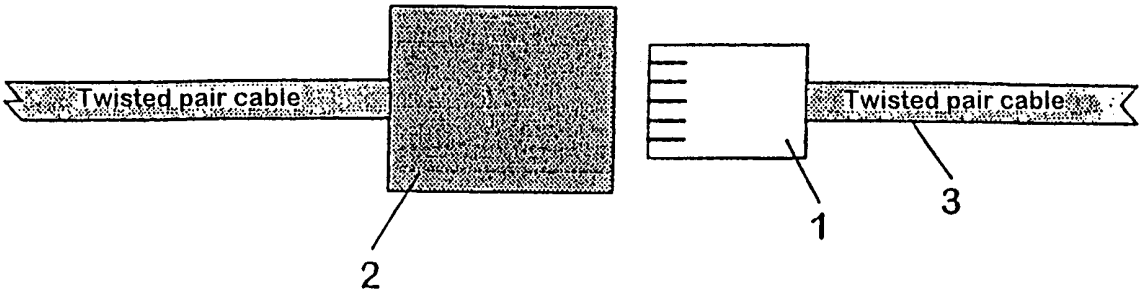

FIG. 1

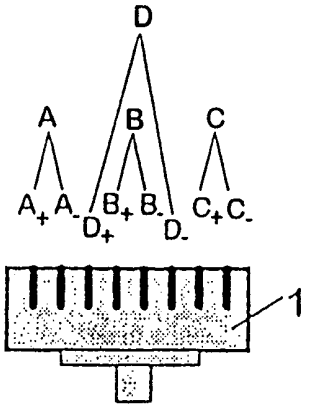

FIG. 2

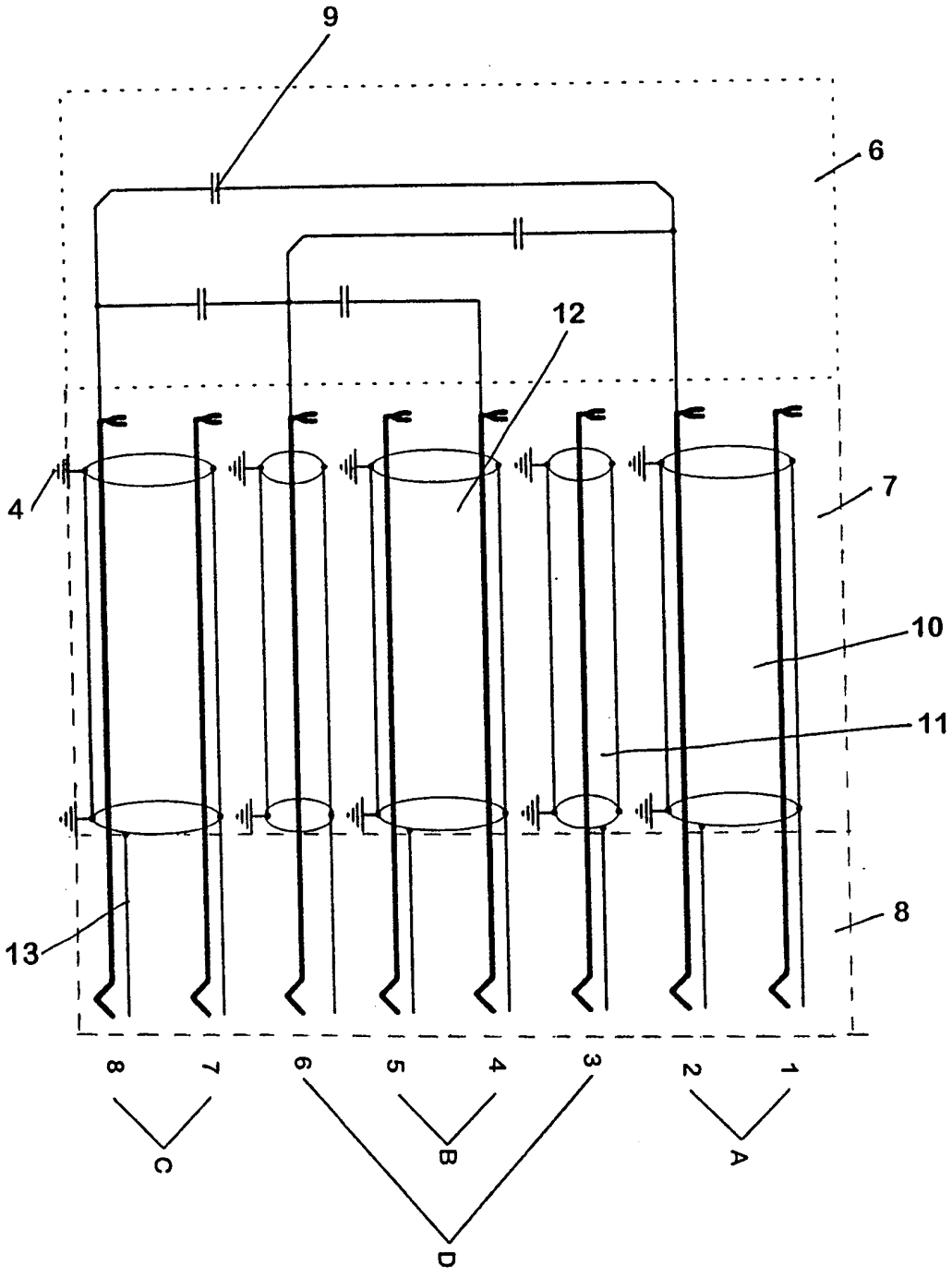

FIG. 3

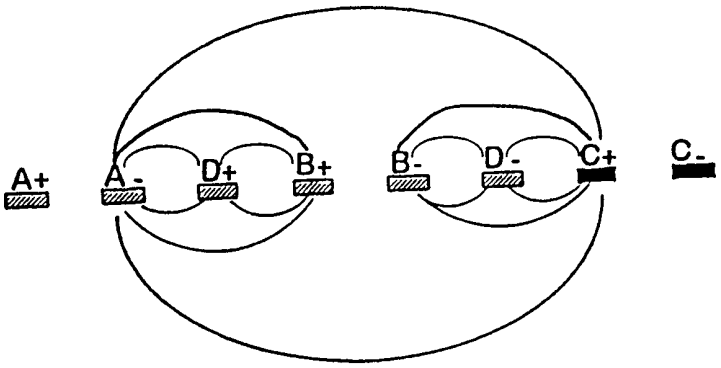

FIG. 4

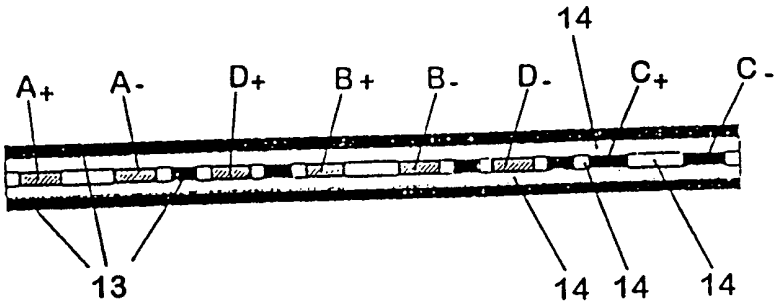

FIG. 5

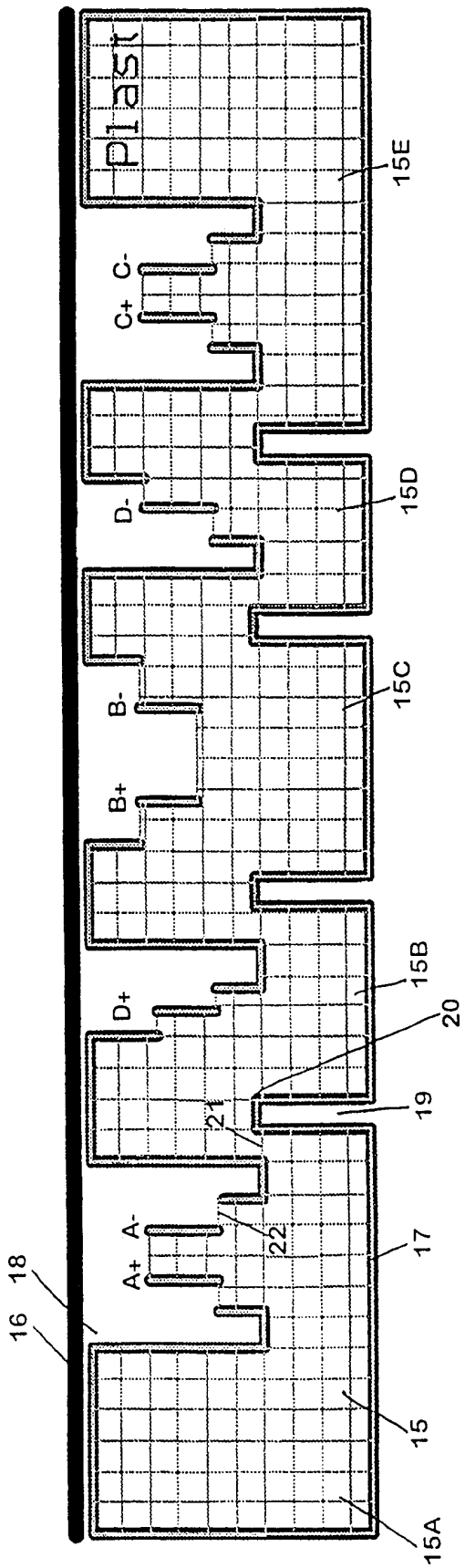

FIG. 6

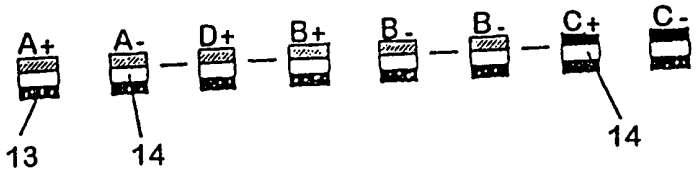

FIG. 7

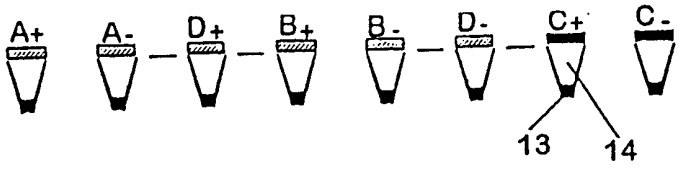

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 98/00528

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01R 13/658, H01R 23/68 // H01R 23/00, H01R 17/12
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5345105 A (S.-W. SUN ET AL), 6 Sept 1994 (06.09.94), column 1, line 61 - column 2, line 35; column 4, line 57 - column 5, line 59; column 6, line 47 - line 50, figures 7,9, abstract --	1-9
Y	US 5186647 A (W.J. DENKMANN ET AL), 16 February 1993 (16.02.93), column 2, line 5 - line 40, figure 2 --	1-9
Y	US 5628647 A (B. ROHRBAUGH ET AL), 13 May 1997 (13.05.97), column 2, line 8 - column 3, line 21, figures, abstract --	1-9

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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PCT/DK 98/00528

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5296651 A (F.E. GURRIE ET AL), 22 March 1994 (22.03.94), column 3, line 11 - line 60, figure 2a, abstract --	1-9
A	US 5094623 A (R.M. SCHARF ET AL), 10 March 1992 (10.03.92), column 3, line 52 - column 4, line 33, figure 4, abstract --	1-9
A	WO 8605311 A1 (AMP INCORPORATED), 12 Sept 1986 (12.09.86), page 3, line 5 - line 21, claim 1, abstract --	1-9
A	US 5470244 A (G. LIM ET AL), 28 November 1995 (28.11.95), column 1, line 50 - column 2, line 2, figures, abstract -- --------	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/02/99

International application No.
PCT/DK 98/00528

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5345105 A	06/09/94	US 5262353 A	16/11/93
US 5186647 A	16/02/93	AU 651028 B	07/07/94
		AU 3296093 A	02/09/93
		CA 2085270 A,C	25/08/93
		DE 69306012 D,T	13/03/97
		EP 0558225 A,B	01/09/93
		SE 0558225 T3	
		HK 42597 A	11/04/97
		JP 6084562 A	25/03/94
		KR 9701947 B	19/02/97
		SG 43175 A	17/10/97
US 5628647 A	13/05/97	CA 2211197 A	29/08/96
		CN 1176024 A	11/03/98
		EP 0811258 A	10/12/97
		JP 10506751 T	30/06/98
		WO 9626556 A	29/08/96
US 5296651 A	22/03/94	JP 6243729 A	02/09/94
US 5094623 A	10/03/92	CA 2065195 A,C	31/10/92
WO 8605311 A1	12/09/86	EP 0214276 A,B	18/03/87
		US 4680423 A	14/07/87
		US 4642480 A	10/02/87
		US 4663098 A	05/05/87
		US 4628599 A	16/12/86
		US 4738027 A	19/04/88
		US 4640569 A	03/02/87
US 5470244 A	28/11/95	CA 2133635 A	06/04/95
		EP 0649194 A	19/04/95
		JP 7201394 A	04/08/95
		SG 48308 A	17/04/98
		US 5454738 A	03/10/95