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[Continued on next page]

(54) **Title**: SHIELDED ELECTRODE CONNECTOR

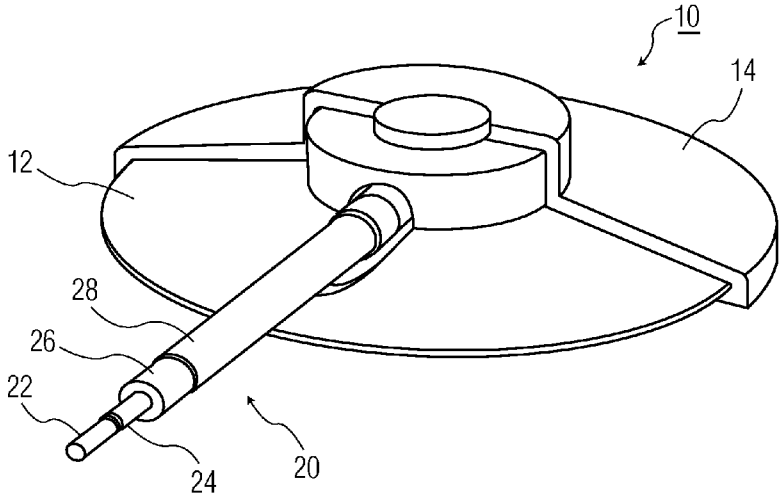

FIG. 2

(57) **Abstract**: An ECG lead set is described which is shielded against electrostatic charge hazards. An electrical shield (12) is located at the end of each lead (20) of the lead set and electrically shields the connection (30) of the lead set to an ECG electrode (33). The electrical shield is covered by a nonconductive cover (14) and is electrically connected to the shield of the coaxial cable (26) of the lead set.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

SHIELDED ELECTRODE CONNECTOR

This invention relates to medical electrodes for sensing electrical signals from the body and, in particular, to connectors for medical electrodes which are shielded against electrostatic interference.

Medical electrodes can be used for sensing various electrical signal present in the body such as those produced by the heart (electrocardiography) and brain (electro-encephalography). Such bodily signals are very low in intensity and are thus subject to electrical interference from various sources. One such source is electrostatic energy developed by clothing, bedding and from caregivers. A patient's clothing such as sweaters and fleece vests and jackets can generate electrostatic charge. Likewise, electrostatic charge can be generated by blankets and other bedding. A caregiver's body can develop an electrostatic potential which is much greater than that of a patient under the care of the caregiver, resulting in interference as the caregiver approaches the patient. It would therefore be desirable to protect body sensor electrodes from capacitively coupled electronic interference from nearby people and objects of a different electrical potential.

In accordance with the principles of the present invention, a body electrode is provided which is shielded against electrostatic charge hazards. The electrode attaches to the body and is used to sense electrical signals which are processed by a medical instrument such as an electrocardiograph. The electrode is connected to the medical instrument by a lead conductor which is disconnectably coupled to the electrode. An electrical shield is located at the

end of the lead conductor which acts to shield the electrical connection when the lead conductor is coupled to the electrode.

In the drawings:

FIGURE 1 is a plan view of an electrode lead set with electrostatic shields located at the connector ends of the leads.

FIGURE 2 illustrates in cutaway perspective a view of the top of a shielded lead connector constructed in accordance with the principles of the present invention.

FIGURE 3 illustrates in cutaway perspective a view from below the shielded lead connector of FIGURE 2.

FIGURE 4 is a cross-sectional view of the shielded lead connector of FIGURES 2 and 3 located above a mating body electrode.

Referring first to FIGURE 1, a plan view of a five electrode lead set constructed in accordance with the principles of the present invention is illustrated. The illustrated lead set includes five leads 20 with shielded and insulated conductors which couple electrical signals from the body to a medical instrument such as an electrocardiograph (ECG), ECG monitor or defibrillator/monitor. The leads 20 are attached to a connection block 52 where the conductors are electrically attached to a connector block 54. Colored dots 56 on the connection block 52 identify the individual leads for the user. The connector block 54 mates with a trunk cable by which the electrical signals sensed from the body are coupled to the medical instrument.

Located at the distal ends of the leads 20 are shielded connectors which are not visible in this top plan view. Strain reliefs 18 support and strengthen

the leads where they are connected to electrode connectors at their distal ends. Located above and extending outward from the central electrode connectors at the end of each lead is a shield 12 contained within a nonconductive dielectric covering 14. The circular dashed line indicated by reference numeral 12 indicates the outer periphery of the electrostatic shield within its dielectric covering. Located at the center of the shielded electrode connectors are labels 50 which identify the locations on the body where each lead is to be connected to an electrode.

FIGURE 2 is a perspective view from above a shielded electrode connector 10 of the present invention at the end of a lead 20. The lead 20 is a coaxial cable consisting of a central signal conductor 22 surrounded by insulation 24. Around the insulated signal conductor is an outer electrical shield 26. The outer shield 26 can be formed of braided wire, a foil wrap, or wound stranded wire. Generally the outer shield will include a drain wire for attachment to electrical elements of the connector which are to be at the electrical potential of the outer electrical shield 26, generally a reference potential. The coaxial lead 20 extends to the center of the connector 10 through an electrically insulated electrode shield 12. In this embodiment the shield 12 covers the dome-shaped center of the connector where the signal conductor is electrically connected to a female snap connector 30a, shown in FIGURE 3. The outer shield 26 is electrically connected to the electrode shield 12. The illustrated shield 12 radiates outwardly from the center as a slightly concave disk. The shield 12 is insulated by a nonconductive dielectric cover 14.

The cover 14 can be molded around the shield or sandwiched between an upper and a lower dielectric sheet which wraps around or is sealed beyond the periphery of the shield disk 12. In this embodiment the cover 14 is made of a thermoplastic elastomer. The shield 12 can be formed of a foil sheet or conductive paint or other highly conductive material. In this embodiment the shield 12 is formed of a conductive cloth with a conductivity of 1.0 Ohm-cm or less.

FIGURE 3 is a partially cutaway perspective view of the shielded electrode connector 10 of FIGURE 2 from below the connector. This view shows the female snap connector 30a which mates with a male snap connector 30b of an electrode. The shield 12 is seen encapsulated in its dielectric cover 12 which radiates out from the center of the connector 10.

FIGURE 4 is a cross-sectional view of the shielded electrode connector 10 of FIGURES 2 and 3, positioned over a patient electrode 33 to which it connects. In this embodiment the electrical connection of the conductor 22 to the female snap connector 30a is contained within a plastic insulator sleeve 18, which may not be necessary in some embodiments. The outer shield 26 of the coaxial cable 20 is electrically connected to the electrode shield 12 by a copper crimp ring 16. The dome-shaped space in the center of the connector 10 may be made rigid by a hard plastic ring or cap which surrounds the space where the snap connector 30a is located.

The female snap connector 30a attaches to a male snap connector 30b of the patient electrode 33. In this illustration the electrode 33 is a standard ECG electrode part number M2202A, available from Philips Medical Systems of Andover, MA. The ECG electrode 33

is formed of a disk-shaped plastic film substrate 32. Located on the patient-facing side of the substrate 32 is a central contact electrode 34 made of a gel-soaked foam pad which is electrically conductive. The contact electrode is electrically connected to the male snap connector 30b which is made of a conductive plastic so as to be radiographically transparent. A thin layer of contact adhesive 36 coats the substrate 32 around the contact electrode 34.

In use, when the electrode connector 10 is snapped onto the ECG electrode 33 it can be seen that the electrostatic shield 12 overlays and covers the connection 30a,30b and the contact electrode 34 of the ECG electrode. The shield 12 thus fully shields the connection and the ECG electrode from external electrostatic hazards. Consequently the ECG signals are more noise-free by reason of this shielding.

The dielectric cover 14 insulates the shield 12 and the electrode connection from other external electrical hazards which may arise, such as contact with a defibrillator paddle applied to the patient. For this purpose the cover 14 presents a dielectric strength between the shield 12 and any external conductor of at least 2000 volts DC, and more preferably 5000 volts DC, and most preferably 9000 DC or 6.5K volts AC at 3kHz.

While the embodiment shown in the drawings is seen to extend the shield out to almost the outer periphery of the patient electrode 33, it will be appreciated that greater or lesser degrees of shielding may be desired in particular applications. For example, a shield which only covers the central area of the electrode, such as the extent of the horizontal section of the shield 12 in FIGURE 4, may

provide a sufficient amount of shielding for some requirements. The extension of the shield 12 out beyond the central connection area as shown in FIGURE 4, beyond the radius of the connection region 30a-30b and the contact electrode 34, will provide an even greater degree of shielding which will be sufficient for many applications.

While the illustrated embodiment shows a snap connector, it will be appreciated that other connectors may alternatively be employed such as a clip-on connector which clips onto a conductive tab on the patient electrode. Other adaptations may be employed to make it easier for the user to see the connection site as the connection is being made, such as to make the radiating insulated shield very flexible so that it can be folded back as connection is being made, or allowing it to slide up the lead 20 as connection is being made.

WHAT IS CLAIMED IS:

1. A shielded connector for a body electrode comprising:

a lead having a shielded signal conductor;

a connector electrically attached to the signal conductor for attachment to a body electrode; and

a conductive electrical shield located above the connector when the connector is attached to the body electrode, the electrical shield being covered by a nonconductive cover and electrically connected to the shielding of the signal conductor.

2. The shielded connector of Claim 1, wherein the shielded signal conductor further comprises a coaxial cable having a central signal conductor and an outer shielding conductor,

wherein the conductive electrical shield is electrically connected to the outer shielding conductor.

3. The shielded connector of Claim 2, wherein the connector further comprises a snap connector.

4. The shielded connector of Claim 2, wherein the connector further comprises a clip-on connector.

5. The shielded connector of Claim 2, wherein the body electrode further comprises an ECG electrode.

6. The shielded connector of Claim 2, wherein the body electrode further comprises an electro-encephalographic electrode.

7. The shielded connector of Claim 1, wherein the nonconductive cover presents a dielectric strength to an external conductor of at least 2000 volts DC.

8. The shielded connector of Claim 1, wherein the nonconductive cover presents a dielectric strength to an external conductor of at least 5000 volts DC.

9. The shielded connector of Claim 1, wherein the body electrode includes a patient-contacting area which conducts received signals to the signal conductor,

wherein the conductive electrical shield is located above the patient-contacting area.

10. The shielded connector of Claim 9, wherein the conductive electrical shield comprises a disk-shaped shield having an outer periphery extending to a position between the periphery of the patient-contact area and the outer periphery of the body electrode when the connector is attached to the body electrode.

11. The shielded connector of Claim 1, wherein the body electrode includes a mating connector which connects to the connector which is attached to the signal conductor,

wherein the conductive electrical shield is located above the connection of the mating connector and the connector which is attached to the signal conductor.

12. The shielded connector of Claim 11, wherein

the conductive electrical shield comprises a disk-shaped shield having an outer periphery extending to a position between the outer periphery of the connection of the mating connector and the connector, and the outer periphery of the body electrode when the connector is attached to the body electrode.

13. The shielded connector of Claim 1, wherein the covered electrical shield extends outward and downward from the connector when the connector is attached to the body electrode.

14. The shielded connector of Claim 1, wherein the conductive electrical shield comprises one of a conductive paint, a foil, or a conductive cloth.

15. The shielded connector of Claim 14, wherein the conductive electrical shield exhibits a conductivity of 1.0 Ohm-cm or less.

16. A shielded ECG lead set comprising:

a plurality of leads, each having an insulated coaxial cable;

a snap connector electrically connected to the signal conductor of the coaxial cable; and

an electrostatic shield, extending over and outward from the snap connector, the electrostatic shield being covered by a nonconductive cover and the electrostatic shield being electrically connected to the outer shielding of the coaxial cable.

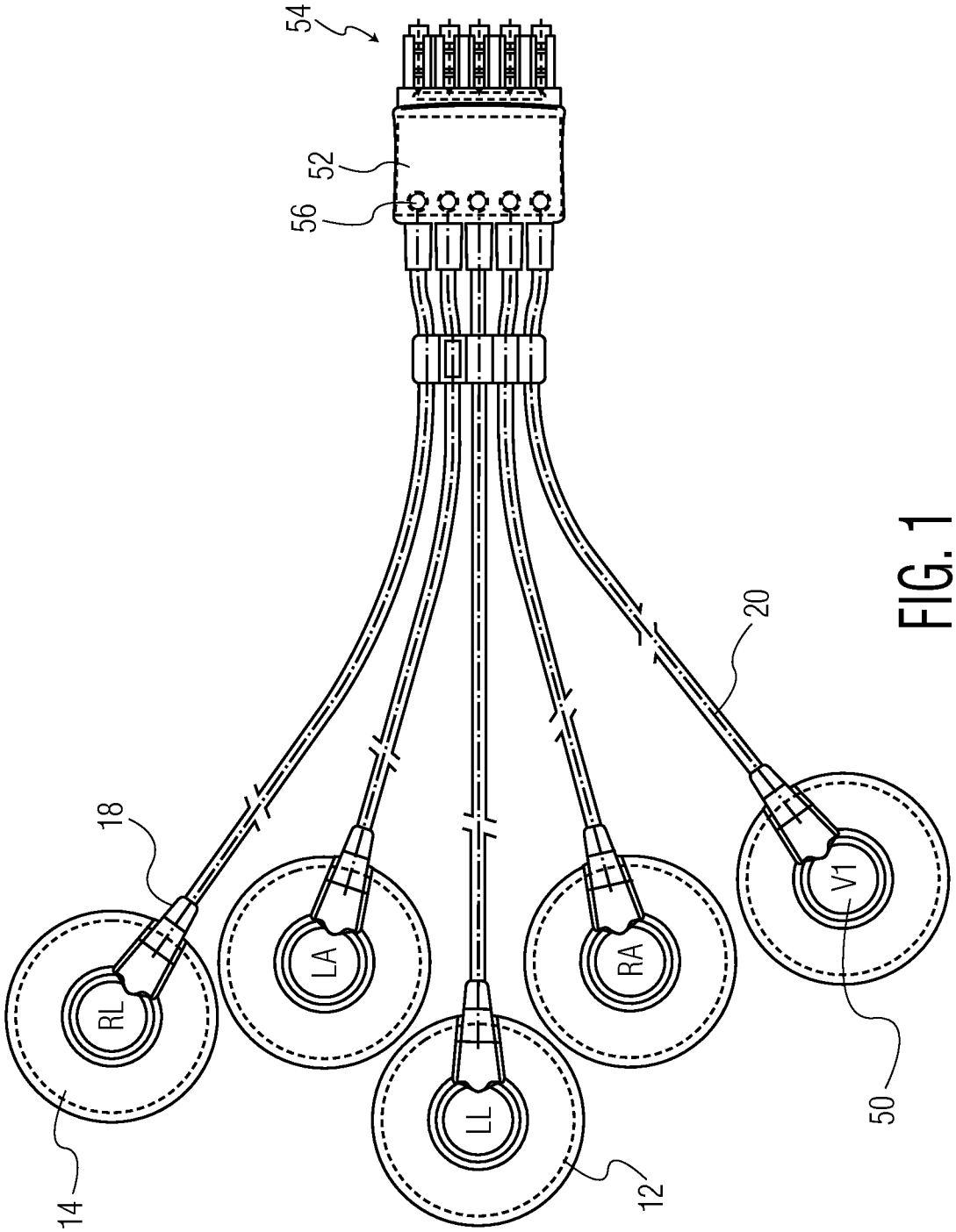

FIG. 1

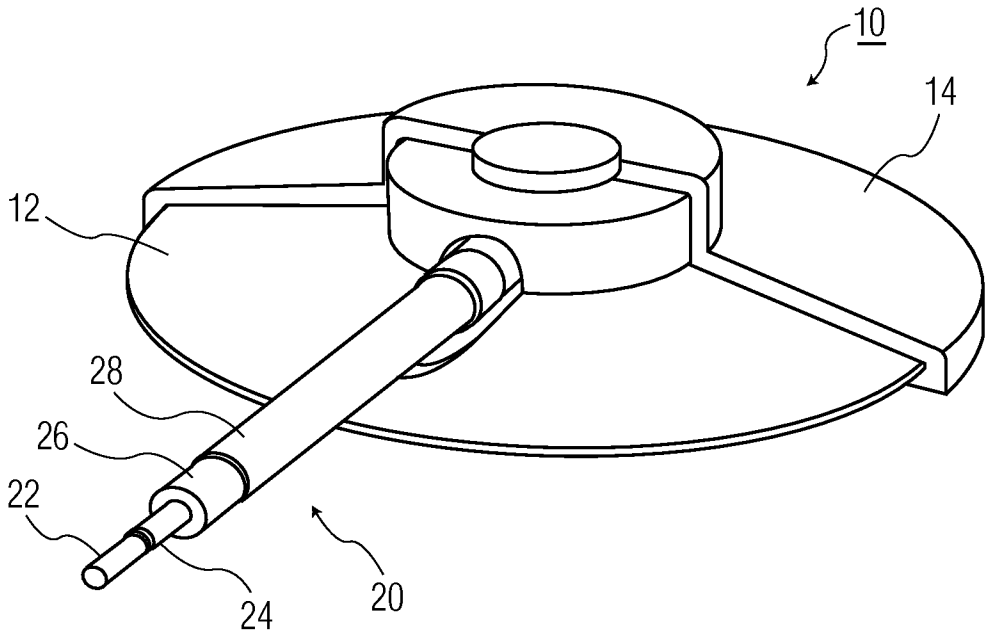

FIG. 2

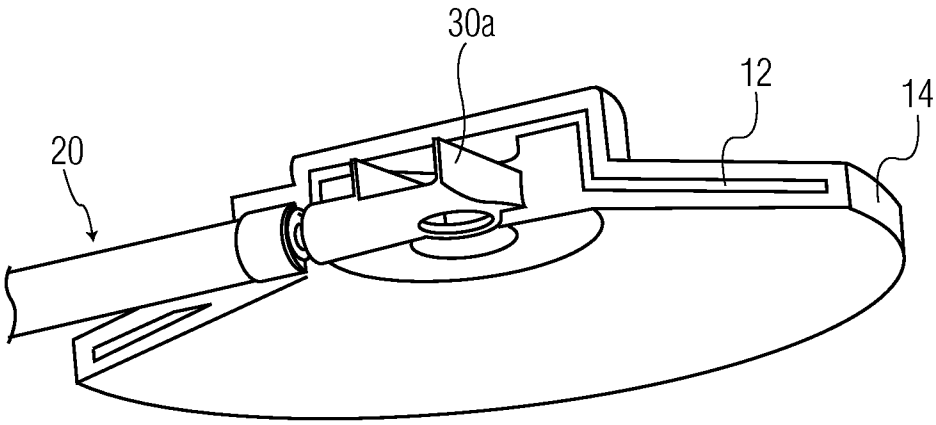

FIG. 3

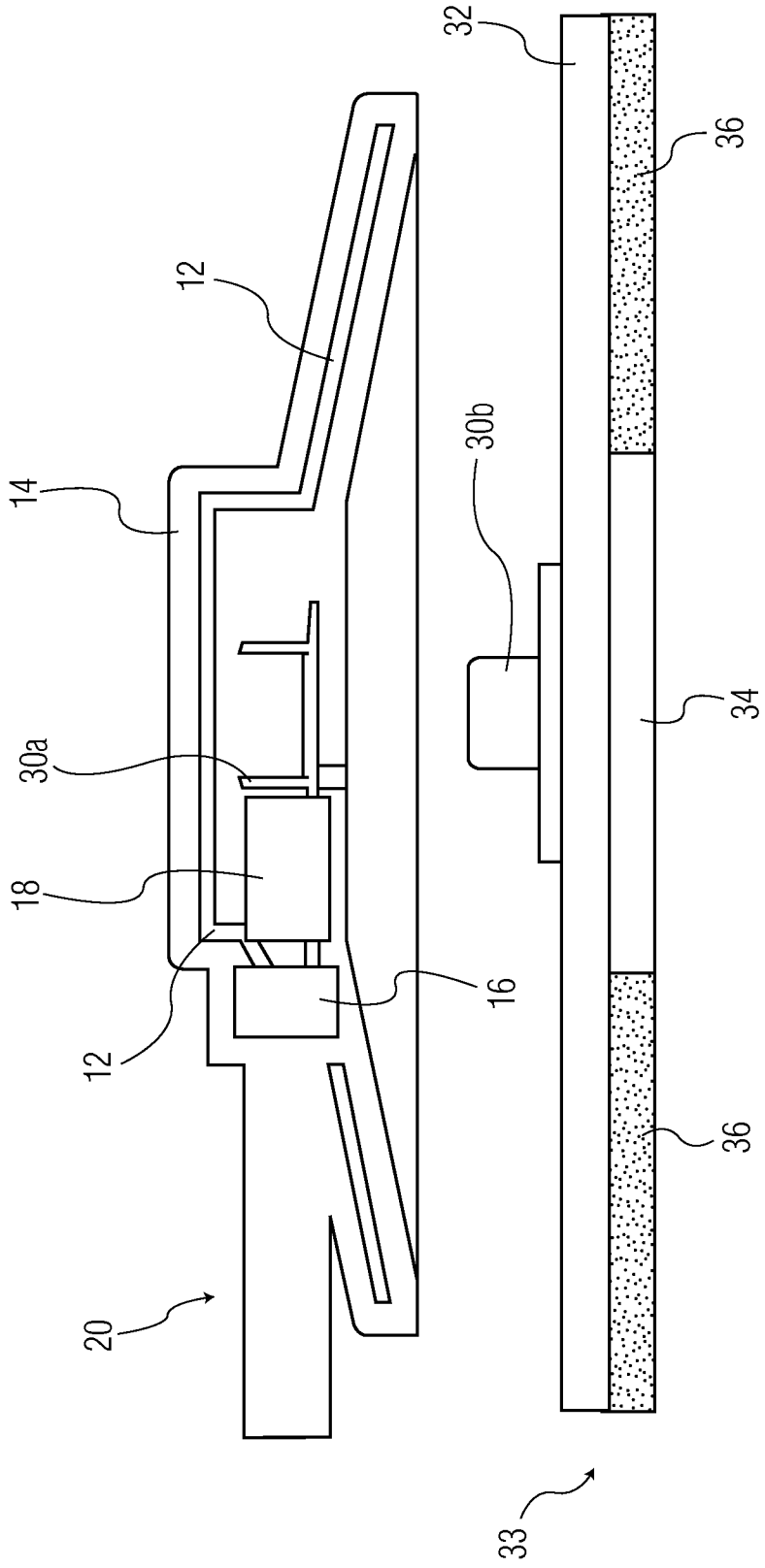

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/050352

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/0408 A61B5/0416 A61B5/0478

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B A61N

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 4 890 630 A (KROLL MARK W [US] ET AL) 2 January 1990 (1990-01-02) column 1, line 5 - line 34; figures 1,4 column 2, line 9 - line 33	16
Y	US 4 067 342 A (BURTON CHARLES V) 10 January 1978 (1978-01-10) column 3, line 30 - line 36; figure 2	15
A	US 2002/019166 A1 (UBBY JOHAN [SE] ET AL) 14 February 2002 (2002-02-14) paragraph [0029] - paragraphs [0030], [0038]; figures 1D,2A,2B	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
3 June 2009	12/06/2009

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/050352

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 4 353 372 A (AYER GEORGE E) 12 October 1982 (1982-10-12) column 5, line 14 - line 53; figures 1,2,4	1,14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/050352

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