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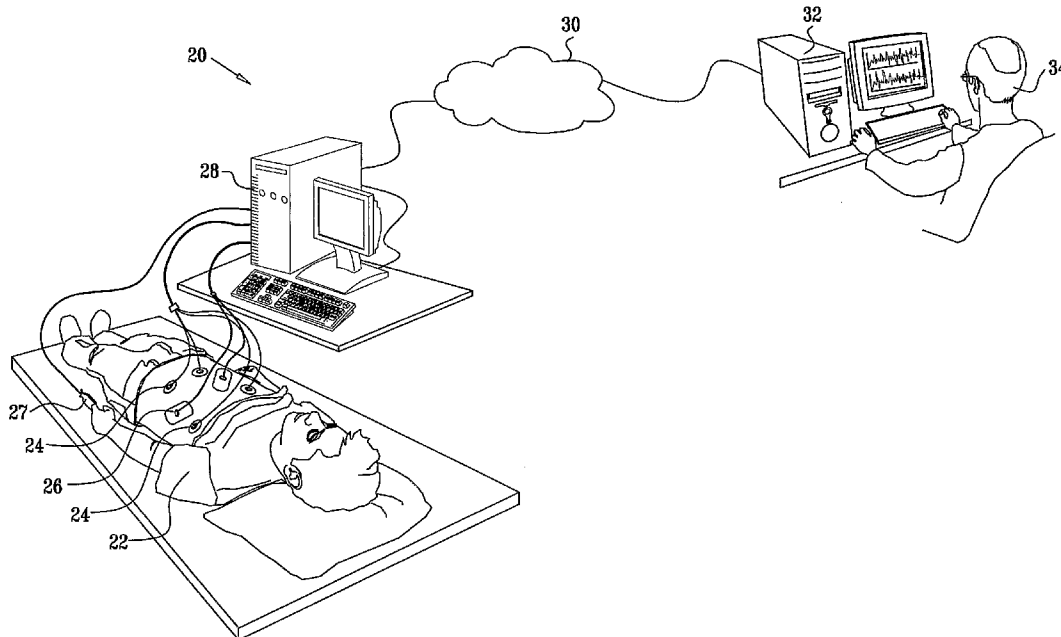
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Published:

— with international search report

[Continued on next page]

(54) Title: SLEEP STAGING BASED ON CARDIO-RESPIRATORY SIGNALS



(57) Abstract: A method for diagnosis of a sleep-related condition of a patient. The method includes receiving physiological signals from sensors (24, 26, 27) coupled to the lower body of the patient, and analyzing the physiological signals, independently of any electroencephalogram (EEG) or electro-oculogram (EOG) signals, in order to identify sleep stages of the patient.

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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*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(88) Date of publication of the international search report:

18 October 2007

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL05/01233

A. CLASSIFICATION OF SUBJECT MATTER

IPC: A61B 5/00(2006.01),5/02(2006.01),5/04(2006.01),5/08(2006.01)

USPC: 600/483,481,509,529,538,500,323

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)

U.S. : 600/483,481,509,529,538,500,323

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 practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,101,831 A (KOYAMA et al) 07 April 1992 (07.04.1992), abstract, figure 1, and column 3, line 11, to column 8, line 68.	1-37, 62-98, and 123
A	US 5,280,791 A (LAVIE) 25 January 1994 (25.01.1994), Abstract and figure 2.	1, 62, and 123



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL05/01233

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

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

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

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

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
 2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
 3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
 4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-37,62-98 and 123
- Remark on Protest**
- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
 - ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
 - ☐ No protest accompanied the payment of additional search fees.

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

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

Group 1, claim(s) 1-37, 62-98, and 123, drawn to a computer-implemented method and apparatus for diagnosis of a sleep-related condition of a patient, including analyzing the physiological signals, independently of any EEG or EOG signals, in order to identify sleep stages of the patient.

Group 2, claim(s) 38-42, 99-103, and 124, drawn to a computer-implemented method and apparatus for diagnosis of a sleep-related condition of a patient, including finding a respective characteristic of the energy in each of a plurality of time segments, and determining the patient to have moved during one or more of a time segments responsively to a respective characteristic.

Group 3, claim(s) 43-47, 104-108, and 125, drawn to a computer-implemented method and apparatus for diagnosis of a sleep-related condition of a patient, including computing a characteristic of the variability of the heart rate, and finding, responsively to the characteristic, a period during which the heart rate was decoupled from a respiratory function of the patient.

Group 4, claim(s) 48-56, 109-117, and 126, drawn to a computer-implemented method and apparatus for diagnosis of a sleep-related condition of a patient, including evaluating a complexity of the signal during a selected time period, and identifying a sleep stage of the patient responsively to the complexity.

Group 5, claim(s) 57-61, 118-122, and 127, drawn to a computer-implemented method and apparatus for diagnosis of a sleep-related condition of a patient, including identifying a periodic event, which comprises a sequence of the individual events that are separated by time gaps whose respective durations are within predetermined limits, and classifying a sleep stage of the patient responsively to the complexity.

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1.

The inventions listed as Groups 1-5 do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: each Group have distinct inventive features, as shown in the above grouping, which require separate searches in the art.