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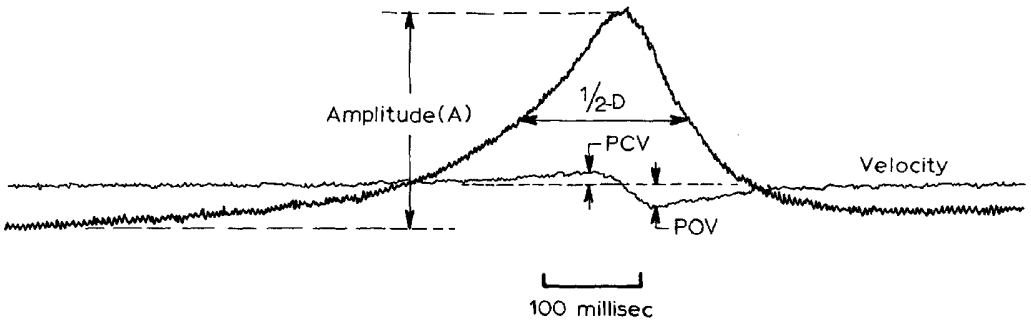
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ALERTNESS MONITOR



A/PCV = 14·6
1/2-D = 122 millisec

(57) Abstract: An alertness monitoring system uses reflectance measurement of infrared light pulses to monitor eye movement of a vehicle or machine operator. The data is used to measure eye and eyelid movement for presence slow or drifting eye movements, and/or eyelid closure and optionally one or more of, absence of saccadic movement, loss of eye co-ordination, wavering eyelids, partial eye closure, and drooping eyelids as indicators of loss of attention and drowsiness. The eye movements of a subject are analysed using reflected infra red light to obtain measures of the blink amplitude velocity ratio and the saccade amplitude velocity ratio. The readings are continuously compared with eye movement data indicative of degrees of alertness which correlate to blood alcohol content values so that the monitor provides an indication of the operator's legal fitness to operate the vehicle or machine from the point of view of drowsiness no matter how it is caused.

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ALERTNESS MONITOR

This invention relates to a method and device for testing alertness and the onset of drowsiness by monitoring eye and eyelid movement.

Background to the invention

The detection of drowsiness is of importance because drowsiness impairs the ability of operators of a wide range of equipment including motor vehicles, aircraft and boats as well as industrial equipment. The problem of drowsy driving cannot be solved by educating drivers to take remedial action when feeling drowsy. The difficulty is that many people are unaware of their drowsiness before and during the drowsiness even though they may be alert and aware after they rouse. This means one cannot predict when their level of drowsiness will next decrease to the point of danger because the drowsy state involves a loss of awareness of the present ; an involuntary lapse of attention.

USA patent 5745038 discloses an eye monitor that examines reflected light from the eye to detect blinking behavior as an indicator of drowsiness.

USA patent 5867587 discloses a system which utilises digital images of the face and eyes of an operator, derives a parameter attributable to an eye blink and compares this to a threshold value of that parameter. A warning signal is given if the parameter falls below the threshold.

Patent specification WO 98/49028 also uses a video image as an eye gaze monitor to view a range of eye movements and analyse and compute a degree of alertness.

USA patent 6091334 discloses a system for analysing drowsiness which monitors head movement and gaze stability.

USA patent 6102870 uses eye tracker data such as fixations and saccades to infer mental states of the operator such as scanning, reading, searching, thinking and an intention to select. It is a system to enhance computer software responsiveness.

USA patent 6097295 discloses a system of image analysis based on eye pupil size.

USA patent 6147612 discloses a system of preventing sleep which detects eyelid movement and actuates an alarm when the eyelid movement is indicative of drowsiness.

USA patent 6346887 uses a video based eye tracking system which tracks eye activity and pupil diameter and position to produce a signal representing eye activity that can be used to estimate alertness.

All of the above approaches fail to provide a real time alertness monitor that can provide a calibrated measure of the operator's alertness. It is an object of this invention to provide an alertness monitor that provides an objective and calibrated measure of the operator's fitness to operate a vehicle or machinery.

Brief description of the invention

To this end the present invention provides an alertness monitoring system which includes

a) means to measure eyelid and eye movement for presence of one or more of relatively slow eye and eyelid movements in relation to their amplitude, wavering eyelids, partial eye closure, drooping eyelids; slow or drifting eye movements, slow and prolonged eyelid closure, absence of saccadic movement and loss of eye co-ordination
b) storage means to continuously record the measurements
c) a data processor to compare the measurements against a pre determined scale, said scale being averaged measurements of the eye and eyelid movement parameters for a sample population measured against predetermined incremental blood alcohol levels
d) a display for showing the alertness measurement based on the scale or
e) an alarm means triggered by the scale reading reaching a predetermined legal limit based on the blood alcohol equivalent scale.

This invention is predicated on a realisation that changes in eye and eyelid movements are an early and reliable indication of drowsiness and alertness loss. More particularly this invention is predicated on the realization that the peak velocity of normal saccadic eye movements and of eyelid closure during blinks varies with the amplitude of those movements. It has been discovered that with drowsiness the velocities are lower for the same amplitude. The ratio of amplitude to peak velocity for blinks and saccades increases with the level of drowsiness. Because the dimension of this ratio is time neither the amplitude nor the velocity

needs to be measured in absolute terms so long as the measurements involve the same arbitrary scale. In the device of this invention it is volts.

This invention is also based on the realisation that blood alcohol levels have effects on eye movements that parallel the effects of drowsiness. That is drowsiness, loss of alertness and blood alcohol induce behavioural states that show the same patterns of eye and eyelid movements. In laboratory settings impairment in performance of many psychophysiological tests because of progressively longer sleep deprivation that causes increasing levels of drowsiness has been correlated with the equivalent effects that increasing blood alcohol concentrations have on the performance of those tests.

It is a benefit of this invention that the monitor can continuously record the operators alertness as being equivalent to that associated with a blood alcohol content. Many countries have legislated that it is illegal to drive a vehicle or have control of machinery etc with a blood alcohol level above specified values. Therefor this invention enables drowsy operators to be judged as if they were impaired by alcohol and provide a measure of legal fitness to operate a vehicle or machinery.

In another aspect of this invention there is provided An alertness measuring system for a subject which includes

a) an infrared pulse emitter adapted to be located adjacent at least one eye of a subject
b) at least one reflected light detector located adjacent said emitter
c) means to transmit the detector signals
d) data processing means to receive the detector signals and to subtract the total level of light immediately before each pulse is transmitted from the combined level of the measured reflectance during the pulse to provide a reflectance measure
e) said data processing means analyzing said reflectance measure to assess eyelid and eye movement for presence of one or more of relatively slow eye and eyelid movements in relation to their amplitude, wavering eyelids, partial eye closure, drooping eyelids; slow or drifting eye movements, slow and prolonged eyelid closure, absence of saccadic movement and loss of eye co-ordination.

It is preferred to use reflectance off both eyes as a means of measuring eye and eyelid movement. Infrared light sources and detectors may be mounted on the face, near the eyes, to measure the changes in light reflected back from each eye. One detector can be adjacent the emitter and one may be across the eye to best detect eyelid closure. These emitters and detectors can communicate with a computer based analysis and recording system by wire or wireless [radio frequency] connection.

The reflectance data may be analysed into several frequency domain or time domain ranges to obtain relative position and velocity data for each eye that can be analysed to show presence of relatively slow eye and eyelid movement, eyelid closure, impairment of binocular co-ordination of the eyes and prolonged ocular quiescence.

The data recorded may be continually compared to prerecorded data, which averages the saccadic movement data of a population sample measured at incremental levels of blood alcohol content. This data, which establishes the correlation between eye movement blood alcohol content and reduction in alertness, is stored in a form accessible for comparison against the data being recorded. The stored data may be in the form of a look up table or an image display. The recorded data used for comparison is a set of readings of several parameters of eye movement over a predetermined duration generally 5 to 60 seconds which is continually updated. When this matches a set of data for a particular blood alcohol content that blood alcohol value is recorded as the alertness level of the operator.

Vision is blocked by eyelid closure but detecting such closure is not enough to detect all drowsiness episodes. Even when eyelids are open very drowsy subjects still cannot see due to central or neural blocking of vision and impaired oculomotor control. Neural blocking occurs during blinking and saccade movement although subjects are unaware that vision is temporarily switched off at these times. Some drowsy subjects striving to stay awake do keep their eyelids open for a number of seconds after they begin to lose oculomotor control particularly binocular coordination of eye movements. The first subjective awareness of this would be double vision or diplopia. Subjects are not usually aware of subsequent slow and poorly coordinated eye movements, presumably due to neural blocking of vision.

By comparison the subjects head is unlikely to nod forward until drowsiness has progressed to sleep. Consequently a nodding head may be a late warning of dangerous drowsiness.

The device of this invention monitors the relative positions and movements of the eyes and eyelids. With the onset of drowsiness the mean duration of spontaneous blinks blinks increase from about 300 milliseconds to more than 450 milliseconds. Eventually eyelid movements become so slow that they are no longer blinks but slow eyelid closures which occur intermittently and last from a half to several seconds. During the waxing and waning of alertness and drowsiness that is typical of this state other eyelid movements occur such as partial blinks and wavering movements of the lids that need to be distinguished from slow eye movements. The I R reflectance used in this invention allows the distinction to be made.

In another aspect of this invention there is provided a method of measuring alertness in which the eye movements of a subject are analysed using reflected infra red light pulses to obtain measures of the blink amplitude to velocity ratio and/or the saccade amplitude to velocity ratio averaging these over predetermined periods of time and measuring the deviation of the average from a predetermined average for alert subjects.

Detailed description of the invention

Figure 1 is a schematic diagram showing the location of the emitters and detectors

Figure 2 is a schematic layout of the system function according to this invention;

Figure 3 is an example of a graphical output of this invention relating to eye lid movement;

Figure 4 is an example of a graphical output of this invention relating to eye movement for the left and right eyes;

Figure 5 illustrates a graph used to determine the blink amplitude velocity ratio (BAVR);

Figure 6 illustrates a graph used to determine the saccade amplitude velocity ratio (SAVR);

Figure 7 illustrates the difference between the opening and closing velocity of blinks;

Figure 8 illustrates the signal from a slow, partial blink of a sleep deprived subject;

Figure 9 illustrates the BAVR per minute plotted during a 10minute performance test done repeatedly during sleep deprivation over night;
Figure 10 illustrates the relationship between mean BAVR and blood alcohol concentration.

Referring to figure 1 each eye is provided with an infra red pulse emitter 10 and two infra red reflectance detectors 13 and 14. Detector 13 detects reflected light horizontally across the eye which corresponds to the movement of the eyeball and detects saccadic movement from which the amplitude and velocity of each saccade can be derived to provide a saccade amplitude to velocity ratio. Detector 14 detects reflected light vertically across the eye which corresponds to the movement of the eyelid and detects eyelid movement from which the amplitude and velocity of each blink can be derived to provide a blink amplitude to velocity ratio. The subject wears a light supporting frame to hold the light emitters and detectors. The device is akin to the lower half of a spectacle frame and does not restrict the wearer's field of vision. A second part which can be in a pocket or attached to a belt contains the pulse generating and timing circuitry and the transmitter.

As shown in figure 2 the system of this invention uses IR pulse generators an IR detector and a wireless transmitter to transmit the detected signals to a receiver. The reflected infrared pulse height varies as the eye and eyelid move. The LED's preferably send out 50 microsecond duration pulses every 500 microseconds (that is 2000 times a second).

The receiver sends the signals to a pulse analyzer that measures the height of each reflected I R pulse (in volts) after subtracting the effects of environmental light. It then analyses the data in several ways including comparisons between the two eyes. .

The out put of the drowsiness quantifier can be stored, displayed or used to actuate an alarm when a threshold condition is passed. The control portion of the device which contains the display and alarm incorporates a micro processor programmed to analyse the received signals. The memory store contains data about the subject's drowsiness over a preceding time period and can be used much

as a black box is used for aircraft accidents should an accident occur. The device does not require calibration before each use.

In night driving the levels of environmental light both visible and IR can change rapidly as with the headlights of oncoming traffic approaching and rapidly passing or with day driving when sunlight is interrupted by trees. All such sources of IR light can be detected on the subject's face. For this reason the device of this invention measures the total level of light immediately before each pulse is transmitted and subtracts this from combined level of the pulse and environment. This means the device can be used in all light conditions from bright sunlight to night conditions. The amount of IR light reflected is related to the position of the eyes due to the conical shape of the cornea and to the position of the eyelids ands also to differences in reflectance of the tissues exposed when eyelids are open and when closed. The I R pulses directed to each eye are separated in time by about 100microseconds to avoid interference.

The levels and patterns of change in the light reflected from each eye enable the relative positions of each eye and eyelid to be monitored continuously. The device can detect and distinguish vertical and horizontal movements including saccadic and slow eye movements such as those in smooth pursuit of a target or because of vestibular-ocular movements that enable ocular fixation in spite of head movements.

Figure 3 illustrates the reflectance signal from a series of normal saccades and blinks. This data is analysed to identify signal patterns relating to loss of bi-ocular co-ordination, slow saccades, partial and slow eye closure.

Figure 4 illustrates slow eye movements of a sleep deprived subject with eyes open. There is a phase difference between the left and right eyes equivalent to 150 milliseconds whereas movements of the two eyes are usually coordinated to within about 10 milliseconds.

Also detected are the slow drifting and poorly coordinated eye movements that are a hall mark of drowsiness as shown in figure 8. These movements begin early in the drowsiness state usually several minutes before electro encephalogram (EEG) measurements indicate sleep onset.

The reflected light may be analysed for saccade duration over a range of frequencies or a range of time domains. Saccade duration for normal alert eye movement is 5-70 milliseconds while slow eye movement indicative of drowsiness is of the order of 1-5 seconds. In alert subjects saccades are synchronised to within 10 milliseconds and blinks within 20 milliseconds but in drowsiness the coordination is reduced and the slow eye movements of drowsiness are often asynchronous by 50 to 200 or more milliseconds.

The preferred method is to analyse the reflectance signals to derive the blink amplitude and velocity values from the signals of detector 14.

Figure 5 illustrates the peak closing velocity (PCV) and the peak opening velocity (POV) of a normal blink. The peak closing velocity is greater than the peak opening velocity. Duration of blinks is preferably measured at half the amplitude (1/2 D) of the blink because of difficulty in determining when a blink ends. A normal ½ D is about 110 +/- 35 milliseconds .

The device of this invention and the analysis system is able to differentiate between grimaces that involve forced closure or opening of the eyes. Drowsy subjects do this to alleviate discomfort of their eyes. Grimaces may be separated from blinks in calculating BAVR's and they can be separated from spontaneous blinks regardless of duration. This means that faking of drowsiness may also be detected.

The analysis is carried out on a computer in cable or wireless communication with the LEDs and detectors. The software filters out the signals to provide patterns of eye movements at differing frequencies.

The method of analysis of the data uses ratio of the amplitude of each eye/eyelid movement to its peak velocity. For saccades there is only one such velocity while for blinks there are two namely closure velocity and opening velocity. It is preferred to use only the peak velocity of the eyelid closure as it varies in an understandable way, and opening velocity less so. The ratios are called the saccadic amplitude to velocity ratio (SAVR) illustrated graphically in figure 7 and the blink amplitude to velocity ratio (BAVR) illustrated graphically in figure 6, respectively.

Figure 6 shows the relationship between the blink amplitude and peak closing velocity for 200 blinks in 12 alert over a 30 second period. Figure 7 shows that in

alert subjects the peak velocity of saccades is linearly related to the amplitude but this is a different relationship from that with blinks.

These ratios are independent of the set up conditions and the exact location of the transducers during the measurement (about 100 milliseconds).The SAVR reflects the contractile properties of the extra-ocular muscles and the BAVR reflects the contractile properties of the orbicularis muscles. These properties are influenced directly by the state of activation/deactivation of the central nervous system. The ratios increase progressively (up to 40 or more for the BAVR) as the level of drowsiness increases. Tests indicate that normal BAVR's are in the range of about 4.0+/- 0.. BAVR increases before subjects begin to fail to respond because of drowsiness during in performance tests (see figure 9). Figure 9 shows that for this subject there was no significant change in BAVR until after 20hours of wakefulness after which it begins to increase progressively.

In drowsy subjects BAVR can vary widely in a matter of seconds. A mean BAVR or similar measure can be calculated in relation to any time scale from seconds to hours. The mean BAVR and the number of times individual BAVRs exceed the normal range as well as the total duration of such episodes per unit of time is measured and used to assess alertness. These measurements are then related to those previously recorded in subjects with blood alcohol levels preferably at 0.01% intervals to give an alertness measure based on blood alcohol equivalent levels. Figure 10 illustrates the indicative relationship between the measured BAVR and blood alcohol concentration. A blood alcohol conc'n of 0.05% is approximately equivalent to a BAVR of 6.

Drowsiness is quantified over a period of seconds or minutes by a combination of the following variables:

- measurement and comparison of BAVR
- whether saccades are normal or abnormal based on SAVR and their frequency per unit of time
- the presence and duration of slow eye movements with impaired binocular coordination
- whether the eyelids are open or closed and for what proportion of time

- the presence of drooping or wavering eyelids as indicated by high BAVR
- the degree of binocular coordination including vestibular-ocular and smooth pursuit eye movements which are required for clear vision when driving a vehicle
- the frequency of long duration blinks and other eyelid closures with high BAVRs and their cumulative duration per unit of time
- the frequency of voluntary grimaces involving forced closure or opening of the eyes
- the duration of unusually long periods of ocular quiescence (many seconds) without eye or eyelid movements
- particular levels of drowsiness can be equated with particular blood alcohol concentrations

From the above it can be seen that this invention provides a unique means of providing an alertness measure based on legal definitions of fitness to operate machinery or drive vehicles.

The method and apparatus described may be varied or modified to suit the particular application or equipment being used without departing from the fundamental elements of the method and device defined.

CLAIMS

1. An alertness monitoring system which includes

a) means to measure eyelid and eye movement for presence of one or more of relatively slow eye and eyelid movements in relation to their amplitude, wavering eyelids, partial eye closure, drooping eyelids; slow or drifting eye movements, slow and prolonged eyelid closure, absence of saccadic movement and loss of eye co-ordination

b) storage means to continuously record the measurements

c) a data processor to compare the measurements against a predetermined scale, said scale being averaged measurements of the eye and eyelid movement parameters for a sample population measured against predetermined incremental blood alcohol levels

d) a display for showing the alertness measurement based on the scale or

e) an alarm means triggered by the scale reading reaching a predetermined limit based on the blood alcohol level scale.

2. An alertness system as claimed in claim 1 in which at least one infra red pulse emitter and one infra red detector is mounted on at least one eye.

3. An alertness system as claimed in claim 2 in which the detector measures the total level of light immediately before each pulse is transmitted and subtracts this from combined level of the measured reflectance during the pulse.

4. A method of measuring alertness in which the eye movements of a subject are analysed using reflected infra red light pulses to obtain measures of the blink amplitude to velocity ratio and/or the saccade amplitude to velocity ratio averaging these over predetermined periods of time and measuring the deviation of the average from a predetermined average for alert subjects.

5. A method as claimed in claim 4 in which the measured blink amplitude to velocity ratio and the saccade amplitude to velocity ratio values are related to a scale of blood alcohol content equivalent values.

6. A method as claimed in claim 5 in which the reflected light pulses are detected at two locations on each eye.

7. A method as claimed in claim 5 in which one location detects reflectance associated with eyelid movement and the second location detects reflectance associated with saccadic movement.

8. An alertness measuring system for a subject which includes
   a) an infrared pulse emitter adapted to be located adjacent at least one eye of a subject
   b) at least one reflected light detector located adjacent said emitter
   c) means to transmit the detector signals
   d) data processing means to receive the detector signals and to subtract the total level of light immediately before each pulse is transmitted from the combined level of the measured reflectance after the pulse to provide a reflectance measure
   e) said data processing means analyzing said reflectance measure to assess eyelid and eye movement for presence of one or more of relatively slow eye and eyelid movements in relation to their amplitude, wavering eyelids, partial eye closure, drooping eyelids; slow or drifting eye movements, slow and prolonged eyelid closure, absence of saccadic movement and loss of eye co-ordination.

9. An alertness measuring system as claimed in claim 8 in which the reflected light pulses are detected at two locations on each eye.

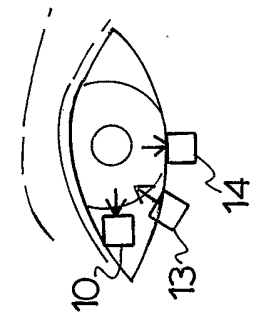
10. An alertness measuring system as claimed in claim 9 which one location detects reflectance associated with eyelid movement and the second location detects reflectance associated with saccadic movement.

11. An alertness measuring system as claimed in claim 10 in which the data processing system analyses the reflectance signals to obtain measures of

the blink amplitude to velocity ratio and/or the saccade amplitude to velocity ratio, averaging these over predetermined periods of time and measuring the deviation of the average from a predetermined average for alert subjects.

12. An alertness measuring system as claimed in claim 11 in which the measured blink amplitude to velocity ratio and the saccade amplitude to velocity ratio values are converted to a scale of blood alcohol content equivalent values.

13. An alertness measuring system as claimed in claim 12 which includes a display for displaying the alertness measurement or an alarm triggered by the scale reading reaching a predetermined limit based on the blood alcohol level scale.



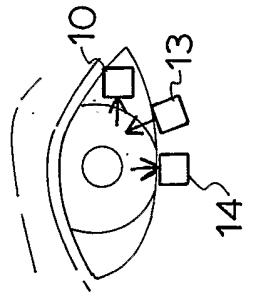


FIG. 1.

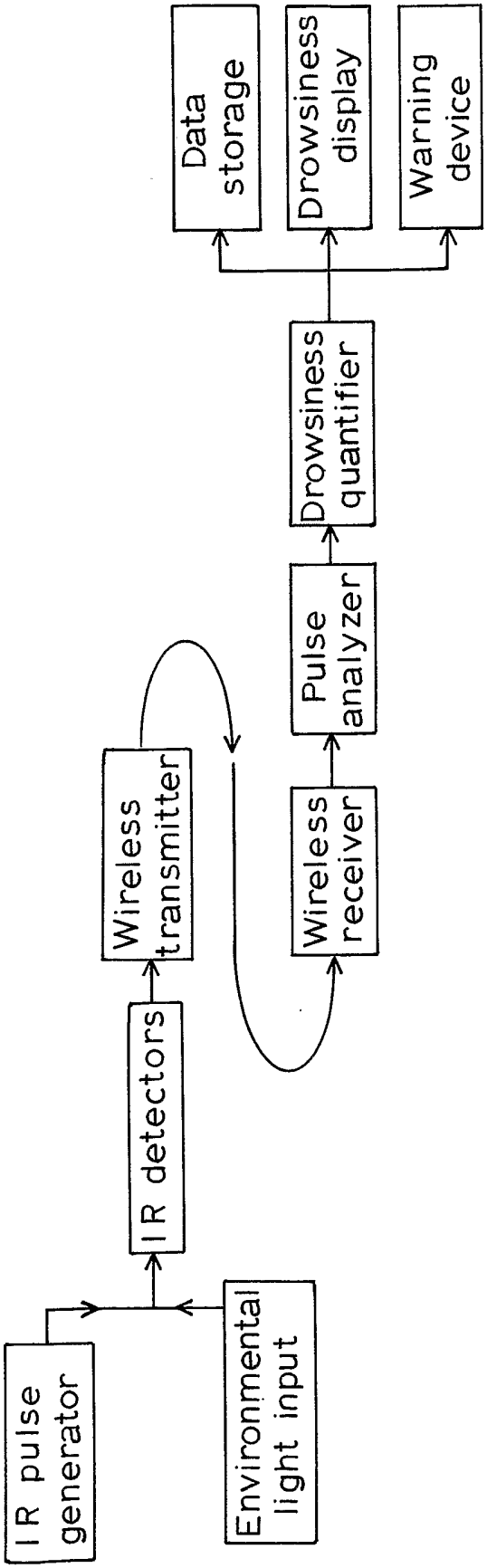

IR pulse generator
Environmental light input
IR detectors
Wireless transmitter
Wireless receiver
Pulse analyzer
Drowsiness quantifier
Data storage
Drowsiness display
Warning device

FIG. 2.

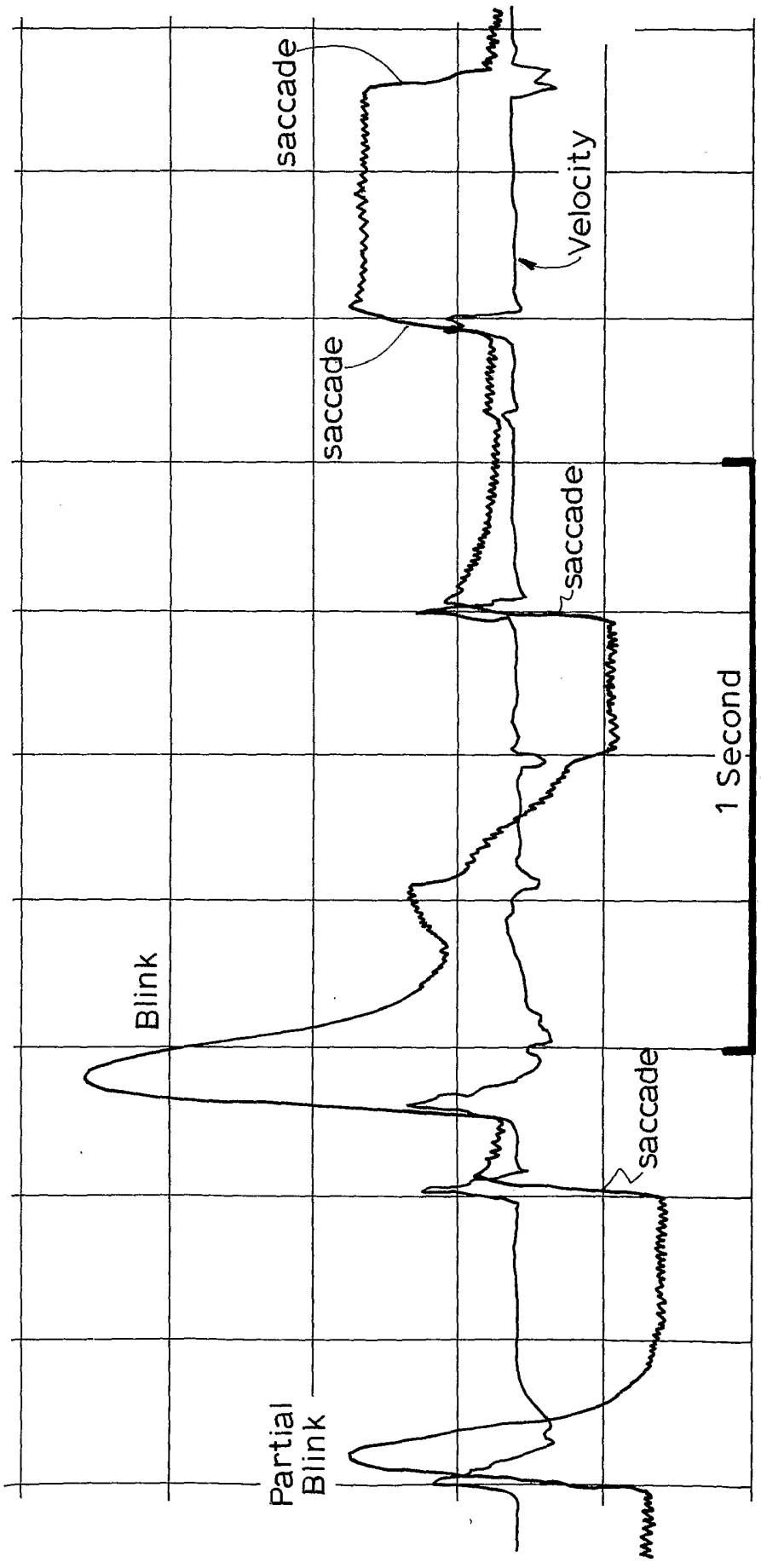

saccade
Velocity
saccade
saccade
1 Second
Blink
saccade
Partial
Blink

FIG.3.

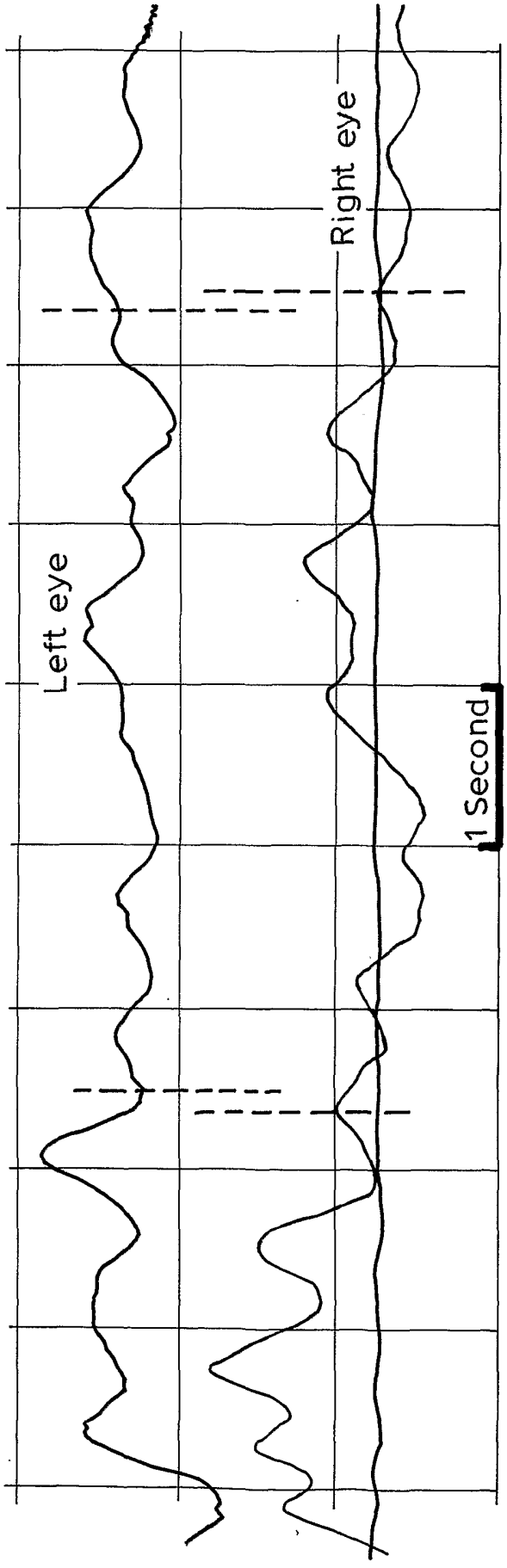


FIG.4.

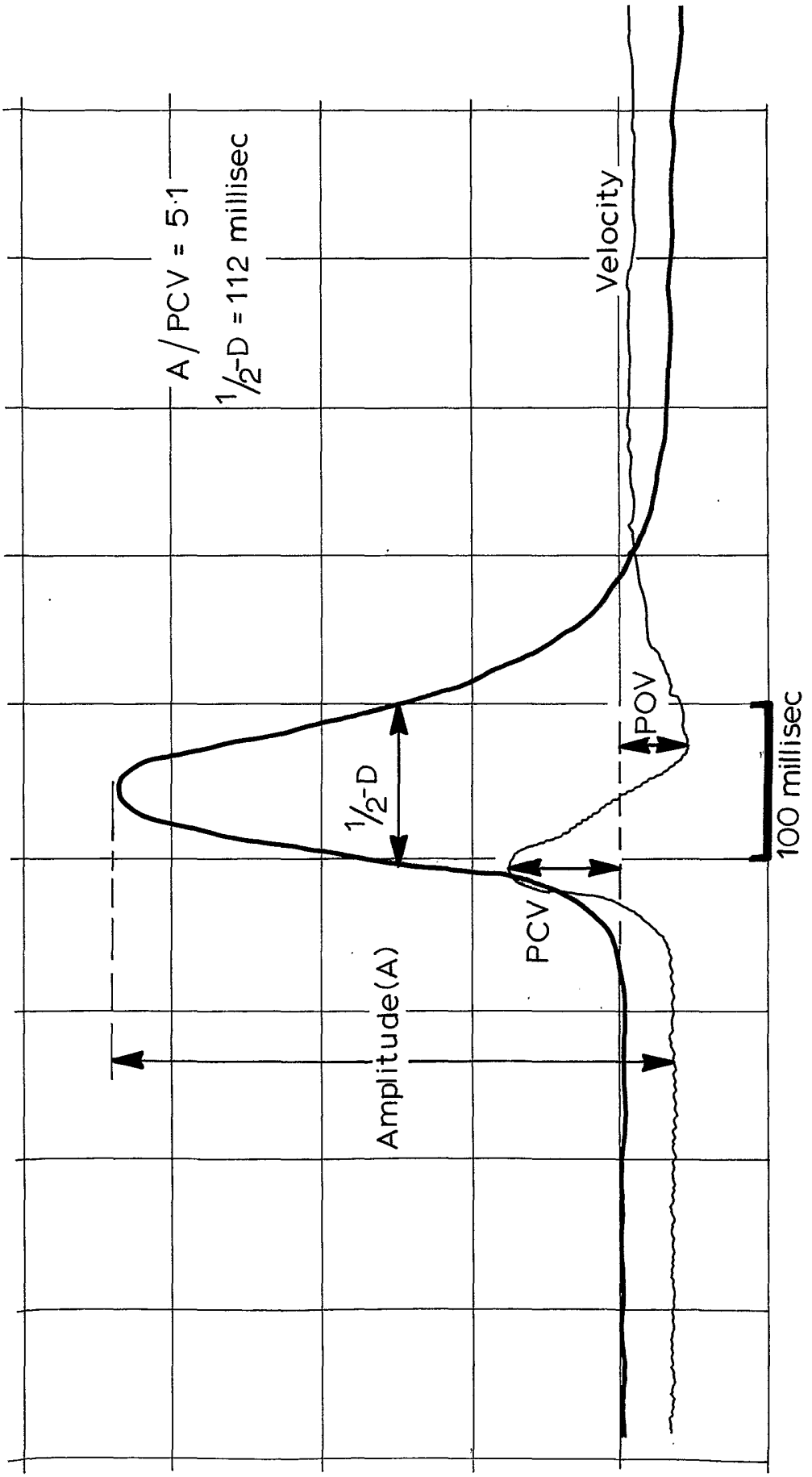

A/PCV = 5:1
½-D = 112 millisec
Velocity
½-D
POV
100 millisec
PCV
Amplitude(A)

FIG.5.

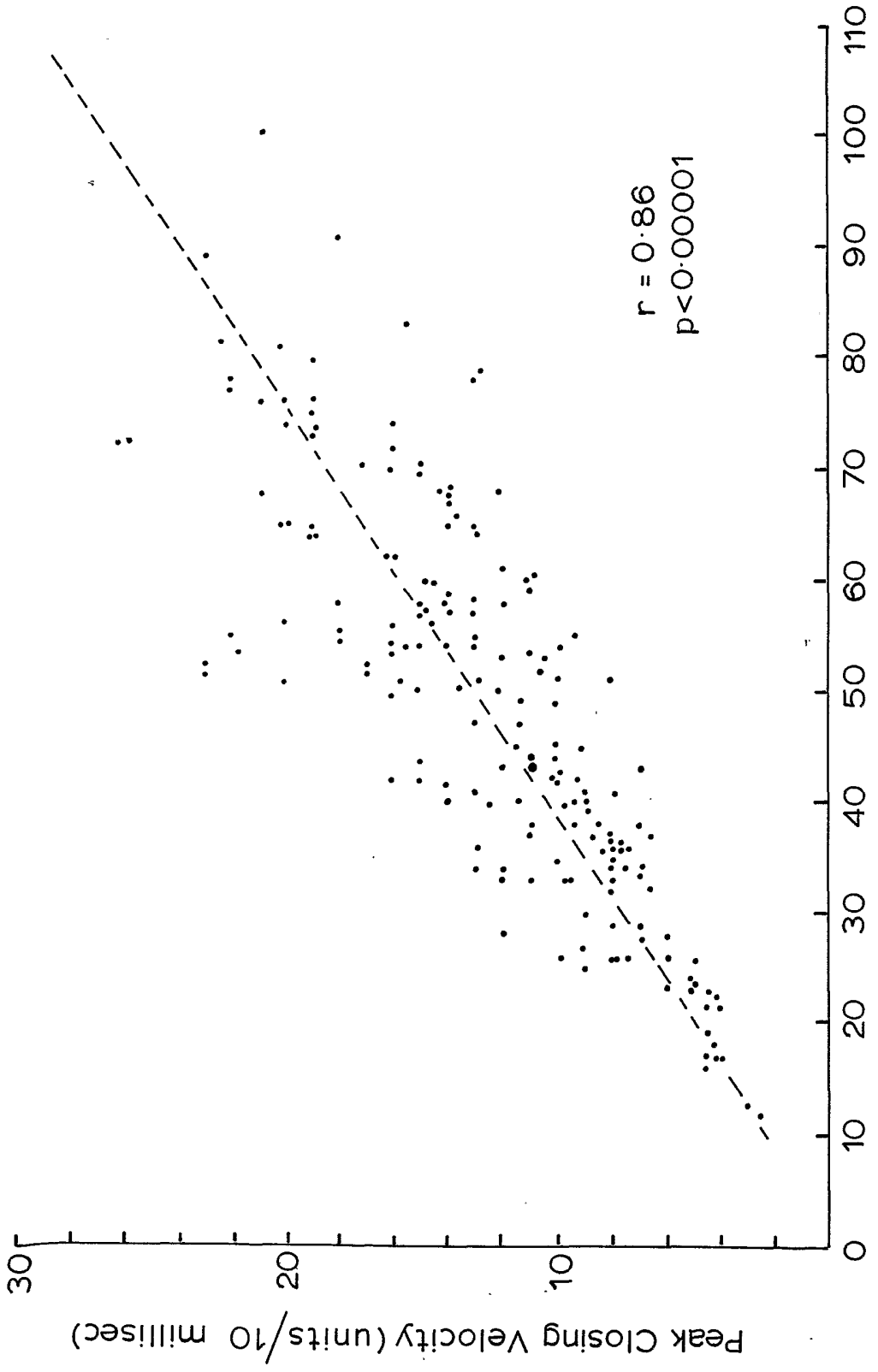

Peak Closing Velocity (units/10 millisec)
30
20
10
0
10
20
30
40
50
60
70
80
90
100
110
Amplitude of blinks (arbitrary units)
r = 0·86
p<0·00001

FIG. 6.

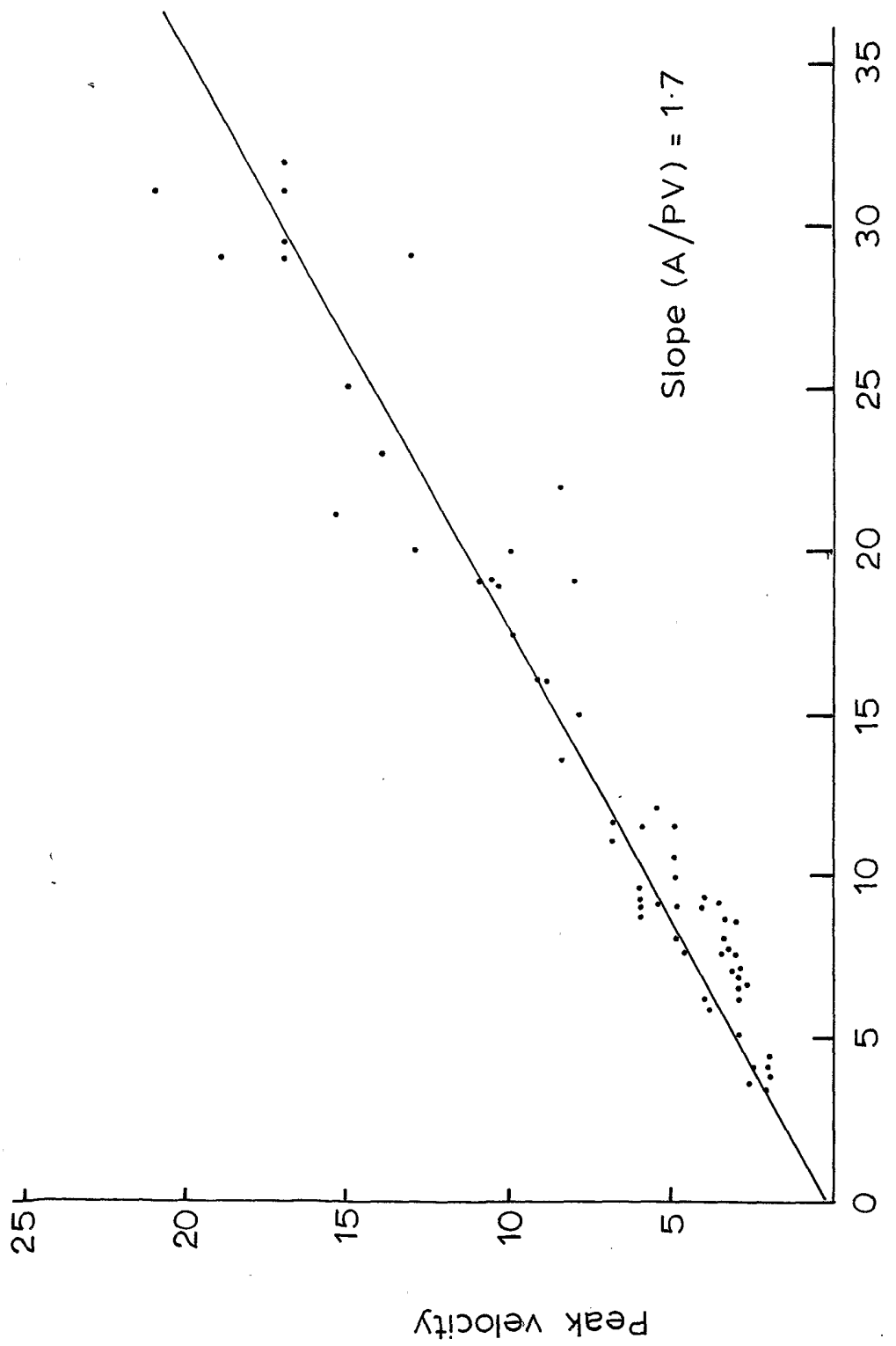
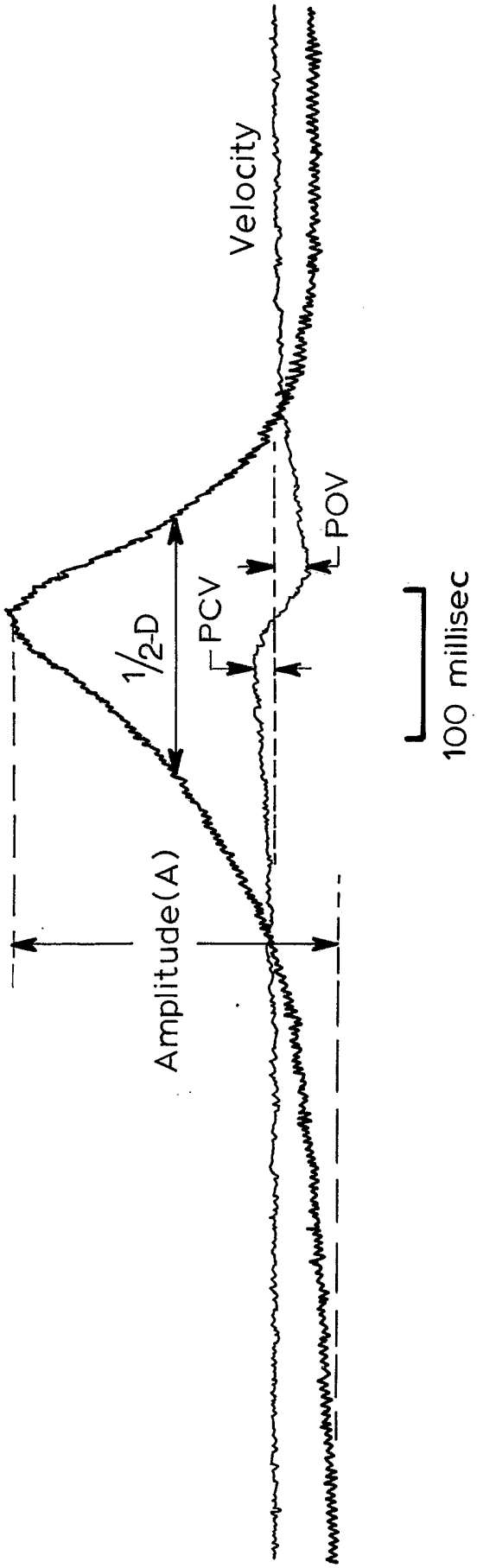

Peak velocity
25
20
15
10
5
0
5
10
15
20
25
30
35
Amplitude (A) of saccades (arbitrary units)
Slope (A/PV) = 1·7

FIG.7.



A/PCV = 14·6
1/2-D = 122 millisec

FIG.8.

The mean Amplitude Velocity Ratio
(BAVR) per minute
3
4
5
6
7
8
9
13 14 15 16 17 18 19 20 21 22 23 24
Hours of wakefulness
20 21 22 23 24 1 2 3 4 5 6 7 am
Time of day

FIG.9.

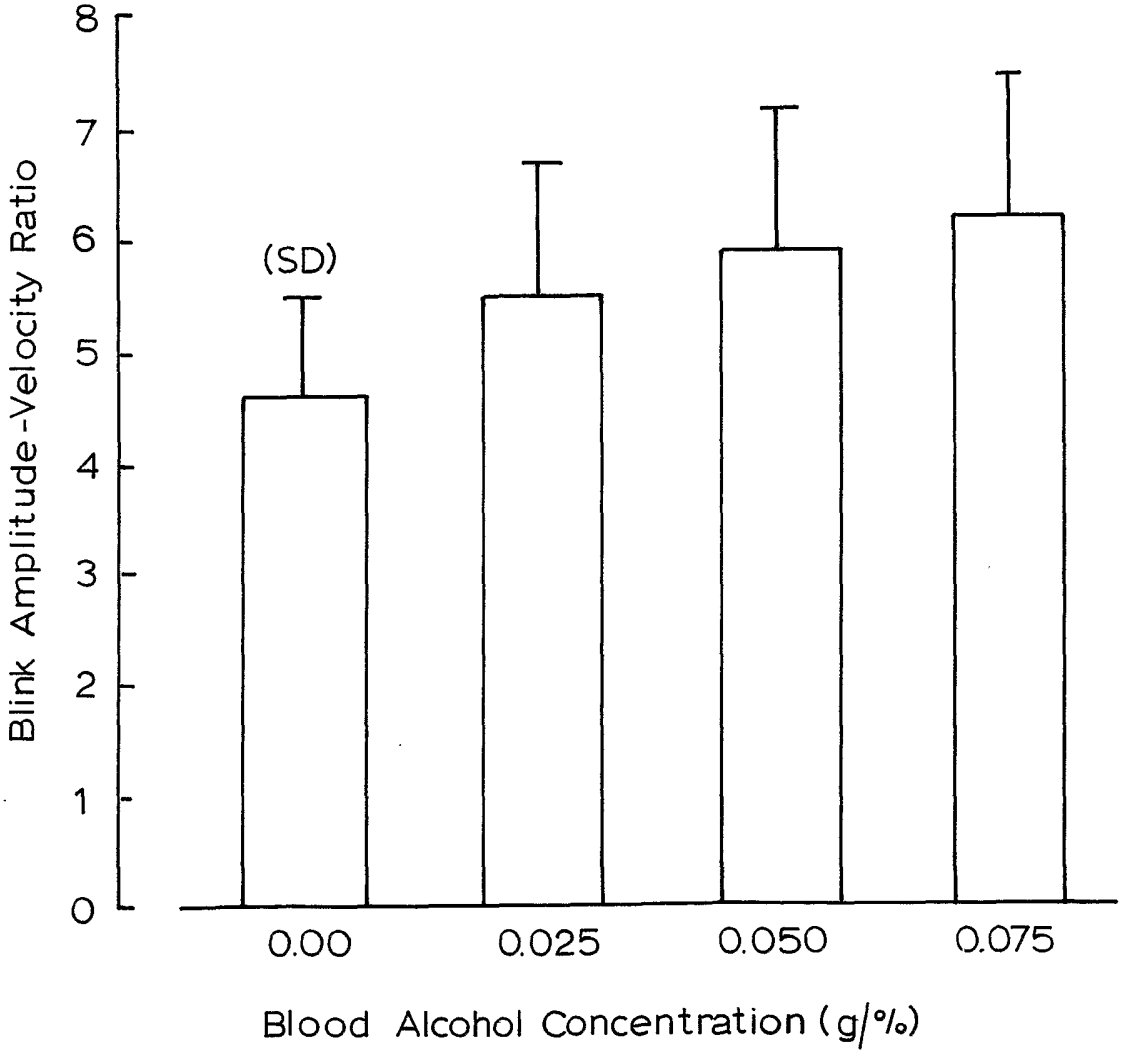

Blink Amplitude-Velocity Ratio
0
1
2
3
4
5
6
7
8
(SD)
0.00
0.025
0.050
0.075
Blood Alcohol Concentration (g/%)

FIG.10.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/01508

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A61B 3/113, G08B 21/06

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)

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)
DWPI Keywords (impair, eye, move, monitor, infrared, alcohol) and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5745038 A (VANCE) 28 April 1998 column 2, line 38 to column 3, line 10	8
X	US 6147612 A (RUAN et al) 14 November 2000 column 4, lines 10-32, column5, lines 26-39	8
X	WO 97/15033 A2 (PATZ) 24 April 1997 abstract	8

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

"E" earlier application or patent 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 when the document is taken alone

"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

Date of the actual completion of the international search	Date of mailing of the international search report
4 December 2002	16 DEC 2002
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **VINCE BAGUSAUSKAS** Telephone No : (02) 6283 2110

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/01508

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent Abstract Accession No. G1976 K/19, Class Q14 DE 3229773 A1 (XANADU LTD) 10 October 1982	8
A	WO 98/49028 A1 (APPLIED SCIENCE GROUP INC) 5 November 1998 page 5, lines 15-24, page 8, lines 5-9	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/01508

Box I 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 II 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:

1. Claims 1-3
   Alertness monitor using data processor that compares alertness to predetermined scale of blood alcohol level,
2. Claims 4-13
   Alertness monitor using reflected infra-red pulses to obtain measurements of eye and eyelid movements,
   as reasoned on extra 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 an additional fee, this Authority did not invite payment of any additional fee.
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.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-3 are directed to an alertness monitoring system comprising a data processor that compares measurements of eye and eyelid movement against a predetermined scale, said predetermined scale being averaged measurements of eye and eyelid movement parameters for a sample population measured against predetermined incremental blood alcohol levels. It is considered this comparison of alertness to blood alcohol level comprises a first "special technical feature".
2. Claims 4-13 are directed to a method of measuring alertness and an alertness monitoring system using reflected infra-red pulses to obtain measurements of eye and eyelid movements. It is considered using reflected infra-red pulses to obtain measurements of eye and eyelid movements comprises a second "special technical feature".

The feature common to all of the claims is the concept of monitoring alertness using eye and eyelid movement. However this common feature is generic in the art. Consequently the common feature does not constitute "a special technical feature" since it makes no contribution over the prior art. Since there exists no other common feature which can be considered as a special technical feature, no technical relationship between the different inventions can be seen. Consequently it appears that a posteriori, the claims do not satisfy the requirement that they relate to one invention only.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU02/01508

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
US	5745038	NONE	
US	6147612	NONE	
WO	97/15033	AU	15897/97
DE	3229773	IL	63535
WO	98/49028	NONE	

END OF ANNEX