

[54] ATTENTION-LEVEL ANALYZER

[76] Inventor: **Karel Montor**, 732 Cottonwood Dr.,
Severna Park, Md. 21148

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128/2.06 R, 2.08, 2.1 B, 2.1 R; 340/279, 407

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Primary Examiner—William E. Kamm

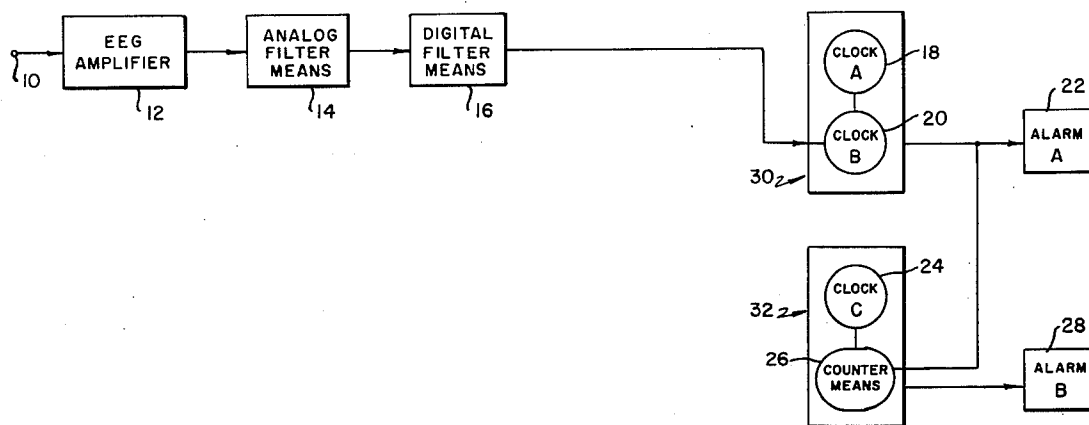
Attorney, Agent, or Firm—R. S. Sciascia; P. Schneider

[57]

ABSTRACT

An attention-level analyzer comprising an electroencephalograph instrument the output of which is filtered by an analog filter and a digital filter to pass only brain waves in the 8-13 Hz band, which is the band of frequencies of the inattentiveness wave. An output from the filters actuates a clock which, if advanced in time sufficiently within the predetermined timing interval of another clock, actuates a tone generator. The output of the first clock also advances a third clock or counting means in time which, if advanced sufficiently within the predetermined time interval of a fourth clock, actuates another tone generator which may be placed to alert a monitor.

8 Claims, 3 Drawing Figures



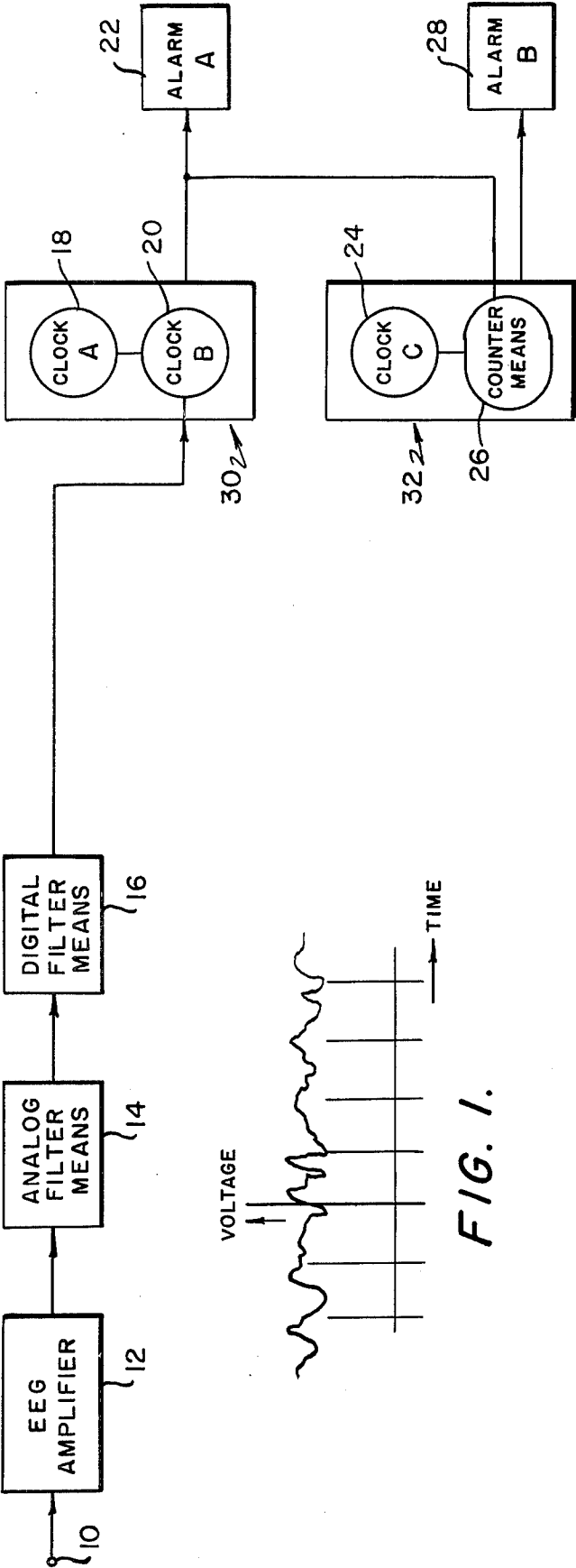


FIG. 3.

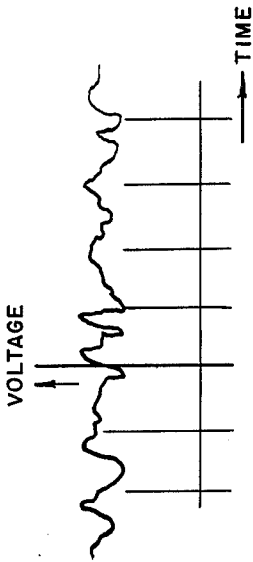


FIG. 1.

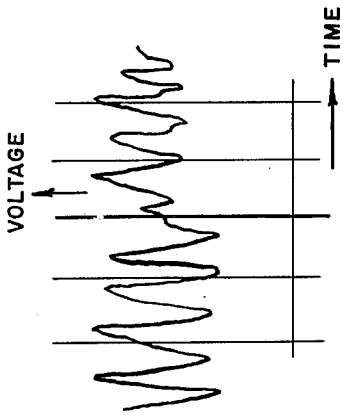


FIG. 2.

ATTENTION-LEVEL ANALYZER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention relates to means for indicating the condition of inattention in an individual and for alerting him to this condition.

It is obvious that a machine which can measure the level of attention of an individual and alert him when his attention level is too low would be valuable in many applications. For example, it would be useful for alerting the driver of any vehicle, a sonarman or radarman on watch, and many others, that they are not paying enough attention to the task at hand.

Another extremely useful application would be the classroom or individual learning situations where an individual's attention often starts to wander and he loses part of the instructional material. This would be prevented by the Attention-Level Analyzer (ALA).

SUMMARY OF THE INVENTION

The present invention comprises means to detect the brain waves of a subject and to pass them through a sharp bandpass filter. If this filter has an output, it means that the subject is being inattentive. Inattentiveness outputs are fed to clock means which provide an output to a tone generator if the duration of the inattentiveness signals during a given time interval rises above a predetermined amount. The tone generator alerts the subject.

The output of the clock means is also fed to a second clock means which, if the number of outputs of the first clock means exceeds a predetermined number in a second, larger timing interval, actuates a second tone generator to alert a monitor.

OBJECTS OF THE INVENTION

An object of the invention is to monitor the attention level of a human subject.

Another object is to alert a subject to the fact that his attention has fallen below a predetermined level.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a representation of a brain wave of an attentive subject.

FIG. 2 is a representation of a brain wave of an inattentive subject.

FIG. 3 is a block diagram of an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

It has been found that the brain waves of a human subject are different when he is paying attention to something from those when he is inattentive. FIGS. 1 and 2 show brain waves (alpha waves) when a subject is attentive and when he is inattentive, respectively. The frequencies in the attentive wave (FIG. 1) contain

frequencies ranging from about $\frac{1}{2}$ to 50 Hz but the amplitude of its components in the 8-13 Hz range is quite low. On the other hand, the inattentive wave (FIG. 2) is characterized by the fact that its components in the 8-13 Hz band (the inattentiveness band) are of high voltage amplitude. The differences between these waves form the basis for the ALA.

In FIG. 3, an electroencephalograph (EEG) amplifier 12 has leads, shown generally by 10, which are attached to the head of a human subject, not shown. The brain waves of the subject are picked up and amplified by the EEG means 12 and fed to an analog filter 14 which passes frequencies in the 8-13 Hz band. However, since this is not a sharp-cutoff filter, the wave is then passed through digital filter means 16, which cuts the wave off sharply at 8 and 13 Hz, effectively providing a pulse output in the frequency spectrum.

The digital frequency means 16 also contains a power supply connected to a switch, which may be a relay, for example. When an inattention signal which has relatively high threshold level (e.g., 10 microvolts); in the 8-13 Hz range comes through, the relay closes the switch, thereby applying an actuating signal to clock means 30 which comprises clocks A and B (18 and 20, respectively).

Clock A is set to continually recycle itself at a predetermined interval, say 3 seconds. Clock B, which acts as a counter, is actuated by a pulse from the digital filter means 16.

At this point, it is necessary to state that concentration or attentiveness differs for different people. For example, one person may spend $\frac{1}{2}$ second out of every 3 in daydreaming even when he is attentive; another may spend a quarter of a second out of every 3 in inattentiveness. Thus, the subject should first be tested to determine how many fractions of a second he is inattentive even when he is nominally attentive.

Clock B may typically be set for a 100 percent overload, i.e., if the subject daydreams $\frac{1}{4}$ second out of every 3 seconds, clock B could be set for $\frac{1}{2}$ second. Clock B essentially operates like a counter; the interval of the actuating (inattentiveness) pulse determines how much time is counted. If $\frac{1}{2}$ second or more is cumulatively counted in the 3-second cycle of clock A, a relay in clock B is actuated, sending a pulse to an alarm A (22) which may be a tone generator. The tone put out by the generator A alerts the subject to the fact that he is not concentrating.

The pulse from the closing of the relay in clock B is also fed to counter 26 in a second clock means 32, which means also comprises a clock C (24). Clock C (24) has a cycle of 15 seconds, for example, after which it resets itself and the counter 26. A pulse from clock B will start the counter 26 which may be set for 5 pulses, for example. If 5 pulses are fed to the counter 26 from clock B within the 15-second cycle of clock C, a relay in the counter means 26 is closed, thereby actuating another alarm B (28), which also may have a tone generator, at the instructor's (or any monitoring person's) location.

Thus, if tone generator A is not keeping the subject alert, a predetermined number of pulses from clock B, showing prolonged inattentiveness of the subject, actuate the tone generator B at monitoring station, so that a monitor can warn the subject of his lack of concentration.

The predetermined times of the clocks and counter means can be varied as necessary to fit the needs of different situations.

The types of analog and digital filters which can be used herein are shown in an article "A Hybrid Circuit to Indicate the Presence of Alpha Activity" in D. A. Paskewitz, in Psychophysiology, Vol. 8, No. 1, January 1971.

Clocks A and C may be 5-in-1 timers, Model No. 58033, manufactured by Lafayette Instrument Company, Lafayette, Ind.

Clock B may be a 5-in-1 timer, Model No. 58034, manufactured by Lafayette.

The tone generators may be the Model No. 58025 Tone Generator manufactured by Lafayette.

The EEG amplifier may be the Grass Model 79C EEG.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Apparatus for determining the level of attention of a human subject comprising, in combination:
 - wave-detection means adapted for connection to the subject's head for obtaining an electrical wave output corresponding to the brain waves of the subject;
 - filter means for filtering said electrical wave output, said filter means passing signals having frequencies lying in the attentiveness band and cutting off lower and higher frequency signals;
 - first clocking means to which the output of the filter means is fed as an input for establishing repeatable time intervals and for producing an output signal if the cumulative duration of inattentiveness signals exceeds a predetermined amount of time for a given timing interval; and
 - first alarm means for producing an alarm signal upon receipt of an output signal from said clocking means.
2. Apparatus as in claim 1, further including:
 - second clocking means to which the output of the first clocking means is fed as an input for producing an output signal if the number of its input signals during a given timing interval equals a predetermined number; and
 - second alarm means for producing an alarm signal

upon receipt of an output signal from said second clocking means.

3. Apparatus as in claim 1, wherein said wave-detection means comprises an electroencephalographic apparatus.

4. Apparatus as in claim 2, wherein said filter means comprises an analog filter in series with a digital filter.

5. Apparatus as in claim 1, wherein said first timing means comprises a pair of clocks, A and B, clock A being of the continually recycling type and acting to recycle itself and clock B after each timing interval and clock B being of the type which is advanced during each timing interval in accordance with the cumulative duration of any inattentiveness signals coming from the filter means.

6. Apparatus as in claim 1, wherein said first alarm means comprises a tone generator.

7. Apparatus as in claim 1, wherein:

said wave-detection means comprises electroencephalographic apparatus;

said filter means comprises an analog filter in series with a digital filter;

said first timing means comprises a pair of clocks, A and B, clock A being of the continually recycling type and acting to recycle itself and clock B after each timing interval and clock B being of the type which is advanced during each timing interval in accordance with the cumulative duration of any inattentiveness signals coming from said first filter means; and

said first alarm means comprises a tone generator.

8. Apparatus as in claim 7, further including:

second clocking means to which the output of the first clocking means is fed as an input for producing an output signal if the number of its input signals equals a predetermined number during a given timing interval,

said second timing means comprising a clock and a counter, the clock being of the continually recycling type which acts to recycle itself and the counter after each timing interval, and the counter producing an output signal if its count equals said predetermined number during said given timing interval; and

second alarm means comprising a tone generator for producing an alarm signal upon receipt of the output signal from said counter.

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