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- (71) **Applicant (for all designated States except US):** Johnson Controls Automotive Electronics GmbH [DE/DE]; Benzstraße 6, 75196 Remchingen (DE).
- (72) **Inventor; and**
- (75) **Inventor/Applicant (for US only):** TUZSUZOV, Jordan [BG/DE]; Schwetzingen Straße 34, 76139 Karlsruhe (DE).
- (74) **Agent:** LIEDTKE, Markus; Liedtke & Partner, Elisabethstraße 10, 99096 Erfurt (DE).

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(54) **Title:** METHOD AND APPARATUS FOR MONITORING AND CONTROL ALERTNESS OF A DRIVER

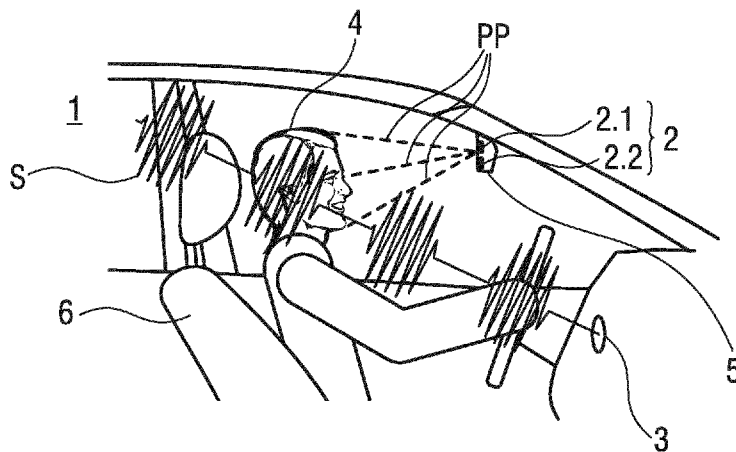


FIG 1

(57) **Abstract:** The present invention relates to a method for monitoring the alertness of the driver (4) of a vehicle, comprising: - continuously detecting and evaluation of at least one physical parameter (PP) of the driver (4) while the vehicle is in motion, - transmitting a periodic audio signal (S) with a predetermined frequency into a vehicle interior (1) within a predetermined time period if the evaluated physical parameter (PP) is in a critical range, whereby the critical range indicates an appropriate level of fatigue of the driver (4). Furthermore the present invention relates to an apparatus for monitoring the alertness of the driver (4) of a vehicle, comprising: - a monitoring unit (2) with a sensor unit (2.1), which detects at least one physical parameter (PP) of the driver (4), and - an evaluation unit (2.2), which evaluates the detected physical parameter (PP) while the vehicle is in motion, and whereby - the evaluation unit (2.2) is coupled to an audio device (3), which transmits a periodic audio signal (S) into a vehicle interior (1) within a predetermined time if the evaluated physical parameter (PP) is in a critical range.



Method and apparatus for monitoring and control alertness of a driver

Technical Field

5 The present invention relates to a method for monitoring the alertness of the driver of a vehicle. Furthermore, the present invention relates to an apparatus for monitoring the alertness of the driver of a vehicle.

Background of the invention

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Monitoring units for monitoring a condition of a driver are well known by prior art. Therefore, at least one sensor, mounted within a motor vehicle, is directed to a driver. As a result physical parameters are detectable, allowing conclusions on a level of awareness and/or fatigue of the driver. For example
15 it is known, that a dizziness of a driver is detectable. In particular, it should be detected, whether the driver is tired and hence an increased accident risk can be assumed. If fatigue is detected, the driver is being warned early and for example asked to stopped to look for a rest.

20 In addition, motor vehicles are usually equipped with audio facilities, by which it being possible to output songs audibly to entertain vehicle passengers.

It is otherwise known that neural impulses of the human brain have a frequency spectrum, which depends on a condition of the human brain. So-called delta and theta waves are detectable during sleep and have lower
25 frequencies than beta waves, which are detectable when an individual is in a fully awake condition. Scientific studies show, that acoustic and/or optical impulses with respective frequencies can affect a condition of the human brain.

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DE 10 2007 036 987 A1 discloses a method and an apparatus for transmitting impact sound into an interior of the motor vehicle by an impact sound generator. The impact sound is transmitted over the impact sound generator to a passenger of the motor vehicle in such a manner that an effect
5 is obtained. The effect is selected from a group of effects comprising the passenger is concentrated by the impact sound, the passenger is prevented from falling asleep, a driving feeling of the passenger is increased, and unwanted vibrations of the motor vehicle are suppressed.

10 Summary of the invention

It is an object of the present invention to provide an improved method and an improved apparatus for monitoring the alertness of the driver of a vehicle.

15 According to the invention, the object is achieved by a method according to claim 1 and an apparatus according to claim 7.

Preferred embodiments of the invention are given in the dependent claims.

20 According to the invention, a method for monitoring the alertness of the driver of a vehicle comprises:

- continuously detecting and evaluation of at least one physical parameter of the driver while the vehicle is in motion,
- transmitting a periodic audio signal with a predetermined frequency into a
25 vehicle interior within a predetermined time period if the evaluated physical parameter is in a critical range, whereby the critical range indicates an appropriate level of fatigue of the driver.

A tired driver is one of the important factors that cause traffic accidents. The
30 transmission of a periodic audio signal with a predetermined frequency into a vehicle interior, in particular to the driver, enables an increase of the

concentration of the driver, if the driver is tired and hence an increased accident risk can be assumed. With the method according to the invention, the driver is prevented from falling asleep and thus, a drive comfort and drive safety are improved.

5

According to a preferred embodiment, at least the face of the driver is being detected. The human face indicates more fatigue signs than other human body parts. This fact allows a reliable detection of an appropriate level of fatigue of the driver.

10

Preferably, the physical parameter is a time period and/or a frequency of an eyelid closure of the driver. The eyelid closure of an individual can be voluntary or involuntary, whereby fatigue affects a slower eyelid closure, in particular a longer time period of eyelid closure, than the eyelid closure of an individual, when it is awake. Thus, a time period and/or a frequency of an eyelid closure are reliable parameters for detection of an appropriate level of fatigue of the driver.

15

A frequency of the transmitted periodic audio signal is in a frequency range between 12 hertz and 15 hertz and thus in a frequency range of alpha and beta waves of a human brain. Therefore, the transmitted periodic audio signal enables a stimulation of the brain waves of the driver such, that a concentration of the driver can be increased. Furthermore, the frequency of the transmitted periodic audio signal is in a non audible frequency range of an individual, so that the transmitted periodic audio signal has no influence on other vehicle passengers.

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In a preferred embodiment, the transmitted periodic audio signal is superimposed with further audio signals. For example, the further audio signals are generated by music reproduction or receiving radio broadcast of an audio device, integrated in the vehicle interior. Preferably, this allows a

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support of the further audio signals of the audio device, which are usually in an audible range of the driver and other vehicle passengers.

The predetermined time period in which the periodic audio signal is transmitted, ends when the evaluated physical parameter is out of the critical range. That means, that the transmission of the periodic audio signal stops, when the driver is no more tired. This allows that the brain waves of the driver are stimulated as long as the driver is in the critical range, so that the driver is reliably prevented from falling asleep.

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An apparatus for monitoring the alertness of the driver of a vehicle, comprises:

- a monitoring unit with a sensor unit, which detects at least one physical parameter of the driver, and
- 15 - an evaluation unit, which evaluates the detected physical parameter while the vehicle is in motion, and whereby
- the evaluation unit is coupled to an audio device, which transmits a periodic audio signal into a vehicle interior within a predetermined time if the evaluated physical parameter is in a critical range.

20

The apparatus is well suited to be used as a combination of an audio device coupled with a monitoring unit, which are usually already arranged in modern vehicles. Thus, the apparatus enables a cost-efficient and packaging-optimized solution for monitoring the alertness of the driver of a vehicle, whereby the driver is helped to become awake.

25

The sensor unit is an optical sensor, by which an appropriate level of fatigue of the driver is reliably detectable, because fatigue signs, especially a longer time period of eyelid closure, are detectable optically best.

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- 5 -

Preferably, the sensor unit is arranged into an inside mirror of the vehicle interior. In particular, this allows to detect the face of the driver in a best way, because usually the inside mirror is arranged near the area of a driver's head. Furthermore, the arrangement in the inside mirror enables a
5 packaging-optimized arrangement of the sensor unit in the vehicle interior. Alternatively, the sensor unit is arranged in other suitable places in the vehicle interior, such as instrument panel, steering wheel or even windscreen.

10 The sensor unit is directed to a driver seat. With this, only the driver is monitored, and stimulated as necessary. Thus, other vehicle passengers are not influenced by the apparatus and may sleep untroubled during a long vehicle drive.

15 Details of the present invention are described hereinafter. However, it should be understood that the detailed description and the specific examples indicate possible embodiments of the invention and are given by way of illustration only. Various changes and modifications of the illustrated embodiments within the spirit and scope of the invention are appreciated by
20 those skilled in the art.

Brief description of the drawings

The present invention will be better understood from the detailed description
25 given in the following. The accompanying drawings are given for illustrative purposes only and do not limit the scope of the present invention.

Figure 1 schematically a side view of a section of a vehicle interior with a monitoring unit and an audio device,

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Figure 2 schematically a side view of a section of the vehicle interior 1
with a driver 4,

5 Figure 3 schematically an exemplary graphic view of human brain
waves, and

Figure 4 schematically an exemplary graphic view of a section of an
audio signal.

10 Detailed description of the preferred embodiments

Figure 1 shows schematically a side view of a section of a vehicle interior 1
of a vehicle with a monitoring unit 2 and an audio device 3.

15 However, concentrate decrease of a driver 4 as a result of fatigue and, in
consequence, decreased ability to respond is a reason for many accidents in
traffic. Studies have shown that about 20% of accidents are due to driver
fatigue. Thereby for reducing the potential dangers to traffic participants, the
present invention involves a method and an apparatus for monitoring the
20 alertness of the driver 4 of a vehicle.

The apparatus comprises the monitoring unit 2, which includes at least one
sensor unit 2.1 and an evaluation unit 2.2.

25 Preferably, the sensor unit 2.1 is an optical sensor, which detects at least one
physical parameter PP of the driver 4 continuously while the vehicle is in
motion. In a preferred embodiment of the invention, the at least one physical
parameter PP is a time period and/or a frequency of an eyelid closure of the
driver 4.

The time period and/or the frequency of the eyelid closure are reliable parameters for detection of an appropriate level of fatigue of the driver 4, because fatigue affects a slower eyelid closure, in particular a longer time period of eyelid closure, than the eyelid closure of an individual, when it is
5 awake. Furthermore, the time period and/or the frequency of the eyelid closure are detectable optically best.

Alternatively, the physical parameter PP is a pupil width or a heart beat of the driver 4, whereby the heart beat is not optically detectable. In this alternative
10 embodiment, the sensor unit 2.1 is designed as an electro-mechanical sensor, which is arranged for example in a steering wheel.

In the present embodiment, the sensor unit 2.1 is arranged into an inside mirror 5 of the vehicle interior 1 and directed to a vehicle seat 6. This allows
15 detecting a face or at least suitable parts of the face of the driver 4, if he takes a usual placement on the vehicle seat 6 for driving the vehicle. Thus, the time period and/or the frequency of the eyelid closure are reliably detectable.

20 Alternatively, the sensor unit 2.1 is arranged in other suitable places inside the vehicle interior 1, such as instrument panel, steering wheel or even windscreen.

The sensor unit 2.1 transmits the continuously detected physical
25 parameter PP to the evaluation unit 2.2, which is designed for example as a microprocessor and also arranged in the inside mirror 5.

After getting the physical parameter PP, the evaluation unit 2.2 evaluates physical parameter PP, for example by using a Kalman Filter, which is
30 integrated as a program sequence in the evaluation unit 2.2. If the evaluation indicates that the physical parameter PP is in a critical range, the evaluation

unit 2.2 generates an appropriate signal and transmits this signal to the audio device 3.

5 In this case the critical range indicates an appropriate level of fatigue of the driver 4, in which a concentration of the driver 4 is decreased, so that an increased accident risk can be assumed. For example, the eyes of the driver 4 are closed over a time of two seconds. For this example, the two seconds are a limit for the critical range.

10 After getting the transmitted signal of the evaluation unit 2.2, the audio device 3 processes the signal and transmits the signal as a periodic audio signal S into the vehicle interior 1, in particular directed to the driver 4.

15 Preferably, a frequency of the audio signal S is in a frequency range between 12 hertz and 15 hertz and thus in a frequency range of alpha waves and beta waves of a human brain, which are shown in figure 3 more detailed. The transmitted periodic audio signal S is transmitted as monaural beats or binaural beats or isochronic beats. Monaural beats are a result of an arithmetic sum of waveforms of two tones as they add or subtract from one another, becoming louder and quieter. That means that they are constant
20 sine wave pulses. Binaural beats are perceived by presenting two different tones at slightly different frequencies separately into each ear of the driver 4. In the present embodiment, the audio signal S is designed as an isochronic beat. Isochronic beats are regular beats of a single tone.

25

Furthermore, the frequency of the audio signal S is in a non audible frequency range of an individual, so that the audio signal S has no influence on other vehicle passengers.

30 Therefore, the audio signal S enables a stimulation of the brain waves of the driver 4 such, that a concentration of the driver 4 is increasable.

In a preferred embodiment, the audio signal S is superimposed with further audio signals. For example, the further audio signals are generated by music reproduction or receiving radio broadcast of the audio device 3. Preferably,
5 this allows a support of the further audio signals of the audio device 3 to improve a sound of the audio device 3.

The audio signal S is transmitted in a predetermined time period, which ends when the evaluated physical parameter PP is out of the critical range. That
10 means, that the transmission of the audio signal S stops, when the driver 4 is no more tired. This allows a stimulation of the brain waves of the driver 4 as long as the concentration of the driver 4 is decreased. Thus, the driver 4 is reliably prevented from falling asleep.

15 Figure 2 shows schematically a side view of a section of the vehicle interior 1 with the driver 4.

In the face of the driver 4 a mark 7 is shown, which is bordered by a first dashed line 7.1. The mark 7 represents a detection area of the sensor
20 unit 2.1. A second dashed line 7.2 is perpendicular onto an eye of the driver 4 and represents the detection of an eyelid closure as a physical parameter PP for a reliable detection of an appropriate level of fatigue of the driver 4.

25 For example, the face is located using a so-called "Haar algorithm", which is integrated as a program sequence in the evaluation unit 2.2. The eye location of the driver 4 can be found for example with projection techniques.

The human face indicates more fatigue signs than other human body parts.
30 This fact allows a reliable detection of an appropriate level of fatigue of the

driver 4, so that the brain waves of the driver 4 can be stimulated, if he indicates a decrease of concentration.

Figure 3 shows exemplary a graphic view of such brain waves.

5

Depending on their frequency brain waves are classified as beta waves B, alpha waves A, theta waves T and delta waves D, which are shown in this sequence from top to down in the present drawing.

10 Delta waves D are in a frequency range from 1 Hertz to 4 Hertz. They have high amplitudes and slow waves. Usually, they appear when the brain rests, in particular when an individual is in a slow wave sleep.

15 Theta waves T are in a frequency range from 4 Hertz to 7 Hertz. They appear usually when an individual is drowsy or in a sleep latency.

Alpha waves A are in a frequency range from 8 Hertz to 12 Hertz. They appear usually when an individual closes the eyes and is in relaxation, and attenuates with eye opening or mental exertion.

20

Beta waves B are in a frequency range from 12 Hertz to about 30 Hertz. They appear usually when an individual is fully awake and highly concentrated.

25 With the audio signal S, the brain waves are such stimulated, that a tired driver 4 with theta waves T preferably becomes a full concentrated driver 4 with high alpha waves A or low beta waves B.

Figure 4 shows an example of a section of such an audio signal S.

30

The audio signal S is amplitude and/or frequency modulated and designed as a monaural beat.

The audio signal S effects a stimulation of the brain waves of the driver 4 as
5 described in figures 1 to 3.

The periodic characteristic of the audio signal S enables a continuous and uniform stimulation of the brain waves of the driver 4 until he is awake with full concentration.

List of references

- 1 vehicle interior
- 2 monitoring unit
- 5 2.1 sensor unit
- 2.2 evaluation unit
- 3 audio device
- 4 driver
- 5 inside mirror
- 10 6 driver seat
- 7 mark
- 7.1 first dashed line
- 7.2 second dashed line

- 15 A alpha waves
- B beta waves
- D delta waves
- PP physical parameter
- S audio signal
- 20 T theta waves

Claims

1. Method for monitoring the alertness of the driver (4) of a vehicle, comprising
 - continuously detecting and evaluation of at least one physical parameter (PP) of the driver (4) while the vehicle is in motion,
 - transmitting a periodic audio signal (S) with a predetermined frequency into a vehicle interior (1) within a predetermined time period if the evaluated physical parameter (PP) is in a critical range, whereby the critical range indicates an appropriate level of fatigue of the driver (4).
2. Method according to claim 1, comprising
 - detecting as one physical parameter (PP) the face of the driver (4).
3. Method according to any one of the claim 1 or 2, characterized in that the predetermined time period ends when the evaluated physical parameter (PP) is out of the critical range.
4. Method according to any one of the claims 1 to 3, characterized in that the physical parameter (PP) is a time period and/or a frequency of an eyelid closure of the driver (4).
5. Method according to any one of the claims 1 to 4, characterized in that the predetermined frequency of the transmitted periodic audio signal (S) is in a frequency range between 12 hertz and 15 hertz.
6. Method according to any one of the claims 1 to 5, characterized in that the transmitted periodic audio signal (S) is superimposed with further audio signals.

7. Apparatus for monitoring the alertness of the driver (4) of a vehicle, characterized by
 - a monitoring unit (2) with a sensor unit (2.1), which detects at least one physical parameter (PP) of the driver (4), and
 - an evaluation unit (2.2), which evaluates the detected physical parameter (PP) while the vehicle is in motion, and whereby
 - the evaluation unit (2.2) is coupled to an audio device (3), which transmits a periodic audio signal (S) into a vehicle interior (1) within a predetermined time if the evaluated physical parameter (PP) is in a critical range.

8. Apparatus according to claim 7, characterized in that the sensor unit (2.1) is an optical sensor.

9. Apparatus according to claim 8 or 9, characterized in that the sensor unit (2.1) is arranged into an inside mirror (5) of the vehicle interior (1).

10. Apparatus according to any one of the claims 7 to 9, characterized in that the sensor unit (2.1) is directed to a driver seat (6).

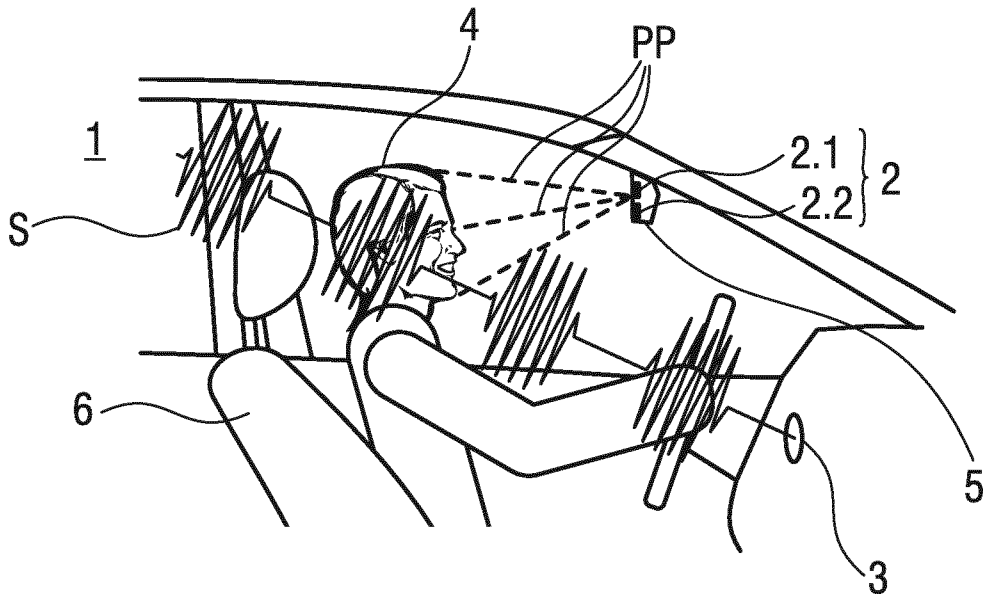


FIG 1

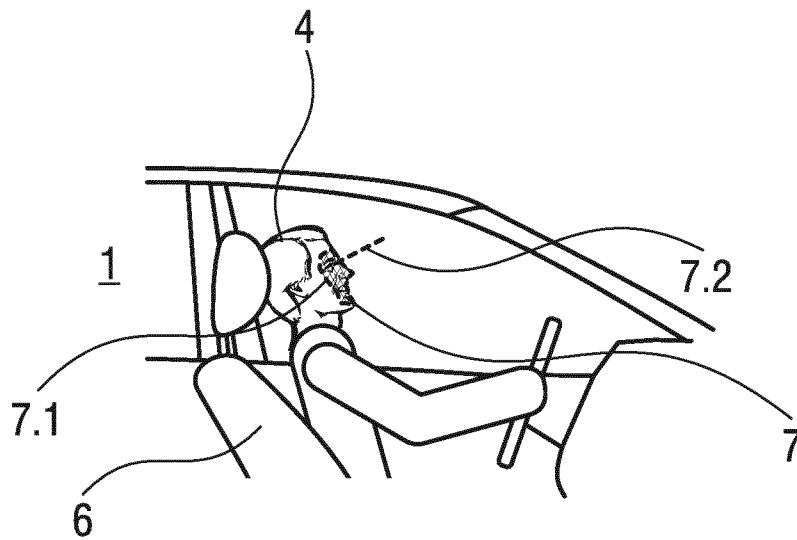


FIG 2

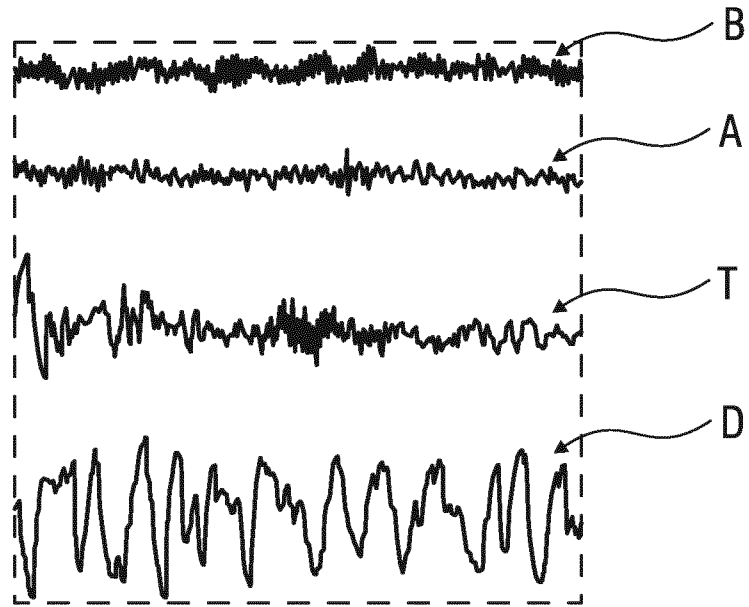


FIG 3

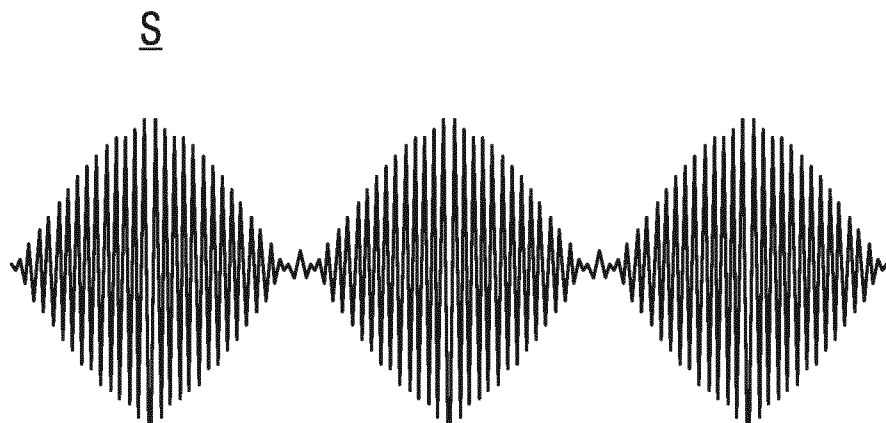


FIG 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2012/054020

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60K28/06

ADD. A61B5/18 B60W40/08

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)

B60K

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, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Schombacher, Hanno

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/054020

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