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(71) Applicant *(for all designated States except US)*: THE MIND CONNECTION [NL/NL]; Becanusstraat 13 B.05, P.O. Box 124, NL-6200 AC Maastricht (NL).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: DRIESSEN, Gerardus, Johannes, Maria [NL/NL]; Mariabastion 31, NL-6217 NB Maastricht (NL). TERHORST, René [NL/NL]; St. Jozefstraat 44, NL-6227 SN Maastricht (NL). MULDERS, Josef, Wouterius, Maria [NL/NL]; Kapittellaan 64 D, NL-6229 VP Maastricht (NL). BLOEMEN, Joost, Lodewijk, Karel, Frans [NL/NL]; Misboekstraat 69, NL-6131 CX Sittard (NL).

(74) Agent: DE BRUIJN, Leendert, C.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).

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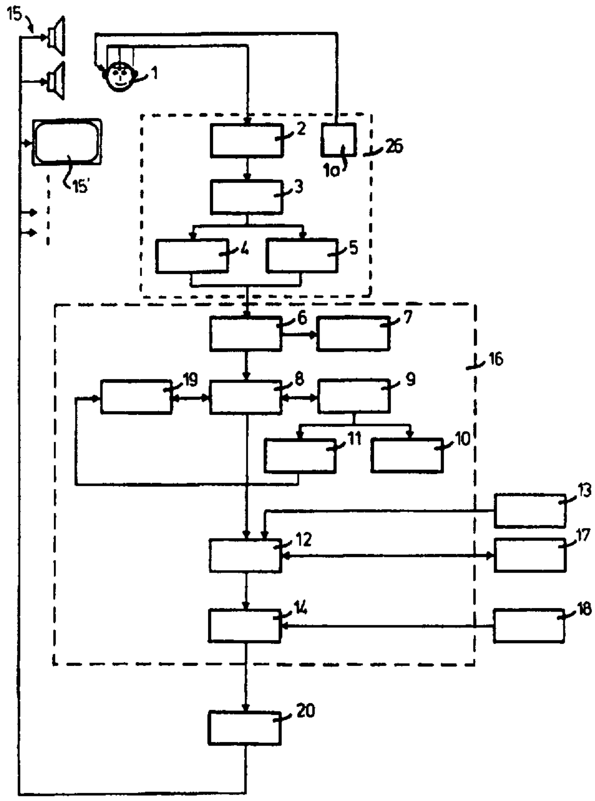
(57) Abstract

Device for the interactive generation of sensorially perceptible signals comprising at least one sensor (1) for detecting brainwaves and supplying brainwave signals, a processor (16) which is coupled to the at least one sensor and is designed to receive and analyse the brainwave signals, pattern generator means (14) with an output for outputting a pattern signal, which is related to the brainwave signals, feedback means (15), coupled to the pattern generator means, for generating the sensorially perceptible signals on the basis of the pattern signal, the processor being designed to convert the brainwave signals received into a control signal and to forward this control signal to the pattern generator means (14) and the pattern generator means comprising pattern file (23) in which predetermined files, MIDI files for example, are stored, and being designed to convert these files into the above-mentioned pattern signal as a function of the above-mentioned control signal.



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Device and method for the interactive generation of sensorially perceptible signals

The present invention relates to a device for the interactive generation of sensorially perceptible signals comprising at least one sensor for detecting brainwaves and supplying brainwave signals, a processor which is coupled to the at least one sensor and is designed to receive and analyse the brainwave signals, pattern generator means with an output for outputting a pattern signal, which is related to the brainwave signals, feedback means coupled to the pattern generator means for generating sensorially perceptible signals on the basis of the pattern signal.

A similar system is known from WO-A-90/01897, which discloses a device for converting an EEG signal into music. At least one sensor detects the EEG signal from the brains of a test object. A processor converts this EEG signal into electrical signals, which in turn is converted into music by synthesizers. The music that is generated is fed back to the brains by means of a loudspeaker or a set of headphones after a predetermined time delay. The music that is generated comprises at least one signal component, which follows the current contour of the EEG signal that has been detected, in order to amplify a predetermined desired EEG activity by means of a resonance effect. So, there exists in this known device a direct link between the detected EEG signal and the music that is generated. There is no possibility of controlling the actual conversion of the above-mentioned electrical signals into music.

WO-A-94/05210 discloses a bio-feedback system that detects EEG signals in the range from 0 - 90 Hertz. By means of a fast Fourier transform (FFT), amplitudes in predetermined bandwidths of the EEG signals are calculated. Relevant bandwidths can be selected and displayed on a screen. A person can be trained by means of the screen and audio feedback, or oral feedback. Controlling the generated music is not disclosed.

WO-A-95/18565 discloses a non-invasive, neuropositive test method and a system for carrying out a similar method. A computer station presents a test, for example a "visumotor" memory task, to a person. Brainwaves and other physiological activities are detected, multiplied and analysed. By comparing the results with standard measurements a score is awarded to the person that has been tested, after which it can be established whether or not the person has passed the test.

The object of the present invention is to provide a device and method for the interactive generation of music from sensorially perceptible signals, which is based on bio-feedback and with which the feedback can be set or controlled, as desired, either automatically, manually or using external signals.

Therefore, a device for interactive music as defined above according to the invention is characterized in that the processor is designed to convert the brainwave signals received into at least one control signal, and to supply this at least one control signal to the pattern generator means and in that the pattern generator means comprise a pattern file, in which previously generated files, MIDI files for example, are stored, and are designed to convert these files into the said pattern signal as a function of the said at least one control signal.

By not even immediately converting the brainwave signals into sensorially perceptible signals for feedback, but rather first converting them into a control signal, after which the control signal controls the manner in which the files are converted into sensorially perceptible signals, the generated signals to be fed back can be controlled either automatically or manually.

In order to make manual influencing of the control signal possible, in one embodiment the device has an input device, for example a keyboard or a mouse, by means of which a user can input instructions for the processor, the processor being designed to generate the said control signal on the basis of these instructions. Moreover, the device has one or more inputs and/or outputs. Control signals can be sent between at least two devices via these inputs and/or outputs. Devices can also be looped together via these inputs and/or outputs.

The processor may be designed to generate the said control signal on the basis of the said instructions in such a manner that the control signal is derived from at least one frequency band, selected by the user, of the brainwave signals received. The user can, for example, select frequency bands of this kind with the aid of a mouse, by means of which frequency areas on a screen, on which the brainwave signals are displayed, are selected. This can be carried out, for example, by means of arrows, which are displayed on the screen and indicate the width of frequency bands to be selected. Techniques of this kind using a mouse are known per se. Their advantage is that the user can, as desired, eliminate the effect of specific frequency bands from the detected frequency spectrum of the brainwave signals. This is linked with the personal preference of people for the type of the signals to be fed back, for example music: one person may find it more pleasant to stress higher tones than another.

In a further embodiment, the processor is designed to generate the said control signal on the basis of the said instructions in such a manner that the control signal is derived from the received brainwave signals with an amplification factor determined by the user for each frequency band selected. In such an embodiment, it is specified not only whether or not selected frequency bands are converted into the control signal, but also the degree to which the selected frequency bands are converted into the control signal. This provides a greater freedom in controlling the feedback.

In a further embodiment, the device is provided with skin-resistance measuring means, which are coupled to the at least one sensor, for measuring the skin resistance in the region of the sensor and displaying the skin resistance on display means. The skin resistance forms, inter alia, a good indication of the quality with which the sensor is applied to the body of a person. By reading out the skin resistance from the display means, it can be checked whether the sensor is correctly applied. The skin resistance may also affect the control signal. This is important, since the skin resistance forms a good indicator of emotional states of a person.

In a preferred embodiment, the device is designed to filter artefact signals which are caused, for example, by blinking of the eyes or by a source from the electricity supply. Artefact signals of this kind can recur at undesirably high amplitudes in the brainwave signals, while it is undesirable for them to affect the feedback. As an alternative, artefacts (whether or not defined by filtering) can also affect the control signal.

Sometimes the brainwave signals detected change very quickly or very slowly. In that case, the control signal generated also changes very quickly or very slowly, as a result of which the fed-back signals will change to a scarcely perceptible degree. In that case, it may be desirable to delay the rapid changes. With that in mind, the processor may, in a subsequent embodiment, be designed to generate the control signal in such a manner that the generated sensorially perceptible signals are affected in a delayed manner by the incoming brainwave signals.

The present invention also relates to a method for the interactive generation of sensorially perceptible signals, comprising the followings steps:

a. the detection of brainwaves;
b. the conversion of the brainwaves into brainwave signals;
c. the generation of a pattern signal, which is related to the brainwave signals;
d. the conversion of the pattern signal into sensorially perceptible signals

characterized in that step c comprises:

e. the conversion of the brainwave signals into a control signal and the conversion of predetermined files, for example MIDI files, into sensorially perceptible signals as a function of the control signal. Further methods according to the invention are defined in the subclaims 12 to 18.

Finally, the present invention relates to a device for supplying an EEG signal, comprising at least one sensor for detecting brainwaves and supplying brainwave signals, an analysis unit, which is coupled to the at least one sensor, for receiving and analysing the brainwave signals and putting together the EEG signal, characterized in that it is provided with a voltage or current source, which is coupled to the at least one sensor for the purpose of supplying a measuring signal with a predetermined measuring frequency thereto, on which measuring signal, during use, a signal which corresponds to the EEG is superposed by the at least one sensor, in that the device is also provided with a skin-resistance meter, which is coupled to the at least one sensor, for measuring the skin resistance in the region of the sensor, on the basis of the amplitude of the measuring signal received by the skin-resistance meter, and displaying the skin resistance on display means. By means of a device of this kind, it is possible in a simple manner simultaneously to measure both an EEG and a skin resistance.

The invention will be explained in more detail below with reference to a number of drawings, which are only intended to illustrate the invention, and not to limit it, and in which:

Figures 1a, 1b and 1c show a representation of brainwave signals, depicted in the form of small bars in the frequency spectrum, with different amplitudes for the left-hand and right-hand halves of the brain;

Figure 2a shows a block diagram of the device according to the invention;

Figure 2b shows a block diagram of a detail of the block diagram from Figure 2a;

Figure 3 shows a display of recorded brainwave signals in accordance with the traditional form of display based on "writing pens", as is usual for EEG measurements;

Figure 4 shows a display of brainwave signals in the frequency range for the left-hand and right-hand halves of the brain, minimum, maximum and average values measured during a specific period being shown;

Figure 5 diagrammatically shows the principle of the interactive generation of sensorially perceptible signals.

The invention provides a new development in mind technology, opening up new possibilities in the field of attention training. Consideration may be given here to the encouragement of mental and emotional relaxation, to improving attention and concentration, or to stimulating creativity.

The invention, as a two-channel EEG apparatus, also offers the technical innovation of visual, arithmetical feedback. The recorded brain activities are processed in different ways. In doing so, the brain information is displayed via clear and incisive graphics. As a result, the device can be used, inter alia, to perform comparative measurements. The device is thus also suitable for comparative analysis. Obviously, the measurement data are also displayed numerically. Progress in the field of attention control can thus be kept up with efficiently.

To explain the invention, there first follows a brief description of brainwaves. Brainwaves are in fact slight electrical oscillations. These oscillations have an amplitude (horizontal) and a frequency (vertical). Both the frequency and the amplitude of brainwaves can be recorded. The (diagnostic) electro-encephalogram measurement (EEG) is known in this connection.

Via two channels, the device measures the activities of the left-hand and right-hand halves of the brain. The graphic windows show that the activities of the two halves of the brain are not always identical.

Various brainwaves, having different frequencies and amplitudes, are active at the same time. This can be compared to a musical concert. During a concert, the various instruments have varying frequencies (ranging from the high tones of the violin to the low tones of the double bass). The amplitudes and sounds of these instruments are also variable. At a concert, one listens to the combined effect of the instruments. It is also possible specifically to follow the playing of one instrument (or a section) within this total composition. The same applies to the silent symphony of brainwaves: it is possible to observe the total pattern and the activities of separate brainwaves.

Figures 1a, 1b and 1c provide a graphic display of brainwave activities of the left-hand and right-hand halves of the brain in the frequency domain. The frequency domain is divided into four parts. Delta waves have the slowest frequency (1 and 2 Hertz). This is followed by the slightly quicker theta waves (2 to 8 Hertz), the alpha waves (8 to 14 Hertz) and the fast beta waves (14 to 32 Hertz). Of the beta waves, the frequencies 14 to 17 are visible in the graphical representation. For the frequencies from 17 to 33 Hertz, an average is given in the top bar.

In the graphical representation given in Figure 1a, there are four vertical double arrows v1-v4 and four horizontal double arrows h1-h4. Their meaning will be explained later.

During the day, most people produce a large number of fast beta waves. In this state, one is awake and alert. Fast, logical thought processes and actions are taking place. In doing so, critical considerations are weighed up, arguments are collected and decisions are taken. However, if the beta waves are dominant, a person may also be extremely tense and nervous. The memory is then working in a less than optimum manner and concentration problems may arise. Alpha waves generally occur in a relaxed state in which a person feels calm and balanced. In alpha, information is assimilated more easily. Access to the memory increases. Dominant alpha waves in principle are not accompanied by fear and aggression. One becomes agitated less quickly. For the average person, dominant theta waves generally occur in a state which is balanced between being awake and being asleep, or when dreaming. One is then no longer so receptive to external signals and one is focused more on oneself. It is more often a time of expressive recollections and creative insights. Delta waves are produced in particular during (dreamless) sleep. The deeper someone is sleeping, the slower the brainwaves are. In delta, one is generally not aware of the situation and surroundings.

Figure 2a shows a device according to the invention, by means of which interactive music can be produced.

The device comprises one or more (preferably three) sensors 1, which are to be applied to the head of a person. For the purpose of measuring the skin resistance, one or more of the sensors 1 are connected to a current or voltage source 1a, which during operation generates a current. This will be explained further later on. The signals detected by the sensors 1 are fed to an amplifier 2, which transmits an amplified signal to an analog/digital converter 3. A skin-resistance measuring unit 4 is connected to the output of analog/digital converter 3. The latter output is also connected to an input of a two-channel EEG measuring unit 5. The outputs of the skin-resistance measuring unit 4 and the EEG measuring unit 5 are together connected to a processor 16, for example a personal computer.

The elements 2 to 5 inclusive can be mounted in one small housing 26, which is referred to as a "transor".

Elements 6 - 12 and 14 are situated within the processor 16. However, if desired it is equally possible to arrange a number of these elements outside the processor 16 as a separate unit.

Both the output of the skin-resistance measuring unit 4 and the output of the two-channel EEG measuring unit 5 are connected to an input of an input window 6. One output of the input window 6 is connected to a wave window 7. Another output of the input window 6 is connected to the input of an analysis window 8.

One output of the analysis window 8 is connected to an input of a recording window 9 via a two-way connection. One output of the recording window 9 is connected to an input of a statistics window 10. Another output of the recording window 9 is connected to an input of an average window 11.

The output of the average window 11 is connected to an automation window 19, which in turn is connected to the analysis window 8 via a two-way connection.

A further output of the analysis window 8 is connected to the input of a feedback window 12. The feedback window 12 is directly or indirectly connected to input means 13 and 17, such as a keyboard, mouse or other means, by means of which a user can input external instructions. An output of the feedback window 12 is connected to an input of a pattern generator 14, in which, for example, controllable MIDI files are stored. An output of the pattern generator 14 is connected, via a sensorially-perceptible signal generator 20, to a loudspeaker 15, a display screen 15' etc. Obviously, it is also possible to use a set of headphones instead of a loudspeaker 15. The pattern generator 14 is also connected to project-data storage means 18, in which the user can store project data.

In the device shown in Figure 2a, use is made, for example, of a loudspeaker 15 and/or display screen 15' for feeding back music and/or generated images. In the latter case, no music/MIDI files are then stored in the pattern generator 14, but rather image files, the playback of which is affected by the control signal originating from the feedback window 12. As well as sound and/or images, it would also be possible to operate with other sensorially perceptible feedback signals. The invention is explained in more detail with reference to music feedback.

A distinction can be made in the device between recording, on the one hand, and induction, on the other hand. Via an electroencephalograph (EEG) the brainwaves are recorded and stored in the memory of the processor 16. Hitherto, measuring an EEG has been known mainly from the medical world. In this sphere, the EEG serves primarily to perform diagnosis. To do this, generally 20 or more sensors (measuring points) are placed on the skull. The brainwaves recorded are compared with one another for each measuring point. Applying the sensors is time-consuming and not particularly comfortable.

The device has not been developed primarily for medical diagnosis. Via the two-channel EEG measuring unit 5, the device records the shift in the brainwave activities in the left-hand and right-hand halves of the brain. This gives the user a general impression of the changes in his/her brainwave activities, and this is precisely the intention.

The device displays the recorded brainwaves via clear and incisive graphics. Moreover, the changing brainwave patterns of the user are fed back in changing musical compositions. This musical feedback is here referred to as musical induction.

In a general sense, musical induction has a changing effect on someone's emotional and mental perception (and thus also on the consequent attention shifts). For example, for one and the same person the induction of house music very quickly has a different effect than the induction of classical music.

Before going into a detailed description, the processing of the brainwave information by the device will firstly be briefly explained.

The brainwaves are picked up via the sensors 1 which are arranged on the head for this purpose. The picked-up electrical oscillations of the left-hand and the right-hand halves of the brain are transmitted to the amplifier 2 and then to the A/D converter 3, where the brainwave information is digitized. The digitized signals are then passed onto the computer 16.

The brainwave signal arrives first of all at the input window 6. Using the input window 6, it is possible, inter alia, to adjust the strength of the incoming signal. It should be noted that a "window" is here intended to mean both a screen (or part of a larger screen) and the means which are necessary to receive and process signals such that they can be displayed on the screen.

From the input window 6, the adjusted brainwave signal passes to the analysis window 8. In this analysis window 8, the total spectrum of the incoming signals from the left-hand and right-hand halves of the brain are displayed in real time (i.e. both the frequencies and the amplitudes of the brainwaves as recorded at that specific moment). The constantly changing diagram shown by the analysis window 8 is also referred to as a mind mirror diagram.

From the input window 6, the signal is also passed on to the recording window 9. Here, all incoming data is stored. The recording window 9 thus provides a total overview of all brainwaves recorded during a measuring session. The data from a measuring session can be stored in the computer's memory (not shown). It is also possible to calculate the average values of the recorded brainwaves. These average values can be seen in the statistics window 10.

The signal from the analysis window 8 is also passed on to the feedback window 12. The feedback window 12 also receives instructions input by a user via a keyboard/mouse 13. These instructions relate to various musical projects, for example playing and/or training projects.

A playing project contains a large amount of basic musical information. Each project is characterized by its own musical character. As a result, the various playing projects have various (musical) influencing characteristics (relaxing, dreamy, alert, etc.). These influencing characteristics encourage specific states of attention (for which one can read: specific brainwave activities). The user determines in advance which playing project he/she wishes to activate and control interactively.

On the basis of the input signals, the feedback window 12 produces control signals for the pattern generator 14. These control signals relate to the left-hand half of the brain, for example a control signal for the frequency with the highest amplitude and, separately from this, to the right-hand half of the brain, for example a control signal for the frequency with the highest amplitude, the difference between these two control signals and the one with the highest amplitude. The output signal from the pattern generator 14 generates music via the sensorially-perceptible signal generator 20, the content of which depends on the control signal emanating from the feedback window 12. The user hears this music, as a result of which his/her brain and thus attention is influenced. The feedback of music, which owing to its rhythm again has an inductive effect on the consciousness, is known as entrainment biofeedback.

Preferably, brainwaves are recorded by means of the sensors 1 at a sampling frequency of 100 samples per second.

A suitable sensor 1 is, for example, the Bleu Sensor - type BS 3500 from Medicotest. This type of sensor is light, relatively inexpensive, quick to apply and has good conductivity. The sensor also continues to adhere well when used over a long period.

However, other suitable sensors for different applications and at different prices are also commercially available. They are generally composed of a small conductive disc of metal or some other material, which is provided with an adhesive paste which is electrically conductive and reduces the skin resistance. It is generally possible to distinguish between two types.

- The first type is the disposable electrode, which acts on the basis of a conductive silver chloride solution. This is easy to use and can be attached as a sticker, but cannot be stuck to regions where hair is growing.
- The second type is the tin-lead electrode. This operates together with a separate tube of paste and can be reused again and again. However, it is rather laborious to use, although it can be used in regions where hair is growing.

Depending on the person and the frequencies to be measured, there are various positions to which the sensors 1 can be fastened. The alpha waves (7 to 14 oscillations per second) generally occur in the back of the head and as they become stronger move from the back of the head towards the other parts of the brain. A good position for measuring these waves is a few centimetres behind and above the ears (there is a specific calculation method for determining this location). In general, this region is covered by hair, as a result of which reliable application of a simple adhesive sensor is difficult.

A good alternative is to stick the left-hand sensor and the right-hand sensor directly behind the ears and as high as possible next to the hair line (there is generally no hair growing immediately behind the ears).

The sensor on the forehead is a reference sensor and can best be stuck as high as possible in the centre of the forehead (likewise just below the hairline present there). This is because this is where the lowest interference signals as a result of eye movements or other muscle contractions occur.

The sensors 1 are, as it were, the senses of the system. It is extremely important that they be applied correctly. If the sensors are not attached well, the risk increases of signals which are not relevant (interference) being recorded. Interference sources are defined below as artefacts. Artefacts which frequently occur are: muscle contractions, the beating of the heart and in particular eye artefacts (blinking of the eye and eye movements which when the eyes are closed are caused by "rolling" eyeballs). The signal from artefacts is frequently much more powerful than the signal of the brainwaves. In principle, artefacts are also recorded by the sensors and are transmitted to the computer 16 as a signal. The artefacts primarily affect the recording of the low brainwave frequencies. In some embodiments, artefacts are not filtered out, but rather are defined as the control signal.

The critical factor in applying the sensor to the skin is the skin resistance. The skin resistance is on average several hundred thousand ohms. In the case of EEG measurements for the purpose of (medical) diagnosis, it is generally sought to reduce the skin resistance to below five thousand ohms. At a skin resistance of this level, the measurement is also optimal for the invention.

The level of the skin resistance is permanently measured during the measuring session with the aid of the skin-resistance meter 4 and is then displayed in the input window 6. Practical experience has shown that for some people the measurement is even reliable at a higher skin resistance (up to thirty thousand ohms or more). On the basis of individual users' experience it can be investigated whether a higher skin resistance (higher than five thousand ohms) is acceptable for the user in question. Generally, however, it is the case that the higher the skin resistance the greater the risk of artefacts being recorded.

The measurement of the skin resistance takes place as follows. The current generated by the current or voltage source 1a arrives in attenuated form at the amplifier 2 via at least one of the sensors. Due to the fact that the current flows over part of the skin of the person, a signal which is an indication of the EEG is superposed thereon.

As shown, use is made of an analog/digital converter 3. The currently commercially available types are characterized by the following features:

- high resolution (20-24 bits);
- the sampling frequency is a multiple of the mains frequency; as a result, the so-called 50 Hertz source (60 Hertz in the United States) can be filtered in a simple manner.

In one embodiment, a signal of precisely one quarter of the sampling frequency of the A/D converter 3 is supplied to the sensors 1 via a resistor of, for example, 4.7 megaohms. If the sampling frequency is 100 Hertz, the signal thus has a frequency of 25 Hertz. The amplitude of this signal will be attenuated as a function of the skin resistance between the left-hand or the right-hand sensor and the reference sensor placed on the forehead. However, the amplitude of the signal will overwhelm the detected brainwaves considerably. An indication of the skin resistance is thus obtained by measuring the amplitude of the total incoming signal.

The brainwaves can then be derived again from the total signal in the following simple manner: a sample which was picked up two samplings earlier is added to each sample. As a formula, this represents: $y = x(n) + x(n-2)$. The transfer function of this filtering has a theoretically infinitely strong attenuation at precisely a quarter of the sampling frequency, and since the 25 Hertz signal is derived from the sampling frequency, this signal is thus completely suppressed.

A further improvement to the skin-resistance measurement can be achieved by applying, for the amplitude determination, the reciprocal transfer characteristic to the signal: $y = x(n) - x(n-2)$.

Thus:

$$\text{Brainwave} = x(n) + x(n-2)$$

$$\text{Skin resistance} = \text{ampl}\ \{x(n) - x(n-2)\}$$

A method of this kind in fact has consequences for the brainwaves measured. For further interpretation, they will have to be corrected using the inverted transfer characteristic of x(n) + x(n-2).

It goes without saying that a skin-resistance measurement of this kind is only possible if the analog/digital converter 3 used has a sufficient resolution and a sufficient dynamic range to measure the brainwaves and the skin-resistance signal at the same time.

The nature and character of the musical data vary for each playing project. By means of attention shifts, which translate into changing brainwave signals, the user influences the pattern variations and in so doing, for example, the tone colours, the pitches, the tempo, the amplitudes, the stereo image, etc., of the data of the relevant project. In this way, the user creates (within the musical frameworks of the selected playing project) his/her own thought music.

There follows an example of the possibilities of the input window 6.

As has been stated, the device records not only the brainwaves but also the skin resistance. The signals recorded (brainwaves and skin resistance) are firstly transmitted to the input window 6. In the input window 6, the incoming signals of brainwaves, on the one hand, and skin resistance, on the other hand, are displayed.

The level of the skin resistance can be expressed on a scale of 0 to 10 (in reality: 0 ohms to 100,000 ohms). Anyone wishing to carry out comparative research would be wise to reduce the skin resistance to 5,000 ohms. In general cases, a slightly higher skin resistance may be acceptable for recreational use. The acceptable level may vary from individual to individual.

The signal strength of the recorded brainwaves can vary as a function of factors related to the specific person. The incoming brainwave signal can be adjusted with the aid of an indication in the input window 6 and the use of a mouse 13.

The brainwave patterns vary considerably from moment to moment. 100 samples per second are taken from this dynamic process. An average of the incoming brainwave signals over a period of time to be determined is calculated without impairing the accuracy of the measurement. In this way, a workable pattern is formed. This average calculation can be changed by means of an indication in the input window 6 and a mouse 13.

As has been said, the recording of the extremely minor (electrical) brainwaves can quickly be interfered with by artefacts. The sensors can pick up signals which are not caused by brainwaves. As a result, the recording can be distorted.

In order to limit the recording of interference, the processor is preferably designed to filter artefacts automatically. As an alternative, a separate artefact filter may also be provided. Specific interference signals are identified and filtered (out). This applies, for example, to interference signals which emanate from an electricity network which is present (hum) or from passers-by (who may likewise form an interfering electrical voltage source).

The user him/herself can also cause interference signals (artefacts). Artefacts are the consequence, inter alia, of beating of the heart, swallowing, muscle movements and - in particular - of (unconscious) eye movements. Artefacts can even be caused with the eyes closed (as a result of rolling eyeballs). For example, when the imaginative (dream) capacity is activated, a person may "follow" these images which have been called up with his/her eyes. Eye artefacts occur primarily in the low frequency range. In general, it is true that the worse contact the sensor makes the greater is the risk of interfering artefacts being recorded.

Artefacts interfere with the brainwave measurement (the interfering influence of, for example, an eye movement can immediately be seen in the analysis window 8). Since, in the device, the brainwaves form the source for controlling the music, it is important that the effect of spurious signals (artefacts) be limited. To do this, the artefact filter is incorporated. This filter recognizes large, suddenly occurring changes in the recorded signal.

The artefact filter preferably has an adjustable threshold. Recorded signals which are more powerful than the set threshold value are filtered out. These filtered signals are then transmitted from the input window 6 to the analysis window 8 in less powerful form, or are not transmitted at all. Due to this filtering, the reproduction of the brainwave signal in the analysis window 8 also stabilizes itself more quickly.

The artefact filter can be switched off.

The device offers the possibility of storing the recorded brainwave information in brainwave files. As a result, the results of different measuring sessions for a user can be compared. It can be determined, inter alia, whether over the course of time change patterns occur in recorded brainwaves. It can also be investigated whether the person reacts differently to the various musical projects. A precondition for a useful comparison between various measuring sessions for a user is that the settings in the input window 6 are always identical. It should also be ensured that the sensor contact does not exhibit excessively large differences in skin resistance during the measuring sessions to be compared.

An explanation of the wave window 7 is given below.

With EEG measurements for the purpose of (medical) diagnosis, brainwaves are generally displayed via the traditional method of "writing pens". The wave window 7 is incorporated, inter alia, for the purpose of investigating the measurement technology by comparing the two-channel EEG measurement of the device and the recording of other EEG measurement apparatus. As shown in Figure 3, the wave window 7 likewise displays the recorded brainwaves graphically via "writing pens".

The recorded activities of the left-hand and right-hand halves of the brain can be seen on a real-time basis in the wave window 7. The top part of the graphic here shows the activities of the left-hand half of the brain. The bottom part shows the activities of the right-hand half of the brain.

The analysis window 8 will now be explained.

The analysis window 8 has two functions:

- a graphic real-time display of the incoming signals of the left-hand and right-hand recording channels.
- The analysis window 8 here has a number of (optionally automated) setting possibilities which determine the sophistication of the control of the music.

The analysis window 8 shows the changing brainwave patterns from moment to moment. It is usual for all the different brainwave frequencies to exhibit some level of activity simultaneously. However, the amplitudes for each frequency may differ or begin to differ considerably.

As shown in Figures 1a, 1b and 1c, the centre of the analysis window 8 contains a vertical column with a numerical scale which runs from 1 to 16 inclusive. This numerical scale represents the various brainwave frequencies. The recorded amplitudes of the left-hand and right-hand halves of the brain are respectively shown to the left and right of the numerical scale. The letter B (for beta) is situated above the scale divided into 1 to 16. The amplitude result at B is an average calculation of the recording from 17 to 25 Hertz, which is not specified for each separate frequency.

The display of the brainwave activities in the analysis window 8 is defined as the mind mirror. The dynamics of the mind mirror (the difference in amplitudes between the various brainwaves) generally increases when the eyes are closed.

When the brainwave signal "leaves" the input window 6, this signal is stored in the computer memory (not shown) as being "immutable". If a user adjusts the input window 6 in the same way during each measuring session, he/she can subsequently compare the results of his/her various measuring sessions with one another on a numerical basis. To do this, the statistics window can be "opened".

The signal as transmitted from the input window 6 is thus first fixed in definitive (and thus immutable) values. The brainwave signal can then be manipulated in the analysis window 8 in various ways. A manipulation of this kind thus has no influence on the way in which the brainwave signal is stored in the computer memory. The manipulation does have an influence on the way in which the brainwave signal is visually displayed via the analysis window 8.

A manipulation of this kind is frequently desirable in order to increase the distinctions between the amplitudes of the separate brainwave frequencies. This "refinement" makes the musical playing projects react in a more subtle manner to the differences in amplitude occurring between the various brainwaves.

The level of subtlety with which the device can control interactive music is limited by minimum and maximum values. These minimum and maximum values can be defined for each user. The type and character of the recorded brainwave signal will differ from user to user.

In fact, one user may emit a relatively powerful brainwave signal, while the signal recorded from another user may be weaker. It may be that a relatively large number of alpha waves are recorded from one user via the sensors behind the ears, while a relatively large number of theta waves are determined for the other user. All this is very much dependent on physiological factors. It is therefore somewhat premature to compare the brainwave patterns from various users with one another. It is much more relevant to compare the results and developments for one and the same user over a period of time.

The maximum and the minimum results of the brainwaves in analysis window 8 can be adjusted, for example using sliders on the screen. The setting has no further effect on the recording of the absolute values of the incoming brainwave signal.

In the recording window 9, starting from the instant of detection, the incoming brainwave information is picked up and stored. The brainwave information can then be played back again, rewound, saved, etc. In the process, the measuring session picked up is graphically depicted in the recording window. This graphic display in fact shows all the changes in brainwave patterns which occur during this measuring session.

Recording the information from a specific measuring session is further referred to below as the recording of a brainwave file.

On the basis of, for example, various colour displays of yellow, white and purple in the recording window 9, it is possible to read out whether the signal from the left-hand half of the brain was relatively more powerful than the signal from the right-hand half of the brain, or vice versa.

If the recording window 9 becomes a grey colour at the level of a specific frequency, this means that at that specific moment the recorded signals from both the left-hand and the right-hand halves of the brain are picked up at precisely equal strength. The lighter or darker this colour, the stronger or weaker, respectively, the signal is. If the yellow colour predominates, then at that instant (at this specific brainwave frequency) the recorded amplitude of the left-hand channel was more powerful than the recorded amplitude of the right-hand channel. If the purple colour dominates, the reverse is true and the right-hand channel was more powerful than the left-hand channel.

Therefore, after practising for a while, a user can use the colour shades and colour intensity to interpret the characteristics of a brainwave file at a glance. For example, if a user relaxes him/herself deeply for a certain period of time, this can result in an increase in the alpha or theta activity.

With the aid of a special run function key, it is possible to mark out a specific area in the brainwave file. This may be particularly suitable since it is then possible to have average calculations carried out using other function keys across the specific area which has been marked out. The marking-out is made possible by the use of, for example, two coloured indicator strips.

When the special run function key is activated, the recording window 9 is in fact divided into two horizontal bands. The separating line between these two bands lies between 7 and 8 Hertz. The lower band is reserved for determining the position of, for example, red and blue indicator lines of the run function with the aid of the mouse 13. The top band is reserved for determining the position of a standard, for example white, indicator line with the aid of the mouse 13.

Three sliders are situated in the recording window 9. These sliders can be used to adjust the colour intensity, a threshold value and the colour differentiation of the brainwave file, as displayed in the recording window 9. The standard setting of the sliders in principle brings about an effective display of the brainwave files. Certain aspects of the brainwave file can be accentuated using the sliders. The setting of the sliders in the recording window 9 only has a visual effect. The setting has no further effect on the recording of the absolute values of the incoming brainwave signal.

With the aid of the amplitude slider, the intensity with which the three colours yellow, white and purple are displayed in the recording window 9 can be adjusted. If the amplitude slider is set to a low value, only the lightest colour variations are displayed in the recording window 9, due to the fact that only the most powerful brainwave signals are displayed. If the amplitude slider is set to the maximum value, the colour intensity may be so powerful that differences disappear. If an incoming brainwave signal is in relative terms extremely powerful or else extremely weak, it may be decided to position the amplitude slider at a slightly lower or slightly higher setting.

Using the threshold slider, a threshold value can be set. This threshold value applies to all brainwave frequencies. Only after the recorded brainwave signals exceed the set threshold are these brainwave signals displayed in the recording window. If the threshold slider is set at a high value, only the most powerful brainwave signals will exceed the threshold value and then be visible in the recording window 9. In this way (optionally in combination with the run function) it can quickly be checked at which locations in the brainwave file powerful brainwaves were active.

Using the differentiation slider, the colour differentiation between the three colour shades can be set (as pointed out earlier, yellow stands for a dominant left-hand brainwave signal, purple for a dominant right-hand brainwave signal and white for a signal where the left-hand and right-hand halves of the brain are equally dominant). The lower the value at which the differentiation slider is set, the more blurred the differentiated colour indication between the amplitude of the left-hand and right-hand channels becomes. If the differentiation slider is set at a high value, the recorded amplitude differences between the measurement of the left-hand and right-hand channels are expressed more explicitly in colour differences in the recording window 9.

The averaging window 11 is activated with the aid of an averaging function key in the recording window 9. This window 11, an example of which is illustrated in Figure 4, shows the minimum, the average and the maximum values of the brainwaves as were displayed in the analysis window 8. This calculation is carried out over that part of the brainwave file which was marked out using the loop. In this context, the calculation is coupled to the setting of the sliders in the analysis window 8.

As an alternative, the averaging window 11 may have horizontal coloured bars. The start of the horizontal coloured bars shows for each frequency the minimum value of the brainwaves as it was displayed in the analysis window 8. The end of the coloured bars shows the maximum value of the brainwaves as it was displayed in the analysis window 8. The average of the brainwaves displayed corresponds to horizontal white strips in the frequency bars.

The averaging window 11 is a visual aid. In combination with the setting of the sliders in the analysis window 8, the averaging window 11 provides a rapid assessment of the minimum and maximum values of the brainwaves. This helps the user in manually setting the feedback range.

The parameters of the averaging window 11 can also be combined with the properties of one or more phases in the automation window 19.

There now follows an explanation of the use of the arrows v1-v4 and h1-h4 in Figure 1a, which is actually a reproduction of the analysis window 8 together with the feedback window 12.

The double arrows v1-v4 and h1-h4 have a standard setting which can be used in most situations. The double arrows can be shortened or lengthened in an appropriate manner using the mouse 13, as a result of which the action of the feedback is matched more accurately to the brainwave patterns of each user. This is carried out, for example, by clicking on and dragging the arrow points using one of the mouse buttons. The horizontal double arrows h1-h4 mark out the minimum and maximum limits of the effects of the amplitude of the brainwaves in a specific frequency range on the musical feedback. The vertical double arrows v1-v4 mark out the minimum and maximum limits of the effects of the frequency of the brainwaves in a specific range on the musical feedback. Thus vi corresponds to hi for i = 1, ..., 4. Each combination of a vi with an hi defines, as it were, a quadrilateral, by means of which a small frequency range is marked out (specifically by the length of vi) and the extent to which the small frequency range affects the final control signal, which is transmitted to the pattern generator 14, (specifically by the length of hi). For example, it is possible to define a maximum of 8 feedback windows, each with four combinations from the two halves of the brain. Therefore there are then at most 32 different effects on the interactive musical process.

The feedback windows 12 will now be explained. On the basis of at least one feedback window, it is possible to make a distinction between a feedback window for variations occurring in the amplitude and a feedback window for variations occurring in the frequencies.

The feedback window for the purpose of variations occurring in the amplitude can display a plurality of control signals. These control signals may - within the frequency range marked out with the aid of the vertical double arrows - be derived from, for example:

1.a the left-hand brainwave signal

1.b the right-hand brainwave signal

1.c the largest amplitude variation of the left-hand or the right-hand brainwave signal

1.d the difference between the amplitude variation of the left-hand and right-hand brainwave signals (1b - 1a).

For the benefit of control signal 1d, the feedback window contains a rotary button for attenuating or amplifying the difference (1b minus 1a). The reaction rate of the control signals can be slowed down or accelerated with the aid of an adjustable filter (implemented in the form, for example, of a rotary button in the feedback window).

The feedback window for variations occurring in the frequencies can likewise display a plurality of control signals. These control signals can - within the frequency range marked out with the aid of the vertical double arrows - be derived, for example, from the dominant frequency of:

2.a the left-hand brainwave signal

2.b the right-hand brainwave signal

2.c the left-hand and the right-hand brainwave signals together

2.d the difference between left-hand and right-hand brainwave signals (2b minus 2a).

Furthermore, the feedback window contains, for example, rotary buttons which act in a similar way to the rotary buttons as described under 1 (feedback windows for variations occurring in the amplitude).

The standard setting of the double arrows h1-h4 can in the first instance - by means of the display of the brainwave signal in the analysis window 8 - outwardly be altered. If desired, it is possible at any time to switch over from manual operation to automated operation, and vice versa. This is done by making use of the automation window 19. The purpose of this is to adjust the double arrows automatically by means of an analysis of the frequency spectrum. This can be done by (irrespective of the nature and the character of the recorded brainwave signals, which in practice can differ considerably depending on the person being measured and the measurement circumstances) converting the brainwave signal into at least one control signal, which during a recording session has available an optimum control range. To this end, an analysis of the incoming brainwave signal is continuously taking place in the automation window 19. It is possible here to use as a basis various phases of analysis, it being possible for the properties to differ for each phase. If desired, the phases can be implemented gradually during a recording session.

The properties of a phase may, for example, relate to:

- whether or not to activate the relevant phase;
- the duration of the phase;
- the detection of the highest amplitude in the entire frequency spectrum, so that this is displayed by the analysis window 8. If this amplitude is higher than a set maximum or lower than a set minimum, the volume of the incoming signal is adjusted in the analysis window 8. The speed with which this adjustment takes

place can be set using a regulator;

- the arrows v1-v4 and the corresponding arrows h1-h4; the increasing adjustment speed and the decreasing adjustment speed can be set for each single arrow point, optionally including in the calculation an adjustable positive or negative increment value. If necessary, a general arrow-setting speed can be determined for each phase for all the ranges together;
- the properties of a phase may optionally be combined with parameters provided by the averaging window 11.

The final control signals which are displayed in the feedback windows 12 can be processed internally via the processor or can be output via output 17 to drive external processes, for example a coffee-maker. This output serves to start up and/or continuously influence and drive external processors.

The processing of the control signals by pattern generator 14 will now be explained. Pattern generator 14 generates an output signal which is a function of data from project-data store 18 and of the control signals as supplied by the feedback window 12. The data from data store 18 form a series and are, for example, MIDI data. They are intended to influence the sensorially-perceptible signal generator 20. The data inside data store 18 thus indicate to pattern generator 14 what is to be done with the output signal from the feedback window 12 before passing it on to the sensorially-perceptible signal generator 20. The user him/herself can alter the content of the data in data store 18.

The pattern generator 14 has, for example, the structure as illustrated in Figure 2b. A table window 21 is connected to the output of the feedback window 12. The table window 21 has a two-way connection to a group window 22 and a two-way connection to a connections window 24. The output of the group window 22 is connected to an input of the connections window 24. Furthermore, the group window 22 is connected to a pattern file 23 via a two-way connection. An output of the connection window 24 is connected to an output window 25, an output of which is provided for connection to the sensorially-perceptible signal generator 20. The data in the pattern file 23 emanate from data store 18.

Within the pattern generator, the project data input from data store 18 can be edited via various text files and/or windows (Figure 2b). In the first instance, this editing takes place via the table window 21. It is determined here how the control signal is translated into at least one characteristic for (musical) control.

A plurality of patterns emanating from data store 18 are arranged in groups (matrices) in pattern file 23. At least one of the patterns from a group in the group window 22 is selected by means of one or more control signals. The playback speed of the said selected pattern is also determined as a function of a control signal.

It is then determined in the connections window 24 how the control signal affects the selected pattern. The selected pattern comprises one or more "events". Such "events" may (for example in the case of MIDI) be: control-change; note on/note off; programme change; pitch wheel, etc. The "events" may, for example, be identified here on the basis of pattern number, group number, controller number and MIDI channel. It is possible to determine for each discernible "event" what the effect is of a control signal on the associated value of the said "event". It is also possible to define a scale.

This information is then processed by output window 25, in which a number of definitive choices are specified, which choices (in the case of music) may relate, for example, to instrumentation, sounds, etc. Via output window 25, it is also determined, for example, whether the feedback takes place via images or music.

Consequently, the pattern generator 14 not only activates a specific pattern but also generates the playback variation of this pattern. This variation may, for example, comprise the playback speed and also (for each stored MIDI event) the degree to which associated values are affected by means of the control signal. In the case of music, this associated value may, for example, comprise the pitch, the filter frequency, the filter resonance, the sound effects, the tempo, the musical patterns, the volume and the balance.

Via the sensorially-perceptible signal generator 20 and the loudspeakers/television 15, 15', the control signal which is caused by a changing brainwave, an artefact occurring or a changing skin resistance, is converted into a perceptible signal. This signal passes in a sensory manner to the user. This sensory signalling may have an effect on the further development of control signals generated by the user. In that case, it is possible to talk about an interactive process, which is depicted diagrammatically in Figure 5. This interactive process can be consciously stimulated, if in compiling the project data for data store 18 the law of physics of "frequency following response" is taken into account. As a result, the perceptible signal can act inductively.

As a result, a user can (whether interactively or not) experiment with analysing the effect of his/her brainwaves on the music generated and can discover the connection between spheres of experience, images, music and brainwave patterns. This may serve a recreational purpose, but also offers the possibility of training the brain, for example with the aim of relaxing, imagining, remembering, concentrating, meditating, etc.

Claims

1. Device for supplying an EEG signal, comprising at least one sensor (1) for detecting brainwaves and supplying brainwave signals, an analysis unit (16), which is coupled to the at least one sensor, for receiving and analysing the brainwave signals and putting together the EEG signal, characterized in that it is provided with a voltage or current source (1a), which is coupled to the at least one sensor (1) for the purpose of supplying a measuring signal with a predetermined measuring frequency thereto, on which measuring signal, during use, a signal which corresponds to the EEG is superposed by the at least one sensor, in that the device is also provided with a skin-resistance meter (4), which is coupled to the at least one sensor (1), for measuring the skin resistance in the region of the sensor, on the basis of the amplitude of the measuring signal received by the skin-resistance meter (4), and displaying the skin resistance on display means (6).

2. Device according to Claim 1, characterized in that the device performs the following steps:
- the measuring signal received is sampled at a sampling frequency which is four times as great as the frequency of the measuring signal;
- the skin resistance is determined on the basis of the amplitude of the signal thus sampled;
- the EEG signal is filtered out of the signal sampled in this way by adding a sample picked up two samplings earlier to each sample of the sampled signal.

3. Device according to Claim 2, characterized in that the amplitude on the basis of which the skin resistance is determined is equal to the amplitude of the signal which is formed by subtracting a sample picked up two samplings earlier from each sample of the signal sampled in this way.

4. Device for the interactive generation of sensorially perceptible signals comprising at least one sensor (1) for detecting brainwaves and supplying brainwave signals, a processor (16) which is coupled to the at least one sensor and is designed to receive and analyse the brainwave signals, pattern generator means (14) with an output for outputting a

pattern signal, which is related to the brainwave signals, feedback means (15, 15') coupled to the pattern generator means for generating sensorially perceptible signals on the basis of the pattern signal, characterized in that the processor is designed to convert the brainwave signals received into at least one control signal, and to supply this at least one control signal to the pattern generator means (14) and in that the pattern generator means comprise a pattern file (23), in which previously generated files, MIDI files for example, are stored, and are designed to convert these files into the said pattern signal as a function of the said at least one control signal.

5. Device according to Claim 4, characterized in that it is provided with an input device (13), by means of which a user can input instructions for the processor (16), and in that the processor is designed to generate the said control signal on the basis of these instructions.

6. Device according to Claim 5, characterized in that the processor is designed to generate the said control signal on the basis of the said instructions in such a manner that the control signal is derived from at least one frequency band, selected by the user, of the brainwave signals received.

7. Device according to Claim 5, characterized in that the processor is designed to generate the said control signal on the basis of the said instructions in such a manner that the control signal is derived from the brainwave signals received with an amplification factor specified by the user for each frequency band selected.

8. Device according to one of Claims 4 - 7, characterized in that it is provided with skin-resistance measuring means (4), which are coupled to the at least one sensor, for measuring a skin resistance in the region of the sensor and displaying the skin resistance on display means (6).

9. Device according to Claim 8, characterized in that the skin-resistance measuring means supply an output signal which partly determines the form of the control signal.

10. Device according to one of Claims 4 - 9, characterized in that it is designed either to filter artefact signals caused, for example by blinking of the eyes, in the brainwave signals received, or to affect the control signal by means of artefact signals of this kind.

11. Device according to one of Claims 4 - 10, characterized in that the processor is designed to store brainwave signals received at various periods of time and to compare them with one another.

12. Device according to one of Claims 4 - 11, characterized in that the processor is designed to sample the received brainwave signals at a predetermined frequency and to display them after having calculated an average value for the amplitude over a predetermined period of time for each predetermined frequency band.

13. Device according to one of Claims 4 - 12, characterized in that the processor is designed to generate the control signal in such a manner that the sensorially perceptible signals generated are affected at different speeds by the incoming brainwave signals.

14. Method for the interactive generation of sensorially perceptible signals, comprising the following steps:

a. the detection of brainwaves;

b. the conversion of the brainwaves into brainwave signals;

c. the generation of a pattern signal, which is related to the brainwave signals;

d. the conversion of the pattern signal into sensorially perceptible signals

characterized in that step c comprises:

e. the conversion of the brainwave signals into a control signal and the conversion of predetermined files, for example MIDI files, into sensorially perceptible signals as a function of the control signal.

15. Method according to Claim 14, characterized in that the said control signal is generated in such a manner that the control signal is derived from at least one frequency band, selected by the user, of the brainwave signals received.

16. Method according to Claim 14, characterized in that the said control signal is generated in such a manner that the control signal is derived from the received brainwave signals with an amplification factor specified for each frequency band selected.

17. Method according to one of the preceding Claims 14 - 16, characterized by measuring a skin resistance and displaying the skin resistance on display means (6), the value of the skin resistance possibly determining the control signal.

18. Method according to one of the preceding Claims 14 - 17, characterized by either filtering artefact signals caused, for example by blinking of the eyes, in the brainwave signals received, or by affecting the control signal by means of artefact signals of this kind.

19. Method according to one of the preceding Claims 14 - 18, characterized by storing brainwave signals received at various periods of time and by comparing them with one another.

20. Method according to one of the preceding Claims 14 - 19, characterized by sampling the received brainwave signals at a predetermined frequency and displaying them after having calculated an average value for the amplitude over a predetermined period of time for each predetermined frequency band.

21. Method according to one of the preceding Claims 14 - 20, characterized by generating the control signal in such a manner that the sensorially perceptible signals generated are affected at different speeds by the incoming brainwave signals.

*****

fig-1a

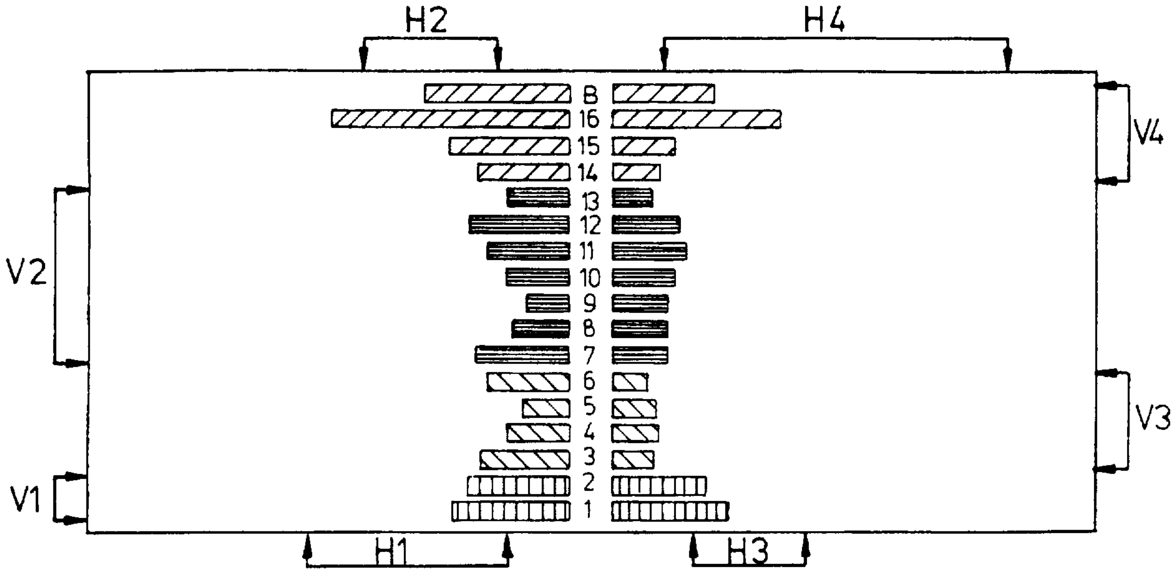


fig-1b

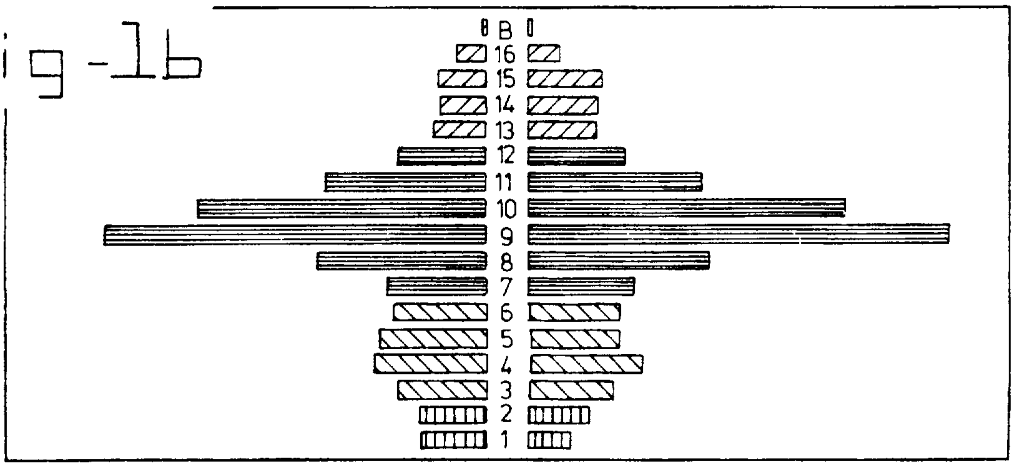


fig-1c

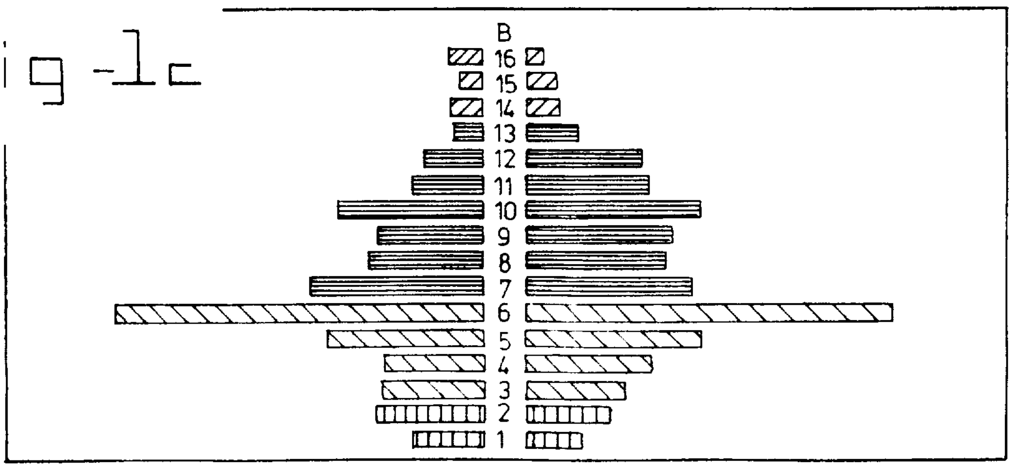


Fig-2a

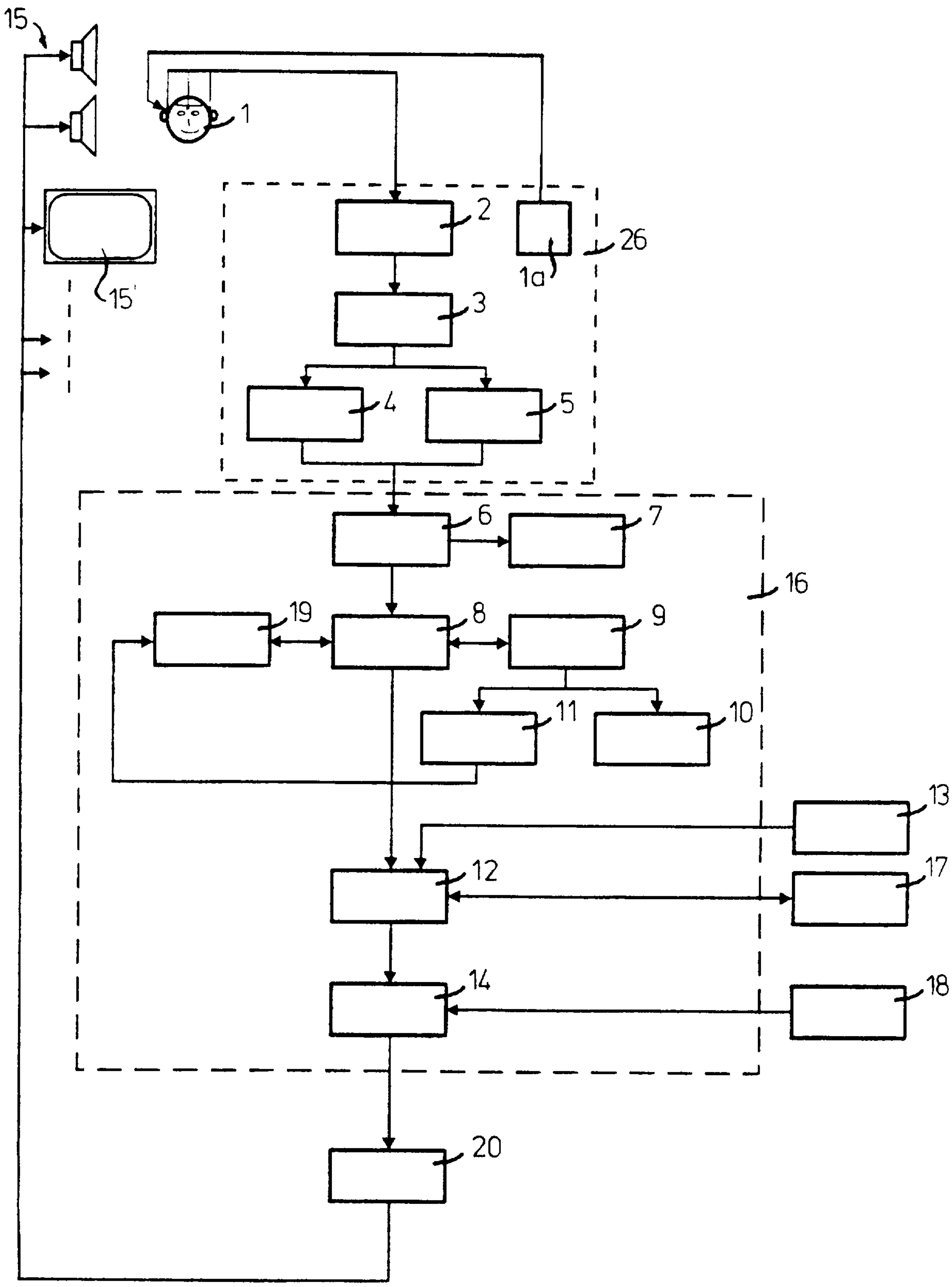


Fig-2b

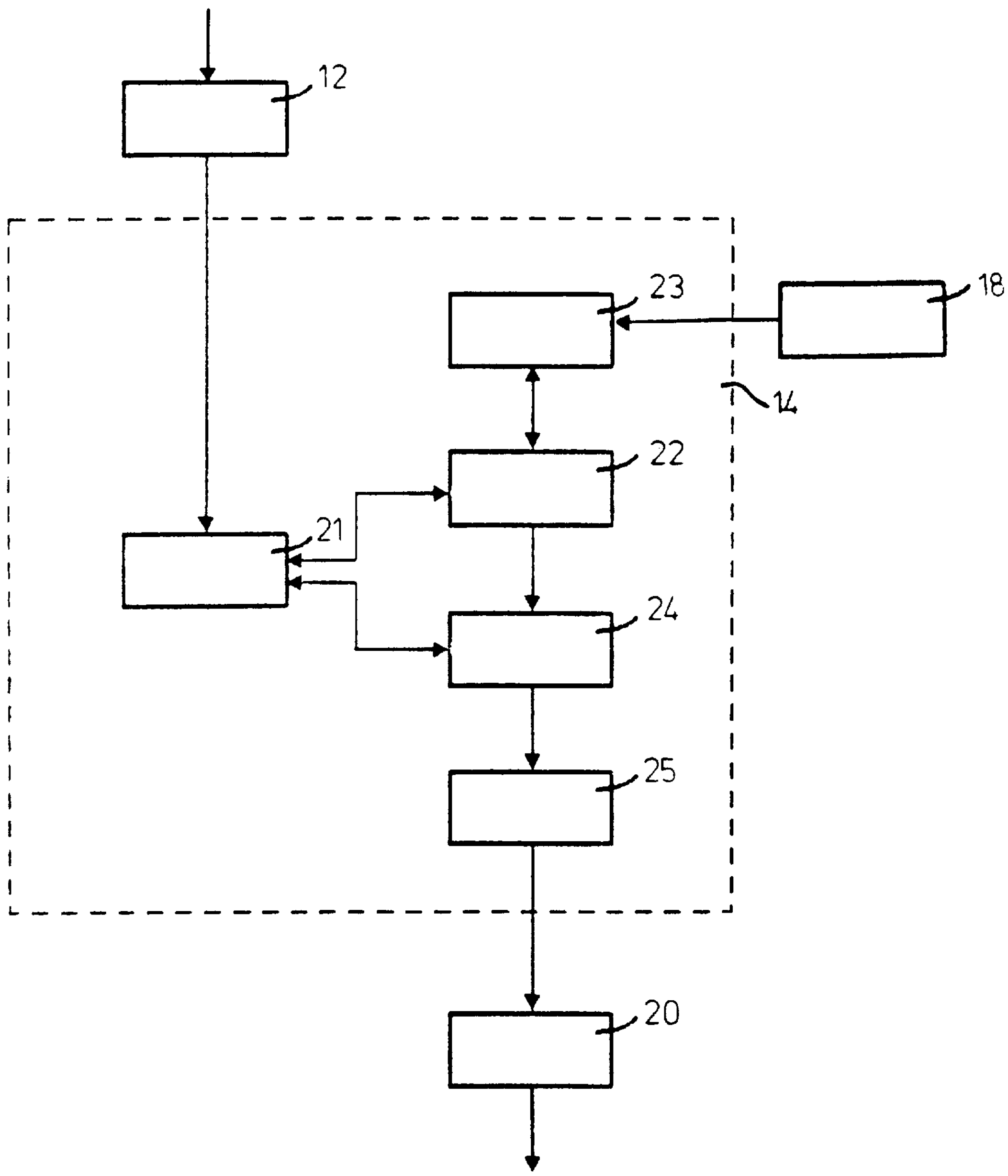


Fig-3

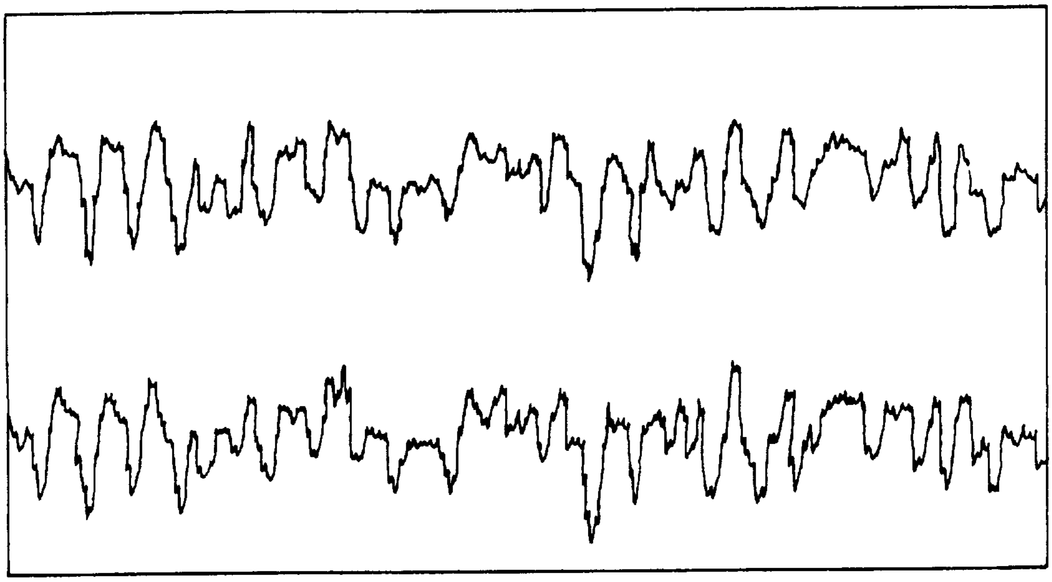


Fig-4

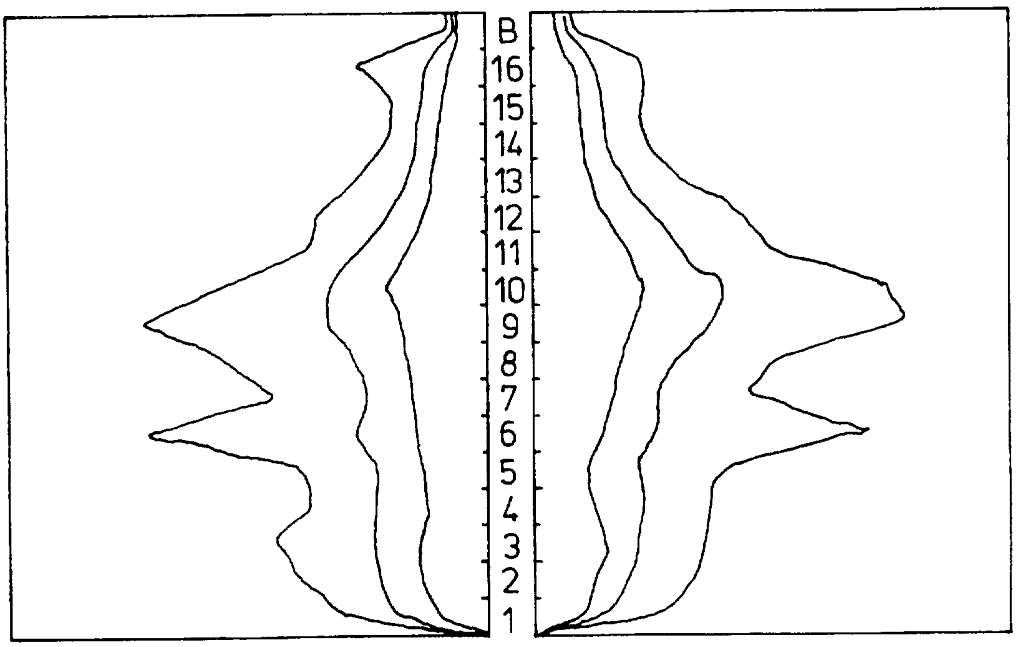
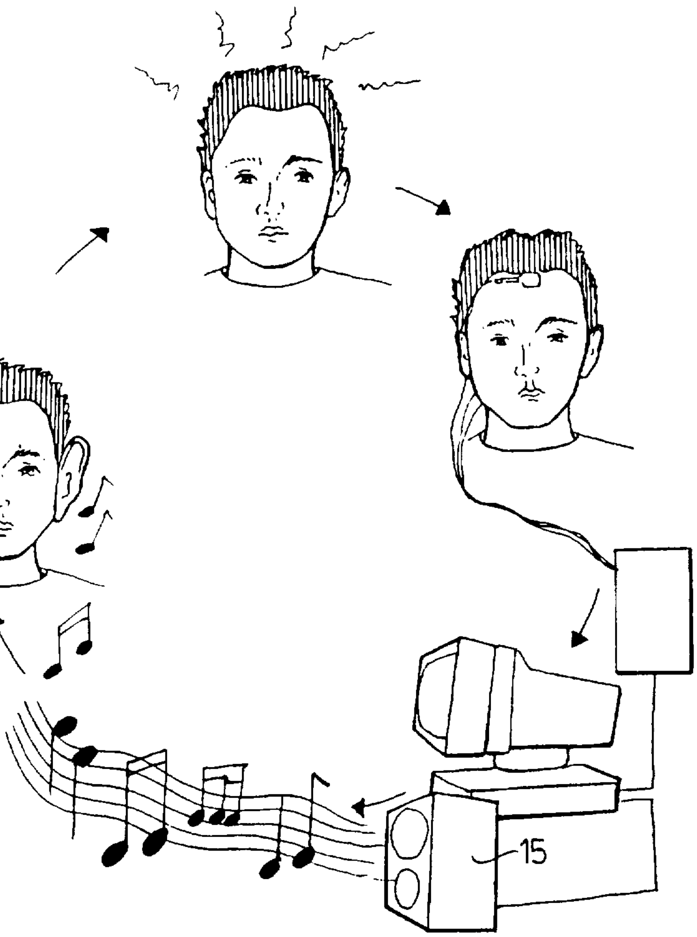


Fig-5



INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 97/00360

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61B5/0482 G06F19/00

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)
IPC 6 G06F

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 474 082 A (JUNKER ANDREW) 12 December 1995	4-7, 10-16, 18-21
A	see column 6, line 14 - column 9, line 17 see column 13, line 60 - column 14, line 30 see column 15, line 41 - line 46; figures 1-3,6 ---	1,8
X	US 4 928 704 A (HARDT JAMES V) 29 May 1990	4-7, 10-16, 18-21
A	see column 3, line 45 - column 5, line 42 see column 10, line 19 - line 26; figure 1 --- -/--	1

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

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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

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"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
22 October 1997	06. 11. 97

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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Guingale, A

International Application No
PCT/NL 97/00360

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 32 46 261 A (PICKER INT GMBH) 29 March 1984	1
A	see abstract; figures 1-3 see page 9, line 14 - page 12, line 10 ---	2,8,17
A	US 4 184 485 A (AGOSTON MIHALY) 22 January 1980 see column 4, line 21 - column 5, line 64; figure 2 ---	1,4-21
A	JANITZKI ET AL: "mehrkanal-hautwiderstandsmessungen" BIOMEDIZINISCHE TECHNIK, vol. 32, no. 5, 1987, WEST GERMANY, pages 98-107, XP002044130 see page 99, column 1, line 20 - page 100, column 2; figure 1 -----	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 97/00360

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5474082 A	12-12-95	WO 9721382 A	19-06-97
		AU 4516596 A	03-07-97
US 4928704 A	29-05-90	CA 2008472 A	31-07-90
		DE 69025966 D	25-04-96
		DE 69025966 T	05-09-96
		EP 0381090 A	08-08-90
		JP 3029668 A	07-02-91
DE 3246261 A	29-03-84	NONE	
US 4184485 A	22-01-80	CS 188989 B	30-03-79
		DE 2604177 A	26-08-76
		US 4126125 A	21-11-78