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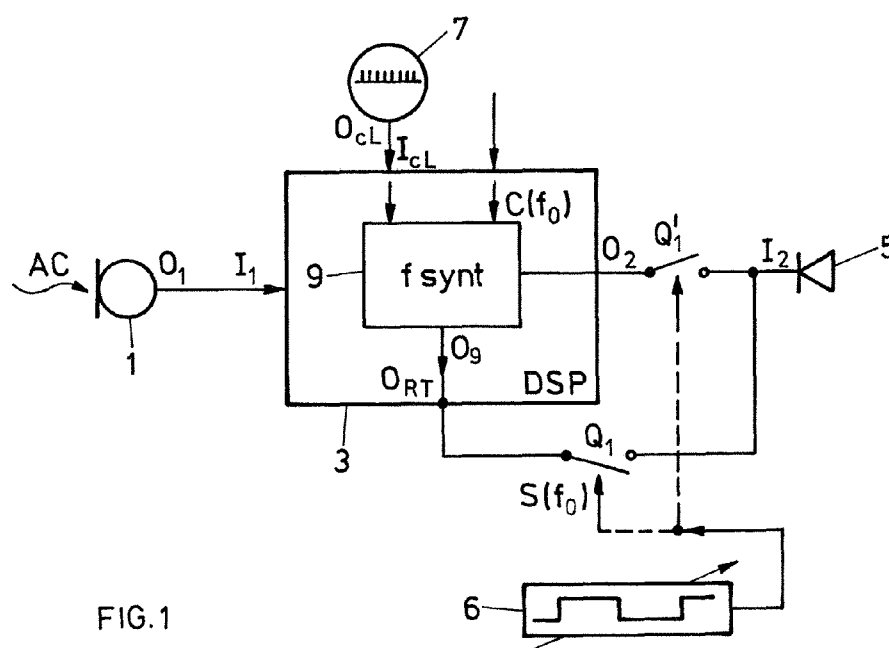


FIG. 1

(57) Abstract: A hearing device for musicians combines customary hearing device operation and tuning ability to help the musician in tuning his instrument or voice. Based on system clock (7) the digital signal processing unit (3) of the hearing device synthesizes a reference signal at tuning frequency (f_0). The resulting tuning signal is switched on the output converter (5) of the hearing device. So as to allow intermittent hearing of the tuning reference signal and of the tone as played by the instrument, a timing unit (6) may be provided so as to control when the reference signal is heard and when, by customary function of the hearing device, the tone as played is heard.

Hearing Device for Musicians

The present invention is directed on a hearing device for musicians. We understand throughout the present description and claims under the term "hearing device" a device which
5 is worn by an individual closely adjacent to or in an ear up to being located within the ear canal. Such hearing device is an active device. It comprises an input acoustical-to-electrical converter. The output of this converter is operationally connected to an input of a
10 digital signal processing unit. An output of this processing unit is operationally connected to the input of an output electrical-to-acoustical converter. A clock oscillator is operationally connected to the processing unit and provides the system clock.

15 More and more frequently such hearing devices are worn by individuals who have unimpaired hearing abilities just to facilitate hearing in every day acoustical surrounding. Further, such hearing devices are frequently used by hearing impaired persons so as to improve their hearing
20 towards the hearing ability of standard human hearing. Still further, such hearing devices are used for hearing protection purposes, i.e. for protecting the individual from excessive audio stimulus power. Thereby, two or three of the addressed types of hearing device applications may
25 be combined in one device and the respective task may be e.g. selected by the individual user.

With respect to wearing such a hearing device musicians are not an exception, so that more and more frequently this

group of persons too wears a hearing device as addressed above for one or more than one of the addressed purposes.

It is well-known that in practicing music it is customary to tune an individual instrument -including voice - by establishing comparison between an individually played standard tone and a reference tone.

Thereby the perceived pitches of the individually played standard tone and of the reference tone are either compared by the individual hearing perception or with the help of a tuning apparatus.

We understand in the present description and claims under the "pitch of a tone" the tone at that frequency of the spectrum of the respective individually played or reference tone which has maximum energy.

As a reference tone an absolute reference tone may be used or a relative reference tone. We understand throughout the present description and claims under an "absolute reference tone" a tone the pitch of which being predefined by its frequency. It is customary to use as an absolute reference tone the tone "A1" and thereby defining its frequency to be in a limited frequency range e.g. of at most 430 Hz to 450 Hz. In spite of the fact that the standard frequency for this tone A1 is set to be 440 Hz different orchestras set their absolute reference tone for A1 with a frequency which is different from 440 Hz, so e.g. on 442 Hz. Thus, a musician who plays in a group or orchestra with a selected absolute reference tone A1 e.g. on 445 Hz may, when practicing individually, check his instrument on proper

tuning with respect to this absolute reference tone at 445 Hz.

We further understand under a "relative reference" tone that tone which is given by a reference instrument when music is performed in a group. E.g. it is common in orchestras that the oboe plays a relative reference tone which accords to the tone A1, but from which the frequency is not necessarily known and needs not to be known. The other members of the group tune their instruments on this relative reference tone which is customarily done by each individual based on his proper audio perception.

As was addressed individual instrument tuning is today most frequently performed with the help of a tuning instrument, wherein the absolute reference tone is selected in Hz, normally for the tone A1 between 430 and 450 Hz. The individually played tone is picked up by a microphone and the frequency of its pitch is compared with the frequency of the absolute reference tone as selected. The difference in frequency is displayed at the tuning apparatus normally in terms of percentage deviation from the frequency of the absolute reference tone so as to inform the individual musician whether the individually played tone is rather sharp or rather flat. Thereby, such known tuning apparatus may not only check on the basis of the "A1"-related absolute reference tone, but may also check on any tone of the scales based on the selected frequency for the tone A1.

The present invention has the object of improving the benefits of a hearing device as addressed above for musicians. This is achieved by a hearing device which

comprises an input acoustical-to-electrical converter with a first output which latter is an electrical output. The device further comprises a digital signal processing unit which has a first input and a second output and further has
5 a clock input.

The hearing device further comprises an output electrical-to-acoustical converter with a second input which is an electrical input. Still further the device comprises a clock oscillator with a clock output. More generically the
10 electrical-to-acoustical converter may be realized as an electrical-to-mechanical converter.

The operational connections of the addressed units are as follows:

The output of the input acoustical-to-electrical converter,
15 which is the first output, is operationally connected to the first input of the digital signal processing unit. The output of the digital signal processing unit, which is the second output, is operationally connected to the second input, which is the input of the output electrical-to-
20 acoustical converter. Further, the clock output is operationally connected to the clock input of the digital signal processing unit. Thereby, the digital signal processing unit generates within a limited frequency range containing 440 Hz, especially in the range of 430 Hz to 450
25 Hz, a signal at a frequency f_0 of the pitch which signal is switchably operationally connectable to the second input, i.e. to the input of the output electrical-to-acoustical converter.

Thereby, there is generated by the signal processing unit and based on the clock signal input to the clock input a signal which is switchably made hearable to the individual wearing the hearing device as an absolute reference tone
5 for checking proper tuning of his instrument.

In spite of the fact that the addressed frequency f_0 of pitch may be pre-established in a fixed manner, i.e. manufacturer-established in the hearing device, e.g. on the standard frequency of pitch of 440 Hz, in one embodiment of
10 the device according to the invention, which may be combined with any subsequently addressed embodiments unless in contradiction, the frequency f_0 of pitch is selectable by the individual. Such selection of the frequency of the pitch in the addressed limited range may be done by the
15 individual by operating a selection member at the hearing device and/or by means of acting on a remote control for the hearing device. In that case, where the addressed frequency selection is performed at the device itself, it is advantageous for the individual to perform such
20 selection as the device is removed from his ear so as to have the possibility to check visually at an indication on the hearing device which frequency f_0 of pitch has been selected or set. If on the other hand, alternatively or additionally, the addressed frequency - f_0 - selection is
25 performed by means of a remote control unit for the hearing device, the respectively selected frequency of pitch will advantageously be displayed on the remote control.

It might be not too easy for the individual wearing the hearing device, on one hand to hear the absolute reference

tone at the frequency f_0 via the output electrical-to-mechanical converter of the hearing device and, on the other hand, to simultaneously hear the tone as played and thereby to perceive whether the tone as played has a
5 frequency of pitch which is higher or lower than f_0 to such an amount that tuning of the instrument is necessary.

Therefore, in one embodiment of the hearing device according to the present invention, which may be combined with any of the preaddressed embodiments and with any of
10 the embodiments to be addressed, if not in contradiction, the absolute reference tone generated by the digital signal processing unit at frequency f_0 of its pitch is intermittently output at the output electrical-to-mechanical converter. This allows to intermittently compare
15 the addressed absolute reference tone at the frequency f_0 of its pitch with individual's playing, which significantly facilitates accurate perception of a tuning need.

Thereby the reference tone may intermittently be output by user control, i.e. in that the user switches such output on
20 and off or switches the output just on and the reference tone is then perceived for a predetermined time span and is if desired restarted. Alternatively, the reference tone is output repeatedly at preset intervals and for a preset amount of time.

25 Up to now the device according to the invention in all its embodiments as discussed, presents to the individual an absolute reference tone at the frequency f_0 of its pitch, whereby the accurate estimation, whether individual's

instrument is properly tuned, is left to the ability of the individual.

In a further embodiment of the hearing device according to the invention, which may be combined with any of the

5 preaddressed and subsequently addressed embodiments, unless in contradiction, the digital signal processing unit comprises a frequency comparing unit which has - generically in processing terms - two inputs, namely a third and a fourth input, as well as an output, the third
10 output. The frequency comparing unit generates an output signal at the addressed third output which is dependent from the frequency difference of pitch signals applied to the fourth and fifth inputs of the frequency comparing unit. One of the addressed third and fourth inputs is
15 operationally connected to the first output, i.e. the output of the input converter, whereas the other of the addressed third and fourth inputs to the frequency comparing unit is operationally connected to the reference tone output of the digital signal processing unit, whereat
20 the tone with frequency f_0 of pitch is generated.

Thereby, the hearing device picks up by means of the input acoustical-to-electrical converter acoustical signals from the surrounding. When the individual plays his instrument, the pitch of this signal is governed by such playing. The
25 frequency of the respective pitch is compared at the frequency comparing unit with frequency of pitch of the established reference tone. Thus, the resulting frequency difference at the output of the frequency comparing unit is an indication of proper tuning or mistuning of individual's

instrument with respect to the established absolute reference tone of the frequency f_0 of its pitch.

If necessary, there might be provided a bandpass filter unit e.g. with a pass band of 430 to 450 Hz between the
5 output of the input acoustical-to-electrical converter and the one input to the frequency comparing unit.

Mistuning or proper tuning may be acoustically displayed to the individual wearing the hearing device, e.g. by a single beep indicating that the individually played tone is flat
10 (frequency lower than f_0), a double-beep for proper tuning within preestablished tolerances and by a triple-beep indicating to the individual that his instrument is tuned too sharp (frequency higher than f_0).

Alternatively or additionally, tuning information may be
15 displayed on a remote control for the hearing device.

Thus, by the addressed embodiment there is performed automatic comparison of an individually played tone with the absolute reference tone generated within the hearing device.

20 Thereby, it is perfectly clear to the skilled artisan that the operation of the embodiment as was just addressed to establish automatic frequency comparison may selectively be activated or disabled by the individual, be it by a respective action upon the hearing device and/or by means
25 of a remote control for the hearing device.

In a further embodiment of the hearing device according to the present invention, which may be combined with any of the formerly addressed and of the subsequently addressed

embodiments if not in contradiction, the digital signal processing unit comprises a frequency comparing unit with a third and with a fourth input and with a third output.

Thereby, both inputs of the frequency comparing unit are
5 controllably and intermittently operationally connectable to the first output. Thereby, controllably, one or the other addressed inputs to the frequency comparing unit become connected to the output of the input acoustical-to-electrical converter.

10 Thus, in this embodiment, whenever one of the third and fourth inputs to the frequency comparing unit is operationally connected to the output of the input acoustical-to-electrical converter and, e.g. in an orchestra, one instrument plays the relative reference tone
15 and, afterwards, the other input to the frequency comparing unit is operationally connected to the addressed output of the input acoustical-to-electrical converter and the individual plays his instrument, then the output of the frequency comparing unit will be indicative of the
20 difference of the signal frequencies of the pitches of the relative reference tone and of the respective individually played tone.

Thereby, in a further variant of the just addressed embodiment the control of the fact which of the third and
25 of the fourth inputs to the frequency comparing unit is momentarily to be connected to the output of the input acoustical-to-electrical converter is performed by the individual by means of a remote control for the hearing device.

On the remote control there is e.g. provided a first key labeled "reference tone" which controls the one input to be connected to the output of the input converter. This key is operated by the individual whenever the addressed relative
5 reference tone is played. Then the individual operates a second key at the remote control e.g. labeled with "tuning", this leads to operational connection of the other input to the output of the input converter. In this operating mode the individual plays his instrument so that
10 after having operated both keys at the output of the frequency comparing unit the respective tuning information is present. The tuning information is again dispatched e.g. at the remote control unit.

Again, it may be necessary to provide a bandpass filter,
15 e.g. with a pass band of 430 Hz to 450 Hz downstream the first output, i.e. the output of the input acoustical-to-electrical converter and upstream the third and fourth inputs to the frequency comparing unit.

When we speak of a "frequency comparing unit" having two
20 inputs, it has to be understood that these two inputs need not be separate hardware inputs. As perfectly clear to the skilled artisan, it is absolutely possible to first detect and store the frequency of one of the played or of the relative or absolute reference tones and then have it
25 compared to the frequency of the other tone. Thereby necessitating at the frequency comparing unit only one hardware input. The manner and technique of establishing comparison of two distinct signals may be realized in a lot of different manners. It further has to be pointed out that

digital signal processing units of hearing devices as addressed throughout the present description and claims are customarily equipped with FFT units so that analysis of a prevailing tone so as to establish its pitch and the frequency of such pitch may be performed with equipment which is already built in customary hearing devices.

In spite of the fact that for some applications a frequency accuracy of 1% may suffice for the frequency f_0 and/or for the frequency of the pitch of a played tone, in a further embodiment of the device according to the present invention, which may be combined with any of the preaddressed and the subsequently addressed embodiments, unless in contradiction, the clock oscillator of the device is selected to provide for a frequency stability within the range of $\pm 0.1 \%$ and, even better, of ± 100 ppm.

The present invention further provides for a method of tuning an instrument which comprises generating, in a hearing device, an absolute reference tone at a predetermined or at a selected reference frequency of pitch. The frequency of the pitch of a tone to be tuned is compared by the hearing device with the frequency of the pitch of the reference tone. There is generated a perceivable tuning indication for the tone to be tuned, based on the result of the addressed comparing. Thereby, tuning based on an absolute reference tone is established.

In another mode of the present invention which may be combined with the method that was just addressed, there is proposed a method of tuning an instrument which comprises generating, in a hearing device, a difference of

frequencies of pitches of subsequently impinging tones.
There is generated in the hearing device an indication
about frequency deviation of one of the addressed pitches
to the frequency of the pitch of the other tone. Thereby,
5 tuning based on a relative reference tone as was addressed
above is established.

The present invention shall now further be described and
exemplified with the help of figures. The figures show:

Fig. 1 in a schematic and simplified functional-
10 block/signal-flow diagram, a first embodiment of a
hearing device according to the present invention
and operating a method according to the invention;

Fig. 2 in a representation in analogy to that of fig. 1,
a further embodiment of a hearing device according
15 to the present invention and operating a method
according to the present invention, and

Fig. 3 still in a representation in analogy to those of
the figs. 1 and 2, a further embodiment of a
hearing device according to the present invention
20 and operating a method according to the present
invention.

Fig. 1 shows a simplified schematic signal-flow/functional-
block diagram of an embodiment of a hearing device
according to the present invention. The hearing device
25 comprises an input acoustical-to-electrical converter
arrangement 1 with a first output O_1 . A digital signal
processing unit 3 of the hearing device comprises a first
input I_1 , to which the first output O_1 of the input
acoustical-to-electrical converter 1 is operationally

connected. The digital signal processing unit 3 comprises a second output O_2 , which is operationally connected to a second input I_2 of an output electrical-to-mechanical converter 5. A clock oscillator 7 which is jitter-optimized and frequency-stable e.g. in dependency of temperature and/or electric supply variations and is tailored e.g. as a crystal oscillator or a surface acoustic wave resonator. Dependent on jitter and stability requirements also a more common RC oscillator may be applied. The oscillator 7 provides at the clock output O_{c1} the system clock which is fed to the clock input I_{c1} of the digital signal processing unit 3. The hearing device as described up to now is - with the exception of selecting an exceptionally stable and jitter-free oscillator 7, as of a crystal oscillator or a surface acoustic wave resonator - is customary and treats acoustical signals AC impinging on the input acoustical-to-electrical converter 1 by the digital signal processing unit 3 as is required by the intrinsic object of the hearing device.

In spite of the fact that under some circumstances an RC-based oscillator or clock unit 7 may suffice for the improvement according to the present invention, which will be described, it is preferred to make use of a system clock unit 7 which is more accurate and stable than an RC oscillator as concerns the frequency of the generated clock, as was addressed.

According to the present invention the digital signal processing unit 3 comprises a frequency synthesizer unit 9 which may e.g. be tailored as a direct digital synthesizer

unit DDS to provide at an output O_9 a signal with a desired frequency f_0 as a pitch frequency. The frequency output from the frequency synthesizer unit 9 is within a limited frequency range of e.g. 430 Hz to 450 Hz. The output signal $S(f_0)$ from the frequency synthesizer unit 9 is selectably applied to the second input I_2 of the output electrical-to-mechanical converter so as to be heard by the individual wearing the hearing device and as schematically shown by switching unit Q_1 . Thus, the digital signal processing unit 3 comprises a reference tone output O_{RT} at which the addressed signal $S(f_0)$ of reference frequency f_0 is generated. Whenever the operational connection between the output O_{RT} of the digital signal processing unit (DSP) 3 is disabled as schematically shown by the switch Q_1 the hearing device operates in its normal mode for which it has been customized. Whenever the addressed operational connection is established as schematically shown in fig. 1 by closing switch Q_1 the individual wearing the hearing device hears the reference tone according to $S(f_0)$ at a frequency f_0 of pitch within the addressed limited range of e.g. 430 to 450 Hz.

Hearing this reference tone which is an absolute reference tone of pre-established frequency f_0 , the individual may now play a respective tone on his instrument and consider whether his instrument is well-tuned or not with respect to the addressed reference tone.

As was addressed in the introductory part of the description it is customary to make use of the reference tone A1 which is standardized on 440 Hz.

Nevertheless, it is further customary to select the addressed tone A1 on frequencies different from 440 Hz, but within a limited range of e.g. 430 to 450 Hz. Very customary is to attribute to A1 442 Hz.

5 Thus, in spite of the fact that the frequency f_0 of the reference tone may be programmed and established in the frequency synthesizer unit 9, in one embodiment of the hearing device according to the invention there is provided at the frequency synthesizer unit 9 a control input $C(f_0)$
10 at which the value of the output frequency f_0 may be selected e.g. within the addressed limited frequency range.

The operation of controllably switching as shown by Q_1 , in fig. 1 and of selecting the value of frequency f_0 as schematically shown in fig. 1 at the control input $C(f_0)$ is
15 performed by an individual. Respective operating members to control the addressed selecting - Q_1 - on one hand and to select the frequency f_0 on the other hand may be provided at the hearing device itself. Nevertheless, in one embodiment enabling and disabling the operational
20 connection as schematically shown in fig. 1 by Q_1 as well as selection of the value for f_0 is performed by the individual at a remote control unit (not shown).

Thus, whenever the operational connection, according to Q_1 is established, the individual hears the reference tone and
25 when playing the respective tone with his instrument may judge whether his instrument is well-tuned on this reference tone or not.

Nevertheless, it might be of some difficulties for the individual musician to establish, whether his instrument is

well-tuned or not when simultaneously hearing the reference tone at frequency f_0 and the respective tone played with his instrument.

So as to facilitate auditive recognition of a frequency deviation between f_0 of the pitch of the reference tone and the frequency of the pitch of the tone played with the instrument and as also shown in fig. 1, whenever operational connection of the reference tone output O_{RT} to the input of the output electrical-to-mechanical converter 5 is established, as shown by switch Q_1' schematically, the operational connection of the addressed input I_2 to the output O_2 of the digital signal processing unit 3 is disabled. Thus, the individual may select to hear intermittently the reference tone from output O_{RT} or the tone as played on his instrument.

Thereby, the rhythm of switching on Q_1 and switching off Q_1' and inversely may be controlled automatically e.g. displaying the reference tone $s(f_0)$ during 3 sec. and allowing check of the player tone for 10 sec. A respective timing unit is schematically shown at Ref. Nr. 6 of fig. 1. Thereby, the respective rhythm may be adjusted by the individual e.g. taking into account the type of instrument to be tuned.

Fig. 2 shows a further embodiment of the device according to the present invention. Thereby, connections as well as units which have already been explained and addressed in context with fig. 1 are labeled with the same reference numbers and are not explained again. According to the embodiment of fig. 2 the output O_9 of the frequency

synthesizer unit 9 is operationally connected to an input I_3 of a frequency comparing unit 11. A second input I_4 to the frequency comparing unit 11 is operationally connected to the output O_1 of the input acoustical-to-electrical
5 converter 1. Whenever the frequency comparator unit 11 is enabled, which is done by the individual at the hearing device itself and/or with the help of a remote control (not shown) and is schematically shown in fig. 2 by the control signal E_n , the frequency comparing unit 11 compares the
10 frequency of the pitch of the reference tone (f_0) at input I_3 with the frequency of the pitch of the tone received by input acoustical-to-electrical converter 1 and thus with the frequency of the pitch of the instrument tone. At the output O_3 of the frequency comparing unit 11 there appears
15 a signal Δf indicative of the frequency deviation of f_0 and of the frequency of the pitch of the played tone. As schematically shown in fig. 2 by the threshold unit 13 and the acoustical signal generator unit 15 there is generated at the input I_2 of the output electrical-to-mechanical
20 converter 5 an acoustical signal, e.g. a beep-indication which indicates whether the frequency of the pitch of the played tone is flat or sharp with respect to f_0 .

Alternatively or additionally, the respective deviation is displayed in analogue or digital form on a remote control
25 unit (not shown) for the hearing device. As perfectly clear to the skilled artisan, establishing the pitch of the played tone and its frequency is performed by abilities of the digital signal processing unit 3 which are anyway provided for intrinsic hearing device functioning. Such
30 digital signal processing units customarily comprise e.g.

FFT processing, wherefrom the spectral representation of an acoustical signal is generated. Thereby, the pitch may easily be discriminated as well as its frequency.

Further, it has to be noted that the frequency comparing
5 unit 11 is most generically tailored to perform comparison of the frequencies of the addressed two signals. Any suitable technique to do so may be applied.

The embodiments as have been described with the help of the
figs. 1 and 2 provide for a help for the individual to tune
10 his instrument relative to an absolute reference tone which in one embodiment may be selected with respect to its frequency.

In a further embodiment of the present invention which may be combined with the embodiments as of the figures 1 and/or
15 2 tuning with respect to a relative reference tone as e.g. played by the oboe in an orchestra becomes possible.

According to fig. 3 in this embodiment the inputs I_3 and I_4 are intermittently and controllably operationally connected to the output O_1 of the input acoustical-to-electrical
20 converter 1. To allow frequency comparison in frequency comparing unit 11, the frequency of the pitch of a tone impinging on converter 1, as schematically shown by switch Q_3 , is applied to one of the inputs I_3 or I_4 and is stored just for comparison purposes (not shown). At the output O_3
25 there is generated a signal $\Delta f'$ which is indicative of the frequency deviation between the frequencies of the pitches of the respective tone received when output O_1 is operationally connected to input I_3 and of the tone when the addressed output O_1 is operationally connected to input

I₄. Evaluation of the signal at output O₃ is e.g. performed as was exemplified in context with the embodiment of fig. 2. As further shown in fig. 3 by the control signal IND the selection of which of the inputs I₃ and I₄ is momentarily operationally connected to the output O₁ is controlled by the individual, be it at the hearing device and/or by means of a remote control for the hearing device (not shown). One of the inputs I₃ and I₄, in Fig. 3 input I₃, is defined as being the relative reference tone input REF. Either by acoustical signaling to the individual wearing the hearing device and/or by means of an indication on the remote control the individual is informed and may control which of the inputs I₃ and I₄ is momentarily operationally connected to output O₁. Thus, in the embodiment as shown, whenever a relative reference tone is received as e.g. played by the oboe of an orchestra, the individual switches via the control signal IND the output O₁ to be operationally connected to the input I₃ REF of the frequency comparing unit 11. There the frequency of the pitch of this relative reference tone is stored. Subsequently, the individual switches the output O₁ of the input acoustical-to-electrical converter 1 to be operatively connected to input I₄ of the frequency comparing unit 11 and the latter generates the output signal at output O₃ which is representative for the deviation of the frequency of the pitch of the tone played by the individual's instrument when the output O₁ is operationally connected to input I₄ relative to the frequency of the pitch of the relative reference tone which was previously stored. Thus and with the help of the hearing device, the individual wearing the

hearing device gets an indication whether his instrument is correctly tuned, is tuned rather flat or is tuned rather sharp with respect to the relative reference tone as e.g. played by the oboe in an orchestra. The embodiment of fig.

5 3 is considered per se as inventive but may be also combined with the embodiments as were exemplified in context with figs. 1 and 2.

Claims

1. A hearing device comprising

- an input acoustical to electrical converter with a first output being an electrical output
- a digital signal processing unit with a first input, a second output and a clock input
- an output electrical-to-mechanical converter with a second input being an electrical input
- a clock oscillator with a clock output,

said first output being operationally connected to said first input, said second output being operationally connected to said second input, said clock output being operationally connected to said clock input, said digital signal processing unit generating, within a limited frequency range containing 440 Hz, a signal with a frequency f_0 of pitch at a reference tone output, said signal being selectably operationally connectable to said second input.

2. The device of claim 1, said frequency f_0 being selectable by an individual by means of a selecting member at the device and/or by means of a remote control for said hearing device.

3. The device of one of claims 1 or 2, wherein said signal is intermittently applied to said second input.

4. The hearing device of one of claims claim 1 to 3, said digital signal processing unit further comprising a frequency comparing unit with a third and a fourth input

and with a third output, generating an output signal at said third output which is dependent from the frequency difference of the pitches of signals applied to said third and fourth inputs, one of said third and of said fourth inputs being operationally connected to said first output, the other of said third and fourth inputs being operationally connected to said reference tone output.

5. The hearing device of one of claims 1 to 4, said digital signal processing unit further comprising a frequency comparing unit with a third and a fourth input and with a third output, said third and said fourth inputs of said frequency comparing unit being both controllably and intermittently operationally connectable to said first output.

6. The hearing device of claim 5, said intermittently controllably connecting being performed by means of a remote control for said hearing device.

7. A hearing device comprising

- an input acoustical-to-electrical converter with a first output being an electrical output
- a digital signal processing unit with a first input, a second output and a clock input
- an output electrical-to-mechanical converter with a second input being an electrical input
- a clock oscillator with a clock output,

said first output being operationally connected to said first input, said second output being operationally

connected to said second input, said clock output being operationally connected to said clock input, said digital signal processing unit further comprising a frequency comparing unit with a third and with a fourth input and
5 with a third output, said third and said fourth inputs of said frequency comparing unit being both controllably and intermittently operationally connectable to said first output.

8. The hearing device of one of claims 1 to 7, wherein
10 said clock has a frequency stability of at least 1%, preferably of at least 0.1% even more preferred of 100ppm.

9. A method of tuning an instrument comprising generating, in a hearing device, an absolute reference tone at a predetermined or at a selected reference frequency of
15 pitch, comparing by the hearing device the frequency of the pitch of a tone to be tuned with said reference frequency and generating a perceivable tuning indication for said tone to be tuned based on the result of said comparing.

10. A method of tuning an instrument comprising generating
20 in a hearing device a difference of frequencies of pitches of subsequently sensed tones and generating an indication about frequency deviation of one of said pitches from the frequency of the other of said pitches.

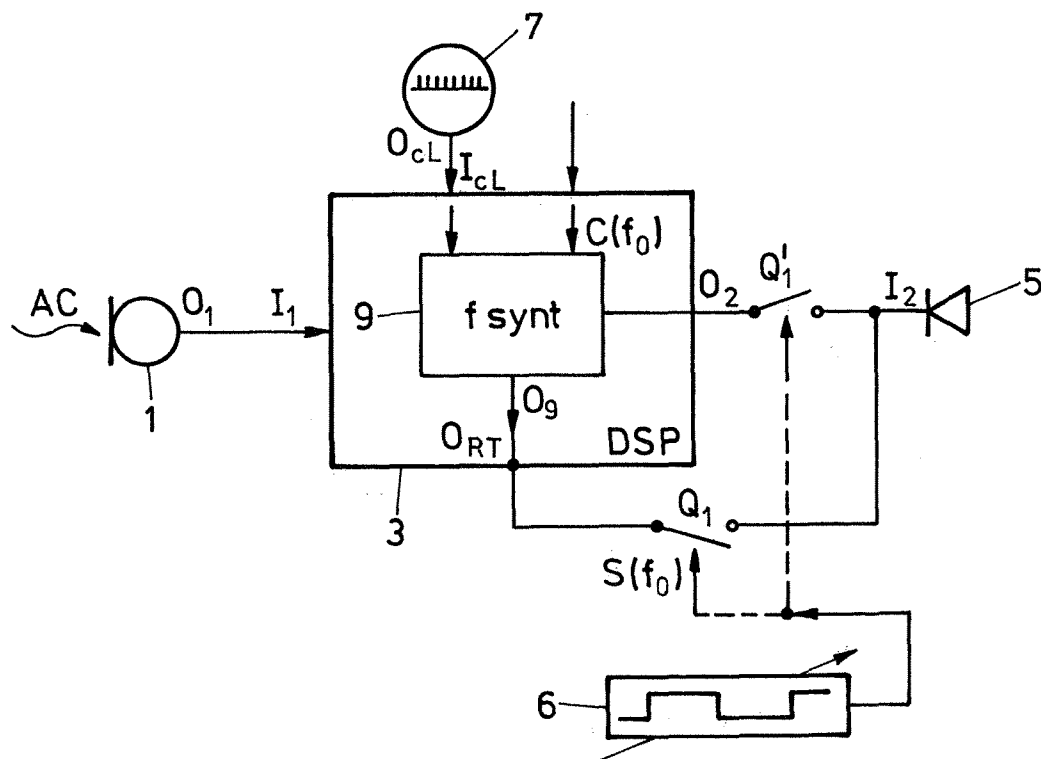


FIG. 1

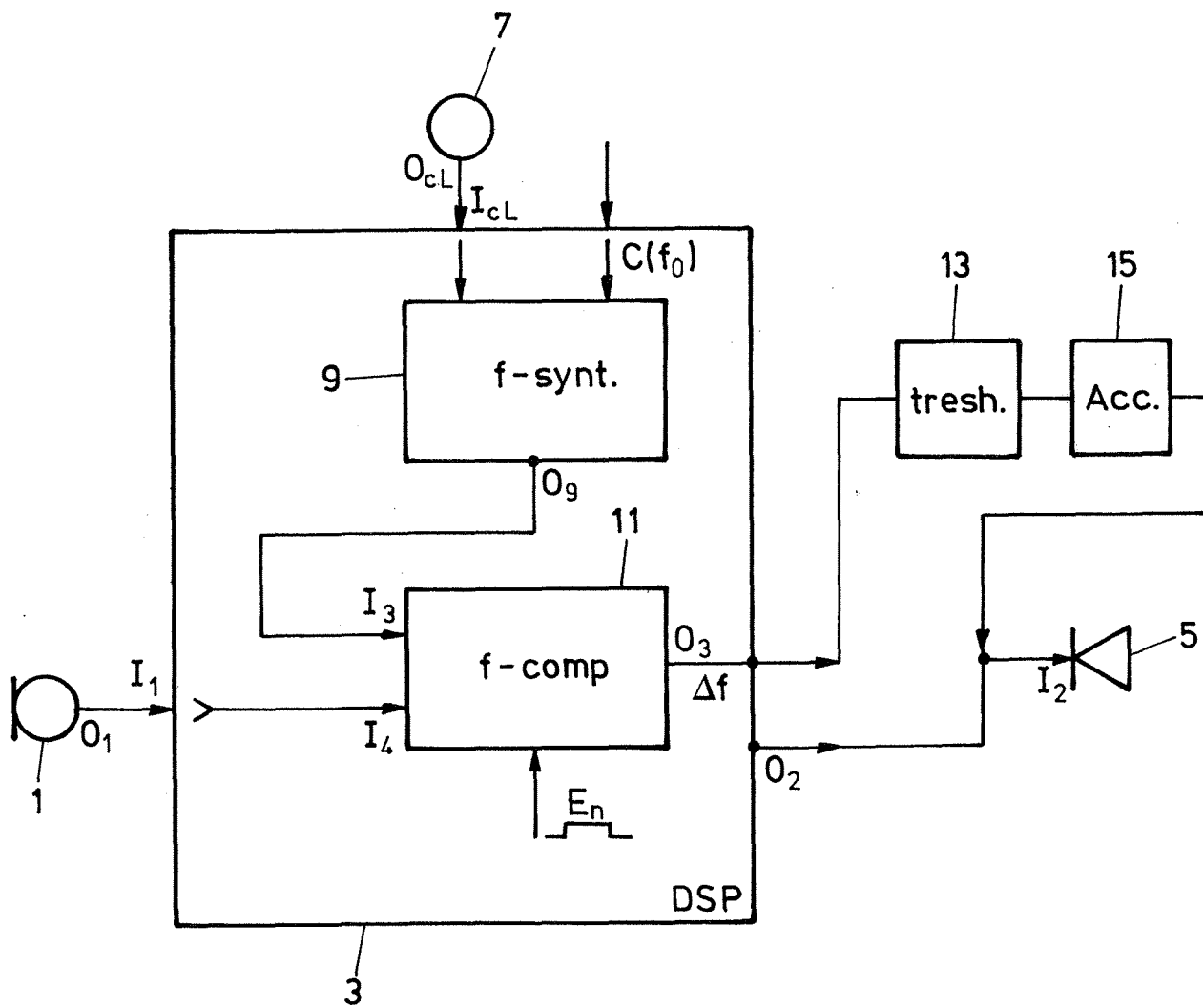


FIG. 2

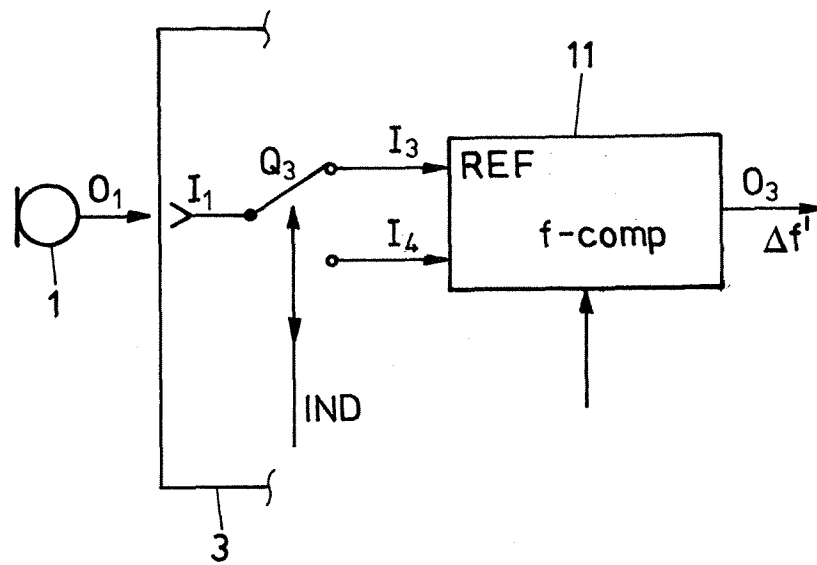


FIG.3