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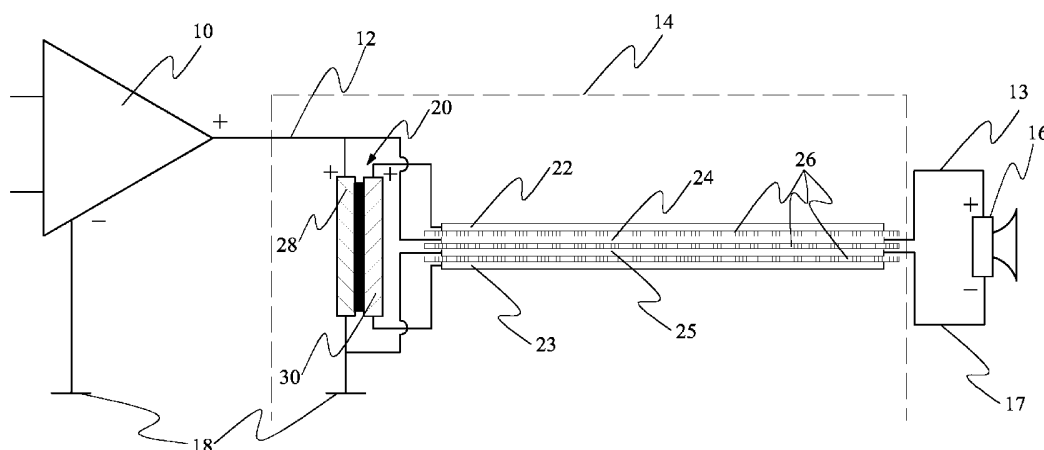
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(54) Title: METHOD AND DEVICES FOR IMPROVING THE QUALITY OF SIGNAL TRANSMISSION AND REPRODUCTION



(57) Abstract: The present invention relates to a method for improving the transmission and reproduction of electronic signals, particularly of complex signals in audio systems. The present invention also relates to a device (14) for improving the transmission and reproduction of electronic signals, which device is arranged to be connected between a first device (10) and a second device (16). The device comprises conductive film elements (22-25) separated by intermediate layers (26).

METHOD AND DEVICES FOR IMPROVING THE QUALITY OF SIGNAL TRANSMISSION AND REPRODUCTION

Field of the invention

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The present invention relates to a method and devices for improving the quality of signal transmission and reproduction. More particularly the present invention relates to transmission and reproduction of complex signals in audio and other systems.

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Background of the invention

The reproduction of complex signals which have fluctuating signal levels and signal bursts of short duration at different frequencies, such as audio signals or other signals, have improved considerably primarily due to development work related to discrete electronic components used in said systems. Amplifiers, speakers and other devices in audio systems and other systems are designed to minimize interference and various types of distortion that said devices introduce into such signals. By these means advancements have been made in particular in improving sound quality.

Nevertheless, the transmission and reproduction of such complex signals still suffers from certain inaccuracies compared with original or live signal sources or performances. For instance, all the components of the signal are not transmitted or reproduced at exactly the correct time compared with the original signal. Amplifiers and other devices also cause various types of distortion and noise in the reproduced signal, and signal quantization in digital systems causes noise. For example, audio signal components may be reproduced at the correct time on average, but a certain amount of variation and interference is continuously present.

The present invention is related to accurate reproduction and transmission of complex audio and other signals, audible or non-audible, such as to sound reproduction technology's high-end range, where the intent is to achieve extremely accurate and natural signal reproduction. It is known in this field that such factors, which cannot be fully explained or measured using current technical knowledge and measurement technology, have been observed to have an impact on the naturalness and accuracy of the reproduction. Ordinary technical measurements, such as frequency response or distortion measurements, do not explain all the differ-

ences in the reproduction in different reproduction equipment. For example, it is possible to detect audible differences between the sound reproductions of two or more equipment or assemblies even though they have been determined to be completely similar and faultless in their technical specifications when measured
5 using traditional measurement technologies. It is now known, for example, that Fourier analysis techniques commonly used in the measurement of these signals are poorly suited for analyzing complex signals, especially in the case of essentially short-duration signals, which commonly appear for example in music.

As a result, in evaluating high-end equipment to reproduce and transmit music and
10 similar complex analog signals, the human ear and hearing are often relied on to assess the accuracy, naturalness and quality of the reproduction. This also means that it is currently not known how to measure or take into consideration all the physical phenomena affecting complex signal reproduction or transmission. In general, for example, factors related to and affecting the phases of the signal are
15 considered to have an impact on the quality of the signal reproduction and transmission. One area where large numbers of efforts have been made to minimize the phase-distorting effects is for instance the intermediate wires between amplifiers and speakers. Very different types of functional wiring designs have been employed to improve the influence on the quality of such wires, with audible im-
20 provements in the transmitted and reproduced signal.

One traditional method to improve the signal transmission and reproduction is to increase the cross-section of the conductors used. The resistance of the conductor thereby decreases accordingly as its cross-section increases. For example the cross-section of a so-called return conductor may be larger by a certain proportion
25 than the actual signal conductor. Using large conductors with special cross-sections increases the manufacturing cost of such cables.

Increasing the cross-section of a conductor also decreases the so-called skin effect. This refers to a crowding of electric current into the outer layer of a conductor as the frequency of a transmitted signal rises. Naturally, said skin effect increases
30 the resistance of the conductor. When electric current squeezes into the surface layer of a conductor, another undesirable phenomenon results. Mechanical or chemical stress damages the crystal structure of the surface layer of a conductor over time. Areas in which the surface layer is in effect broken are formed on the surface of the conductor. Consequently, the resistance formed by the surface layer
35 of the conductor grows even more, which is detectable as a deterioration of the sound quality of a sound reproduction system, especially when transmitting weak

signals. To eliminate this phenomenon, a solution is presented in reference publication EP 0306067 B1, in which the metal of a conductor is replaced with a large amount of specially treated insulated carbon fibers, which are twisted together into one conductor. This prevents formation of the skin effect and above-mentioned
 5 mechanical and chemical fractures. A conductor manufactured in this manner is, however, very expensive compared with conventional conductor arrangements that utilize metals. Furthermore, such conductors are only supplied in precut form.

One manner of examining a speaker cable is to interpret it as a transmission wire, which has specific impedance. The structure of the cable determines the imped-
 10 ance level of the cable. Impedance matching is used to minimize undesired reflection phenomena at the junction between impedances. However, these kind of solutions require special cables, which are expensive to manufacture.

The characteristics of cables used can also be examined by means of the reactive components they contain. The capacitance and inductance values of a cable are
 15 determined on the basis of cable geometry and materials used. The resistance, conductance, capacitance and inductance of a cable determine the phase coefficient β of a transmission wire. At low frequencies, if the inductance value is small, β depends primarily on resistance and capacitance. The phase coefficient determines the phase velocity, which at low frequencies is approximately

$$20 \quad v_p = \omega / \beta = \sqrt{4\pi f / RC} \quad (1)$$

The phase velocity v_p depends on the frequency (f), for which reason the various components of a transmitted signal advance at different velocities in a cable, thereby causing audible deterioration of signal quality.

One possibility of changing this frequency behavior of a cable at audio frequencies
 25 is to increase its inductance considerably by some means or other. Patent publication US 4920233 presents a coaxial cable whose inductance is increased by covering the cable's insulation with magnetic material, such as ferrite, whereupon the inductance of the cable increases so much that the phase velocity of a signal is primarily determined by the cable's inductance and capacitance at audio frequen-
 30 cies, also.

$$v_p = \omega / \beta = 1 / \sqrt{LC} \quad (2)$$

By this means the phase velocity is nearly constant, and the transmitted signal is not distorted.

The transmission characteristics of a cable can also be corrected by means of electronic devices connected to the cable. EP patent 0649268 presents an arrangement in which separate adjusting means are connected to both ends of an audio cable. A speaker cable is implemented by means of Litz conductors, which are comprised of a sufficient number of very thin individually insulated conductors connected in parallel to achieve a specific conductor cross-section. Litz conductors strive to diminish the skin effect and magnetic coupling between conductors. In the presented solution the adjusting means at the speaker end strives to prevent oscillation of the amplifier-speaker circuit at a relatively high resonance frequency in the magnitude of a few MHz. The adjusting means at the audio amplifier end adjusts the rate of current rise λ of the cable's conductors to a desired rate. The following correlation is in effect for the rate of current rise

$$\lambda = L/R \quad (3)$$

According to the publication, to achieve optimal reproduction quality the value of λ should be 0 – 30 μ s. According to the publication, the adjustable L and R values of the components connected in series with the cable's conductors are in the magnitude of 0.1 – 1 μ H and 0 – 0.2 Ω , whereupon the optimal value for the rate of current rise λ is achieved. Due to the Litz conductor used, the manufacturing cost of the presented solution is high. Furthermore, the adjusting means include other discrete components, which further increase the production cost of the arrangement.

An electric signal in an ordinary metal conductor is transmitted by means of free electrons moving in the metal. A moving charge, such as an electron, always forms a magnetic field around itself. An electrical conductor and the material surrounding it influence how said magnetic field is formed. Diamagnetic materials, such as copper, resist formation of a magnetic field, while ferromagnetic materials, such as iron in general, strengthen an external magnetic field introduced in them. Therefore, a varying electric current traveling in a copper conductor creates a magnetic field around itself, thereby causing a current and voltage phase difference of a certain magnitude in the conductor, which can be assumed to contribute to a change in the time relationships of the components of a transmitted audio signal.

WO 03042971 discloses a method and device for improving the quality of an audio signal wherein before the audio signal is conducted to speaker it is conducted into a coil or an intermediate component made of ferromagnetic material. In said intermediate component the audio signal creates a magnetic field according to

mediate component the audio signal creates a magnetic field according to said signal, which improves the quality of said signal transmission and reproduction.

The improvement of the transmission and reproduction of complex signals, such as audio signals, is becoming an increasingly critical problem, due to the common
5 compression of analog signals into digital format for the storage and transmission of the signal.

As mentioned above, all the physical phenomena affecting the quality of reproduced audio and other complex signals are not currently known. Generally it is
10 presumed that such phenomena will be better explained with the aid of quantum physics rather than classical physics. Most current electronics applications are merely exploiting the fact that electrons carry electric charge. The intrinsic magnetic dipole moment of electrons, related to their quantum-physical property called spin, plays no role e.g. in the design of transistors. However, it may be possible to
15 manipulate electric currents by addressing the charge carriers' spin degree of freedom. An example is the field of spin electronics, or spintronics, which explore ways to control electric currents by addressing the intrinsic magnetic moment of charge carriers. Spintronics refers to all electronic applications and devices where the spin degrees of freedom of electrons are non-trivially utilized. One approach to
20 spintronics is based on quantum coherence of electron spins. It may be possible to control the precession of charge carriers' spin by external gate voltages (Zülicke, U. Electronics with spin: Current research and future possibilities, Proceedings of the 11th Electronics New Zealand Conference, preprint 2004). Spin current and some ways to utilize it is described in Sharma. P., Science 307: 531–533 (2005).

25 One candidate theory which may be associated with the quality of signal reproduction is the Aharonov-Bohm effect. The Aharonov-Bohm effect is a quantum-mechanical phenomenon by which a charged particle is affected by electromagnetic fields in regions from which the particle is excluded, first proposed by Aharonov and Bohm in 1959. Such effects are predicted to arise from both magnetic fields and electric fields, but the magnetic version has been easier to observe.
30 In general, the profound consequence of Aharonov-Bohm effects is that knowledge of the classical electromagnetic field acting locally on a particle is not sufficient to predict the quantum-mechanical behavior.

The most commonly described case, sometimes called the Aharonov-Bohm solenoid effect, is where a charged particle passing around a long solenoid experi-
35

ences a quantum phase shift as a result of the enclosed magnetic field, despite the magnetic field being zero in the region through which the particle passes. This phase shift has been observed experimentally by its effect on interference fringes. (There are also magnetic Aharonov-Bohm effects on bound energies and scattering cross sections, but this case has not been experimentally tested.) An electric Aharonov-Bohm phenomenon was also predicted, in which a charged particle is affected by regions with different electrical potentials but zero electric field, and this has also seen experimental confirmation. A separate "molecular" Aharonov-Bohm effect was proposed for nuclear motion in multiply-connected regions, but this has been argued to be essentially different, depending only on local quantities along the nuclear path (Wikipedia: http://en.wikipedia.org/wiki/Aharonov-Bohm_effect).

An electrical solenoid is a form of electromagnet. In its simplest construction it consists of a number of turns of conductive wire, a coil, through which a current is passed. This creates a magnetic field which is concentrated at the centre of the windings. Any ferromagnetic material that is brought into proximity is attracted by the magnetic field. Generally the construction is arranged so that the ferromagnetic material is presented as a plunger within the coil which is free to move in and out and is held out by a spring when the current is switched off.

Much more efficient solenoids are made by winding the coil around a ferrous C-shaped core and using a T-shaped ferrous core. When a current flows, this structure creates a tight magnetic loop, the T fitting into the C and touching at the lip and bottom.

The term solenoid can also refer to an idealization of a coil, in which loops of current carrying wire are stacked on top of each other in a cylinder (the wires do not curve in a helix). Another way to think of this is simply as a cylinder of electric current, rotating in place about its axis. This model is used in calculations of the magnetic field and inductance of a coil (Wikipedia: <http://en.wikipedia.org/wiki/Solenoid>).

One of the striking quantum properties of an electron is its *intrinsic* magnetic dipole moment. In contrast to the *orbital* magnetic moment, which is basically due to the electric current caused by a moving electron charge, the intrinsic, or *spin* magnetic moment is not due to any currents. Instead, it is more appropriate to think of an electron as a permanent bar magnet with a fixed dipole moment of $\sqrt{3} \mu_B = 1.606 \times 10^{-23} \text{ A}\cdot\text{m}^2$. The quantum-physical wave nature of electrons in semiconductor

nanostuctures results in spatial interference effects similar to those exhibited by coherent light. In complete analogy to the fringes seen in optics experiments, oscillatory modulations of electric conductances signify electronic interference phenomena in small conductors. These have been observed recently, e.g. in electronic double-slit and Mach-Zehnder interferometers (Zülicke, U. Electronics with spin: Current research and future possibilities, Proceedings of the 11th Electronics New Zealand Conference, preprint 2004).

The present invention addresses how to improve the transmission and reproduction of signals through the specific inventive device, with the intent to improve the accurate transmission and reproduction of the signal. The improvement in the reproduction is significant, and with respect to for instance audio signals, said improvement manifests itself among other things in an improvement in the dispersion of the reproduced signal, in an improvement in the articulation of vocal signals, and in an improvement in the sound field of the reproduced signal.

The present invention enables the construction of more cost effective reproduction and transmission of complex signals, such as audio signals.

The basic principle of the present invention is believed to be as follows: a complex signal such as an audio signal in a conductor is conducted into a polarizer, which polarizes the spins of the electrons transferring or transmitting the signal.

The present invention is based on the surprising finding that when the audio or similar complex analog signal is conducted through a device according to the present invention, herein called an electrical polarizer, the quality of the reproduced signal, such as audio signal, is improved, as measured by the accuracy, musicality and soundstage of the reproduction.

Brief description of the invention

The present invention provides a device for improving the quality of an electronic signal transmission and reproduction. Said device is arranged to be serially connected in the signal pathway of said signal to be transmitted in a conductor between a first device and a second device, said device having at least two film elements separated by an intermediate layer.

In one embodiment said device of the present invention comprises two conductive film elements of ferromagnetic metal which are separated by an intermediate layer comprising carbon, one element being arranged to be connected to the first device and the other to the second device.

In another embodiment said device of the present invention comprises two conductive film elements which are separated by a dielectric intermediate layer, one element being arranged to be connected to the first device and the other to the second device.

In audio applications one of the film elements may be arranged to be connected for example to the amplifier and the other one to the speaker. The film elements may be electrically connected with a resistor.

In another embodiment said device of the present invention comprises at least one conductor film in said signal pathway on at least one signal conductor and at least two secondary conductive film elements on both sides of said conductor film all said elements being electrically insulated by the intermediate layer, and a transformer connected to the output of said first device by the primary coil and connected to said film elements by the secondary coil. Said signal may be transmitted from an audio amplifier to a speaker.

The present invention also provides a method for improving the quality of signal transmission and reproduction. One embodiment of the present invention provides a method containing a step of polarizing in a conductor spins of the electrons transmitting the signal to improve the reproduction of said signal. The spins of said electrons may be polarized for example by using any of the devices according to the present invention. In one embodiment of the method said signal is transmitted from an audio amplifier to a speaker in a conductor by conducting said signal from

said amplifier first into said device of the present invention before conducting it to said speaker.

5 When the signal is conducted to the device of the present invention, a phenomenon is believed to take place wherein the spins of electrons on the surface of the conductive material, such as the conductor films or carbon layer with high specific surface area, are polarized. Such action of spin manipulation may be called spin orientation or spin orbit coupling. The phenomenon will improve the quality of the signal transmission and reproduction, for example by improving the dispersion of
10 the high tones and the articulation of soloists in reproduced music, and by expanding the stereo effect and by improving the accuracy of the rhythm in the reproduced music.

15 If the polarization is done with polarizer films, i.e. film elements, the polarization effect is strongest when the polarizer elements are thin or film-like. Further, in some embodiments the film elements should have substantially large area. The same applies for the conductor elements as well since they are positioned very close to the film elements. Further the insulator layer between the conducting elements should be as thin as possible. This way the polarizing effect is maximized.
20 As the electrons tend to move on the surface of the thin films and as the polarizer and conductor films are close to each other, the polarizing effect takes place improving the reproduced signal. According to the theory of the invention in such arrangement the electrons act as miniature magnets affecting the other electrons in the parallel film, thus creating a strong polarization effect.

25 The examples presented herein refer to audio applications of some embodiments of the invention, but they should not be considered as limiting the scope of the invention. All the publications cited are incorporated herein by reference.

30 **Definitions**

Term "signal" as used herein refers generally to any signal, analog or digital, audio signal or other signal, audible or not, to be reproduced in the present invention. Generally such signal may be a complex signal containing fluctuating signal levels
35 or bursts at different frequencies. Said signal may be audible at certain frequencies, but it may not be audible at all frequencies. For example, generally high frequencies or very low frequencies in the audio signal may not be audible to all listeners or they may not be audible at all. Even though audio signal is generally

considered comprising frequencies between 20–20,000 Hz, the signal referred to in the present invention should not be limited to this. Term “audio signal” as used herein refers to said signal used for audio reproduction in any system, such as audio system. It is generally considered as “audible signal” but it should be noted
5 that it may contain also non-audible frequencies or components, as described above.

Terms “polarizer” or “electric polarizer” as used herein refer to the means in the device and the method according to the present invention wherein the polarization
10 of electrons is believed to occur, as described above. Accordingly, the term “polarization” refers to said electrical polarization, i.e. parallel arrangement of the spins of the electrons, which impacts the quality of the signal transmission and reproduction. In the polarization event spins of electrons transferring or transmitting the signal will be substantially polarized. The degree of polarization does not
15 need to be complete, as it hardly is in real situations, but sufficient to improve the quality of signal transmission and reproduction. In some embodiments of the invention the energy used to polarize the electrons is originated from said signal itself, either directly or indirectly. Generally the polarization occurs substantially on the surface of the conductor transferring the signal, such as on the surface of the
20 film used in some embodiments.

Term “speaker” or “loudspeaker” as used herein refers to any device known in the art which is used to transfer electrical signal into audible form. In addition to general speakers, the term “speaker” may thus also refer to other devices, such as
25 headphones or earphones or the like. Non-limiting examples of speakers are traditional housed-in loudspeakers, such as closed or bass-reflex types, which may contain one or more speaker elements and band division filters, electrostatic speakers and hi-fi headphones. Generally any device capable of creating audible sound in any medium, such as air, according to electric signal, may be considered
30 as a speaker.

The term “amplifier” as used herein refers to any known amplifier, such as an audio amplifier, for example main amplifier or integrated amplifier, which can produce an electric signal which, when conducted to a speaker as mentioned above, can
35 produce audible sound. The amplifier and speaker are electrically connected, generally by using conductor cables or the like. The amplifier may be a separate unit, but it may also be integrated with said speaker, as is the case generally in active speakers.

Term "conductor", "cable" or "signal cable" as used herein refers to any conducting means for conducting an electrical signal between the first device and the second device, for example from an amplifier to a speaker. Generally such conducting means is a cable, but also other methods and arrangements may be used or involved. For example in audio systems the amplifier may be integrated with the speaker, without any traditional speaker cables, but with other kind of conductor element or means for conducting. In such case the device according to the present invention is arranged to be serially connected in the signal pathway between said amplifier and speaker in a suitable way. Also, part of the signal pathway may be wireless, but the polarization event occurs in a conductor. It is assumed herein that there are two signal conductors between the first device and the second device, the ones generally marked as "+" and "-".

Next the present invention is described in detail referring to the following drawings.

Drawings

Figure 1 shows a typical audio arrangement containing an amplifier, speaker, cables and the device of the present invention.

Figure 2 shows one embodiment of the device of the present invention wherein said device comprises a transformer, two conductor elements, two secondary film elements and dielectric layers between said elements. In this embodiment said device is positioned between an amplifier and a speaker.

Figure 3 shows one embodiment of the setup of the device wherein said device is placed on +-signal cable.

Figure 4 shows one embodiment of the setup of the device wherein said device is placed on - -signal cable.

Figure 5 shows one embodiment of the setup of the device wherein one device is placed on each signal cable.

Figure 6 shows one embodiment of the setup of the device wherein the secondary film elements cover both conductor elements, as shown in figure 2 in detail.

Figure 7 shows one embodiment of the device wherein said device comprises two film elements with intermediate layer between said elements, and said elements are electrically connected by a resistor. In further embodiments the intermediate layer may be dielectric material or it may comprise carbon.

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Detailed description of the invention

In the method and device of the present invention said signal is electrically transferred from a first device to a second device in a conductor and the device of the invention is arranged to be serially connected in the signal pathway between the first device and the second device. Generally the first device is any suitable device sending the signal and the second device is any suitable device receiving the signal. Non-limiting examples of the first device are an amplifier, a microphone, a transformer, an electron tube and a transistor. Non-limiting examples of the second device are a loudspeaker, an amplifier, a transformer, an electron tube and a transistor. For example the method and device of the present invention may be applied to arrangements of an amplifier and a speaker, a microphone and an amplifier, a first amplifier and a second amplifier, a first transistor and a second transistor and the like.

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The device according to the present invention is arranged to be placed in the signal pathway. In one embodiment said device 14 is arranged to be positioned between an amplifier 10 and a speaker 16 (Figure 1). In traditional audio systems the device is usually serially connected to the speaker cables.

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In one embodiment (Figure 2) the device 14 is connected to both cables (or conductors) 12, 18, 13, 17 between an amplifier 10 (first device) and a speaker 16 (second device) and it comprises two conducting film elements 24, 25, one for each cable. The conducting films 24, 25 are separated with insulator layers 26. On both sides of the conducting film elements 24, 25 there are the polarizer film elements (or secondary film elements in this embodiment) 22, 23, also separated by insulator layers 26. In this embodiment both conducting film elements 24, 25 are between the same two polarizer film elements 22, 23. In another embodiment the conducting film elements 24, 25 may each have separate two polarizer film elements 22, 23. The polarizer film elements 22, 23 are connected to a transformer 20 comprising a primary coil 28 and a secondary coil 30. The secondary coil 30 is connected to said secondary polarizer film elements 22, 23 and the primary coil 28 is connected to the output 12, 18 of the amplifier 10 or the speaker cables. The

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electrical signal from the amplifier 10 is fed to the transformer 20 and further transformed to the polarizer elements 22, 23 wherein the polarization effect affecting the quality of the signal will occur.

5 In another embodiment (Figure 3) the device 14 is connected to one cable 12 only and it comprises one insulated conductor element 24 between two polarizer film elements 22, 23. Said cable may be either one of the two cables 12, 18 (Figures 3 and 4). In still another embodiment there are at least two separate devices 14 connected to both cables 12, 18 separately (Figure 5).

10

In another embodiment the transformer is serially connected to the signal pathway from the amplifier 10 to the speaker 16 (Figure 6).

15 In still another embodiment (Figure 7) the device 15 comprises two polarizer film elements 34, 36 optionally connected by a resistor 32. The other one of the polarizer film elements 34 is connected to the amplifier 10 and the other 36 to the speaker 16. Between the polarizer film elements 34, 36 there is a thin layer of insulation 26 (the intermediate layer). The resistance of the resistor 32 may be in the range 10 kOhm to 1 MOhm. Said device 15 may be set up as the device 14 in any
20 of the figures 3–5. In this embodiment the transformer is not required, but the area of the films should be higher when compared to the embodiments having the transformer, such as in the range of 5–10-fold higher.

25 In a preferred embodiment (Figure 7) the device 15 comprises two ferromagnetic polarizer film elements 34, 36 optionally connected by a resistor 32 as described above. However, in this embodiment the intermediate layer 26 is not of dielectric material but comprises conductive carbon. This way the area of the films required may be reduced radically. In tests conducted, the films of 1–10 cm² were found sufficient in audio signal reproduction with conventional hi-fi system. With ear-
30 phones the area of few square millimeters may be sufficient. Suitable carbon types to be used in the invention comprise activated carbon, such as pharmaceutical grade, or carbon used in certain double layer capacitors (e.g. Panasonic Goldcap or Elna Dynacap). The carbon may also be other type of porous carbon, such as nanoporous carbon, and have high surface area, such as 1,000 m²/g or even
35 2,000 m²/g. It is known that carbons with controlled pore size distribution result in specific double layer capacitances as high as 200 F/g. The high surface area is believed also to play important role in the present invention. Another option is to use nanotubes, such as modified single-wall or multiwall nanotubes which exhibit

large specific capacitance. A group of porous carbon material, carbide-derived carbons (CDCs), which can be obtained by selective leaching of metals from metal carbides with halogens (e.g. from B_4C and Ti_2AlC), may also be used (see Chmiola *et al.*, Double-Layer Capacitance of Carbide Derived Carbons in Sulfuric Acid, 5 Electrochemical and Solid-State Letters 8 (7) A357–A360: 2005 which is incorporated herein by reference). Typical values for activated carbon used in experiments of the invention include density of 2.5 g/cm^3 , particle size of about $6\text{ }\mu\text{m}$, average pore size of $0.5\text{--}1\text{ nm}$, purity of 94 %, film thickness of about $175\text{ }\mu\text{m}$ and conductivity in the order of 1 Ohm/cm .

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Electrolytes may or may not be present in the device. When using electrolytes, the pore size should be large enough to be completely accessed by the electrolyte, but small enough to result in a large specific surface area (Chmiola *et al.*, *supra*). In general, pore sizes of roughly twice the solvated ion size should be sufficient, 15 such as 0.5 nm for an aqueous electrolyte.

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The carbon may be applied on conducting films as fine powder or it may be printed on the film using techniques well known in the art, such as silk-screen print or the like using carbon pasta.

The dimensions of the conductor and polarizer film elements may vary. When film polarizers are used, preferably both elements are substantially equal in area. The elements should be substantially thin or film-like in order to produce the desired effect. Generally the thickness of said conductor and polarizer elements may be 25 from a layer of few atoms to 0.1 mm . Experiments conducted with a film of 0.2 mm thickness did not gain as good an effect on audio signal reproduction as thinner films. Preferred thickness of the film is in the range of from few atoms (few Ångströms) to 0.1 mm , more preferably from few atoms to 0.05 mm , most preferably from few atoms to 0.02 mm .

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The material of the conductor and polarizer elements may be any conducting material, such as metal. Examples of such conductors are aluminum, copper and iron. Aluminum is preferred in embodiments with insulating layer, since the electrons tend to move on the surface of an aluminum conducting layer. In the em- 35 bodiments with carbon layer it is essential that the film elements comprise ferromagnetic material. For example Al or Cu do not work as well and thus do not enable the smaller size elements.

The material of the insulating dielectric layer may be any suitable insulating material, such as cellophane, PVC or any other plastic or the like. The thickness of the insulator layer should also be very thin, such as from a layer of few atoms to 0.1 mm, preferably from few atoms to 0.05 mm.

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The area of a conductor element or a polarizer film element may vary. In embodiments containing the transformer the element may be for example about 30 x 40 cm (1,200 cm²). Suitable size of the conductor or the polarizer film is in the range of 500–10,000 cm², preferably 1,000–5,000 cm², more preferably 1,000–2,000 cm². An element relatively large in area is preferred to promote the electrons to move on the surface of said element. In another embodiment not having the transformer, such as shown in Figure 7, and having dielectric material as the intermediate layer the required size of the conductor or polarizer film elements is about 5–10-fold higher, i.e. in the range of 2,500–100,000 cm². In similar embodiments having carbon as intermediate layer the required size of the conductor or film elements is lower, i.e. in the range of 0.01–100 cm², preferably 0.1–50 cm², more preferably 1–10 cm².

Due to the insulated layers with large film element areas close to each other in some embodiments a large capacitance will be formed between the layers, such as a capacitance of 0.1–10 Farads. Capacitance this high is far beyond the capacitances normally used e.g. in audio signal reproduction systems, such as in band division filters or the like wherein capacitances normally range from nanofarads to microfarads, generally maximum of 1,000 microfarads in special cases.

The area of the film elements and the thickness of the insulation layer affect the capacitance formed.

In one embodiment the conductor and polarizer element setup is rolled or folded up to save space. Such setup works substantially as well as unrolled setup as far as the structure of the setup and the insulators is not disturbed.

The transformer used for creating the polarizing current may be any suitable transformer, for example an audio transfer with power of 1–50 VA. The transformer ratio may be in the range of 1:5–100 (primary:secondary coil), preferably 1:5–40, but this may depend on the other parameters of the system setup. The transformer should operate at least at the audible frequency range of 40–15,000 Hz, but experiments made with transformer capable of only up till 5,000 Hz were nevertheless successful.

Examples

Example 1

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A device according to the invention was set up as shown in Figure 2. The conductor and film elements were made of 0.02 mm aluminum foil sized 30 x 40 cm (1,200 cm²). The insulator layers of 0.02 mm slightly larger than said elements were placed between each element and the setup was fixed. An audio transformer of 50 VA, 40–15,000 Hz with a ratio of 40 was used. The setup was connected to cables between an amplifier and a speaker as shown in Figure 1. The conductor film elements were connected at the opposite edges of the elements. Improvements in the sound reproduction were observed, such as a clear improvement in the separation of nuances of the music, better reproduction of transients, increase in the rhythm of music and dynamics, better articulation of the soloist, better accuracy of the bass and the stereo image, especially the depth of the sound.

Example 2

20 A device according to the invention 15 was set up as shown in Figure 7. The film elements 34, 36 were made of 0.02 mm aluminum foil sized 30 x 90 cm (2,700 cm²). An insulating intermediate layer 26 of 0.02 mm slightly larger than said film elements was placed between each element and the setup was fixed. A resistor 32 of 10 kOhms was connected between the elements. The setup was connected to cables 13, 12 between an amplifier 10 and a speaker 16 as shown in Figure 7. Improvements in the sound reproduction were similar to what is described in example 1.

Example 3

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A device according to the invention 15 was set up as shown in Figure 7. The film elements 34, 36 were made of 0.02 mm iron foil sized 2 x 3 cm (6 cm²). A carbon intermediate layer 26 of about 0.02 mm slightly larger than said film elements was placed between each element and the setup was fixed. The setup was connected to cables 13, 12 between an amplifier 10 and a speaker 16 as shown in Figure 7. Improvements in the sound reproduction were similar to what is described in example 1. Different carbon sources were tested. Pharmacy-grade activated carbon was crushed in a mortar to obtain very fine powder which was applied onto the foil.

Also carbon obtained from Panasonic Goldcap Ultra 10 F and 50 F and Elna Dynacap 50 F capacitors was used. All the types of carbons worked in the setup enabling the smaller size of the device.

Claims

1. A device (14, 15) for improving the reproduction of an electronic signal, said device being arranged to be connected in the signal pathway of said signal to be transmitted in a conductor (12, 13, 17, 18) between a first device (10) and a second device (16), **characterized** in that it has two conductive film elements (34, 36) of ferromagnetic metal separated by an intermediate layer (26) comprising carbon, one element (34) being arranged to be connected to the first device (10) and the other element (36) to the second device (16).
2. The device of claim 1, **characterized** in that said carbon is porous carbon.
3. The device of claim 1 or 2, **characterized** in that said carbon comprises activated carbon.
4. The device of claim 1 or 2, **characterized** in that said carbon comprises nanotubes.
5. The device of claim 1 or 2, **characterized** in that said carbon comprises carbide-derived carbon.
6. The device of any of the preceding claims, **characterized** in that the area of any of the film elements is $0.01\text{--}100\text{ cm}^2$.
7. A device (14, 15) for improving the reproduction of an electronic signal, said device being arranged to be connected in the signal pathway of said signal to be transmitted in a conductor (12, 13, 17, 18) between a first device (10) and a second device (16), **characterized** in that it has two conductive film elements (34, 36) separated by a dielectric intermediate layer (26), one element (34) being arranged to be connected to the first device (10) and the other element (36) to the second device (16).
8. The device of claim 7, **characterized** in that the area of any of the film elements is $2,500\text{--}100,000\text{ cm}^2$.
9. The device of any of the preceding claims, **characterized** in that said film elements are electrically connected with a resistor (32).

10. The device of claim 9, **characterized** in that the resistance of said resistor (32) is 10 kOhm – 1 MOhm.
11. A device (14, 15) for improving the reproduction of an electronic signal, said device being arranged to be connected in the signal pathway of said signal to be transmitted in a conductor (12, 13, 17, 18) between a first device (10) and a second device (16), **characterized** in that it has
- at least one conductor film (24, 25) arranged to be serially connected in said signal pathway on at least one signal conductor (12, 13, 17, 18), and two secondary conductive film elements (22, 23) on both sides of said conductor film (24, 25), all said elements being electrically insulated (26) by intermediate layers, and
 - a transformer (20) connected to said first device (10) by the primary coil (28) and to said secondary film elements (22, 23) by the secondary coil (30).
12. The device of claim 11, **characterized** in that it comprises two conductor films (24, 25) each arranged to be serially connected to each signal conductor (12, 13 and 17, 18).
13. The device of claim 12, **characterized** in that each conductor film (24, 25) comprises two secondary film elements (22, 23) on both sides of said conductor film (24, 25).
14. The device of claim 12, **characterized** in that both conductor films (24, 25) are in between the same two secondary film elements (22, 23).
15. The device of any of the claims 11–14, **characterized** in that the ratio of said transformer (20) is from 1:5 to 1:100.
16. The device of claim 15, **characterized** in that the ratio of said transformer (20) is from 1:5 to 1:40.
17. The device of any of the claims 11–16, **characterized** in that the area of any of the secondary film elements and/or the conductor films is 500–10,000 cm².
18. The device of any of the preceding claims, **characterized** in that the thickness of any of said films (22, 23, 24, 25, 34, 36) is in the range from few atoms to 0.2 mm.

19. The device of any of the preceding claims, **characterized** in that said signal is audio signal.

20. The device of any of the preceding claims, **characterized** in that said first
5 device (10) is an amplifier and/or said second device (16) is a speaker.

21. A method for improving the reproduction of an electronic signal wherein said
signal is transmitted in a conductor between a first device (10) and a second de-
vice (16), **characterized** in that it contains a step of polarizing in said conductor
10 spins of the electrons transmitting said signal to improve the reproduction of said
signal.

22. The method of claim 21, **characterized** in that said polarization comprises
- conducting said signal from said first device (10) into the device (14, 15) of any of
15 the claims 1–20, and
- conducting said signal from said device (14, 15) into said second device (16).

23. The method of any of the claims 21–22, **characterized** in that said signal is
audio signal.

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24. The method of any of the claims 21–23, **characterized** in that said first de-
vice (10) is an amplifier and/or said second device (16) is a speaker.

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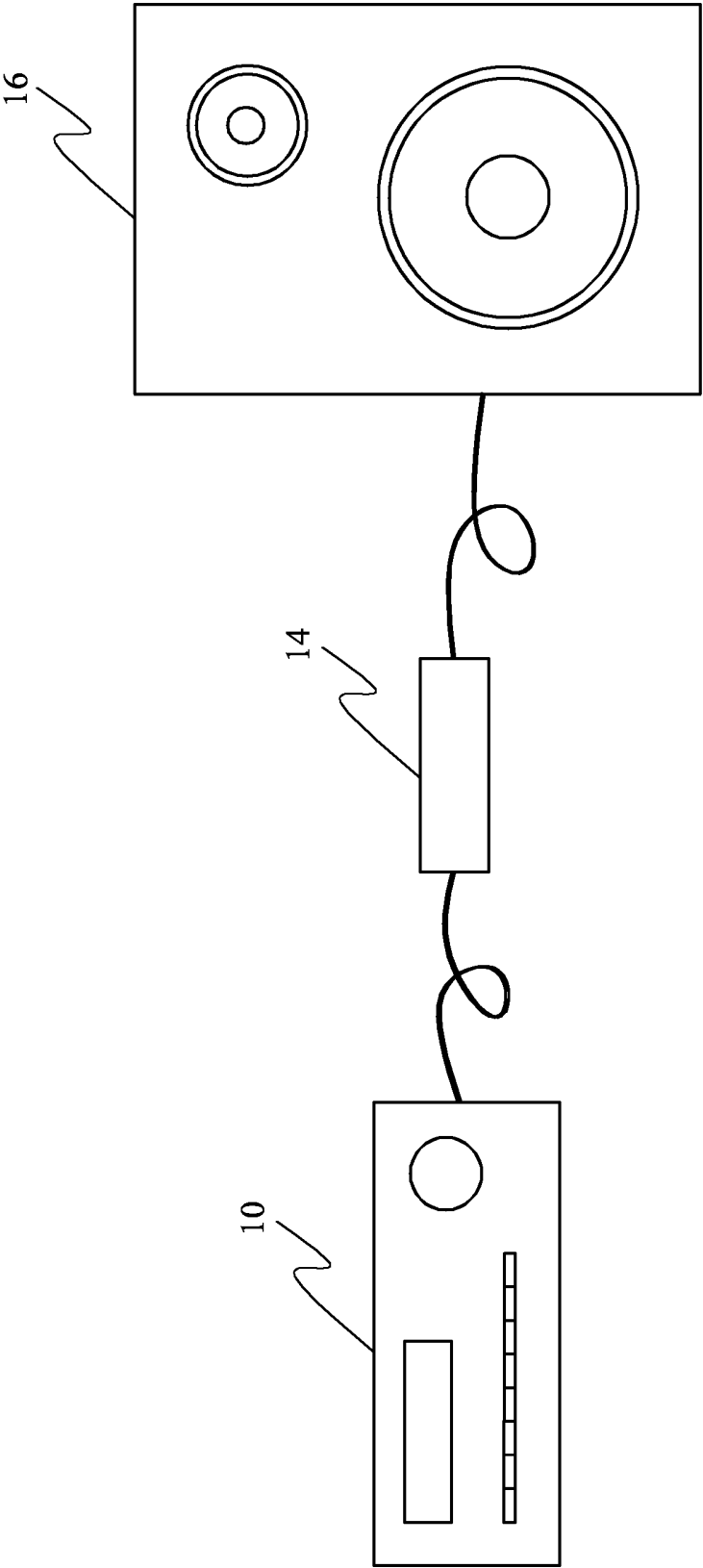


Fig. 1

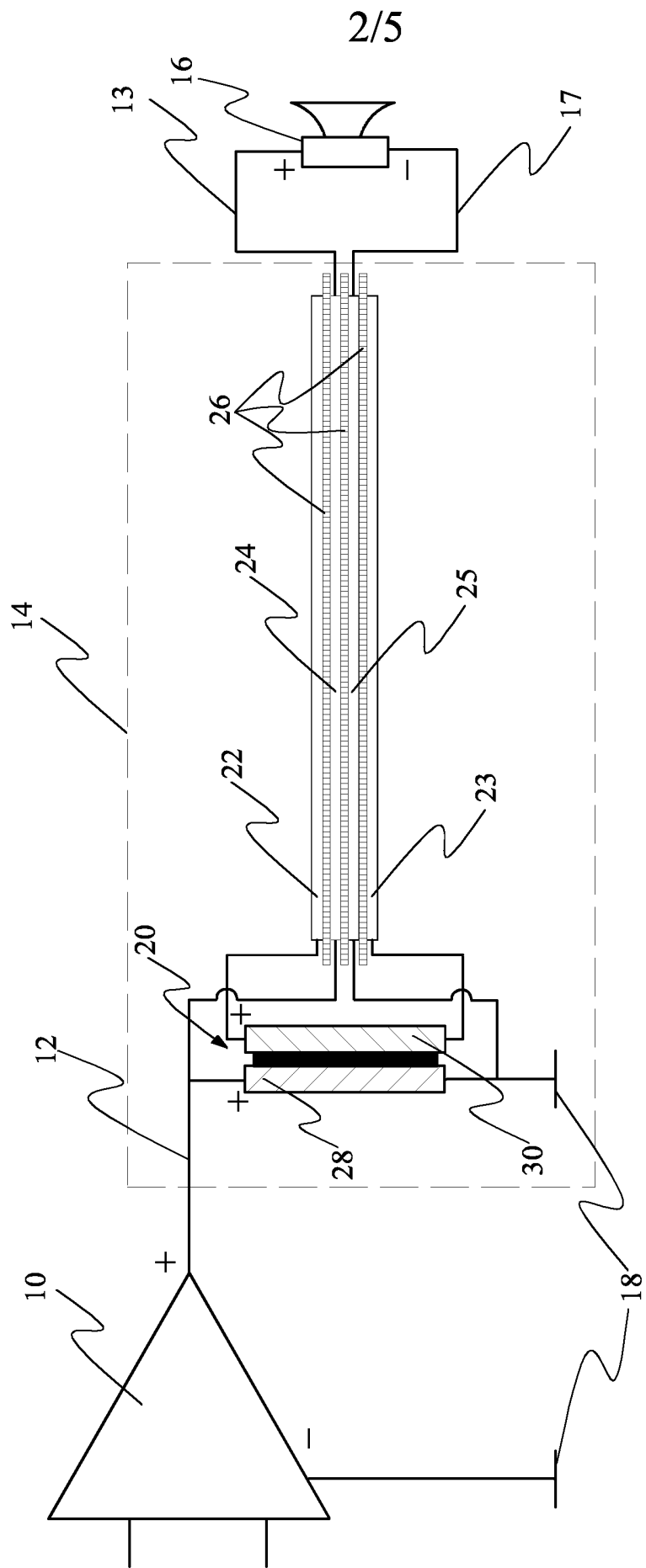


Fig. 2

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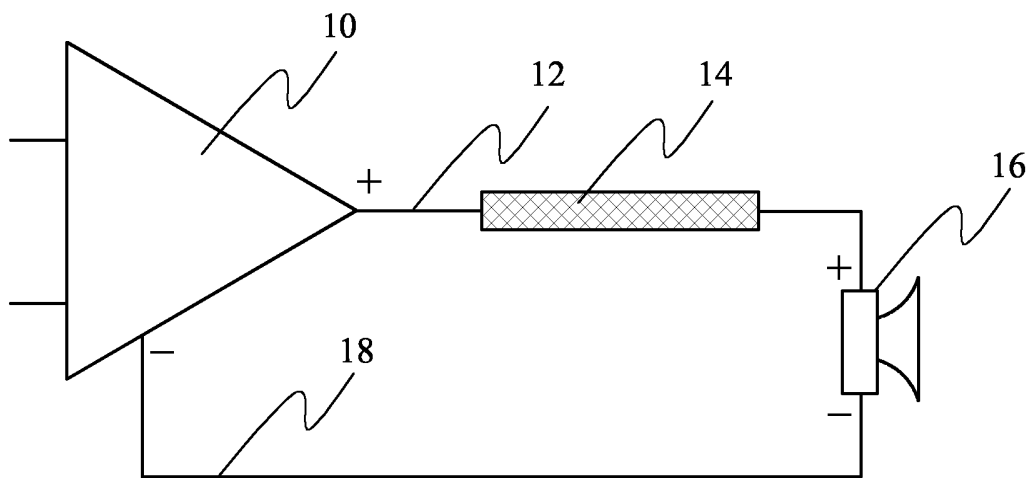


Fig. 3

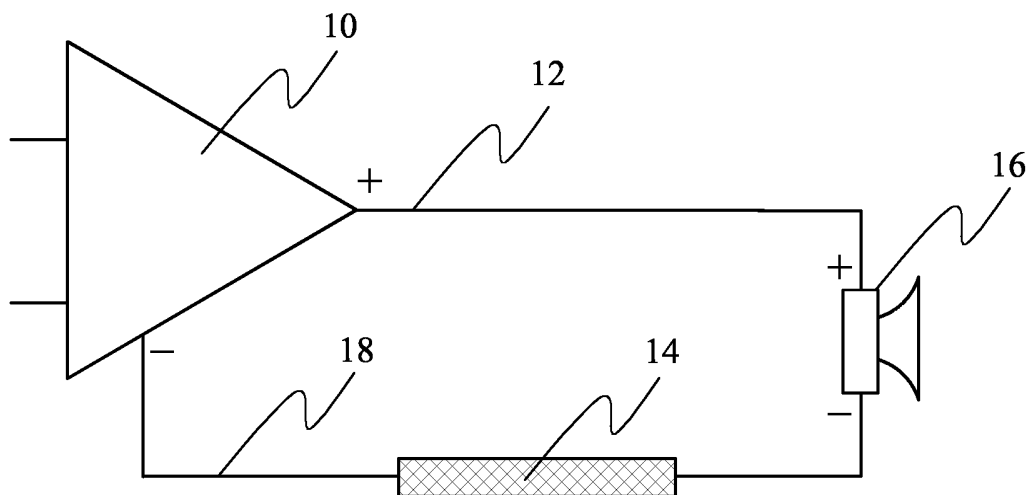


Fig. 4

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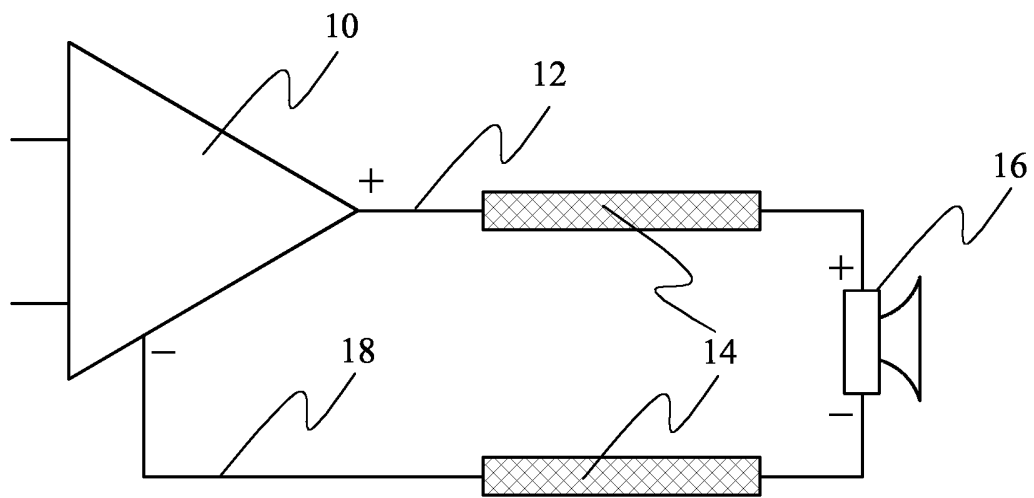


Fig. 5

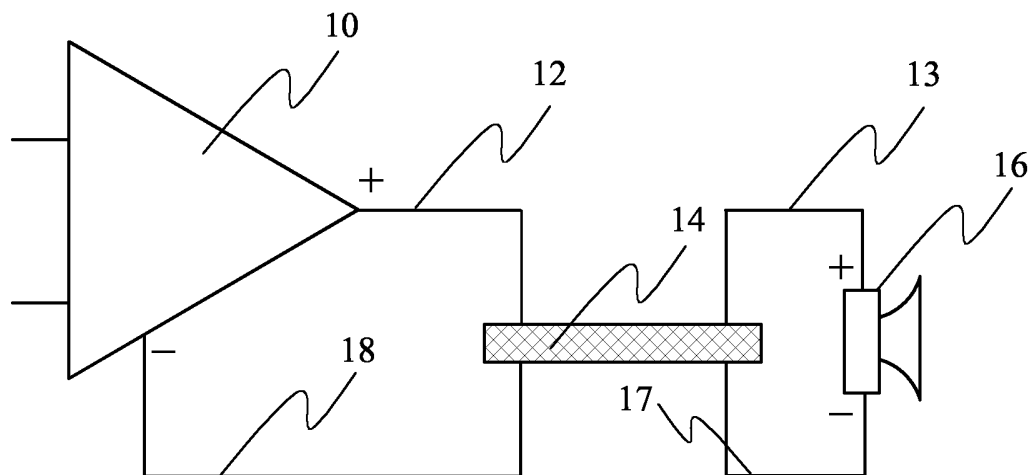


Fig. 6

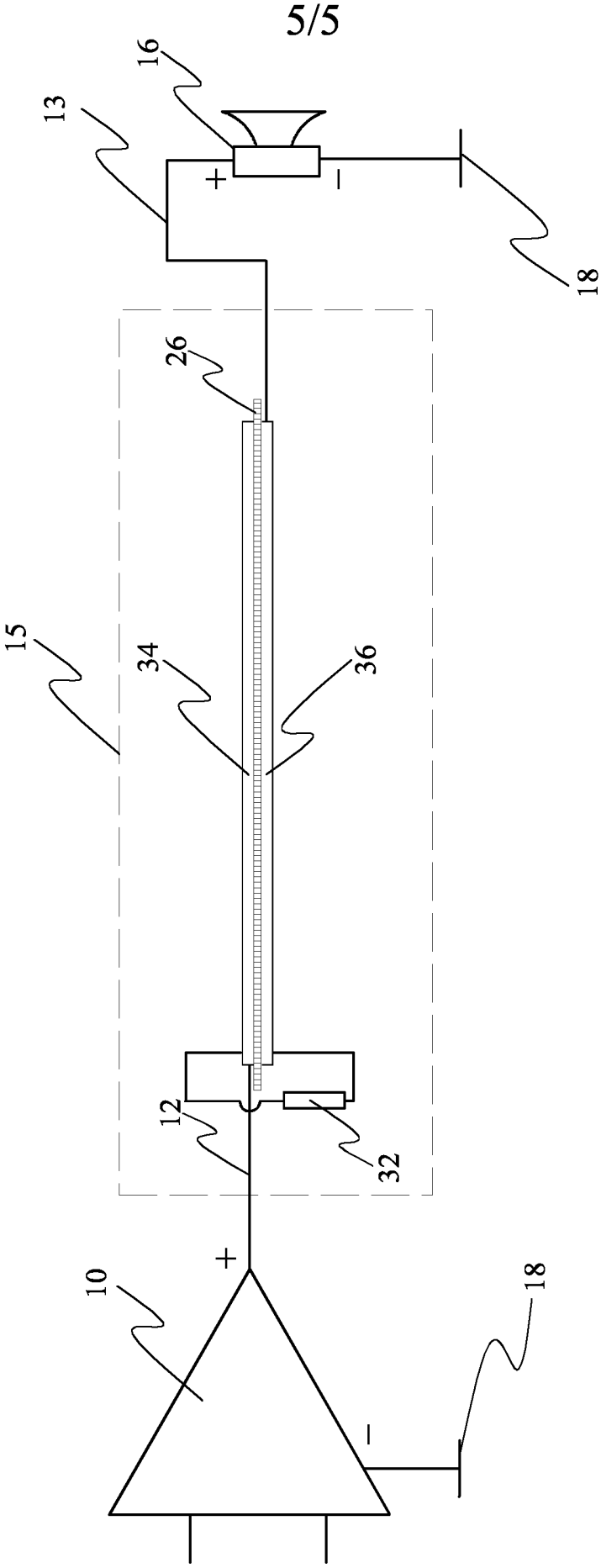


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2005/050464

A. CLASSIFICATION OF SUBJECT MATTER See extra sheet 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) IPC8: H04R, G10H, H01B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched DK, FI, NO, SE Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-internal, WPI, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5373109 A (ARGYRAKIS, S. N. et al.) 13 December 1994 (13.12.1994), Abstract, Fig. 1	1 - 24
A	US 5393933 A (GOERTZ, O. S.) 28 February 1995 (28.02.1995), Abstract, Fig. 1	1 - 24
A	US 6225563 B1 (POULSEN, P. U.) 01 May 2001 (01.05.2001), Abstract, Fig. 2	1 - 24
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A	DE 3633156 A1 (KOJER, K.) 10 December 1987 (10.12.1987), whole document	1 - 24
A	WO 03042971 A1 (SAASTAMOINEN, P. et al.) 22 May 2003 (22.05.2003), cited by the applicant, whole document	1 - 24
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 23 February 2006 (23.02.2006)		Date of mailing of the international search report 21 March 2006 (21.03.2006)
Name and mailing address of the ISA/FI National Board of Patents and Registration of Finland P.O. Box 1160, FI-00101 HELSINKI, Finland Facsimile No. +358 9 6939 5328		Authorized officer Jari Partanen Telephone No. +358 9 6939 500

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2005/050464

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

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G10H 1/06 (2006.01)

H01B 7/08 (2006.01)