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(54) A hearing aid

(57) The present invention provides a hearing-aid device (41) including a circuit (21) which is responsive to an externally applied magnetic field to control a setting of the hearing-aid. In one example. the circuit (21) is a variable gain amplifier circuit (21) which is responsive to the applied magnetic field to control the volume setting of the hearing-aid device (41). The magnet may be provided at one end of a hand-held rod (42) enabling a user to adjust the volume setting of the hearing-aid device discretely.

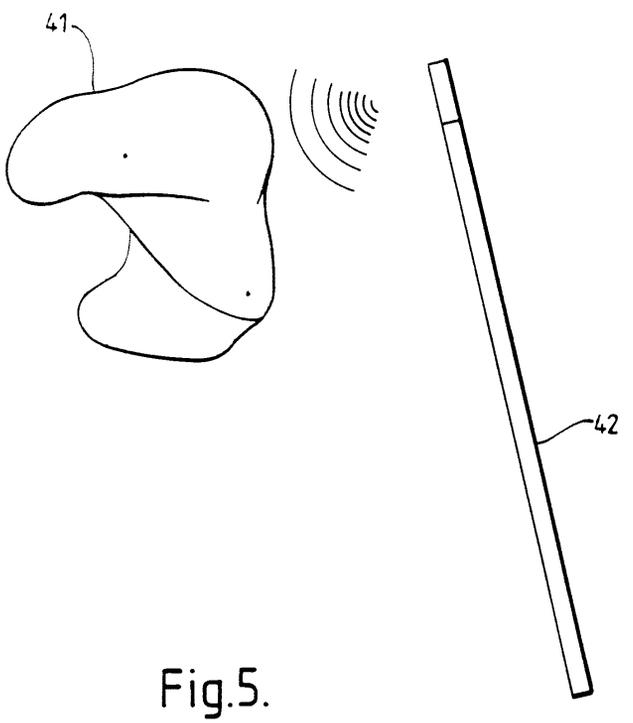

Fig.5.

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Description

[0001] A hearing-aid is a device which is worn within the ear to provide amplified sound directly to the user's ear. A typical hearing-aid is controlled by a manually operated rotary on/off-volume control switch on the outwardly facing surface of the hearing-aid. Figure 1 shows a perspective view of a conventional hearing-aid device 10 with an externally mounted rotary volume control 11, a battery door 12 for an internal battery housing, and an external microphone 13. To adjust the volume of the hearing-aid the user must rotate the volume control switch. This process is awkward to perform and is an act about which most hearing-aid users feel very self-conscious. As a result. many users of hearing aids operate their respective devices at a volume level which is often inappropriate. Furthermore. these relatively cheap designs are not well designed cosmetically and in general are not particularly aesthetically pieasing.

[0002] More advanced designs utilize automatic-volume-control circuitry to control the volume of the hearing-aid device. Such devices do not require any external mountings and consequently are generally much more aesthetically pleasing since the outwardly facing surface can be sculpted and cosmetically-finished to match the user's ear. However, this technology is still relatively expensive and hearing-aids which incorporate this are generally outside of the price range suitable for the mass market.

[0003] According to a first aspect of the present invention there is provided a hearing-aid device comprising a circuit which is responsive to an externally applied magnetic field to control a setting of the hearing-aid.

[0004] Preferably, the circuit is a variable gain amplifier circuit which is responsive to an externally applied magnetic field to control the volume setting of the hearing aid.

[0005] Preferably, the variable gain amplifier is responsive to a magnetic field to cause a change in the gain of the amplifier proportional to the length of time of application of the magnetic field.

[0006] More preferably, the variable gain amplifier circuit is responsive to a first application of a magnetic field to cause an increase in the gain of the amplifier proportional to the length of time of the first application of the magnetic field and to a second application of a magnetic field to cause a decrease in the gain of the amplifier proportional to the length of time of the second application of the magnetic field.

[0007] Preferably, the hearing-aid device comprises a switch responsive to an applied magnetic field and more preferably the switch is a magnetic reed relay switch.

[0008] According to a second aspect of the present invention there is provided a hearing-aid system comprising a hearing-aid device according to the first aspect of the present invention in combination with a magnet.

[0009] Preferably, the magnet is a permanent magnet and more preferably it is mounted at one end of a hand-held rod.

[0010] The settings of a hearing-aid device and system according to the present invention can be adjusted by the discrete raising and lowering of a magnet into the proximity of the device. This overcomes the problem of performing the awkward act of rotating the control switches or push-buttons associated with the prior art. Furthermore. because no external mountings are required. the device is generally much more aesthetically, pleasing since the outwardly facing surface can be sculpted and cosmetically-finished to match the user's ear. Also, because the device may be built using off-the-shelf electronic components. the cost of the device is within a price range suitable for the mass market.

[0011] An example of the present invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 shows a perspective view of a conventional variable gain hearing-aid device:
Figure 2 shows a schematic representation of an example of a hearing-aid circuit according to the present invention:
Figure 3 shows a more detailed schematic representation of a control circuit of the hearing-aid of Figure 2;
Figure 4 shows a graph of Time (s) against Gain (dB) illustrating the response of an example of a hearing-aid device according to the present invention to an applied magnetic field: and.
Figure 5 shows a simplified view of a hearing-aid device and a control magnet.

[0012] Figure 2 shows a block diagram of an example of a hearing-aid according to the present invention. In this example, the hearing-aid comprises a microphone 20. a variable-gain amplifier circuit 21 and a transmitter 22 connected in series. The amplifier 21 is responsive to a magnetic field to control the gain, and hence the volume setting. Sound is detected by the microphone 20 and converted to an electrical signal which is then coupled to the amplifier 21 which amplifies the signal by a predetermined amount corresponding to the gain of the amplifier. The amplified signal is coupled to the transmitter 22 where it is converted back to a sound signal.

[0013] Figure 3 shows a more detailed block diagram of the variable-gain amplifier circuit 21 of the hearing-aid of Figure 1. As shown. the amplifier 21 comprises a variable impedance circuit 31 connected to an amplifier circuit 32, and a switch 33 which is responsive to an externally amplified magnetic field. The switch 33 is used to control the output impedance of circuit 31. The amplification circuit 32 includes an operational amplifier having a gain which is determined by the ratio of a fixed feed back resistor (not shown) within circuit 32 and the source impedance of circuit 32. The source impedance is equal to the output impedance of the variable imped-

ance circuit 31 and therefore by changing the value of this output impedance. the overall gain of the amplifier can be determined. Suitable semiconductor devices for use in such a hearing-aid, as circuits 31 and 32, respectively, are those sold by *GENNUM* Corporation as chipsets GT560 and GP509.

[0014] The control switch 33 may be a magnetic reed relay switch having a coil and a switch (not shown). When an applied magnetic field energizes the coil of the relay the switch is closed, thereby causing the impedance of circuit 31 to increase or decrease. as will be described in detail below with reference to Figure 4. A suitable source for a magentic field is a permanent magnet mounted on one end of a rod (see Figure 5). The hearing-aid would be sold together with the magnetic rod.

[0015] Figure 4 illustrates the response to the hearing-aid circuit to an externally applied magnetic field. At time T_0 a magnet is brought into close proximity of the hearing-aid housing to cause the switch 33 to close. This causes the output impedance of circuit 31 to increase in steps. and to continue to do so until the switch 33 is opened again. thereby causing proportionate stepwise adjustments in the gain of circuit 32. There is a maximum gain of the amplifier which is determined by the components used in circuits 31 and 32. Once the user is satisfied with the volume level, the magnet is removed so that the switch opens and the gain is latched at level G_1. If the magnet is then re-applied after say four seconds. ie. some later time T_2 when the user wishes to reduce the volume setting, so that the switch 33 closes again, the output impedance of circuit 31 then decreases in steps, and continues to do so until the magnet is taken away and switch is opened again. thereby causing proportionate adjustments in the gain of circuit 32. The magnet is maintained until a later time T_3 when a new (lower) gain G_2 is achieved. This procedure is repeated each time the user wishes to change the volume setting of the hearing-aid device, and it is possible without requiring the user to make awkward manual adjustments.

[0016] In the above example. it is the variable gain amplifier circuit of the hearing aid which is adapted to be responsive to an applied magnetic field to set the volume. However, other more sophisticated hearing aid designs exist which, although they include automatic volume control technology, incorporate a push-button program selector. In this design. a user is required to push the button to select from a number of programs configured for different listening environments. It is possible to replace this push-button design with a magnetic field actuated circuit in accordance with the present invention and thereby provide a more discrete way of changing these program settings.

[0017] Figure 5 shows a hearing-aid device 41 and a magnetic control "wand" 42. Since there is no need for any external control on the hearing-aid, the outside surface can be made of moulded coloured plastics to suit the colouring of the user's skin.

Claims

1. A hearing-aid device comprising a circuit which is responsive to an externally applied magnetic field to control a setting of the hearing-aid.

2. A hearing-aid device according to claim 1, wherein the circuit is a variable gain amplifier circuit (21) which is responsive to an externally applied magnetic field to control the volume setting of the hearing aid.

3. A hearing-aid device according to claim 2, wherein the variable gain amplifier circuit (21) is responsive to a magnetic field to cause a change in the gain of the variable gain amplifier circuit (21) proportional to the length of time of application of the magnetic field.

4. A hearing-aid device according to claim 2 or 3, wherein the variable gain amplifier circuit (21) is responsive to a first application of a magnetic field to cause an increase in the gain of the amplifier proportional to the length of time of the first application of the magnetic field and wherein the variable gain amplifier circuit (21) is responsive to a second application of a magnetic field to cause a decrease in the gain of the amplifier proportional to the length of time of the second application of the magnetic field.

5. A hearing-aid device according to claim 3 or 4, wherein said changes in the gain of the amplifier are stepped.

6. A hearing-aid device according to any of claims 2 to 5, wherein said variable gain amplifier circuit (21) comprises a first circuit (31) having a variable output impedance and a second circuit (32) having a gain dependent on the output impedance of said first circuit (31).

7. A hearing-aid device according to claim 6. further comprising a switch (33) responsive to an applied magnetic field.

8. A hearing-aid device according to claim 7. wherein said switch (33) is a magnetic reed relay switch.

9. A hearing-aid device according to claim 8. wherein said switch (33) closes in response to an applied magnetic field to change the gain of the hearing-aid device and wherein said switch (33) opens in response to the removal of the magnetic field to set the gain.

10. A hearing-aid device according to claim 1. wherein the circuit is responsive to select from one of a

number of different programs adapted for different listening environments.

11. A hearing-aid device according to any preceding claim, having an inner surface and an outer surface and a battery compartment. wherein access to said battery compartment is provided on said inner surface so that said access is concealed when said hearing-aid device is worn.

12. A hearing-aid system comprising a hearing-aid device according to any preceding claim in combination with a magnet.

13. A hearing-aid system according to claim 12, wherein said magnet is a permanent magnet.

14. A hearing-aid system according to claim 12 or 13. wherein said magnet is mounted at one end of a hand-held rod (42).

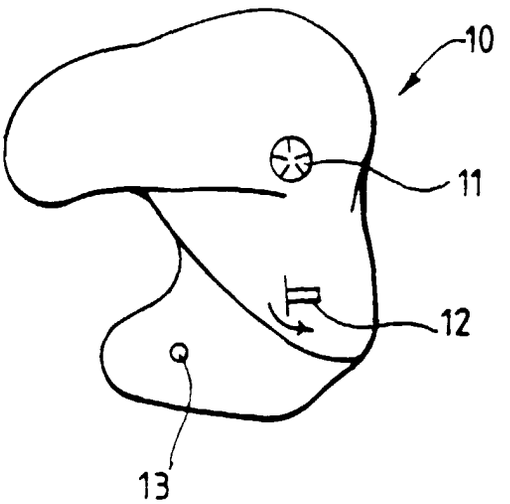

Fig.1.

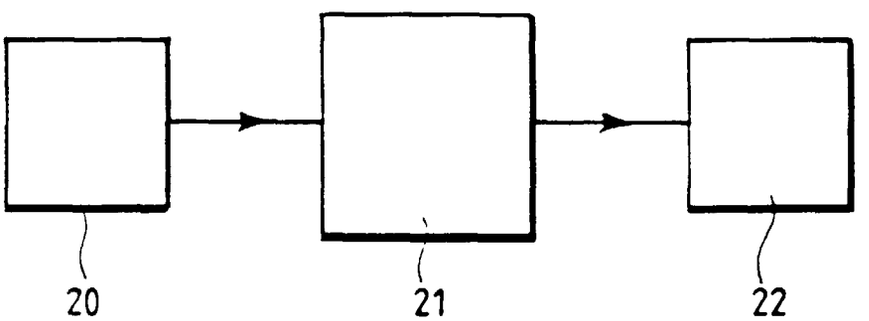

Fig.2.

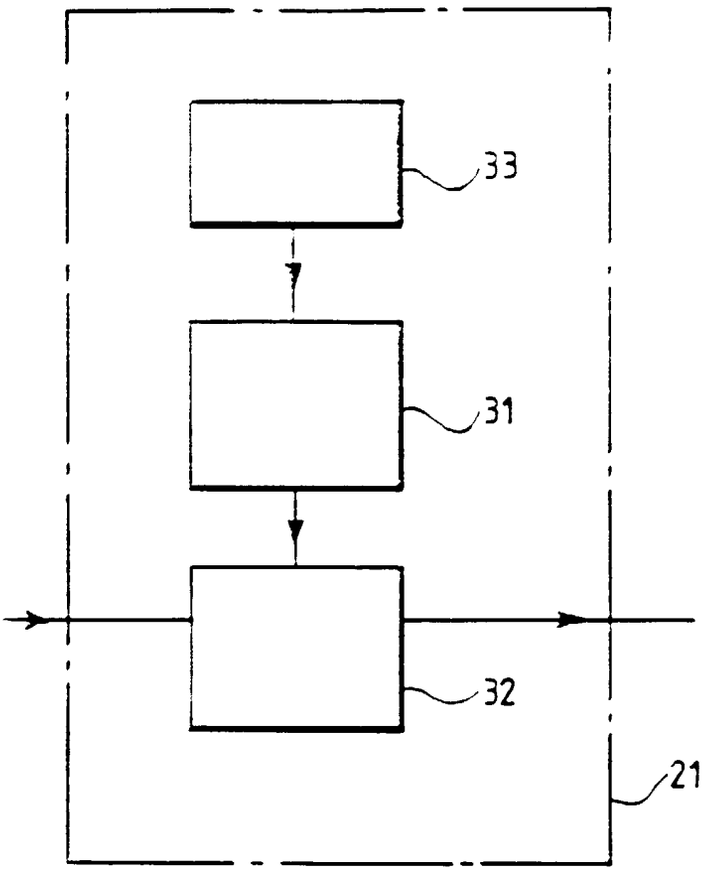

Fig.3.

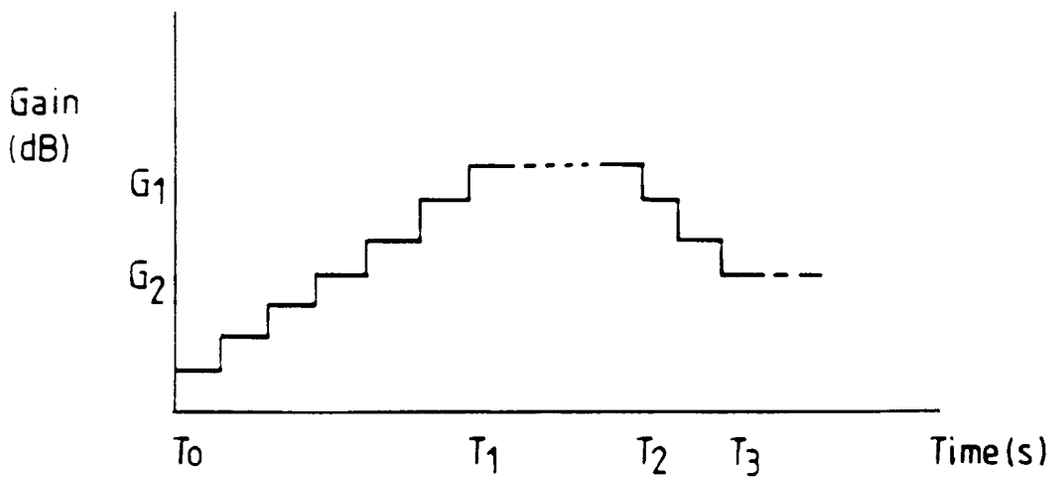

Fig.4.

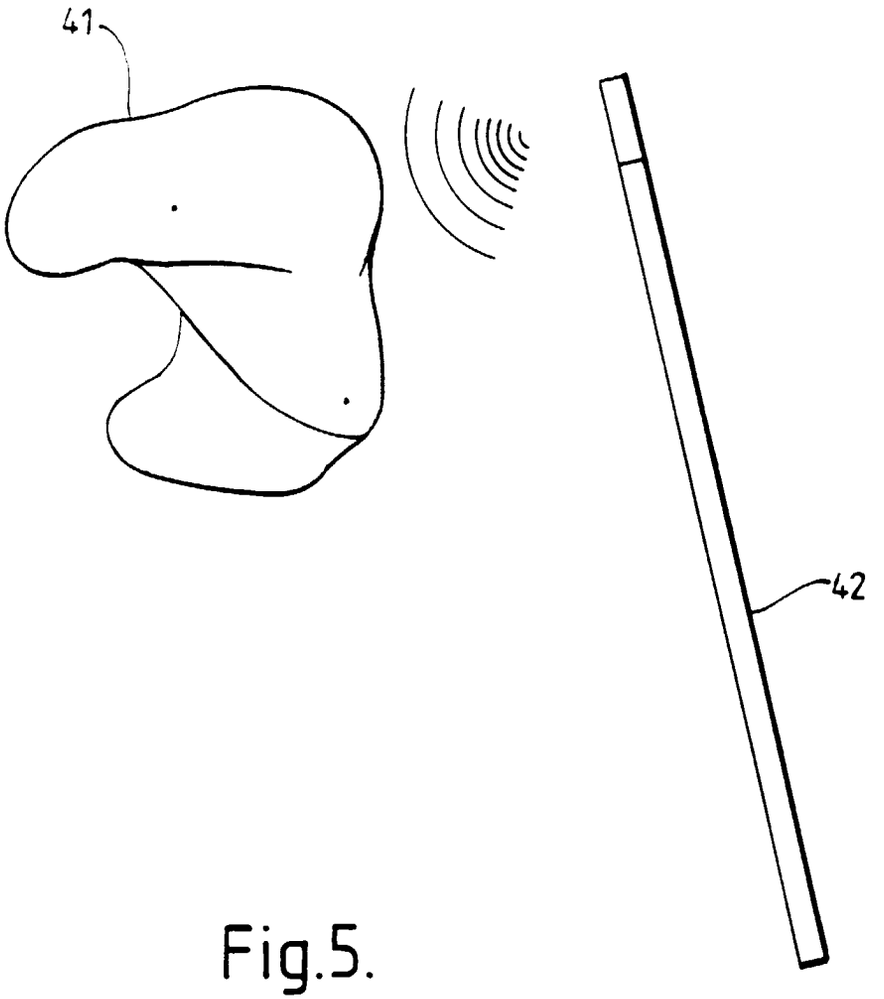

Fig.5.