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Ruegg

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[54] **HEARING AID**

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[73] Assignee: **Bommer AG**, Zurich, Switzerland

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[52] **U.S. Cl.** .... **179/107 FD**, 179/121 D, 179/1 DM

[51] **Int. Cl.** **H04p 25/00**

[58] **Field of Search** ..... 179/107 R, 107 BC, 107 E, 179/107 H, 107 S, 179, 180, 178, 121 D, 1 DM, 107 FD; 181/23

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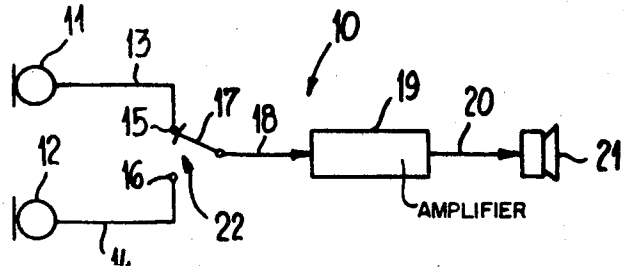
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

A hearing aid for the hard of hearing incorporating a microphone system connected with an amplifier. The microphone system embodies a first microphone with approximately spherical-shaped sensitivity characteristics and a second microphone with directional sensitivity characteristics. The amplifier can be selectively connected with one or the other of both microphones.

12 Claims, 5 Drawing Figures



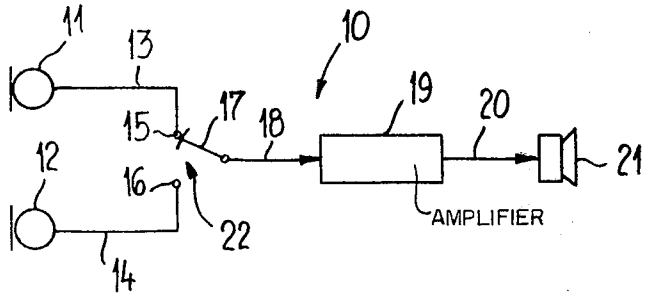


Fig.1

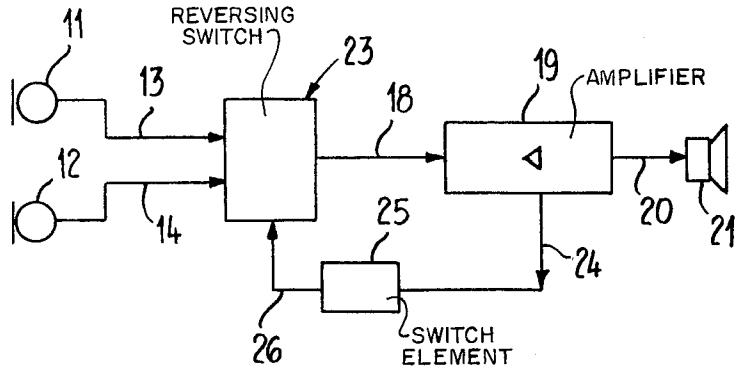


Fig.2

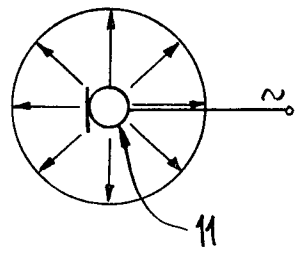


Fig.3

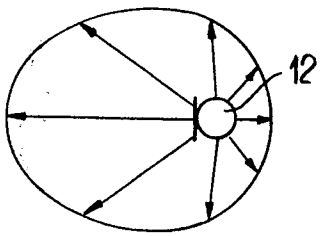
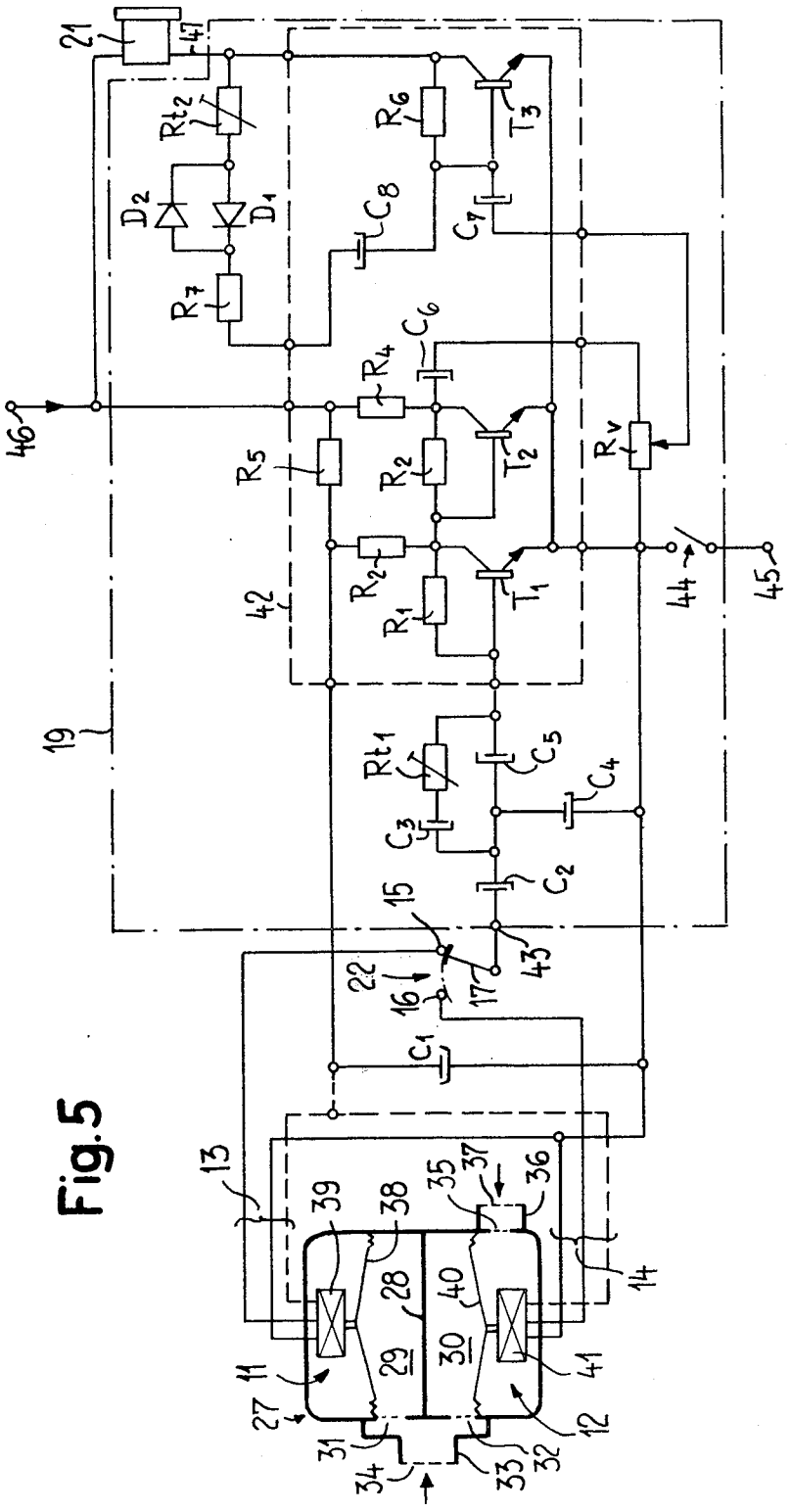


Fig.4


21
47
Rt2
D2
D1
R7
R6
T3
C8
C7
C6
R4
46
R5
R2
T2
Rv
R2
R1
T1
42
44
45
19
Rt1
C5
C4
C3
C2
15
22
16
17
43
C1
13
39
38
35
37
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14
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Fig.5

HEARING AID

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved construction of hearing aid for the hard of hearing of the type incorporating a microphone system coupled with an amplifier. In the context of this disclosure the expression "hearing aid" or "hearing device," or equivalent terminology, should be understood as encompassing both the so-called "behind-the-ear" as well as also the so-called "in-the-ear" hearing aid and hearing aid eyeglasses, in other words all hearing aids worn at or about the head of the user.

It is well known in this particular field of technology to equip such hearing aids with microphones which possess a pronounced directional characteristic. With such hearing aids the sound waves which arrive from a predetermined direction are amplified and transmitted to the wearer of the hearing aid, this direction, as a general rule, coinciding with the line of sight or viewing direction of the wearer. Although such hearing aids provide adequate aid to the user during normal conversation with another person, they are not totally satisfactory in an environment of use where the sound emanates from all directions, since the user becomes unsure of himself. It has been particularly determined that people who are hard of hearing and who wear a hearing aid having a microphone exhibiting directional sensitivity characteristics become extremely unsure of themselves in traffic because, from the entire background of sounds, they are only able to perceive those sounds which coincide with their momentary line of sight.

On the other hand, there are known to the art hearing aids of the previously mentioned type in which the microphone possesses a so-called spherical sensitivity characteristic. Also such constructions of hearing aids do not satisfy all of the needs of the hard of hearing. Thus, for instance, a conversation with another person is only possible for the person who is hard of hearing when using such hearing aid if the party to whom the hard of hearing person speaks raises his voice above the general sound level of the surroundings, or then when the person who is hard of hearing, in addition to listening to the sounds of the words of the speaking person also lip reads.

SUMMARY OF THE INVENTION

Hence, it is a primary object of the present invention to provide an improved construction of hearing aid which is capable of reliably fulfilling the needs of the hard of hearing practically for all encountered situations.

A further object of the present invention relates to an improved construction of hearing aid which combines the advantages of a hearing aid equipped with a microphone having directional characteristics with a hearing aid equipped with a microphone having spherical sensitivity characteristics while avoiding the drawbacks present when only using a microphone in a hearing aid having one or the other of such sensitivity characteristics.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the proposed hearing aid is manifested by the features that the microphone system possesses a first microphone having spherical sensitivity characteristics and a second microphone with directional sensitivity characteristics, and wherein the amplifier can be selectively switched to either one of both microphones.

Thus, a minature hand-operated reversing switch can be provided between the microphones and the amplifier, and which switch can be actuated, when required, by the user without having to remove the hearing aid. On the other hand, both of the microphones can be arranged through the agency of a controlled reversing switch following a threshold value amplifier, which upon exceeding a predetermied signal peak controls the reversing switch for switching to the second microphone, that is to say, to that microphone which has a pronounced directional characteristic. This predetermined signal peak can be set to a value which occurs when the wearer is carrying out a conversation with another person at a normal distance.

Both of the microphones are preferably each arranged in a respective compartment of a housing subdivided by a partition wall into two compartments or chambers, wherein in the first compartment there opens a sound inlet opening and in the second compartment two oppositely situated sound inlet openings. In order to avoid acoustical feedback it is advantageous to arrange the diaphragms or membranes of the microphones and which are capable of vibrating or oscillating such that they are each essentially parallel to the partition wall. For further avoiding acoustical feedback there can be arranged at the second compartment the one sound inlet opening at one side of the vibratable diaphragm and the other sound inlet opening at the other side thereof of the associated microphone.

Moreover, the directional characteristics of the second microphone can be increased if the one sound inlet opening associated with such microphone possesses a greater sound absorption capacity than the other sound inlet opening.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. **1** is a simplified block circuit diagram of a hearing aid which can be manually switched;

FIG. **2** is a simplified block circuit diagram of a hearing aid which can be automatically switched;

FIG. **3** schematically illustrates the sensitivity characteristics of a first microphone;

FIG. **4** schematically illustrates the sensitivity characteristics of a second microphone; and

FIG. **5** is a circuit diagram of a hearing aid equipped with manually-switchable microphones, wherein the arrangement of both microphones is illustrated in a common housing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, the hearing aid **10**, depicted by way of example in FIG. **1**, possesses two microphones **11** and **12**, wherein the first microphone, the microphone **11**, as will be understood by referring to FIG. **3**, is assumed to possess a spherical-type of sensitivity characteristic, whereas the second microphone, the microphone **12**, as indicated in FIG. **4**, is assumed to possess a sensitivity having a pronounced directional

characteristic. The microphone **11** is electrically coupled via a conductor or line **13** with one fixed contact **15** and the microphone **12** via a conductor or line **14** with the other fixed contact **16** of a reversing switch or switch means **22.** The movable contact **17** of the reversing switch **22** is connected through the agency of a conductor **18** with an amplifier **19.** The output of amplifier **19** is connected via a conductor **20** with an electro-mechanical transducer, for instance a loud-speaker **21** where the electrical signals emanating from the microphone **11** or the microphone **12** are amplified by amplifier **19,** and again transformed into mechanical oscillations, that is to say, sound waves.

The same elements will be also recognized to be present with the constructional embodiment of FIG. **2,** wherein, however, in this case, instead of the reversing switch **22** there is employed an automatically controlled electronic reversing switch **23.** In this embodiment the amplifier **19** is a so-called threshold value amplifier which, apart from the output or output conductor **20** which leads to the loudspeaker **21,** possesses a second output **24** where there then appears a signal when the signal prevailing from one of both microphones **11** and **12** exceeds a predetermined signal peak. The output **24** is connected through the agency of a further switching element, designated by reference character **25,** with the control input **26** of the reversing switch or switch means **23.** The switch element **25** can be a control or regulator, but also can be a frequency-dependent discriminator stage, so that switching-over to the microphone **12** possessing the pronounced directional characteristic, not only then occurs when a sound has assumed a predetermined intensity, rather when such sound also possesses a predetermined frequency spectrum. Switching back to the microphone **11** possessing the spherical sensitivity characteristic can occur both automatically upon the absence of a signal at the amplifier output **24,** or also however manually, so that the user has the possibility of intentionally controlling the hearing aid.

It is to be observed that both in the embodiment of FIG. **1** as also in the embodiment of FIG. **2** the microphones can be electro-magnetic, piezo-electrical or dielectrical microphones wherein, however, both microphones always will be of the same type owing to the nature of the different frequency characteristics. Also the amplifiers of both embodiments can be linear, AGC (automatic gain control) or non-linear controlled amplifiers.

Now in FIG. **5** there is illustrated a detailed circuit diagram of hearing aid with the two schematically arranged microphones of such hearing aid collectively accommodated in a single housing. Initially on the basis of the discussion of FIG. **5** there will be considered the construction of the microphone system. Both of the microphones **11** and **12** are arranged in a common housing **27,** the internal compartment of which is subdivided into two compartments or chambers **29** and **30** by a partition wall **28.** In the compartment **29** there is arranged the microphone **11** with its diaphragm or membrane **38** and its transducer component **39,** while in the compartment **30** there is arranged the microphone **12** with its diaphragm or membrane **40** and its transducer component **41.** The compartment **29** possesses a sound inlet opening **31** which, as best seen by referring to FIG. **5,** opens into the compartment **29** at the side or face of the diaphragm **38** facing away from the transducer component **39.** On the other hand, the compartment **30** possesses two oppositely situated sound inlet openings **32** and **35,** wherein the sound inlet opening **32** opens into the compartment **30** at the side of the diaphragm **40** which faces away from the transducer component **41** and the sound inlet opening **35** opens at the side of the diaphragm **40** which confronts the transducer component **41.**

A common sound inlet funnel **33** is arranged forwardly of both sound inlet openings **31** and **32.** The sound inlet funnel **33** possesses a single inlet opening **34.** On the other hand, connected in front of the sound inlet opening **35** is a stud or connection piece **36** having an opening **37.** The arrangement is carried out such that the sound absorption capacity of the inlet locations formed by the openings **35, 37** and the stud **36** is greater than the sound absorption capacity of the inlet location formed by the openings **31, 32** and **34** as well as the funnel **33.**

Now if this arrangement is subjected to sound vibrations or oscillations, then initially the entire outside of the housing **27** will be uniformly impinged by the sound pressure, something which for itself will not have any effect upon the microphone **11** and **12.** The parts of the compartments **29** and **30** which are located, on the one hand, between the partition wall **28** and, on the other hand, the respective diaphragms **38** and **40** will be subjected to the action of the sound pressure which enters via the openings **31** and **32.** The partition wall **28** will therefore so to speak be impinged in a push-pull mode from both sides by the sound oscillations or vibrations, so that as a practical matter it does not begin to vibrate or oscillate, whereby there is practically eliminated the possibility of acoustical feedback between the compartments **29** and **30.** Since the microphone **11** only has associated therewith one sound inlet opening, namely the opening **31,** the diaphragm **38** will be activated by all of the oscillations which enter through such opening, independently of the direction in which such arrive at the funnel opening **34** and therefore at the sound inlet opening **31.** Hence the microphone **11,** insofar as its receiving sensitivity is concerned, possesses a spherical-type characteristic as same has been schematically depicted in FIG. **3.** The conditions are different for the microphone **12.** In this case both sides of the diaphragm or membrane **40** are impinged by the sound pressure, wherein, however, the sound waves which enter the opening **35** are dampened to a greater extent than the sound waves which enter through the opening **32.** Consequently, the diaphragm **40** is placed into oscillation which, however, is only predicated upon the magnitude of the pressure differential in the compartment **30** which prevails between both faces or sides of the diaphragm **40.** Since additionally the sound inlet openings **32** and **35** are arranged opposite one another the microphone **12** possesses, as concerns its receiving sensitivity, a pronounced directional characteristic, and specifically such microphone possesses in the position depicted in FIG. **5** a considerably greater sensitivity for sound waves which emanate from the left than for those which can enter from the right through the opening **35.**

Both of the microphones **11** and **12** are each coupled through the agency of the conductor lines **13** and **14** respectively, with the reversing switch **22** and the amplifier **19.** At such conductor lines **13** and **14** there is shown in phantom lines a supply conductor for the situ-

ation where the microphones **11** and **12** are of the type belonging to the class of piezo-electrical or dielectrical microphones. The illustrated amplifier **19** is a conventional miniaturized hearing aid-amplifier. The power supply to such amplifier **19** takes place through the agency of a suitable and therefore not particularly illustrated current source coupled with the terminals **45** and **46**, wherein an installed switch **44** serves to switch-on the amplifier **19**. The weak tone-frequency signal which emanates from one of the microphones **11** and **12**, depending upon the position of the reversing switch **22**, is delivered to the amplifier **19** through the agency of the input terminal **43**. Amplifier **19** is composed of the resistors R1–R6, the capacitors C1–C7, the transistors T1–T3 as well as the potentiometer Rv serving as the loud-speaker control and the variable resistor Rt1. A non-linear network is arranged in circuit with the conductor **47** leading to the loud-speaker **21**, and this non-linear network consists of the resistor R7, both of the diodes D1 and D2 which are arranged in an anti-parallel circuit configuration and the variable resistor Rt2. This network produces a non-linear alternating-current feedback which, in turn, produces an amplification- or output-dependent, approximately logarithmic feedback or output limiting effect.

It should be understood that those skilled in the art will have considerable leeway as concerns the construction of the amplifier. Purely by way of example it is mentioned that the circuit components enclosed by the phantom-line box **42** can be constructed as an integrated circuit, at which there are coupled the adjustable or regulatable switching elements, namely the switch **44**, the potentiometer Rv as well as the variable resistors Rt1 and Rt2. It is, however, also possible to provide, instead of the illustrated amplifier **19**, a linear-amplifying amplifier which is controlled by a DC-voltage or limited by so-called "peak clipping," and which constitutes electrical hardware particularly well known to those skilled in the hearing aid art.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:

1. An individual hearing aid for wearing by the hard of hearing, the hearing aid being transportable by the wearer and comprising amplifier means, a microphone system electrically coupled with said amplifier means, said microphone system comprising a first microphone having approximately spherical sensitivity chatacteristics and a second microphone with directed sensitivity characteristics, and means for selectively connecting the amplifier means with one or the other of both microphones.

2. A hearing aid for the hard of hearing comprising amplifier means, a microphone system electrically coupled with said amplifier means, said microphone system comprising a first microphone having approximately spherical sensitivity characteristics and a second microphone with directed sensitivity characteristics, means for selectively connecting the amplifier means with one or the other of both microphones, and further including a housing, a partition wall for subdividing the housing into two compartments, each of the microphones being arranged in a respective compartment of the housing, means defining a sound inlet opening which opens into one of the compartments and means defining two oppositely situated sound inlet openings opening into the other compartment.

3. The hearing aid as defined in claim **2**, wherein each of the microphones has a diaphragm which can be placed into oscillation, and wherein said diaphragms are arranged substantially parallel to the partition wall.

4. The hearing aid as defined in claim **3**, wherein for said other compartment one sound inlet opening is arranged at one side of the diaphragm which can be oscillated and the other sound inlet opening is arranged at the other side of said diaphragm of the associated microphone.

5. The hearing aid as defined in claim **4**, wherein the sound inlet opening of said one compartment and said one sound inlet opening of the other compartment communicate with a common sound inlet funnel.

6. The hearing aid as defined in claim **5**, wherein said other sound inlet opening possesses a greater sound absorption capacity than the remaining sound inlet openings.

7. The hearing aid as defined in claim **6**, wherein both microphones are connected via a controlled reversing switch means with a threshold value amplifier constituting said amplifier means, and said threshold value amplifier upon exceeding a predetermined signal peak controls the reversing switch means for switching to said second microphone.

8. The hearing aid as defined in claim **1**, wherein both microphones are connected via a controlled reversing switch means with a threshold value amplifier constituting said amplifier means, said threshold value amplifier upon exceeding a predetermined signal peak controlling the reversing switch means for switching from one of the microphones to the other of the microphones.

9. The hearing aid as defined in claim **8**, wherein the reversing switch means normally connects the first microphone with said threshold value amplifier and in response to said threshold value amplifier exceeding a predetermined signal peak connects the second microphone to said amplifier.

10. The hearing aid as defined in claim **1**, wherein the hearing aid is a self-contained unit arranged for accommodation on the wearer.

11. The hearing aid as defined in claim **1**, further comprising common housing means for accommodating at least the first and second microphones for positioning on the wearer.

12. The hearing aid as defined in claim **11**, wherein said amplifier means is contained in said housing means.

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