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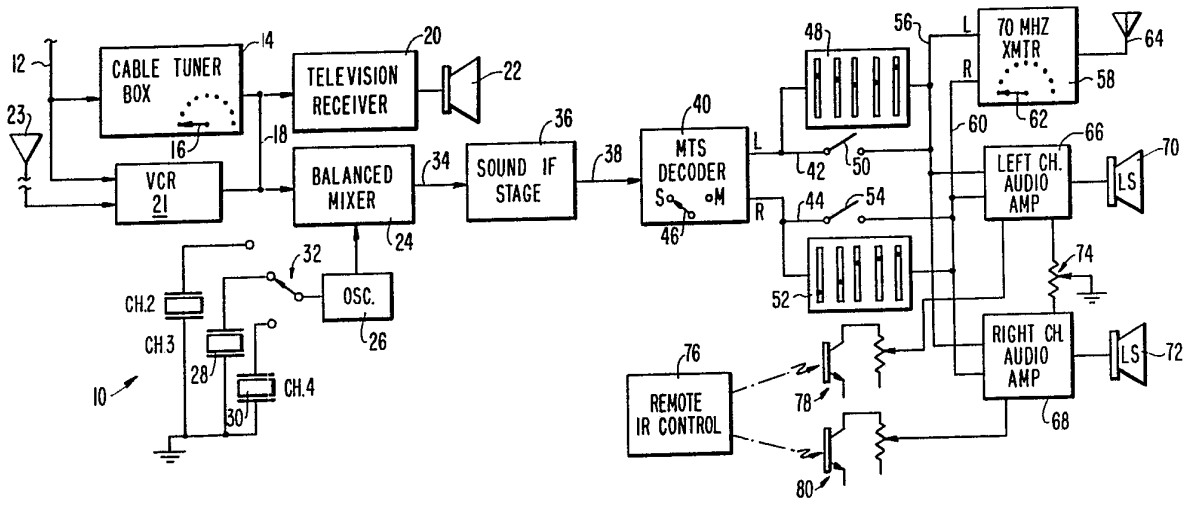
(54) Title: ASSISTIVE LISTENING DEVICE



(57) Abstract

An assistive listening method, for use by a listener with diminished sensitivity to certain frequencies, includes receiving a broadcast signal (12), converting to a predetermined intermediate frequency (34), demodulating the intermediate frequency into a baseband signal containing left and right stereo signals. The left and right signals (42, 44) are separately equalized (48, 52) to compensate for the listener's hearing loss at given frequencies, the relative amplitude balance between the left and right signals is adjusted (74), and the signals are separately reproduced (71, 72) for the listener.

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ASSISTIVE LISTENING DEVICE

Field of the Invention

The present invention relates to methods and apparatus for assisting aural perception for those hard of hearing. More particularly, the present invention relates to methods and apparatus enabling a hard of hearing person to tailor an aural reproduction system to his or her particular hearing characteristics without intrusion upon proximate listeners of normal hearing characteristics.

Background of the Invention

Presently available figures indicate that approximately twenty two million Americans suffer from hearing loss or impairment. Approximately two million of these people suffer from neurological damage or impairment, and unfortunately they cannot be aided by amplification techniques conventionally provided by hearing aids. For the other remaining population suffering from hearing impairment, the general characteristic appears to be a falloff of sensitivity with frequency, as well as an overall diminishment of sensitivity to sound levels. A greater level of high frequency audio sound is typically required for the hard of hearing listener than for persons with normal hearing characteristics. When listening to radio or television broadcasts, the high audio level needed by the hearing impaired listener frequently causes severe discomfort to other listeners of normal hearing in the same room or viewing area.

Conventional hearing aids, even the most modern, professional types, do not solve this problem, although they provide some help. Hearing impaired listeners outfitted with hearing aids still typically desire the sound level for radio and television broadcasts to be higher than the levels preferred by persons with normal hearing; and, the hearing impaired need the frequency response to be adapted to their particular hearing deficiency.

More importantly, however, is the fact that even the

most sophisticated and expensive hearing aids usually produce some degree of physical and acoustical discomfort, sometimes lowering the hearing impaired person's pleasure in listening to speech and music. Hearing becomes an ordeal rather than an enjoyment. Because of size restrictions, "in the ear" and "behind the ear" hearing aids have considerable trouble generating the requisite sound levels over the needed frequency range without also generating substantial levels of harmonic distortion.

The use of high quality "high fidelity" type stereo headphones, properly driven and equalized to compensate for the hearing loss characteristics of the listener can provide pleasurable listening for speech and music content. However, conventional high fidelity or stereo headphones do not provide a realistic or practical answer for the hard of hearing listener for television broadcasts, because the headphones must be plugged into the television set and typically equipped with a long cord extending to a comfortable viewing location some distance away from the display screen. Most commercially available television receivers are not equipped for headsets, and substantially all available television receivers lack sound equalizers to adjust the frequency characteristics to compensate for the hearing loss characteristics of the hearing-impaired viewer. Also, those television sets equipped with jacks for headphones cause the sound to the internal loudspeaker to be disconnected when the headphone is plugged into the jack, thereby effectively depriving any other viewers in the room from listening to the television program.

Two different wireless transmission methods have been proposed to eliminate the problem with the connection cord from the television set to the listener's headphone. These methods typically employ small, battery operated receivers which accommodate one or more headsets, and which typically provide for local volume control adjustment. One approach for wireless transmission employs a modulated infrared light beam. A drawback of the infrared light beam method is that

anyone passing in front of the transmitter will effectively cut off the signal to the listener. The other method employs low power radio waves within the FM broadcast band spectrum. In both methods the useful range is very limited, with the infrared beam method requiring the listener to be within the visual range of the transmitter and with the FM radio range limited to about twenty feet of the transmitter, and subject in many locations to severe interference from local broadcast stations, for example. While these two wireless transmission methods have been used by the hearing impaired listener in some public locations such as theaters, auditoriums and cinemas, neither method has been specifically tailored to compensate for the hearing loss characteristics of the listener.

Thus, a hitherto unsolved need has arisen for an assistive listening method and apparatus which effectively overcomes the limitations and drawbacks of the prior art approaches.

Summary of the Invention with Objects

A general object of the present invention is to provide an assistive listening method and apparatus which enables the hearing impaired listener to have sound frequencies and levels tailored to compensate for a particular hearing loss without imposing on other proximate listeners of normal hearing in a manner which overcomes the limitations and drawbacks of the prior art.

Another more specific object of the present invention is to provide an assistive listening method and apparatus which may be used with standard television broadcast reception equipment in a manner that enables sound levels to be uniquely tailored to the left and right ear characteristics of a hearing-impaired person and which also enables conventional sound levels to reach a person of normal hearing within the same proximity to the reception equipment.

One more specific object of the present invention is to provide an assistive listening method and apparatus which

includes a portable personal receiver for receiving left and right sound compensated signals from a source and for further separate processing of the left and right sound signals to compensate for the characteristics of the left and right ears of the listener in those cases where transmitter compensation is made to an average nominal hearing loss. This includes public places such as churches, theater, cinema, auditoriums and public meeting halls, for example.

Yet another more specific object of the present invention is to provide an assistive listening method and apparatus which works conveniently with a cable tuner box of a television cable distribution network to extract the broadcast stereo or monaural sound portion of a selected channel and program as is followed and reproduced by the conventional sound path within a television receiver connected to the cable tuner box.

Yet a further specific object of the present invention is to provide an assistive listening device in connection with a video cassette recorder (VCR) RF output in those cases where the associated television receiver is internally adapted to tune to the various channels used by the cable television system without an external cable box, or where the VCR is used as a tuner connected to the cable system or to an external antenna or other signal source.

Still a further more specific object of the present invention is to provide an assistive listening method and apparatus which includes a small, battery powered, self contained radio receiver for receiving left and right path signals from a local source and for sending the signals to both ears of a hearing impaired person or other user.

In accordance with one facet of the present invention, an assistive listening method is provided for assisting the perception of broadcast aural material by a listener having diminished sensitivity to sounds of certain frequencies or aural bands. The method includes the steps of:

intercepting a signal containing the broadcast aural

material at a predetermined intermediate frequency,

demodulating the intermediate frequency into a baseband signal containing the aural material as a component thereof,

detecting the aural material from the component of the baseband signal,

separating and putting out a left signal path intended for perception by the left ear, and separating and putting out a right signal path intended for perception by the right ear,

separately adjusting plural spectral portions of the left signal path and of the right signal path in order to compensate for frequency losses characterizing the left ear and the right ear of the listener,

adjusting relative amplitude balance between the left signal path and the right signal path to compensate for differences in aural sensitivities of the left and right ears of the listener, and

separately reproducing the sounds from the left signal path and from the right signal path for perception by the listener.

In one aspect of the method of the present invention further steps include transmitting the left and right signal paths via a transmitter means, and receiving and separating the left signal path and right signal path before separately further adjusting plural spectral portions of the left signal path and of the right signal path.

In another aspect of the method of the present invention, the transmitting step includes the step of encoding the left and right signal paths into a baseband component and into a subcarrier component, and the receiving and separating step includes the steps of decoding the subcarrier component and combining the decoded subcarrier component with the baseband component to recover the left signal portion and the right signal portion.

In still one more aspect of the present invention, the encoding step comprises the steps of encoding the baseband

component as left signal path plus right signal path and encoding the subcarrier component as left signal path minus right signal path.

In yet another aspect of the present invention, the step of intercepting a signal containing the broadcast aural material at a predetermined intermediate frequency comprises the step of detecting the broadcast aural material at an intermediate frequency output of a tuning device, such as a cable television tuner box.

As a separate facet of the present invention, an assistive listening device for the hard of hearing person comprising:

left signal path and right signal path providing circuitry for providing left and right aural signals intended respectively for sound perception by the person's left and right ears,

an encoder encodes the left and right aural signals into a baseband component and into a subcarrier component,

a radio frequency modulated transmitter circuit generates and radiates within a limited spatial range a carrier signal frequency modulated by a composite of the baseband component and the subcarrier component,

a radio frequency modulated receiver circuit receives and detects the composite from the transmitter when within the limited spatial range of radiation thereof,

a binaural or stereo decoder circuit is connected to the receiver circuit and decodes the composite into a received left aural signal and into a received right aural signal,

an adjustable left aural signal spectral equalization circuit is provided for further adjusting the spectrum of the received left aural signal to compensate for hearing loss characteristics of the left ear of the person,

likewise, an adjustable right aural signal spectral equalization circuit is provided for adjusting the spectrum of the received right aural signal to compensate for hearing loss characteristics of the right ear of the person,

left and right signal amplifiers separately amplify the compensated left and right aural signals, and

left and right electoaural transducers, such as various types of headphones are respectively connected to the left and right signal amplifiers for reproducing the compensated left and right aural signals for the hearing-impaired person. For the listener's greater comfort, the small receiver may be snapped into a modified "BONE FONE" unit, U.S. Patent No. 4,070,853, which consists of a flat cloth sleeve 3½" wide by 28" long by 5/8" thick with two small 3" loudspeakers inside, each loudspeaker positioned 9½" from the center of the sleeve. At each end of each sleeve is a small plastic case 5" by 2 3/4" by 5/8". One case holds two small audio amplifiers to drive the two loudspeakers, and a small rechargeable lead acid "Gel Cell" battery to run the system. The other case is open on one of its large sides to allow the small receiver to snap in and be connected to the audio amplifiers and the rechargeable batteries.

As one aspect of this facet of the invention, at least one of the left and right receiver amplifiers may include circuitry for picking up and amplifying ambient sounds in the vicinity of hearing-impaired person and for combining the ambient sounds with the aural signal being amplified and put out through the earphone for that ear.

As a further aspect of this facet of the invention, in order to obtain a clear, interference free signal, both transmitter and receiver are selectable multi-channel units designed to employ special channels set aside by the WARC Convention countries of the world for the exclusive use of the hard of hearing.

These and other objects, aspects, advantages and features of the present invention will be more fully understood and appreciated upon consideration of the following detailed description of a preferred embodiment, presented in conjunction with the accompanying drawings.

Brief Description of the Drawings

In the Drawings:

Fig. 1 is a block diagram of an assistive listening system for the hard of hearing listener incorporating principles of the present invention.

Fig. 2 is a radio receiver-based assistive listening device for aiding the hard of hearing listener in conjunction with a transmitter portion of the Fig. 1 system.

Detailed Description of a Preferred Embodiment

With reference to Fig. 1, an assistive listening system 10 is provided for the hearing-impaired listener. The system 10 is particularly adapted for connection to, and use with, a cable television installation including a distribution cable 12, a cable television tuner box 14 having a channel selector 16 and a single channel output path 18 leading to a conventional television receiver 20, or VCR 21 connected to the cable 12, or to an antenna 23. The television receiver 20 includes a suitable display screen (not shown) and one or more loudspeakers 22, whose sound levels and frequency responses are determined in conventional fashion. The loudspeaker 22 of the television receiver 20 may or may not be used, depending upon whether persons with normal hearing are present for viewing the television screen.

The single channel output path 18, typically providing the selected television signal on channel 2, 3 or 4, enters the system 10 at a balanced mixer 24. The balanced mixer also receives a selected channel 2, 3 or channel 4 hetrodyne signal from an oscillator 26. The particular frequency of the hetrodyne signal is fixed by a channel 2 or 3 sound carrier hetrodyne crystal 28 or a channel 4 sound carrier hetrodyne crystal 30 as selected by a switch 32. The balanced mixer 24 mixes the hetrodyne signal with the incoming signal on the path 18 to produce a baseband signal at an output 34. Only the FM sound signal at a subcarrier of 4.5 MHz is recovered and is present at the output 34.

The FM sound subcarrier signal is the passed through a conventional IF amplifier and discriminator stage 36 which

limits amplitude excursions and recovers the audio signal and puts it out at an output 38. An MTS stereo decoder 40 decodes the stereo signal in conventional fashion and puts out a left channel signal on a path 42 and puts out a right channel signal on a path 44. A manual selection switch 46 enables selection between stereo and monaural modes at the decoder 40. Automatic switching between these modes may alternatively be implemented.

The left channel signal on the path 42 passes through a user operable five stage graphic equalizer 48 which enables the user to manipulate the amplitude of components of the left channel signal within discrete passbands in order to compensate for hearing loss in the left ear, for example. A switch 50 enables the graphic equalizer 48 to be bypassed, if desired. Similarly, the right channel signal on the path 44 passes through a user-operable five stage graphic equalizer 52 which enables the user to manipulate the amplitude of components of the right channel signal within discrete passbands in order to compensate for hearing loss in the right ear, for example. A switch 54 enables the right channel graphic equalizer 52 to be bypassed, if desired.

An equalized left channel path 56 from the left channel graphic equalizer 48 leads to a left channel input of a 70 MHz limited range stereo transmitter 58 and an equalized right channel path 60 from the right channel graphic equalizer 52 leads to a right channel input of the transmitter 58. A selector 62 enables the operating channel of the stereo transmitter 58 to be selected.

Currently, thirty two frequency channels are allotted under international treaty and implementing Federal regulations in the 70 MHz band for assistive listening devices; and, the selector 62 enables one of the available channels to be selected. An antenna 64 radiates an RF signal generated by the transmitter 58. In proper operation, the transmitter 58 and antenna 64 should limit the effective range of the RF signal to the listener's home

or auditorium. The transmitter 58 encodes the incoming left and right path signals into conventional FM stereo format and FM modulates a preselected 70 MHz channel carrier with the baseband (left plus right) and suppressed subcarrier (left minus right) composite signal.

The left and right paths 56 and 60 also lead to two amplifiers: a left signal amplifier 66 and a right signal amplifier 68. The left signal amplifier 66 drives a left signal loudspeaker 70, and the right signal amplifier 68 drives a right signal loudspeaker 72. A balance control 74 enables the sound levels of the speakers to be balanced to the listener's relative left ear-right ear hearing loss. A conventional infrared remote control unit 76 and associated left and right IR detectors 78 and 80 enable the impaired listener to control overall loudness level remotely from the listener's viewing position.

The system of Fig. 1 works very well for a hearing impaired listener when persons of normal hearing are not present. The graphic equalizers 48 and 52 and balance control 74 may be set to compensate precisely for the hearing loss characteristics of the listener. Once set, these controls may then be left unattended. The remote IR control unit 76 then is used to control overall loudness and muting, for example. If persons having normal hearing are present, then a privacy arrangement is most desireable.

Fig. 2 shows a privacy subsystem 82 for use with the transmitter 58 of the Fig. 1 system 10. The subsystem 82 includes a receiving antenna 84 connected to an RF input of a 70 MHz tuner 86. The tuner 86 may include a channel selector 88 enabling the tuner selectively to tune to the channel to which the transmitter 58 is set.

An output path 90 from the tuner 86 leads to an IF and stereo demodulator 92 wherein the signal received by the tuner 86 is subjected to amplitude limiting and bandpass amplification, FM detection and FM stereo decoding. A left channel path 94 and a right channel path 96 are put out by the circuit element 92.

The detected and decoded audio signal at the left channel path 94 is amplified by a left channel preamplifier 98 and put out at a left signal output 100. A small microphone 102 and preamplifier 104 may be suitably connected to either the left path 94 or right path 96 by the user, or to both paths, through a suitable level control 106. The path chosen is preferably to the ear having the least diminished sensitivity. The microphone 102 enables the listener to remain aware of ambient sounds, such as other voices, telephone rings, doorbells, etc., while headphones 114 are being worn. Alternatively, the headphones may be mechanically adapted to enable ambient sounds also to reach the listener's ears.

The left path 100 from the preamplifier 98 leads to a three band graphic equalizer 108 and thence through an audio amplifier 110 to a left earphone 112 of the headset 114. The right channel path 96 leads through a right channel preamplifier 116 and a right output 118 to a three band graphic equalizer 120. The output from the equalizer 120 leads through a power amplifier 122 to a right earphone of the headset 114. A balance control 126 enables the user to adjust balance between the left and right channel sounds at the earphones 112 and 124 respectively. Alternatively, the output of amplifiers 110 and 122 may be used to drive the two "BONE FONE" adaptor loudspeakers via amplifiers 126 and 132.

The subsystem 82 (separate from the headset 114) is completely self contained in a small, battery operated package which conveniently fits within a shirtpocket, or clips onto the garment of the wearer. Modern large scale, surface mount semiconductor technology enables the subsystem 82 to be packaged in a very small and convenient package and to be operated at very low power consumption by a small battery (not shown).

By setting the graphic equalizers 48 and 52 of the system 10 to settings corresponding to average hearing loss characteristics of the population, it is entirely practical

to provide the RF signal from the transmitter 58 to a number of different receiver subsystems 82. Each receiver subsystem 82 may be effectively tailored to the hearing loss characteristics of the particular listener by adjustment of the local graphic equalizers 108 and 120 and further adjustment of the local balance control 126 to accommodate different overall sensitivities in the left and right ear of the listener. An overall level control (not shown) may also be provided for the left and right channels in order to adjust listening levels to be appropriate to the listener.

Thus, it is apparent to those skilled in the art that the amplifiers 66 and 68 of the system 10 may be omitted when the transmitter 58 is always to be used, and that the transmitter 58 and subsystem 82 may be omitted when the amplifiers 66 and 68, together with their respective loudspeakers 70 and 72 are always to be used. Alternatively, the loudspeakers 70 and 72 may be selectively replaced by the headset 114 with a suitably lengthed cord and a plug and jack which switches off the loudspeakers when engaged. While the system 10 has been illustrated specifically for use with a cable tuner box 14, or VCR 21 having a fixed channel RF output, many other connections to electronic sound-generating appliances may be readily envisioned. Connections may be made directly to an audio or stereo output of the television receiver 20. Connections may be made directly to an audio or stereo output of the VCR 21, or stereo sound system, or any other appliance sought to be used by a person who is hard of hearing. While the graphic equalizers 4, 52, 108 and 120 have been illustrated as graphically depicting the resultant aural spectrum, many other forms of equalizers are equally well suited, and they may be adapted for individual adjustment by the hearing-impaired listener, or for adjustment by a professional audiologist, or both.

Having thus described a presently preferred embodiment of the present invention, it will now be appreciated that the objects of the invention have been fully achieved and it

will be understood by those skilled in the art that many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the present invention. The disclosures and the description herein are intended to be illustrative and are not in any sense limiting of the invention, more particularly defined in scope by the following claims.

1. An assistive listening method for assisting the perception of broadcast aural material by a listener having diminished sensitivity to certain frequencies, the method including the steps of:

intercepting a signal containing the broadcast aural material at a predetermined intermediate frequency,

demodulating the intermediate frequency into a baseband signal containing the aural material as a component thereof,

detecting the aural material from the component of the baseband signal,

separating and putting out a left signal path intended for perception by the left ear, and separating and putting out a right signal path intended for perception by the right ear,

separately adjusting plural spectral portions of the left signal path and of the right signal path in order to compensate for frequency losses characterizing the left ear and the right ear of the listener,

adjusting relative amplitude balance between the left signal path and the right signal path to compensate for differences in aural sensitivities of the left and right ears of the listener, and

separately reproducing the sounds from the left signal path and from the right signal path for perception by the listener.

2. The assistive listening method set forth in claim 1 comprising the further steps of transmitting the left and right signal paths via a transmitter means, and receiving and separating the left signal path and right signal path before the step of separately adjusting plural spectral portions of the left signal path and of the right signal path.

3. The assistive listening method set forth in claim 2 wherein the transmitting step includes the step of encoding the left and right signal paths into a baseband component and into a subcarrier component, and the receiving

and separating step includes the steps of decoding the subcarrier component and combining the decoded subcarrier component with the baseband component to recover the left signal portion and the right signal portion.

4. The assistive listening method set forth in claim 3 wherein the encoding step comprises the steps of encoding the baseband component as left signal path plus right signal path and encoding the subcarrier component as left signal path minus right signal path.

5. The assistive listening method set forth in claim 1 wherein the step of intercepting a signal containing the broadcast aural material at a predetermined intermediate frequency comprises the step of detecting the broadcast aural material at an intermediate frequency output of a tuning device.

6. The assistive listening method set forth in claim 5 wherein the intermediate frequency of the tuning device comprises the output of a cable television tuner and comprises a standard television broadcast channel.

7. The assistive listening method set forth in claim 6 wherein the intermediate frequency is a predetermined one of broadcast channels two, three and four.

8. An assistive listening device for the hard of hearing person comprising:

left signal path and right signal path providing means for providing left and right aural signals intended respectively for sound perception by the person's left and right ears,

encoding means for encoding left and right aural signals into a baseband component and into a subcarrier component,

radio frequency modulated transmitter means for generating and radiating within a limited spatial range a carrier signal frequency modulated by a composite of the baseband component and the subcarrier component,

radio frequency modulated receiver means for receiving and detecting the composite from the transmitter when within

the limited spatial range of radiation thereof, the said receiver means including:

a. stereo decoder means connected to the receiver means for decoding the composite into a received left aural signal and into a received right aural signal,

b. left and right signal amplifier means for separately amplifying the left and right aural signals, and

c. left and right electoaural transducer means respectively connected to the left and right signal amplifier means for reproducing the left and right aural signals within listening proximity of the person, and wherein the device further comprises:

adjustable left aural signal spectral equalization means for adjusting the spectrum of the received left aural signal to compensate for hearing loss characteristics of the left ear of the person, and

adjustable right aural signal spectral equalization means for adjusting the spectrum of the received right aural signal to compensate for hearing loss characteristics of the right ear of the person.

9. The assistive listening device set forth in claim 8 wherein at least one of the left and right signal amplifier means includes means for picking up and amplifying ambient sounds in the vicinity of person and combining the ambient sounds with the aural signal being amplified and put out.

10. The assistive listening device set forth in claim 8 further comprising:

mixer means for connecting to an intermediate frequency output of a broadcast signal reception device,

local oscillator means for generating and supplying a local carrier signal to the mixer means to recover a baseband signal spectrum,

detector and decoder means connected to receive the baseband signal spectrum from the mixer means and thereupon to separate the baseband signal spectrum into the left signal path and into the right signal path.

11. The assistive listening device set forth in claim 8 wherein the adjustable left aural signal spectral equalization means and the adjustable right aural signal spectral equalization means are located within the receiver means.

12. The assistive listening device set forth in claim 8 wherein the adjustable left aural signal spectral equalization means and the adjustable right aural signal spectral equalization means are located within the left signal path and right signal path providing means.

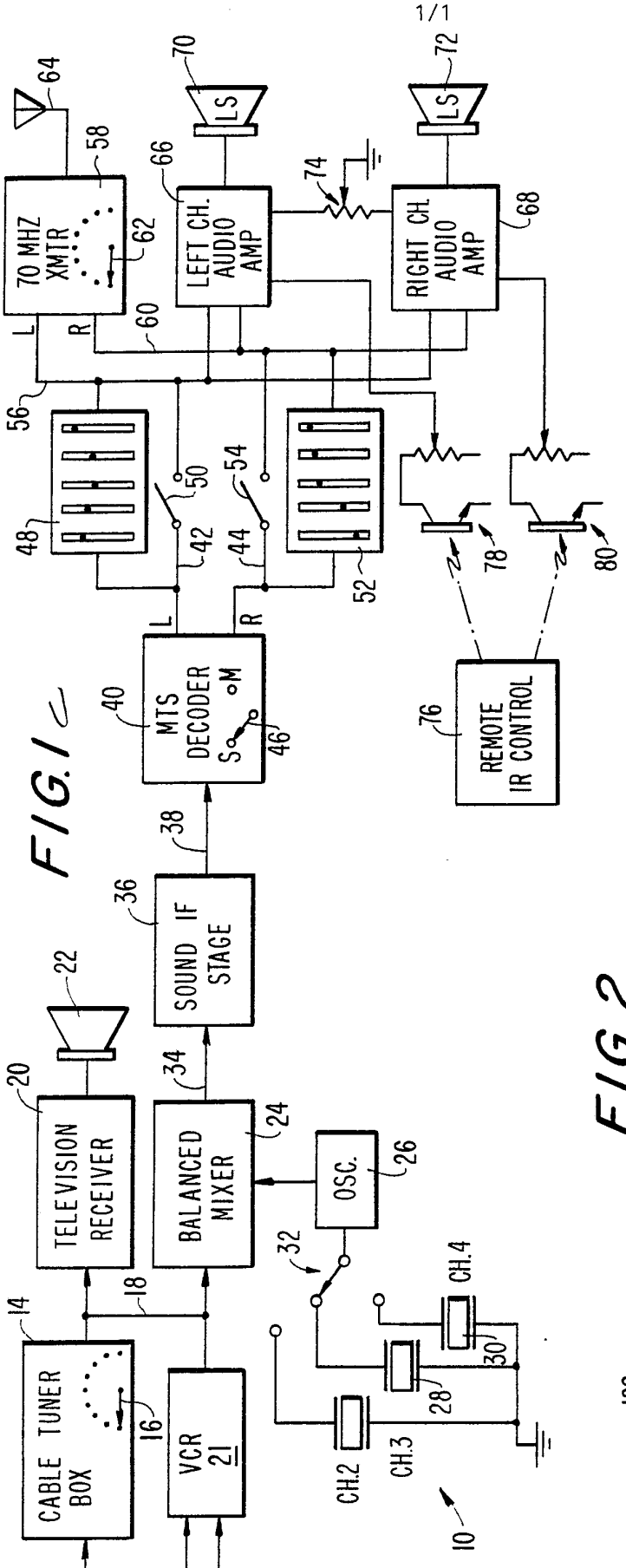
13. The assistive listening device set forth in claim 8 further comprising level balance means connected to adjust the balance of sound levels put out by the left and right signal amplifier means.

14. The assistive listening device set forth in claim 8 wherein the left and right electroaural transducer means respectively comprise left and right loudspeaker means.

15. The assistive listening device set forth in claim 14 further comprising remote control means for remotely adjusting the sound levels of the left and right loudspeaker means.

16. The assistive listening device set forth in claim 8 wherein the left and right electroaural transducer means respectively comprise left and right headphones of a headset.

17. The assistive listening device set forth in claim 8 wherein the left and right electroaural transducer means respectively comprise loudspeaker transducer means for transducing sound vibrations both to the ears and via the bone structure of the listener.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RIGHT CH. AUDIO AMP
LS
MTS DECODER
REMOTE IR CONTROL
SOUND IF STAGE
TELEVISION RECEIVER
BALANCED MIXER
OSC.
CABLE TUNER BOX
VCR 21
CH.2
CH.3
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FIG. 1

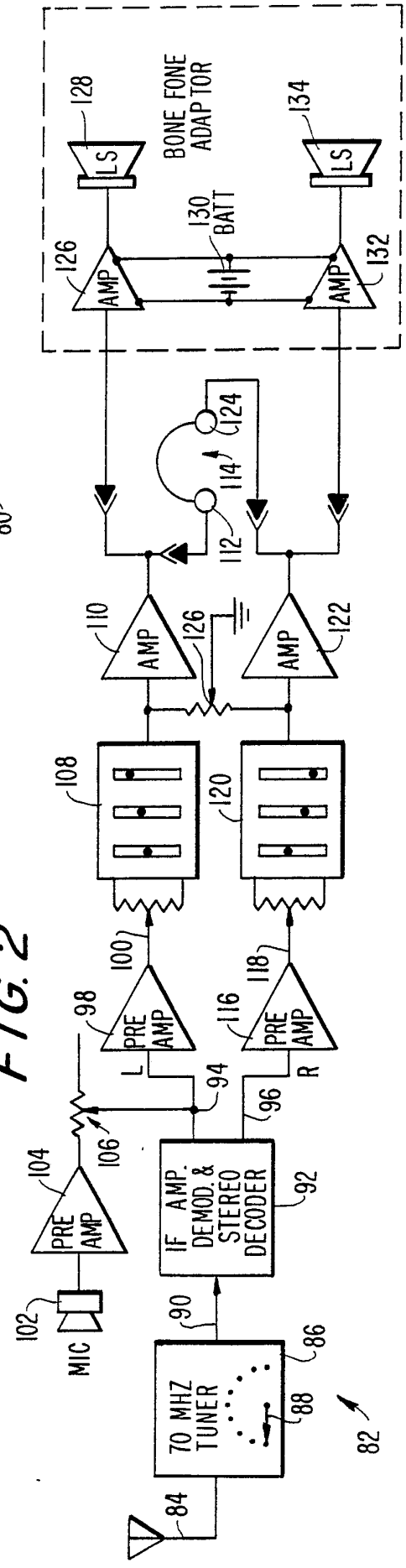
BONE FONE ADAPTOR
LS
AMP
BATT
PRE AMP
IF AMP. DEMOD. & STEREO DECODER
70 MHZ TUNER
MIC
L
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FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/022[illegible]

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.(5): H04B 5/00
U.S. CL.: 381/79

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	381/1,25,68.2,68.3,68.4,72,79,85

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 3,906,160 (NAKAMURA ET AL.) 16 September 1975, See column 3, lines 8-45 and Figure 2.	1,5,8-14,16, 17,19
Y	US, A, 4,491,980 (ICHIKAWA) 01 January 1985, See column 2, lines 25-43 and column 2, line 66 to column 3, line 9, and figure 1.	1,5,8-14,16, 17,19
Y	US, A, 4,790,019 (HUEBER) 06 December 1988, See column 1, lines 41-53 and figure 2.	15
Y	US, E, RE 25,652 (Kennedy) 06 October 1964, See column 3, Lines 18 - 36 and Figure 1.	1,5,8-14,16, 17,19

* Special categories of cited documents: [10]

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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