



(11) **EP 1 575 250 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
17.08.2011 Bulletin 2011/33

(51) Int Cl.:
H04M 1/60 ^(2006.01) **H04M 9/08** ^(2006.01)

(21) Application number: **05251339.7**

(22) Date of filing: **07.03.2005**

(54) **Method and apparatus for optimizing speakerphone performance based on tilt angle**

Verfahren und Gerät zur Optimierung der Lautsprecherleistung auf der Basis des Neigungswinkels

Procédé et appareil d'optimisation du rendement d'un haut-parleur en fonction d'un angle d'inclinaison

(84) Designated Contracting States:
DE FR GB

(30) Priority: **10.03.2004 GB 0405341**

(43) Date of publication of application:
14.09.2005 Bulletin 2005/37

(73) Proprietor: **Mitel Networks Corporation**
Ottawa, ON K2K 2W7 (CA)

(72) Inventors:
• **Dedieu, Stephane**
Ottawa,
Ontario K2B 6Y8 (CA)

• **Moquin, Phillipe**
Ottawa,
Ontario K2K 2H6 (CA)

(74) Representative: **Naismith, Robert Stewart et al**
Marks & Clerk LLP
Aurora
120 Bothwell Street
Glasgow
G2 7JS (GB)

(56) References cited:
EP-A- 0 796 026 **DE-A1- 3 149 061**
GB-A- 2 344 500 **US-A- 4 885 773**
US-A1- 2002 041 679 **US-B1- 6 411 828**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 575 250 B1

Description

Field of the Invention

[0001] The invention relates generally to speakerphones, and more particularly to the use of a tilt sensor for detecting tilt angle of a speakerphone and in response improve performance characteristics.

Background of the Invention

[0002] Telephones are now commonly provided with an adjustable stand to permit the user to adjust the tilt angle to a preferred viewing angle for reading the phone display (e.g. LCD display) as disclosed in document US 6,122,370. This is beneficial from a visual perspective, but does not take into account the audio performance of the speakerphone. Typically, acoustical designers have relied on establishing an acceptable compromise between visual and audio considerations in selecting an industrial design for a set, or have tried to use adaptive filters to address audio performance issues. In the first case, only a compromise can be achieved. In the second case, adaptive filters are not always capable of obtaining enough information to provide the ideal correction to the audio signal. Moreover, adaptive filters have only been applied to the transmit signal of the set thus leaving the designer with only a compromise solution for optimizing the receive signal to the user.

[0003] Tilt sensors are known in the art of portable telephones to determine in which mode to operate a telephone. Colonna et al, in US Patent 6,115,620, disclose a mechanical switch that determines the position of the two parts of a portable telephone and based on this information permits a louder level of receive operation of the set. Lands and Banh, in US Patent 6,411,828, disclose the use of a gravitational sensor to perform the same function. Kielsnia, in US Patent 6,449,363, discloses a safety mechanism based on a tilt sensor that prevents a portable telephone from entering the speakerphone mode (i.e. louder receive signal) when the set is at an angle that would correspond to a user placing the set in handset mode. Martschink and Pai, in US Patent 6,510,326, disclose a tilt sensor that permits selecting the operational mode of a portable telephone dependant on its relation to an independent reference system (i.e. gravity). Martschink and Pai specifically set forth a telephone that switches between quiet and loud operation (i.e. substantially the same as handset and speakerphone modes) where, in the quiet (i.e. handset) mode, only the user can understand the receive signal. All of foregoing prior art relates to handheld telephones where only the receive volume is adjusted.

[0004] An example of a speakerphone system is described by US6411828, which describes a wireless user terminal that operates in a mode that is selected based on an indication of the orientation of the wireless user terminal. When the wireless user terminal is in a first ori-

entation, the wireless user terminal operates in a speakerphone mode and when the wireless user terminal is in a second orientation, the wireless user terminal operates in a handset mode.

[0005] GB2344500 describes a method of improving convergence of an echo canceller in a full duplex speakerphone, wherein the echo canceller includes a line echo canceller and an acoustic echo canceller.

[0006] US2002/0041679 describes a far-end activity detector for a hands-free telephone that is configured to freeze operation of a steering functionality of a beamformer in the event that far-end acoustic energy exceeds near-end acoustic energy by more than said predetermined amount.

Summary of the Invention

[0007] Various aspects of the present invention are defined in the independent claims. Some preferred features are defined in the dependent claims.

[0008] Described herein a method is disclosed for adjusting the performance of a speakerphone based on the tilt angle of the set. Unlike the prior art, the actual loudness of the receive level is not significantly affected by the tilt angle of the telephone. However, other aspects of acoustical performance are adjusted to compensate for tilt angle. For example, the frequency response may be affected by tilt angle since tilt results in more or fewer reflections off of a desk, and the speaker grill can have directional effects. In a speakerphone, the microphone response is generally also affected by the angle the set makes with the desk. In a full-duplex speakerphone an adaptive filter is used to reduce the receive to transmit signal, and this coupling path is strongly affected by the angle the set makes with the desk. Finally, when microphone or loudspeaker arrays are embedded in a telephone, the tilt angle greatly affects their behaviour since they are very sensitive to the diffraction effects afforded by the set.

[0009] A tilt sensor may be used to determine the tilt angle and this information is used to optimize both the receive and transmit signals for the chosen tilt angle. The information can also be used to adjust performance of any beamformer(s) where the speakerphone incorporates a microphone array. Vibrational data may be provided by the tilt sensor for enhancing the receive signal and acoustic echo cancellation.

[0010] Several tilt angle sensors are known in the art and can be used. The simplest is a mechanical switch actuated by the telephone stand. Alternatively, a simple inclination meter can be used, such as that disclosed by Ryan et al in US Patent 4,846,954. Or, a dual axis solid-state accelerometer may be used, such as the Analog Devices ADXL311.

[0011] The choice of sensor depends on the amount of information required and the specific implementation. Of the three sensors discussed above, the most information is provided by the accelerometer. However, it is also

the most expensive solution. As will be evident from the detailed description below, it may be advantageous to use the additional information provided by accelerometers to overcome non-linear effects due to vibrations in the adaptive filtering used by full-duplex audio algorithms and to linearise the loudspeaker response.

[0012] Once the tilt sensor has been chosen and the tilt angle detected, the information may be used to adjust the frequency response of the handsfree receive and transmit signals. This information can also be used to select a previously stored set of coefficients for an adaptive handsfree algorithm, as set forth by Popovic and McLeod in GB2344500. The information can further be used in a set that incorporates a conformal microphone and /or loudspeaker array to adjust the beamshape (i.e. beamformer coefficients) for the tilt angle of the set.

Brief Description of the Drawings

[0013] Embodiments of the present invention will now be described more fully with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a telephone incorporating a tilt sensor, according to a general aspect of the present invention;

Figure 2 is a schematic cross-section view of a telephone as in Figure 1, where the tilt sensor comprises mechanical switches;

Figure 3 is a schematic illustration of a prior art inclination meter using conductive fluid;

Figure 4 is a schematic cross-section view of a telephone as in Figure 1, where the tilt sensor comprises a solid-state accelerometer to determine tilt angle via an analogue signal;

Figure 5 is a schematic cross-section view of a telephone as in Figure 1, where the tilt sensor comprises a solid-state accelerometer to determine tilt angle via a digitised signal;

Figure 6 is a block diagram of a speakerphone with direct control of receive and transmit signals using information from a tilt sensor, according to a first embodiment of the invention;

Figure 7 is a block diagram illustrating the signal path for a prior art speakerphone using adaptive filter; and

Figure 8 is a block diagram illustrating the signal path a speakerphone with information from the tilt sensor used to control operation of an adaptive filter, according to the preferred embodiment.

Detailed Description of the Preferred Embodiments

[0014] Turning now to Figure 1, a loudspeaker telephone 10 is shown, commonly referred to as a "speakerphone". Loudspeaker telephone 10 includes a housing (not shown) with a cradle that accommodates a handset 12 and an associated hookswitch 14 within the cradle. A display 16 and a keyboard 18 are provided on the housing. At least one loudspeaker (an array of loudspeakers 20 is shown), and at least one (an array of microphones 22) are also provided in the housing to enable "hands-free" calls to be made.

[0015] Disposed within the housing are the loudspeaker telephone electronics generally indicated to by reference number 30. As can be seen, the loudspeaker telephone electronics 30 include a controller 32 coupled to a communications line 34 via an audio bus 36 and a line interface 38. The communications line 34 and the line interface 38 can either be analogue public switched telephone network (PSTN), digital time-division multiplexed (TDM), wireless, packet switched (e.g. VoIP, ATM) or any other voice carrier line interface. The controller 32 is also coupled to a computer (not shown) via a computer interface bus 3.

[0016] A digital signal processor (DSP) 40 communicates with the controller 32 and with a number of coder/decoders (CODECs) 42 and 44. CODEC 42 is coupled to the handset 12 via amplifiers 50 and 52. CODEC(s) 44 is coupled to the array of loudspeakers 20 and microphones 22 via amplifiers 54 and 56. The DSP 40 typically provides volume control 71, equalisation 70, beamforming 72, acoustic echo cancellation 73, hands-free functionality, tone generation, and other necessary functionality for the operation of the loudspeaker telephone. The controller 32, which communicates with the display 16 and keyboard 18, connects either one or both voice channels of the loudspeaker telephone to the line interface 38.

[0017] A tilt sensor 19 provides an electrical signal to a conditioning circuit 58. The signal is processed by DSP 40 to determine the state of the sensor. The output of DSP 40 is used either: to adjust the receive response or transmit response in the equalisation block 70; provide pre-recorded weights to an adaptive filter 73; adjust beamformer coefficients 72 for one or both of the microphone and loudspeaker array. The tilt sensor signal is also processed to extract vibrational data that can be used to adjust adaptive filter 73 (either separate from or integrated with the acoustic echo canceller). This vibrational data can also be used to ensure that the loudspeaker linearity is preserved by the use of active control.

[0018] There are several possible embodiments and the following will describe the possible choices for the preferred embodiments from the simplest to the most complex. Finally, the preferred embodiment will be described in full detail.

[0019] Firstly, three common methods of detecting tilt angle are described. One skilled in the art will be aware of these known methods, and their relative merits are

explained herein to afford a better understanding of the invention and its various embodiments.

[0020] Turning to Figure 2, a telephone 201 is illustrated with a stand 202 and switches 203 that are actuated as the stand is set to the desired angle. Selective activation of switches 203 controls a current applied to the switches via pull-up resistor 205 to generate a discrete binary signal 204, which is used by the processor 40 in Figure 1, to control performance characteristics of the speakerphone. The system of Figure 2 is easily implemented as it is not complex and yields the reliability afforded by a mechanical system. However, it is limited by the resolution afforded by the number of switches implemented and may be costly to implement, as it requires a plurality of mechanical devices.

[0021] With reference to Figure 3, a tilt sensor 301 is illustrated similar to that disclosed by Ryan in US Patent 4,846,954. The detection output may be implemented either as a binary output, as illustrated, or as a continuous analogue signal (not shown), to permit the resolution of a plurality of angles. Placement of the tilt sensor 301 requires precise positioning within the speakerphone. The primary drawback is that the sensor operates by encapsulating a conductive fluid, which is not compatible with contemporary high-speed electronic fabrication techniques.

[0022] Turning now to Figure 4, a micro-machined integrated circuit accelerometer 401 is mounted either on the main circuit board 402 or on an auxiliary circuit board 403 within a telephone set 404. Solid-state accelerometers are a preferred choice as they provide the required static acceleration, the technology is naturally compatible with electronic fabrication techniques, and they are more robust to handling and are less expensive than conventional piezo-electric accelerometers. In the preferred embodiment an Analog Devices ADXL311 accelerometer was chosen. The accelerometer 401 provides an output voltage from which a reliable calculation of static acceleration can be determined. The angle at which the device 401 is placed is related to gravity by the simple relationship of $\sin^{-1}(\text{output}/V_0)$ where V_0 is the voltage output corresponding to 1g of acceleration. In Figure 4, the output from the accelerometer 401 is filtered at 405 so as to pass only the D.C. component. Analogue circuitry 406 then detects the required resolution. A simple threshold circuit can be used instead to yield a binary output. Generally, more than two positions are required so the analogue circuitry implements an inverse sine function and is followed by multiple threshold detection yielding the required number of positions for a particular application.

[0023] Figure 5 is similar to Figure 4 in that a solid-state accelerometer 501 is used. However, its output is digitised at 502 and a digital signal processor 503 is used to determine the tilt angle from the binary numerical output. The conversion resolution, the signal processor accuracy, and the accuracy of accelerometer 501 limit the precision, although all are typically within acceptable limits. The configuration of Figure 5 has the same advantages

mentioned having regard to Figure 4, but as the signal determination is implemented in the digital domain, more flexibility is possible (e.g. the output can also be used for adaptive filtering of the speakerphone operation).

[0024] Figure 6 illustrates a hardware-only implementation of the invention, wherein discrete signals from the tilt sensor 601 are used to adjust the frequency response of the transmit signal 602, receive signal 603, or both. This is typically accomplished by varying the resistance of an active filter and can be done either with an analogue or digital signal. One skilled in the art will recognise that there is a plurality of solutions.

[0025] According to the preferred embodiment of the invention, acoustic performance adjustment is effected using a digital signal processor. A general-purpose processor may also be used but is less efficient. Figure 7 illustrates, generally, the signal path of a prior art speakerphone system. Because of its generality, Figure 7 omits the implementation details of the adaptive filters, digital beam formers, and frequency shaping filters, as they are not essential to understanding the invention. One skilled in the art will recognise that these are all controlled by a set of coefficients that are initially fixed and may be adaptive. In Figure 7, the far end signal (receive) 725 is filtered by a digital filter 731. This signal is then either directly sent to the output 722 or to the output via a beamformer 732. The signal is also fed to an adaptive filter 734 that performs acoustic echo cancellation. The microphone signal(s) 723 are, if necessary, passed through a beamformer 733 before the output of the adaptive filter 734 is subtracted from the signal. It is then used as a feedback signal for the adaptive filter 734 and also filtered 730 before being transmitted at the far end 724.

[0026] A person of skill in the art will appreciate that the signal components of Figure 7 may be part of a variety of telephonic devices and that the illustrated "four-wire" signals are appropriately processed to connect to a network. The filter coefficients for the receive frequency response 711 and the transmit frequency response 712, as illustrated, may incorporate volume control. The beamforming coefficients for the loudspeakers 713 and the microphones 715 may be dynamically allocated based on user feedback or automatic speaker recognition as disclosed in US Patent Application 20020041679 (Beaucoup). The adaptive filter for the echo canceller may have coefficients 714 supplied to it in a manner as disclosed by Popovic and McLeod in GB2344500.

[0027] Turning now to Figure 8, a signal diagram of the preferred embodiment is illustrated. In this embodiment, a solid-state accelerometer that has been digitised as shown in Figure 5, is employed, but most of the functionality (except that requiring the vibrational data 822) can also be implemented using other techniques. Figure 8 differs from Figure 7 in a number of important respects. Firstly, an additional input is provided, from the accelerometer 820. The detecting block 850 uses this digitised signal 820 to create a control signal 821. In the preferred

embodiment, the detecting block 850 consists of a low pass filter to determine the DC component 802, an inverse sine function 803 to calculate the tilt angle and finally a discrimination algorithm 804 that provides outputs corresponding to the required increments set by the angular resolution 815. Thus, the output signal 821 is mapped, in a one to one ratio, to the tilt angles of interest in a specific implementation. This signal is then used to select one or more of the following: transmit equalisation and volume coefficients 810, receive equalisation and volume coefficients 811, microphone array beamformer coefficients 812, loudspeaker array beamformer coefficients 813, acoustic echo canceller initial coefficients and operating parameters 814. The selection of these parameters is accomplished by selecting a sub-array in this implementation (840,841,842,843,844).

[0028] According to the preferred embodiment, the beamformers are fixed so the array of coefficients is calculated a priori. However, an adaptive beamformer may also be used wherein the coefficients are stored before changing from one tilt angle to the next. The information concerning the tilt angle is used to correct the coefficients due to the change in orientation of the set body relative to the tabletop. In co-pending U.K. Application No. 0405790.7 filed March 15, 2004 by Dedieu et al., a universal microphone array in a stand is disclosed with a mechanism to determine the set body attached to the stand and coefficients selected on that basis. This tilt angle detection mechanism adds another dimension to the coefficient array.

[0029] One skilled in the art will appreciate that by incorporating an appropriate detection block 850 any tilt angle detector may be used. The implementation of the selection of coefficients or parameters may also be accomplished in a general-purpose processor or by the use of hardware and/or discrete circuitry. It will also be appreciated that cost considerations favour implementation of the digital signal processor in software.

[0030] There are other significant differences between Figure 8 and Figure 7. Since an accelerometer is being used to detect the tilt angle, low frequency information can be filtered from the signal output 820 by the use of an appropriate filter 805, to correct for non-linearities introduced by the vibration of the set. This is possible since the accelerometer is mounted either on the main printed circuit board of the set or on a daughter card. Non-linearities in the loudspeaker operation can be corrected by the use of an appropriate adaptive filter that uses the vibrational information as input. Adding another canceller for vibrational effects enhances the acoustic echo canceller 734 operation. Actual implementation will govern whether the additional canceller should be set before or after the main echo canceller. It may also be possible to incorporate this information in the main acoustic echo canceller block.

[0031] A person of skill in the art may conceive of other embodiments that do not depart from the scope of the invention, which is defined by the claims appended here-

to.

Claims

1. A fixed telephone set (201, 404) resting on a surface provided with an adjustable stand (202) **characterised in that** the fixed telephone set comprises a speakerphone (10), a sensor (19) for generating a signal indicative of the angle of tilt between said speakerphone (10) and said surface, a processor (40) for receiving said signal and in response adjusting at least one operational parameter affecting performance of said speakerphone (10), said at least one operational parameter comprising at least one of acoustic echo canceller initial coefficients, beamforming coefficients for a microphone array, and beamforming coefficients for a loudspeaker array, and wherein said sensor (19) is selected from the group consisting of at least one mechanical switch, an inclination meter, and a dual axis solidstate accelerometer.
2. The improvement of claim 1, wherein said at least one operational parameter further includes loudspeaker equalisation and volume adjustment.
3. The improvement of claim 1, wherein said at least one operational parameter further includes microphone equalisation and volume adjustment.
4. A method of optimizing speakerphone (10) performance in a fixed telephone set (201, 404) resting on a surface provided with an adjustable stand (202), the method comprising the steps of:
 - detecting the angle of tilt between said speakerphone (10) and said surface;
 - adjusting at least one operational parameter in accordance with said angle of tilt so as to affect performance of said speakerphone (10); and
 - processing a tilt sensor (19) signal to extract vibrational data and using said vibrational data to control at least one adaptive filter within said speakerphone (10) to either linearise the loudspeaker response or enhance the performance of an acoustic echo canceller within said speakerphone (10);
 - said at least one operational parameter comprising at least one of acoustic echo canceller initial coefficients, beamforming coefficients for a microphone array, and beamforming coefficients for a loudspeaker array.
5. The method of claim 4, wherein said at least one operational parameter further includes loudspeaker equalisation and volume adjustment.

6. The method of claim 4, wherein said at least one operational parameter further includes microphone equalisation and volume adjustment.

Patentansprüche

1. Festnetz-Telefonapparat (201, 404), der auf einer Oberfläche ruht, die mit einem verstellbaren Ständer (202) ausgestattet ist, **dadurch gekennzeichnet, dass** der Festnetz-Telefonapparat Folgendes umfasst: einen Sensor (19), zum Erzeugen eines Signals, das indikativ ist für den Neigungswinkel zwischen einem Lautfernsprecher (10) und der Oberfläche, einen Prozessor (40) zum Empfangen des Signals und, als Antwort darauf, zum Einstellen mindestens eines Betriebsparameters, der die Leistung des Lautfernsprechers (10) beeinflusst, wobei der mindestens eine Betriebsparameter mindestens eines von Folgendem umfasst: erste Koeffizienten eines akustischen Echounterdrückers, strahlbildende Koeffizienten für eine Mikrofonanordnung und strahlbildende Koeffizienten für eine Lautsprecheranordnung, und wobei der Sensor (19) ausgewählt ist aus der Gruppe bestehend aus mindestens einem mechanischen Schalter, einem Neigungsmesser und einem zweiachsigen Festkörper-Beschleunigungsmesser.
2. Verbesserung nach Anspruch 1, wobei der mindestens eine Betriebsparameter ferner Lautsprecherentzerrung und Lautstärkeregelung einschließt.
3. Verbesserung nach Anspruch 1, wobei der mindestens eine Betriebsparameter ferner Mikrofonentzerrung und Lautstärkeregelung einschließt.
4. Verfahren zur Optimierung der Leistung eines Lautfernsprechers (10) in einem Festnetz-Telefonapparat (201, 204), der auf einer Oberfläche ruht, die mit einem verstellbaren Ständer (202) ausgestattet ist, wobei das Verfahren die folgenden Schritte umfasst:

Erfassen des Neigungswinkels zwischen dem Lautfernsprecher (10) und der Oberfläche;
Einstellen mindestens eines Betriebsparameters entsprechend dem Neigungswinkel, damit die Leistung des Lautfernsprechers (10) beeinflusst wird; und
Verarbeiten des Signals des Neigungssensors (19), um Vibrationsdaten zu extrahieren und Benutzen der Vibrationsdaten, um mindestens ein adaptives Filter innerhalb des Lautfernsprechers (10) zu steuern, um die Lautsprecherantwort entweder zu linearisieren oder die Leistung eines akustischen Echounterdrückers innerhalb des Lautfernsprechers (10) zu steigern;

wobei der mindestens eine Betriebsparameter mindestens eines von Folgendem umfasst: erste Koeffizienten eines akustischen Echounterdrückers, strahlbildende Koeffizienten für eine Mikrofonanordnung und strahlbildende Koeffizienten für eine Lautsprecheranordnung.

5. Verfahren nach Anspruch 4, wobei der mindestens eine Betriebsparameter ferner Lautsprecherentzerrung und Lautstärkeregelung einschließt.
6. Verfahren nach Anspruch 4, wobei der mindestens eine Betriebsparameter ferner Mikrofonentzerrung und Lautstärkeregelung einschließt.

Revendications

1. Ensemble de téléphone fixe (201, 404) reposant sur une surface équipée d'un support ajustable (202), **caractérisé en ce que** l'ensemble de téléphone fixe comprend un poste à haut-parleur (10), un capteur (19) pour générer un signal indicateur de l'angle d'inclinaison entre ledit poste à haut-parleur (10) et ladite surface, un processeur (40) pour recevoir ledit signal et ajuster en réponse au moins un paramètre opérationnel affectant la performance dudit poste à haut-parleur (10), ledit au moins un paramètre opérationnel comprenant des coefficients initiaux d'annulateur d'écho acoustique et/ou des coefficients de formateur de faisceau pour un réseau de microphones et/ou des coefficients de formateur de faisceau pour un réseau de haut-parleurs, ledit capteur (19) étant sélectionné dans le groupe constitué d'au moins un interrupteur mécanique, un inclinomètre, et un accéléromètre à l'état solide à deux axes.
2. Amélioration selon la revendication 1, dans laquelle ledit au moins un paramètre opérationnel comprend en outre une égalisation de haut-parleur et un ajustement de volume.
3. Amélioration selon la revendication 1, dans laquelle le au moins un paramètre opérationnel comprend en outre une égalisation de microphone et un ajustement de volume.
4. Procédé d'optimisation d'une performance de poste à haut-parleur (10) dans un ensemble de téléphone fixe (201, 404) reposant sur une surface équipée d'un support ajustable (202), le procédé comprenant les étapes suivantes :

détecter l'angle d'inclinaison entre ledit poste à haut-parleur (10) et ladite surface ;
ajuster au moins un paramètre opérationnel conformément à l'angle d'inclinaison afin d'affecter la performance dudit poste à haut-parleur

- (10) ; et
traiter un signal de capteur d'inclinaison (19)
pour extraire les données vibrationnelles et uti-
liser lesdites données vibrationnelles pour con-
trôler au moins un filtre adaptatif dans ledit poste 5
à haut-parleur (10) pour soit linéariser la répon-
se du haut-parleur, soit améliorer la performan-
ce d'un annulateur d'écho acoustique dans ledit
poste à haut-parleur (10) ;
ledit au moins un paramètre opérationnel com- 10
prenant des coefficients initiaux d'annulateur
d'écho acoustique et/ou des coefficients de for-
mateur de faisceau pour un réseau de micro-
phones et/ou des coefficients de formateur de
faisceau pour un réseau de haut-parleurs. 15
5. Procédé selon la revendication 4, dans lequel ledit
au moins un paramètre opérationnel comprend en
outre une égalisation de haut-parleur et un ajuste-
ment de volume. 20
6. Procédé selon la revendication 4, dans lequel ledit
au moins un paramètre opérationnel comprend en
outre une égalisation de microphone et un ajuste-
ment de volume. 25

30

35

40

45

50

55

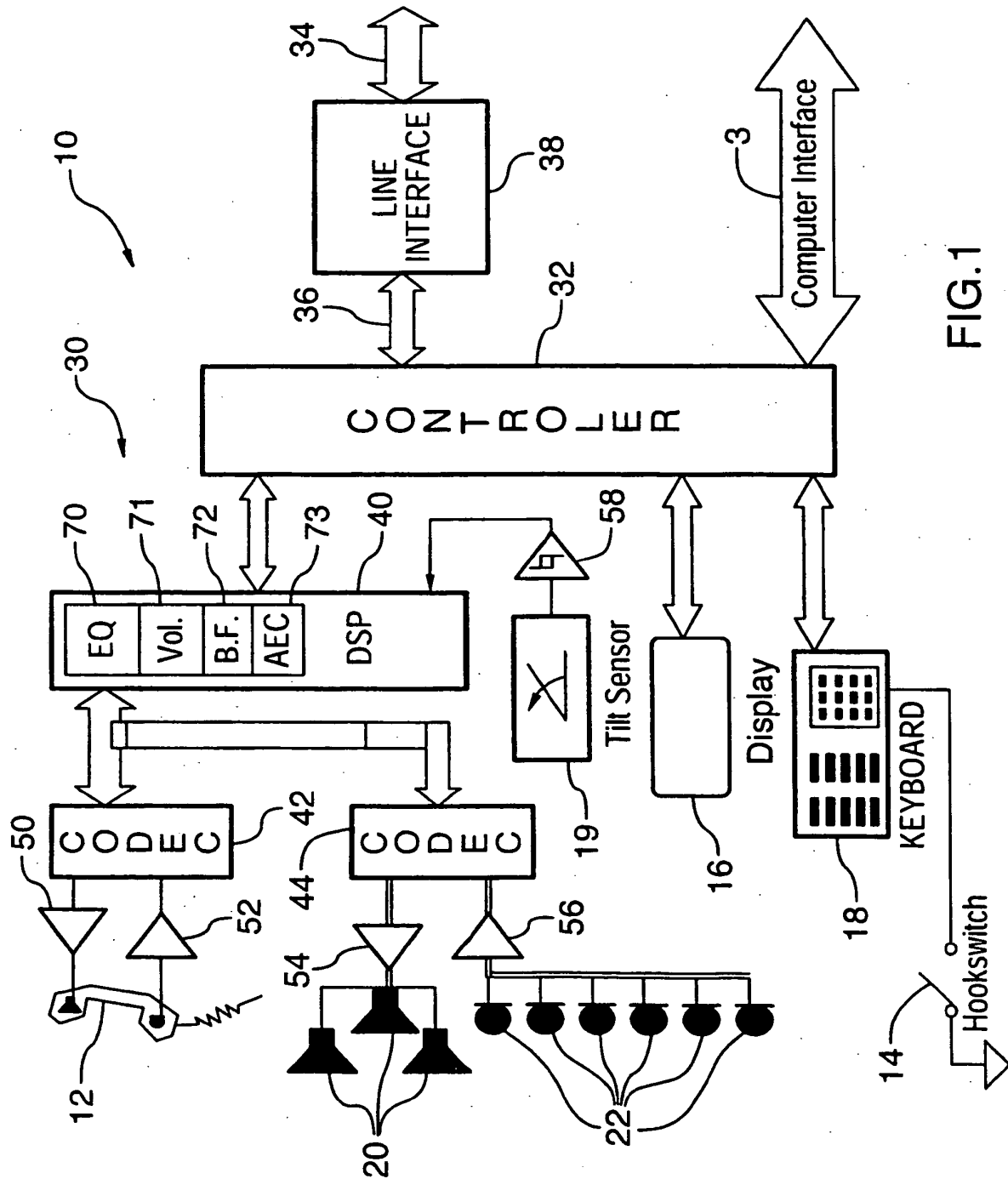


FIG.1

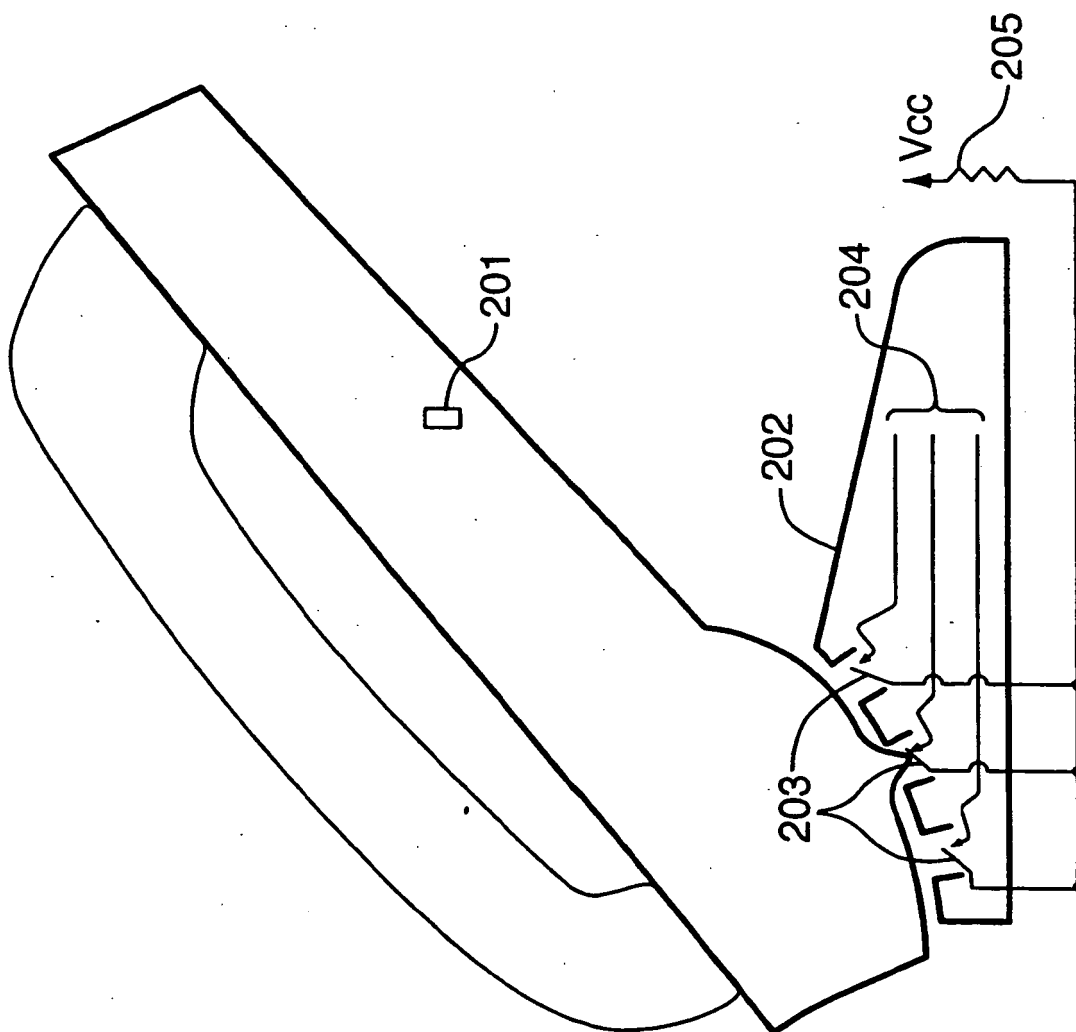


FIG.2

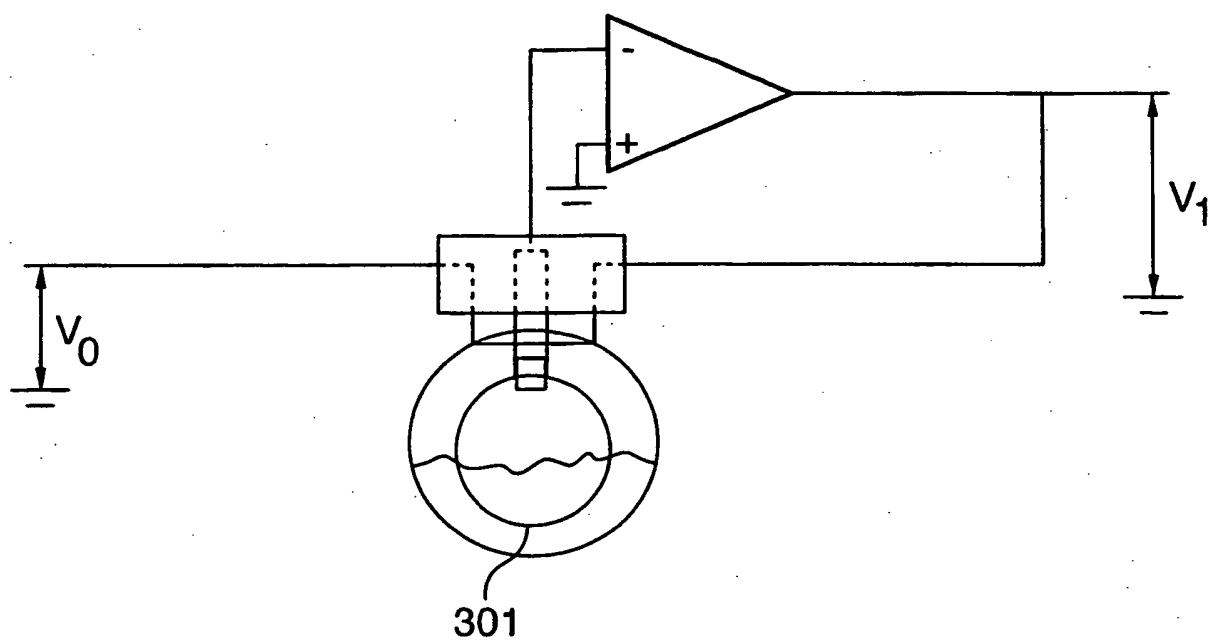


FIG.3

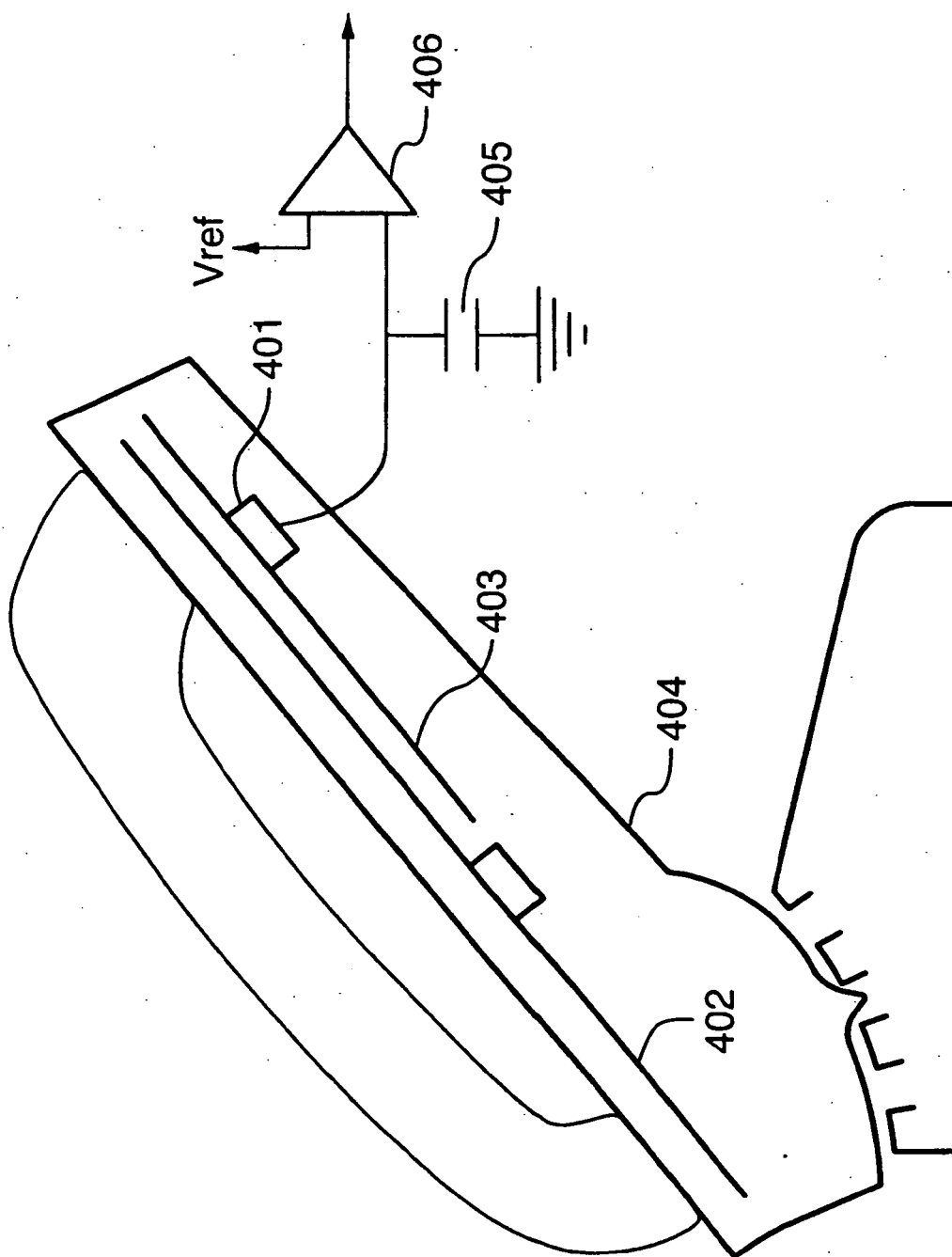


FIG.4

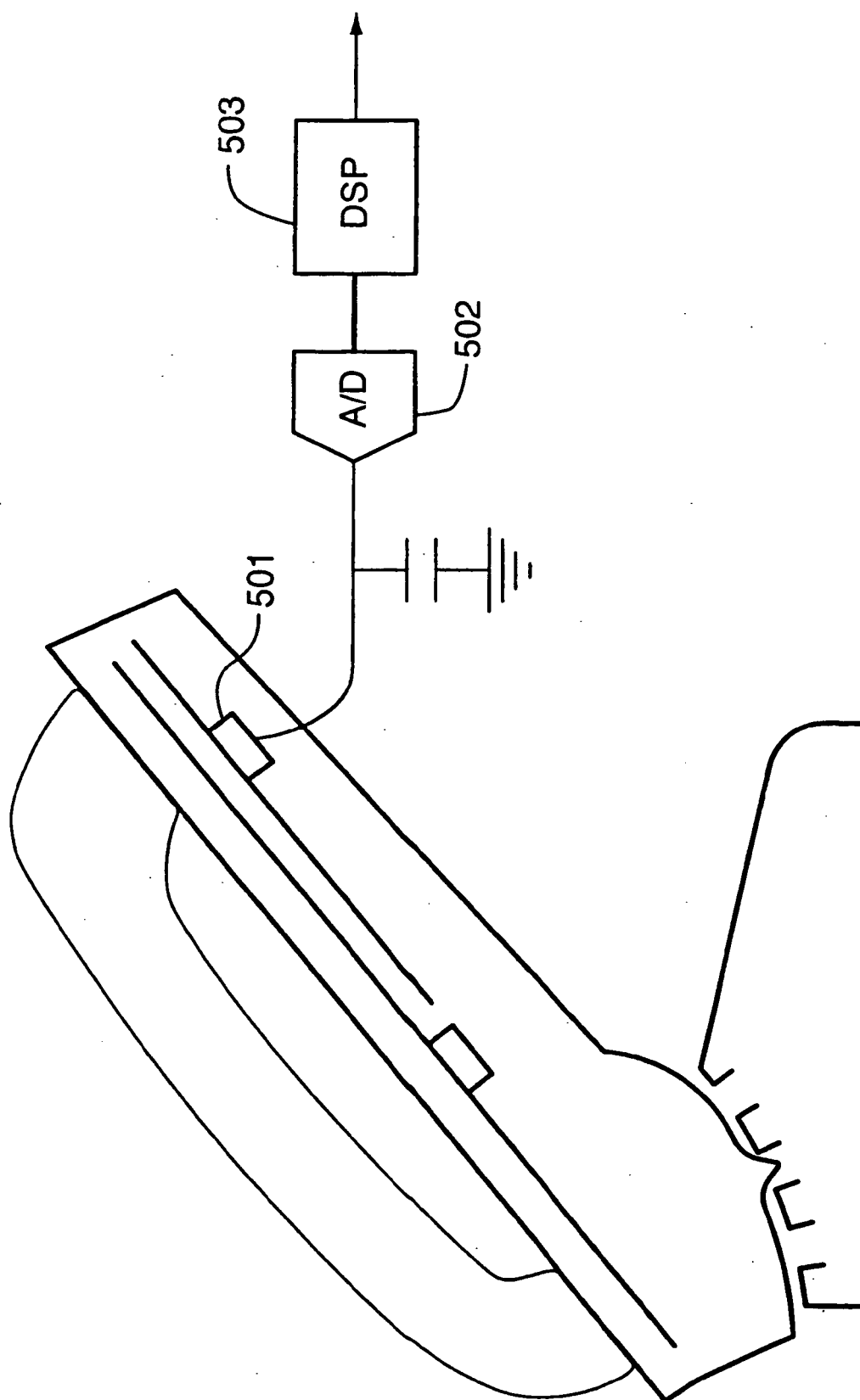


FIG. 5

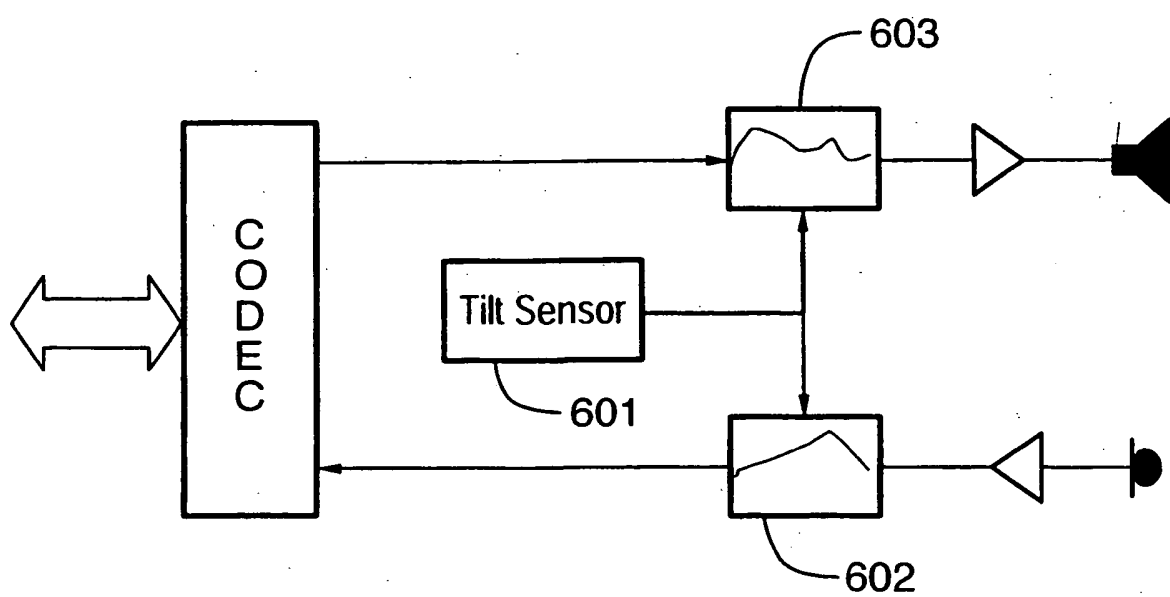


FIG.6

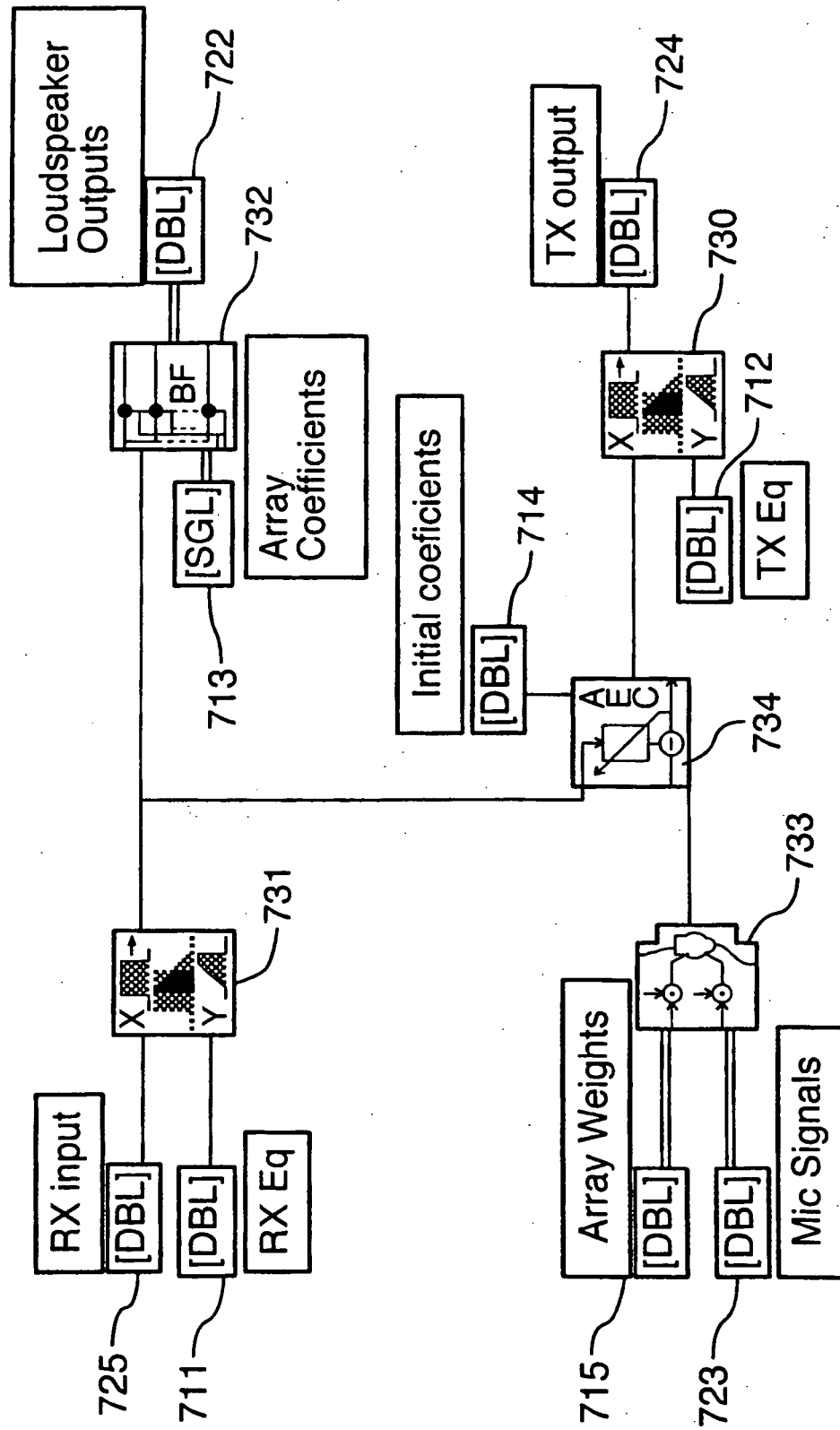


FIG. 7

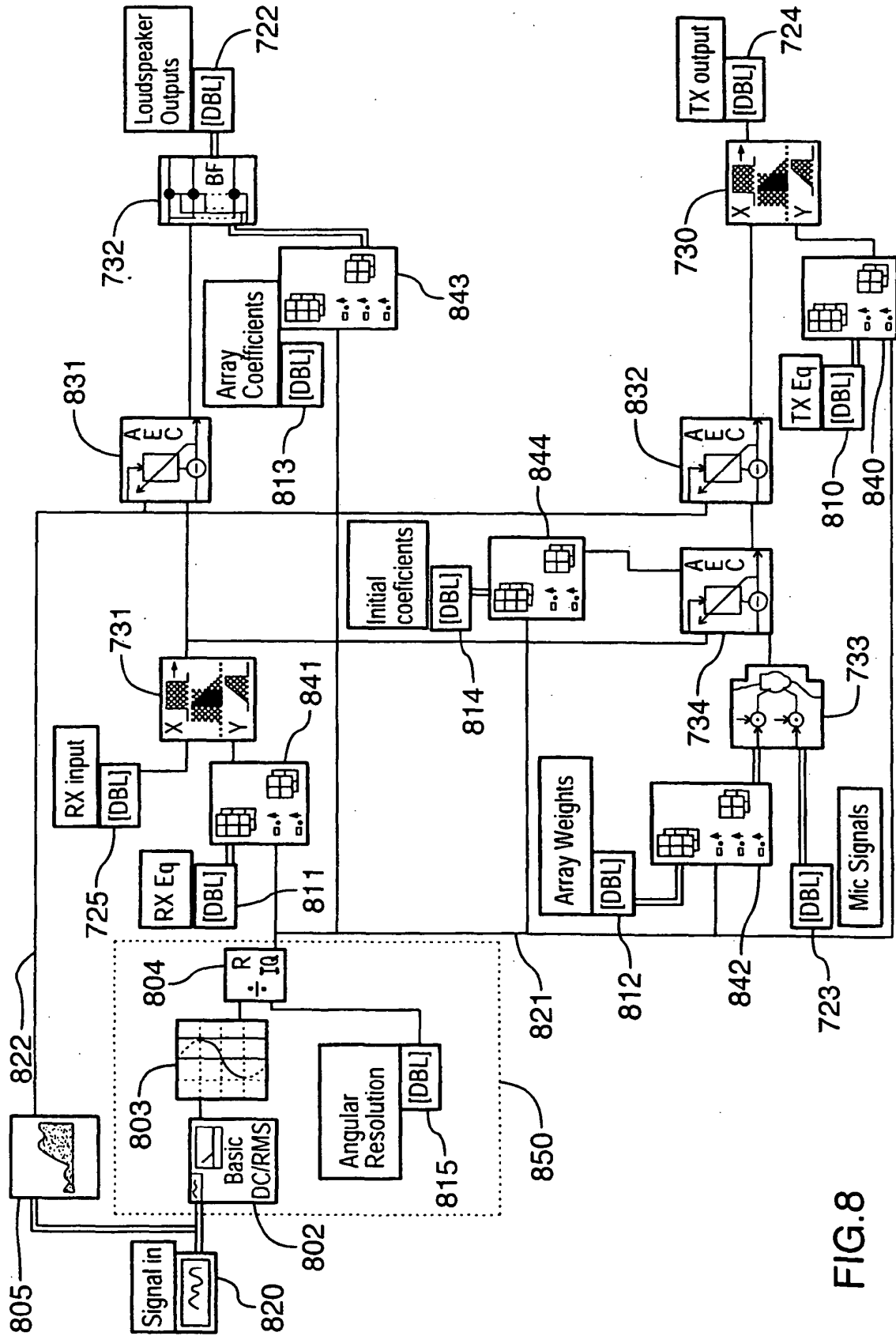


FIG.8

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6122370 A [0002]
- US 6115620 A [0003]
- US 6411828 B [0003] [0004]
- US 6449363 B [0003]
- US 6510326 B [0003]
- GB 2344500 A [0005] [0012] [0026]
- US 20020041679 A [0006] [0026]
- US 4846954 A [0010] [0021]
- GB 0405790 A, Dedieu [0028]