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Published
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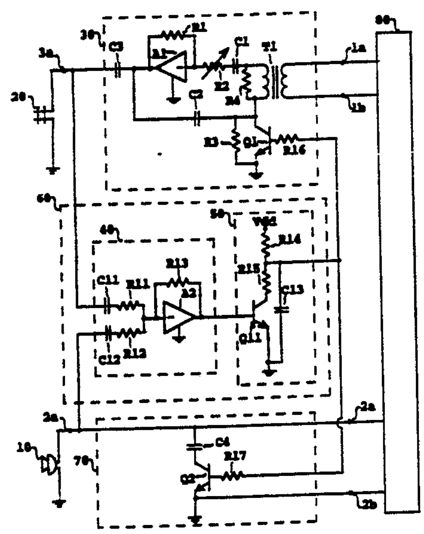
With amended claims.

(54) Title: VOICE-SWITCHED HANDSET RECEIVE AMPLIFIER

(57) Abstract

A voice-band receive amplifier for telephone handsets that mitigates loud sidetone and acoustic sing. A receive channel (30) with amplification and voice-switched attenuation is disposed between a receive port of a telephone network (80) at terminals (1a, 1b), and an electro-acoustic receiver (20). A transmit channel (70) having voice-switched attenuation that varies inversely with the receive channel attenuation is disposed between a transmit port of the telephone network at terminals (2a, 2b), and an acousto-electric microphone (10). A controller (60) with an output lead connecting to the transmit and receive channels has an input lead connecting to the microphone and an output lead connecting to the receiver. The controller provides a varying DC control signal at its output lead in response to varying levels of transmit and receive signals appearing at the input of the controller. The attenuation in each channel is characterized by having more attenuation at high-end voice-band frequencies than at lower frequencies.



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VOICE-SWITCHED HANDSET RECEIVE AMPLIFIER

FIELD OF THE INVENTION

This invention is concerned with electronic amplifiers in telephone handsets and, in particular, involves a voice-switched receive amplifier for use by the hearing-impaired or in noisy environments.

BACKGROUND OF THE INVENTION

The need for supplemental amplification for telephone receivers has been recognized by the introduction of products into the marketplace such as feature telephones and public pay telephones with built-in adjustable receive amplification, as well as replacement handsets and in-line modules which contain manually adjustable receive amplifiers. These products are beneficial for people with normal hearing in noisy environments, as well as for people with impaired hearing in normal environments. However, there are a number of shortcomings in providing receive amplification that the prior art has not satisfactorily resolved in the over twenty five years since amplified handsets have been available.

Built-in receive amplifiers typically provide up to 12dB of gain. Most replacement handsets and in-line modules provide gain up to 20dB. An additional five to ten decibels of gain is desirable for hearing reasons, but not for other unpleasant side effects of high gain. Receive gains around 13dB can cause a condition known as "sing" to occur when a handset is placed on a hard, acoustically reflecting surface, such as a glass table-top. Sing is a self-sustained, audible oscillation that occurs when the acoustic-to-acoustic loop gain, in part provided by the supplemental receive amplifier, is greater than unity. Sing manifests itself in shrill audible tones which are usually uncomfortable to both the near-end talker and far-end listener.

Increased receive gain normally results in increased sidetone. Sidetone is the part of the near-end talker's voice that couples into the near-end receive circuit through the telephone hybrid network as a result of mismatched network and loop impedances. A certain amount of sidetone is desirable to give the effect of a "live" telephone circuit; however, when a weak receive signal is amplified to a satisfactory level, sidetone is usually amplified to an uncomfortable level. It is well known that talkers tend to subconsciously speak more softly when sidetone is increased. Even so, spontaneous, loud expressions by the near-end talker, such as laughter, can be disconcerting. For this reason, users usually set receive gain at the minimum level needed to compensate for incoming receive levels that vary because of call-to-call differences in transmission conditions and far-end talking levels.

When one talks in a normal level after unwittingly picking up a handset having receive gain set at a high level by a prior user, one can be beset with a sudden, uncomfortably loud sidetone/receive signal. A solution to this problem is addressed in U.S. Pat. 4,466,120 issued to Walker, Jr. et al. which automatically resets the receive gain to nominal when the handset is restored to its switchhook cradle. The Walker solution is burdened by the inconvenience of having to re-establish a new listening level upon each use of the telephone.

For the above stated reasons, manual adjustment of the receive gain is frequently needed.

The well-known, half-duplex technology of voice-switching complementary gains in transmit and receive channels has been used over the years in free-air speakerphone applications to avoid sing. However, in an application where the receiver is close to the ear, as is the case with a handset, voice switching sounds unnatural and distracting because the handset user hears "pumping" of both sidetone and incoming receive levels when the receive channel makes gain transitions. Full-duplex technology, such as with adaptive echo-cancellation, can mitigate these problems, but has the disadvantage of complexity and high costs.

U.S. Patent No. 4,536,888, issued to Donald R. Wilson, August 20, 1985, teaches receive signal "conditioning" that superficially resembles the instant invention. However, the Wilson patent aspires to provide receive amplification while mitigating acoustic shock. It does not address solutions to sidetone and sing problems, nor does it fully satisfy the need for avoiding frequent gain control adjustments. The Wilson patent provides linear compression (attenuation) or expansion (amplification), as needed to keep output receive signals at about a constant level. This presumably would avoid the need for frequent gain adjustments. However, when the gain is set to provide high amplification, the aforementioned loud sidetone problem must necessarily be present in the invention, indeed aggravated by the automatic additional amplification of low level signals. The Wilson patent also includes voice-switched gain in the transmit channel to suppress local background noise when the talker is quiet. But, it fails to mitigate sing since the transmit and receive channels can simultaneously be at maximum gain.

Emphasis of upper voice-band frequencies (2K-3KHz range, as herein used) is desirable for users with presbycusis, a hearing loss at the upper voice-band frequencies that affects many in the elderly population as well as younger people with a history of prolonged exposure to hearing-damaging sound levels. Current receive amplifier technology either provides no emphasis for upper voice-band frequencies or requires an inconvenient, separate "treble" control adjustment, in addition to an overall gain adjustment, such as in Radio Shack model 43-27.

A basis for the instant invention lies in the psychoacoustics of human speech and hearing along with the inherent characteristics of acoustic feedback in telephone handsets: It is known that sidetone at upper voice-band frequencies is perceived to be more irritating than at lower frequencies. The average level of the spoken male voice is highest around 400Hz and continually decreases at higher frequencies. The typical human ear perceives tones in the 2K-3KHz range to be louder than at lower frequencies. (See Beranek, *Acoustics*, McGraw-Hill Book Company, Inc.,New York, NY, 1954, chapter 13, pp 398,408) Furthermore, receiver-to-microphone acoustic coupling for conventional telephone handsets resting on acoustically reflecting surfaces is highest in the 2K-3KHz range. The implication for realizing a natural sounding, voice-switched, receive amplified handset is to minimize switching in the lower voice frequencies where most of the voice energy occurs, and to provide most of the switching in the 2K-3KHZ range, where sing is more of a problem and where sidetone is more irritating.

Accordingly, a broad objective of the invention is to provide a natural sounding, voice-switched receive amplifier that mitigates sidetone and sing. An additional objective is to provide a receive amplifier with a single, manual volume control that automatically emphasizes upper voice-band frequencies in response to high gain settings. A further objective is to provide a receive amplifier that suitably services a wide range of incoming receive levels at a single gain setting.

SUMMARY OF THE INVENTION

The invention achieves the above stated and additional objects by combining in a handset having a transmit channel, a receive channel, a microphone and a receiver: an amplifier disposed in the receive channel with first and second negative feedback loops; a manually operated volume control working in relation with the first feedback loop; two variable impedances, one disposed in the transmit channel and the other disposed in the second feedback loop; and a controller circuit which controls the variable impedances to concurrently modify the gain/attenuation of each channel in response to varying levels of voice signals in the transmit and receive channels. The variable impedances are imbedded within their respective channels such that the receive and transmit channels experience voice-switched attenuation varying inversely relative to one another. When receive and transmit levels are below predetermined thresholds, the transmit channel is lossy while the receive channel gain varies from unity to its maximum under control of the manual volume control. When the transmit level reaches its threshold, loss in the transmit channel is switched out and a corresponding amount of loss is switched into the receive channel. When the output of the receive channel tries to exceed its threshold level, output receive levels are compressed by automatic gain control (AGC) action. A feature of the invention is that more loss is switched at upper voice-band frequencies than at lower frequencies. An additional feature is that the amount of gain switched is proportional to the amount of gain added by the volume control.

BRIEF DESCRIPTION OF THE DRAWING

The aforementioned and other features and advantages of the instant invention will become more readily apparent to persons skilled in the art by reference to the following detailed description when read in light of the accompanying drawing in which:

FIG. 1 is a schematic circuit diagram of a preferred embodiment in accordance with the invention.

DETAILED DESCRIPTION

Now referring to the accompanying drawing FIG. 1, the invention is described hereinafter in a preferred embodiment. Numerous other environments will readily come to mind in which the invention can find use.

The receive port of a host telephone network **80** connects to a receive channel **30** at terminals **1a,1b.** At terminal **3a** and a common terminal **2b**, the output of the receive channel connects to an electro-acoustic receiver **20**, which transduces electrical signals to acoustical signals. An acousto-electric microphone **10**, which transduces acoustical signals to electrical signals, connects through a transmit channel **70** to a transmit port of the network at terminals **2a,2b.**

Network **80** is a conventional 2-wire to 4-wire hybrid network, well known to those versed in the art. The network delivers incoming receive signals and a portion of the transmit signal (sidetone) to its receive port; it receives transmit signals at its transmit port, and it provides direct current DC) line power at its transmit port to bias, among other things, microphone **10**. Other details of the network do not pertain to the instant invention.

Receive channel **30** includes an operational amplifier **A1**; an amplifier input circuit comprising a manually variable potentiometer **R2** (volume control) for adjusting gain in the receive channel, and a capacitor **C1**; two negative feedback loops, the first comprising a resistor **R1**, the second comprising a capacitor **C2**, and a resistor **R3**. Collector-emitter terminals of a transistor **Q1** are connected across resistor **R3**. Also included is a voice-band, 1:1, 300Ω transformer **T1** which couples incoming receive signals from the network while providing longitudinal isolation of the receive channel from the network.

Transmit channel **70** includes a shunt attenuation circuit that includes a series combination of capacitor **C4** and collector-emitter terminals of a transistor **Q2**.

Controller **60** comprises a summing amplifier **40** having two inputs, the first connecting to microphone **10** at terminal **2a**, the second connecting to the output of the receive channel at terminal **3a**, and a rectifier-filter circuit **50** having an input lead that connects to the output of summing amplifier **40**. Summing amplifier **40** comprises an operational amplifier **A2**, a negative feedback loop comprising a resistor **R13**, a first summing input circuit comprising a capacitor **C12** and a resistor **R12**, and a second summing input circuit comprising a capacitor **C11** and a resistor **R11**. As well known to those skilled in the art, the two summing input circuits allow two different levels of amplification to be provided to their respective input signals. Rectifier-filter circuit **50** includes a resistor **14** which connects to a conventional DC power supply **Vdd**, a transistor **Q11**, a resistor **R15**, and a capacitor **C13**.

Details for power supply **Vdd** are not shown, to simplify the drawing and description. As well known in the art, a line-powered supply may be derived from the transmit port of the network, such as one of the schemes described in U.S. Patent 4,319,094 issued to Naganawa et al. on March 9, 1982. A line-powered supply is preferred for applications where sufficient DC line power is available, e.g., about 1.5 volts and 1-3mA, such as with PBXs and with single off-hook residential telephone sets. In applications involving multiple off-hook telephone sets at long residential loops, a battery is preferred. Also not shown are biasing arrangements derived from power supply **Vdd** for the operational amplifiers, as this is common knowledge to those versed in the art.

DETAILED DESCRIPTION: OPERATION

The controller output provides a varying DC control signal to the bases of transistors **Q1,Q2** through resistors **R16,R17** respectively, in response to varying levels of the transmit and receive signals. Resistors **R16,R17** are chosen to be equal to one another, their purpose being to help ensure equal base currents into the bases of transistors **Q1,Q2**. Transistors **Q1,Q2** act as variable resistances, exhibiting low resistance when the control signal is "high", high resistance when the control signal is "low", and intermediate values of resistance for corresponding intermediate control signal levels. Transistors **Q1,Q2** are chosen so that their respective resistances are approximately equal to one another at any given control signal level. The effect of transistors **Q1,Q2** varying between their high and low resistance states is to switch complementary attenuation between the receive and transmit channels. As well known to those versed in the art, the function of transistors **Q1,Q2** could be effected equally well by other devices which can exhibit variable impedance such as field-effect transistors and photo-transistors.

Capacitor **C4** and transistor **Q2** determine loss in the transmitter channel. The value of capacitor **C4** is chosen to effect moderate shunt attenuation at low frequencies, around 300Hz, and increasing attenuation at increasing frequencies, when transistor **Q2** is in a low resistance state. When **Q2** is in a high resistance state, it provides nil shunt attenuation to the transmit channel.

When transistor **Q1** is in a low resistance state, it removes negative feedback from the second feedback loop by shunting resistor **R3**. This is the normal listening, or "quiescent", state of the receive channel which is in effect when both transmit and receive levels are below predetermined threshold levels. In the quiescent state, the gain of the receive channel is determined by resistor **R1** in ratio with the series sum of the impedances of potentiometer **R2** and capacitor **C1**. At the upper frequency of the receive signal (about 3KHz), the impedance of capacitor **C1** is chosen to be small relative to the maximum value of potentiometer **R2**, and large relative to the minimum value of potentiometer **R2**. In this way the quiescent gain of the receive channel advantageously provides a "flat" frequency response at low and medium gain settings and emphasizes high frequency response at higher gain settings. Potentiometer **R2** can be varied from 0-10KΩ. When resistor **R1** is 10KΩ, and capacitor **C1** is 0.22μF, and potentiometer **R2** is set at 0Ω, receive signals are amplified about 25dB, with signals at 3KHz amplified about 15DB more than signals at 300Hz.

When transistor **Q1** is in a high resistance state, it has negligible shunting effect on resistor **R3**. Attenuation is then provided to receive signals in two ways: 1. The second negative feedback circuit increases attenuation at increasing frequencies by providing negative feedback across resistor **R3**, through capacitor **C2**. 2. Resistor **R3** increases the effective impedance of the input circuit of amplifier **A1**, thereby further attenuating the receive channel. The advantageous effect of resistance **R3** adding to the impedance of the input circuit is that the attenuation in the receive channel is less when potentiometer **R2** is maximum (quiescent gain setting) than when potentiometer **R2** is minimum (maximum gain setting). Advantageously, when high frequency emphasis is being provided by capacitor **C1**, it is that high frequency emphasis that is first removed during voice-switching.

At transmit and receive levels below threshold, the gain and bias of amplifier **A2** are chosen such that peak voltages at its output lead are insufficient to activate transistor **Q11**. When transistor **Q11** is non-conducting, the output lead of rectifier-filter circuit **50** is driven high by power supply **Vdd** through resistor **R14**. When either transmit or receive levels reach their respective threshold levels, the voltage at the collector of transistor **Q11** is driven toward ground on positive peak cycles thereby driving the controller output low through resistor **R15**. Capacitor **C13** serves as a low-pass filter, as well as helps to determine the charge (attack-time) and discharge (release-time) characteristics of the control signal. In association with resistors **R14,R15,R16,R17**, capacitor **C5** is chosen to provide a fast, but not too fast discharge time, and a slow, but not too slow charge time. Thus the control signal tends to approximately follow the average of the absolute value of the sum of the envelopes of the amplified signals from the transmit and receive channels. In addition, the values of resistors **R14,R15,R16,R17** are chosen so that, relative to either resistance **R3** or the impedance of microphone **10**, the resistance values of transistors **Q1,Q2** are small when the control signal is high, and large when the control signal is low.

Transmit and receive threshold levels are determined as follows: Component values in the first summing input circuit of summing amplifier **40** are chosen, along with resistor **R13**, so that voice-band acoustic signals of about 60dB relative to 20μPa (reference threshold of hearing) into microphone **10** cause the control signal to go low, thereby switching attenuation out of the transmit channel. Component values in the second summing input circuit are chosen, along with resistor **R13**, so that voice-band acoustic signals at receiver **20** of about 90dB relative to 20μPa cause the control signal to be driven toward a low state, thereby providing AGC action in the receive channel to compress signals above that level.

Since switched attenuation in the transmit channel varies inversely with that of the receive channel, AGC action in the receive channel switches a corresponding amount of loss from the transmit channel. This has the advantageous effect of minimizing the amount of switched attenuation that occurs when near-end and far-end parties are interrupting each other. A further advantage of AGC is to soften loud signals, such as dial-tone, and loud talkers. An even further advantage of AGC is to improve linearity by helping to keep loud signals within the linear operating region of the receive channel. Thus, with the previously described switched-attenuation characteristics mitigating sidetone and sing problems, and with AGC action mitigating the effects of excessively loud receive signals, the instant invention requires little, if any, adjustment of the gain setting. In some applications, such as in public telephones, it allows a single gain setting, thereby eliminating an external volume control which would otherwise be subject to acts of vandalism.

Capacitor **C3** serves as a DC blocking capacitor. Resistor **R4** is an input impedance setting resistor.

Transistors **Q1,Q2,Q11** are npn silicon transistors such as Motorola MPS 2N3904. Microphone **10** is an electret microphone such as EM80P, and receiver **20** is an electromagnetic receiver such as DH60, both available from Primo Microphone Inc., Tokyo, Japan. Amplifiers **A1,A2** are conventional operational amplifiers such as National Semiconductor model LM10.

It is understood that the presently preferred embodiment described herein is merely illustrative of the principles of the invention. Various modifications may be made thereto by persons skilled in the art without departing from the scope of the invention. Additionally, while the invention is primarily directed at telephone handset applications, it could be employed equally as well in telephone bases, modular in-line amplifiers, operator head telephone sets, speakerphone sets, or other situations requiring mitigation of sidetone or sing, or both. It is my intention that the following claims cover all equivalent modifications and variations as followed within the scope of the invention.

CLAIMS: What I claim is:

1. In a voice-band communication system, an apparatus for interfacing a microphone and a speaker to a hybrid network having a transmit port for receiving transmit signals and a receive port for delivering receive signals, said apparatus comprising:

receive channel means connected between the receive port and the speaker for providing varying, frequency dependent gain to the receive signals in response to changes in a control signal;

transmit channel means responsive to the changes in the control signal connected between the microphone and the transmit port for providing varying transmit gain to the transmit signals, with said transmit gain varying in complementary relation to said receive gain; and

control means coupled to the receive and transmit channels for monitoring transmit and receive signals and for producing and varying said control signal to cause the transmit gain to increase and the receive gain to decrease in proportion to changes in the control signal when at least one of the transmit signals and the receive signals are at least greater than predetermined threshold levels.

2. For a telephone handset having a microphone and a receiver and for a telephone base having a transmit port for receiving voice transmit signals and for delivering direct current line power, and a receive port for delivering voice receive signals, an apparatus comprising:

a transmit channel having input connectors to the microphone for receiving the transmit signals, and having output connectors to the base for delivering the transmit signals and for receiving the direct current line power, with means for connecting one of the input connectors and one of the output connectors to each other thereby making a common lead;

said transmit channel including means for coupling the remaining one of the input connectors to the remaining one of the output connectors;

said transmit channel further including a transmit attenuation means connected across the transmit channel input connectors and coupled to a control signal for providing variable, frequency dependent attenuation to the transmit signals in response to changes in a control signal;

a receive channel having receive input connectors for receiving the receive signals and receive output connectors to the receiver for delivering the receive signals;

said receive channel including a receive amplification means coupled between the receive input connectors and the receive output connectors for amplifying said receive signals;

said receive channel further including a receive attenuation means coupled to said receive amplification means and coupled to the control signal, for providing variable, frequency dependent attenuation to the receive signals in inverse relationship with said transmit attenuation means, in response to said same changes in the control signal;

control means coupled to the microphone and the receiver and the receive attenuation means and the transmit attenuation means for producing the control signal and for varying the control signal amplitude in proportion to the transmit signals varying above a predetermined transmit threshold level.

3. The amplification circuit in accordance with claim 2 where said control means further includes means for varying the control signal amplitude in proportion to the receive signals varying above a predetermined receive threshold level.

4. The amplification circuit of claim 3 wherein said transmit attenuation means comprises:

a first variable impedance coupled to the control signal and including a first lead and a second lead, said first lead connecting to the common lead; and

a shunt impedance circuit having two leads and having means for exhibiting lower impedance at higher frequencies than at lower frequencies, said shunt impedance circuit having one of its leads connected to the microphone and its remaining lead connected to the second lead of the first variable impedance.

5. The amplification circuit of claim 4 wherein said receive amplification means comprises:

an input circuit having first and second leads;

an amplifier having input, output, and ground terminals with the amplifier input terminal connecting to the input circuit second lead, and the amplifier ground terminal connecting to said common lead;

means coupling said amplifier output terminal to the receiver;

a first negative feedback circuit connecting across the amplifier input and output terminals, with the closed-loop gain of said amplifier being determined by said first negative feedback circuit in ratio with said input circuit;

a second negative feedback circuit having first, second, and third leads, with the second negative feedback circuit first lead connecting to the amplifier output terminal, and the second negative feedback circuit third lead connecting to said common lead; and

means connecting receive signals from the receive input connectors between the negative feedback circuit second lead and the input circuit first lead.

6. The amplification circuit of claim 5 wherein said receive attenuation means is a second variable impedance coupled to said control signal and connecting in

parallel across the second negative feedback circuit second lead and said common lead.

7. The amplification circuit of claim 6 wherein:
said shunt impedance circuit comprises a first capacitor;
said first variable impedance comprises collector and emitter terminals of a first transistor, said first transistor having a base terminal with means coupling to said control signal;
said input circuit comprises a second capacitor and a two terminal resistance element, connected in series;
said first negative feedback circuit comprises a first resistor;
said second negative feedback circuit comprises a third capacitor connecting between the second negative feedback circuit first and second leads, and a second resistor connecting between the second negative feedback circuit second and third leads; and
said second variable impedance comprises collector and emitter terminals of a second transistor, said second transistor having a base terminal with means coupling to said control signal.

8. The amplification circuit in accordance with claim 7 wherein said two terminal impedance element is a potentiometer to provide manual gain adjustment such that the receive amplification means provides receive flat frequency response at low gain adjustment settings and provides increased emphasis to high frequencies at higher gain adjustments.

9. The amplification circuit in accordance with claim 3 wherein said control means comprises:
a rectifier filter means having an input and having an output coupled to the transmit channel and the receive channel and for producing and varying the control signal;

control amplification means having a first input coupling to the microphone, a second input coupling to the receiver, and an output connecting to the input of the rectifier filter means;

said control amplification means further including means to simultaneously provide one level of amplification to signals appearing at its said first input and a second level of amplification to signals appearing at its said second input, and to provide an output signal to the rectifier filter circuit representative of the algebraic sum of the two amplified signals; and

said rectifier-filter circuit including means for rectifying and low pass filtering and for providing to the transmit and receive channels, a filtered, direct current signal with amplitude that is approximately representative of the average absolute value of the envelope of the signals from the output of the control amplification means.

AMENDED CLAIMS

[received by the International Bureau on 20 May 1992 (20.05.92); original claims 1 - 9 cancelled; new claims 10 - 16 added (3 pages)]

10. In a voice-band communication system, an apparatus for interfacing a microphone and a speaker to a hybrid network having a transmit port for receiving transmit signals and a receive port for delivering receive signals, said apparatus comprising:

receive channel means coupled between the receive port and the speaker for providing varying, frequency-dependent gain to the receive signals in response to changes in a control signal;

transmit channel means responsive to the changes in the control signal and coupled between the microphone and the transmit port for providing varying transmit gain to the transmit signals, with said transmit gain varying in complementary relation to said receive gain; and

control means having input means coupled to the transmit channel means and output means coupled to the transmit channel means and to the receive channel means for monitoring transmit signals and for producing and varying said control signal to cause the transmit gain to increase and the receive gain to decrease in proportion to changes in the control signal when the transmit signal is at least greater than a transmit threshold level.

11. The apparatus in accordance with claim 10 wherein the control means further includes means coupled to the receive channel means for monitoring receive signals and means for varying said control signal to cause the receive gain to decrease in proportion to increasing changes in the control signal when the receive signal is at least greater

than a receive threshold level, thereby providing automatic gain control for receive signals.

12. In a telephone speech communication system having a receiver which is used in proximity with a user's ear, and a microphone, and a receive port for delivering receive signals from a telephone line, and a transmit port for delivering transmit signals to said telephone line, an amplification circuit comprising:

transmit channel means coupled to said microphone for receiving transmit signals from said microphone, and coupled to said transmit port for delivering the transmit signals;

said transmit channel means further including a transmit attenuation means for providing variable, frequency-dependent attenuation to the transmit signals in response to changes in a control signal;

receive channel means coupled to said receive port for receiving receive signals, and coupled to said receiver for delivering the receive signals;

said receive channel means further including a receive amplification means for amplifying the receive signals;

said receive channel means further including a receive attenuation means for providing variable, frequency-dependent attenuation to the receive signals in inverse relationship with said transmit attenuation means, in response to said same changes in said control signal;

control means coupled to the transmit channel means for monitoring transmit signals and for producing and varying said control signal to cause the transmit gain to incresase and the receive gain to decrease in proportion to changes in the control signal when the transmit signal is at least greater than a transmit threshold level, thereby mitigating adverse effects of sidetone and mitigating tendencies of the system to self-oscillate.

13. The amplification circuit in accordance with claim 12 wherein said control means further includes means coupled to the receive channel means for monitoring the receive signals and for varying said control signal to cause the receive attenuation to increase in proportion to changes in the control signal when the receive signal is at least greater than a receive threshold level, thereby providing automatic gain control for receive signals.

14. The amplification circuit in accordance with claim 12 wherein said receive channel means further includes volume control means for manually adjusting receive gain.

15. The amplification circuit in accordance with claim 14 further including means for rendering the amount of varying receive attenuation to be proportional to the amount of gain added by the volume control means.

16. The amplification circuit in accordance with claim 14 wherein said volume control means further includes means for providing to receive signals flat frequency response at low gain adjustment settings and for providing increased emphasis to high frequencies at higher gain adjustment settings.

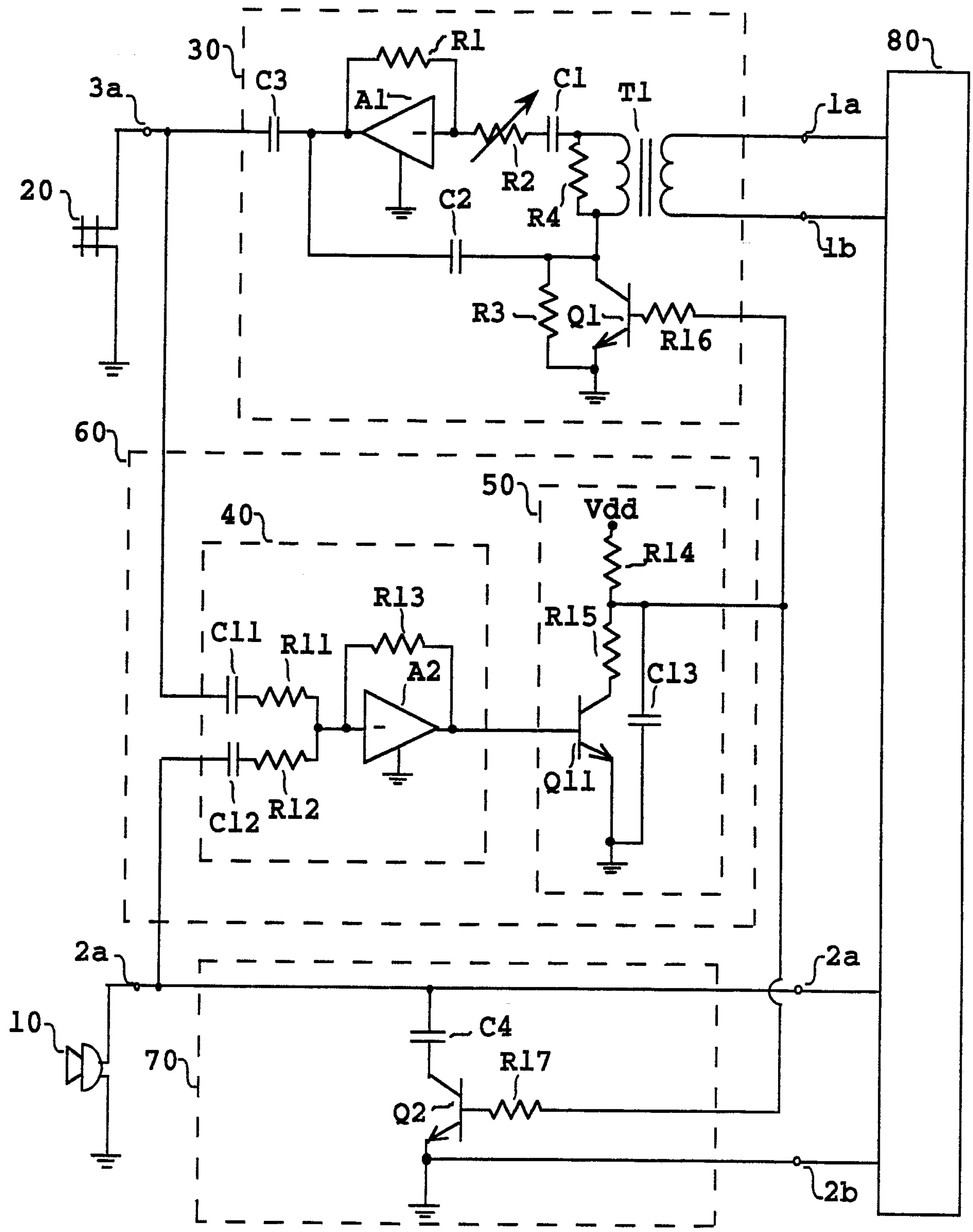
30
3a
C3
R1
A1
C1
T1
80
1a
20
R2
C2
R4
1b
R3
Q1
R16
60
50
Vdd
40
R14
R13
R15
C11
R11
A2
C13
Q11
C12
R12
2a
2a
10
C4
70
R17
Q2
2b

FIG. 1

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/09154

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

IPC(5): H04M 1/60
US CL : 379/389

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	379/387,395,388,389,390

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]
A	US, A, 3,894,187 (SHIBATA ET AL.) 08 JULY 1975	1-9
A	US, A, 3,925,618 (KATO ET AL.) 09 DECEMBER 1975	1-9
A	US, A, 4,147,892 (MILLER) 03 APRIL 1979	1-9
X Y	US, A, 4,513,177 (NISHINO ET AL.) 23 APRIL 1985 See the entire document.	1 2,3
A	US, A, 4,555,596 (BLOMLEY) 26 NOVEMBER 1985	1-9
Y	US, A, 4,608,462 (BLOMLEY ET AL.) 26 AUGUST 1986 See entire document.	2,3
A	US, A, 4,899,380 (SHIMADA) 06 FEBRUARY 1990	1-9
A	US, A, 4,955,055 (FUJISAKI ET AL.) 04 SEPTEMBER 1990	1-9
P, A,	US, A, 4,984,265 (CONNAN ET AL.) 08 JANUARY 1991	1-9
P,A,	US, A, 4,989,242 (ARNAND) 29 JANUARY 1991	1-9
P,A,	US, A, 5.058,153 (CAREW ET AL.) 15 OCTOBER 1991	1-9

* Special categories of cited documents: [10]

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

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"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
23 FEBRUARY 1992	25 MAR 1992
International Searching Authority	**Signature of Authorized Officer** NGUYEN NGOC-HO INTERNATIONAL DIVISION
ISA/US	for MAGDY SHEHATA *Nghto Nguyen*

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	JP, A, 60-54555 (NIPPON DENKI, K.K.) 29 MARCH 1985	1-9
A	JP, A, 61-195054 (MASUSHITA ELECTRIC WORKS, LTD) 29 AUGUST 1986	1-9
A	JP, A, 1-143452 (OKI ELECTRIC IND. CO. LTD.) 06 JUNE 1989	1-9
A	JP, A, 1-212950 (MATSUSHITA ELECTRIC IND. CO. LTD.) 25 AUGUST 1989	1-9

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

3. ☐ Claim numbers___________, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.