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SIGNAL POWERED SIGNAL-TO-NOISE SQUELCH

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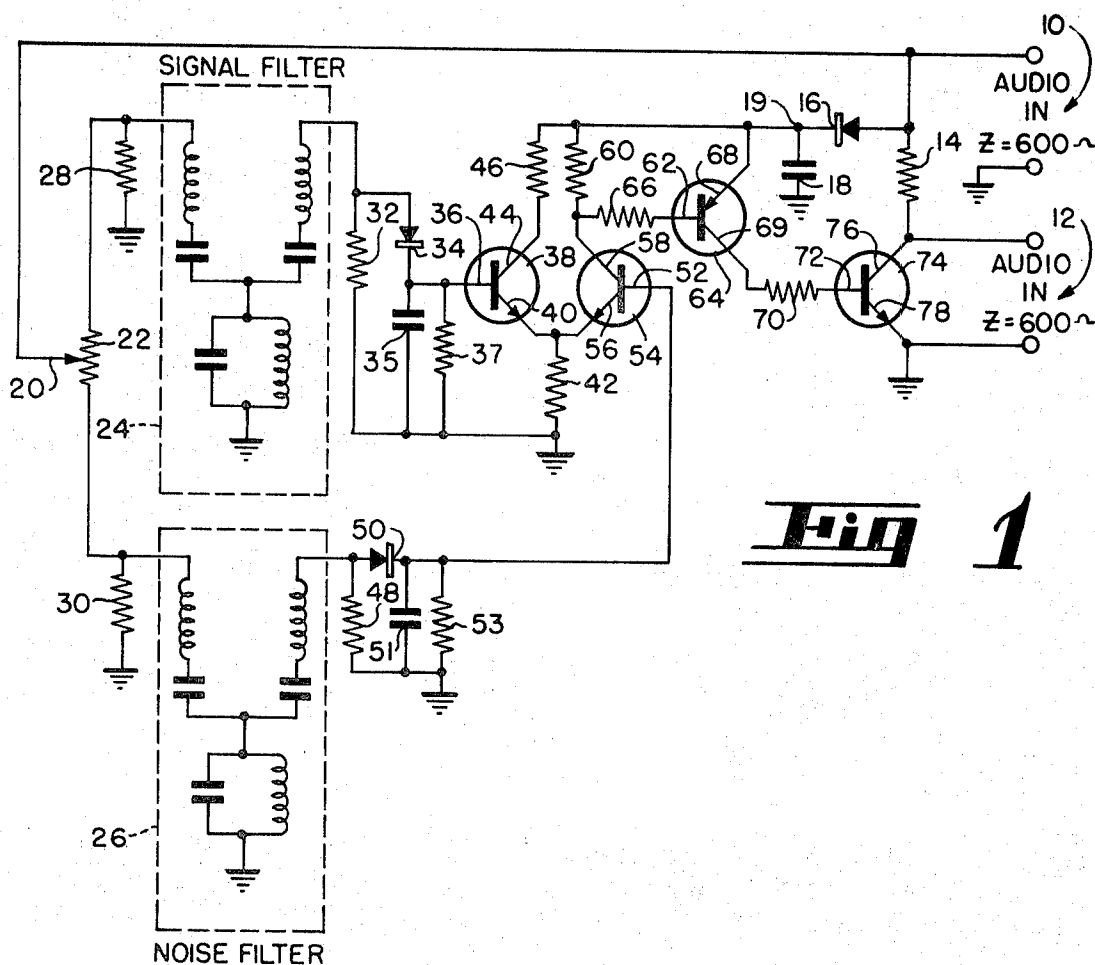


Fig 1

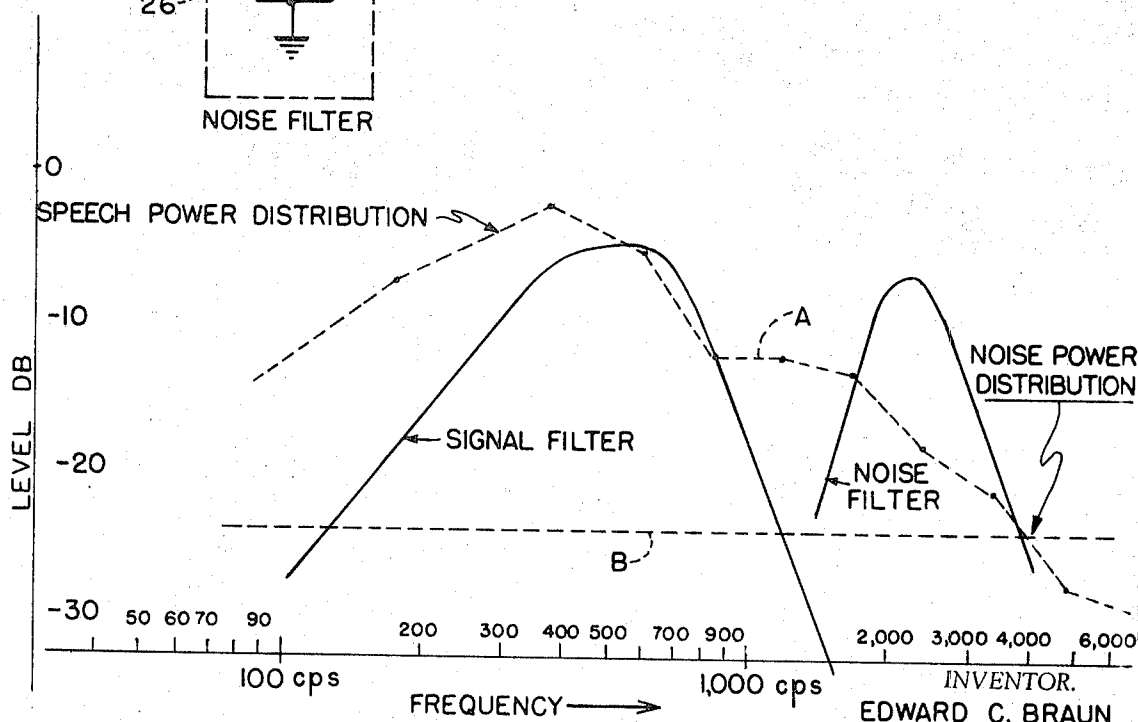


Fig 2

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SIGNAL POWERED SIGNAL-TO-NOISE SQUELCH
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7 Claims

ABSTRACT OF THE DISCLOSURE

A transistorized squelch circuit which is signal powered serves to shunt the audio signal when the noise level exceeds a predetermined relationship to signal. A portion of the audio signal is rectified and supplies the power for each of the transistors which are used in the circuit. The remainder of the audio signal is applied through a ratio determining resistor to a signal filter tuned to pass approximately 500 c.p.s. and a noise filter tuned to pass approximately 2200 c.p.s. The output to each filter is applied to a difference amplifier which produces a voltage drop when the output from the 2200-cycle noise filter exceeds the output from the 500-cycle signal filter. The output from the difference amplifier closes an electronic switch to shunt the audio output.

BACKGROUND OF THE INVENTION

There are many signal-to-noise squelch circuits taught by the prior art including those which operate on the concept of comparing the energy distribution of the audio signal with the distribution of noise. The present invention utilizes this concept, taking advantage of the inherent difference between the spectral characteristics of noise and voice intelligence. Statistically, noise is comprised of varying but equal amplitude power components across the 300 to 3000 c.p.s. band. On the other hand, in the spectral distribution of speech over the same frequency range, half of the signal power is found in the 300 to 800 c.p.s. band and half of the signal power is found in the 800 to 3000 c.p.s. band. Thus, when the power distribution above and below 1500 c.p.s. is of equal magnitude, noise alone must be present. On the other hand, when both noise and speech signal are present, an unbalance in power occurs. This presence of a power difference or a power equality is the factor used to control the actuation of the squelch network.

In known voice communication systems presently used, squelch circuits must be built into the circuitry and powered by the main power supply. This invention, utilizing the power spectrum distribution phenomenon, provides a signal-powered circuit which serves to shunt or short-circuit the audio output in the presence of excessive noise. The circuit is fail safe in that failure of the squelch circuit will disable the squelch but will permit the passage of signal.

THE DRAWINGS

FIG. 1 is a schematic diagram of a signal powered signal-to-noise squelch circuit; and

FIG. 2 is a plot of the speech spectrum of a male voice at conversational level, the noise spectrum, and transfer characteristics of both the signal and noise filters.

DETAILED DESCRIPTION

The circuit of FIG. 1 includes audio input terminals 10 and audio output terminals 12, each of which in practice will comprise a conventional jack-type connector, one being a female and the other a male. In a radio not provided with a squelch, the circuit shown in FIG. 1 could be inserted by disconnecting the standard jack from the

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speaker and by reconnecting it to the terminals 10. The speaker is then connected to the terminals 12.

Audio input signals applied to the terminals 10 are directed in three paths. The first is a signal flow path to the output terminals 12 through a resistor 14. This is a path which is effective in the absence of squelch.

The second path is to a diode 16 and a capacitor 18 which serve to rectify the audio signal and provide at a terminal 19, the power for all of the active elements in the circuit.

The third path is to the movable tap 20 on a balance control resistor 22. The signal applied to the tap 20 is again divided, a portion of it flowing through a signal filter 24, the other half flowing through a noise filter 26. The position of the tap 20 on the balance control resistor 22, together with values of the resistors 28 and 30 and the input impedance of the filter 24 and 26, determines the ratio of the signal appearing in the signal and noise channels.

As may be understood from the curves of FIG. 2, operation of the squelch circuit is based on the fact that there is an inherent difference between the spectral characteristics of noise and voice. Curve A represents a typical voice power spectrum of a male voice at conversational level, while curve B shows the noise power distribution. While curve B is essentially level, i.e., has constant power distribution from 300–3000 c.p.s., maximum voice power appears at about 3–600 c.p.s. Thus while noise is distributed substantially equally, approximately half of the voice signal power is distributed between 300 and 800 c.p.s. This means that if the spectrum is divided approximately in half, and the power from each half measured, there will be an equal distribution of energy when only noise is present, but an unequal distribution when both signal and noise are present. Therefore, the signal filter 24 is tuned to approximately 500 c.p.s. while the noise filter 26 is tuned to approximately 2200 c.p.s.

The output from the signal filter 24 is applied across a resistor 32 to a rectifier network, comprising a diode 34, a capacitor 35, and a resistor 37, and then to the base 36 of a transistor 38. The emitter 40 of transistor 38 is connected to ground through a resistor 42 while its collector 44 is connected to the diode 16 through a resistor 46. Similarly, the output from the noise filter 26 is applied across a resistor 48 to a rectifier network, comprising a diode 50, a capacitor 51, and a resistor 53, and then to the base 52 of a transistor 54. The emitter 56 of transistor 54 is connected to ground through the resistor 42 while its collector 58 is connected to the diode 16 through a resistor 60.

The circuit including the transistors 38 and 54 comprises a difference amplifier of conventional design. In practice transistors 38 and 54 are Type 2N2484 which have a beta of over 200 and a collector current of 30 microamps and maintain the low power requirements. The difference amplifier operates such that the transistor 54 conducts at any time the potential at the base 52 of transistor 54 exceeds that at the base 36 of transistor 38. When transistor 54 conducts current, a potential drop appears across the resistor 60.

The junction of resistor 60 and collector 58 is connected to the base 62 of a transistor 64 through a resistor 66. The emitter 68 of transistor 64 is connected to the diode 16 while the collector 69 is connected through a resistor 70 to the base 72 of a switching transistor 74. The collector 76 of the switching transistor 74 is connected to the resistor 14 while its emitter 78 is connected to ground.

The power relationship between the outputs of the two filters controls the operation of the switching transistor 74. That is, the output from the signal filter 24 is compared with the output from the noise filter 26 in the dif-

ference amplifier (transistors 38 and 54). When the output of filter 26 exceeds that of filter 24, the potential drop resulting at resistor 60 is applied across the base emitter of transistor 64 which supplies collector current through the base emitter of transistor 74. The resistor 66 is required to assure sufficiently low current to flow through transistor 64, and the resistor 70 is used to limit the base current of transistor 74.

Transistor 74 is a bilateral switching transistor Type 2N1996 that allows the alternating current signal to be shunted to ground when base emitter current is supplied from the transistor 64. The alternating current impedance of the transistor 74 is such that adequate squelch is obtained even when the impedance of resistor 14 is very low. The squelch on-off ratio is approximately equal to the saturation resistance of transistor 74 (several ohms) to the generator impedance of 600 ohms. Resistor 14 appears as a loss to the output signal, but is required for enabling the generation of a voltage from the rectifier 16 from the available noise when the output is being squelched. However, this resistor represents a loss of only 1 db since it is not necessary to have a squelch action on extremely low level signals.

The squelch circuitry is fail safe in that the switching transistor 74 is non-conducting as no power is rectified by the diode 16.

Diode 34 and capacitor 35 rectify the signal output from filter 24. Diode 34 is a hot carrier diode to obtain a low rectification threshold with no need for pre-bias circuitry. The time constant of capacitor 35 and resistor 37 has been set at approximately one second. This was found to be optimum for average speech; however, a broad range of from one to three seconds appears to be satisfactory. Resistor 32 is 2000 ohms and serves as the filter load. Diode 50, capacitor 51, resistor 53, and resistor 48 serve the same function for filter 26.

In summary, this invention provides a squelch circuit in which noise is shunted to ground in the absence of signal, and in which the active elements are powered with the available signal and noise, and which analyzes the power spectrum to produce switching at a predetermined signal to noise ratio. The outstanding feature of this invention is the use of low power circuitry operated by means of energy taken from the incoming signal wavetrain. This provides an increase in receiver dynamic range and at the same time alleviates the need for batteries, external power, or receiver modifications. The system utilizes all solid state components.

Various modifications of this invention will be apparent to persons skilled in the art. It is intended therefore that this invention be limited only by the following claims as interpreted in the light of the prior art.

I claim:

1. In a voice communications system:

- a source of audio signals comprised of intelligence signals and noise, said source being connected between an audio input terminal and a point of reference potential;
- an audio output circuit connected between an audio output terminal and said point;
- a connection between said terminals for coupling said source to said output circuit;
- a transistorized squelch circuit, said squelch circuit including means for analyzing said audio signals and means for connecting said output terminal to said point below an established intelligence signal-to-noise ratio for short-circuiting said output circuit;
- a connection from said input terminal to said transistorized squelch circuit; and
- a power supply for said transistorized squelch circuit, said power supply comprising a semiconductor diode rectifier connected between said input terminal and

said squelch circuit, the power for said squelch circuit being derived entirely from said input terminal through said rectifier.

2. The invention as defined in claim 1, wherein said means for analyzing said audio signals includes first and second tuned filters, said first filter being tuned to pass a frequency at which voice signals are at approximately maximum power level, said second filter being tuned to pass a frequency at which voice signal power is at a relatively low level, said connection from said input terminal to said squelch circuit dividing the power to said filters in inverse relation to said ratio;

means for generating a control voltage when the output from said second filter is greater than the output from said first filter; and

means responsive to said control voltage for connecting said output terminal to said point.

3. The invention as defined in claim 2, wherein said means for connecting said output terminal to said point comprises:

a first transistor having a collector connected directly to said output terminal, an emitter connected to said point, and a base;

a second transistor having an emitter connected to said junction, a collector connected to the base of said first transistor, and a base, said control voltage being applied between the base of the second transistor and said point.

4. The invention as defined in claim 3, wherein said means for generating said control voltage is a difference amplifier comprising third and fourth transistors, each of said third and fourth transistors having a base, a collector, and an emitter, the emitters of said third and fourth transistors being connected to said point through a common resistor, the collectors of said transistors being connected to said junction through respective load resistors, the base of said third transistor being supplied with the output from said first filter, the base of said fourth transistor being supplied with the output from said second filter, the junction between the collector of said fourth transistor and its load resistor being connected to the base of said second transistor.

5. The invention as defined in claim 4 wherein the output of each of said filters is rectified.

6. The invention as defined in claim 1 wherein said connection between said terminals for coupling said source to said output circuit comprises a resistor.

7. The invention as defined in claim 1 wherein said power supply comprises said semiconductor diode rectifier in series with a capacitor, said power supply being connected between said input terminal and said point, the power for said squelch circuit being derived through said rectifier entirely from the junction of said rectifier and said capacitor.

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