ELECTRONIC NOISE GENERATOR

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2 Claims. (Cl. 250—36)

1. The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment to me of any royalty thereon.

This invention relates to noise generators and more especially to an electronic circuit in which is generated the audio frequencies representative of noise frequencies of aircraft.

The noise which is encountered in aircraft has two principal components. The first is that of the propeller which sends out radially compression waves of very high intensity, producing a characteristic throbbing or humming. This noise can be represented as a discontinuous or line spectrum, consisting of a fundamental frequency equal to the frequency with which the propeller tips pass any given point, and a series of higher frequencies which are harmonics or multiples of the fundamental frequencies. The second source of noise is turbulence in the air stream, and such turbulence is to be found associated with various irregularities presented by an airship to the smooth flow passing its surface. This noise consists of a continuous or random spectrum. In other words, this noise contains all frequencies from the lowest to the highest audible sounds. There are also other sources of noise which may be disregarded for the purpose of this invention.

According to this invention, a relaxation oscillator is used to generate a line frequency spectrum and a gas-filled diode-connected triode tube is used to generate a continuous or random frequency spectrum. The two frequency spectrums are combined in an amplifying circuit and passed to a frequency control network which is coupled to a frequency dividing network. The frequency dividing network provides outputs for low frequency speakers and high frequency speakers in order that the frequency spectrums generated and the harmonics thereof may be produced in the audible range. The relaxation oscillator has a band pass filter in its coupling to the amplifying circuit for selecting the most desired frequencies closely simulating the frequencies of airplane noise while the frequency control network emphasizes the group of frequency components which simulate those frequency components occurring in the average airplane noise. The noises thus produced over the speakers simulate the propeller and airflow noises realized of an airplane in flight.

It is an object of the invention to reproduce airplane noise by synthesizing electrically a discontinuous or line spectrum and a continuous or random spectrum. Another object of the invention is to isolate a desired band of frequencies from one of the spectra and to mix the desired band of frequencies with frequencies of the other of the spectra to produce as nearly as possible the true principal components of airplane noises in suitable relation to each other.

In the accompanying drawings:

Fig. 1 is a block diagram of a sound generating system;

Fig. 2 is a wiring diagram of one type of noise generating apparatus; and

Fig. 3 is a wiring diagram of another type of noise generating apparatus.

The invention in general comprises a noise generating apparatus which includes a relaxation oscillator and a gas-filled diode, the combined output of which is amplified, subjected to a frequency control and ultimately passed to loud speakers.

I have found that a relaxation oscillator, when utilized as a generator of noise may be satisfactorily employed to produce the line spectrum component of airplane noise. The relaxation oscillator consists of a condenser which is charged at a gradually decreasing rate through a high resistance. When the potential across this condenser reaches a critical high value, the gas contained in the tube is ionized and the condenser is rapidly discharged. When the potential has fallen to a second critical low value the current through the tube no longer maintains ionization and the tube ceases to conduct. A harmonic analysis of the resulting waveform reveals the fact that it contains a fundamental frequency corresponding with its period and a long series of higher harmonics.

I have also found that a gas-filled diode may be utilized to generate a noise spectrum which is particularly suitable to constituting the random or continuous spectrum component of airplane noise.

In the gas-filled diode, current is carried principally by the relatively large and slow-moving ions of gas. Because of their properties the momentary fluctuations in the cathode-to-anode current of such a gas-filled diode far exceed those produced by other sources. It is to be anticipated that the maximum output will be produced when such a tube is operating near the critical ionization point. In applying such potentials to purposes of this invention, it is necessary first to isolate and amplify this noise, and then to pass it through such filtering networks as will give the proper distribution of energy in the various regions of the sound spectrum.

In Fig. 2 of the drawings, I have illustrated a
suitable wiring diagram of a circuit in which a gas-filled diode connected triode is utilized to generate a random spectrum. The output of this generator is led to a preamplifier and then to the same power amplifier into which the output of the line spectrum generator is passed (Fig. 1).

In Fig. 3 of the drawings, I have illustrated one suitable wiring diagram of a circuit in which a relaxation oscillator is utilized to generate a line spectrum. The output of the line spectrum generator, as illustrated in the block diagram of Fig. 1, is passed through filters to a preamplifier and then to a power amplifier where it is mixed with the output of a random spectrum generator. The filters act in a manner well understood in the art to select relatively more of the harmonics lying between 100 cycles and 250 cycles and to attenuate markedly frequencies lying above 250 cycles. The amplification and mixing is accomplished by familiar electronic methods, the detailed manner of operation of which is immaterial to the invention.

The combined output of the two generators is passed from the power amplifier to a frequency control then to a dividing network and finally to high frequency and low frequency speakers as has been illustrated in the block diagram of Fig. 1.

The frequency control network is capable of emphasizing a particular group of components which have been found to closely simulate similar components occurring in average airplane noise. This particular band of frequencies from the line spectrum generator has been found to occur between 100 cycles and 250 cycles. The selection of desired frequencies from the line spectrum generator was accomplished as shown above by a band-pass filter. It remains at this point to attenuate in smaller measure (than the band-pass filter) the high frequency components of the output of the random spectrum generator. It was found possible to accomplish this with conventional tone control of the power amplifier although it might equally well have been done with other known filtering networks. This tone control consists of a condenser in series with a resistor. By utilizing the voltage across the condenser, the output decreases proportionally to the frequency because of the decreasing impedance of the condenser at high frequencies. This combination of resistance and capacitance for this purpose is common practice in the art.

The numerical values of the elements which have been found to produce a desirable noise are given below although these values may be changed to produce noise over a greater frequency band without departing from the spirit and scope of the invention.

\[ C_1 = 1 \text{ mfd.} \ 600 \text{ v. paper condenser} \]
\[ C_2 = 0.02 \text{ mfd.} \ 600 \text{ v. paper condenser} \]
\[ E_b = \text{Battery 12 volts} \]
\[ E_T = \text{Battery 22.5 volts} \]
\[ GR = \text{Output, line spectrum} \]
\[ GR_R = \text{Output, random spectrum} \]
\[ P_1 = 50,000 \text{ ohm potentiometer} \]
\[ P_2 = 5 \text{ megohm} \]
\[ R_1 = 1000 \text{ ohms} \]
\[ R_2 = 200,000 \text{ ohms} \]
\[ T_1 = \text{Transformer} \]
\[ V_1 - V_2 = \text{Gas tube—984} \]

Any good power amplifier with a wide range of frequency response and a reasonably small distortion will adequately meet the needs of this noise generator. It should have good dynamic power handling capacity. The power needed will depend principally upon the sound level to be achieved, and upon the characteristics of the room in which the noise is to be produced. For example, a battery of six 50-watt power amplifiers is sufficient to produce an overall noise level of better than 120 db. in a room of 10,000 cu. ft. volume, with hard plaster walls. For most purposes, commercially available 50-watt power amplifiers are quite suitable.

If more than 50-watt power is required, these units can be used in parallel with suitable adjustment of the output circuit to match the impedance of the speakers used. Loudspeaking equipment of the type particularly utilized in systems for theatre application have been found to give best results. Current engineering practice indicates the desirability of using a dividing network and both a low frequency and a high frequency horn. Satisfactory results have been obtained from a system which includes an PLT-18B in a bass reflex cabinet to handle frequencies up to 400 cycles. This apparatus was set up in a brick-walled room of 2500 cu. ft. volume.

The noise generating equipment described is effective in synthesizing an average noise generally corresponding to the noise field in which the pilot of a plane is required to operate. By simulating a noise field by means of electronic generation, more realistic training conditions are available to student pilots and others. This is especially useful in determining the ability of the pilot to hear and understand directions received in the earphones or other types of communication equipment. Electronically generated noise also can be made use of in various other training situations, covering a variety of types of equipment.

Having thus described my invention, what I claim is:

1. An electronic device for producing audio frequencies simulating the audio frequencies of the noise produced by aircraft that are adapted to be audibly produced over low frequency and high frequency sound producing means comprising a circuit including a gas-filled triode tube for producing voltages over a random frequency spectrum corresponding to the frequencies of air turbulence about an airplane in flight, a circuit including a relaxation oscillator for producing voltages of a fundamental frequency and harmonics thereof, a band pass filter in circuit with the relaxation oscillator for selecting the harmonics corresponding in frequencies to harmonics present in propeller noises, means for amplifying the output voltages of said gas-filled tube, means for amplifying the voltages passed by said band pass filter, means for combining the outputs of said amplifying means, a power amplifier, means for applying the combined outputs of said amplifying means to said power amplifier, a network having an adjustable frequency transmission characteristic, means for applying the output of said power amplifier to said network, and means for applying the output of said network to an audio frequency dividing network for separating the output frequencies into a low frequency band output and a high frequency band output, whereby composite electrical signals of low audio frequency and high audio frequency are produced that simulate the frequencies of the noises produced by an airplane in flight.

2. An electronic device as set forth in claim 1 wherein said band pass filter selectively passes the
harmonics lying between 100 and 250 cycles and attenuates frequencies below 100 cycles and above
250 cycles, and said network having an adjustable frequency characteristic attenuates the high fre-
quency components produced by said gas-filled
triode filtered circuit, and attenuating means in
each spectrum generating circuit for selectively
controlling the propeller or air turbulence fre-
quency characteristic and signal level of said sim-
ulated aircraft noise frequencies.

STANLEY SMITH STEVENS.

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file of this patent:

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