July 16, 1963 W. B. WADSWORTH 3,098,121

AUTOMATIC SOUND CONTROL

Filed Sept. 15, 1958

FIG. 1

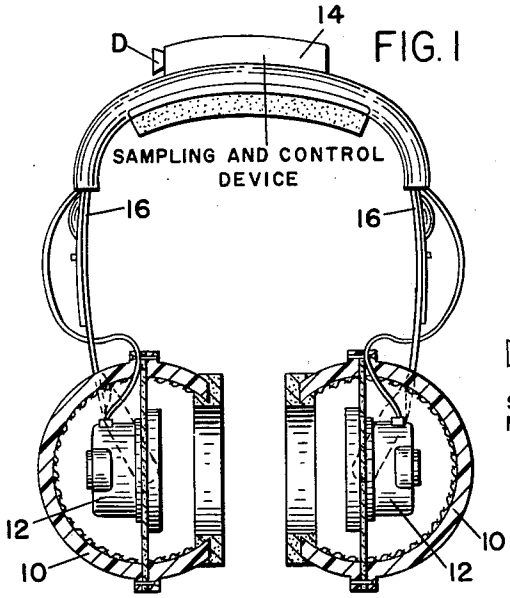


FIG. 2

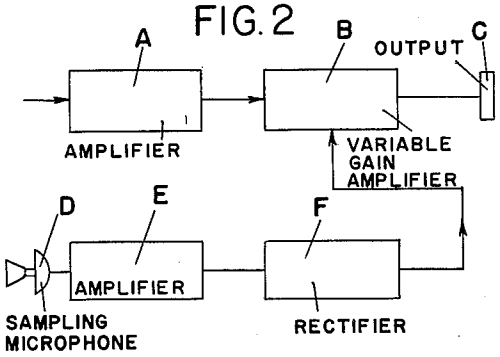
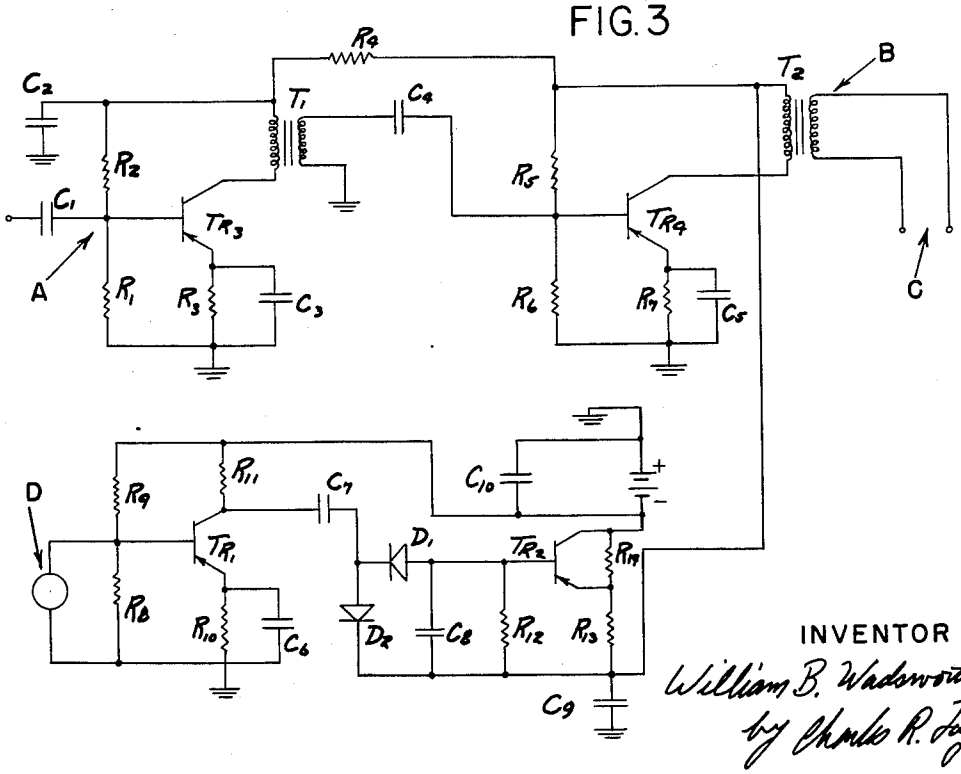


FIG. 3



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3,098,121

AUTOMATIC SOUND CONTROL

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1 Claim. (Cl. 179—1)

This invention relates to a unique application of automatic control of sound in a noisy location. The prior art utilizes the principle that where a public address system is used in a noisy location, a constant signal to noise ratio can be approximated if a sampling microphone is used to produce a control signal for the amplifier in the public address system, whereby the sound power output is increased in proportion to the increase in the local interfering noise. A fundamental difficulty lies in the fact that the sampling microphone picks up both sound and desired signal, and some differentiating means is required. Many schemes have been proposed in the prior art with varying success.

In the present invention this problem does not exist over the range of sound signal required, and therefore this invention is simple and more effective. The principal application for this new method is in noisy environments where the operator is using earphones such as in jet airplane ground crews, etc., where a desired signal or sound is transmitted to the listener through the earphones which are themselves shielded from the ambient noises by means as described in prior pending applications, e.g., S.N. 597,161, filed July 11, 1956 and 603,111 filed August 9, 1956, now Patent Numbers 2,899,683 and 2,981,958 respectively.

The principal object of the present invention resides in the provision of devices such as ear protectors, including earphones, which are adapted to protect the ears of the user from a high noise level which is not desired to impinge upon the ears of the user, and including a sampling device and an electronic control for the loudness of the signal impressed upon the earphones. The sampling device samples the ambient local surrounding atmosphere for increase and decrease in unwanted sounds, and the electronic system is controlled by the sampling device to increase and decrease substantially proportionately the ear phone signal in the ear protector, whereby the user automatically hears wanted signals from a distance at approximately the same sound level regardless of the increase and decrease in the unwanted loudness of the sound level surrounding the user and the earphones which he is using.

Other objects and advantages of the invention will appear hereinafter.

Reference is to be had to the accompanying drawings, in which

FIG. 1 is a view illustrating the present device;

FIG. 2 is a diagrammatic view showing the system; and

FIG. 3 is an electronic diagram showing the details of the system.

In carrying out the present invention, there is provided a set of ear protectors **10** which may be such as are described in copending application Serial No. 495,394, filed March 21, 1955, now Patent No. 2,946,862. These ear protectors are provided with phones **12, 12.** These phones and ear protectors are not a part of the present invention except as part of the combination, and it is believed that they do not need to be further described. However, these earphones are connected into the sampling and control device which is indicated in this case as being in a housing **14** and may be mounted on the headband **16, 16.** The sampling device is provided with a sampling microphone and it is to be understood that the wanted signal feeds into the ear protector by well known means, and thence feeds to the earphones, so that the user receives all his

information from a remote point while his ears are at the same time effectively protected against the deleterious effects of high sound energy existing locally in the atmosphere surrounding the user. In this way the operator is apprised of information he needs in spite of the high level of noise surrounding him.

Referring now to FIG. 2, it will be seen that the speech input or desired signal is impressed upon amplifier A which then is transferred to the variable gain amplifier B and thence to the speech output at C which is of course the earphones **12.** Without the present invention, the loudness of the speech output at C (or earphones **12, 12**) depends only on the origin of the signal, and the signal level to the user therefore depends solely on the ambient noise level. Total signal-to-ambient-noise ratio tends to rise and fall, making for less intelligible speech, in the absence of means for causing the loudness of the speech output to rise and fall with the rise and fall of the ambient noise.

The sampling microphone is shown as at D in the diagram of FIG. 2, and also in FIG. 1. This microphone is in constant communication with amplifier E and this microphone signal is then transferred to the rectifier F which then controls the variable gain amplifier B to increase or decrease the level of loudness and speech output at C, depending upon the signal received by the sampling microphone at C.

A circuit for carrying out this effect is shown in FIG. 3 wherein the connections are as indicated and the various elements are as follows:

C_1=input coupling (D—C blocking)
C_2=De-coupling
C_3=Emitter by-pass
C_4=Coupling (D—C blocking)
C_5=Emitter by-pass
C_6=Emitter by-pass
C_7=Coupling (D—C blocking)
C_8=Filtering and noise leakage reduction. Also affects time constant of control circuit
C_9=Filtering and decoupling
C_{10}=Decoupling
R_1 and R_2=Bias of TR_1 base
R_3=Emitter bias
R_4=Decoupling
R_5 and R_6=Base bias
R_7=Emitter bias
R_8 and R_9=Base bias
R_{10}=Emitter bias
R_{11}=Collector load
R_{12}=Time constant and base return
R_{13}=Decoupling
R_{14}=Voltage level set with no noise pickup
D_1 and D_2=Rectifiers of amplified noise signal
T_1 and T_2=Coupling transformers
TR_1 and TR_2=Audio voltage amplifiers
TR_3=Noise signal amplifier
TR_4=Control device

It is believed from the foregoing that the use and operation of this invention will be apparent. The device provides an automatic amplifier for desired signal which is to be impressed on a protected ear-phone from a remote point, whenever the noise level increases in the surrounding atmosphere as respects the user of the device. Therefore regardless of the ambient noise level, the desired signal through the ear-phones comes in on a level which is intelligible to the operator at all times. The strength of the signal at the ear-phones can be varied by varying the values of portions of the circuit but in general the variation of increase of signal at the phones will be more or less proportional to the increase in ambient noise

level although this proportion may be varied to suit special conditions.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claim, but what I claim is:

Audio communication apparatus with volume control operated by ambient noise; comprising in combination an ear protector shell adapted to be applied to the head of a user against the user's ear, support means for retaining said shell in position on the user's head, said shell having relatively high attenuation of exterior sound waves and ambient noise, a transducer mounted in said shell for communicating wanted sound to the user's ear as the function of an electrical signal applied to the transducer, means for picking up wanted sound and transforming the same into an electrical signal, a variable gain amplifier connected to said wanted sound pick up means and to said transducer for applying to the latter a signal of a variable gain, a sampling microphone mounted on said support means for picking up unwanted ambient noise, second amplifying means connected to said microphone, and rectifying means connected to said second amplifying means and to said variable gain amplifier for applying a rectified electrical signal to the latter to increase the gain of the signal applied to said transducer in response to an increase in volume of ambient noise sampled by said microphone, and conversely to decrease the gain of the signal in response to a decrease in volume of ambient noise.

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