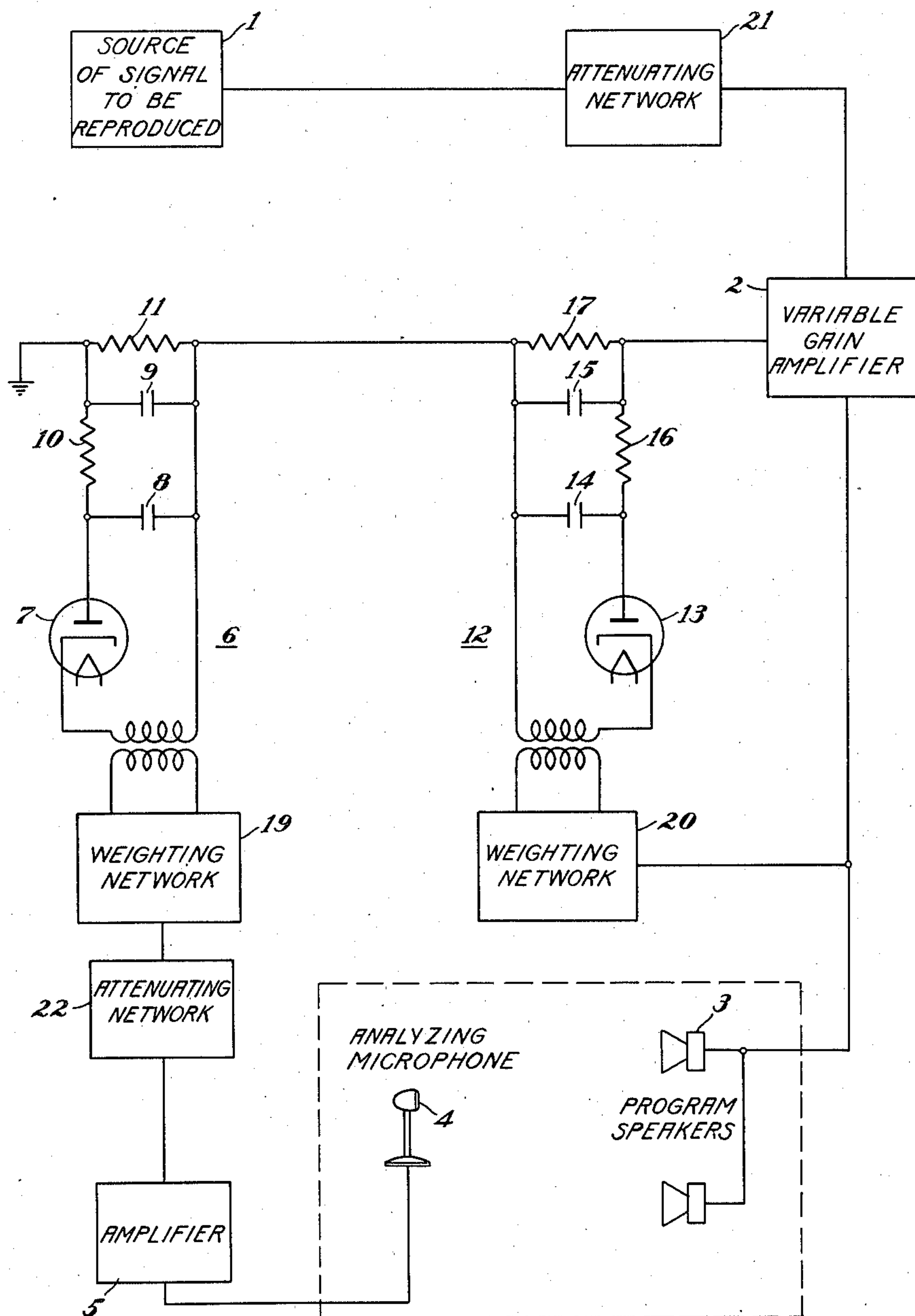


Feb. 22, 1949.

F. A. MORRIS
SOUND SYSTEM WHICH COMPENSATES
FOR VARIABLE NOISE LEVELS
Filed June 13, 1947

2,462,532



INVENTOR.
FRANK A. MORRIS

BY *J. L. Bowes*
ATTORNEY

UNITED STATES PATENT OFFICE

2,462,532

SOUND SYSTEM WHICH COMPENSATES FOR
VARIABLE NOISE LEVELSFrank A. Morris, Rochester, N. Y., assignor to
Stromberg-Carlson Company, a corporation of
New York

Application June 13, 1947, Serial No. 754,473

7 Claims. (Cl. 179—1)

1

This invention relates to sound reproducing systems and more particularly to sound systems, such as public address or paging systems, for example, adapted for use in areas having variable noise levels as in factories, dining rooms, theaters, schools, and the like.

Sound reproducing systems of the type indicated above may be provided with volume control means. Manual controls have been used to enable an operator to adjust the output level to take account of changes in the noise level which may take place because of variations in the size of an audience in a theater or the number of persons using a dining room or restaurant, for example. However, it is disadvantageous to require the services of an operator merely for the control of the volume of sound reproduction. Moreover, where the sound reproducing devices, such as loud-speakers, are located in different remote positions, such as in various parts of a factory, a single manual control is not adequate.

Sound reproducing systems have been proposed, wherein the noise level in the speaker area automatically controls the volume of reproduced sound in response to changes in the ambient noise level to provide a signal which is loud enough to be heard, but not objectionably loud when the noise level is low. Heretofore, such proposals have been expensive and in many cases, increases in reproduced sound serve to energize the noise pickup means so that the increase in volume of sound reproduced changes at a greater rate than desired.

It is an object of my invention to provide a new and improved system for accurately controlling the volume of reproduced sound in accordance with the noise level within the listening area.

Another object of my invention is to provide a new and improved sound reproducing system having volume control means arranged such that changes in the volume of reproduced sound depend only upon changes in the noise level and are not affected by changes in the volume of desired sound.

In carrying out the objects of my invention, there is provided a suitable source of sound signal to be reproduced, a variable gain amplifier and at least one sound reproducer or loud-speaker, suitable noise responsive means such as a microphone and means for comparing the signal and noise levels, the resultant being utilized to control the gain of the variable gain amplifiers. In the preferred embodiment of my invention, the output from an analyzing microphone, located in the listening area, and the output of the ampli-

2

fier, are both rectified. The rectified voltages are delayed, as by integration, and then combined in opposition, the resulting voltage being utilized to bias the amplifier.

The details of my invention and refinements, thereof, as well as further objects and advantages will be apparent from a reading of the following specifications and claims in connection with the accompanying drawing which illustrates one embodiment of the principles of my invention.

Referring to the drawing, there is indicated a source of signal to be reproduced, represented by the numeral 1. This source may be a microphone including a suitable speech amplifier, if necessary, a record player or magnetic sound reproducer, the audio system of a radio receiver, a wired sound service, or other suitable source. A suitable variable gain amplifier 2 is employed to amplify the output of the source 1 after attenuation in a suitable attenuation network 21, if such is employed, the amplifier being variable with respect to gain in order to permit adjustment of the sound output. The variable gain amplifier may comprise a plurality of amplifiers, one of which is provided with variable gain. Such an amplifier may employ variable mu tubes, such as Type 6L7, which increases in mu with decreasing negative bias applied thereto.

The output of amplifier 2 is suitably connected to at least one sound reproducing device or loud-speaker 3. The number and disposition of speakers depends upon known factors such as the size of the listening area, the noise level to be expected, etc. The listening area may comprise a single room or space or a plurality of spaces or rooms which may be adjacent or remote from each other in the same building or in separate buildings.

In each area in which it is desired to maintain a predetermined sound level above ambient noise, there is located noise responsive means such as an analyzing microphone or noise pickup means 4, the placement of which is not critical.

In order to obtain a suitable control voltage for regulating the gain of amplifier 2, the output of the pickup microphone 4 may be amplified by suitable amplifying means 5. The output of the amplifier 5 is utilized to develop a first control quantity such as a direct current voltage representative of the combined noise and reproduced sound levels, as, for example, circuit means represented by the numeral 6 including suitable rectifying means such as the diode rectifier 7.

In order to prevent rapid variations in the volume of reproduced sound, which might otherwise take place because of the presence of tran-

3

sient noises such as breaking dishes, laughter, etc., and also to eliminate the effect of phase differences between the voltages representing direct and picked up sound, the output of the rectifier 7 is impressed upon a suitable filter and integrating means including condensers 8 and 9 and resistance 10, the values of resistance and capacity being chosen so that integration is carried out over a sufficiently long period of time to avoid the above mentioned undesirable effects, as several seconds, for example. There is provided an output resistor 11 across the output condenser 9, one end of the resistor being grounded and the other being suitably connected to the variable gain amplifier as explained hereinafter.

Inasmuch as pickup means 4 is responsive to both noise and desired sound, means is provided to enable the system to distinguish between sound components and noise components and thereby prevent forcing the system to maximum gain under its own excitation.

In the preferred embodiment of my invention, there is provided means for establishing a second control quantity such as a direct current voltage representative only of the sound to be reproduced, such as circuit means 12, associated with the output of amplifier 2 in such a way that a portion of the output of variable gain amplifier 2 may be rectified as by means of diode rectifier device 13 and passed through filter and integrating means comprising capacitors 14 and 15 and resistance 16. The output of the integrating means is impressed across a suitable resistance 17, resistance 17 being connected in series with resistance 11 between a reference potential as ground, for example, and amplifier 2. The resistances 11 and 17 are so connected in the series circuit that the control quantities may be compared and utilized to control the volume of sound. In the illustrated form of my invention the difference between the voltages is applied as bias to the variable gain amplifier 2. In the arrangement shown in the drawing, the two bias sources are connected in such a way as to oppose and the resultant voltage is fed to the amplifier 2. If there is no excitation noise in the listening area, the resultant bias is zero because the outputs of bias circuits 6 and 12 are equal and opposite, but if there is noise, there is a resulting bias in bias circuit 13, and the control quantities due to desired sound cancel, leaving only the noise component in circuit 6 representing the noise level in the listening area. Hence, the system cannot build up to a level beyond that necessary to provide the desired degree of audibility of desired signal over noise because changes in the noise level but not changes in the desired sound volume cause variation of bias.

It is important that the characteristics of bias circuits 6 and 12 be as nearly the same as possible.

It is known that high frequency noise components affect audibility to a greater extent than low frequency noise components. In order to weight the response of the system so that the masking effects of various frequencies may be taken into account, suitable well-known non-linear weighting networks 19 and 20 may be interposed between amplifiers 5 and 2 and bias circuits 6 and 12, respectively. Inasmuch as it is necessary that the response of the two bias systems be substantially the same, a weighting network must be used in both circuits or not at all.

In order to adjust the actual levels of the desired sound and the output of pickup means 4,

4

there may be provided suitable attenuating networks as indicated by the numerals 21 and 22, the former being useful to increase the absolute level and the other being utilized to adjust the signal-to-noise ratio. Whether a program is maintained at a constant signal-to-noise ratio or changes disproportionately with variations in ambient noise is a function of the gain-bias characteristics of the variable gain amplifier which can be made to have any desired characteristic.

If only one listening area is provided, a single system variable gain amplifier is sufficient, but if the reproducing means 3 are located in separated areas, it may be desirable to provide a separate variable gain amplifier for each device 3 or group of devices and a corresponding number of control units.

While I have illustrated and described what I now consider to be the preferred embodiment of the principles of my invention, other embodiments and modifications may be made. For example, the comparison or bias circuits 6 and 12 may be differently arranged and different control quantities representing desired sound and combined noise and desired sound may be developed for control purposes, as thermistors, for example. It is intended that the following claims will cover all such modifications as fall within the scope and intent of this invention.

What I claim as new and desire to secure by United States Letters Patent is:

1. In a sound reproducing system of the type comprising a source of sound to be reproduced, at least one sound reproducing means, and means arranged for automatically controlling the volume of reproduced sound, the last mentioned means comprising means for developing a first control quantity representative of the combined noise and reproduced sound level in the vicinity of said reproducing means, means for establishing a second control quantity representative only of the sound to be reproduced, and means for combining said quantities for control purposes, said last mentioned means comprising resistance means connected between a source of reference potential and said volume control means, said first quantity being impressed across one portion of said resistance means and said second quantity being impressed across another portion of said resistance means.

2. In a sound reproducing system of the type comprising a source of sound to be reproduced, at least one sound reproducing means, and means for automatically controlling the volume of reproduced sound, the combination of means for providing a voltage representing the total noise level in the vicinity of said sound reproducing means, means for providing a voltage representing the sound to be reproduced, means for integrating both voltages over a period sufficiently long to render the system substantially unaffected by noise transients or phase differences between the voltages representing the noise level and the signal and means for combining the integrated voltages for control purposes.

3. A sound system as defined in claim 1 having attenuating means for permitting adjustment of the amplitude of the first-mentioned voltage.

4. A sound system as defined in claim 1 having attenuating means for permitting adjustment of the amplitude of the second-mentioned voltage.

5. In a sound reproducing system as defined in claim 1, frequency responsive means associated

5

with each voltage establishing means for weighting the frequency response of each establishing means, each of said frequency responsive means having substantially the same frequency characteristics.

6. In a sound reproducing system of the type comprising a source of sound to be reproduced, at least one sound reproducing means, and an amplifier, the combination of means for providing a direct current voltage representing the total noise level in the vicinity of said sound reproducing means, means for providing a direct current voltage representing the sound to be reproduced, means for filtering both voltages, means for integrating both voltages over a period sufficiently long to render the system substantially unaffected by noise transients, voltage divider means connected between said variable gain amplifier and a source of reference potential, one of said integrated direct current voltages being connected across one portion of said divider means and the other integrated direct current voltage being applied across another portion of said divider means, said voltages being applied in opposition, and means utilizing the difference between the integrated voltages for controlling the output of said amplifier.

7. In a sound reproducing system of a type comprising a source of sound to be reproduced, at least one sound reproducing means, a variable amplifier for controlling the volume of sound reproduced, and means arranged for automatically controlling the gain of said amplifier, said last-mentioned means comprising means for de-

6

5 riving a voltage representative of the sound to be reproduced, means for rectifying said derived voltage, filtering and integrating means comprising a resistance in series with said rectifier and a capacitor shunting said rectifying means on each side of said resistance, an additional resistance shunting the capacitor most remote from said rectifier, means for deriving a voltage representative of the combined noise and program levels, means for rectifying the last mentioned voltage, filtering and integrating means associated with said second rectifier comprising a resistance in series with said second rectifier and a capacitor shunting said second rectifier on each side of said last mentioned resistance, a second shunting resistance connected across the capacitor most remote from said second rectifying means, and means connecting said shunt resistances in such a manner that the difference between the voltages applied across said shunting resistances is utilized to control the gain of said variable gain amplifier.

FRANK A. MORRIS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

30	Number	Name	Date
	1,356,403	Pridham	Oct. 19, 1920
	2,338,551	Stanke	Jan. 4, 1944
	2,382,848	Baumgartner	Aug. 14, 1945
35	2,392,218	Anderson	Jan. 1, 1946