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3,296,373

AUTOMATIC SOUND VOLUME CONTROLLER

Filed April 19, 1963

2 Sheets-Sheet 1

Fig. 1

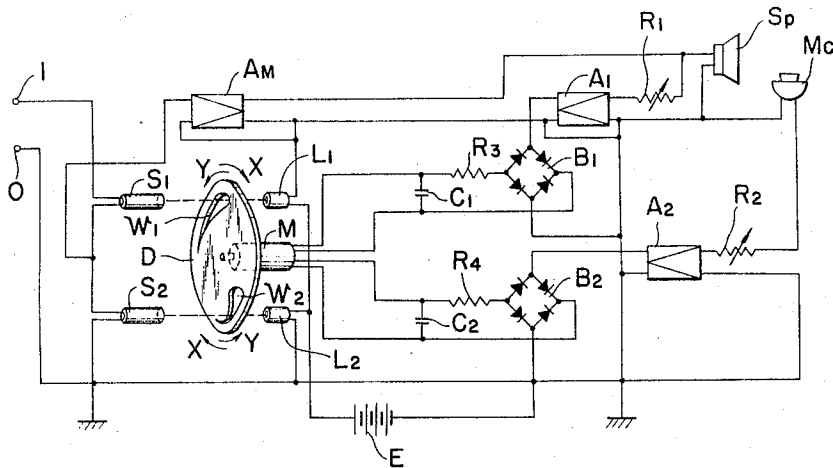


Fig. 2

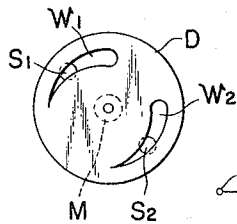
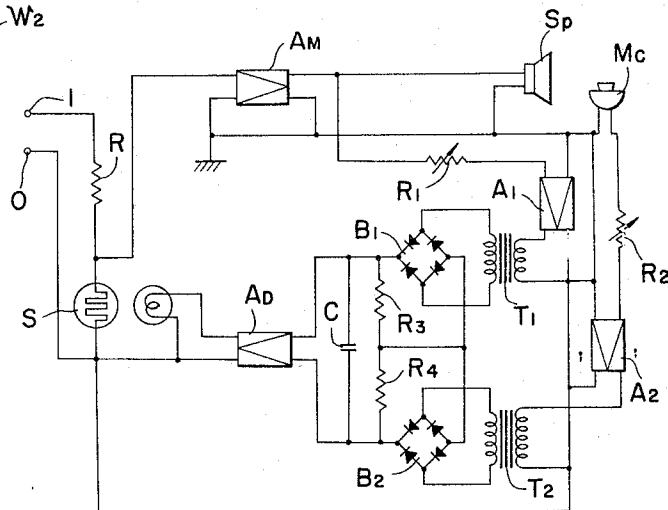


Fig. 3



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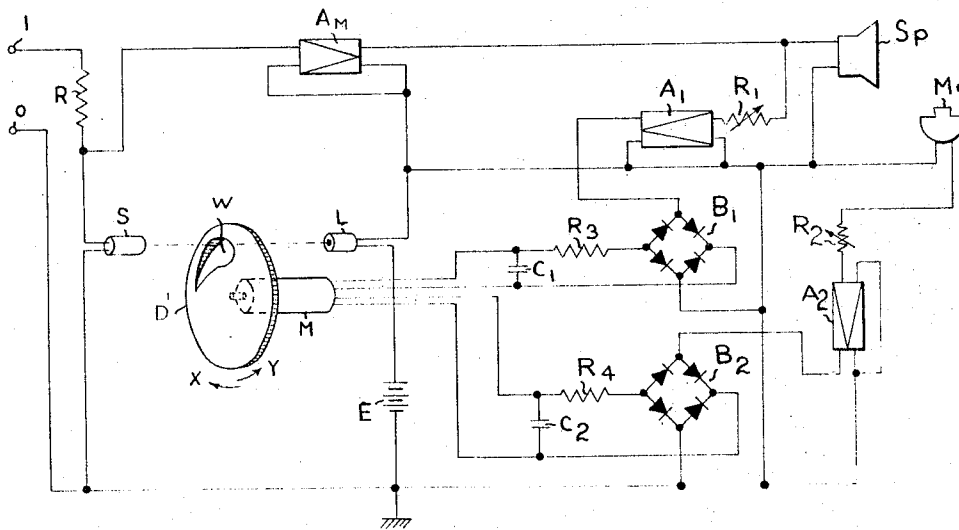
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Fig. 4



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AUTOMATIC SOUND VOLUME CONTROLLER
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37/17,797, 37/17,799

2 Claims. (Cl. 179—1)

This invention relates to an automatic sound volume controller having a mechanism for always keeping the ratio of the level of the strength of such signal as a music coming out of a loud speaker to the level of the noise in the background of an operating chamber constant.

In this kind of automatic sound volume controller, there has been known a method wherein the background noise is collected by a microphone and is amplified and the input to a loud speaker is controlled by this signal. However, in such method, there are defects that such signal as a music from the speaker will be also simultaneously collected, the level of such signal as a music will rise with the rise of the noise level and thus, when a sound is issued from a speaker, its signal will be further collected by the microphone, a positive feedback loop of the microphone→amplifier→speaker→microphone will be formed and oscillated and the sound issuing level of the speaker will rise to the maximum sound volume. Therefore, it has been difficult to practice such method. In order to eliminate such defects, there has been adopted a method wherein the quality difference between such signal as a music coming out of a speaker and the background noise of the operating chamber is detected, only the noise signal is taken out and the input to the speaker is controlled by said signal. However, according to such method, there are defects that the operation will be influenced by the wave form, phase and frequency difference between such signal as a music and the noise signal and that no expected effect cannot be attained.

A principal object of the present invention is to provide an automatic sound volume controller wherein, independently of the wave form or phase difference between such signal as a music coming out of a loud speaker and a background noise signal, only the volume corresponding to the noise volume is taken out and the input to the speaker is controlled so that a sound level automatically at a constant ratio to the noise volume may be always obtained.

Another object of the present invention is to provide an automatic sound volume controller wherein a controlled signal is applied to a voltage divider formed of such photoconductor as a cadmium sulfide element and is thereby controlled so that no distortion may be given to the controlled signal.

The present invention shall now be described with reference to the drawings in which:

FIGURE 1 shows an embodiment of the automatic sound volume controller of the present invention;

FIGURE 2 shows a controlling disk to be used in the automatic sound volume controller in FIGURE 1;

FIGURE 3 shows another embodiment of the present invention; and

FIGURE 4 shows a simplified variation of the controller illustrated in FIG. 1.

In the several figures, identical parts bear identical reference numerals.

In FIGURE 1, 0 and 1 are input terminals, S_1 and S_2 are photoconductors such as cadmium sulfide elements and D is a controlling disk provided with windows W_1 and W_2 for controlling the amounts of light to the respec-

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tive photoconductors and rotated as connected with a dual coil meter M. L_1 and L_2 are light source lamps for feeding light to the photoconductors. A_M is a main amplifier. A_1 and A_2 are amplifiers. S_p is a loud speaker. Mc is a microphone. R_1 and R_2 are variable resistances. R_3 and R_4 are resistances. B_1 and B_2 are full-wave rectifiers. C_1 and C_2 are condensers. E is an electric source. In the formation, the photoconductors S_1 and S_2 are connected with each other in series and are connected to the input terminals 0 and 1. The voltage from the photoconductor S_2 is applied to the main amplifier A_M . The output from said amplifier A_M is applied to the speaker S_p . A part of the output from the main amplifier A_M is applied to the full-wave rectifier B_1 through the variable resistance R_1 and amplifier A_1 . The output from said full-wave rectifier is applied to the condenser C_1 through the resistance R_3 . On the other hand, such signal as a music coming out of the loud speaker S_p in a fixed position is picked up together with the background noise by the microphone Mc in a fixed position and is applied to the full-wave rectifier B_2 through the variable resistance R_2 and amplifier A_2 . The output from said full-wave rectifier is applied to the condenser C_2 through the resistance R_4 . The outputs from the condensers C_1 and C_2 are applied to the dual coil meter M which is so formed as to be rotated in the direction indicated by the arrow X by the output from the condenser C_1 and in the direction indicated by the arrow Y by the output from the condenser C_2 , that is, to act to rotate clockwise or anticlockwise depending on the difference between the inputs. The disk D is connected to said dual coil meter so as to rotate clockwise or anticlockwise depending on the rotation of the dual coil meter. The lamps L_1 and L_2 are lighted by an electric current fed from the electric source of a constant voltage. As illustrated, the disk D is provided with the windows W_1 and W_2 whose widths vary with the rotation. The lights of the lamps L_1 and L_2 are projected on the photoconductors S_1 and S_2 of cadmium sulfide elements, respectively, through the respective windows. Said cadmium sulfide element has characteristics that the resistance varies with the amount of light. Thus the resistance value varies in inverse proportion to the amount of the incident light. That is to say, the larger the amount of the incident light, the lower the resistance. On the contrary, the smaller the amount of the incident light, the higher the resistance.

The operation of the apparatus of the present invention shall now be explained. When, in the minimum noise state of a room, a signal of a standard input level is given to the terminals 0 and 1 and an optimum ratio of the background signal to the noise is obtained with the relative positions of the windows of the disk D and the photoconductors S_1 and S_2 of cadmium sulfide as shown in FIGURE 2 by adjusting the variable resistances R_1 and R_2 , the condenser C_1 in FIGURE 1 will have been charged with a voltage corresponding to the signal level and the condenser C_2 will have been charged with a minimum voltage corresponding to the level of the sum of the signal sound from the speaker S_p and the minimum noise in the room, therefore the disk D will be stationary as displaced somewhat in the direction indicated by the arrow Y from its position at the time when the room noise is zero, then the two inputs of the dual coil meter will be equal to each other and the difference between them will be zero. In case the input level applied to the input terminals 0 and 1 in a fixed state rises, the output from the main amplifier A_M will increase in response to the increased part of the input level and the sound volume from the speaker will tend to become larger. Further, a part of the output of the main ampli-

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fier A_M will be rectified by the full-wave rectifier B_1 through the resistance R_1 and amplifier A_1 and will be applied to the condenser C_1 . Therefore, the output from this condenser C_1 as increased by the increased part of the signal level to be more than before the signal level rises will be applied to the dual coil meter, said dual coil meter will rotate in the direction indicated by the arrow X and thus the disk D will also rotate. As a result, the amount of light to the photoconductor S_1 will decrease, the resistance value will increase, the amount of light to the photoconductor S_2 will increase, its resistance will decrease and the input applied to the main amplifier A_M will decrease. As a result, the output applied to the dual coil meter M from the condenser C_1 will also decrease and, in the position where the difference between the two inputs entering the dual coil meter is zero, the meter will be balanced and stop. The signal level applied to the condenser C_1 in such case is the same as the input level applied to the condenser C_2 . That is to say, so long as the sound from the speaker does not vary and the noise level does not vary, even if the input varies, a fixed level will be always kept.

On the contrary, in case the noise is in a fixed state and the input level applied to the input terminals 0 and 1 falls, the same as in the above, the disk will rotate in the reverse direction, the two inputs of the dual coil meter will be balanced with each other and a fixed output will be obtained from the speaker S_p . That is to say, in such cases, a kind of dynamic negative feedback will be applied between the main amplifier A_M and the input terminals 0 and 1 and there will be carried out an operation of obtaining a fixed output by controlling the feedback by varying the feedback ratio with the variation of the input level of the speaker in this loop.

Now, in case the input level does not vary but only the noise increases, the input to the microphone Mc will increase in response to the increased noise part and will be applied to the second amplifier A_2 through the variable resistance R_2 , the output from the amplifier A_2 will be applied to the full-wave rectifier B_2 , the output from this full-wave rectifier B_2 will be applied to the condenser C_2 through the resistance R_4 and the output from the condenser C_2 will be applied to one of the coils of the dual coil meter. As the input to the upper coil of said dual coil meter M does not vary but the input to the lower coil increases, the dual coil meter M will rotate, the disk D will be rotated in the direction indicated by the arrow Y, the amount of light incident upon the photoconductor S_1 will increase and the amount of light incident upon the photoconductor S_2 will decrease. As a result, the input to the main amplifier A_M will increase, the terminal voltage of the condenser C_1 will rise and the disk D will stop in the position where the increased input part of the upper coil and the increased part by the increase of the noise volume of the lower coil of the dual coil meter are balanced with each other. Thus, the output of the speaker S_p will increase by the part proportional to the increase of the noise volume and a fixed signal-noise ratio will be obtained.

On the contrary, in case the input level does not vary but only the noise decrease, the disk D will rotate reversely to the above, the output from the main amplifier A_M will decrease and a fixed ratio of the signal to the noise will be obtained. That is to say, in case only the noise varies in a fixed input state, the gain of the negative feedback loop will be controlled by the noise voltage, the feedback ratio will be controlled by the variation of the input level to the speaker S_p and, as a result, the operation of keeping a fixed signal-noise ratio will be made by controlling the negative feedback gain.

In the circuit in FIGURE 1, two photoconductors are connected in series to the input terminals so that, when the amount of light incident upon one photoconductor increases and the resistance value of the photoconductor decreases, reversely the amount of light incident upon

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the other photoconductor may decrease and its resistance value may increase. This is to make the impedance of the input terminal as seen from the signal source constant irrespective of the variation of the resistance value of the photoconductor and to take the control range large by making the rate of the variation of the resistance value large. Therefore, in the case that the impedance of the input terminal as seen from the signal source may vary and the control range may be somewhat narrowed, if the photoconductor S_1 connected to the plus (+) side of the input terminal and to one end of the other photoconductor S_2 is replaced with a fixed resistance, R, of a proper value, the photoconductor S_1 , the window W_1 of the disk and the lamp L_1 will be able to be omitted, as illustrated in FIG. 4. In such case, the resistance value of the photoconductor S_2 connected to one end of the fixed resistance and to the ground side of the input terminal will vary with the amount of light, the principle will not be different from that in FIGURE 1 at all and the operation will be also the same as in FIGURE 1.

FIGURE 3 shows another embodiment of the apparatus of the present invention. 0 and 1 are input terminals. R is a resistance. R_1 and R_2 are variable resistances. R_3 and R_4 are output resistances. S is a photoconductor such as of cadmium sulfide. A_M is a main amplifier. A_1 and A_2 are amplifiers. A_D is a direct current amplifier. S_p is a loud speaker. Mc is a microphone. T_1 and T_2 are combined transformers. C is a condenser. L is a lamp.

The resistance R and photoconductor S are connected with each other in series and are connected to the input terminals 0 and 1. The voltage produced at both ends of the photoconductor S is led to the main amplifier A_M . The output from said main amplifier A_M is applied to the speaker S_p and a part of the output is fed to the output resistance R_3 from the full-wave rectifier B_1 through the variable resistance R_1 , amplifier A_1 and combined transformer T_1 . The signal coming out of the speaker S_p is picked up together with the background noise by the microphone Mc in a fixed position and is applied to the full-wave rectifier B_2 through the variable resistance R_2 , amplifier A_2 and combined transformer T_2 . The output from the full-wave rectifier is fed to the output resistance R_4 . The output resistances R_3 and R_4 are connected with each other in series. The difference between their direct current voltages is taken out. The condenser C is charged with the thus obtained voltage difference. The output voltage of the condenser C is amplified by the direct current amplifier A_D . Its output is fed to the lamp L. The light of the lamp L irradiates the photoconductor S. The resistance of the photoconductor S varies in inverse proportion to the amount of light of the lamp.

The operation of the apparatus shown in FIGURE 3 shall now be described. When the speaker S_p and microphone Mc are set in proper fixed positions in an operating chamber, if an optimum signal-noise ratio is obtained by adjusting the variable resistances R_1 and R_2 in a fixed noise state, then as evident from the circuit diagram, the lamp L will be lighted by the voltage proportional to the difference between the full-wave rectifying output voltage proportional to the signal voltage and the full-wave rectifying output voltage proportional to the (noise+signal sound) voltage and the resistance variation part corresponding to the amount of the irradiating light of the lamp L will be given to the photoconductor S.

Now, when the noise state is fixed, if the input level varies and a larger input signal is applied to the terminals 0 and 1, the output of the main amplifier A_M will increase in response to this increased part, the signal entering the variable resistance R_1 will also increase and therefore the terminal voltage of the output resistance R_3 will rise. If the time constant of the circuit is properly selected, the output of the amplifier A_D will be varied by the variation of the terminal voltage of the output

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resistance R_3 , the amount of light of the lamp L will be increased, the resistance of the photoconductor S will be decreased and the input applied to the main amplifier A_M will be decreased by the increased part of the input applied to the terminals 0 and 1. After all the resultant input to the main amplifier will become constant and the sound from the speaker S_p will be kept at a fixed strength.

When the input level applied to the input terminals 0 and 1 is constant and the noise level varies, if a voltage corresponding to the sum of the signal from the speaker S_p and the noise is induced by the microphone Mc and is applied to the amplifier A_2 and the noise increases, the terminal voltage of the output resistance R_4 will increase with it. As a result, the input to the main amplifier A_M will increase, the output from the speaker will increase and the signal-noise ratio will be kept constant. On the contrary, when the noise decreases, in the same manner, a fixed signal-noise ratio will be kept. In such case, the operating theory is the same as in the above mentioned embodiment.

According to the embodiment illustrated in FIG. 4, the fixed resistance R and photoconductor S are connected in series to the input terminals 1 and 0. One end of said fixed resistance is connected to the plus (+) side of the input terminals. One end of photoconductor S is connected to the ground side. Controlling disk D' is provided with a single window W of a shape generally similar to the shapes of windows W_1 and W_2 . To one of the two condensers C_1 and C_2 there is applied the output obtained by full-wave-rectifying a signal obtained from any point in the line leading from the connecting point of the fixed resistance R and photoconductor S to a loud speaker S_p , whilst to a second one of said two condensers there is applied the output obtained by full-wave-rectifying a signal from microphone Mc collecting background sound, as already described in connection with FIG. 1. The outputs from condensers C_1 and C_2 are fed to the respective coils of dual coil meter M . The output of the loud speaker S_p is controlled in response to variation of the noise by varying the resistance value of the photoconductor with variation in the amount of light by the rotation of disk D_1 , so the noise-signal may be maintained constant.

As the apparatus of the present invention is formed as described above, it has effects

(1) That, as the signal applied to the speaker and the background sound obtained from the microphone are full-wave-rectified and the input to the main amplifier is controlled by comparing these full-wave-rectified voltages, the signal-noise ratio can be always kept constant irrespective of the wave forms, phases and frequencies of the signal and the background sound and the relative positions of the speaker and microphone,

(2) That, as the terminal voltage of such photoconductor as a cadmium sulfide element is used for the input applied to the main amplifier, the resistance variation of said photoconductor will be stabilized and will act as

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a pure resistance and therefore no distortion will be given to the input applied to the main amplifier.

Further, if the present invention is used to amplify public addresses in an oratorical meeting hall, it will be possible to perfectly prevent howling by the speech microphone and loud speaker.

What is claimed is:

1. An automatic sound volume controller comprising two photoconductors connected in series to input terminals, a disk disposed in front of said photoconductors and having windows of any desired shapes so as to vary the amounts of light incident upon the photoconductors when rotated, a dual coil meter to rotate said disk, a condenser to which is applied an output obtained by full-wave-rectifying a signal obtained from any point in the line leading from the connecting point of said two photoconductors to a loud speaker and a condenser to which is applied an output obtained by full-wave-rectifying a signal from a microphone collecting the background sound, the outputs from said two condensers being fed to the respective coils of said dual coil meter and the output of the speaker being controlled in response to the variation of the noise by varying the resistance values of the photoconductors with the variation of the amount of light by the rotation of said disk so that the noise-signal ratio may be constant.

2. An automatic sound volume controller comprising a fixed resistance and a photoconductor connected in series to input terminals, one end of said fixed resistance being connected to the plus (+) side of the input terminals, one end of said photoconductor being connected to the ground side, a disk disposed in front of said photoconductor and having windows of any desired shapes so as to vary the amount of light incident upon the photoconductor when rotated, a dual coil meter to rotate said disk, a condenser to which is applied an output obtained by full-wave-rectifying a signal obtained from any point in the line leading from the connecting point of said fixed resistance and photoconductor to a loud speaker and a condenser to which is applied an output obtained by full-wave-rectifying a signal from a microphone collecting the background sound, the outputs from said two condensers being fed to the respective coils of said dual coil meter and the output of the speaker being controlled in response to the variation of the noise by varying the resistance value of the photoconductor with the variation of the amount of light by the rotation of said disk so that the noise-signal ratio may be constant.

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