

Nov. 9, 1937.

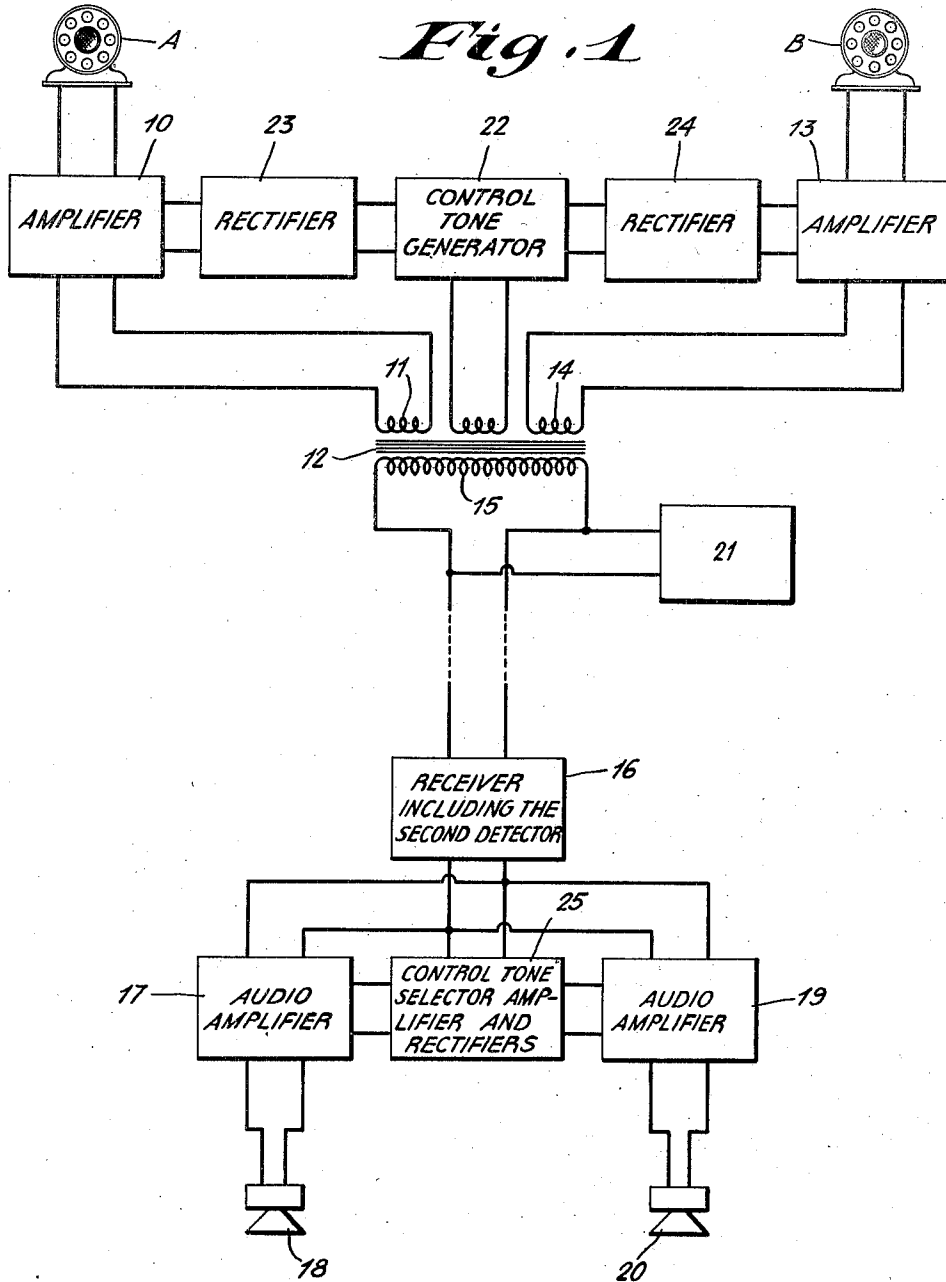
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SYSTEM FOR PRODUCING STEREOSONIC EFFECTS

Filed Feb. 9, 1934

3 Sheets-Sheet 1



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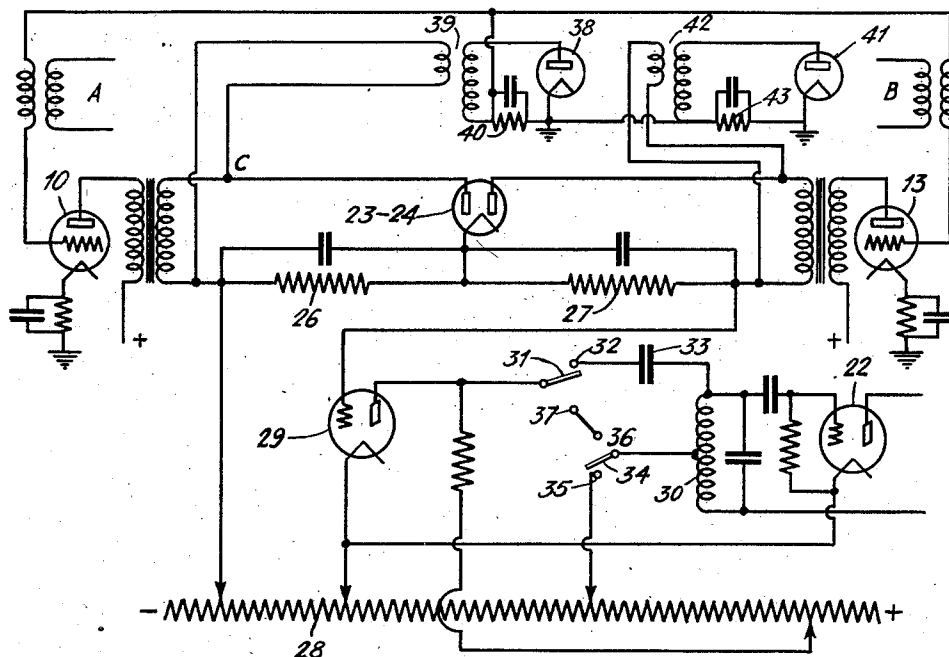


Fig. 2

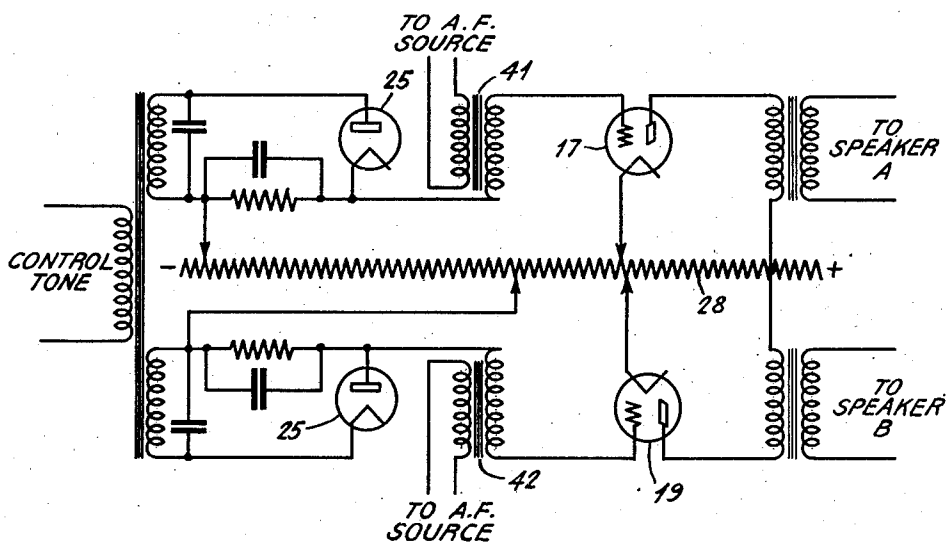


Fig. 3

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Fig. 4

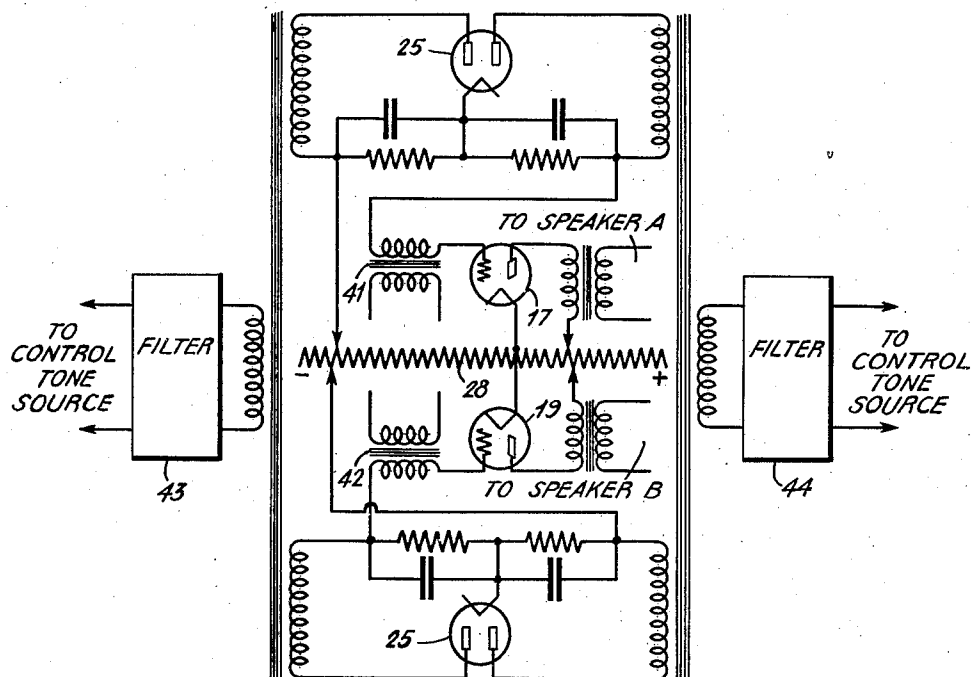


Fig. 5

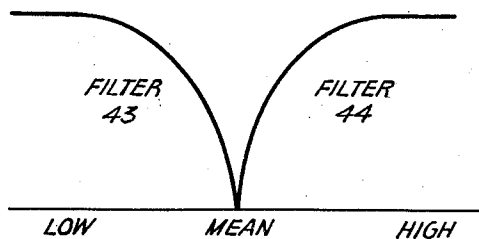
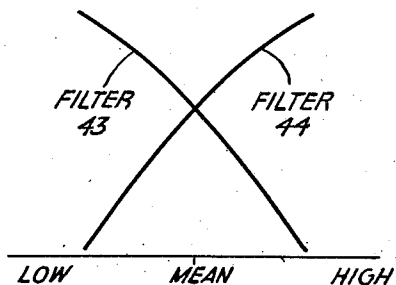


Fig. 6



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SYSTEM FOR PRODUCING STEREOSONIC EFFECTS

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13 Claims. (Cl. 179—1)

This invention relates to systems for producing binaural or stereosonic effects, and has for its principal object the provision of an improved apparatus and method of operation whereby such effects may be produced, transmitted and reproduced or recorded without the necessity of the complicated and expensive apparatus heretofore required for this purpose.

Another object is the provision of a stereosonic receiver adapted to be utilized in conjunction with a stereosonic transmitter to produce a binaural effect and also adapted to be utilized in conjunction with an ordinary transmitter to reproduce programs in the customary manner.

A further object is to provide a stereosonic transmitter suitable for operation in conjunction with the usual broadcast receiver.

An auxiliary object is the provision of a system operable to record sound in such a way that stereosonic or a binaural effect may be imparted to it upon its reproduction.

In accomplishing these various objects, the amplitude or frequency of a control tone is caused to vary in accordance with the relation between the outputs of different microphones or other sound pick-up devices, and this control tone is radiated or otherwise transmitted simultaneously with the program. At the receiver, the control tone is utilized to control the relation between the outputs of different loud speakers or different sound recorders so that these outputs vary in accordance with the intensity of the sound intercepted by the corresponding microphones.

The invention will be better understood from the following description when considered in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Referring to the drawings:

Fig. 1 illustrates a transmitting and receiving system arranged in accordance with the invention,

Fig. 2 illustrates details of the transmitter,

Fig. 3 illustrates details of a receiver adapted to function with amplitude modulation,

Fig. 4 illustrates details of a receiver adapted to function with frequency modulation, and

Figs. 5 and 6 are explanatory diagrams relating to the operation of the electrical filters utilized in the receiver of Fig. 4.

Fig. 1 of the drawings is a diagrammatic showing of a signal transmitting and receiving system which includes a pair of sound pick-up devices or microphones A and B. These devices may be located in a radio broadcasting studio, a sound recording studio or in any other loca-

tion where sound is to be picked up. They are preferably spaced from one another by several feet and may be of any suitable type.

The audio-frequency output of the sound pick-up device A is supplied through an amplifier 10 to a primary circuit 11 of a transformer 12. The output of the device B is likewise supplied through an amplifier 13 to a primary circuit 14 of the transformer 12. From the secondary circuit 15 of the transformer 12, the combined audio frequency outputs may be fed through the broadcasting stations modulator (not shown) to a radio broadcast receiver of any well known type such as a superheterodyne receiver 16. Any equivalent mixing circuit may, of course, be used instead of the transformer 12. The output of this receiver is supplied through an amplifier 17 to a loudspeaker 18 and through an amplifier 19 to loudspeaker 20. The outputs of the transformer 12 may be utilized also to operate a double sound track recorder 21, the radio frequency elements of the system being of course unnecessary in the case of sound studio recording.

In order to control the outputs of the audio amplifiers 17 and 19 selectively in accordance with the intensity of the sound picked up by the microphones A and B, a control tone generator 22 is provided with control circuits connected to the amplifiers 10 and 13 respectively through rectifiers 23 and 24.

Through the use of these two rectifiers, either the amplitude or frequency of the control current produced by the generator 22 is varied in accordance with the relation between the outputs of the microphones A and B. For example, if the output of microphone A is greater than that of the microphone B, the rectifier 23 may be arranged to cause an increase in the plate voltage and output of the generator 22. If the output of microphone B is greater than that of microphone A, the rectifier 24 may be arranged to decrease the plate potential and output of the generator 22. The generator 22 is of course operated at a frequency or within a frequency range which is inaudible.

The inaudible control current of the generator 22 is supplied through the transformer 15 to a control tone selector amplifier and associated rectifiers indicated at 25. It will be evident that in the case of radio broadcasting, the usual station modulators and the receiver 16 will also be included in this circuit. The selector amplifier includes selective circuits which transmit only the inaudible control current of the generator 22. The selector amplifier rectifiers are inter-

posed in the circuits leading to the amplifiers 17 and 19 respectively, and function to control the grid potentials and outputs of these amplifiers in accordance with the intensity of the sound picked up at microphones A and B. Thus, if the sound intensity at the amplifier A is relatively high, the grid potential of the amplifiers 17 and 18 are changed in a manner to make the output of the amplifier 17 relatively large and vice versa.

Instead of varying the amplitude or output of the generator 22 in accordance with the relation between the sound intensities at the microphones A and B, the rectifiers 23 and 24 may be arranged to vary the frequency of the control current. In this case, the frequency of the control current is made to have a certain normal value when the outputs of the microphones A and B are equal and to increase or decrease in response to change in the relation between the sound intensities at the different microphones. It will be apparent that variation of either the amplitude or frequency of the control current can be used directly to control the response of the loudspeakers, both of which variations are directly determinable in the receiving circuit and may, therefore, be used to directly control the loudspeakers.

If the outputs of the transformer 12 are recorded by the recorder 21, it will be evident that the loudspeakers through which these records are reproduced should be spaced in a relation similar to that of the microphones A and B.

Fig. 2 shows one arrangement for providing either amplitude or frequency modulation of the control tone generator in accordance with the relative intensity of the sounds impressed on the microphones A and B. As indicated by this diagram a double diode or rectifier 23—24 is so arranged that the audio output from each channel is applied to one of the diodes. A pair of resistors 26—27 in the output circuits of the two diodes are connected in series. One end of this resistor network is connected to the negative end of a resistor 28 representing the B supply system, the other end being connected to the control grid of a control tube 29. The cathode of the control tube 29 is connected to the B supply system at a point more positive than the point at which the diode output resistors are connected. It will be noted that a signal applied to the diode coupled to channel A due to the rectifying action of the diode will cause the control grid of tube 29 to become more positive with respect to its cathode. A signal applied to the diode coupled to the channel B will cause the control grid of tube 29 to become more negative. If like signals are applied to each diode the control grid bias of tube 29 will remain unchanged. The anode of tube 29 is connected to the B supply system through a resistor or reactor 30 connected in the circuit of the control tone generator 22.

If it is desired to cause the frequency of the control tone generator 22 to vary in accordance with the relative intensity of the signal derived from channels A and B the contact arm of a switch 31 is adjusted to close the circuit through terminal 32, thus connecting the anode of control tube 29 through a coupling condenser 33 to the grid side of the control tone circuit. Under this condition, the contact arm of switch 34 is connected to the terminal 35. With the switches in these positions, the plate cathode impedance of the control tube 29 is connected in series with the condenser 33 and is shunted across a portion of the control tone generator tuned circuit. As the plate impedance of tube 29 is varied the fre-

quency of the control tone generator varies accordingly.

If amplitude modulation of the control tone generator is desired, switch 34 is adjusted to make contact with terminal 36 and switch 31 is moved to terminal 37. With these connections, change in the grid bias potential of tube 29 will produce corresponding changes in the plate potential of the generator 22 and cause amplitude of the oscillations produced by this generator to vary.

It will be noted that the system illustrated in Fig. 2 is not independent of the amplitude of the signals applied to it through channels A and B. In other words, the signal having a very small amplitude applied to channel B when no signal is received from channel A would cause the same effect on the control tone generator 22 as if strong signals were applied to channels A and B differed by an amount equal to the small signal previously applied to channel B. In the first case, it is desired to have an effect on the control tone generator such as to cause the sound to be reproduced entirely by one loudspeaker, whereas in the second case both loudspeakers should reproduce sounds of approximately the same amplitude.

In order to correct this difficulty, it is desirable to provide channels A and B with automatic volume controls which are so interconnected that as the sensitivity of the amplifier in channel A is reduced the sensitivity of the amplifier in channel B is reduced to the same value or vice versa. In the arrangement of Fig. 2 this result is produced by means of diodes or rectifiers 38 and 41 connected respectively through transformers 39 and 42 to channels A and B. Connected in series with one another and with the secondary circuits of these transformers are resistors 40 which function to control the grid potentials of the audio amplifiers 10 and 13 connected respectively in the channels A and B.

This arrangement maintains the signal level applied to the double diode 23—24 approximately constant while still maintaining the proper relation between the signals received through channels A and B. The effect of this system with the volume control arrangement on the control tone generator will be independent of the amplitude of the sounds impressed on the microphones A and B, but the frequency or amplitude of the control tone generator will be caused to vary in accordance with the relative intensity of the sounds impressed on the two microphones.

Fig. 3 shows an arrangement which may be used in the receiver or reproducing system to cause variation in the amplitude of the control tone to vary the intensity of the sounds reproduced by the two speakers. Diodes 25 are coupled to the control tone source. The control grid bias of tubes 17 and 19 is controlled by the two diodes. Tubes 17 and 19 are amplifier tubes which are connected through transformers 41 and 42 or other suitable means to the source of the signal which it is desired to reproduce. The outputs of these amplifiers are fed to loudspeakers A and B respectively. It will, of course, be understood that additional stages of amplification may be interposed between these tubes and the loudspeakers in order that the audio frequency potentials applied to the grids of the tubes may be kept relatively low in order to avoid distortion as the control grid bias is varied. It will be apparent from the connections that when no control tone signal is received the amplifier 17

is provided with a relatively high negative bias whereas the amplifier 19 is provided with the normal bias for maximum gain. When a control tone signal is applied to the two diodes the control grid bias of amplifier 17 is caused to become less negative thereby increasing its gain, while the control grid bias of amplifier 19 is caused to become more negative thus reducing the gain in this tube. With a control tone signal of a certain amplitude the gain in the two amplifiers will be equal.

Fig. 4 shows an arrangement for controlling the relative output of the two loudspeakers when the frequency of the control tone is varied. The control tone is passed through filters 43 and 44 and applied to the double diodes 25. The control grid bias of the amplifier tubes 17 and 19 is controlled by these diodes. A signal applied to double diodes 25 through the filter 43 causes the control grid bias of the amplifier 17 to become less negative while at the same time causing the bias of amplifier 19 to become more negative. A signal applied to the double diodes 25 through filter 44 has the opposite effect insofar as the bias of amplifiers 17 and 19 is concerned. With no signal applied to the diodes 25 the normal bias of amplifiers 17 and 19 is more negative than that required to give maximum gain. As the frequency of the control tone is varied the bias of these tubes is varied above and below this normal value.

Filters 43 and 44 may have response characteristics such as those illustrated by Figs. 4 and 5. If they have the characteristics illustrated by Fig. 5, the effect of variation in the control tone amplitude will be minimized whereas if they have characteristics such as indicated by Fig. 4, it may be desirable to provide the control tone generator in the reproducing equipment with an automatic volume control to eliminate any variation in amplitude of the control tone. It is to be understood that the filter characteristic may be caused to have any desired curvatures or slope so as to compensate for any particular relation between change in bias of the amplifier tubes and gain. Similar results with regard to the arrangement shown in Fig. 3 may be obtained by use of a self-biasing resistor with one or both of the amplifier tubes 17 and 19 or by the use in the plate circuit of these tubes of some material having a non-linear voltage current relation such as thyrte.

It is to be noted that a program transmitted by the system herein described may be received by the ordinary receiver and vice versa. This is of advantage in that either the transmitting or receiver part of the system has general utility and its use is not restricted to special apparatus. It will be understood that a separate microphone may be used for picking up the program and the two spaced microphones A and B may then be used solely for varying the control tone frequency or amplitude. It is to be understood that the number of loudspeakers at the receiving location may be different from the number of microphones used to control the control tone generator and that other changes may be made without surrendering the advantages realized by the invention.

Having thus described my invention, I claim:

1. The combination of a plurality of sound pick-up devices, a plurality of sound reproducers, means for combining the outputs of said pick-up devices, means for transmitting the combined outputs of said pick-up devices to said

reproducers, a control current generator, means for varying the current produced by said generator in accordance with the relation between the sound intensities at said pick-up devices, and means actuated by said variable current for causing the sounds emitted at said reproducers to bear the same relation as the sound intensities at said pick-up devices.

2. The method of producing stereosonic effects which includes transmitting audio impulses to a plurality of circuits, picking up sound at different locations, converting said sound into corresponding electrical currents, adding an inaudible control current, varying the amplitude of said current in accordance with the amplitude of said sounds, transmitting said impulses and currents through a single channel, and distributing said impulses in said circuits in accordance with the amplitude of said control current.

3. The combination of a plurality of sound pick-up devices, means for combining the outputs of said pick-up devices, means for transmitting the combined outputs of said devices, a plurality of circuits arranged to be energized in response to the output of at least one of said devices, a control current generator, means for varying the current produced by said generator in accordance with the relation between the outputs of some of said devices, sound reproducers, and means responsive to said variable current for causing the sounds emitted at said sound reproducers to bear a relation dependent on the sound intensities at some of said devices.

4. The combination of a plurality of sound pick-up devices, means for combining the outputs of said pick-up devices, means for transmitting the combined outputs of said devices, a plurality of sound reproducers, a control current generator, means for varying said generator current in accordance with the relation between the sound intensities at said pick-up devices, and means responsive to said variable current for causing the sounds emitted at said reproducers to bear the same relation as said intensities.

5. The combination of a plurality of sound pick-up devices, amplifying means for causing their outputs to be amplified at the same sensitivity, means for combining the outputs of said amplifying means, means for causing the combined outputs of said amplifying means to remain substantially constant irrespective of variations in applied signals, means for transmitting the combined amplified outputs of said devices, a plurality of sound reproducers, a control current generator, means for varying said generator current in accordance with the relation between the sound intensities at said pick-up devices, and means actuated by said variable current for causing the sounds emitted at said reproducers to bear the same relation as said intensities.

6. The combination of a plurality of sound pick-up devices, means for combining the outputs of said pick-up devices, means for transmitting the combined outputs of said devices, a plurality of sound reproducers, a control current generator for generating an alternating control current, means for varying the frequency of the output of said generator in accordance with the relation between the intensities at said pick-up devices, and means actuated by said variable frequency current for causing the sounds emitted at said reproducers to bear the same relation as said intensities.

7. The combination of a plurality of sound

pick-up devices, means for combining the outputs of said pick-up devices, means for transmitting the combined output of said devices, a plurality of sound reproducers, a control current generator, means for modulating the amplitude of the output current of said generator in accordance with the relation between the sound intensities at said pick-up devices, and means actuated by said modulated amplitude current for causing the sounds emitted at said reproducers to bear the same relation as said intensities.

8. The combination of a plurality of sound pick-up devices, a control current generator, and means responsive only to the relative sound intensities at said pick-up devices for controlling the amplitude of the output of said generator.

9. The combination of a plurality of sound pick-up devices, a control current generator, and means operable independently of the absolute sound intensities at said pick-up devices for controlling the amplitude of the output of said generator.

10. The combination of a plurality of sound pick-up devices, a control current generator, and means for controlling the output current of said generator, and means connecting said pick-up devices and said generator control means for operating said control means only in response to the relative intensity of sounds impressed on said pick-up devices and independently of the absolute intensity of said sounds.

11. The combination of a plurality of sound pick-up devices, a single channel for transmitting the outputs of said devices, means for rectifying a portion of the output of said devices, a plurality of sound reproducers, a control current

generator, means including a relay responsive to rectified components of said outputs for controlling the frequency of the output of said generator in accordance with the relation between the sound intensities at said pick-up devices, and means including electric filters responsive to said frequency for causing the sounds emitted at said reproducers to have a relation dependent on said intensities.

12. The combination of a plurality of sound pick-up devices, a single channel for transmitting the outputs of said devices, means for rectifying a portion of the output of said devices, a plurality of sound reproducers, a control current generator, means including a relay responsive to rectified components of said outputs for controlling the amplitude of the output of said generator in accordance with the relation between the sound intensities at said pick-up devices, and means responsive to said controlled amplitude for causing the sounds emitted at said reproducers to have a relation dependent on said intensities.

13. The combination of a plurality of sound pick-up devices, a plurality of sound reproducers, means for transmitting the combined outputs of said pick-up devices to said reproducers, a control current generator for generating current of an inaudible frequency, means for varying the generator current in accordance with the relation between the sound intensities at said pick-up devices, and means responsive to said variable current for causing the sounds emitted at said reproducers to bear the same relation as the sound intensities at said pick-up devices.

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