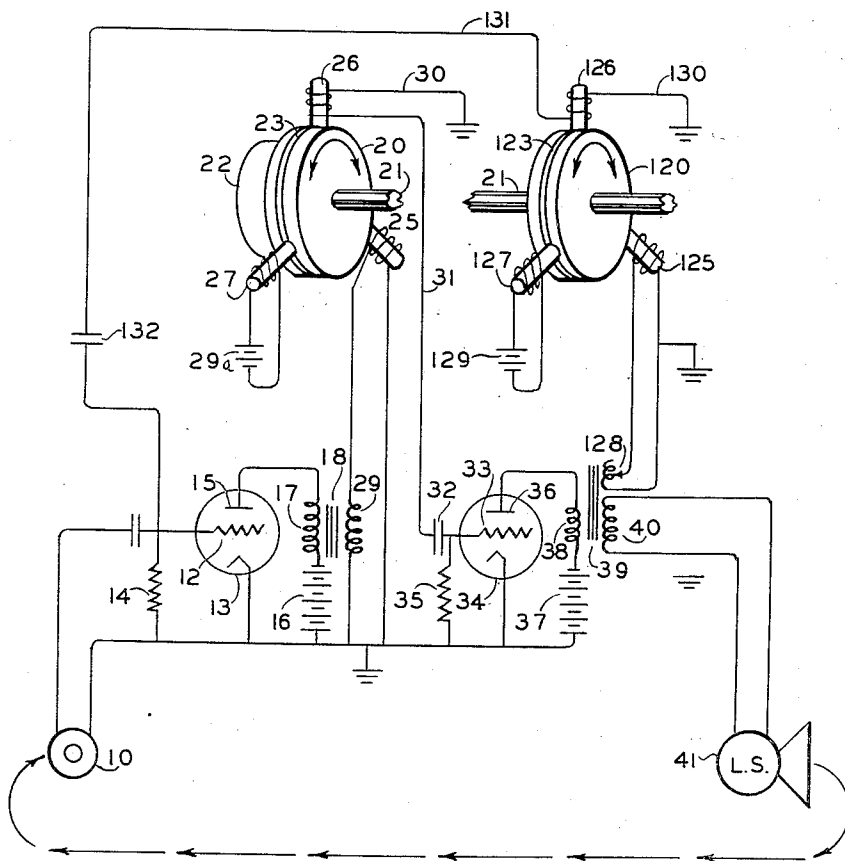


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SOUND REPRODUCING SYSTEM

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SOUND REPRODUCING SYSTEM

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7 Claims. (Cl. 179—1)

This invention relates to a sound reproducing system of the character commonly known as a public address system. In the amplification of sound to make it available throughout a large area, it is customary to provide a microphone adjacent to the origin of sound and a loud speaker situated at a different portion of the amphitheatre, the loud speaker being arranged to emit its sound in synchronism with the sound coming to the audience direct through the air. Where such systems are used, however, to produce a substantial increase in the volume of sound, there is apt to occur what is commonly referred to as acoustic feed back, a phenomenon depending on the fact that the sound produced by the loud speaker is transmitted throughout the entire amphitheatre, and thus a portion of it is fed back to the transmitting microphone through the air.

This fed back sound, however, is out of phase with the original sound because of the time delay required by the sound in traveling from the loud speaker back to the microphone. It possesses also the limitation that it has picked up on the way numerous sounds from the amphitheatre which are added to the original sound, amplified, reproduced upon the loud speaker, and again fed back. This acoustic feed back, therefore, produces a blurring of the sound which interferes with the correct rendition and it may easily be raised to the point of regeneration producing a howl.

It is an object of this invention to suppress all sounds reaching the microphone from the loud speaker, whether they originated in the amphitheatre or whether they merely constitute reproductions of the original sound out of phase with the original.

The invention accordingly comprises a system possessing the features, properties and the relation of elements which will be exemplified in the article hereinafter described and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description, taken in connection with the accompanying drawing, in which:

The figure diagrammatically illustrates an apparatus embodying this invention.

Sound travels to the loud speaker through the electrical system instantaneously, whereas it takes an appreciable time for it to travel the same distance through the air. It is desirable, therefore, to introduce an artificial delay into the electrical

system in order to bring the reproduced sound into synchronism with the air-borne sound. This invention is herein illustrated as embodied in such a system, although it will be understood that the principles of the invention do not depend upon the use of such a system.

In the drawings, the numeral 10 designates a microphone connected by condenser 11 to the grid 12 of an amplifying system here shown as a triode 13. The grid is connected to the ground directly by a biasing resistance 14. The plate 15 of the grid is fed with energy from a battery 16 acting through the primary 17 of a transformer 18.

The means for introducing the delay between the microphone and the loud speaker is shown as an acoustic reservoir, such as that shown in the copending application of Frank Rieber, assignee of the instant application, which is filed of even date herewith and bearing Serial No. 536,407. I have chosen that particular form of acoustic reservoir for use in this invention because it is simple, accurate and free from noise.

In general, there is provided a disc 20 mounted for rotation about a shaft 21 by a synchronous motor 22. This disc carries upon its periphery a plurality of turns of a magnetic wire wound helically and designated by the numeral 23. Arranged around the periphery of the disc in position to cooperate with the wire surface thus formed are three magnets, 25, 26 and 27. The magnet 25 is the recording magnet and it is connected across the secondary 29 of the transformer 18. The magnet 27 is for the purpose of wiping the magnetic record clean, and it is actuated by a battery 29.

The magnet 26, which reproduces the electrical oscillations corresponding to the sound, is mounted for adjustment about the axis of the shaft 21 so that its angular position relative to the recording magnet 25 may be altered at will. This magnet is connected to ground at one side by a wire 30 and is connected at its other side by a wire 31 to a condenser 32 which is connected to the grid 33 of an amplifier 34 shown also in the form of a triode tube. This grid is connected to ground by a biasing resistance 35. The plate 36 of this tube is energized by a battery 37 through the primary 38 of a transformer 39, and this transformer has a secondary 40 which drives the loud speaker 41.

With the arrangement thus far described, it will be clear that the loud speaker 41 will reproduce the sounds fed to the microphone 10 after a delay dependent upon the speed of rotation of the disc 20 and the distance between the mag-

nets 25 and 26, which distance will be adjusted to bring the reproduced sound into synchronism with the air-borne sound at the point of the loud speaker.

With such a system, however, the sound emitted by the loud speaker travels back to the microphone 10 through the amphitheatre and reinforces the original sound. However, this reinforcement or feed back is not in synchronism with the original sound, but is delayed by the amount of delay produced by the reproducing magnet 26 in addition to the time required for the sound to travel from the loud speaker back to the microphone. This feed back, therefore, is out of synchronism with the original sound and produces a blurring effect which is amplified and again produced at the microphone 41. There is thus established a vicious cycle of energy fed to the microphone through the air from the loud speaker and fed back from the microphone to the speaker through the amplifying system. Under such circumstances, unless the gain of the amplifier is kept very small, these noises build up until a howl is produced. In many instances, moreover, sounds occurring within the amphitheatre are picked up over the microphone amplified with the original sound and transmitted to the loud speaker, and this becomes particularly objectionable if the system is such that these sounds are again fed back to the microphone and carried through the amplifier a second or third time.

To avoid this difficulty, there is provided a second acoustic reservoir similar to that already described, comprising a disc 120 driven by the shaft 21 having a record surface 123 and three magnets, a recording magnet 125, a reproducing magnet 126, and a wiping magnet 127, of identical construction to the parts 23, 25, 26 and 27 already described.

This recording magnet 125 makes a record corresponding to the energy fed to the loud speaker and the reproducing magnet 126 re-creates from that record energy which is fed back through the amplifying system in phase opposition to the effect created by the sound borne by the air from the loud speaker to the microphone. By reason of the fact, however, that the reproduction takes the form of electrical variations, it is not necessary to convert the sound from the loud speaker into electrical energy and then convert those variations again into sound as a means of counteracting the acoustic feed back, since the simpler method is available of taking the electrical energy as it is fed to the loud speaker to produce the record and then of feeding the reproduction into the electrical circuit between the microphone and the amplifier. Thus while the same effect is produced, the mechanism is simplified. It will of course be understood that the amplifiers may be introduced into any of these circuits as desired, and the need for them will be determined by the other constants of the circuit.

As shown, the recording magnet 125 is fed with energy from any suitable source in synchronism with the loud speaker. It is connected across a secondary 128 on the transformer 39. Adjustment of the volume of reproduction is effected by any convenient means. There is here shown schematically a means of varying the intensity of the record made by the magnet 125 by varying the secondary 128. The wiping magnet 127 is operated by a battery 129. The reproducing magnet 126 is connected to ground on one side, as shown at 130, and has its other side connected to the

microphone circuit by a wire 131. As specifically shown herein, the wire 131 is directly connected to the terminal of the grid 12 through a condenser 132 and is at that point superposed upon the energy from the microphone and carried through the amplifying system.

It will be understood that the magnet 126 is adjusted to give to this fed-back current a delay precisely equal to the time required for the sound to pass from the loud speaker 41 back to the microphone 10, and this fed-back current is connected with a polarity to oppose the acoustic feed back through the microphone.

I have preferred to connect the feed back current to the microphone circuit at the microphone, since in this way the neutralizing current is introduced to the circuit at precisely the point where the current to be neutralized first makes its appearance, and this enables me to adjust the magnet 26 to bring the loud speaker in synchronism with the air-borne sound independent of the adjustment of the magnet 126 and to feed the magnet 126 to neutralize the feed back independent of the adjustment of the magnet 26. It will be obvious, however, that the feed back current may be introduced into the electrical circuit after the original circuit has been delayed by connecting the wire 131 directly to the wire 31. In such instance, however, the adjustment of the magnet 26 must be altered, since in such instance the fed-back energy is not being delayed by the acoustic reservoir in the main circuit.

It will also be clear that while I have shown this feed back neutralizing system in connection with the microphone system having a delay mechanism, that it may equally be applied to a system which does not include such a delay, provided only that the electrical signal as fed to the loud speaker shall be fed back into the microphone circuit in phase, volume and time relation, such as to neutralize the acoustic feed back.

It will be understood that the constants of these systems will be so chosen and the polarities so connected and the amplification factors so determined, that the energy fed to the grid 13 is equal in amplitude and opposite in phase, but otherwise synchronous with that portion of the energy fed to the grid, as a result of the operation upon the microphone of the sounds emanating from the loud speaker; that is, the time delay effected by the acoustic reservoir will be precisely equal to the length of time it requires for the sound emanating from the loud speaker to reach the microphone, but the degree of energy thus fed will be adjusted in phase and volume precisely to nullify that feed back.

It will be understood from this arrangement that where a plurality of different loud speakers are established at different distances from the microphone, to operate at such volume as to cause acoustic feed back from each, that a plurality of apparatus such as I have just described may be employed, each one adjusted to the time delay corresponding to the distance of the particular loud speaker from the microphone.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic

and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a circuit having a microphone at the input end, an amplifier and a loud speaker at the output end, the combination of means for making a record of the sound at the output end of the circuit, means for reproducing that record after time delay, and means for feeding the reproduced sound to the input end of the circuit in phase opposition to the sound fed back to the circuit from the air. 5
2. In a circuit having a microphone at the input end, an amplifier and a loud speaker at the output end, the combination of means for making a record of the sound at the output end of the circuit, means for reproducing that record after time delay, means for feeding the reproduced sound to the input end of the circuit in phase opposition to the sound fed back to the circuit from the air, including means to vary the time delay to an amount equal to the time required for sound to travel from the loud speaker to the microphone, and means to adjust the volume of the reproduction to nullify the feed back effect upon the amplifier. 10
3. In a system, including a microphone, an amplifier and a loud speaker, the combination of means for making a record of the current fed to the loud speaker, means for reproducing this record including means for varying the volume of the record and means for delaying the reproduction, and means for feeding the reproduction to the input side of the amplifier in phase opposition to the sound fed back from the loud speaker. 15
4. In a system, including a microphone, an amplifier and a loud speaker, the combination of means for making a record of the current fed to the loud speaker, comprising a magnet actuated by current fed to the loud speaker for producing a magnetic record on said surface, means for reproducing this record, including means for varying the volume of the record and means for delaying the reproduction, and means for feeding the reproduction to the input side of the amplifier in phase opposition to the sound fed back from the loud speaker. 20
5. In a system, including a microphone, an amplifier and a loud speaker, the combination of means for making a record of the current fed to the loud speaker, means for reproducing this record, comprising a magnet physically spaced from said recording magnet, means for varying the volume of the reproduction, and means for feeding the reproduction to the input side of the amplifier in phase opposition to the sound fed back from the loud speaker. 25
6. In a circuit having a microphone at the input end, an amplifier and a loud speaker at the output end, the combination of means of making a record corresponding to the sound production by the loud speaker, means for reproducing that record after a time delay, means for amplifying the reproduction, and means for feeding the amplified reproduction to the circuit in phase opposition to sound fed back to the microphone from the loud speaker. 30
7. In a circuit having a microphone in an input end, an amplifier, and a loud speaker at the output end, a combination of means for making a record of the sound at the output end of the circuit, means for reproducing that record after a time delay, means for feeding the reproduced sound to the circuit in phased opposition to the sound fed back to the circuit from the air. 35

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