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REVERBERATION CIRCUIT

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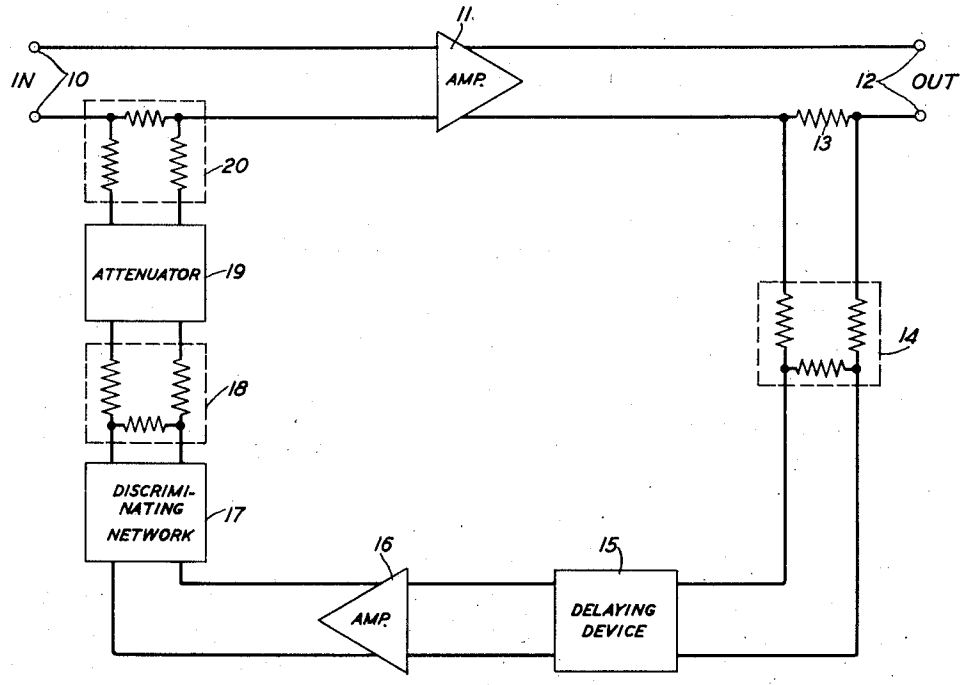

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REVERBERATION CIRCUIT

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This invention relates to sound transmitting systems and particularly to those employing a studio in which to initiate the sounds, such as radio broadcasting and phonograph recording systems.

One of the difficulties encountered in the transmission of sound from a studio is the lack of reverberation in the picked-up sound which often leads to inconsistencies between the sound and what the sound is supposed to represent. It is impractical to use a separate room for each type of program to be transmitted for the reverberation effects since such a scheme would require a great variety of rooms. Not only does the size of a room affect its reverberation characteristics, but the nature of the walls and their sound reflecting or absorbing qualities are also important factors tending to make this method still less practical.

Several systems have been devised to introduce reverberation into a transmitting circuit artificially so that all types of sound can be picked up in the same room and yet be made to contain varying amounts of reverberation. Such systems usually take the form of a delay device of some kind, either acoustical or electrical, inserted in the circuit between the transmitter and receiver. An example of the latter is disclosed in U. S. Patent 1,647,242, to J. Mills, November 1, 1927, which shows a delay network used to simulate reverberation. Systems like this, though effective in producing an echo, do not take into account the selective frequency absorption of the walls of a room so that if it were desired to simulate the production of a program in a well-known auditorium, the frequency absorption characteristics of the studio would necessarily accompany the echo characteristics of the auditorium.

The object of this invention is to provide an improved artificial reverberation circuit by means of which both the echo and the selective frequency absorption characteristics of a room or auditorium can be simulated.

A simple form of the invention comprises a reentrant loop circuit in which a delay device, an amplifier, a discriminating network and an attenuator are connected together in series, with the main channel closing the loop. The attenuator is connected to the main channel above the delay device so that the delayed current is sent through the loop repeatedly until its energy is exhausted. Means are also provided for stabilizing the impedance of various portions of the circuit to facilitate the adjustment of the controls to meet particular reverberation requirements.

The invention is illustrated by way of example in the accompanying drawing. Apparatus well-known in the art is not shown in detail, but is designated by rectangles and triangles for the sake of simplicity and to make the invention more apparent.

A portion of the main channel is shown at 10 connected to an amplifier 11 and continuing on through leads 12 to an output circuit. The source of sound-controlled electrical currents may be any form of sound pick-up and amplifying apparatus such as is used in broadcasting and recording studios and is preferably taken as the output of the mixing panel. The amplifier 11 is of the conventional vacuum tube type and serves in addition to augmenting the energy of a current as a means for causing the current to flow unidirectionally. The outgoing current leaving the amplifier 11 is divided in a suitable manner either by a potentiometer (not shown) across the leads, or by a resistance 13 in one of the leads, across the terminals of which the loop leads are connected. The current thus diverted passes through resistance pad 14, the function of which is to stabilize the impedance of this portion of the circuit, and then to a delay device 15. This delay device may be either acoustical, mechanical or electrical, such as is disclosed, for example, in U. S. Patent No. 1,647,242 to J. Mills. From the delay device 15 the current is again amplified in a conventional vacuum tube amplifier 16 and then passes through a discriminating frequency network 17 where the frequency response characteristic of the system is shaped to conform to that of the room to be simulated. The network is made to terminate in a resistance pad 18 to stabilize its action. The amplifier 15 also serves to maintain the flow of current in one direction only and to block any tendency to flow in the opposite direction. The current then passes to an attenuator 19 which maintains the strength of the delayed currents below that of the transmission line 10 to prevent the system from singing. Another resistance pad 20 is provided through which the delay current reenters the transmission line at the input side of amplifier 11.

When the delayed currents have passed through amplifier 11 and reached the resistance 13 they are again divided in the same proportion as were the original currents, part of them passing on to the output 12 as the first reflection of the echo and the remainder again passing through the loop where they are further delayed

and attenuated to form the second reflection of the echo. This continues until the energy of the echo current becomes negligible.

By selecting the proper time delay the echo produced in any sized room can be simulated. This echo can then be modified by the discriminating network 17 to accentuate the frequencies generally found to be most prominent in the room being simulated, and lastly, the overall "deadness" of the room is simulated by the attenuator 19. For a long reverberation period the attenuation is somewhere near the point at which the system sings; for a short reverberation period the attenuation is greater and approaches the condition where no echo is produced. Any condition between these wide limits can be secured merely by adjusting the attenuator.

The discriminating frequency network 17 is simply a series of filters covering the entire band of frequencies being transmitted. The band may be divided into as many small bands as desired with switching means for making each band effective. In this manner, certain frequencies can be cut out of the echo to simulate the selective frequency absorption of the walls of a particular room. As explained above, the network is made to terminate in a resistance pad 18 to stabilize its action and to decrease the effects upon it of variations in the energy of the main channel.

The delay device 15 is adjustable to give different time delays. The electrical delay network shown in the U. S. Patent to J. Mills, No. 1,647,242, November 1, 1927, referred to above, may be used for this purpose as well as the ordinary acoustic delay device comprising a receiver, a transmitter and an acoustic tube of variable length connecting the diaphragms of each. The latter, however, may not be compact enough or may not provide a sufficient variability to meet the requirements of the use to which it is put. A third form is one disclosed in U. S. patent to H. C. Harrison, No. 1,648,120, November 8, 1927, which comprises a mechanical counterpart of the Mills delay network. In any case, it is resirable to have the delay device variable and compact.

All of the apparatus used in this invention may be enclosed in a single container and can be readily connected into any transmission circuit without necessitating a change in existing studios and associated pick-up apparatus. The reverberation period produced by it is susceptible of variation in both time and quality.

It is understood that the form shown and described is merely illustrative of the invention and that various modifications of it can be devised without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a main sound channel, apparatus comprising a loop circuit for introducing reverberation effects into the main sound channel, and variable and controllable means in the loop circuit for shaping the frequency response characteristic of the loop circuit to simulate the selective frequency absorption of the walls of the room.

2. In a main sound channel for the transmission of sound-controlled electrical currents, apparatus for introducing reverberation effects into the channel comprising a unidirectional amplifier connected into the main sound channel, means for dividing the output of the amplifier into a plurality of channels, one of said channels comprising in series a variable acoustical delay device, an amplifier for the delayed currents, a discriminating network whereby certain of the frequencies transmitted therethrough may be accentuated or attenuated, a variable attenuator whereby the rate of decay may be regulated, and means for connecting the attenuator to the input of the unidirectional amplifier where in the delayed currents are combined with the sound-controlled electrical currents of the main sound channel.

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