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2,157,177

PUBLIC ADDRESS STABILIZING SYSTEM

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FIG. 1.

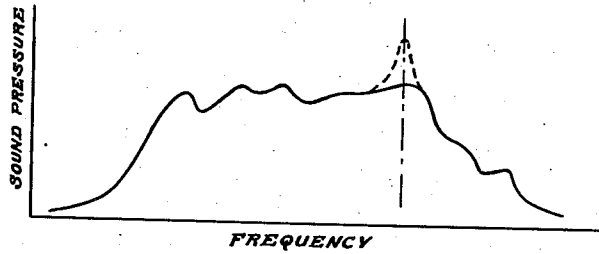


FIG. 2.

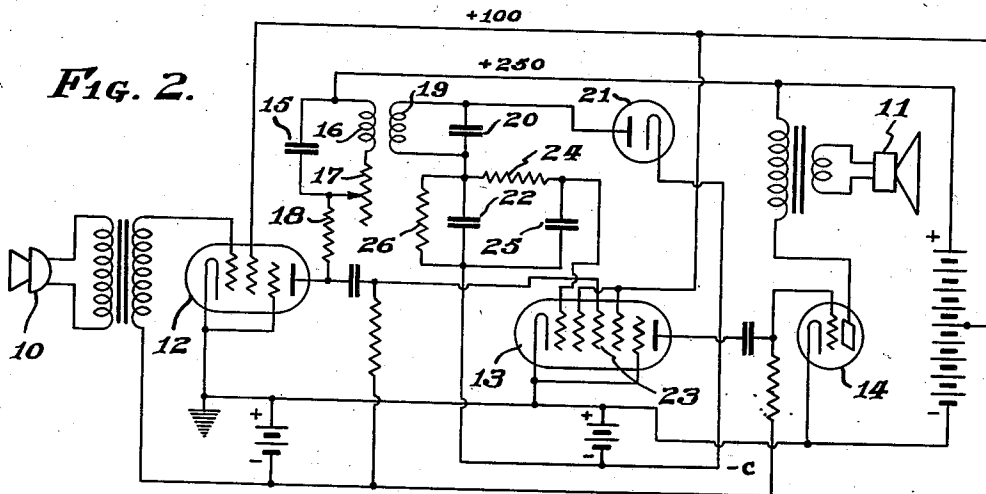
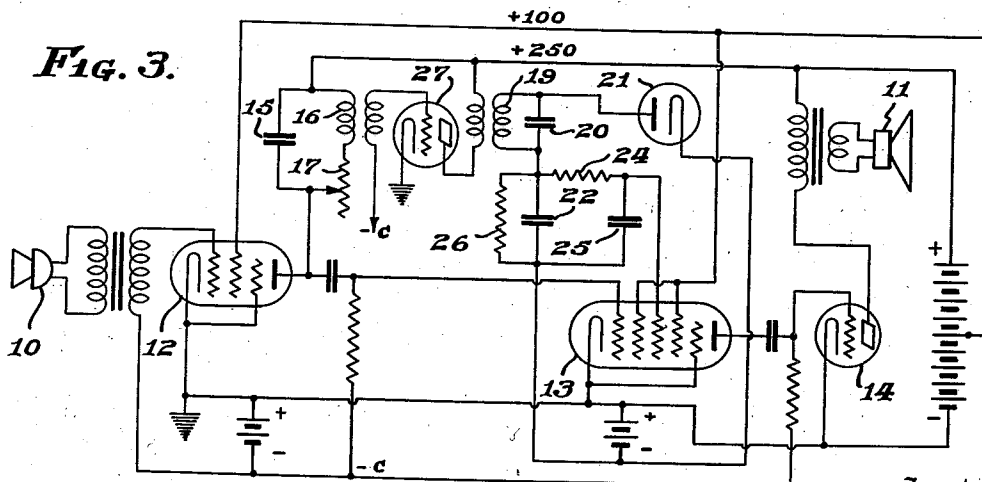


FIG. 3.



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PUBLIC ADDRESS STABILIZING SYSTEM

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9 Claims. (Cl. 179—171)

My invention relates to signal transmitting and receiving systems, such as are utilized for public address, sound reinforcement or like purposes, and has for its principal object the provision of an improved apparatus and method of operation whereby undesired feed-back from the loudspeaker to the microphone of such systems is avoided.

Such feed-back between acoustically coupled sound reproducing and pick-up devices, commonly designated as "singing", results from sound which (1) is produced by the loudspeaker, (2) is picked up by the microphone and (3) produces a corresponding electrical current which is amplified and fed to the loud speaker. If the microphone and loudspeaker are in the same room, the amount of sound amplification which can be employed is practically always limited by the feed-back or "singing" point. Such "singing" almost always occurs at the frequency at which the overall amplification is a maximum. This involves the complete circuit, starting with the microphone and ending with the sound received by the microphone from the loudspeaker, thus including such sound reinforcement or sound losses as are imparted by the entire acoustical environment. The microphone may be especially sensitive at one frequency or the loudspeaker may be especially efficient at a particular frequency or the amplifier may have a peak at a certain frequency. All these factors have a part in determining the frequency at which feed-back or "singing" becomes evident.

It has been found that the usefulness of a sound reinforcing system is greatly enhanced by minimizing all of the peaks in the system so that the overall characteristic is as nearly uniform with respect to frequency as possible. Further advantage has been taken of directive properties of both microphones and loudspeakers in order that the microphone may receive a minimum of sound from the loudspeaker as compared with the sound which the loudspeaker radiates toward the hearers, and the sound which the microphone receives from the original source. In spite of what it has been possible to accomplish by the aforementioned measures, the usefulness of public address systems is still seriously limited by feed-back or "singing".

It has been proposed to cause the amplification to be momentarily increased in response to voice sounds, employing a quick-acting "expander" circuit having a small range of volume control. The theory of this is that the high amplification condition would not last long enough to permit

the building up of feed-back oscillations. It has also been proposed to provide the amplifier of a public address system with a slow-acting automatic volume control of the "compressor" type, to reduce the amplification when there is any prolonged sound. This would serve to stop feed-back if the sustained sounds were due to feed-back. No satisfactory arrangements have been proposed that will enable the microphone to distinguish between sounds of the nature of feed-back and those which it is desired to amplify. In accordance with my invention I make use of the fact that feed-back if present, will occur at a certain frequency, and I cause the automatic volume control or compressor to be responsive to this frequency only. Since the frequency at which "singing" will occur usually depends in part upon the room in which a system is installed, I propose to design the amplifier so that a response peak can be made to occur at a predetermined frequency. The magnitude of this peak should be adjustable and the adjustment would be made by setting the overall amplification at the highest possible point without feed-back, and then increasing the response at the selected frequency until "singing" occurs. Since the automatic volume control is sensitive to this frequency only, it will not often be caused to act in response to speech sounds, but as soon as "singing" starts it will cause a reduction in amplification and check the "singing". It is only necessary to cut down the amplification by 2 or 3 db. in order to make the difference between "singing" and stability. The expander and compressor controls may both be incorporated in the same system. In fact they may both operate on the same variable amplification tube or tubes, the one control being arranged to raise the average grid potential and the other to depress it.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope is indicated by the appended claims.

Referring to the drawing:

Fig. 1 is an explanatory curve relating to the operation of the invention,

Fig. 2 is a wiring diagram of a public address system modified in accordance with the invention, and

Fig. 3 is a diagram of an arrangement differing from Fig. 2 only in the addition of an amplifying element to increase the magnitude of the voltage available for operating the control device.

Fig. 1 shows a typical curve of response or amplification of a complete sound reinforcing sys-

tem. There are numerous peaks in these curves, some of which are due to the effects of standing waves in the auditorium and others to the inherent characteristics of loudspeakers and other elements of the system. The dotted portion of the curve indicates the peak which is deliberately introduced to cause the feed-back to occur at the desired frequency. This frequency is chosen so that it will only at rare intervals be strongly excited by the useful sound which is to be reinforced. It might, for example, be set at 4500 cycles.

The system of Fig. 2 accomplishes the desired purpose. This system includes a microphone 10, the output of which is supplied to a loud speaker 11 through an amplifier including stages 12, 13 and 14. In the output circuit of the stage 12 is provided a tuned circuit which includes a capacitor 15, a coil 16 and an adjustable resistor 17, and is connected in series with a resistor 18. The tuned circuit 15-16-17 together with the resistor 18 constitutes a load on the output of the amplifier stage 12, which load varies with frequency and becomes less when the impedance of the tuned circuit becomes high. This results in an increase of amplification at the frequency for which the circuit 15-16-17 is tuned. Throughout the larger part of the frequency range, the impedance of the circuit 15-16-17 is low and the amplification is determined by the resistor 18. At the frequency for which the circuit 15-16-17 is tuned, the impedance becomes high, the magnitude of the rise in impedance at this frequency being determined by the resistor 17. This provides the desired adjustable peak in the amplifier response at the selected frequency.

Loosely coupled to the coil 16 of the tuned circuit 15-16-17 is a second tuned circuit 19-20 in which voltage is built up whenever current flows in the circuit 15-16-17. The voltage developed in the second tuned circuit 19-20 is applied through a rectifier 21 to a capacitor 22, charging this capacitor in such a direction that the amplification control grid 23 of the stage 13 is biased negative and functions to decrease the amplification of this stage. Resistor 24 and capacitor 25 time the action of this circuit, or otherwise stated, cause the change in the bias of the grid 23 to change only gradually so that the amplification is varied only in response to more or less extended energization of the tuned circuits 15-16-17 and 19-20. When such energization produced by feed-back or "singing" ceases, capacitors 22 and 25 slowly discharge through a resistor 26 and normal conditions of amplification are restored. As will be apparent, the tuned circuits 15-16-17 and 19-20 are little affected by the useful sound currents for the reason that they are sharply tuned to the selected frequency. Thus the system is readily adjusted so that its amplification is controlled by very feeble currents of the selected frequency, provided such currents persist over a considerable period of time.

The sensitivity of the automatic volume or amplification control circuit to currents of the selected frequency or frequency band may be increased by interposing between the tuned circuits 15-16-17 and 19-20 an amplifier stage 27 as shown in Fig. 3. Other useful modifications of the system will be apparent to those skilled in the art. For example, it may be desirable to limit the amount by which the amplification can be depressed by the change of bias. Such a limit can be imposed by operating amplifier tube 27 of Fig. 3 under such conditions that it cannot put out more

voltage than will cause the desired limit value of grid bias change on tube 13.

I claim as my invention:

1. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, the combination of means for causing maximum amplification at a predetermined frequency, means selectively responsive to current of said frequency, and means responsive to said current for controlling the gain of said amplifier.

2. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, the combination of means selectively responsive to current of the frequency at which feed-back between said devices is produced, and means responsive to said current for reducing the gain of said amplifier to a level at which said feed-back is interrupted.

3. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, the combination of means selectively responsive to current of the frequency at which feed-back between said devices is produced, means responsive to said current for reducing the gain of said amplifier to a level at which said feed-back is interrupted, and means for gradually terminating the action of said gain control means.

4. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, the combination of means selectively responsive to current of the frequency at which feed-back between said devices is produced for controlling the gain of said amplifier, and means for delaying the action of said gain control means.

5. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, the combination of means selectively responsive to current of the frequency at which feed-back between said devices is produced, means responsive to said current for controlling the gain of said amplifier, and means for rendering said gain control means unresponsive to feed-back frequency currents of relatively short duration.

6. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, the combination of means for causing maximum amplification at a predetermined frequency, means selectively responsive to current of said frequency for controlling the gain of said amplifier, and means for adjusting the sensitivity of said gain control means.

7. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, means for causing over-all amplification at a specified frequency to exceed that at other frequencies whereby feed-back can be made more likely to occur at said frequency than at any other frequency, and means selectively responsive to sustained currents of said frequency for reducing the amplifier gain at all frequencies.

8. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, means adjustable in amplitude response for causing over-all amplification at a specified frequency to exceed that at other frequencies whereby feed-back can be made more likely to occur at said frequency than at any other frequency, and means selectively responsive to currents of said frequency for reducing the amplifier gain at all frequencies.

9. In a system including an amplifier connected between acoustically coupled sound pick-up and reproducing devices, means for causing over-all amplification at a specified frequency to exceed that at other frequencies whereby feed-back can be made more likely to occur at said frequency than at any other frequency, and means selectively responsive to sustained currents of said frequency for reducing the amplifier gain at all frequencies to a value below that at which self-excited oscillations can be maintained.

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