

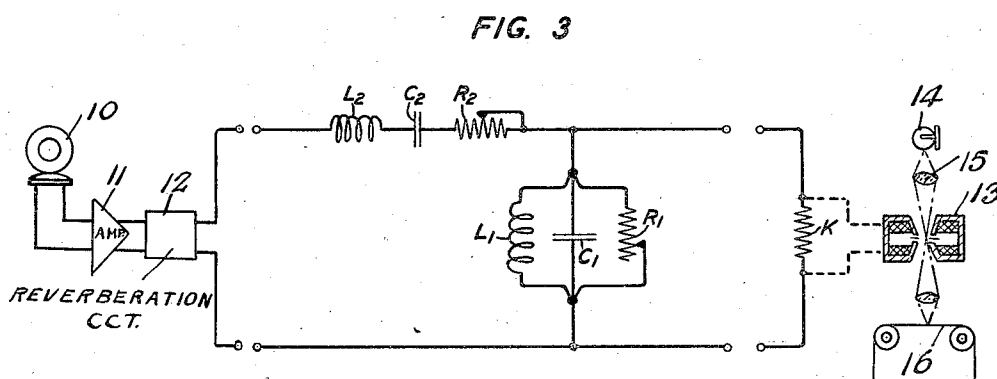
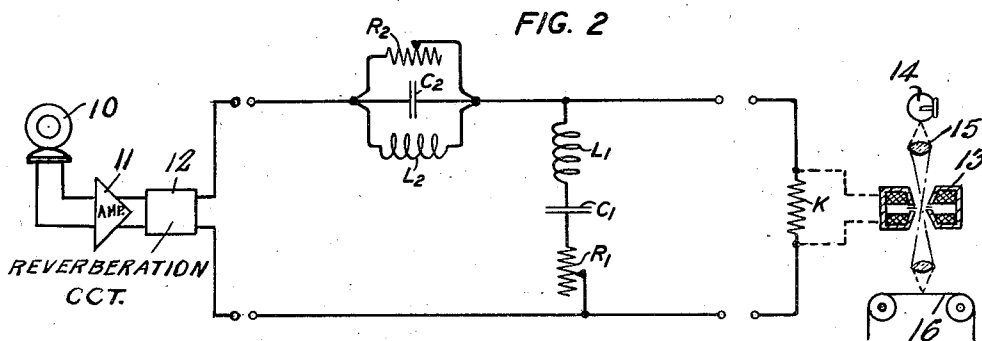
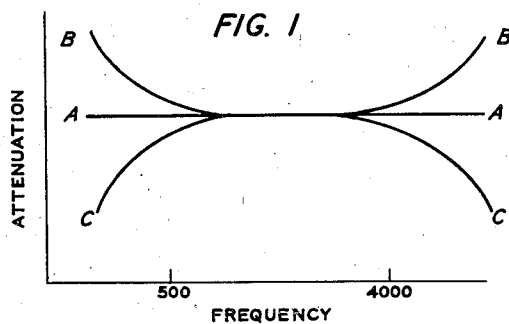
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SOUND TRANSMITTING SYSTEM

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SOUND TRANSMITTING SYSTEM

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4 Claims. (Cl. 179—100.1)

This invention relates to sound transmitting systems and to methods of and means for recording and reproducing sounds in conjunction with motion pictures so that the resulting sound pictures possess a maximum of naturalness.

In addition to perfect synchronism between motion pictures and the sound accompanying the pictures, naturalness in reproducing the pictures requires that the sound appear to issue from the source of sound no matter where the source is located in the picture. Thus, for example, the voice of a man should appear to issue from his lips whether he is at the left or at the right, in the foreground or in the background of the picture.

A suggested method of creating the illusion of the sound moving laterally across the picture comprises recording the sound in two or more separate channels and reproducing the recorded sound with the loud speakers in the same space relation with respect to the picture as were positioned the microphones of the separate channels. For creating the illusion of depth or of sound originating at a distance in the picture, such a system can only make use of volume or intensity changes. Although very important, sound intensity variation alone is not sufficient to produce a true illusion of depth or distance. Other means must be considered. One such means comprises using proper sound reflecting surfaces in the vicinity of the microphones, as shown, for example, in U. S. Patent 1,939,074 to J. P. Maxfield, so that as the source of sound recedes from the camera, the ratio or reflected sound to direct sound becomes greater, thereby accounting for one of the factors influencing the creation of an aural depth illusion.

Another factor equally as important as loudness variation or reverberation content that enables a person to judge the distance of a sound source is the relative intensity of the high, middle and low frequency contents of the sound. As the acoustic output of a sound source is reduced, the characteristics of the ear cause the loudness of the high frequencies and the low frequencies to diminish more rapidly than the middle frequencies. This alteration of the relative loudness of the portions of the frequency range produces an aural illusion of greater distance in addition to that resulting from the diminished intensity or reverberation content. In other words, we estimate the distance of a sound unconsciously by comparing its intensity with intensities of similar sound that we have experienced at other times at known distances by its reverberation content and by the ex-

tent of the alteration of the character or frequency components of the sound accompanying the change in distance.

This latter aural factor is analogous to a visual factor that enables us to perceive depth in a flat photograph, or to judge distance with one eye closed. As an object recedes and becomes more distant, the details of its structure become less distinct, and the outline of its form hazy and not clean-cut. In a similar manner, as a complex sound source becomes more distant, its character is altered; the high and low frequency components are diminished in relative intensity and the sound loses its definition and distinctive character. There is, therefore, a relation between visual distance and aural distance; namely, that distinctness of sound and distinctness of vision connote nearness, and indistinctness of sound and vision connotes remoteness. Since indistinctness in sound is the result of the absence of certain frequencies, the aural illusion of depth should be creatable in part by the proper regulation of the loudness of the component frequencies of a complex sound.

It is the object of this invention to provide a method of and a means for creating an aural illusion of depth in the production of sound for use in sound pictures or other program transmission systems where such an illusion is necessary for naturalness. A feature of this invention is the creation of an illusion of greater acoustic power capacity with a given sound reproducing system.

The invention comprises using variable networks in the microphone and recording circuits so that as the sound source recedes in the picture, the high and low frequencies can be attenuated or accentuated relative to the middle frequencies in synchronism with apparent distance in the picture. For a close-up camera shot for reproduction in a theatre where the sound intensity is normally lower than that indicated by the picture, the high and low frequencies (say above 4000 cycles and below 500 cycles) should be accentuated for best illusion. For a distant camera shot, the microphone can be placed near the sound source (thereby avoiding interfering extraneous noise) and the high and low frequencies attenuated to give the effect of distance as indicated by the picture. For varying distances as with a moving object, the adjustment of the network should be in synchronism with the change in distance in the picture; a sound source in the foreground requires a broad frequency range to be transmitted and as the source moves

away, the transmitted frequency band should be progressively restricted.

In the above application, the "illusion network" has been inserted in the recording system where the picture is made but it may be used to advantage in the reproducing system to give an illusion of sound intensity greater than that which it is practicable or feasible to supply for theatres or large auditoriums. Thus, by accentuating the high and low frequencies (the amount of accentuation depending upon the size of the auditorium and the power capacity of the available amplifiers) the sound can be given a distinctness which is generally associated with nearness and greater volume. When used in this manner, the distorting network would need be adjusted only when installed and might permit amplifiers of smaller capacity to be used to obtain equally good illusion and naturalness.

For greater detail of the invention set forth above, reference is made to the drawing which accompanies this specification and forms a part thereof wherein:

Fig. 1 shows a number of curves of attenuation plotted against frequency representing the attenuation characteristics a transmitting system should have under various conditions;

Fig. 2 is a variable network which may be used to give the system a characteristic varying from curve A to curve B of Fig. 1; and

Fig. 3 is a variable network which may be used to give the system a characteristic varying from curve A to curve C of Fig. 1.

Referring now particularly to Fig. 1, the frequency characteristic usually sought in sound transmitting systems is the flat type illustrated by curve A. This type insures a uniform transmission of all frequencies and represents the condition that obtains when the sound source and sound pick-up are spaced apart a distance commensurate with that between two people carrying on a normal conversation. If such a characteristic is used with sound accompanying a picture in which the speaker is depicted as being fifty or a hundred feet away from the camera, obviously the lack of correspondence will be noticed and an unnatural result will be produced. It is necessary, therefore, to introduce a corrective network of some kind into the system to take care of such a situation.

Fig. 2 shows a type of network which may be used when the sound source is apparently located very near the camera but the pick-up is actually a greater distance away. In such a situation, the upper and lower frequencies should be accentuated and a characteristic somewhat like C should be produced, i. e., a characteristic which is concave downward. In Fig. 2, the network is comprised of a shunt member in which an inductance L_1 , a capacitance C_1 and a variable resistance R_1 are connected in series, and a series member in which an inductance L_2 , a capacitance C_2 and a variable resistance R_2 are connected in parallel. A pick-up 10, an amplifier 11 and a source of artificial reverberation 12 constitute the input to the network. The network preferably terminates in a fixed resistance K and R_1 and R_2 should be so proportioned and so varied that their product always equals K^2 . Bridging resistance K is a light valve 13, the resistance of which is small compared to K . The usual source of light 14, optical system 15 and light sensitive film 16 cooperate with light valve 13 to form an electro-optical sound record. The network attenuates the middle frequencies but not the upper

and lower frequencies and there is no sharp cut-off to make the attenuation unduly obvious and unnatural. By means of the variable resistances, different degrees of attenuation may be obtained and the shape of curve A altered from flatness to extreme concavity downward.

When the sound source is apparently located a considerable distance away from the camera but the pick-up is actually less distant, the characteristic of the system should be somewhat similar to curve B, i. e., the middle frequencies should be at a higher volume level than the upper and lower frequencies. Such a curve may be obtained by the network shown in Fig. 3, wherein inductance L_1 , capacitance C_1 and variable resistance R_1 of the shunt member are in parallel and inductance L_2 , capacitance C_2 and variable resistance R_2 of the series member are in series. This network can be made to yield a series of curves ranging from the flat type as exemplified by curve A to one of extreme concavity upward such as curve B.

The networks of Figs. 2 and 3 are merely illustrative of a manner of obtaining the results desired and the invention is not limited to the use of these particular networks, but can be carried out by other means capable of giving the same results. For example, instead of starting with a system having a flat characteristic and then distorting it by the networks shown, the system can be predistorted to give either curve B or curve C, and then by the use of one variable network a number of resultant curves may be obtained varying in form from curve B to curve C. Other types of networks may likewise suggest themselves to those skilled in the art. For a complete discussion of corrective networks, reference is made to Transmission Circuits for Telephonic Communication by K. S. Johnson, Chapter XVIII.

When this invention is employed for recording purposes, the pick-up and camera need not be located to secure complete correspondence between the sound and apparent location of the camera, but the pick-up may be located wherever the exigencies of the situation permit and the frequency characteristic of the system can then be changed to give the required illusion of correspondence. To obtain a complete illusion, it is necessary to incorporate some reverberation producing means, either of the mechanical type, such as is described in the Maxfield patent, or of the electrical type, one of which is disclosed in U. S. Patent 1,947,621 to E. H. Schrieber dated February 20, 1934. With the aid of the reverberation producing means the proper echo effects can be produced to accompany the long shots.

The frequency distortion and echo effects may also be introduced at the reproducing end, but here it becomes less satisfactory since the projectionist is less likely to be proficient in the creation of the depth illusion than the recording engineers. Furthermore, the projectionist would not have time to tend to his machines and manipulate the network controls and hence an additional operator would be required which would make the expense prohibitive.

It is possible, however, by means of a frequency network to set the reproducing system to give an attenuation characteristic which is concave downward to accentuate the high and low frequencies over the middle frequencies and thereby produce the illusion of nearness and greater volume, since nearness usually implies distinctness, and distinctness is generally asso-

ciated with greater volume. Such an illusion is useful in theatres in which the maximum acoustic power available is not quite sufficient to carry the sound distinctly to all parts of the audience.

- 5 By accentuating the upper and lower frequencies, or more accurately, by attenuating the middle frequencies, the overall volume level is slightly decreased but the distinctness of the sound is greatly increased and the illusion of greater
10 power is thereby created. The illusion is likewise useful in sound reproducing devices in the home where reduced volume may be desirable without a loss in clarity. In such cases the upper and lower frequencies are not attenuated at the
15 same rate as the middle frequencies and thus the entire frequency range may be maintained within the threshold of audibility even though the overall volume level of the system is reduced.

What is claimed is:

- 20 1. In a sound picture system, the method of securing correspondence between the apparent location of a source of sound and the quality of the sound which consists in picking up the sound at any convenient location with respect
25 to the sound source and then altering the relative loudness of the component frequencies of the sound so that for a close-up the high and low frequencies predominate, while for long shots the middle frequencies predominate.
- 30 2. In a sound picture system, the method of securing correspondence between the apparent location of the source of sound issuing from the system and the quality of the sound which consists in picking up a sound at any convenient

location with respect to the sound source, introducing reverberation artificially into the system in an amount sufficient to give naturalness to the sound when reproduced with the picture of the source of sound and altering the frequency characteristic of the sound so that for apparent nearness of the source of sound, the upper and lower frequencies predominate and for apparent remoteness of the source of sound the middle frequencies predominate.

3. A method of recording sounds in conjunction with talking motion pictures of the source of sound which consists in using a unitary pick-up for the recording system, locating the pick-up at a fixed distance with respect to the camera, transmitting the sound controlled electrical currents generated in the pick-up to a variable corrective electrical network and operating the network so that the frequencies recorded as the source of sound moves relative to the pick-up correspond to those that would be within the threshold of audibility of the ear if it were at the apparent location of the camera.

4. In a sound transmitting system, the combination of a variable corrective network and a source of variable artificial reverberation, said network being adapted to accentuate the upper and lower frequencies as the amount of reverberation is decreased and to accentuate the middle frequencies as the amount of reverberation is increased, whereby the quality of a sound may be made to correspond to the apparent distance of the source of sound from the observer.

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