Oct. 31, 1944. W. A. MUELLER 2,361,490

SOUND REPRODUCING SYSTEM

Filed Dec. 29, 1941

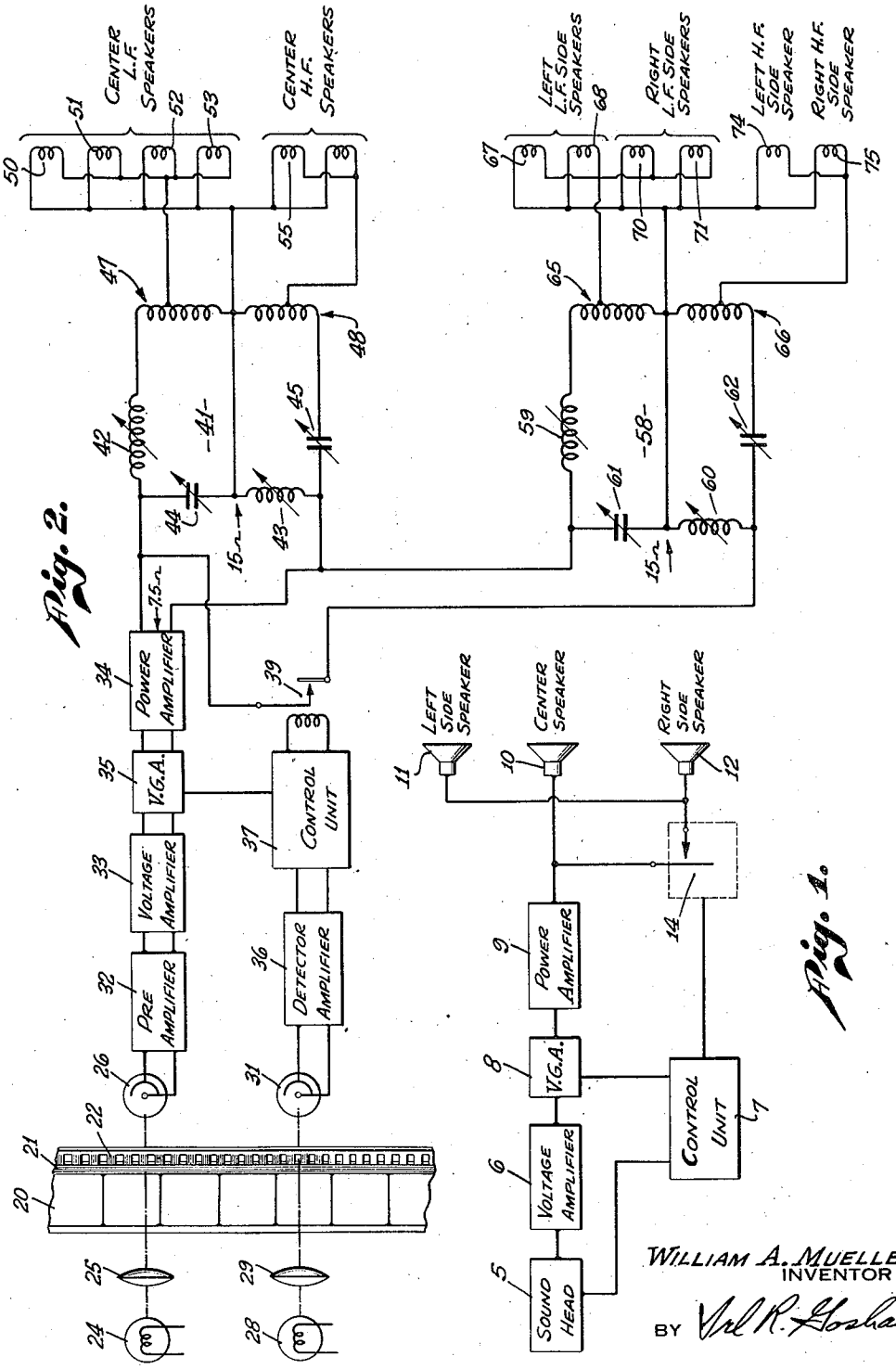

Fig. 2.

Fig. 1.

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Patented Oct. 31, 1944

2,361,490

UNITED STATES PATENT OFFICE

2,361,490

SOUND REPRODUCING SYSTEM

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Application December 29, 1941, Serial No. 424,749

13 Claims. (Cl. 179—100.3)

This invention relates to sound reproducing systems and particularly to a theatre sound system employed in conjunction with the projection of motion pictures.

During recent years, the exhibition of motion pictures with sound has improved considerably, one of these improvements being in the reproduction of the sound wherein the sound amplitudes are varied to enhance the dramatic effect of certain sequences of the picture or story. U. S. Patent 2,207,249 to A. N. Goldsmith and U. S. Patent 1,850,701 to J. Weinberger disclose and claim sound reproducing systems of this general type. In such systems, the entire sound volume range may be expanded beyond that on the film by the use of independent control tracks or records, or such control tracks may be used to considerably increase the volume level of only the normally high level passages.

Another function of control tracks is to distribute the sound among different speakers located across the proscenium of a theatre in accordance with the nature of the sound source being depicted at any particular time. For instance, the usual theatre sound equipment employs a speaker or several speaker units located behind the screen, while the new arrangement supplements these center speakers with speakers on each side of the center speakers. During certain sound passages, such as dialogue sequences, only the center units may receive sound energy, while during other passages, such as the showing of a large orchestra, all the speaker units propagate sound to the audience. With such a system, it is necessary to switch back and forth between the center speakers operating together with the side speakers and the center speakers operating alone.

The present invention, therefore, is directed to a system wherein the changeover from center to center and side speakers and vice versa is accomplished in such a manner that the listeners are not conscious of the change from one condition to the other. It is well known that when a single loudspeaker is receiving a certain amount of energy and that energy is then divided between two speakers, the reduction in acoustic output from the firrst speaker is substantially one-half or, in the terms of input energy, substantially 3 db. Thus, if the speakers were separated and a listener were positioned directly in front of one speaker, the changeover from one speaker to both speakers would be quite noticeable. This problem is presented in actual theatre operation whenever the side speakers are paralleled with the center speakers or the side speakers are disconnected from the center speakers at any particular volume level.

The principal object of the invention, therefore, is to facilitate and improve the reproduction and propagation of sound.

Another object of the invention is to vary the position or positions of sound sources with respect to a listening area without substantially varying the acoustic output for a constant signal level.

A further object of the invention is to maintain substantially constant the acoustic energy within a certain listening area during variations in the position or positions of the source of propagation of the acoustic energy.

A further object of the invention is to alternately centralize and spread the propagation of sound and automatically maintain a constant acoustic level within a given listening area.

Although the novel features which are believed to be characteristic of this invention are pointed out with particularity in the appended claims, the manner of its organization and the mode of its operation will be better understood by referring to the following description read in conjunction with the accompanying drawing forming a part thereof, in which

Fig. 1 is a diagrammatic arrangement of a general system involving the invention; and

Fig. 2 is a combination schematic-diagrammatic arrangement of a particular type of theatre sound reproducing circuit involving the invention.

Referring now to Fig. 1, a sound picture film soundhead 5 has two outputs, one to a voltage amplifier 6 for the signal to be reproduced, and the other to a control unit 7 for controlling the amplitude of transmission of the signal through a variable gain amplifier 8 and also controlling the point of switchover between center and side speakers. The output of the variable gain amplifier is fed into a power amplifier 9 and then to a center speaker 10. When a switch 14 is closed by the control track action, side speakers 11 and 12 are paralleled with the center speaker 10. This is the general arrangement wherein the soundhead 5 reproduces signal and control tracks, the control track varying the amplitude of the signal to the power amplifier 9 and operating the switch 14 at a certain predetermined level or character of sound. Thus, the center speaker may operate solely on dialogue, while any increased sound level or particular type of sound, such as that from large orchestras or other sound effects of avalanches or storms, will be divided among the three speakers 10, 11 and 12 to enhance the dramatic effect of the sequence. Any suitable form of control track, variable gain amplifier or marginal relays may be employed wherein the control track expands the signal as it is transmitted to the speakers in any particular grouping as disclosed and claimed in H. J. Reiskind Patent No. 2,299,410 of October 20, 1942.

and U. S. Patent No. 2,314,382 of M. C. Batsel of March 23, 1943. It is realized that when changeover occurs in one direction, the energy from the power amplifier 9 is divided among the three speakers and that a listener directly in front of the center speaker would ordinarily notice a decrease in volume at the changeover point. The present invention minimizes this decrease by automatically varying the transmission loss between the power amplifier and the speakers in accordance with the number of speakers connected to the amplifier.

Referring now to Fig. 2, a film 20 is shown having a signal track 21 and a control track 22, the latter being located in the sprocket hole region of the film as disclosed and claimed in U. S. Patent No. 2,070,260 of C. M. Burrill, of January 20, 1942. An optical system for the signal record is shown diagrammatically by light source 24 and a lens 25 which projects a beam of light on the signal record 21, the emergent light being received by a photocell 26. Similarly, for the control record, light from a source 28 is projected through a lens 29 to the control track section of the film, the emergent light being received by a photocell 31. The above-described scanning arrangement is one particular form, but any other suitable type of control track system may also be employed.

The output of the photocell 26 is impressed upon a pre-amplifier 32 and then passed through a voltage amplifier 33 and variable gain amplifier 35 to a power amplifier 34. The output of the photoelectric cell 31 is impressed upon a detector amplifier 36 and then on a control unit 37, as disclosed in the above-mentioned patent of C. M. Burrill. Control unit 37 varies the output of the variable gain amplifier 35 in accordance with the variations of control track 22 and also, at a definite cue or level, operates a single contact switch 39 in any suitable manner such as shown in the above-mentioned M. C. Batsel application.

The output of the power amplifier 34 is impressed upon a crossover network 41 comprising variable inductances 42 and 43 and variable capacitances 44 and 45, these variable elements being adjusted to a definite value in accordance with the frequency bands to be reproduced by low-frequency and high-frequency speakers, as is well known in the art. Connected to the crossover network is an auto-transformer 47, which feeds four center low-frequency speakers 50, 51, 52 and 53, and also an auto-transformer 48 which feeds two center high-frequency speakers 55 and 56. These units just described will correspond with the center speaker 10 shown in Fig. 1.

Bridged across the output circuit of the power amplifier 34 and connected thereto when the switch 39 is closed, is a second crossover network 58 having inductances 59 and 60 similar to inductances 42 and 43 of network 41 and variable capacitances 61 and 62 similar to capacitances 44 and 45. The output of the network 58 is fed into an auto-transformer 65, to which are connected two low-frequency side speakers 67 and 68 positioned on the left of the center speakers, and two low-frequency speakers 70 and 71 positioned on the right of the center speakers. To another auto-transformer 66 are connected a high-frequency speaker 74 associated with the side speakers 67 and 68, and a high-frequency speaker 75 associated with the low-frequency speakers 70 and 71.

The above description is of a typical theatre installation of speakers in accordance with the invention wherein the center and side speakers compose a plurality of units, although the invention is applicable to a system using any number of speaker units, as will be understood from the following explanation.

As shown in Fig. 2, the output impedance of the power amplifier 34 is 7½ ohms and is connected to the 15-ohm network 41 only when the switch 39 is open, this network constituting the only load on amplifier 34 when the center speakers 50, 51, 52, 53, 55 and 56 are operating alone. It will be noted a 1-to-2 impedance mismatch exists with this connection. However, with the switch 39 closed, the two crosover networks 42 and 58 are in parallel with the power amplifier and the output impedance of the power amplifier is now matched to its load. Thus, impedances are matched when the power amplifier is feeding both center and side speaker units, but mismatched when only the center speaker is operating.

It is well known that to obtain the maximum power transfer from a generator to a load or from one unit to another, the impedance of the two units connected should be matched and that any mismatch ordinarily inserts a transmission loss. This principle is utilized in the present invention. In this circuit, however, it will be noted that the transmission loss is automatically inserted between the power amplifier and the network 42 when the switch 39 is open, which corresponds to when only the center speakers are operating. Thus, in this condition, the center speaker units will receive a certain energy from the power amplifier 34 for a given input energy to the latter. Now, when the switch 39 is closed and the side speakers are connected to the power amplifier, the change in the impedance match is in a direction to increase the energy passing to all the speakers, thus compensating for the drop in energy from the center speakers caused by the side speakers being connected.

From measurements made in actual practice, the actual decrease in input to the center speaker was found to be in the neighborhood of 0.8 of a db. instead of the normal 3 db., which would occur with matched impedances under both conditions. The result of this arrangement is that the listeners directly in front of the center speakers have difficulty in detecting any change whatsoever in the output level. In fact, the spreading effect from the side speakers apparently compensates for this small decrease in volume from the center units. Thus, it has been found that switching back and forth between the center speaker and the center speaker and side speakers combined is not noticeable to the listening audience, while obtaining the dramatic effects of the spread sound source. Although certain definite values of impedances have been given in the above description, it is to be understood that other values will function in the same manner and produce the same results if the ratios and the direction of the impedance changes are in accordance with this invention.

What I claim as my invention is:

1. A sound reproducing system comprising a source of signal currents to be reproduced, an amplifier for said currents, a plurality of sound reproducers for translating said currents into sound waves, and means for connecting one or more of said reproducers to the output circuit of said amplifier, said combined impedances of said reproducers and the impedance of the output cir-

cuit of said amplifier being substantially matched when all of said reproducers are connected to said output circuit, and said impedances being mismatched when less than all of said reproducers are connected to said output circuit, said impedance variation maintaining the acoustic output of any originally connected reproducer substantially constant for an input signal of any given level when one or more additional reproducers are connected to the output circuit of said amplifier.

2. A sound reproducing system in accordance with claim 1 in which the connection of additional groups of reproducers to said output circuit is varied by a control track at a certain predetermined level in said originally connected reproducers.

3. A reproducing system in accordance with claim 1 in which a variable gain amplifier is provided for varying the ratios between the amplitudes of said currents as reproduced and the amplitudes of said currents at said source, said variable gain amplifier being controlled by a control record.

4. A system for the reproduction of sound by a variable plurality of reproducing units comprising means for generating signal currents corresponding to sound waves, means for amplifying said currents, and means for connecting the output circuit of said amplifier with said reproducers, said last-mentioned means being adapted to vary the number of reproducers actually connected to the output circuit of said amplifier at any particular time, the impedances of said reproducers having such a relationship with respect to the impedance of said output circuit that a mismatch in impedances is provided between the output circuit of said amplifier and one of said reproducers, and matched impedances are provided between the output circuit of said amplifier and all of said reproducers, said impedance variation maintaining the acoustic output of any connected reproducer substantially constant for an input signal of any given level when one or more additional reproducers are connected or disconnected to the output circuit of said amplifier.

5. A system for the reproduction of sound in accordance with claim 4 in which means are provided for generating secondary currents, said secondary currents being adapted to vary the ratio of amplification of said signal currents, and the number of reproducer units actually connected to said output circuit at any particular time.

6. A system for the reproduction of sound in accordance with claim 4 in which said signal currents and a secondary current for controlling the ratio of amplification of said signal currents are obtained from photographic film records.

7. The method of maintaining a substantially constant acoustic output from a sound reproducer adapted to be actually connected to and disconnected from a signal amplifier along with other reproducers comprising selecting the impedance of each of said reproducers and the impedance of said amplifier to have a relationship such that the combined impedance of all of said reproducers matches the impedance of said amplifier when all of said reproducers are connected to said source and when less than all of said reproducers are connected to said amplifier, the impedance is mismatched, said impedance variation maintaining the acoustic output of any connected reproducer substantially constant for an input signal of a certain level during the connection and disconnection of other reproducers to said amplifier.

8. The method in accordance with claim 7 in which the impedance of the reproducers is greater than the impedance of the amplifier during the periods when an impedance mismatch exists between said amplifier and said reproducers connected thereto.

9. A system of sound reproduction with a plurality of sound reproducers adapted to be connected and disconnected during sound reproduction comprising means for generating signal currents, means for amplifying said currents, a plurality of reproducers having respective associated units for high and low frequency components of said signal currents, and a plurality of crossover networks connected intermediate said units and the output circuit of said amplifying means, the impedances of said crossover network being matched to the respective units connected thereto and matched to said output circuit when all of said crossover networks are connected to said output circuit, but the impedance of said output circuit being mismatched with the impedance of any one of said crossover networks.

10. A system of sound reproduction in accordance with claim 9 in which said signal current generating means includes a sound film record, and means are provided for generating control currents from said sound film for varying the ratio of amplification of said signal currents and controlling the connection of the number of reproducers connected to said output circuit at any one time.

11. A system for the reproduction of sound by a variable plurality of reproducing units comprising means for generating signal currents for reproduction in said variable plurality of reproducing units, means intermediate said generating means and said reproducing units for amplifying said currents, and means for switching the output circuit of said amplifying means to different numbers of said reproducing units, additional numbers of said reproducing units being connected to and disconnected from the same output circuit as said operating units by actuation of said switching means at a predetermined acoustic output level from said operating units, the input impedance to said reproducing units having a relationship to the output impedance of said output circuit such that a mismatch of impedances is obtained between said output circuit and said reproducing units when less than all of said reproducing units are connected to said output circuit and a matching of impedances is obtained between said output circuit and said reproducing units when all of said reproducing units are connected to said output circuit.

12. A system in accordance with claim 11 in which said switching means includes a relay having contacts connected to said output circuit and contacts connected to certain of said reproducing units.

13. A system in accordance with claim 11 in which a second means for generating control currents is provided, said control currents actuating said switching means to connect and disconnect said additional units to and from said output circuit.

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