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SYSTEM FOR REPRODUCING SOUND FROM A SOUND RECORD

Filed Oct. 14, 1931

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This invention relates to amplifying systems and provides a system for separating electrical energy into a plurality of frequency groups and for amplifying the energy in any or all of the groups in accordance with the strength of the applied energy in that group. The outputs of these systems may be combined and reproduced by a single means, or the output of each system may be reproduced independently.

The invention provides a method by which various frequency groups may be amplified independently, the amplification or gain ratio being greater for strong signals than for weak ones. This is accomplished by the use of filter systems in conjunction with means for controlling the operating characteristics of space discharge amplifiers in accordance with the strength of the applied signals, so that the amplifying ratio or gain of these devices is greater for strong signals than for weak signals.

The system may be used in connection with the pickup from a phonograph or from a photographic sound record and may also be applied to a piano in order to accentuate the high frequencies and give them a greater range of amplification than the low frequencies. The construction of a piano is such that the high notes are produced by thin short strings and therefore have a relatively small amplitude. By utilizing the present system for these notes it is possible to expand the volume range and to cause the high frequency notes to be relatively stronger when the piano is played forte and weaker when it is played pianissimo, thus producing a more balanced effect in the music.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its operation may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 illustrates diagrammatically the system as applied to the reproduction of the sound record of a talking moving picture projector or a phonograph.

Fig. 2 illustrates diagrammatically a modified form of the invention.

Fig. 3 is a front elevation partly in section of a piano constructed in accordance with this invention.
The resistances $R_3$ are shunted by condensers $C_6$ and by rectifiers $R_7$, which are in series with the secondaries of transformers $T_6$. The primaries of these transformers are connected in the plate circuits of space discharge amplifiers $T_7$, the grids of which are connected through blocking condensers $C_2$ to the input circuits of the space discharge devices $S_1$.

In the operation of the invention shown in the accompanying Fig. 1 the switch $S_1$ is thrown down when it is desired to use the phonograph, and is thrown up when it is desired to use the moving picture projector. In either case, the energy received passes through the transformer $T_2$ to the three filter circuits $S_2$, $S_3$, and $S_4$. These separate out the energy of various frequency groups, the filter $S_2$ allowing the high frequencies to pass; the filter $S_3$, the intermediate; and the filter $S_4$, the low frequencies.

The energy from these potentiometers then passes into the input circuits of the space discharge amplifiers $S_1$ of the amplifiers $T_7$, $T_8$, and $T_9$. Parts of these energies pass through the blocking condensers $C_2$ to the input circuits of the space discharge amplifiers $T_7$. The output currents from these amplifiers then pass through the primary windings of the transformers $T_8$. The currents in the secondaries of these transformers are rectified by the rectifiers $R_7$ and flow in the direction of the arrows through the resistances $R_3$. This causes potential differences to be built up across these resistances which are proportional to the currents flowing therein and therefore proportional to the input signal strength of each of the amplifiers. These potential differences cause a decrease of the biases of the space discharge devices $S_1$, thereby decreasing their impedances and increasing their amplification ratios. It is thus seen that the amplification or gain ratios of these devices vary in accordance with the input signal strength, being greater for strong signals than for weak ones. By making the grid of the $S_3$ zero and by reducing the potential of the battery $S_4$ to that for normal bias any of the stages $T_8$, $T_9$, or $T_{10}$ may be made to act as normal amplifiers.

The outputs of the space discharge devices $S_1$ pass through the primaries of the transformers $T_4$, $T_5$, and $T_6$, and through the resistances $R_4$. These resistances are of the order of the internal impedance of the space discharge devices $S_1$, and maintain the frequency characteristics of these devices independent of the amplitude characteristics. The currents from the secondaries of the transformers $T_4$, $T_5$, and $T_6$ are amplified by the push-pull amplifiers $T_7$, $T_8$, and $T_9$. The amplified outputs from these devices then pass through the transformers $T_7$, $T_8$, and $T_9$ to the loudspeakers $X_1$, $X_2$, and $X_3$, where the high frequency, intermediate frequency, and low frequency tones are reproduced in the usual manner.

It is thus seen that by this system the high, intermediate, and low frequency tones are amplified separately, each amplification being accomplished by means of amplifiers in which the amplification or gain ratios vary in accordance with the input signal strength, being greater for strong signals than for weak ones. In this way, each group of tones is amplified independently and to the best advantage, each group being reproduced by a separate loud speaker which tends to work most efficiently. In these ranges thus produced, a much improved or equal effect over that which would be produced by the use of a single amplifier and loud speaker. If found desirable, it would be possible however to connect the outputs of the three amplifying systems to a single loud speaker $X_1$ having individual adjustments $S_4$, $S_5$, and $S_6$. In each amplifying system, it is possible to control the three groups of tones independently. Another advantage of this system is that by having three separate amplifiers a loud note in any particular frequency group will not tend to cause the frequency groups to be amplified out of their true proportions. In this way it is possible to prevent what is known as blowing, which is caused by one very loud note causing the amplifier to amplify the whole scale instead of that particular note.

Referring to the modified form of the invention Fig. 2 shows an amplifying system which receives its energy from a mechanical pick-up $S_7$, or a photoelectric cell $S_8$. This cell receives light from a lamp $S_4$, which is energized from a source of power $S_7$. The light from this lamp is focused by a lens $S_8$ through an aperture $S_8$, and into an aperture plate $S_8$, upon the sound record of the moving film $S_9$. The light which passes through this film then strikes the photoelectric cell $S_8$. This cell is connected through an amplifier $S_8$ to two contacts $S_8$ of a double-pole double-throw switch $S_8$, the other contacts $S_8$ of which are connected to the mechanical pick-up $S_8$. The blades of the switch $S_8$ are connected to the primary of a transformer $S_8$, the secondary of which is connected to two filter circuits $S_8$ and $S_8$, the former being a high pass filter, which allows only the upper harmonics to pass, and the latter being a low pass filter which allows only low frequencies to pass. These filter circuits are connected to the primaries of two transformers $S_8$ and $S_8$, the secondaries of which are connected to potentiometers $S_8$ and $S_8$, respectively.

The potentiometer $S_8$ is connected in the input circuit of a space discharge amplifier $S_8$. The grid return of said amplifier includes resistance $S_8$ and batteries $S_8$ and is connected to a potentiometer $S_8$. A control amplifier $S_8$ is also connected across potentiometer $S_8$ through a stoppage condenser $S_8$. The output circuit of this amplifier $S_8$ is connected through a transformer $S_8$ to a rectifier circuit including a rectifier $S_8$ and resistance $S_8$. The output circuit of the space discharge means $S_8$ is connected to the primary of a transformer $S_8$, the purpose of which is to keep the input resistance of the transformer practically constant and independent of the impedance change between the plate and filament of amplifier $S_8$. The potentiometer $S_8$ is connected in the input circuit of a space discharge amplifier $S_8$, the output circuit of which is connected to the primary of a transformer $S_8$. The secondaries of the transformers $S_8$ and $S_8$ are in the input circuits of two space discharge means $S_8$ and $S_8$, the output circuits of which are connected in parallel to the moving coil of a loud speaker $S_8$, the field winding $S_8$ of which is energized from a source of power $S_8$. The secondaries of the transformers $S_8$ and $S_8$ are in the input circuits of two space discharge means $S_8$ and $S_8$, the output circuits of which are connected in parallel to the moving coil of a loud speaker $S_8$, the field winding $S_8$ of which is energized from a source of power $S_8$.
In the operation of the form of the invention shown in the accompanying Fig. 2, when it is desired to use the pick-up 110 the switch 122 is thrown down, and when it is desired to use the microphone 111, the switch 122 is thrown up. In either case, energy is fed to the transformer 124 from the secondary of which it passes to the two filter circuits 125 and 126. The former allows only the high frequencies to pass. The energy from this circuit passes through the transformer 121 to the potentiometer 131, where any desired amount may be fed to the input circuit of the space discharge means 133. Some of the energy in this circuit passes through the stopping condenser 143 to the control amplifier 145. The output from this amplifier passes through the transformer 146 and is rectified by the rectifier 146, causing a D. C. current to flow in the direction of the arrow, through the resistor 142. The amount of current flowing through this resistor varies with the voltage drop therein. Thus, as the current is increased the potential drop of resistance 142 will be increased which causes a decrease of the negative potential of the grid of the space discharge amplifier 133 allowing more current to pass therethrough. In this way an increase of amplification for loud signals is obtained. The energy from the transformer 141 is then amplified by the space discharge means 153, the output of which passes through the moving coil of the loud speaker 55, thereby causing the high frequency tones to be reproduced in the loud speaker. The volume of the sound is controlled by the potentiometer 131 and the amplification varies according to the strength of the original tones so that the amplification ratio is greater for louder tones than for weak ones.

The low frequencies are passed through the filter 125 and the transformer 129 to the potentiometer 132. The energy from this potentiometer is amplified by the space discharge amplifier 151, the output of which passes through the transformer 153 and is applied to the space discharge amplifier 154, the output of which passes through the moving coil of the loud speaker 155 where it is combined with the output of the space discharge means 153. Thus the low frequencies are reproduced in the loud speaker 155, the volume being controlled by the potentiometer 132. These frequencies, however, are amplified by a straight system of amplification so that the tones of high and low intensities are amplified in the same ratio.

Referring to Fig. 3 a piano 161 is shown which is provided with the usual sound board 162 and action 164. Mounted on the cross bracing 165 of the piano is the electric magnetic pickup device 110, such as that shown in Fig. 2. The armature 166 of this device is secured to the sound board 162 and the winding is connected to the primary of the transformer 124 of Fig. 2. Secured to the under surface of the sound board 162 is the loud speaker 155 which is connected to the output circuit of the devices 153 and 154 of Fig. 2. A hole 167 may be provided in the sound board above the loud speaker 155.

In the operation of the systems applied to a piano as shown in Fig. 3 the piano 161 is played in the usual manner. The vibrations of the sound board 162 are picked up by the pick-up device 110 and passed to the transformer 124. From here on the operation is the same as that described in connection with Fig. 2. The vibrations from the loud speaker 155 are transmitted to the sound board 162, thus causing a regenerative action and also adding the tonal qualities of the sound board to the reproduced music.

This system is particularly useful as applied to a piano inasmuch as the higher frequency notes are ordinarily of relatively low intensity and do not produce as much audible response as the low notes unless struck with greater force. The present system avoids this difficulty and permits the notes of the higher register to be amplified in any desired ratio with respect to the lower frequency notes whereby various audible effects may be obtained.

Although only a few of the various forms in which this invention may be embodied have been shown here in, it is to be understood that the invention is not limited to any specific construction, but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A system for producing sound from a sound record comprising in combination a sound record, a pick-up device therefor, a receiver of sound energy, a plurality of paths connecting said pick-up device and receiver, means for passing different frequency bands of the sound energy, and means in at least one of said paths controlled by the dynamics of the frequency bands passing through said path for controlling the intensity of the sound passed through said path.

2. A system for producing sound from a sound record comprising a pick-up device, three amplification channels, means for separately selecting the high frequency, intermediate frequency and low frequency tones and applying the selected tones to the respective channels, means for independently controlling the gain ratio of each of said channels by the average intensity of energy passing through the particular channel and means for producing sound effects thereby.

3. A system for producing sound from a sound record comprising a pick-up device, a plurality of amplification channels, means for separately selecting the high frequency, intermediate frequency and low frequency tones and applying the selected tones to the respective channels, means for independently controlling the gain ratio thereof so that the energy ratio of said certain frequency ranges is expanded and means for producing sound effects in accordance with the energy of each of said channels.

4. A system for producing sound from a sound record comprising a pick-up device, a plurality of amplification channels, means for separately selecting various frequency ranges and applying the selected frequencies to the respective channels, means controlled by the average input energy in certain of said channels for independently controlling the gain ratio thereof so that the energy ratio of said certain frequency ranges is expanded and means for producing sound effects in accordance with the energy of each of said channels.

5. A system for producing sound from a sound record comprising a sound record, a pick-up, a pair of amplification channels, filter networks associated therewith whereby the high and low frequency tones are separately amplified, said channel means for varying automatically the gain ratio only of the high frequency channel in accordance with the strength of signal there-
in and means for combining the sound effects from the various channels.

6. In a sound producing system, a piano having a sounding board and strings, pick-up means for picking up vibrations therefrom, filter circuits for separating the high and low frequency energy derived from said pick-up means, means for separately amplifying said high and low frequency energies and means for controlling the ratio of said energies to produce the desired sound effect.

7. In a sound producing system, a piano having a sounding board and strings, pick-up means for picking up vibrations from said sounding board, filter circuits for separating the high and low frequency energy derived from said pick-up means, means for separately amplifying said high and low frequency energies, means for varying the amplification ratio of the high frequency energy in accordance with the strength of said energy and means for producing a sound effect by the combined action of the high and low frequency energies.

8. In a phonographic system, a source of sound energy, a receiver of sound energy, a plurality of paths between said source and said receiver, means in said paths for passing different frequency bands of the sound energy, and means in at least one of the paths controlled by the dynamics of the frequency bands passing through said path for modifying the dynamics of the sound passing through that path.

9. In a sound reproducing system, a sound record, a pick-up device therefor, a speaker for delivering sound, a plurality of paths between said pick-up device and said speaker, means in said paths for passing different frequency bands of the sound energy, and means in at least one of the paths controlled by the dynamics of the frequency bands passing through said path for expanding the dynamics of the sound passing through that path.

10. The method of reproducing a recorded selection from a sound record which comprises picking up said selection, dividing said selection into different frequency bands and separately expanding the dynamics of at least the highest frequency band.

11. In a phonographic system, the method of reproducing a recorded selection from a sound record which comprises picking up the selection from said record, dividing said selection into different frequency bands and separately modifying the dynamic contrast between the loud and soft notes of at least one of the frequency bands.

12. In a phonographic system, the method of changing the dynamics of a selection which comprises picking up said selection, separately modifying the dynamic contrast between loud and soft notes in each range of the different registers of the entire audible spectrum and delivering the modified selection into an output device.

13. The method of reproducing a recorded sound selection which comprises picking up said selection, separately expanding the dynamic range between the loud and soft notes of the different registers of the entire audible spectrum and delivering the modified selection into sound waves.

14. The method of reproducing a recorded sound selection which comprises picking up said selection, expanding the dynamic range of the higher pitch notes while leaving the dynamic range of the lower pitch notes substantially unchanged and delivering the modified selection into an output device.

15. In a phonographic system, the method of improving a sound selection which comprises picking up said selection, modifying the dynamic range of a part of the audible spectrum while leaving the dynamic range of the rest of the audible spectrum substantially unchanged, and delivering the modified selection into an output device.

16. In a system of amplifying audio frequency signals, means for translating a signal from a sound record, a pair of amplifying circuits, filters associated with each of said circuits and connected with said translating means, one of said filters being adapted to pass the high frequency components of the applied signal and the other of said filters being adapted to pass the low frequency components of the applied signal, and means in each of said amplifying circuits controlled in accordance with the intensity of the signal in said circuit for varying the gain ratio of said amplifier whereby the volume ratio of each of said components is expanded.

17. In a sound record system, an originator of sound energy, a receiver for said sound energy, a plurality of paths connecting said originator and said receiver, filter means in each of said paths for passing different frequency bands through said paths, an amplifier in each path, means in each path controlled by variations in intensity of the sound energy in that path for controlling the gain ratio of the amplifier in that path.

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