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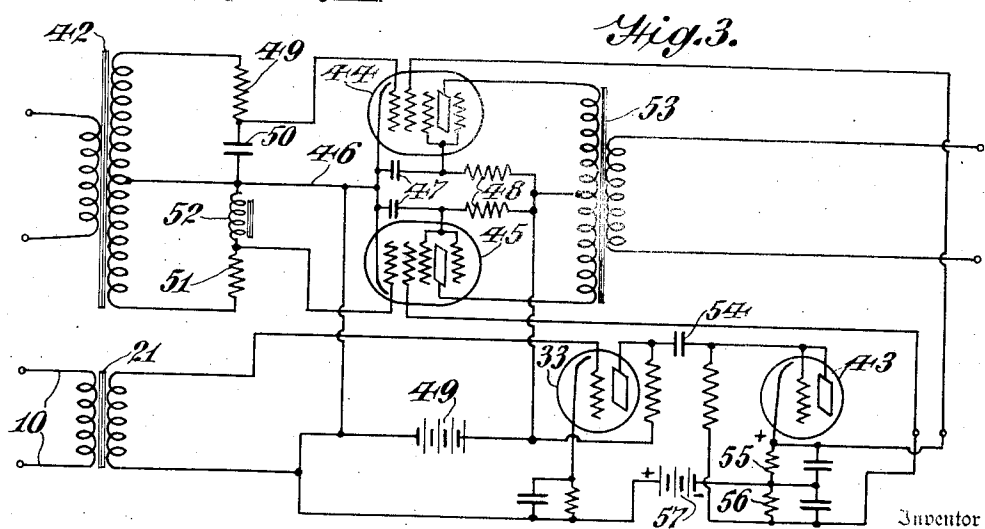
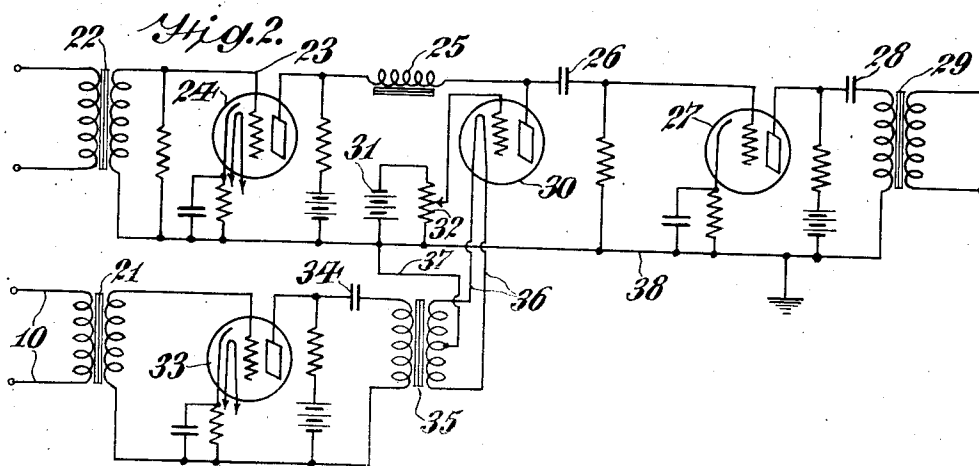
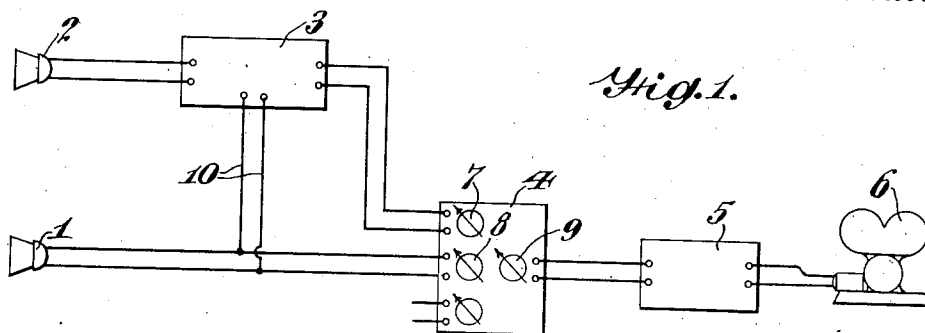
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2,173,222

METHOD AND APPARATUS FOR SOUND RECORDING

Filed April 30, 1936

2 Sheets-Sheet 1



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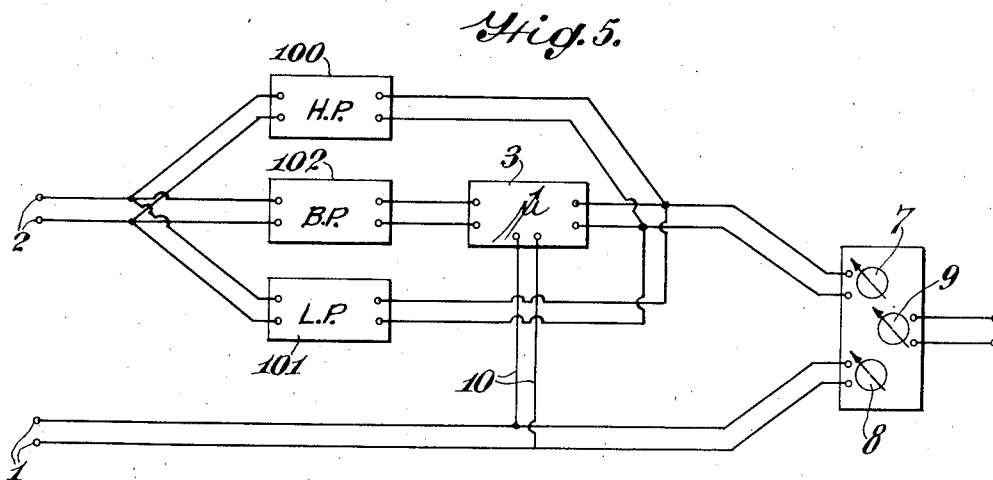
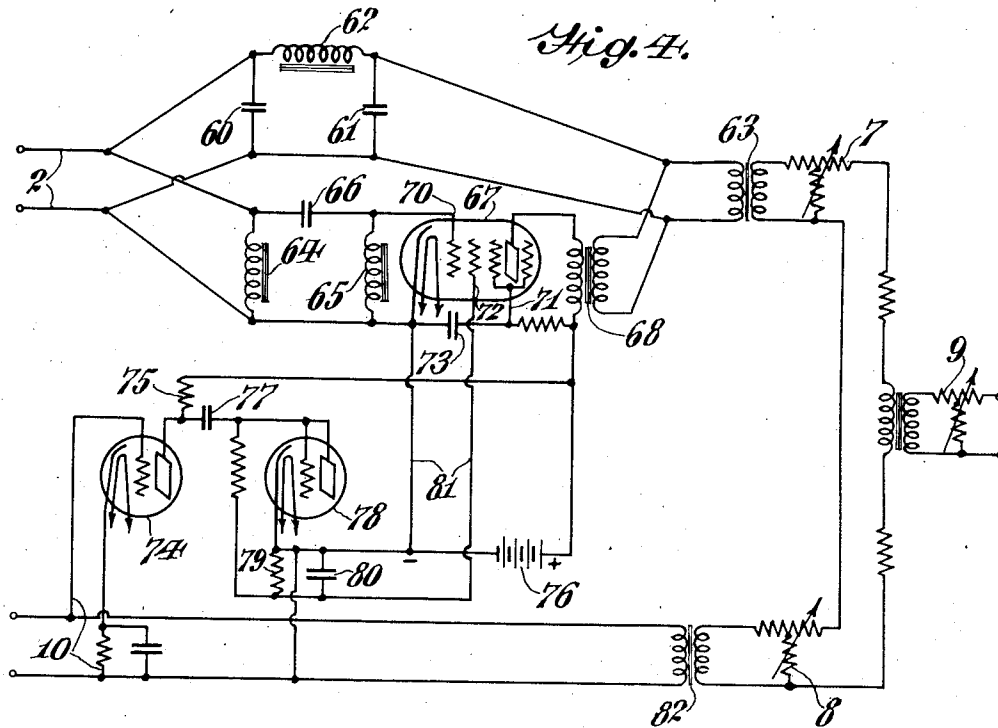
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METHOD AND APPARATUS FOR SOUND RECORDING

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR SOUND  
RECORDING

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5 Claims. (Cl. 179—100.1)

This invention relates to an apparatus for mixing sound from two or more sources and more particularly to a variety thereof wherein the sound from one source controls a characteristic of the sound from the other source or sources. In the recording of sound particularly for sound picture records it is customary to provide a music record and then add to the music either at the time the picture is being taken or afterward the appropriate speech. This is usually done in re-recording, i. e. the picture is taken and the voice is recorded therewith. Thereafter, the desired music is provided in the form of a sound record and is run through a phonograph, preferably using a film music record and a film phonograph while the voice record is similarly played back, the two being mixed and recorded as a single record. In doing this, it is necessary that the voice be rendered loud and rather harsh if the music be kept at a substantially uniform level. As an alternative method, the level of the music has been decreased during the speech and increased to its normal value at the conclusion thereof. As pointed out in Patent No. 1,888,467 to Mueller, this has been accomplished manually and the said patent proposes to do the same thing automatically, controlling the music directly by the voice impulses.

None of the foregoing methods are entirely satisfactory nor are they in accord with ordinary orchestral practice.

Where voice is rendered with orchestral accompaniment it has not been found satisfactory in practice to reduce the volume of the entire orchestra during the vocal passages. On the contrary, usually only those instruments are reduced in volume or suppressed which, from their tone quality or pitch, would interfere with the audibility of the voice. For example, during vocal passages, particularly of dance music, the drums and other rhythm instruments are not suppressed or reduced in volume but are kept at normal volume. On the other hand, with a soprano or alto solo such instruments as the cornet, the clarinet and soprano saxophone may be either suppressed or reduced in volume, the corresponding portion of the piano accompaniment may be either omitted or reduced in volume and instruments approaching the same frequency range, such as the alto horn and the alto saxophones and cellos, may be somewhat reduced in volume and caused to play a harmonizing rather than a similar part. On the other hand, instruments of much higher range and having such tone quality as not to interfere with the voice rendition such, for ex-

ample, as the violins and flute, may be maintained at full volume.

Similarly, in the rendition of a baritone or bass solo the conflicting instruments such as the trombone, tenor saxophone, etc. may be suppressed while the instruments remote from the particular voice range are left substantially unchanged.

It is the purpose of my invention to accomplish automatically in the mixing of voice and sound records what is accomplished in the manner pointed out above in the original rendition of voice with proper orchestral accompaniment, and I do this by decreasing the volume of the music record in the particular tonal range wherein it will conflict with the voice record. It will be apparent that my novel method may be accomplished manually, but I prefer, in order to more closely follow the voice passages, to accomplish the control automatically from the voice passages themselves.

One object of my invention is to provide a novel method of making voice and music records.

Another object of my invention is to provide a novel method of suppressing undesired portions of music records during voice passages.

Another object of my invention is to provide an apparatus for mixing voice and music records and suppressing undesired portions of the music record.

Another object of my invention is to provide means for automatically suppressing undesired frequency ranges in the music record in accordance with or by means of the voice input.

Other and incidental objects of my invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawings in which

Figure 1 is a diagrammatic illustration of one arrangement of the apparatus,

Figure 2 is a schematic wiring diagram of the automatic frequency control used in connection with Figure 1,

Figure 3 is a schematic wiring diagram of a second form of frequency control which may be used in conjunction with Figure 1,

Figure 4 is a schematic wiring diagram of a third circuit which I may use in conjunction with my invention as shown in Figure 1, and

Figure 5 is a diagrammatic illustration of a second arrangement of apparatus which I may use in conjunction with any of the foregoing circuits.

Referring, first, to Figure 1, the voice input

which may be either a microphone, a disc phonograph, a film phonograph or any other equivalent source of electrical waves corresponding to voice impulses is indicated at 1. The corresponding source of music which may be any desired variety and not necessarily the same type of source as source 1 is indicated at 2. The frequency-control or frequency-selective amplifier is indicated at 3, the mixer at 4, the recording amplifier at 5 and the recorder at 6. The mixer 4 includes manual control means 7 and 8 for determining the relative volumes of the outputs from the sources 1 and 2 and a control means 9 for determining the total output from the two sources to the amplifier 5. The amplifier 5 may be of any appropriate or convenient type having sufficient voltage gain and power output to properly actuate the recorder 6. The recorder 6 is preferably, as diagrammatically illustrated, a sound-on-film recorder of the variable area or any other suitable type. The control means 7, 8 and 9 of the mixer 4 may be of any desired type such as a simple potentiometer but are preferably of the T-pad or H-pad type which are well known in the art and which move to keep the impedances of the several circuits properly matched.

A portion of the input from the voice source 1 is diverted through the leads 10 to the music control amplifier 3 of which one species is shown in schematic form in Figure 2.

In the species of voice-controlled amplifier shown in Figure 2, the voice input from the leads 10 is fed into the apparatus through the transformer 21 and the music input from the source 2 is fed in through the transformer 22. In music recording, when there is no speech input, the output from the transformer 22 is applied to the grid 23 of the tube 24 in the manner shown, and the audio frequency output from the plate of the tube 24 passes through the reactor 25 and the capacitor 26 to the grid of the tube 27 which further amplifies the impulses, passing them through the condenser 28 to the output transformer 29. The tube 30 does not operate under these circumstances. When voice input is received from the leads 10, it passes through the transformer 21 to the amplifier tube 33 where it is amplified and passed through the condenser 34 to the transformer 35. The output from the transformer 35 is fed through the leads 36 to the cathode heating circuit of the tube 30, the middle tap of the transformer being connected through the lead 37 to the ground lead 38 of the other portion of the amplifier. Approximate grid bias for the tube 30 is provided by the C battery 31 and the potentiometer 32. The tube 30 is preferably of the variety known as a type 30 Radiotron which requires, for normal characteristics, a filament voltage of two volts and a filament current of .060 ampere.

It will be apparent that when there is no voice input there is no output from the transformer 35 and therefore no emission from the filament of the tube 30, which remains at an infinite resistance. The reactor 25 presents a high impedance to the high frequency components of the sound and is effective to produce between the anode and cathode of the tube 30 a voltage which varies with frequency and increases with frequency. Accordingly, when input is applied across the leads 10 the output from the transformer 35 serves to heat the filament of the tube 30 and to thereby present a relatively low resistance across the circuit. On account of the characteristics of the inductance 25, the high frequencies will be more or less by-

passed through the tube 30, thereby eliminating high frequencies from the output of the amplifier 3 in proportion to the amount of voice input received.

The amplifier shown in Figure 3 is of a slightly different type. In this amplifier the input from the leads 10 is applied through a transformer 21 to a tube 33 as before, the output from the tube 33 being applied through a resistance-capacitance coupling to the tube 43. The input from the transformer 42 which is connected to the music source is applied through a coupling arrangement hereinafter described to the tubes 44 and 45. These tubes are preferably of the variable gain pentode type, such for example as the type 6D6 Radiotron and the type 58 triple-grid super control Radiotron amplifier or 73 triple-grid super control Radiotron amplifier, for reasons which will hereinafter be explained. These tubes have their cathodes connected to a common lead 46 with the usual by-pass condensers 47 and screen bias resistors 48 interposed, and derive their plate and screen currents from the same battery 49 as the tube 33. The lead 46 is connected to the midpoint of the transformer 42, of which one side is connected to the tube 44 through the resistor 49 and the condenser 50, while the other side is connected to the tube 45 through the resistor 51 and inductance 52. With the circuit shown and the tubes referred to a negative grid bias is not always necessary in the lead 46 but if so desired bias may be supplied here by the insertion of an appropriate C battery or equivalent biasing circuit. The output from the tubes 44 and 45 is connected through the transformer 53 to the leads to the control member 7 of the mixer 4.

It can be shown mathematically that if the square root of the inductance of the choke 52 divided by the impedance of the condenser 50 is equal to the resistance of the resistors 49 or 51, which are similar, then the amplification of the amplifier will be flat over substantially the entire frequency range if the gain of the two amplifier tubes is the same. If, however, the gain of these amplifier tubes 44 and 45 is changed then the entire characteristic of the amplifier will be tilted one way or the other about a predetermined frequency increasing the gain at high frequencies and decreasing the gain at low frequencies or vice versa, according to the direction of shift of the gain of the tubes. The frequency about which this tilt of the amplifier characteristic occurs is determined by the relation of the condenser 50 and the inductance 52, i. e. this frequency equals the reciprocal of  $2\pi$  times the square root of the product of the inductance and the capacitance, these units being expressed in farads, henries, ohms and cycles per second. When the gain of the tube 45 is increased and that of the tube 44 decreased a gain in high frequencies and decrease in low frequencies results. On the other hand, when the gain of the tube 44 is increased and the gain on the tube 45 is decreased an increase in low frequencies and decrease in high frequencies is produced and this is the condition which we desire to cause by the introduction of speech.

In order to accomplish this, the output from the tube 33 is fed through a condenser 54 to the tube 43 which has its grid and plate tied together to act as a rectifier. It will be apparent that any diode or other appropriate rectifier may be used in place of the tube 43. This rectified output establishes a potential drop across the resistors 55 and 56 which have their center tap connected through the battery 57 to the lead 46. It will be

apparent that when voice is applied through the circuit 10 current varying as the volume of the sound will pass through the resistors 55 and 56 rendering the cathode end of the resistor 55 positive and the opposite end of the resistor 56 negative, thereby rendering the amplification-control grid of the tube 45 more negative and decreasing the amplification thereof while at the same time correspondingly increasing the amplification of the tube 44. It will thus be apparent that any voice input will cause a decrease in high frequencies and of increase in low frequencies of the music transmitted. It will be apparent that this amplifier, as well as the form shown in Figures 2 and 4, is not limited to use in the arrangement shown in Figure 1 or Figure 5. For example, the leads indicated at 10 may be connected to the same source of sound as the input of this amplifier indicated at 2, and in this case the frequency response will be shifted according to the loudness of the input sound.

Further, instead of connecting my frequency control unit 3 to a source of audio input such as 1, I may connect the leads 10 to an appropriate source of current such as a battery and a potentiometer, omitting the intervening tubes and transformers and I thereby have an amplifier having a remote frequency-response control.

In the third form of the circuit shown in Figure 4 the input from the source 2 is divided, a portion passing through the low-pass filter including the shunt condensers 60 and 61 and the series inductance 62 to the transformer 63, and another portion passing through the high pass filter including the shunt inductances 64 and 65 and the series condenser 66 to the amplifier tube 67. The output from this tube 67 passes through the transformer 68 to the transformer 63 and the output from this transformer 63 passes to the mixer control 7, which is here shown as a T pad arrangement of resistors.

The tube 67 is of the triple-grid type including a control grid 70, a screen grid 71 and an amplification-control grid 72. The control grid 45 and screen grid are connected in the usual manner, the screen grid being bypassed by the condenser 73. The input from the leads 10 is applied to the grid-cathode circuit of the tube 74, the plate of which is supplied through a resistor 75 from the B battery 76. The audio output of this tube is supplied through the condenser 77 to the tube 78 which is a triode having the grid and plate connected together to act as a diode rectifier. The output from the tube 74 is rectified by the tube 78 and appears as a voltage drop across the resistor 79 and the condenser 80. This voltage drop is applied through the leads 81 across the cathode and amplification control grid of the tube 67. In this type of tube as the grid goes more negative the amplification decreases, and accordingly when the output from the tube 74 increases the amplification of the tube 67 decreases thereby decreasing the amount of the higher audio frequencies passing through the filter 64, 65, 66 and the transformer 68 to the transformer 63.

The low and intermediate frequencies are, as shown in Figure 1, transmitted through a transformer 82 to the mixer control 8 and from the mixer control 7 and 8 to the volume control 9.

In the form of the invention shown in Figure 5 the input from the music source 2 is divided into three circuits passing through a high pass filter 100, a low pass filter 101 and a band-pass filter 102. The band-pass filter is so designed

or adjusted as to pass the frequencies which would interfere with the voice rendition which is to be used, while the high-pass and low-pass filters transmit respectively frequencies higher than and lower than those which would cause difficulty. The leads 10 in this case are connected to a voice controlled amplifier 3 which is connected in the band pass filter circuit only, and this control unit 3 may be made according to any of the foregoing circuits shown as applied to the high frequency portion of the music. The current passed by the high-pass and low-pass filters and by the band-pass filter and the voice controlled amplifier are again combined and transmitted to mixer at 7, while the output from the source 1 is transmitted to the mixer at 8 and the combined output is controlled in volume by the control 9.

It will be apparent to those skilled in the art that my invention is not limited to the controlling of high frequencies or the controlling of a band of intermediate frequencies but that I may control bands of frequencies at either or both ends of the audio spectrum or at one or more selected bands in any desired portion of the spectrum.

It will be also apparent that my method may be performed manually by controlling the gain of amplifiers or by the use of mixer controls so as to select or eliminate specific portions or bands of the audio spectrum which might interfere with the voice to be recorded.

Having now described my invention, I claim:

1. An amplifier, including an inductance and a capacitance connected in series in one side of a voice channel, a thermionic tube connected from the connection of said inductance and capacitance to the other side of said channel, and means for controlling the conductance of said thermionic tube in accordance with independent impulses whereby predetermined frequencies are bypassed by said tube in accordance with said other impulses.

2. A thermionic amplifier, including audio frequency current supply means, means for decreasing the amplification of high frequency impulses, means for simultaneously and similarly increasing the amplification of low frequency impulses, and means responsive to said current for controlling the aforesaid means.

3. A thermionic amplifier, including means for decreasing the amplification of high frequency impulses, means for simultaneously and similarly increasing the amplification of low frequency impulses, means for controlling the aforesaid means in accordance with other high frequency impulses, and means for combining said impulses.

4. A thermionic amplifier, including means for decreasing the amplification of high frequency impulses, means for simultaneously and similarly increasing the amplification of low frequency impulses, means for controlling the aforesaid means in accordance with other high frequency impulses, and means for combining all of said impulses.

5. The method of mixing sounds comprising producing sounds having a broad frequency range, producing other sounds having a narrower frequency range, controlling the loudness of sounds corresponding to said narrower frequency range only in said sounds having a broad frequency range in accordance with said sounds having a narrow frequency range, and combining said sounds.

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