Oct. 23, 1934. B. F. MIESSNER 1,977,832

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

Filed Oct. 11, 1932

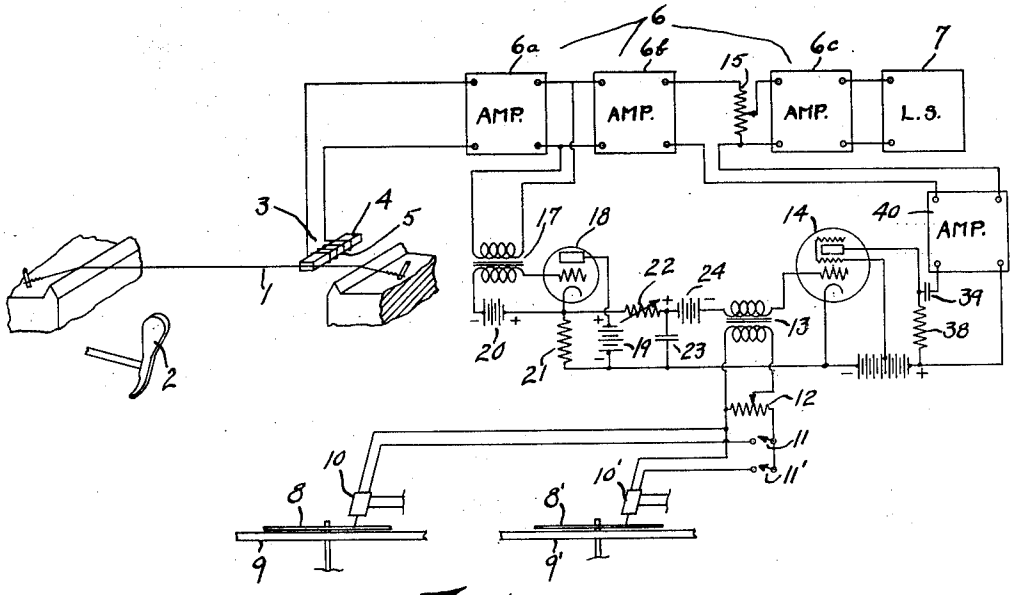


Fig. 1

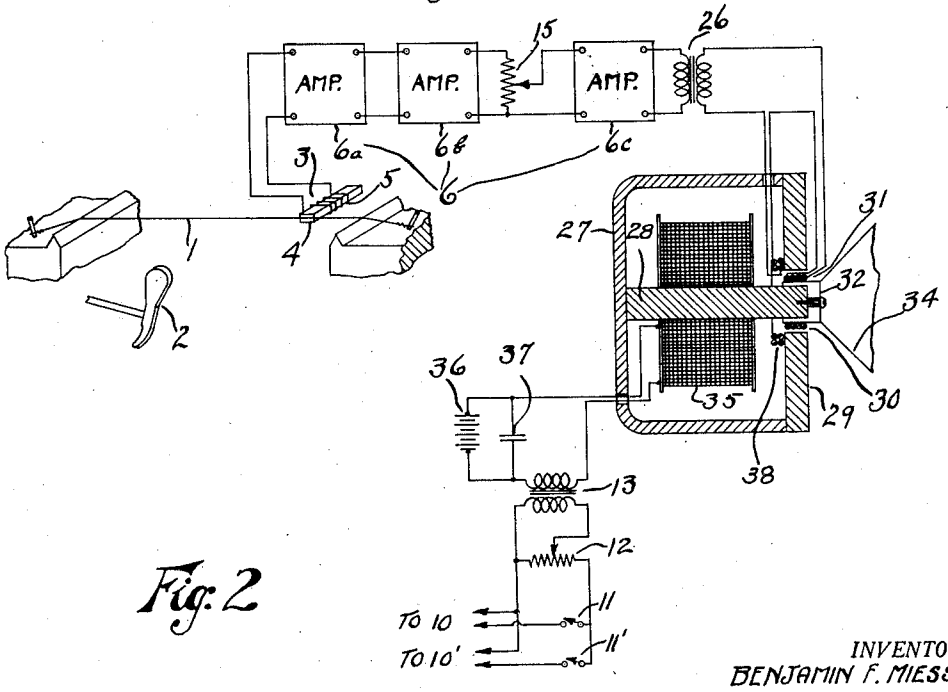


Fig. 2

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Patented Oct. 23, 1934

1,977,832

UNITED STATES PATENT OFFICE

1,977,832

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

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Application October 11, 1932, Serial No. 637,257

10 Claims. (Cl. 84—1)

This invention relates to musical instruments of the type wherein the output sound is translated from electric oscillations, and more particularly to the improved creation thereby of conventional musical tones.

It is well known that the output tones of almost all conventional instruments comprise not only a series of harmonically related partial frequencies, or purely musical components, but also certain attendant sounds which may be identified as noises, in that they lack the attributes of pure music, such as harmonic frequency relationship to the fundamental tone, etc. Thus such noises may be the bow scrape characteristic of stringed instruments, the wind-rush of organ pipes, the "spitting" sounds attendant upon horn tones, and the like.

While these noises are of non-musical nature, they are highly important constituents of the composite output tones of these conventional instruments. For this reason certain instruments wherein each output tone is translated from electric oscillations of purely harmonically related frequencies frequently fail to provide an effect which appeals as realistic to the ear, accustomed as it is to attendant noises of the type described. Expressed in other words, the character of the tone is deficient in respect of the lack of these noises.

It is an object of my invention to provide methods and means, adaptable for use generally with musical instruments wherein the output sound is translated from electric oscillations, for injecting any desired noise or noises into the output tones of such instruments. It is a further object to provide such methods and means characterized by complete automaticity in action. It is a further object to provide methods and means for altering the character of the output tones of instruments of the class described by the suitable addition of non-musical noises. It is still a further object to provide an improved musical instrument whereby the output tones of conventional instruments may be simulated. Other and allied objects will more fully appear from the following description and the appended claims.

In the detailed description of my invention hereafter set forth, reference is had to the accompanying drawing, of which:

Figure 1 is a schematic diagram of one embodiment of my invention, and Figure 2 is a partly schematic and partly cross-sectional view of an alternative embodiment. In each of the figures an illustrative musical electric oscillation source is shown in perspective.

Reference being had to Figure 1, such musical oscillation source will be seen as comprising a tuned string 1 of magnetic material, a hammer 2 movable in a vertical plane as by a conventional piano action (not shown) to strike string 1, and a mechanico-electric translating device 3 in spaced relation to the string. The translating device may for example be sensitive to horizontal components of the vibration of string 1, this being achieved by arranging the permanent magnet 4 of the translating device horizontally. The coil 5 surrounding the magnet 4 may be connected to the input of an electrical amplifier 6, which it is convenient in this embodiment of my invention to illustrate in three cascaded sections 6a, 6b and 6c. A loudspeaker or other electro-acoustic translating device 7 may be connected to the output of the amplifier. Preceding the final amplifier section 6c may conveniently be provided volume control or potentiometer 15.

For the production of the desired noise effects I employ sources of electric oscillations corresponding to these noises, which sources may be designated as "noise oscillation sources" to distinguish them from the musical oscillation source illustrated as 1—2—3. These noise oscillation sources have been shown as phonograph records 8 and 8', continuously rotatable as by turntables 9 and 9' and provided with continuously operating electric pick-ups 10 and 10'. Each of the records may be provided with a single continuous needle groove in which has been recorded at constant amplitude a noise of the desired character.

On record 8 there may be recorded, for example, the sound of a continuous bow scrape without attendant musical tones. This may be effected either by mechanically or electrically recording the sound of the scrape of a bow on a substantially non-vibrating body, or by electrically recording the scrape of a bow on a harmonically vibrating body and suppressing the several partial tones of such body in the recordation process. Again, on record 8' there may be recorded for example the noise of wind rush. This may be effected by any of a plurality of methods analogous to those described for recording the bow scrape. Further records such as 8 and 8' may be provided, each having recorded thereon a different type of noise. Further, it will be understood that I intend no limitation to disc phonograph records and electric pick-ups, since it will be obvious that other forms of records and pick-ups may equally well be employed in my invention. It will finally be appreciated that any alternative oscillation

sources may be employed yielding electric outputs which, when translated into sound, comprise noises similar to the noise components of conventional instruments, or dissimilar thereto but useful in the production of pleasing output tones. Thus such simple sources may be employed as a poor carbon microphone, or other electrical device characterized by poor or intermittent contact, with a current continuously passing therethrough; an electrical device characterized by leakage, with a voltage continuously impressed across it; an electrolytic device caused continuously to "sizzle" by a current passing therethrough; a thermionic emission device with high "Schott" effect; a carbon or other form of arc; a neon tube oscillator; an electrical device characterized by continuous brush discharge; a wheel of magnetic material and with irregularly spaced teeth rotating in the field of an electromagnetic pick-up; etc.

The output oscillations from the noise sources may be led through selecting switches 11 and 11'—one for each source for example—to the noise level control or potentiometer 12. From this control they are to be suitably combined with the oscillations from the musical oscillation source; and while I do not wish to limit my invention to particular methods and means of effecting such combination, I hereinafter set forth certain useful and advantageous ones.

It is desirable not merely that the noise oscillations shall reach the loudspeaker 7 only when musical oscillations are being translated thereby, but also that the noise oscillations be combined with the musical oscillations in amplitude varying with the amplitude of the latter. Accordingly in Figure 1 I have shown the noise oscillations applied through a transformer 13 to the input of a thermionic vacuum tube 14, preferably of the four-element "variable-mu" type, whose amplification action, or effective transmission efficiency, is automatically varied from zero or a negligible value upward through a wide range. Such amplification variation is effected in accordance with the amplitude of the musical oscillations. The output oscillations from this tube 14 may be developed across a resistance 38, applied through stopping condenser 39 to the input of amplifier 40 and therefrom introduced into the main amplifier 6, preferably ahead of volume control 15. An arrangement for effecting the necessary automatic variation of the amplification of tube 14 has been illustrated in the drawing and may be described as follows:—

The output voltage of the amplifier portion 6*a*, comprising amplified musical oscillations, is not only applied to the input of the amplifier 6*b* following it in the cascade, but is also applied, as through transformer 17, to a rectifier system. This may advantageously be of high or infinite input impedance, so that reaction back on the output circuit of amplifier 6*a* may be avoided. Thus as a rectifier I show a three-element thermionic vacuum tube 18, with anode current supply 19. The cathode of tube 18 may be energized in any suitable manner. A negative biasing source 20 for the grid of tube 18 may be provided in the input circuit. The relative voltages of sources 19 and 20 are preferably adjusted to produce high rectification by tube 18 of alternating voltages applied to its grid.

In the anode circuit of tube 18 may be provided a resistance 21, and it will be understood that by virtue of the rectifying action of the tube 18 the musical oscillations will produce across the resistance 21 pulsating voltages whose amplitudes will increase with increasing amplitude of the musical oscillations. The voltage drop across resistance 21 may be applied through a variable resistance 22, whose action is hereinafter more completely discussed, to a condenser 23; and it will be seen that the polarity of the upper-shown extremity of this condenser 23 will be positive. Condenser 23 is connected in the grid circuit of tube 14, in series with a battery or other grid biasing source 24 which is poled so that its voltage is opposed by such voltage as may appear across the condenser. The voltage value of the source 24 should be sufficient to reduce to zero or practically to zero the transmission efficiency of tube 14 in the absence of the production of musical oscillations.

It will now be seen that upon the production of musical oscillations by the source thereof, they will be amplified by amplifier sections 6*a* and 6*b* and will appear across potentiometer 15; at the same time they will be applied to the input of tube 18, will produce a pulsating increase of voltage across resistance 21 and an increase of voltage across condenser 23, will reduce the negative bias on the grid of tube 14 by the amount of such last mentioned increase, and will thus increase the amplification, or transmission, of the noise oscillations by tube 14 from a substantially zero value to a value dependent on the amplitude of the musical oscillations. The noise oscillations from the tube 14, after passing through condenser 39 and amplifier 40, will be applied to potentiometer 15; by that potentiometer both noise and musical oscillations may be simultaneously controlled in respect of amplitude; and therefrom both may be amplified by amplifier section 6*c* and translated into sound by loudspeaker 7. It will be understood that the function of the noise level control 12 is to adjust the general relation of noise to musical oscillation amplitude, in distinction to the function of the volume control 15, which is to adjust the absolute amplitude of the combined noise and musical oscillations.

The function of the resistance 22 and condenser 23, in association with resistance 21, is to control the nature of the grid bias variation on tube 14 and hence of the amplification variation of this tube. If the resistance 22 and condenser 23 be omitted, the amplification of tube 14 will be raised pulsatingly—i. e., at every alternate half cycle of the musical oscillations; the resulting regulation of the noise oscillations in essentially the variation of their amplitude in accordance with the amplitude of the musical oscillations, together with their modulation at the musical oscillation frequency. This is not necessarily fatal to the effects to be produced, but will produce a different effect on the character of the composite sound from that produced if the noise oscillations, although regulated in amplitude in accordance with the musical oscillation amplitudes, are not so modulated before combination with the musical oscillations. The inclusion of the condenser 23 and a resistance 22, however, tends to reduce this modulating effect, more nearly averaging the amplification of tube 14 over each cycle of the musical oscillations and thus restricting the regulation of the noise oscillation amplitude more nearly to simple variation with the amplitude of the musical oscillations. This restricting effect will be greater, the greater be the time-constant (or capacity-resistance product) of condenser 23 and the combined resistance value of 22 and 21. Too great a time constant, however, is to be avoided since it results in

appreciable delay of the noise inception beyond the instant of tone inception. I therefore find it convenient to make resistance 21 of variable value, adjusting it to the lowest value consistent with satisfactory output tone effects.

It will be understood that while I have shown means for combining regulated noise oscillations with the music oscillations, and joint volume control, final amplification and translation into sound of the two, the noise oscillations may if desired be separately amplified and translated into sound, with or without a volume control co-acting with the musical oscillation volume control 15.

An alternative and somewhat simpler method and means of suitably combining the noise oscillations with the musical oscillations is illustrated in Figure 2. Herein the musical oscillation source and amplifier 6 and volume control 15 are shown as in Figure 1. The output of the final amplifier section 6c is shown connected through a transformer 26 to the "dynamic" or movable coil 31 of an electrodynamic sound reproducer which, except for the features hereinafter specifically mentioned, may be of the conventional type. Thus it may include for example a cylindrical casing 27 closed on one end, a central pole 28 centrally fastened to said end, and a disc 29 fastened to the other end of said casing and having a central hole forming an annular gap 30 with the free end of the pole 28. These parts are of magnetic material. In the gap 30, and supported as by flexible disc 32 to permit relatively free axial motion, may be provided the dynamic coil 31, to which may be secured the diaphragm 34 of the reproducer. Surrounding pole 28 may be provided field coil 35, which may be energized by a battery or other source of direct current 36. Should this source 36 have any appreciable impedance, it may advantageously be by-passed by condenser 37, and in series therewith may be provided the secondary of the transformer 13. The primary of this transformer, as in Figure 1, may be supplied with noise oscillations as from sources 10 and 10', through selective switches 11 and 11' and through noise level control 12. Thus the noise oscillations are superimposed on the steady excitation of field coil 35.

It is well known in connection with electrodynamic sound reproducers that oscillations present in the field supply are induced from the field coil into the dynamic coil and there combine with the currents supplied from externally to the dynamic coil. Such oscillations ordinarily comprise residual ripple remaining after imperfect filtration of a rectified alternating current employed as a source of field energization. Also well known as a means of reducing the intensity of these induced oscillations is the use of a stationary "bucking" coil closely associated with the air-gap of the reproducer and connected in series opposition to the dynamic coil. Oscillations are induced by the field coil into the bucking coil as well as into the dynamic coil, and these two sets of oscillations tend to cancel in the common circuit.

In Figure 2 I have shown such a bucking coil 38 so connected; it will be understood that it is to be apportioned, according to principles well understood in the electrodynamic reproducer art, to result in as effective as possible elimination of oscillations induced from the field coil into the moving coil circuit under conditions of no input to the latter from transformer 26. It will be appreciated, however, that such an adjustment of the stationary bucking coil 38 can be fully effective only for a single position of the moving coil, since any motion of the latter varies its coupling to, and hence the amplitude of oscillations induced in it by, the field coil. Thus upon both positive and negative peaks of the musical oscillations supplied to it by transformer 26, the moving coil 31 will be in a position other than that for which the bucking coil has been adjusted, and noise oscillations will be induced into its circuit by the field coil. It will furthermore be seen that the amplitude of these induced noise oscillations will be greater, the greater be the peak amplitude of the motion of the moving coil—i. e., of the musical oscillations. If the amplitude of noise oscillations of the field coil be sufficiently great, this action will be very pronounced and a satisfactory noise-to-music amplitude ratio may be obtained.

It may be noted that in the system of Figure 2 the regulation of the noise oscillations is essentially the variation of their amplitude in accordance with the amplitude of the musical oscillations, together with their modulation at twice the frequency of the musical oscillations.

In the United States Patent No. 1,915,859, issued June 27, 1933, to me, there was shown a musical instrument wherein components of vibration of a string at right angles to the direction of original displacement were translated into electric oscillations and thence into sound. As was shown in that patent, the output tones of such an instrument are relatively free of the influence of the form of excitation employed; and percussion effects which might ordinarily result from the use of a hammer as a means of exciting the string are rendered negligible by such translation. Thus the use of a musical oscillation source of such a type, as therein illustrated, provides a tone relatively free of abruptness of inception; and if the noise oscillation sources 8, 8', etc., be made to supply oscillations corresponding to bow scrape, wind rush, "spitting", etc., an instrument is provided whereby stringed instruments, the organ, brass instruments, etc. may be respectively simulated by selective closing of switches 11, 11', etc., the amplitude of the characteristic noises in relation to that of the music proper being adjusted by the noise level control 12.

It will of course be appreciated that any other types of musical oscillation sources may of course be employed and that my invention is equally adapted to use therewith. It will furthermore be understood that in respect of methods and means of carrying out my invention I do not intend to limit myself to those specifically disclosed, these being in their nature rather illustrative than comprehensive, and that the scope of my invention is to be determined in accordance with the following claims.

I claim:—

1. The combination with a musical instrument comprising a system for selectively generating electric oscillations and for translating said oscillations into sound to form the output tones, of means for altering the character of said tones, said means comprising an electro-acoustic system for generating electric oscillations representing non-musical noises and translating the same into sound; and means associated with and controlled by said first system for increasing and decreasing the efficiency of said second system in accordance with increases and decreases, respectively, in the amplitudes of said first mentioned oscillations.

2. The combination with a musical instrument comprising a system for selectively generating electric oscillations and for translating said oscillations into sound to form the output tones, of means for altering the character of said tones, said means comprising an electro-acoustic system for generating electric oscillations representing non-musical noises and translating the same into sound; means associated with and controlled by said first system for increasing and decreasing the efficiency of said second system in accordance with increases and decreases, respectively, in the amplitudes of said first mentioned oscillations; and independent control means individual to said second system and adjustable at will to regulate the efficiency thereof.

3. The combination with a musical instrument comprising a system for selectively generating electric oscillations and for translating said oscillations into sound to form the output tones, of means for altering the character of said tones, said means comprising an electro-acoustic system for generating electric oscillations representing non-musical noises and translating the same into sound; means associated with and controlled by said first system for increasing and decreasing the efficiency of said second system in accordance with increases and decreases, respectively, in the amplitudes of said first mentioned oscillations; and control means common to said two systems and adjustable at will to regulate jointly the efficiencies thereof.

4. In the selective production of musical tones by the selective generation of corresponding electric oscillations and translation of said oscillations into sound, the method of tone character alteration which comprises generating non-musical noise for combination with said tones; and increasing and decreasing the amplitude of said noise in response to increases and decreases, respectively, in the amplitudes of said electric oscillations.

5. In the selective production of musical tones by the selective generation of corresponding electric oscillations and translation of said oscillations into sound, the method of tone character control which comprises selectively generating, for combination with said tones, any of a plurality of predetermined non-musical noises; and increasing and decreasing the amplitude of said generated noise in response to increases and decreases, respectively in the amplitudes of said electric oscillations.

6. The combination with a musical instrument including a system for selectively generating music-representing electric oscillations and an electro-acoustic translating device connected therewith for translating the output tones from said oscillations, of means for altering the character of said tones, said means comprising a source of electric oscillations representing non-musical noises; an electric circuit connected with said source for transmitting oscillations therefrom to said translating device; and means connected in said circuit and connected with said system for increasing and decreasing the efficiency of transmission of said circuit in response to increases and decreases, respectively, in the amplitudes of said music-representing oscillations.

7. The combination with a musical instrument including a system for selectively generating music-representing electric oscillations and an electro-acoustic translating device connected therewith for translating the output tones from said oscillations, of means for altering the character of said tones, said means comprising a source of electric oscillations representing non-musical noises; an electric circuit connected with said source for transmitting oscillations therefrom to said translating device; a space-discharge device having a control element for regulating its transmission included in said circuit; and means for applying to said control element a voltage derived from said music-representing oscillations, whereby to increase and decrease said transmission of noise-representing oscillations in response to increases and decreases, respectively, in the amplitudes of said music-representing oscillations.

8. In a musical instrument, the combination of an electro-dynamic sound reproducer including a magnetic circuit, an air-gap therein, a field coil energizing said circuit, and a coil operatively located in said air-gap and movable in accordance with oscillations supplied thereto; a circuit supplying music-representing oscillations to said movable coil; means for supplying noise-representing oscillations to said field coil; and means for eliminating induction of said noise-representing oscillations from said field coil into said movable coil circuit only when said movable coil occupies a predetermined position.

9. In a musical instrument, the combination of an electro-acoustic translating device having a diaphragm movable in accordance with oscillations supplied to said device; means for supplying music-representing oscillations thereto to produce vibratory displacements thereof; and means for vibrating said diaphragm at predetermined frequencies and at an amplitude varying with the instantaneous value of said displacement of said diaphragm.

10. In a musical instrument, the combination of a source of electric oscillations representing non-musical noises; an electro-acoustic translating device responsive to said noise-representing oscillations; means included in said translating device for actuating the same in accordance with applied oscillations and for simultaneously modifying the response of said device to said noise-representing oscillations; and means for applying music-representing oscillations to said first mentioned means.

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