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ELECTRICAL MUSICAL INSTRUMENT

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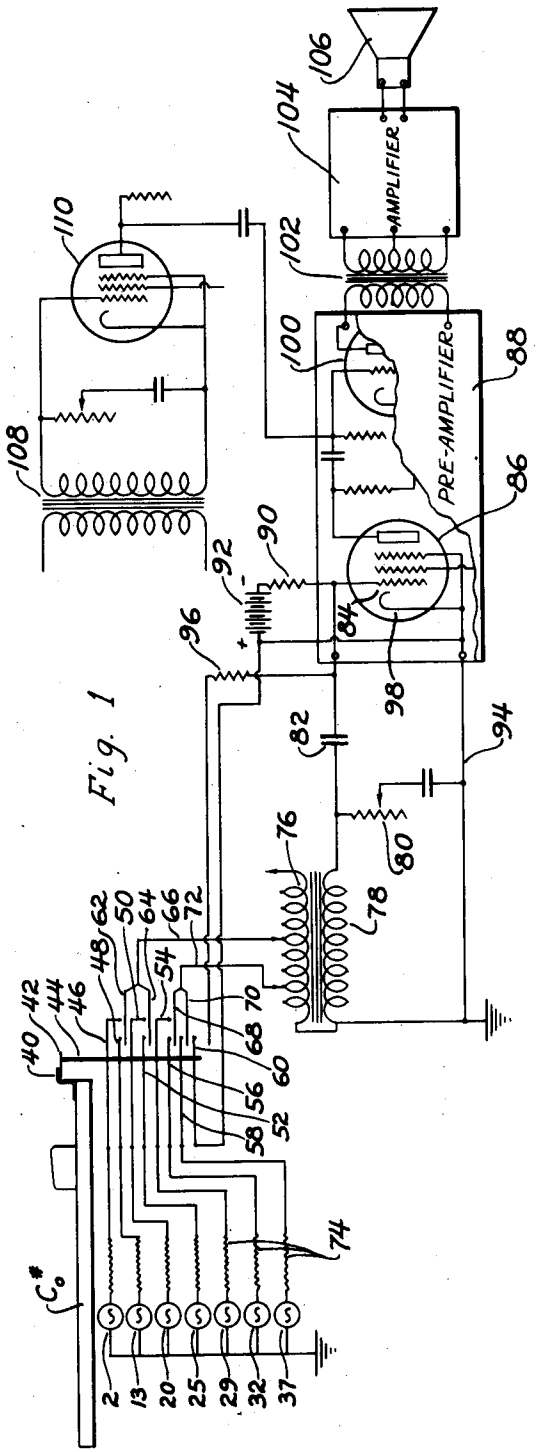


Fig. 1

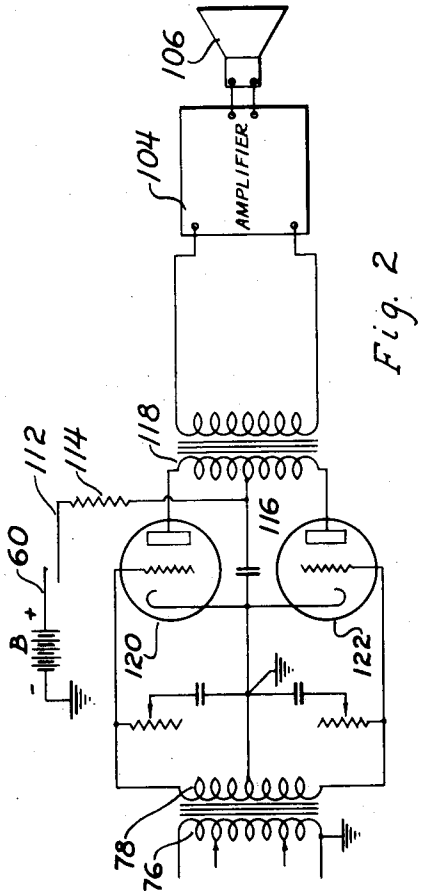


Fig. 2

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ELECTRICAL MUSICAL INSTRUMENT

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8 Claims. (Cl. 84—1)

My invention relates generally to electrical musical instruments and more particularly to improvements upon the type of instrument shown in my prior Patent No. 1,956,350 granted April 24, 1934.

In the instrument disclosed in said patent the envelopes of the tones produced are substantially rectangular in form; that is to say, upon depression of a key the tone reaches full volume substantially instantaneously, sounds at said full volume, and upon release of the key, drops substantially instantaneously to zero value. This sudden attack and substantially instantaneous decay is usually desirable, especially in the upper registers, but when the instrument is played in a room in which there is little reverberation, it is desirable to compensate for such acoustical deficiency of the room by controlling the attack, or both the attack and decay, of the tone. My invention relates to means for obtaining a gradual attack and gradual decay of the tone.

It is thus the object of my invention to provide an improved means for obtaining gradual attack in the tones produced by an electrical musical instrument.

A further object is to provide an improved means for controlling the envelope of tones produced by electrical musical instruments by varying the potential of a control grid in a vacuum tube included in the circuit for transmitting the tone signal.

Other objects will appear from the following description, reference being had to the accompanying drawing, in which:

Figure 1 is a wiring diagram of a portion of electrical instrument showing my improved attack control means.

Figure 2 is a wiring diagram of a portion of an electrical musical instrument showing a modified form of attack control means.

In Figure 1 a pedal $C_0\#$ of the pedal clavier is illustrated as representative of all of the pedals of the pedal clavier. It is suitably mounted for depression by the foot, and at its rearward end is provided with a Z-shaped bracket **40** which has a leaf spring **42** riveted or welded thereto. The spring **42** is adapted to engage a switch actuating bar **44** made of insulating material, and which engages flexible resilient switch arms **46**, **48**, **50**, **52**, **54**, **56**, **58**, and **60**. Upon depression of the key, the switch arms **46**, **48**, **50** and **52** are adapted to make contact with bus bars **62** and **64** which are connected to a conductor **66**, while the switch arms **54**, **56** and **58** are adapted to make contact with bus bars **68** and **70** which are connected to a conductor **72**. The switch arms **46** to **58** are connected respectively to alternating current generators **2**, **13**, **20**, **25**, **29**, **32** and **37** through high resistance wires **74**. The generators are adapted to supply impulses of frequencies corresponding to the fundamental of the note $C_0\#$, and the second, third, fourth, fifth, sixth, and eighth harmonics thereof.

The conductors **66** and **72** are adapted to be connected to any one of a plurality of taps on the primary winding **76** of an output transformer in any suitable manner, for example, as disclosed in my aforesaid patent. The secondary winding **78** of the transformer is connected through a suitable network having a volume control impedance **80** and a condenser **82**, to one of the control grids **84** of a pentode thermionic vacuum tube **86** which forms part of a resistance coupled pre-amplifier **88**. The control grid **84** is normally maintained at a relatively high negative potential, being connected through a high resistance **90** to a negative potential source illustrated as a battery **92**. Switch **60**, which is operated in conjunction with the other switches upon depression of the pedal $C_0\#$, is adapted to complete a circuit from the grounded conductor **94** through a high resistance **96** which in turn is connected to the control grid **84**. The positive terminal of the potential source **92** is likewise connected to the conductor **94** which latter conductor is connected to the cathode **98** of the tube **86**. The tube **86** is resistance coupled to a triode thermionic tube **100** by which the signal is amplified and fed to the primary of transformer **102**, the secondary of which is connected to an amplifier **104** which supplies the signal to a loud speaker **106** or other suitable means for translating the electrical impulses into sound.

The manuals control the connection of their appropriate generators to the output circuit through a transformer **108** from which the signal is fed to a pentode tube **110**, the plate of which is connected to the second stage of the network of the pre-amplifier **88** so that the signals from both the manuals and the pedal clavier will be fed to the tube **100** of the pre-amplifier.

There is a switch **60** for each of the keys of the pedal clavier, these switches being connected in parallel so that upon depression of any one of the pedals the circuit including the battery **92** and the resistance **90** will be shunted through the resistance **96**. The resistance **96** is of much lower value than the resistance **90** so that upon closure of any of the switches **60**, the effectiveness of the potential bias placed upon the control grid

84 by the battery 92 is gradually reduced. The values of the resistances 90 and 96 may be made such that the potential of the control grid 84 will be raised rather gradually after the closure of one of the switches 60, and since the strength of the tone signal which can pass through the tube 86 is dependent upon the potential of the control grid 84, the rate of the attack of a note may readily be predetermined by proper selection of the values of resistances 90 and 96. If desired, one or both of these resistances may be made adjustable.

To simplify the construction, a single switch 60 may be utilized, and the switch may be closed by means of a bail or similar means extending the full length of the pedal clavier and operated each time any one of the pedals is depressed. There may also be some lost motion between the pedal and the means for actuating the switch 60 so that the latter switch will be closed after the switches 46 to 58 are closed, and opened slightly prior to the opening of the last enumerated series of switches. This is indicated in the drawings by showing a greater spacing between the contacts of the switch 60 than between the contacts of the other switches.

Thus in operation, depression of the pedal C_0# will close the switches 46 to 58 and, either simultaneously therewith, or preferably slightly thereafter, close the switch 60. Upon closure of the switch 60 the negative potential upon the grid 84 is permitted gradually to become positive through the resistance 96. As the control grid bias becomes less negative the signal impulses from the generators 2, 13, 20, etc., will be transmitted in gradually increasing amplitude through the tube 86 and hence through the pre-amplifier 88 and amplifier 104 to the loud speaker 106, thus producing a tone having gradual attack. When the key C_0# is released (it is returned by means of a spring or other suitable means) the switch 60 will open first and the potential on the control grid 84 will gradually be lowered to that of the negative terminal of the battery 92 and thus during the interval between the opening of the switch 60 and the switches 46, 48, 50, etc. there will be a gradual decay of the tone signal. The opening of the switches 46 to 58 may be delayed further by the provision of suitable mechanical means, such as a dashpot. By thus increasing the time intervals between the opening of the switch 60 and the switches 46 to 58, the decay of the tone may be made more gradual.

In the circuit arrangement shown in Figure 2 a push-pull type pre-amplifier is shown as connected to the secondary 78 of the output transformer for the pedal clavier and the tube output or cathode-plate current is controlled by means of the switch 60. The stationary contact 112 of the switch 60 is connected through a high resistance 114 to a conductor 116 which is connected to the center tap of the transformer primary 118. The parts of the circuit of Figure 2 which correspond to those previously described with reference to Figure 1 have the same reference characters applied thereto and further description thereof is therefore believed to be unnecessary.

In the operation of the circuit shown in Figure 2, depression of any one of the pedals will cause closure of the switch 60 or a similar switch connected in parallel with the switch 60 and thus connect the B-current supply to the push-pull pre-amplifier. However, due to the interposition of the high resistance 114 in the B-current supply, the cathode-plate currents in the tubes 120, 122 will not attain their maximum values instantaneously, but will build up gradually, and as a result, the tone produced will have a rather gradual attack. Because of the push-pull type of circuit employed, any transient impulses resultant from closing the switch 60 will be neutralized in the transformer 118 and will not be transmitted to the amplifier 104.

While I have shown and described preferred embodiments of my invention, it will be understood by those skilled in the art that numerous variations and modifications may be made without departing from the basic principles thereof. I therefore claim as my invention all such means as will readily occur to those skilled in the art whereby substantially the same results may be obtained in substantially the same way.

I claim:

1. In an electrical musical instrument of the electric organ type, the combination of a generator producing impulses of a musical tone frequency, an output circuit having means for translating the impulses from said generator into sound, a key, a switch operated by said key for connecting said generator to said output circuit, a thermionic tube in said output circuit, said tube having a control grid, and means for varying the potential on said control grid immediately following the closure of said switch, thereby to cause a gradual increase in the amplitude of the signal transmitted through said tube and to produce the effect of gradual attack in the tone produced by said translating means, said means for varying the potential on said control grid comprising a positive potential source, a resistance element, and a second switch operated by said key for connecting said source to said grid through said resistance element.

2. In an electrical musical instrument of the electric organ type, in combination with a generator producing impulses of a musical tone frequency, an output circuit having an electron discharge device provided with a control grid, and means for translating the impulses from said generator into sound; a key, a first switch operated by said key for connecting said generator to said output circuit, a second switch operated by said key, said switches being closed in sequence upon depression of said key, and means including a high resistance and a direct current potential source in circuit with said second switch and the input of said tube for varying the bias on said control grid and thereby varying the gain of said device following the closure of said first switch, thereby to cause a gradual increase in the amplitude of the signal transmitted through said tube and to produce the effect of a gradual attack in the tone produced by said translating means.

3. In an electrical musical instrument of the type in which sound is electrically originated, the combination of a generator producing impulses of a musical tone frequency, an output circuit comprising an electron discharge device having a grid, and means for translating the impulses from said generator into sound, a first switch for connecting said generator to said output circuit, a second switch, means including a high resistance circuit closed by said second switch for varying the bias on said grid and thereby vary the gain of said electron discharge device to vary the amplitude of the signal transmitted through said tube and to produce the effect of varying attack

and decay in the tone produced by said translating means, and key means for directly actuating said switches in sequence.

4. In an electrical musical instrument of the type in which sound is electrically originated, the combination of a generator for supplying electrical impulses of musical frequency, an output circuit including electroacoustic translating means, an electron discharge device having a control grid in said output circuit, a first switch for connecting said generator to said device for amplification of its impulses thereby, a second switch, means for manually operating said switches, and means controlled by said second switch for changing the potential on said control grid at a predetermined rate, thereby to vary the effectiveness of said tube as an amplifier and to cause a gradual increase in the effective amplitude of the impulses from said generator to produce a gradual attack of the tone upon closure of said switch.

5. In an electrical musical instrument, the combination of a generator of electrical impulses of a musical tone frequency, means to amplify the impulses produced by said generator, said means including a thermionic tube having a control electrode, a relatively high resistance element having one terminal connected to said control electrode, a potential source having its negative terminal connected to the other terminal of said high resistance element, a switch for connecting said generator to said amplifying means, a second high resistance element of lower value than said first resistance element, a second switch for connecting said second resistance element between said control element and the positive terminal of said potential source, and common means to actuate said switches.

6. In an electrical musical instrument, the combination of a generator of electrical impulses of a musical tone frequency, means to amplify the impulses produced by said generator, said means including an electron discharge device having a control electrode, a relatively high resistance element having one terminal connected to said control electrode, a potential source having its negative terminal connected to the other terminal of said high resistance element, a switch for connecting said generator to said amplifying means, a second high resistance element of lower value than said first resistance element, a second switch for connecting said second resistance electrode between said control element and the positive terminal of said potential source, and manually operable means sequentially to close said first switch, close said second switch, open said second switch and open said first switch.

7. In an electrical musical instrument, the combination of a continuously operating generator for producing an electrical signal of a musical nature, means to amplify said signal including an electron discharge device having a cathode, a plate and one or more grids; a playing key, a source of direct current, a switch operated by said key for connecting said source in a circuit with a grid of said device to change the direct current bias thereof, and thus to change the effective gain of the device, thereby to control the musical attack and decay of said signal as it passes through said tube.

8. In an electrical musical instrument in which sound is electrically originated, the combination of a generator for supplying electrical impulses of musical frequency, an output circuit, a key, a switch operated by said key to connect said generator to said output circuit, an electron discharge device for amplifying said impulses, said device having a control grid, and means including a potential source, a resistor, and a second switch operated by said key for connecting said potential source to said control grid through said resistor, thereby gradually to change the potential of said control grid and vary the effectiveness of said device as an amplifier to cause a gradual increase in the effective amplitude of the impulses supplied by said generator.

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