Sept. 20, 1960 J. M. HANERT 2,953,055

PERCUSSION TONE ELECTRICAL MUSICAL INSTRUMENT

Filed Jan. 13, 1954 2 Sheets-Sheet 1

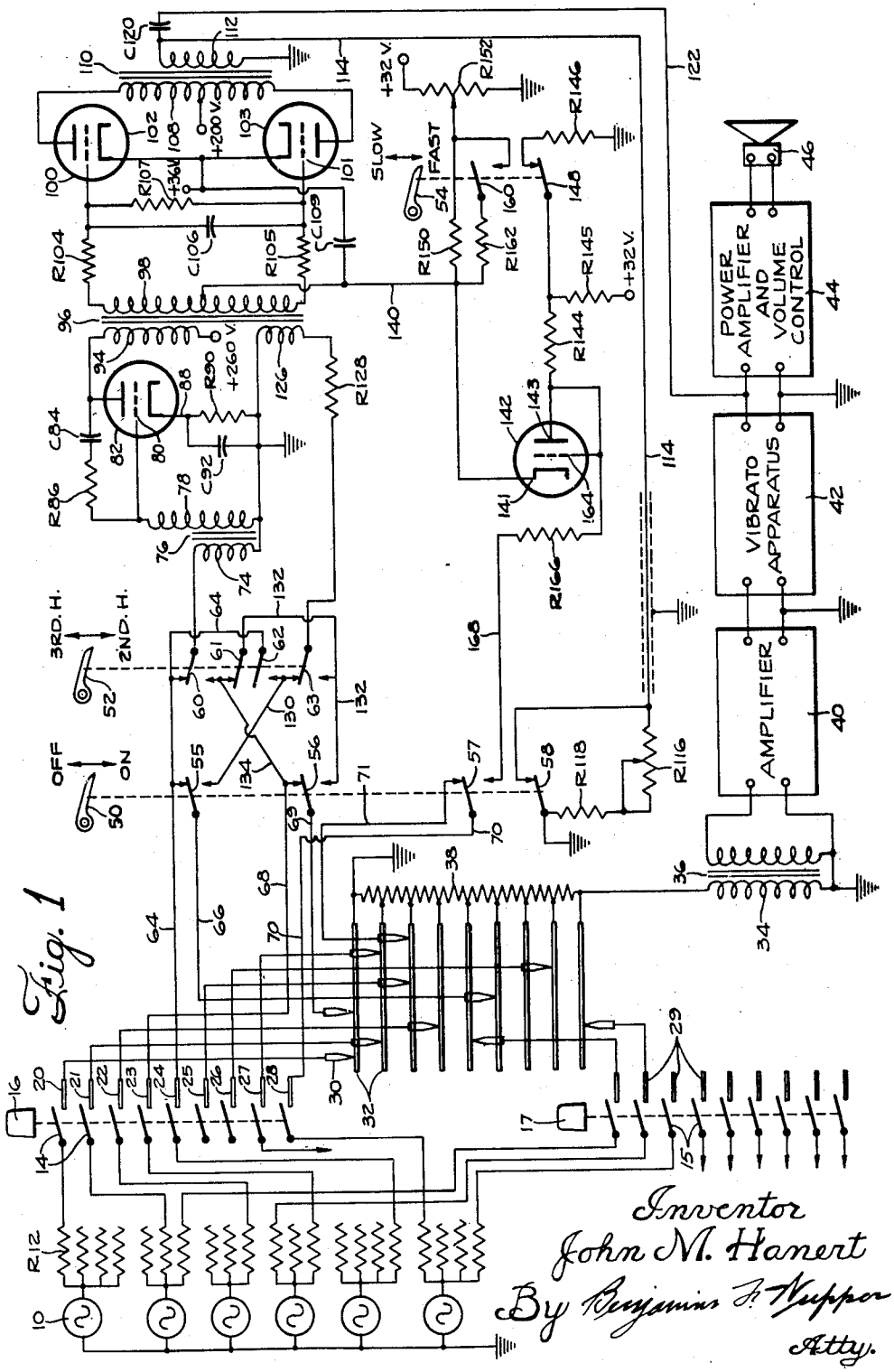


Fig. 1

Inventor
John M. Hanert
By Benjamin F. Nuppor
Atty.

Sept. 20, 1960 J. M. HANERT 2,953,055

PERCUSSION TONE ELECTRICAL MUSICAL INSTRUMENT

Filed Jan. 13, 1954 2 Sheets-Sheet 2

Fig. 2

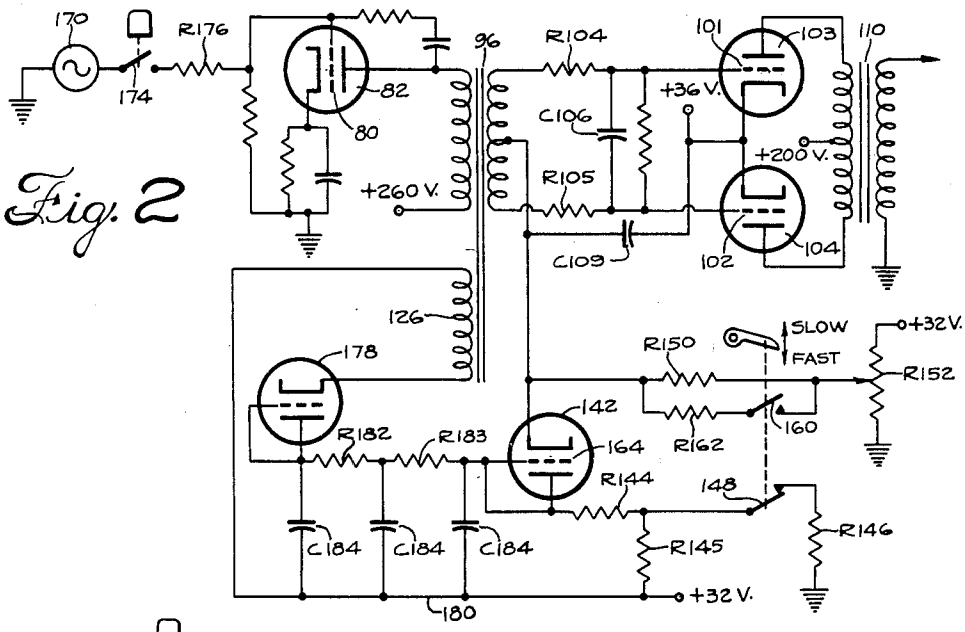
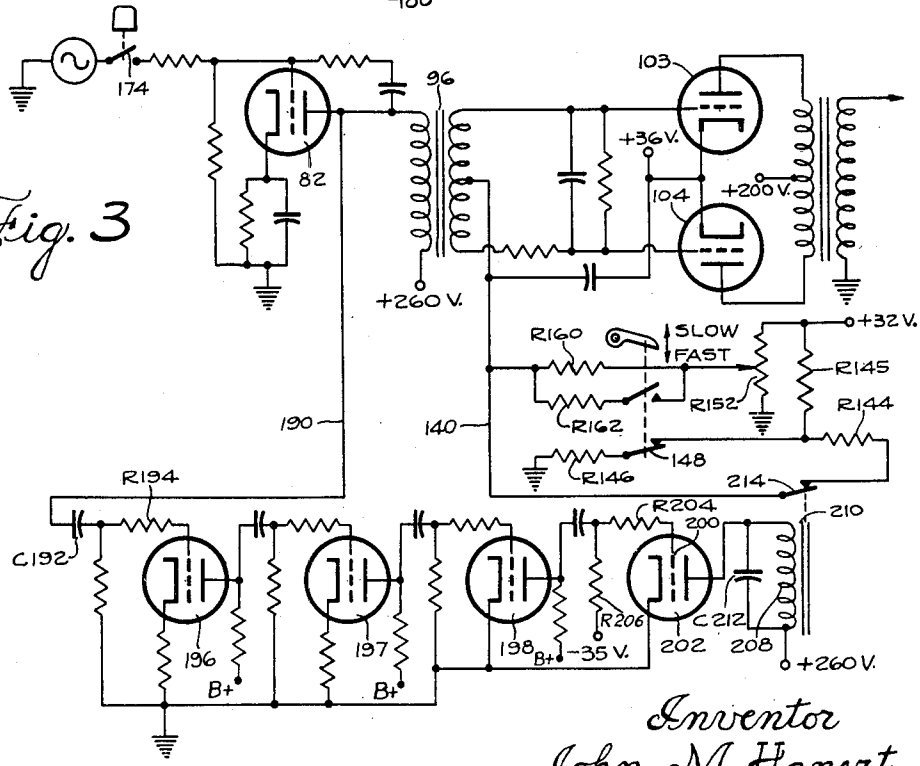


Fig. 3



Inventor
John M. Hanert
By Benjamin F. Wupper
Atty.

United States Patent Office 2,953,055
Patented Sept. 20, 1960

2,953,055

PERCUSSION TONE ELECTRICAL MUSICAL INSTRUMENT

John M. Hanert, Des Plaines, Ill., assignor to Hammond Organ Company, Chicago, Ill., a corporation of Delaware

Filed Jan. 13, 1954, Ser. No. 403,673

8 Claims. (Cl. 84—1.26)

My invention relates to electrical musical instruments and more particularly to means for producing tones having percussive decay envelopes.

A highly desirable musical effect is that of producing percussive tones either with or without sustained accompanying tones. The chime or bell-like tones embellish and enhance the customary organ tones and may very advantageously be employed for emphasis and contrast.

By the use of the present invention, percussive tones may be obtained from any electric or electronic organ, or a similar instrument, by the addition of a relatively small number of parts at slight additional cost. The primary object of the invention is, therefore, to provide an improved electric organ whereby tones with percussive intensity envelopes may be produced.

A further object is to provide percussive envelope tone controlling means which may be used at will and which does not in any way affect normal playing of the instrument.

A further object is to provide an electronic instrument having two manuals, or a divided manual, in which means are provided so that tones with percussive decay envelopes may be played with one hand while sustained tones having a vibrato may be played with the other hand.

A further object is to provide an electric organ capable of producing musical effects similar to those produced by chimes, bells, xylophones, marimbas, harps and other percussion type instruments from non-percussive sustained tone generators, the tone intensity envelopes having very sharp attack and controllable decay.

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

Fig. 1 is a schematic wiring and block diagram of an instrument embodying the invention;

Fig. 2 is a schematic wiring diagram of a modified form of the invention; and

Fig. 3 is a schematic wiring diagram of a further modification of the instrument.

The instrument shown in Fig. 1 comprises a plurality of electric tone signal generators **10** having one terminal connected to ground and their other terminals connected through non-robbing resistors R12 to switches **14** operated by playing keys **16** of the upper manual and keys **17** of the lower manual. The switches **14** of the upper manual make contact with collecting bus bars **20** to **28** which respectively collect signals of the pitch corresponding to the sub-fundamental, the sub-third, fundamental, and the second, third, fourth, fifth, sixth, and eighth harmonics of the fundamental. Similarly, switches **15** of the lower manual make contact with bus bars **29**.

Reference may be had to the patent to Laurens Hammond No. 1,956,350, for more complete disclosure of the generators **10**, the key operated switches **14**, and associated parts and circuits, these being now well-known in the art. It is to be understood, however, that the invention may be applied to other kinds of electrical musical instruments, as will appear more fully hereinafter.

The only essential respect in which the key operated switches for use in the present invention differ from the key switch mechanism shown in said prior patent is that the actuators for the switches **14** are constructed in such manner that the switches **14** for the second and third harmonics, namely the switches **14** which make contact with bus bars **23** and **24**, will close prior to the closing of the remaining switches **14** upon depression of the key, and, upon the release of the key, these two switches should be the last to open. Such sequential operation of the eswitches **14** is desirable but not essential. If the switch structure were made such that upon release of the key the switches **14** open at exactly (within about 25 milliseconds) the same instant, there will be no opportunity for an audible spurious tone to be sounded upon the release of the key.

Each of the bus bars **20** to **28** of the upper manual, and bus bars **29** of the lower manual, is suitably connected to an amplitude regulating drawbar **30** which is adapted selectively to make contact with any one of a plurality of contact strips **32**, as more fully disclosed in the patent to H. E. Meinema No. 2,565,512. The uppermost contact strip **32** is connected to ground and the lowermost contact strip is connected to one terminal of the primary winding **34** of an output transformer **36**, the other terminal of which is connected to ground. The other contact strips are connected to graduated taps on a resistor R38. Thus, the various partials of the tones may be controlled as to intensity by selectively setting the drawbars **30**. The secondary of the transformer **36** is connected to an amplifier **40** which in turn is connected to a vibrato apparatus **42**, the output of the latter being amplified by a power amplifier and volume control **44** and supplied to a speaker **46**.

In addition to its usual controls, the instrument is provided with a percussion "on" and "off" tablet **50**, a second or third harmonic tablet **52**, and a "slow" or "fast" decay tablet **54**. The tablet **50** is connected to operate switch fingers **55**, **56**, **57**, and **58** while the tablet **52** similarly operates switch fingers **60**, **61**, **62**, and **63**. When the control tablet **50** is in its upper position, switch finger **55** connects conductors **64** and **66**, thus maintaining the third harmonic collecting bus bar **24** connected to its drawbar **30**. Similarly, switch finger **56** connects conductors **68** and **69** so that the bus bar **23** for collecting the second harmonic is connected to its drawbar with the result that the drawbars will separate in the normal manner. Likewise, switch finger **57** connects conductors **70** and **71** thereby connecting the eighth harmonic collecting bus bar **28** to its drawbar **30**. Thus, when the tablet **50** is in the "off" position the instrument may be played in the usual manner with the usual results.

When the tablet **50** is in its lower or "on" position the third harmonic bus bar **24** is connected through conductor **64** and switch **60** to the primary winding **74** of a matching transformer **76**. The secondary winding **78** of this transformer has one terminal connected to ground and to one terminal of the primary winding **74**. The other end of the secondary **78** is connected to the control grid **80** of amplifying triode **82**. A certain amount of negative feedback from plate to grid is provided through a capacitor C84 and a resistor R86 connected in series between these electrodes. The cathode **88** is connected to ground through a self-bias resistor R90 shunted by a bypass capacitor C92. Plate current is supplied through the primary **94** of a coupling transformer **96** from a suitable terminal of the power supply, indicated as a terminal +260 v. The secondary **98** of the transformer **96** has its terminals respectively connected to grids **100** and **101** to triodes **102** and **103**, such connection being effected through resistors R104 and R105 respectively. These resistors form part of a key click filtering mesh,

which also includes a capacitor C106 and a resistor R107 connected between the grids 100 and 101.

The cathodes of the triodes 102 and 103 are connected to a +36 v. terminal and are connected to a center tap of secondary winding 98 through a decay determining capacitor C109. The plates of these triodes are connected to the terminals of the primary winding 108 of a transformer 110, the center tap of the primary 108 being connected to a suitable terminal of the power supply, indicated as +200 v. The secondary 112 of transformer 110 has one terminal grounded and its other terminal connected by a conductor 114 to a percussion volume adjusting means, comprising an adjustable resistor R116 and a fixed resistor R118 which are connected in series between the conductor 114 and ground. These resistors are shunted by a switch finger 58 when the tablet 50 is in its upper position so that the secondary winding 112 is short circuited and no noise or extraneous signal can appear across the secondary 112.

The ungrounded terminal of the secondary winding 112 is connected by a capacitor C120 and a conductor 122 to the input of the power amplifier 44.

A tertiary winding 126 on the transformer 96 has one terminal connected to ground and its other terminal connected by a resistance R128 with the switch finger 63. It will be noted that switch finger 63 may connect with either conductor 130 or a conductor 132, that switch finger 62 may connect conductor 64 to conductor 130, that switch finger 61 may connect conductor 132 with a conductor 134, and that switch finger 60 may connect the primary winding 74 either to conductor 64 or to conductor 134.

When the tablet 50 is in its "on" position and the tablet 52 is in the position shown, the third harmonic of the tones corresponding to any playing keys 16 which may be depressed will be impressed across the primary 74, will be amplified by the triode 82, and transmitted through the transformer 96 to the output as previously described. However, these signals also appear across the tertiary winding 126 and are transmitted through resistor R128, switch 53, conductor 130, switch 55, and conductor 66 to the drawbar 30 for the third harmonic. The number of turns on the tertiary winding is such that the amplitude of the signal on the third harmonic drawbar 30 will be the same as that of the signal appearing on the third harmonic bus bar 24. Thus, the third harmonic tones will have their intensity determined by the position of adjustment of the drawbar 30 for the third harmonic.

The triodes 102 and 103 are normally in condition to conduct the signal by virtue of the fact that a center tap on secondary winding 98 is connected by a conductor 140 to the cathode 141 of a triode 142 operating as a diode. The plate 143 of this triode is connected to a +32 v. terminal through resistors R144 and R145, the junction between these resistors being capable of being connected to ground through a resistor R146 upon closure of a switch 148 operated by the decay rate control tablet 54. The conductor 140 is connected through a relatively high value decay rate determining resistor R150 which is connected to the contactor of a potentiometer R152, the terminals of latter being respectively connected to ground and a +32 v. terminal of the power supply. When fast decay is desired the tablet 54 is operated to close the switch 160 and to open switch 148. Closure of switch 160 connects a resistor R162 in parallel with R150, the resistance of R162 being but a fraction of the resistance of R150. Both the plate 143 and the grid 164 of triode 142 are connected by a low value resistor R166 to a conductor 168, which, when the key 50 is in its "on" position, is connected by switch 57 with the eighth harmonic bus bar 28 through conductor 70.

The potentiometer R152 is adjusted to a position such that when the triode 142 is not conducting a bias voltage approximately sufficient to cutoff triodes 102, 103 may be impressed upon their grids 100, 101.

When the tablet 50 is in its upper position the instrument is capable of playing sustained tones in the usual manner because switches 55, 56, and 57 connect the third, second, and eighth harmonic collector bus bars 24, 23, and 28 to their associated drawbars 30, and the secondary 112 of the output transformer 110 is effectively shunted because switch 58 is closed.

Whenever the percussion effect is desired the tablet 50 is depressed, whereupon the third harmonics of the notes corresponding to playing keys 16 which are depressed will, as previously described, be impressed across the primary 74 of the transformer 76. These signals are amplified and transmitted in push pull through the triodes 102, 103 and thus supplied to the amplifier 44 and speaker 46. However, depression of a playing key, such as key 16, will cause the bus bar 28 to be connected to ground through one or more generators 10 and resistors R12. These generators have low impedance and the values of the resistors R12 are low with respect to the values of resistors R144 and R145 so that the plate 143 and grid 164 have their potential rapidly lowered to a value sufficient to prevent current flow through the triode 142.

As a result, the potential on conductor 140, and hence on the grids of the triodes 102, 103 will begin dropping to the cutoff value determined by the setting of potentiometer R152. The rate at which the bias on triodes 102 and 103 increases is determined mainly by the values of capacitor C109 and resistor R150, and also by resistor R162 when the latter is connected in the circuit.

The tone produced will thus commence substantially instantaneously and will decay gradually, or quite rapidly, depending upon the position of the decay control tablet 54. This extremely rapid attack is highly desirable in simulating the tones of the percussion family of instruments but would be difficult to produce, in a practical sense, by the use of control tubes whose transmission might be controlled by external excitation in a manner similar to that in which the slow decay portion of the envelope is obtained in the instrument herein disclosed. An extremely high degree of balance in the control tubes and associated components would be required, which is practically impossible to obtain with ordinary vacuum tubes. The requirement for good balance is especially apparent when one considers that the control tubes must be virtually free from distortion in order that chords may be played without objectionable intermodulation. This means that only a small portion of the grid voltage plate current characteristic could be utilized, which would make it necessary that the steady component of the plate current be large in comparison with the alternating components, thus increasing the probability of producing a "thump," due to the unbalance of the two steady plate current components in the controls tubes.

In the instrument disclosed herein the envelope control apparatus operates in a manner normally to provide full gain, thus substantially instantaneously transmitting the attack portion of the envelope upon closure of the playing key operated switches 14. The decay portion of the envelope is relatively slow and therefore substantially free of undesirable transients in the audio range. Likewise, the change in gain of the envelope control apparatus which occurs when the playing keys are released may also be relatively slow, being limited only by the interval between the release of one key and the depression of the next key as the musician plays in the required non-legato manner. Thus, this apparatus exercises little control on attack but is effective to cause slow decay without the necessity of having perfect balance in the envelope control apparatus. From a practical standpoint, this novel feature is of great importance.

It will be noted that when the table 54 is set for fast decay, resistor R146 is removed from the circuit so that

the potential on the plate **143** and grid **164** will be higher and the tones will sound initially at a high intensity due to the reduced grid bias on triodes **100** and **101**. Of course, the tones will then decay much more rapidly because the relatively low value resistor **R162** is in parallel with resistor **R150**. The values of the components are such that the total energy of the percussive tone with fast decay will be about the same as that of the tone with slow decay.

When it is desired to use the second harmonics of the tones for determining the pitch of the percussion tones, that is, whether the pitch of the percussion tone is but one octave higher than the nominal pitch of the playing keys **16** which are depressed instead of corresponding to the third harmonic of the nominal pitch of the playing keys, the tablet **52** is depressed. Under these conditions the signals taken from the second harmonic collecting bus bar **23** are transmitted through conductors **68**, **134** and switch **60** to the primary winding **74**. The signals impressed upon the third harmonic bus bar **24** are transmitted through conductor **64**, switch **62**, conductor **130**, switch **55**, and conductor **66** to the third harmonic drawbar **30**. Thus, the third harmonic sustained tones will be transmitted to the output system of the instrument in the usual manner and will not sound percussively.

The invention is of particular usefulness when, as disclosed herein, it forms part of a two manual organ of the type which has a phase-shifting vibrato apparatus, of the type shown in my prior Patent No. 2,382,413. Such instrument, provided with the improvement of this invention, may be played to produce orchestral percussion effects without vibrato by playing on one manual while providing sustained accompaniment tones with vibrato by playing on the other manual. Furthermore, the manual which is used to control the supply of percussion signals may also be employed simultaneously to control the supply of sustained tones with vibrato, to further enhance the musical effects. Similar musical results may be obtained with a single "split," or divided, manual in which case only the treble notes would be played with percussive decay.

The instrument is unique in that from a single signal generator capable of producing a sustained tone, a percussive decay tone devoid of vibrato may be derived by playing on one manual, while at the same time a sustained tone with or without vibrato may be derived from the same generator by playing on either manual, or in fact by playing the same key which controls the production of the percussive tone.

The contrast of percussive tones devoid of vibrato played on one manual with sustained tones with vibrato played on the other manual is musically interesting and pleasing.

When playing percussive chords on the instrument with the tablet **54** set for fast decay, it is desirable that some care be exercised in depressing the keys simultaneously so that each element of the chord will be sounded with the same initial intensity. When the percussion effect is being used and the playing keys are depressed, the listener first hears the tone at maximum intensity followed by a slow or rapid decay, depending upon the setting of tablet **54**. After this the tone may be made to continue to sound as long as the keys are held depressed, if the drawbar **30**, corresponding to that of the harmonic used for percussion effect, is not connected to the grounded strip **32**.

When the intensities of the vibrato modulated tone signal supplied by the vibrato apparatus **42** is comparable to that of the non-vibrator signal supplied through the percussive output channel, a very pleasing "percussive vibrator chorus" is produced in which the initial portion of the intensity envelope sounds with both vibrato and non-vibrato components of the same pitch. At the percussive tone subsides, the character of the tone smoothly changes to that of the pure vibrator tone which is supplied by vibrator apparatus. This variation in chorus effect is a pleasingly attractive and unusually different type of percussive tonal envelope. In general, the effect is similar to that of a large chorus of percussive instruments.

In playing musical selections it will frequently be desirable to intersperse percussion and sustained tones. The player may accomplish this with facility by playing in a legato manner for producing sustained tones and in a detached manner for producing percussive tones. That is, for playing sustained tones, the last key depressed is held down until the next key is depressed, but when a percussive tone intensity envelope is desired the last key depressed is released before the next key is depressed.

While the values of most of the components are not critical, it has been found that excellent musical results are obtained if their values are as set forth below. Wide variations in these values are possible without detracting appreciably from the quality of the music which may be produced.

R12	ohms	16
R86	megohms	.47
R104	kilohms	47
R105	do	47
R107	do	56
R116	do	4.7
R118	do	25
R128	ohms	22
R144	kilohms	82
R145	do	22
R146	megohms	.12
R150	do	4.7
R152	kilohms	50
R162	megohm	1
R166	kilohms	5
C84	microfarads	.05
C106	do	.01
C109	do	.3
C120	do	.00015
Triode **82**		6C4
Triodes **102** and **103**		12AU7
Triode **142**		6C4

The invention may be embodied in various forms and may be used with instruments in which complex musical tones are generated. Such tones are generated and transmitted to the output system under the control of the playing keys. Figs. 2 and 3 illustrate two modifications of the invention in which the initial reception of a tone signal at the input of the output system results in producing the percussion effect. In describing these figures, corresponding reference characters will be applied to parts corresponding to parts shown in Fig. 1.

Referring to Fig. 2, a generator **170** is adapted to have its output connected to the control grid of an amplifying triode **82** upon closure of a playing key operated switch **174**, the switch connecting the generator **170** to the control grid of triode **82** through a decoupling resistor **R176**. The generator **170** is intended to be representative of an oscillator, vibrating reed generator, or other generator of electrical musical tone signals. In this embodiment the tertiary winding **126** of transformer **96** has one terminal connected to the cathode of rectifying triode **178**, the other terminal of this winding being connected by a conductor **180** to a +32 v. terminal of the power supply. The plate of triode **178** is connected to the control grid **164** of triode **142** through a pair of series resistors **R182** and **R183** which, together with shunt capacitors **C184**, form a filter for removing the audio frequency components which are present along with the desired direct current component in the output of the rectifier **178**. When a tone signal appears in the winding **126**, a filtered D.C. voltage, negative with respect to the potential of +32 v. on conductor **180**, will appear on the grid **164**. This negative voltage appearing on the grid and plate of triode

142, which is operating as a diode, lowers the potential on these electrodes sufficiently with respect to the potentials on the cathode so as to render this tube non-conducting, thereby permitting the potential on capacitor C109 gradually to drop to the potential determined by the setting of the potentiometer R152, in the manner previously described with respect to the form of the invention shown in Fig. 1.

It will be apparent that whenever the playing key operated switch 174 is closed, the appearance of the signal in the tertiary winding 126 will rapidly result in rendering tube 142 non-conducting with the aforementioned result of producing a tone having a percussive decay characteristic.

In the form of the invention shown in Fig. 3 the signal is, as in the circuit shown in Fig. 2, utilized to control the commencement of the percussion decay portion of the tone intensity envelope. The signal appearing on the plate of triode 82 is transmitted through a conductor 190, a capacitor C192, and a resistor R194, to the grid of a triode 196 which forms the first of a cascaded series of three amplifying and wave clipping stages, the second and third of which include triodes 197 and 198.

The output of the third stage, which includes the triode 198, is impressed upon the control grid 200 of an amplifying triode 202 whose plate current is normally cut off by virtue of the fact that the control grid is connected to a −35 v. terminal of the power supply through series resistors R204 and R206. The plate of triode 202 is connected to a +260 v. terminal through the coil 208 of relay 210. A capacitor C212 is connected in parallel with the relay coil 208 to prevent chattering in the event that the audio frequency input is in the low bass range. The normally closed contactor 214 of the relay connects conductor 140 through resistors R144 and R145 to a +32 v. terminal so that the triodes 103 and 104 are normally conducting.

The relay contactor 214 thus operates in the same manner as the triode 142 of Fig. 1 in that it operates to cause the tone to start decay the instant it commences. The effect of the amplifying and clipping stages, which include triodes 196, 197, and 198, is to minimize relay chatter in the event that two closely related frequencies are transmitted simultaneously. When two such frequencies are simultaneously present the resulting wave form will contain periods of instantaneous low amplitude energy which would cause corresponding periods of conduction in the output triode 202. The duration of these periods of low instantaneous energy is greatly minimized by the clipping action, which changes the wave of the super-position of the two input frequencies into one in which the amplitude of the wave is constant and in which rapid alternations occur at all times. The relatively small capacitor C212 across the relay coil is effective to maintain the relay energy during the very short intervals of time at which the instantaneous energy is at a low value. Thus, the relay remains in operated condition without chattering whenever one or more playing keys are operated to cause audio tone signals to be impressed upon the conductor 190.

Upon depression of the playing key operated switch 174 the bias on the triodes 103, 104 will therefore commence decaying as the capacitor C109 discharges through the resistors R160 and potentiometer R152 in the same manner as previously described to the effect in the circuit in Fig. 1.

In the embodiments of the invention shown in Figs. 2 and 3, the switch 174 is intended to be representative of any means for controlling the transmission of an electrical tone signal to the remaining parts of the apparatus shown. It might be in the form of a valve to cause vibration of a reed with an electrostatic or electromagnetic pickup permanently connected to the resistor R176 or it might be in the form of a switch for applying an exciting potential to one of a large variety of electrical tone signal generators.

Similarly, the apparatus as shown in Figs. 2 and 3, might be utilized to modify the tonal envelope produced by any mechanical musical instrument the tonal output of which would be picked up by a microphone, suitably amplified, and supplied to the terminal of resistor R176. For example, the tone of an organ pipe could be made to sound percussively like that of a piano and the tone of a piano could be made to decay away very rapidly like that of a marimba by using the percussive apparatus of this invention. Another novel application of this apparatus would be to provide percussion envelopes added to the sustained tones provided by a singer's voice, by the use of a microphone having one of its output terminals connected to resistor R176.

The rectifier circuit and the means by which the potential on the grids of the control tubes is determined is not claimed herein per se, but is claimed in my Patent No. 2,828,659 granted April 1, 1958, on application Serial No. 442,523, filed July 12, 1954. The essence of the invention claimed herein resides in exercising a greater degree of amplitude control of the decay portion of the percussion intensity envelope than over the attack portion of the percussion intensity envelope and in the concept that from a single source of tone signals devoid of vibrato a composite tone having a percussion envelope combined with a sustained vibrato phase modulated tone may be produced.

While I have shown and described particular embodiments of my invention, it will be apparent to those skilled in the art that numerous modifications and variations may be made in the form and construction thereof, without departing from the more fundamental principles of the invention. I therefore desire, by the following claims, to include within the scope of my invention all such similar and modified forms of the apparatus disclosed, by which substantially the results of the invention may be obtained by substantially the same or equivalent means.

I claim:

1. In an electrical musical instrument having a generator of electrical musical tone signals which are substantially devoid of frequency and amplitude variations, a playing key, a first output channel including an amplifier having means to vary its gain, means to couple the generator to the first output channel, a switch operable by the playing key to cause the amplifier gain varying means to change the amplifier gain from substantially maximum to minimum value gradually, thereby to cause the tone signals to be transmitted by the amplifier with a percussive decay intensity envelope, a second output channel including phase shift means for introducing a vibrato effect into the signals transmitted thereby, means operable by the playing key to cause the generator to transmit a signal to the second output channel, and electroacoustic translating means coupled to the outputs of the channels.

2. In an electrical musical instrument having a plurality of relatively low impedance electrical tone signal generators, a plurality of signal collecting bus bars; a manual comprising a plurality of playing keys; a plurality of switches operable by each of said keys, circuits each including said switches and a high impedance element for connecting generators of harmonically related pitches respectively to the signal collecting bus bars; an amplitude regulating means connected to each of the bus bars for determining the relative intensities of the partials of the tones to be produced; means for disconnecting one of the amplitude regulating means from its associated bus bar; a first amplifying means for amplifying the signals collected by said bus bar; means for transmitting a portion of the amplified signals to said bus bar; a second amplifying means for further amplifying another portion of the amplified signal, said last named

means including a terminal the potential of which determines the gain of the last amplifying means; means normally maintaining on said terminal a potential of such value as to cause the last named amplifying means to have maximum gain; means operated under the control of one of the playing key operated switches associated with each key to cause a gradual change in the potential on said terminal to a value such as to cause the gain of the last named amplifying means to be reduced to a minimum; a third amplifying means coupled to the signal collecting bus bar; and output means including electroacoustic translating means coupled to the outputs of the second and third amplifiers.

3. For use in a polyphonic electrical musical instrument having playing keys for the production of individual musical tones and chords having a percussive tone intensity envelope, the combination of an amplifier having a terminal the potential of which determines the gain of the amplifier, means normally operating to maintain the potential on said terminal at such value that it causes the gain to be high, this last named means including a resistance capacitance network, means operable by depression of a playing key to cause the potential on said terminal to change gradually to a value such as will cause minimum gain, the rate of change of the potential on said terminal being determined by said resistance capacitance network, said last named means operating upon release of the key rapidly to change the potential on said terminal to a value causing high gain.

4. In a polyphonic electrical musical instrument the combination of an electrical generator of sustained musical tone signals devoid of vibrato, a switch having a first terminal, a second terminal and a playing key for operating the switch, a coupling between the first terminal of said switch and said generator, a first output system including a variable gain means for causing the tones transmitted thereby to have a percussive decay envelope, coupling means between said first output system and the second terminal of said switch, a second output system including means for imparting a vibrato effect into the signal transmitted thereby, a coupling means connecting said second output system to the second terminal of said switch, and electroacoustic translating means coupled to the outputs of both of said output systems, whereby closure of said switch produces a percussive vibrator chorus tone comprising a steady vibrato component and a gradually decaying non-vibrato component.

5. In an apparatus for introducing a percussive decay in a musical tone signal which comprises an electrical musical tone signal source, an output system including a signal transmission channel having an amplifier which is provided with a terminal the potential of which determines the amplitude of the ouput signal, means operative when no signal is supplied by the source to impress a potential of such value upon said terminal as to cause the amplifier to transmit the signal with high gain, and means responsive to the initiation of the transmission of a tone signal from said source through the signal transmission channel to cause the potential on said terminal to change gradually to a value such as to reduce the gain of the amplifier substantially to zero, whereby the generated tone signal is transmitted with a subsequent percussive decay.

6. In an electrical musical instrument having a plurality of electrical tone signal generators, playing key operated switches, a plurality of signal collectors, a playing key operated means for coupling said generators except one to said signal collectors, an impedance common to all of the signal collectors and connected thereto, an amplifier, means operated by the playing key to couple the said one of the generators to said amplifier, signal decoupling means connecting the output of the amplifier to the common impedance, a percussion intensity envelope controlling means also coupled to the output of said amplifier, and means for amplifying and translating into sound the signals which are impressed upon said common impedance and the signals produced at the output of the percussion intensity envelope controlling means.

7. In an electrical musical instrument, the combination of a generator of electrical tone signals, signal amplitude controlling apparatus having a terminal the potential of which determines the gain thereof, an output system including electro-acoustic translating means, a playing key having a first operated means to cause a change in potential on said terminal to produce a gradual reduction in gain thereof, and a second playing key operated means for causing the generator to transmit a signal to the output system after the first means is operated upon depression of the playing key, said first and second means operating in reverse sequence upon release of the key, whereby release of the key is effective to cause cessation of the generated signal to the output system before permitting the gain of the amplitude controlling apparatus to rise.

8. For use with an electric organ of the type wherein constant-amplitude, audio-frequency signals are produced in selected harmonic combinations by depressing one or more manually-operable keys, and wherein said audio-frequency tone signals are to be converted to audible sound signals for listening pleasure, apparatus for transforming said constant-amplitude signals to variable amplitude signals simulating the tonal effect of percussive instruments, comprising, in combination, an input circuit adapted to be coupled to the tone-generating portion of said musical instrument to receive a constant-amplitude audio-frequency signal therefrom, circuit means comprising a sound channel and a control channel coupled to said input circuit, alternating-current rectifying means forming part of said control channel and adapted to produce a pulse of direct-current voltage substantially simultaneously with the receipt of a tone signal in said input circuit, resistance-capacitance discharge means for producing an exponentially-varying control signal upon initiation of a tone signal in said musical instrument, electronic switch means coupled to said rectifying means and arranged to activate said discharge means in response to said direct-current voltage pulse, signal-varying means forming part of said sound channel and coupled to said input circuit, said signal-varying means being under the control of said discharge means and arranged to alter the amplitude of the signal fed to said signal-varying means in accordance with the changing magnitude of said control signal, the variation in magnitude of said control signal being such as to cause the amplitude of said tone signal to decay rapidly in simulation of the desired percussive tonal effect, and an output circuit for coupling said decaying tone signal to the sound producing device of said musical instrument.

References Cited in the file of this patent

UNITED STATES PATENTS

2,216,513	Hammond	Oct. 1, 1940
2,276,389	Hammond	Mar. 17, 1942
2,310,429	Hanert	Feb. 9, 1943
2,382,413	Hanert	Aug. 14, 1945
2,501,172	Hammond et al.	Mar. 21, 1950
2,563,477	Martin	Aug. 7, 1951
2,577,753	Hanert	Dec. 11, 1951
2,583,566	Hanert	Jan. 29, 1952