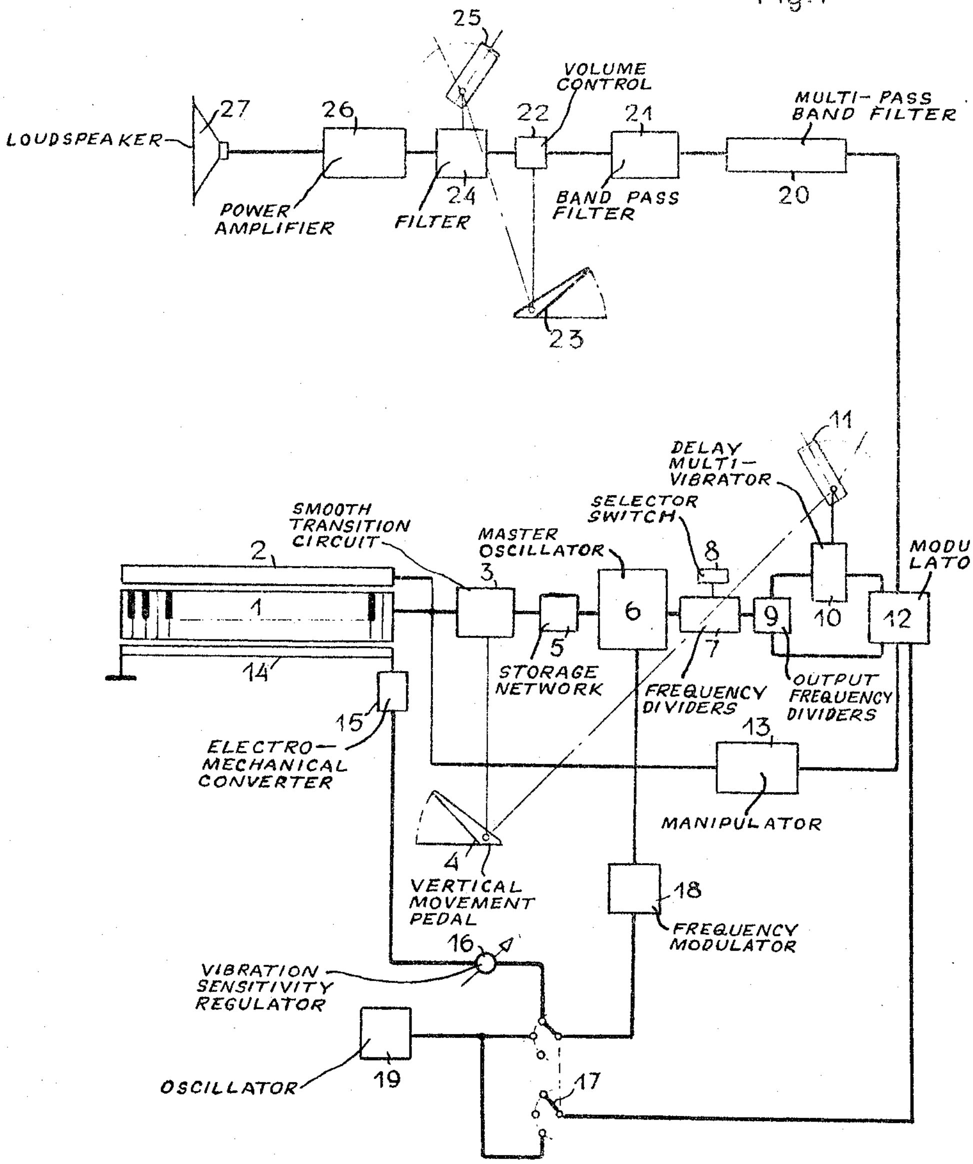
Nov. 29, 1966 A. A. VOLODIN 3,288,909

KEYBOARD ELECTRIC MUSICAL INSTRUMENT

Filed Nov. 21, 1960 8 Sheets-Sheet 1

Fig.1



KEYBOARD ELECTRIC MUSICAL INSTRUMENT

Filed Nov. 21, 1960 8 Sheets-Sheet 2

Fig. 2

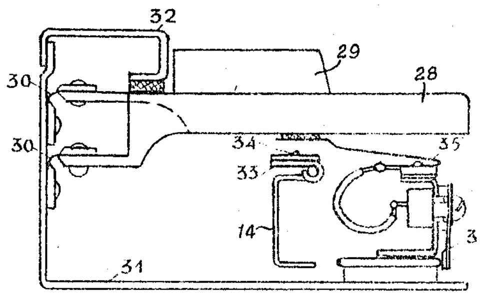


Fig. 4

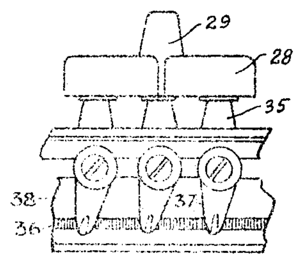


Fig. 3

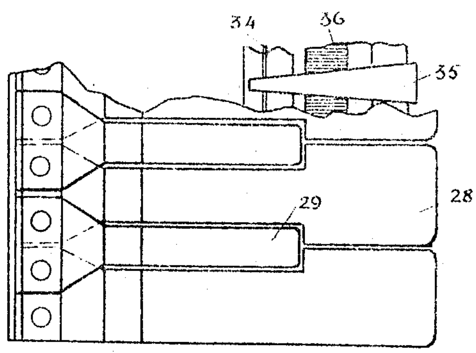
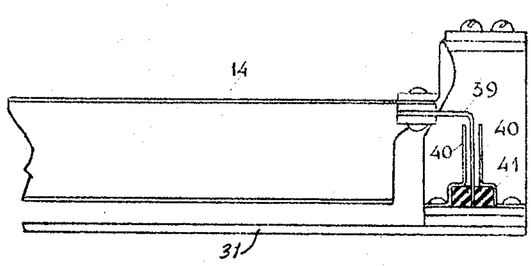


Fig. 5



KEYBOARD ELECTRIC MUSICAL INSTRUMENT

Filed Nov. 21, 1960 8 Sheets-Sheet 3

Fig. 6

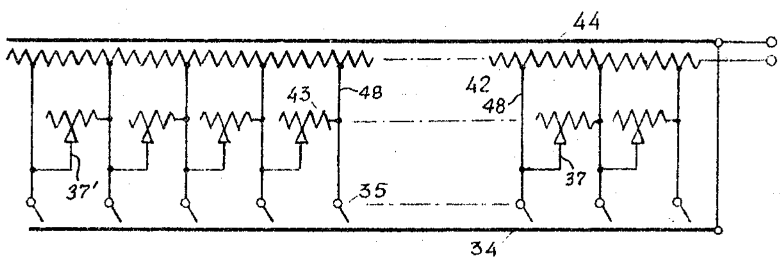


Fig. 7

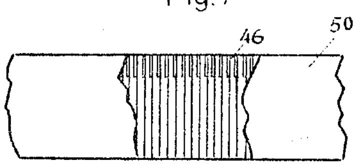


Fig. 8

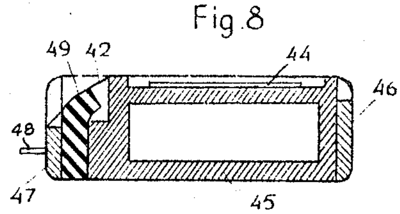
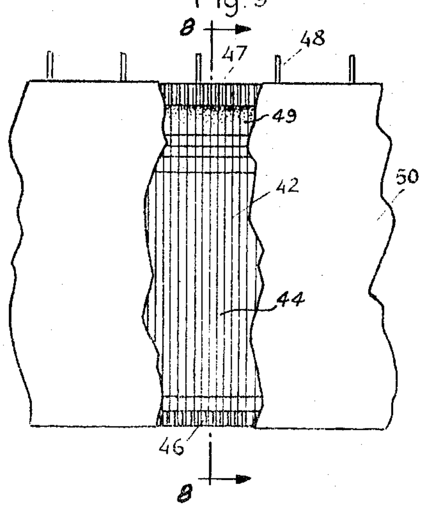


Fig. 9



Nov. 29, 1966 A. A. VOLODIN 3,288,909

KEYBOARD ELECTRIC MUSICAL INSTRUMENT

Filed Nov. 21, 1960 8 Sheets-Sheet 4

Fig. 10

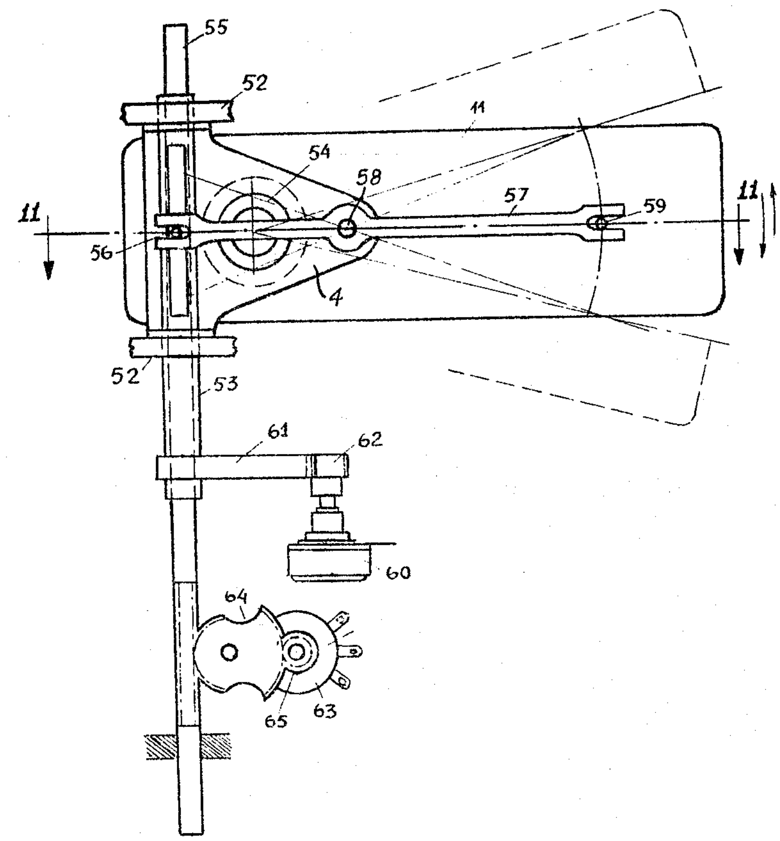


Fig. 11

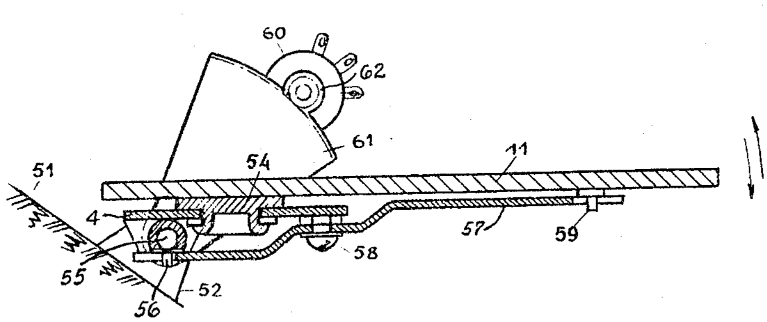


Fig.12

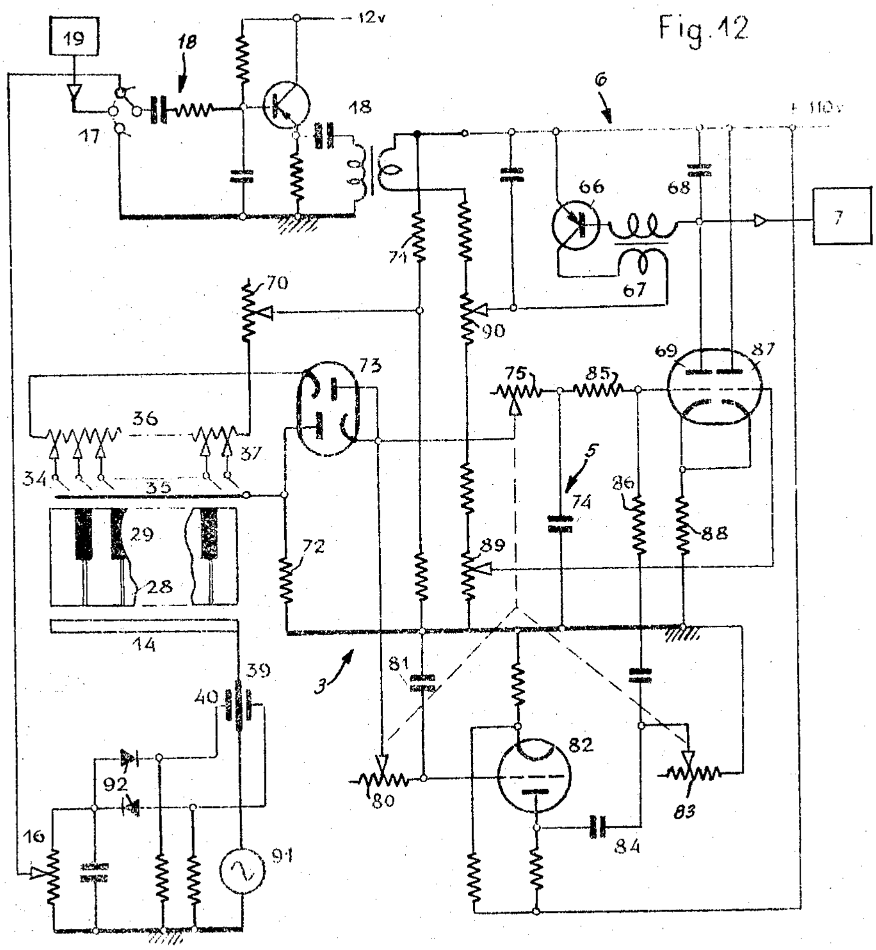

19
18
-12v
18
17
6
+110v
66
68
7
71
67
70
90
73
69
87
75
85
36
37
34
35
5
86
74
29
88
72
89
28
14
39
3
81
40
82
92
80
83
84
16
91

Fig.13

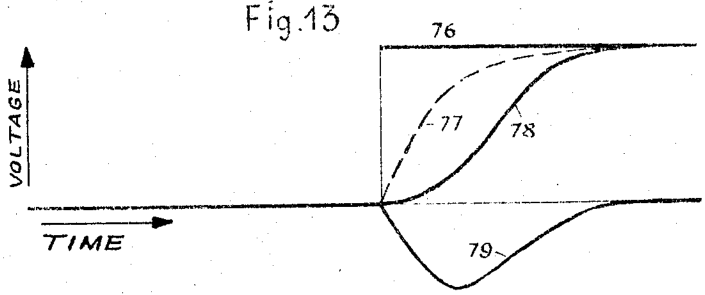

76
VOLTAGE
77
78
TIME
79

Fig.14

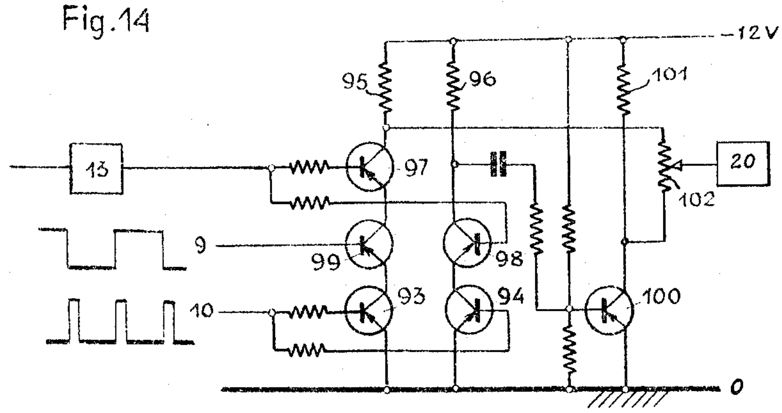
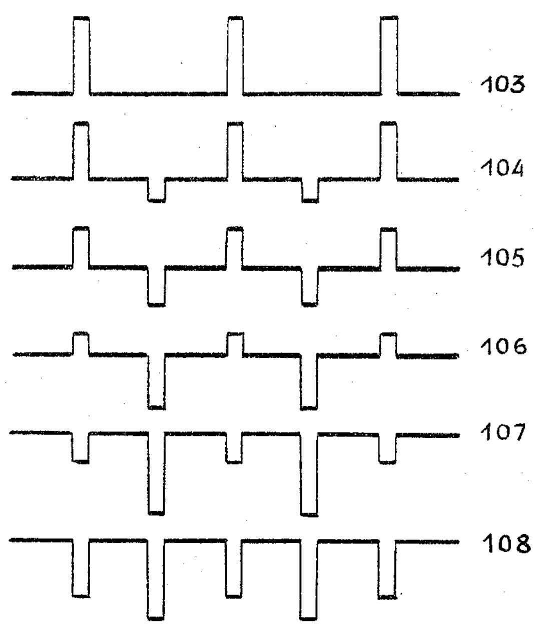

-12V
95
96
101
13
97
20
102
9
99
98
10
93
94
100
0

Fig.15


103
104
105
106
107
108

Nov. 29, 1966 A. A. VOLODIN 3,288,909

KEYBOARD ELECTRIC MUSICAL INSTRUMENT

Filed Nov. 21, 1960 8 Sheets-Sheet 7

Fig. 16

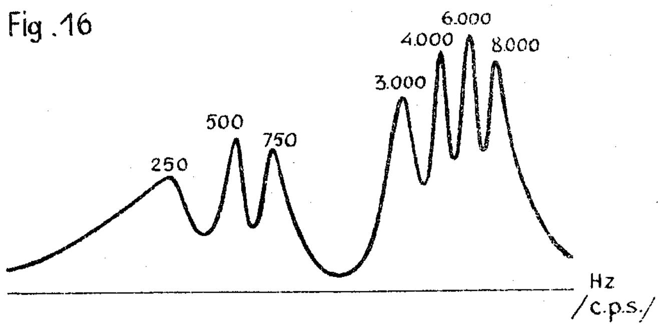


Fig. 17

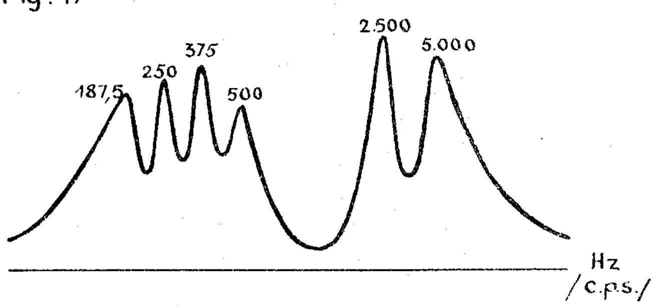
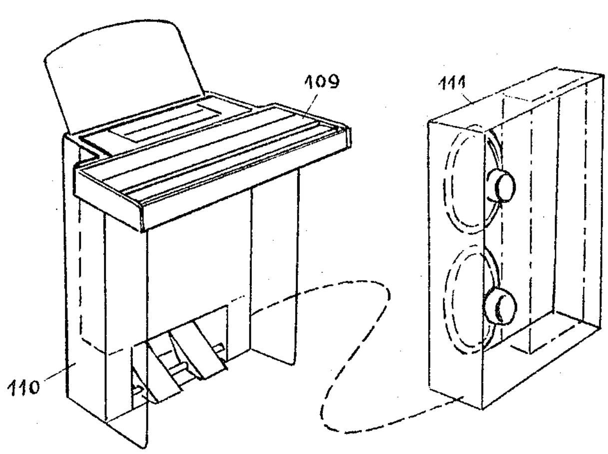


Fig 18



KEYBOARD ELECTRIC MUSICAL INSTRUMENT

Filed Nov. 21, 1960 8 Sheets-Sheet 8

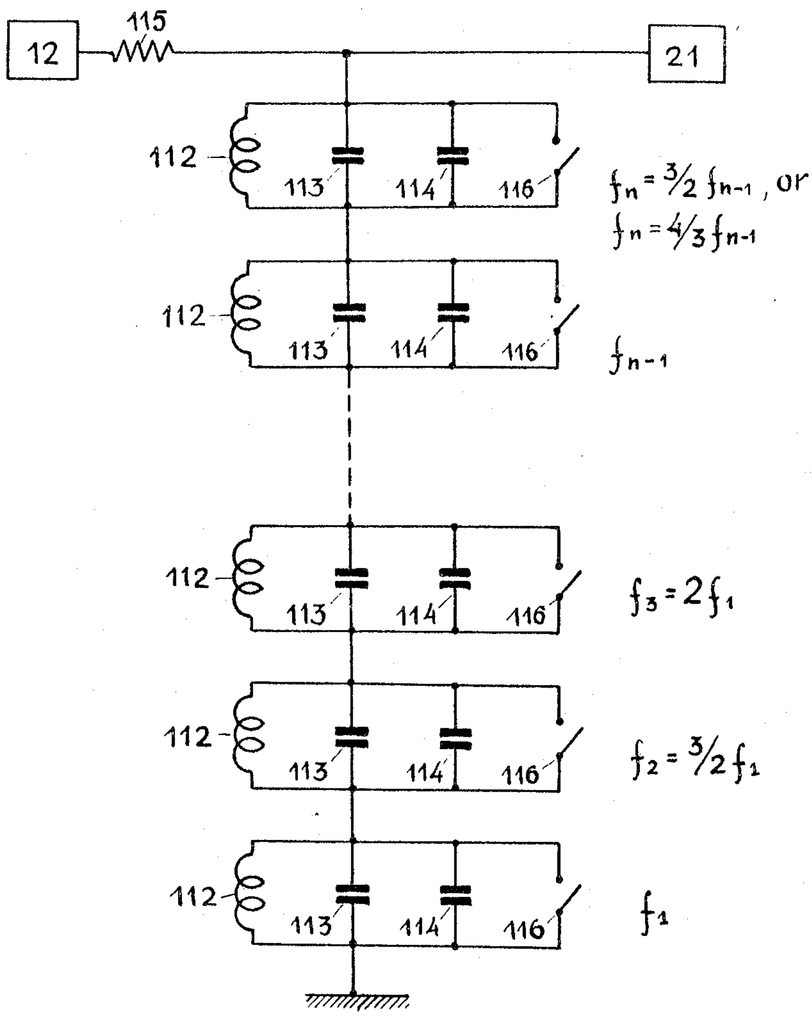


Fig. 19

United States Patent Office

3,288,909
Patented Nov. 29, 1966

1

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KEYBOARD ELECTRIC MUSICAL INSTRUMENT

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Filed Nov. 21, 1960, Ser. No. 72,832
8 Claims. (Cl. 84—1.26)

Known keyboard electrical musical instruments of the single-voice type comprise a master sound frequency oscillator with frequency modulation, relaxation frequency dividers, vibration wave-form converters, filters, and amplifier and a sound reproducing unit, in which for producing vibratory tones there is provided an auxiliary subtonal oscillator or an under-key bar brought into longitudinal vibration by the fingers of the performer by means of keys which touch the under-key bar. The latter is usually mechanically connected to a variable capacitor inserted in the oscillating circuit of the master oscillator, as a result of which any chance shifting of the bar relative to its zero position spoils the tuning of the oscillator. Besides this, such a connection of the condenser makes it difficult to control the vibration sensitivity of the system.

The instruments have a series of other shortcomings which limit their expressiveness and the fineness of musical rendition. For instance, the transition from one sound to another in legato occurs with a sharp change in frequency and the development of noise (a click). There is no possibility for smooth portamento and glissando; the decay of the sound ends cannot be of sufficient duration in view of the change in oscillator frequency when the keys are released; the obtainment of timbres corresponding in tone and musical quality to the classic musical instruments (violin, cello, clarinet, etc.) is not ensured. Provision is not made for smooth timbre control while playing the instrument. The pedal mechanisms employed for controlling the tonal qualities of the instrument have only one degree of freedom for each foot, which restricts the number of elements that can be controlled by one pedal.

The fingerboard of the above musical instruments is inconvenient because for obtaining a reliable contact between the coil and the collector electrode a strong pressure must be exerted on the coil, while localization of the point of contact is insufficient for exact intonation.

In the electrical musical instrument described below, for obtaining with the fingers of the performer notes with a sensitivity of the keyboard that can be regulated without influencing the tuning of the master oscillator, a differential capacitor is employed, the latter being linked with the under-key bar and connected in the circuit of an auxiliary high-tone oscillator. The keys, to ensure vertical movement without additional guides and vibrational pliancy, are secured along the keyboard with their widened ends to the base of the latter with the aid of strip springs.

To obtain delayed sound decay without any oscillator frequency disturbance after separation of the keyboard contacts, a circuit unit for storage of the oscillator frequency is used.

For providing a smooth change in the height of the sounds at a rate controlled by the performer, an integrating circuit is used, the latter having a regulable time constant in combination with a network for correcting the transition wave form.

Sounds with the timbre characteristics of various musical instruments are obtained by the use of a pulse modulator to form the output signal from a band-pass filter and a filter with several passbands. For simultaneous control of several sound parameters (loudness, timbre, smooth transition to sounds of another height, etc.) a

2

multi-function pedal mechanism is used which permits two independent control operations to be performed by each foot by movement of the pedal in vertical and horizontal directions.

The keyboard of the instrument is augmented by a free intonation fingerboard designed in the form of a wire resistance wound as an elastic winding brought under the pressure of the performer's fingers into contact with a collector electrode arranged in a groove in the free intonation fingerboard.

FIGURE 1 illustrates the block diagram of the electric circuits of the instrument.

FIGURE 2 represents a vertical sectional view of the keyboard.

FIGURE 3 represents a partial plan view and cutaway plan detail of the keyboard.

FIGURE 4 represents a partial sectional front view of the keyboard.

FIGURE 5 shows one end of the resiliently suspended under-keyboard bar and the electro-mechanical converter attached to it.

FIGURE 6 represents the schematic circuit diagram of the fingerboard in combination with that of the keyboard.

FIGURE 7 shows a partial front view and cut-away detail of a corresponding part of a separate fingerboard section.

FIGURE 8 represents a cross-sectional view of the fingerboard along line 8—8 of FIG. 9.

FIGURE 9 represents a partial plan view with a cutaway section of the fingerboard.

FIGURE 10 represents a bottom plan view of the pedal mechanism.

FIGURE 11 shows a cross-sectional view along line 11—11 of the pedal mechanism represented in FIG. 10.

FIGURE 12 is a schematic diagram of that part of the electrical circuit of the instrument relating to the master oscillator, arrangement for sound vibration and frequency storage (memory).

FIGURE 13 illustrates the voltage-time relationship in that part of the circuit represented in FIG. 12.

FIGURE 14 is a schematic diagram representing the electric circuit of the amplitude modulator of the instrument.

FIGURE 15 represents oscillograms illustrating the mode of operation of the circuit represented in FIG. 14.

FIGURES 16 and 17 show the frequency response characteristics of the filters employed in imitating violin and cello sounds with the instrument.

FIGURE 18 represents a general view of the instrument.

FIGURE 19 schematically illustrates the circuit of filter 20 and the relative frequencies passed by the several branches of the filter.

In FIG. 1, keyboard **1** in conjunction with fingerboard **2** serves to control the direct current voltage fed into smooth transition circuit **3** which smooths the voltage wave front when the voltage sharply jumps in passage from one key to another. The transition duration is controlled by means of vertical-movement pedal **4**. The voltage taken off from the smooth transition circuit during the pauses is stored in network **5** and controls the frequency of master oscillator **6**, the audio frequency output impulses of which serve to start a series of frequency dividers **7**. The required number of frequency dividers is connected by register selector switch **8**. Output frequency divider **9** is connected to the circuit after the group of frequency dividers **7**.

The output signals from frequency dividers **7** are employed for starting output frequency divider **9** and delay multi-vibrator **10**, the free oscillation cycle process of which is controlled by horizontal-movement pedal **11**.

The signals from the outputs of frequency divider 9 and multi-vibrator 10 are fed into the input of modulator 12 which serves for the obtainment of vibrations with a complicated spectrum. For control of the amplitude envelope wave obtained at the output of modulator 12, keyboard 1 and fingerboard 2 are interlinked with modulator 12 through manipulator 13 in which the control voltage for modulator 12 is shaped. To obtain vibratory tones under-key bar 14 is used, the latter being imparted a longitudinal oscillating movement by the fingers of the performer when the keys on keyboard 1 are pressed down upon it. With the aid of electromechanical converter 15, mechanically coupled to under-key bar 14, the mechanical oscillations of the latter are converted into electrical oscillations which, via vibration sensitivity system regulator 16 and selector switch 17, may be fed into frequency modulator 18, electrically connected to master oscillator 6. For obtaining vibrations without direct action of the performer, an auxiliary sub-tonal frequency oscillator 19 is included. Its voltage, by means of selector switch 17, can be applied in place of the voltage from converter 15 to the input of frequency modulator 18. With the aid of selector switch 17 the voltage from oscillator 19 can be fed into amplitude modulator 12 instead of the frequency modulator 18 in order to obtain oscillations of an amplitude-modulated character.

The audio frequency voltage received at the output of modulator 12 after multi-pass band filter 20 serving for envelope formation, and band pass filter 21, is fed into volume control 22 controlled by vertical-movement pedal 23. The signals obtained from volume control 22 are fed into filter 24, the pass bands of which are controlled by horizontal-movement pedal 25. After amplification in power amplifier 26, sound reproduction takes place in loudspeaker 27.

FIGS. 2, 3 and 4 represent three views in plan and sectional elevation of the keyboard system in the instrument. To provide free movement of keys 28 and 29 without the employment of additional guiding the key end cheeks are made wider and supplied with strip spring 30 serving for securing the keys to keyboard base 31. The absence of a slide-type guideway provides the possibility for vibratory key movement in the horizontal-frontal direction, while the wide fastening head prevents any twisting of the keys about their longitudinal axes. Defined location of the keys in their upper position is determined by stop bar 32; in their lower position-by under-key bar 14, supplied with plate 33 incorporating collector-contact 34. When the keys are depressed, contacts 34 and 35 come in touch, the latter being connected to the winding of potentiometer 36 through sliders 37 which serve for selection of the intermediate points. For preliminary (coarse) adjustment of sliders 37 provision is made for shifting them in the slot of base member 38. Hinged connection of plate member 33 to bar 14 has been incorporated with the aim of bringing into action any other intermediate contacts (for example, manipulator 13) when the keys are depressed.

The electrical circuit connections of elements 34 through 37 for the structural embodiment versions represented in FIGS. 2, 3 and 4 are shown in the schematic circuit diagram given in FIG. 12.

As shown in FIG. 5, under-key bar 14 is mechanically connected to movable electrodes 39 of the electromechanical converter. The position of the said movable electrode is orientated in the gap between stationary contacts 40 by elastic inserts 41.

If fingerboard 2 is used the leads from its winding 42, as shown in FIG. 6, are connected to key contacts 35 in accordance with the chromatic scale. For obtaining true half-tone changes in sound over each interval between each tap-to-tap section of the fingerboard winding and, correspondingly, between adjacent under-key contacts 35 of the keyboard, shunts 43 are incorporated, these shunts substituted in this particular case for potentiometer 36 in the structural embodiment represented in FIGS. 3 and 4 with, however, sliders 37′ similar to the earlier-mentioned sliders 37 incorporated for tuning adjustments. The fingerboard contact-collector 44 is connected to keyboard contact 34, thus placing control of the effective resistance in the fingerboard-keyboard system at the will of the performer, either by contact closing on the fingerboard or on the keyboard.

Use of the shunt-type aligning or trimming of the half-tone fingerboard sections permits complete matching of the said fingerboard scale with that of the keyboard and precludes having the keys produce different frequency sounds when several keys are simultaneously depressed, as occurs in circuit systems in which the aligning is done by means of resistances added in series with the half-tone resistors.

As shown in FIGS. 7, 8 and 9, on fingerboard base 45 there is arranged winding 42, made of small cross-section, high-resistivity uninsulated polished (unannealed) wire. To fix the positions of the turns grooved bars 46 (front) and 47 (rear) are provided. On grooved bar 47 are fastened leads 48 of winding 42, geometrically arranged to conform to half-tone intervals. In the recessed upper part of base 45, at a distance of 0.6 to 0.8 mm. from the winding there is arranged electrode 44 of polished foil. The uniformity and the elastic tension of the turns of winding 42 is ensured by elastic pad 49. To protect the fingerboard against dust and moisture, the latter is enclosed with a cover of elastic film 50. The performer, in exerting pressure on the turns of winding 42, brings them into contact with the contact surface of collector electrode 44 and thus changes the acting resistance of winding 42. Since flexible stretching of the turns of winding 42 results from this action, the point of contact is exactly localized, while the pressure necessary for reliable contacting is very small.

For achieving simultaneous and independent control of pedals 4, 11, 23 and 25 with the aid of the performer's feet, the instrument incorporates a pedal mechanism, the left half of which is shown in FIGS. 10 and 11. The pedal mechanism as a whole, designed for operation by both feet, comprises two similar sets of parts arranged symmetrically opposed and mounted on common base 51. The pedal mechanism is secured to base 51 with bearings 52 in which hollow shaft 53 rotates. Rigidly fixed on hollow shaft 53 is triangular pedal 4, the cheeks of which are confined between the end faces of bearings 52 and thus prevent any lateral shifting of the pedal. Extended through pedal 4 is step bearing 54, provided for attaching pedal 4 to pedal 11 and to allow the latter to be moved to the right or left with step bearing 54 serving as a pivot. Hollow shaft 53, in which rod 55 can freely slide, serves as a guide for the latter. A window provided in shaft 53 allows rod 55, with the aid of drive pin 56, of lever 57 pivoted on pin 58, and pin 59, to be given longitudinal movement as a result of azimuthal movement of pedal 11. Regulator 60 is actuated by the vertical movement of the pedal by means of shaft 53 of toothed part 61, made in the form of a gear sector fixed on shaft 53, and pinion 62 fitted on the shaft of regulator 60. Regulator 63 is operated by horizontal movement of the pedal with the aid of rod 55, intermediate gear 64 in mesh with both gear 65 and rod 55 which is provided with ring grooves having a toothed rack shape.

The circuit arrangements of units 3, 5 and 6 which serve for obtaining signals controlled by means of the keyboard, fingerboard, under keyboard bar 14, including units 16 through 19 connected to it, and pedal 4, are shown in FIG. 12.

The master oscillator of the instrument is of a blocking oscillator circuit design and employs semi-conductor triode 66, transformer 67, storage capacitor 68 and a base leak, the function of which is performed by vacuum triode 69, which controls the oscillator frequency when undergoing changes in its grid bias. To obtain the above bias voltage depending upon the height of the tone, resistor 36 is used, the latter being connected in circuit with a source of direct current together with resistors **70**, **71** and **72**. The current in the above circuit and, therefore, the voltage drop across resistor **72**, depends upon the acting resistance of resistor **36**, cut into the circuit by closing contacts **35** on collector contact **34** under the pressure of keys **28** and **29** on keyboard **1**. From resistor **72** the bias voltage is fed into the triode **69** grid through duodiode **73** and an integration circuit formed by capacitor **74** and variable resistor **75**, which also is a component of regulator unit **60** shown in FIGS. 10 and 11, the shaft of which is mechanically interlinked with pedal **4**. Under changes in the acting resistance of resistor **36** the voltage across resistor **72**, as shown by curve **76** in FIG. 13 will change with a jump. The inclusion of an integrating circuit ensures obtaining of a gradual change in the grid bias of triode **69** along curve **77**. For imparting the transition process a smoothness characteristic corresponding to curve **78** during its initial phase, a corrective envelope pulse with the shape of curve **79** is incorporated. This pulse is shaped in parallel branches **74** and **75** of a circuit consisting of an auxiliary integration network including resistor **80** and capacitor **81**, a stage of amplification using triode **82** and a differentiating branch formed by resistor **83** and capacitor **84**. Resistors **80** and **83** are mechanically linked with pedal **4** and thus make possible control within wide limits of the change in the duration of the transition process without disturbing the relationships necessary for the smoothness of transition. The corrective pulse and the voltages from branches **74**, **75** are applied via resistors **85** and **86** to the grid of triode **69**. To stabilize the operation of triode **69** triode **87** is used, the latter employing cathode resistor **88** in common with triode **69**. Confinement of the oscillator frequency within a given range is achieved with the aid of resistors **70** and **89**, while parallel shifting of the range during tuning of the instrument is accomplished by means of potentiometer **90**.

To provide extended attenuation or rate of decay of the sounds after release of the keys and separation of contacts **34** and **35**, storage circuit **5** is incorporated. It is formed by duodiode **73** and capacitor **74**, which simultaneously serves as a component in the integrating branch of smooth transition circuit **3**. Depending upon the magnitude of the voltages across resistor **72** and capacitor **74**, a current will begin to flow through the corresponding half of triode **73** to either charge or discharge capacitor **74**. When contacts **34** and **35** separate, capacitor **74** is isolated from resistors **36** and **72** by means of diode **73**. Capacitor **74** in this manner stores the control voltage applied to the grid of triode **69** for an interval of time sufficient for gradual decay of the sound, this being achieved in the circuit of modulator **12** in conjunction with a corresponding operating condition of manipulator **13**.

The voltage from auxiliary high-frequency oscillator **91** is applied to movable electrode **39**, which is mechanically connected to under-key bar **14**. Under the vibrations experienced by the under-key bar, the position of electrode **39** is subject to change with respect to fixed electrodes **40** and thus results in a change in the level of the voltage applied to diodes **91** and **92**, which are connected in a diode detector circuit. The resultant voltage at the detector output will be proportional to the amplitudes of the under-key bar **14** vibrations and have a frequency equal to that of the vibrations. This voltage, through selector switch **17**, is fed to modulator **18** which controls the frequency of oscillator **6** by modulating the voltage in the emitter-base circuit of semiconductor triode **66**.

FIG. 14 is a schematic electric circuit of amplitude modulator **12** which simultaneously serves as a vibration spectrum converter. As a result of the spectrum conversion, the second order harmonics are either eliminated or strengthened. If further complication of the circuit on the same principle is incorporated, it will be possible to obtain changes in the relative weights of the harmonics of the third, fourth, or any other order.

The pulses received on the output of delayed multivibrator **10** are fed into the bases of semiconductor triodes **93** and **94**, key-scheme operated and serving to control the currents flowing through local resistors **95** and **96**. The voltage from manipulator **13** is fed to the bases of triodes **97** and **98**. From frequency divider **9** the output voltage is applied to the base of triode **99**. Triode **99** is key-conditioned or pulse operated and serves to suppress every second pulse appearing across load **95**. This results in obtaining a pulse frequency across load **96** that is one octave higher than the pulses appearing across load **95**. Triode **100** functions for phase inversion. The voltages from loads **95** and **101** are applied to potentiometer **102**, the movement of the slider of which allows a range of spectrums of different octave proportions to be obtained—from complete suppression to transition of the sound into an octave. FIG. 15 shows several oscillograms of these voltages. Oscillogram **103** shows the pulses obtained across load resistor **95** as a result of suppression of every other of the multivibrator pulses. Oscillograms **104**, **105**, **106**, **107** and **108** show several graduations of build-up of the pulses at the modulator output.

Further shaping of the sound timbres with the aim of imparting to them the characteristics of various musical instruments (for example, a violin, cello, oboe, trumpet, etc.) or to give them an original sound character is achieved with the aid of filter **20**. FIGURE 19 schematically illustrates the electrical circuit of filter unit **20**. In this figure, there is shown a series of resonance circuits, each consisting of an inductance **112**, a maintaining capacitor **113** and a precise tuning capacitor **114**. The series of circuits has a load, are connected to the output of modulator **12** (see FIGURES 1 and 14) and after resistor **115** so that, at the abovementioned side of the resistor **115** which is connected to the input of the following unit **21**, there will appear the resonant character of the load due to said resonance circuits. To cut out one or more of the resonant frequencies from the make-up of the timbre being passed, a switching means **116** is provided which serves to ship out any one or more circuits as required. The capacitors **114** may also be used to retune the entire system to some other array of coherent frequencies. FIG. 16 shows the frequency characteristic of the filter when imitating a violin timbre. FIG. 17 shows a cello timbre characteristic.

The resonant frequencies of the adjacent networks in the filter are selected so that their ratios form a series with the coefficients 1, 1, 5, 2, 3, 4, 6. Such resonant frequency relationships increase the brightness and musical expressiveness of the sounds since their sound spectrums contain harmonics with consonance relations of the octaves, quints and fourths, while the dissonance relationships are partially suppressed.

The remaining units of the instrument circuit—filter **21**, volume control **22**, regulable passband filter **24**, power amplifier **26** and loudspeaker **27** do not possess any special characteristics.

In FIG. 18 is given a schematic general view of the instrument. For transportation, keyboard unit **109** can be removed from main frame **110** and secured inside loudspeaker case **111** where a special compartment is provided for it.

I claim:

1. In an electrical musical instrument having a keyboard, a base therefor, and including an electrical sound frequency master oscillator, frequency dividers coupled to the output of the master oscillator, frequency filters coupled to the frequency dividers for shaping the wave form to provide a desired timbre of the sound, and means for converting the electrical oscillations to sound waves, the improvement comprising means for obtaining vibratory sound effects by vibrations of the keys of the keyboard by the fingers of a performer, said means including means mounting the keys of the keyboard for vertical movement and horizontal movement relative to and lengthwise of the keyboard, said means mounting the keys including spring means connecting the rear portion

of each key to the keyboard base to permit said vertical and horizontal movements of the keys, the rear portions of the keys being wider than the remaining portions thereof, the rear portions of alternate keys overlapping those of adjacent keys, an elongated bar member beneath the keyboard extending along the length thereof and serving as a seat for the keys when depressed by the fingers, flexible means mounting the bar member for vibratory movements lengthwise of the keyboard by a key when seated thereon, means operated by the mechanical vibrations of the bar member for deriving an oscillating voltage of a frequency corresponding to the vibrations of the bar member, and means for applying said oscillating voltage to the input of said sound frequency oscillator to frequency modulate the latter at the frequency of the mechanical vibrations.

2. In an electrical musical instrument as defined by claim 1 further including a sub-tonal oscillator, said means for applying the oscillating voltage including a switch for disconnecting the input of the sound frequency oscillator from the oscillating voltage deriving means and connecting it to the sub-tonal oscillator to provide a continuous sound vibration effect in the output of the instrument.

3. In an electrical musical instrument having a keyboard, an electrical sound frequency oscillator and means controlled by the keys of the keyboard for applying a unidirectional voltage to the oscillator for controlling its frequency in correspondence with a depressed key to produce the various tones, the improvement comprising means for imparting a significant rise time and a smooth transition of the unidirectional voltage applied to the oscillator by shaping the wave front of the applied voltage so that the wave front initial and end portions have zero slope, said means including a pair of integrating circuits to which the voltage is first applied and a correction network comprising a differentiating circuit controlled by one of the integrating circuits for deriving an output in opposite phase with respect to the output of the other integrating circuit, and means for combining the two outputs and applying the resultant wave form to the oscillator.

4. An electrical musical instrument as defined by claim 3 including a storage capacitor for storing a unidirectional voltage applied to the input of the oscillator for controlling the frequency thereof, whereby the frequency of said oscillator is maintained after the cutting off of said voltage from said input of said oscillator during gradual sound fading.

5. In an electrical musical instrument having a keyboard, an electrical sound frequency oscillator and means controlled by the individual keys of the keyboard for applying a unidirectional voltage to the oscillator for controlling its frequency corresponding to a depressed key to produce the various tones, at least one frequency divider coupled to the output of the oscillator, a multivibrator triggered by the output of the frequency divider, a modulator circuit having two output channels, means for applying the outputs of the frequency divider and multivibrator to the modulator circuit for deriving output pulses of one polarity at the frequency of the multivibrator in one output channel and pulses of opposite polarity in the other output channel of a repetition rate which is one half of that of the pulses of the one channel, and means coupled to both output channels for selectively deriving pulses from either channel or pulses from both channels of the same or different relative amplitudes, for obtaining various even harmonic energy levels of the sound spectrum, a filter having a plurality of bands in simple multiple relationship with the mean pulse frequencies corresponding to octaves, fourths and fifths for accentuating the consonant harmonics in the sound spectrum.

6. In an electrical musical instrument as defined by claim 5 in which the modulator comprises a first input circuit to which the pulses from both the multivibrator and divider are applied and including means for suppressing alternate pulses from the multivibrator under the control of the signal output from the divider, a second input circuit to which the multivibrator pulses are applied and including means for inverting said multivibrator pulses, said means for deriving pulses from either or both output channels comprising a potentiometer coupled at its ends to the respective output channels, and a variable tap for deriving an output from said potentiometer.

7. In an electrical musical instrument having a keyboard and including means for generating electrical oscillations at various sound frequencies, corresponding respectively to the operated keys of the keyboard, means for controlling the rate at which the respective frequency oscillations are built up following depression of a key, means for dividing the frequency of oscillations and controlling the harmonic content of the divided oscillation frequencies, means for controlling the amplitude of the divided oscillation frequencies, means for controlling the shape of the divided oscillation frequency wave form; the improvement comprising a single pedal mechanism for operating at least two of said control means both simultaneously and independently and including, a hollow shaft rotatably mounted on a base and having means for operating one control means upon rotation of the shaft, an operating member secured to the shaft for rotating it about its axis, a pedal forming an extension of the member and mounted thereon for rotation about an axis transverse to the shaft and for rotating the shaft through the member when subjected to a force in the direction transverse to the shaft, a second shaft slidably mounted in the first shaft, means on the second shaft for operating a second of the control means upon axial sliding movement of the second shaft, and means operated by the pedal upon rotation about the transverse axis for slidably moving the second shaft.

8. In an electrical musical instrument having a keyboard, an electrical sound frequency master oscillator, a frequency divider coupled to the master oscillator, means controlled by the individual keys of the keyboard for applying a unidirection voltage to the oscillator to control its frequency for producing musical tones in accordance with the tempered scale, a fingerboard attachable to said instrument in parallel relation to the keyboard and comprising a rectangular base member provided at two opposite sides thereof with a raised edge portion transversely grooved at its upper end, a bare resistance wire tightly wound about the base member with a fixed turns pitch and transversely of the edges and passing through the grooves, an elastic pad positioned adjacent to one of the opposite sides of the base externally thereof and below the raised edge portion and over which the wire is wound for producing an elastic tension in the turns of the wire, a unidirectional source of voltage connected to one end of the winding, an elongated electrical conductor secured to the base substantially parallel to and intermediate the raised edge portions to be engaged by at least a turn of the wire when moved thereagainst for applying a control voltage to the master oscillator to control its frequency in correspondence to the moved turn of wire for producing musical tones at scale intervals different from the tempered scale, said winding having a plurality of equally spaced taps corresponding to half tone intervals in the different musical scale, and a variable resistance connected between the adjacent taps for effecting tuning of said half tone intervals.

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