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ELECTRONIC MUSICAL INSTRUMENT EMPLOYING FINGER-PRESSURE
MEANS TO SEQUENTIALLY ENERGIZE OSCILLATOR
MEANS AND AMPLIFIER MEANS

Filed Feb. 23, 1962

3 Sheets-Sheet 1

Fig. 1

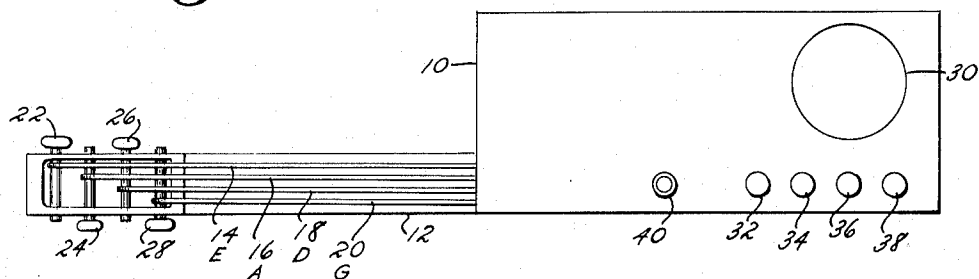


Fig. 2

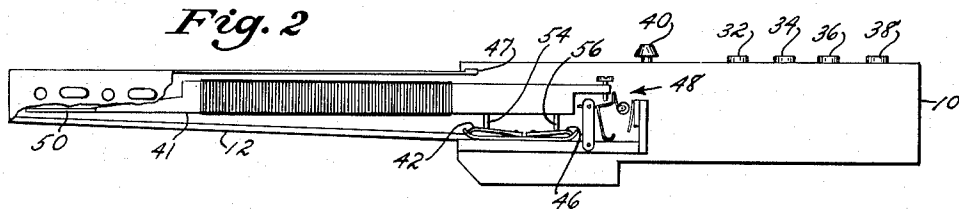


Fig.3

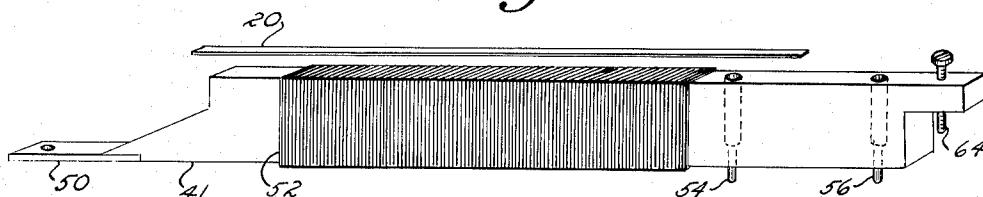
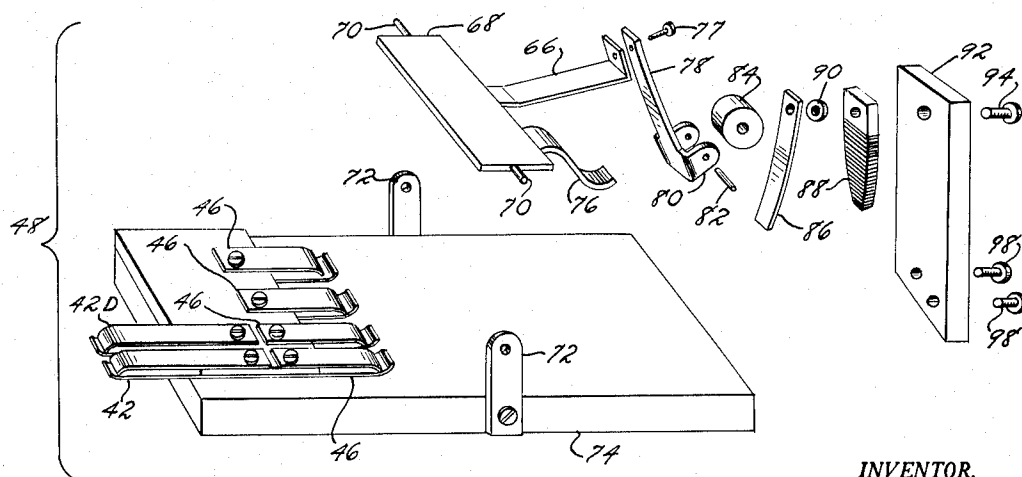


Fig. 4



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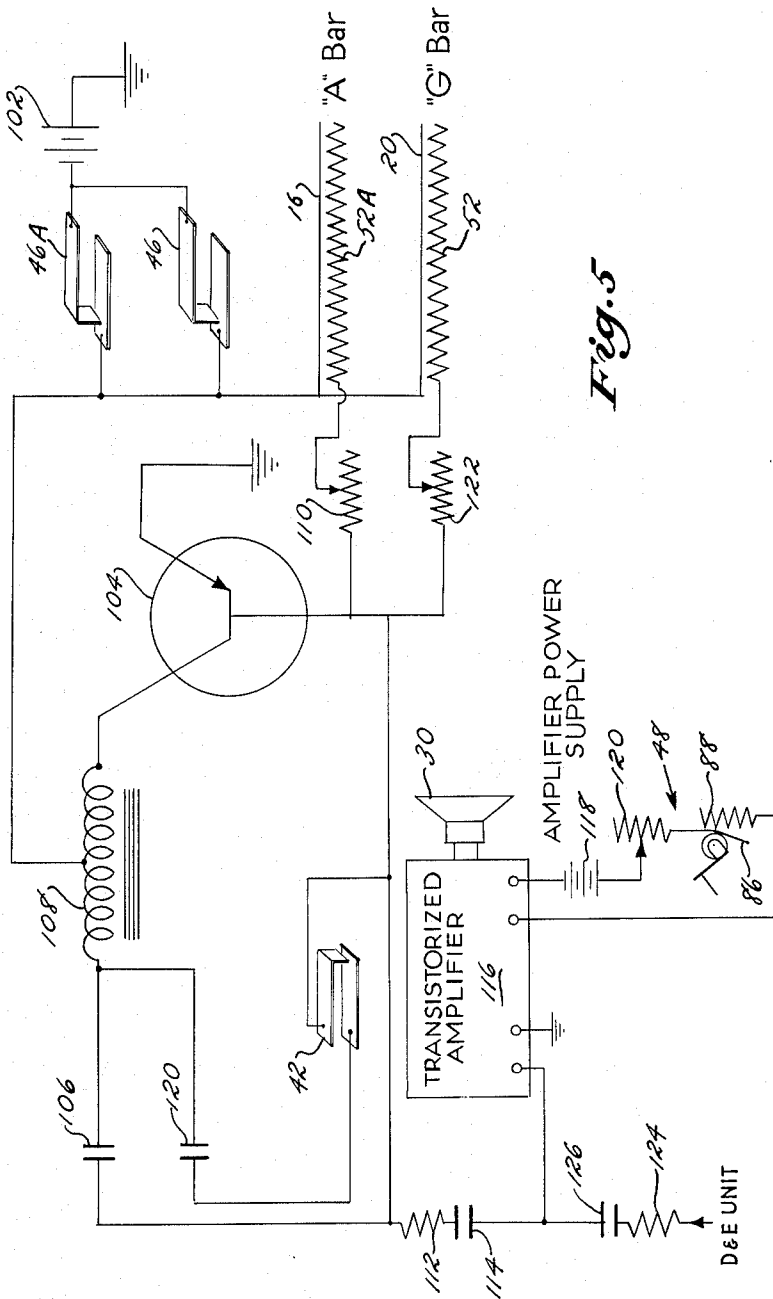
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3. Sheets-Sheet 2



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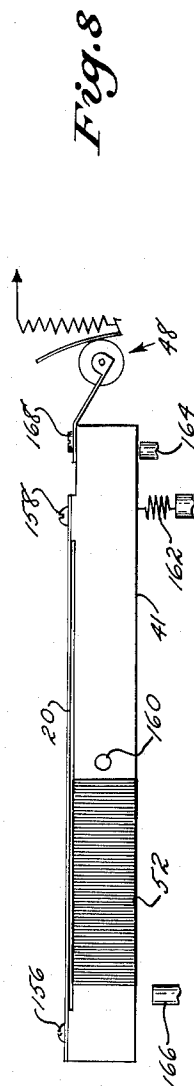
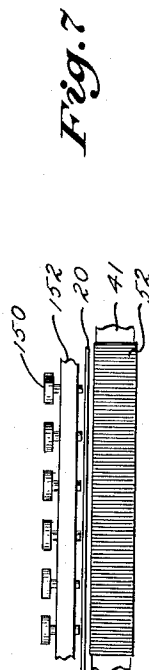
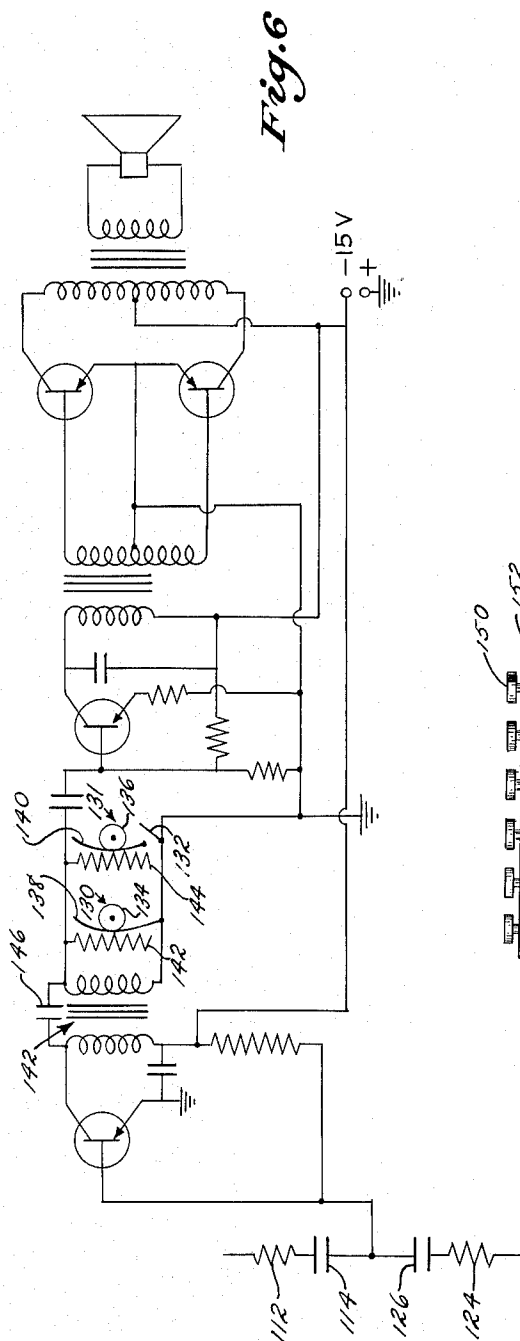
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3 Sheets-Sheet 3



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ELECTRONIC MUSICAL INSTRUMENT EMPLOYING FINGER-PRESSURE MEANS TO SEQUENTIALLY ENERGIZE OSCILLATOR MEANS AND AMPLIFIER MEANS

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2 Claims. (Cl. 84-1.26)

The present invention relates to musical instruments. More particularly it relates to electrical musical instruments of the type which employ tone generating oscillators.

In accordance with the present invention, a musical instrument comprises a transistorized tone generator and a finger-pressure operated means for determining, in a continuously variable manner over a given range, the tone generated by said generator, the attack and decay characteristics of said tone as delivered by said instrument to a listener, and the output volume of the instrument. The invention provides benefits of flexibility in operation which permit the design of electrical instruments having a finger board in the nature of conventional stringed instruments such as the violin, guitar, and the like, and affords the artist unique opportunities for expression.

The invention will be further described in connection with the accompanying drawings which are to be considered as exemplary of the invention and do not constitute limitations thereof.

In the drawings:

FIG. 1 illustrates a view, in plan, of an electrical musical instrument in accordance with the invention which is provided with an E string, an A string, a D string, and a G string in the manner of conventional stringed instruments.

FIG. 2 is a view, in elevation (partially in section) of the musical instrument of FIG. 1, illustrating the disposition of a G bar under the G string and part of the switching mechanism associated with the bar.

FIG. 3 illustrates, in perspective, details of the G string and G bar of FIG. 2.

FIG. 4 shows details of a combined voicing and volume control which is operated by the G bar of FIG. 2.

FIG. 5 is a combined circuit and block diagram of the electrical circuit employed in the musical instrument of FIG. 1.

FIG. 6 illustrates a schematic circuit suitable for use as a transistorized amplifier in the circuit of FIG. 5, the circuit of FIG. 6 illustrating a modified voicing and volume control arrangement.

FIG. 7 illustrates a push button operated finger board suitable for use with the instrument of FIGS. 1-5, and

FIG. 8 illustrates yet another modified finger board arrangement suitable for use in the musical instruments of the present invention.

The musical instrument of FIGS. 1-5 constitutes a casing 10 from which projects a finger board 12 carrying an E string 14, an A string 16, a D string 18, and a G string 20, each of which is affixed at one end to a peg 22, 24, 26, and 28 respectively. Also illustrated in FIG. 1 is a speaker 30 and tuning controls 32, 34, 36, and 38 associated with each of the four strings, E, A, D, and G respectively. A coarse volume control 40 is also provided.

FIG. 2 shows a G bar 41, which is representative of the other three bars associated with the other three strings. Also illustrated in FIG. 2 are a range switch 42, an oscillation control switch 46, and a voicing and volume control assembly indicated generally by the reference character 48, each of which is normally open and which is activated by downward motion of the G bar 41. Also shown in FIG. 2 is the anchoring of an end 47 of the G string

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within the casing 10. Details of the G bar 41 are illustrated in FIG. 3. The G bar, which is rectangular in cross-section, is suspended at one end under the pegs 22, 24, 26, and 28 by a flat ribbon spring 50 which permits vertical travel of the G bar. The G bar 41 carries a continuous helical winding 52 of 0.002 inch diameter Nichrome wire along the central portion of its length, the winding having a resistance on the order of 20,000 ohms. Similar windings are carried by the E, A, and D bars.

The G string 20 constitutes a long, thin (0.005" x 0.062") Nichrome ribbon.

That portion of the G bar 41 which extends into the casing 10 has, depending from its lower surface, two studs 54 and 56 which are adapted to close the range switch 42 and the oscillation control switch 46 on depression of the bar, both of these switches being biased to normally open position.

The G bar projects, on one end, into the casing 10. This end is undercut to clear the voicing and volume control rheostat assembly 48. Depending from the undercut portion of the bar 41 is an adjustable activating screw 64 which rests on a bracket 68 which is more clearly shown in FIG. 4.

The pressure plate 66 extends outwardly from a bracket 68 which is pivoted on pins 70 journaled in mounting posts 72 affixed to an insulator base 74 which in turn is bolted to the outer casing 10 (by bolts which are not illustrated). An S-shaped ribbon spring 76 depends from the bracket 68 and rides on the insulator base 74.

A rivet 77 fastens a saddle 80-carrying extension 78 to the outwardly extended end of the pressure plate 66, and carried within the saddle 80 on a pin 82 is a pressure roller 84. The peripheral surface of the pressure roller rides on a metallic leaf contact spring 86 which is normally spaced a slight distance away from a tapered carbon composition voicing and volume resistor 88 by an insulating spacer 90. The leaf contact spring 86, spacer 90, and voicing and volume resistor 88 are assembled as a unit and held to an insulator block 92 by an insulator 94. The insulator block 92 is disposed at one end of the base 74 by two screws 98 which pass through the bottom of the insulator block into the base.

Also affixed to the base 74 directly under the studs 54, 56 are the oscillation control switch 46 and the range switch 42, as well as the corresponding switches for the E, A and D strings. A separate oscillation control switch is provided for each bar, whereas range switches are provided for operation by the G bar and the D bar only.

FIG. 5 shows the electrical circuitry employed in conjunction with the A and G strings inasmuch as the instant musical instrument employs two primary R-C oscillators, one for use with the A and G strings, and the other for use with the D and E strings. Inasmuch as the circuits of the primary oscillators are substantially the same, for the sake of simplicity, only the oscillator for the A and G system is illustrated. Naturally, however, those components which are common to both systems, and provision for input from the D and E unit, are shown.

In the A and G string oscillator of FIG. 5, a nine-volt mercury cell 102 powers an audio oscillator comprised of a CK 722 transistor 104, a 0.097 microfarad capacitor 106, a tapped inductor 108, a 50-kilohm tuning control or rheostat 110, and the resistance of the A string 16 and A bar winding 52A which, of course, varies as a function of the point at which the A string 16 contacts the A bar winding.

As is apparent from consideration of the circuit, no oscillation can occur until the oscillation control switch 45A is moved to a closed position from its normally open condition, and until the A string 16 contacts the A bar winding 52A. The frequency of oscillation when both

of these contacts have been closed is determined primarily by the fixed capacitor 106 and the resistance in the circuit as established by the setting of the tuning control 110 and the point of contact of the A string 16 with the A bar winding 52A. Output of the oscillator is fed through an isolating resistor 112 of 2,000 ohms and a 0.1 microfarad coupling capacitor 114 to the input of a transistorized amplifier 116, i.e., an electronic amplifier operated by solid state devices with no warm-up period required before being ready for operation.

Operating power is supplied to the transistorized amplifier 116 from a mercury battery 118. In series with the power supply battery 118 is a coarse volume control 120 and the voicing and volume control 48. Thus it may be seen that if the voicing control 48 is not closed to permit the passage of current from the power supply battery 118 to the amplifier, the instant musical instrument is completely silent.

The range switch 42 associated with the G bar 41 serves to place an additional capacitance of 0.088 microfarad in the oscillator circuit by placing a second capacitor 120 of that capacitance in parallel with the capacitor 106 which is normally in the circuit. Of course, when the G bar 41 is in use, the point of contact of the G string 20 with the G bar winding 52 and the setting of the G string tuning control 122 associated therewith determine the resistance in the oscillator circuit, and in conjunction with the capacitors 106, 120 determine the tone generated.

A comparable oscillator circuit is employed in conjunction with the D and E unit, appropriate values of the capacitors employed therein being 0.08 microfarad for the capacitor which is permanently in the circuit and 0.07 microfarad for the capacitor which is switched in parallel therewith during use of the D bar. The D and E oscillator employs separate circuitry, including a separate battery and transistor in order to eliminate interaction between the oscillators and to permit playing of two-note chords, the output of the oscillators being fed to the amplifier 116 through an isolating resistor 124 of 2,000 ohms and a coupling capacitor 126 of 0.1 microfarad. Of course, if desired, four oscillator circuits may be employed to permit the playing of additional chords.

In use, the strings are fingered in a manner similar to a conventional stringed instrument such as a violin (although, of course, no bow is used). Application of finger pressure to a string causes the string to contact and depress the bar beneath it, e.g., the G string 16 will, when subjected to finger pressure, contact the G bar winding 52 and depress the G bar 41. The point of contact of the string with the bar determines the resistance inserted in the circuit of the oscillator by the winding 52, however oscillation can not begin until the oscillation control switch 46 has been closed.

On depression of the bar, e.g., the G bar 41 which is pivotally hinged on the flat ribbon spring 50, the first function activated is closure of the range switch 42. (Of course if the A or E bar is depressed, there is no range switch to be activated.) Subsequently, the oscillation control switch 46 is closed, permitting energization of the oscillator at the frequency determined by the resistance placed in the circuit on contact of the string with the winding 52 on the bar and the insertion in the circuit, in the case of the G and D bars, of additional capacitance.

As downward travel of the bar 41 continues beyond the point at which the oscillator has been energized, the roller 84 causes the leaf contact spring 86 to contact the voicing and volume resistor 88, thereby supplying power to the transistorized amplifier 116. As is apparent, the farther the roller 84 travels down the leaf contact spring 86, the less resistance remains in the circuit, thus increasing the volume of the output of the amplifier 116. Likewise, it will now be apparent that a rapid depression of the bar will effect a rapid attack on the tone being played (inasmuch as the oscillator is already fully in operation), and similarly, the rate of decay of the tone being played

will be controlled by the speed with which the finger is removed from the string and bar against which it has been pressed. Thus, the finger pressure applied determines the volume of the tone generated by the instrument, and the rate of application and release of finger pressure determines the attack and decay rate respectively.

The sequence of switching operations is reversed on the removal of finger pressure from a string 14, 16, 18 or 20.

The transistorized circuit of FIG. 6 includes a pair of voicing and volume controls, 130 and 131. One of these controls 130 is operated mechanically by depression of the bar 41 as in FIGS. 1-5. The other control 131 is mounted on a pivot (not shown) which permits manual operation by the operator's second hand, or one of his feet. The provision of the second voicing and volume control, which by means of a switch 132 may be switched in or out of the circuit, facilitates improved control of staccato action and volume level.

The action of the voicing and volume controls of FIG. 6 differs from that of FIGS. 1-5 in that the pressure rollers 134, 136 are normally biased such that the leaf contact springs 138, 140 make maximum contact with the resistors 142, 144, i.e., the rheostats composed of resistors 142 and 144 and contacts 138 and 140 respectively are normally biased to positions of minimum resistance. The rheostats shunt the secondary of an interstage transformer 142. Their very low initial resistance acts to short out any signal applied to the transformer 142, however on activation of the controls, the resistance thereof is increased permitting passage of signal through the transformer.

The voicing and volume controls 130, 131 each have a maximum resistance on the order of 200 ohms which is feasible in view of the low input impedance of transistor amplifiers such as are used herewith and the fact that the resistors are in shunt with the secondary of the transformer 142. The relatively low resistance of the controls 130 and 131 is advantageous in that it permits the use of wirewound units, which are highly stable and relatively free of any tendency to generate noise during use.

A 25-microfarad capacitor 146 couples the primary and secondary windings of the transformer 142 to provide more uniform output. The amplifier is powered by a 15-volt mercury battery. The remainder of the amplifier, which constitutes a stage of preamplification before the transformer 142 and a stage of amplification subsequent thereto followed by push-pull output, is conventional and will not be described more specifically.

In operation, the optional second volume control 131 may, on soft passages, be set at a low resistance level, permitting passage of only a low signal level (and facilitating playing of pianissimo staccato tones), and on loud passages, the control may be set at a high resistance to permit passage of full signal level. In the system illustrated, setting the optional second volume control 131 at minimum resistance causes the instrument to be completely silent regardless of any operation of the first volume and voicing control 130, and on setting the optional second volume control 131 at highest resistance, maximum output levels may be accomplished by use of the first volume and voicing control 130. The resistance of the optional second volume control 131 may be set to an intermediate setting at will while the instrument is played, permitting enjoyment of a wide range of output level and expression according to the skill of the instrumentalist.

In FIG. 7 there is illustrated a push-button operated keyboard in which push-buttons 150 mounted in a support panel 152 are provided in order to avoid the need for trained fingering required for the operation of the instrument of FIGS. 1-5. It will be appreciated that the push-button operated selector system of FIG. 7 may be used in conjunction with the string 20, bar 41, and wind-

ing 52 as well as the remaining components of the instrument of FIGS. 1-5.

In FIG. 8 yet another modification of the bar 41, string 20, winding 52, and voicing and volume control 48 of FIGS. 1-5 is illustrated in the form of a key such as may be used on a piano or organ-type of keyboard. In this structure the string 20 is held in place by screws 156, 158 and the bar 41 is supported on a pivot 160. A spring 162 biases the bar 41 against a stop 164 in the normal or "off" position illustrated. The portion of the string 20 above the winding 52 is fingered in the manner in which a piano key or organ key is fingered, causing the string 20 to contact the winding 52 and depressing the bar 41 towards or against a second stop 166. Operation of the volume and voicing control 48 also takes place in the manner illustrated hereinabove with respect to the instrument of FIGS. 1-5.

The range of the oscillator controlled by the key of FIG. 8 may be set at one whole or complete diatonic tone in the conventional scale of 8 notes per octave. For example, the key, its winding 52, and associated circuitry may be adjusted such that if the string 20 is struck against the central portion of the winding 52, the note D would be sounded, if the string is struck against one end of the winding, say the end nearest the pivot 160, D-sharp is sounded, and at the outermost end of the winding, i.e. near the stop 166, D-flat is sounded. When struck at intermediate positions, intermediate tones are generated, permitting complete keyboards with only, e.g., eight such keys to an octave. With such keys, unlimited note subdivision, glissando effects, and a true (just intonation) or tempered scale on individual notes or on chords are available at the will and skill of the artist. Thus, a musical instrument using the instant keys is highly advantageous in that it combines the technique of the organist and the string player.

It will now be apparent that the present invention permits the construction of an electronic musical instrument which uses conventional fingering, permits playing of chords, provides for ready control of volume, is completely devoid of key clicks or any electrical disturbances arising from the closing of switches while the instrument is in use, is completely silent at any time at which no tone is being played, is ready for instant use at all times, and provides for artistic control and colorations in the volume and attack and decay characteristics of the tones and chords played. The low impedances of the transistorized oscillator facilitates the use of the instant wirewound bars, which are stable in resistance value over long periods of time and avoid any need for retuning of the instrument caused by changes therein. Similarly, the use of mercury cells to power the tone-generating oscillators is of considerable benefit in that it permits replacement of a cell, after full use thereof, with a fresh cell without requiring retuning of the oscillator powered thereby. Instant operation, complete silence when no tone is being generated, and the use of the present voicing and volume control system are made possible by the immediate operating and low impedance characteristics of the transistorized amplifiers used. The use of a transistorized amplifier is essential to the gain control operating portions of the instant musical instruments; other types of electronic amplifiers, e.g. vacuum tube operated, may be employed in conjunction with such transistorized gain controlling portions or stages if desired.

Musical instruments of the present invention remain stably in tune, contain provision for simple retuning if desired, and may be lightweight and portable, permit operation by one hand, play chords, and provide the artist with an extensive range of tones, volume levels, and expressiveness using fingering conventional to stringed instruments generally.

It is to be understood that the invention herein illustrated and described is to be limited only by the scope of the appended claims and that various changes may be

made in details of construction without departing from the true spirit of the invention.

What is claimed is:

1. A musical instrument comprising a fingerboard carrying four electrically conductive strings under tension, a pivoted bar spring biased under each of said strings, each of said bars carrying a helically wound resistance coil thereon adapted to be contacted by one of said strings on the application of finger pressure to said string, a plurality of transistorized tone generators in which said resistance coils are frequency determining elements, normally open switch means for the application of power to said generators, a transistorized audio amplifier for amplifying the output of said generators, normally open switch means for the application of power to said amplifier, said pivoted bars being adapted, on application of initial finger pressure thereto through said strings, to determine the tone generated by said generator, on the application of further finger pressure thereto, to close said switch means for the application of power to said generators, thereby energizing said tone generator, and on application of yet further finger pressure thereto, to close said switch means for the application of power to said amplifier, thereby energizing said amplifier, whereby the output of said musical instrument is devoid of key clicks and is completely silent when not generating a tone, means for controlling the gain of said amplifier in accordance with the extent of depression of said bar under the application of finger pressure thereto through said string, and an electromechanical transducer for converting the output of said amplifier into audible sound.

2. A musical instrument which comprises a transistorized tone generator having a finger-operated tone selector, means for biasing said tone selector to a normal rest position in which no tone is selected, a power supply for said tone generator connected thereto through a switch operated by said tone selector, said switch being in an open position in which position said tone generator is deactivated when said tone selector is in its normal rest position, a transistorized amplifier for amplifying the output of said tone generator, a power supply for said amplifier connected thereto through a second switch also operated by said tone selector, said second switch normally being in an open position in which position said amplifier is deactivated when said tone selector is in its normal rest position, said finger-operated tone selector being adapted, on application of initial finger pressure thereto, to determine the tone generated by said generator, on the application of further finger pressure thereto, to close said switch between said tone generator and said power supply therefor, thereby energizing said tone generator, and on application of yet further finger pressure thereto, to close said second switch between said amplifier and said power supply therefor, thereby energizing said amplifier, whereby the output of said musical instrument is devoid of key clicks and is completely silent when not generating a tone.

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