May 30, 1967 A. S. HOPPING 3,322,877

ELECTRICAL MUSICAL INSTRUMENT HAVING FINGERBOARD WITH CONTINUOUSLY VARIABLE FINGER TONE SPACING

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Fig.1

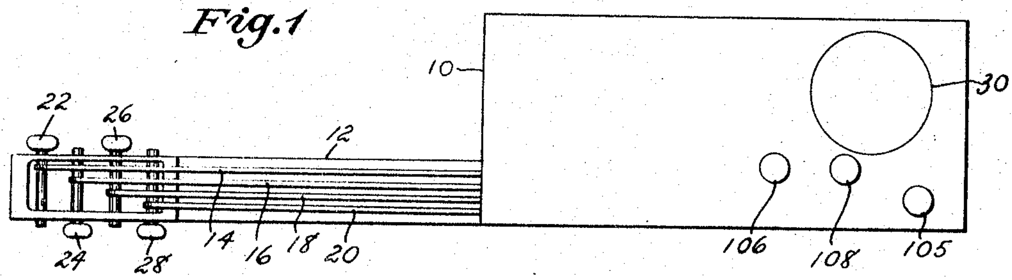


Fig.2

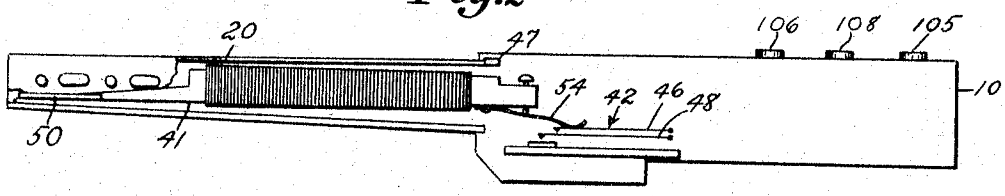


Fig.3

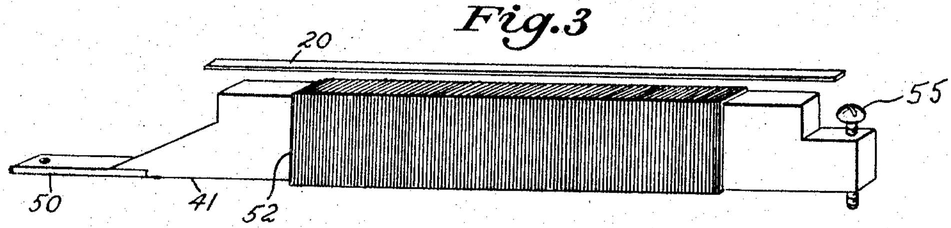


Fig.4

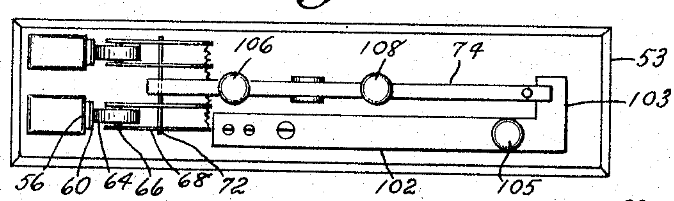
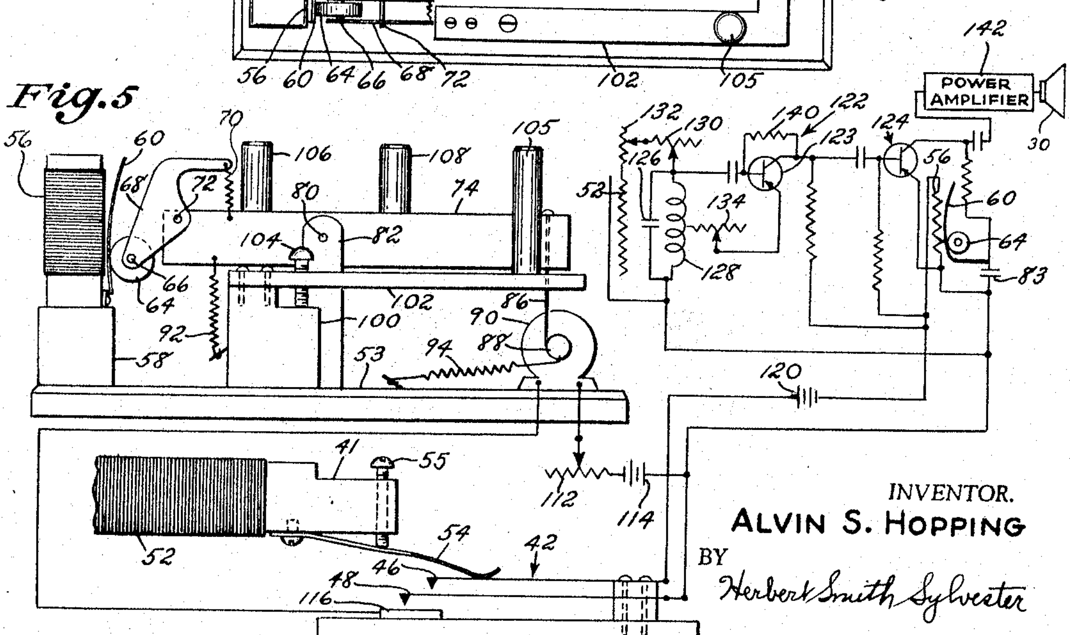


Fig.5



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ELECTRICAL MUSICAL INSTRUMENT HAVING FINGERBOARD WITH CONTINUOUSLY VARIABLE FINGER TONE SPACING

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3 Claims. (Cl. 84—1.16)

This application is a continuation-in-part of my copending application Ser. No. 175,022 filed Feb. 23, 1962, now U.S. Patent 3,223,771 issued Dec. 14, 1965.

This invention relates to a string-type electronic musical instrument having a fingerboard with variable tone spacing.

The conventional violin has been developed over a period of several centuries, with little significant modification during the last 100 years. In the fingerboard which evolved, the finger positions are difficult to reach, especially those for the fourth finger, which requires long training to attain the span needed. In view of this necessity for long training, such training should start during childhood, however instruments having a fingerboard of diminished length, which is necessary to a child, invariably have been characterized by poor tone. In the case of the larger sized string instruments, such as the cello, viola, and double bass, this problem is accentuated. Of necessity, the physical characteristics of the materials available govern the size of conventional string instruments and the spacing of the finger positions necessary to the tone spacing provided.

The musical instrument of the present invention is characterized by a fingerboard having variable tone spacing, in conjunction with electronic circuitry and power operated attack and decay control which permits of a musical instrument which is devoid of key clicks and which is completely silent when not generating a tone. A further advantage of the instant instrument is the stability and purity of the tone it generates. Another is that it permits the winding of the playing bars (which form the fingerboard) from resistance wire of relatively large diameter, thereby facilitating construction and insuring long, trouble-free life.

In accordance with the present invention, a string-type electronic musical instrument having a fingerboard with variable tone spacing comprises a transistorized L–C oscillator tone generator adapted to oscillate at a fundamental frequency, a variable resistance load on said tone generator which increases the frequency of oscillation thereof to a frequency above said fundamental frequency, said load including a pivoted bar resistor adapted to be tapped by contact with an electrically conductive string on application of finger-pressure thereto, said string being mounted on a fingerboard above said pivoted bar, a transistorized audio amplifier for amplifying the output of said generator, and an electromechanical transducer for converting the output of said amplifier into audible sound.

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

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

FIG. 4 illustrates, in plan view, details of a combined voicing and volume control of the musical instrument of FIG. 1, and

FIG. 5 illustrates, in elevation, the combined voicing and volume control of FIG. 4 in conjunction with a schematic diagram of the related circuitry employed therewith.

The musical instrument of FIGS. 1–5 constitutes a casing **10** from which projects a fingerboard **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**.

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 is a three-contact leaf switch **42** which is composed of an oscillation control switch leaf **46** and a voicing and volume control switch leaf **48**, each of which is normally open and which are activated in sequence by downward motion of the G bar **41**. Also shown in FIG. 2 is the anchoring of an end **47** of the G-string 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 0.004 inch diameter Nichrome wire along the central portion of its length, the winding having a resistance on the order of 1,500 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.

As best shown in FIGS. 2 and 5, that portion of the G bar **41** which extends into the casing **10** has, depending from its lower surface, a pressure arm **54** which is adapted to close the three-contact leaf switch **42** on depression of the bar, the leaves of the leaf switch being biased to normally open position against the weight of the bar **41**. An adjusting screw **55** is provided to facilitate positioning of the bar **41** under the string **20**.

Enclosed within the casing **10** is a voicing and volume control subassembly having a base **53** which is affixed to the bottom of the casing **10** (by means not shown).

A gain control resistance element **56** associated with the G bar **41** is mounted on a pedestal **58** to form a vertical track. (Suitably a separate such gain control element and related circuitry is provided for each of the four bars in the manner partially illustrated by FIG. 4 in which two such elements are shown.) A metallic contact tongue **60** formed of a metallic leaf spring is affixed to the pedestal **58** at the bottom of the track, and a pressure wheel **64** is carried on a shaft **66** in a stirrup **68** in a manner such that the pressure wheel urges the contact tongue **60** against the gain control resistor **56**, the tongue **60** being formed such that only that portion under the pressure wheel **64** contacts the resistor **56**. A spring **70** continually urges the pressure wheel **64** against the contact tongue **60** by virtue of the fact that the mounting stirrup **68** is supported on a pivot pin **72** at one end of a lever arm **74**, which in turn is carried on a pivot mount **80** in a mounting yoke **82**. A capacitor **83** is provided to eliminate any noise which might otherwise be generated on motion of the metallic contact tongue **60** over the surface of the gain control resistor **56** under the influence of the pressure wheel **64**.

The projecting end of the lever arm **74** is coupled by a fine flexible wire **86** to the surface of a shaft **88** of a small D.C. electric motor **90**. A coil spring **92** normally biases the lever arm 74 to the position illustrated, in which the pressure wheel urges the metallic contact tongue 60 against the end of the gain control resistor 56 adjacent pedestal 58. An additional coil spring 94 normally biases the shaft 88 of the D.C. electric motor 90 to the position shown, in which there is a slight but sufficient tension applied to the fine flexible wire 86 to eliminate any slack therein.

A mounting block 100 projects upwardly from the base 52 and provides support for a flexible L-shaped limiter beam 102, the major arm of which lies parallel to and slightly below the underside of the lever arm 74. As will be observed in FIG. 5, the minor arm 103 of the L-shaped limiter beam projects under the lever arm 74, and acts as a stop for downward motion thereof. The normal position of the limiter beam 102 is determined by a beam stop-adjusting screw 104, however a push member 105 projects vertically from the beam 102 upwardly through the casing 10 to permit manual depression of the push member and limiter beam 102.

The lever arm 74 is also provided with (manual) digital override push members 106 and 108 which similarly project upwardly through the casing 10 and permit manual displacement of the position of the lever arm 74.

The D.C. electric motor 90 is wired in series with a speed control rheostat 112 and a motor drive battery 114 through the voicing and volume control switch element 48 and a coacting switch member 116. The oscillation control switch leaf 46 coacts with the leaf spring 48 to apply power from a supply battery 120 to a transistorized Hartley oscillator indicated generally by the reference numeral 122, and a transistorized audio amplifier indicated generally by the reference numeral 124.

The Hartley oscillator 122 contains a transistor 123 and the customary frequency determining reactive elements, i.e., a capacitor 126 and an inductance 128 tapped near its midpoint. In shunt with the frequency determining tank circuit (composed by the capacitor 126 and the inductance 128) are a series of three rheostats, a coarse range-selecting rheostat 130, a fine range-selecting rheostat 132, and the tone-selecting G-string 20 and accompanying helical winding 52. Typically the fine range-selecting rheostat 132 will have a maximum resistance value in the order of about 1,000 ohms and the coarse range-selecting rheostat 130 may have a maximum resistance value on the order of 50,000 ohms. The inductance of these rheostats is negligible.

A further range-control variable resistor 134 is provided in series between the emitter of the transistor 123 and the tap on inductance 128. An additional resistor 140 is also provided between the base and the collector of the oscillator transistor 123 and is chosen to be of a value which facilitates disposition of violin G at the extreme end of the helical winding 52. Once selected, the resistor 140 is seldom changed.

The remainder of the Hartley oscillator 122 is conventional, as is the audio amplifier stage 124 with the exception of the gain-control resistor 56. In the "off" or silent position illustrated, the resistance of the gain-control resistor 52 is, in effect, zero, and both the collector and emitter of the transistor of the audio amplifier stage 124 are connected to the positive terminal of the supply battery 120.

The output of the audio amplifier 124 is coupled to a power amplifier 142, which drives the loudspeaker 30.

In adjustment prior to use, the capacitor 126 and inductance 128 are selected such that the fundamental frequency of oscillation of the Hartley oscillator 122 (as determined by the natural resonant frequency of the L–C tank circuit) is substantially below the range desired to be played as, for example, in the instant case, the range of a violin G-string. Inasmuch as the effect of the shunting resistances 130, 132, and 52 is to raise the frequency of oscillation (the lower the resistance the higher the frequency of oscillation) the range-selecting rheostats 130 and 132 are adjusted, in conjunction with the variable resistor 134 in the emitter leg of the transistor 123, to set the tuning range of the Hartley oscillator to the desired range over a suitable length of the winding 52, i.e., suitably the same length as the standard violin fingerboard. Under such circumstances, the tonal spacing along the G-string 20 will correspond to that on a conventional violin fingerboard. However, in the event it is desired to reduce the tonal spacings, as may be appropriate when training children or others of reduced finger span, the tonal spacing and range along the G-string may be diminished by adjustment of the fine and coarse range-selecting rheostats 130 and 132 and emitter rheostat 134, or vice versa.

In operation, finger pressure is applied to the G-string 20, the point of contact thereof with the helical winding 52 determining the tone played. Downward movement of the G-bar 41 under the influence of the digital pressure applied thereto through the G-string causes the pressure arm 54 first to close the upper leaf contact 46 against the lower leaf contact 48. On closing of this pair of switch elements, the positive terminal of the supply battery 120 is connected to the emitter circuit of the Hartley oscillator 122 through the tapped inductance 128, with the result that the fundamental tone of the L-C circuit is not generated but rather tone generation is initiated at the frequency determined by the point of contact of the G-string 20 with the helical winding 52.

As additional digital pressure is applied through the pressure arm 54 to the three-contact leaf switch 42, the voicing and volume control leaf 48 is urged against the bottom contact member 116 as the final action thereof. At this point, the motor drive battery 114 is connected to and drives the D.C. electric motor 90, which takes up on the fine flexible wire 86 and drives the lever arm 74 down against the projecting base of the L-shaped limiter beam 102. This pivoting action of the limiter beam moves the pressure wheel 64 along the metallic contact tongue 60 in contact with the gain-control resistor 56, thereby rapidly applying power from the negative terminal of the supply battery 120 to the collector of the audio amplifier stage 124. Thus, amplification of the output of the Hartley oscillator stage 122 occurs only after all switching members have operated, thereby completely avoiding any key clicks in the output of the instant device.

It will be apparent from consideration of the figures that application of digital pressure to any of the push members 105, 106, or 108 will serve to modify the gain of the audio amplifier stage 124, thus facilitating artistic variation and tempering of the output.

The digital override push members 105, 106, and 108 are operated, of course, by the free hand. The provision of the D.C. electric motor 90 in conjunction with the gain control adjustment, has been found to facilitate faster play than manually operated systems dependant entirely on finger pressure, and as such is much less tiring on the performer. It is also apparent that on release of finger pressure from the G-string 20, the cycle of operations is reversed, i.e., the coil spring 94 returns the shaft 88 of the electric motor 90 to its normal rest position, resulting in the elimination of any output by the audio amplifier stage 124, following which the power from the supply battery 120 is removed from the Hartley oscillator stage 122 and oscillation is stopped.

Although only a single channel (that of the G-string) has been illustrated and described, it is apparent that comparable channels are utilized in a complete instrument for the E-, A-, and D-strings, the output of each audio amplifier stage associated therewith being controlled by separate gain control resistor 56 and fed to the common power amplifier 142.

What is claimed is:

1. A string-type electronic musical instrument having a fingerboard with variable tone spacing which comprises a transistorized L–C oscillator tone generator adapted to

oscillate at a fundamental frequency, a variable resistance load on said tone generator which increases the frequency of oscillation thereof to a frequency above said fundamental frequency, said load including a pivoted bar resistor adapted to be tapped by contact with an electrically conductive string on application of finger-pressure thereto, said string being mounted on a fingerboard above said pivoted bar, normally open switch means for the application of power to said generator, a transistorized audio amplifier for amplifying the output of said generator, normally open switch means for the application of electric power to said generator, an electrically driven gain control for increasing the gain of said amplifier on application of electric power thereto, normally open switch means for the application of power to said electrically driven gain control, said pivoted bar being adapted, on application of finger pressure thereto through said string, 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 generator and amplifier, thereby energizing said tone generator and amplifier, and on application of yet further finger pressure thereto, to close said switch means for the application of power to said gain control, thereby increasing the gain of said amplifier, means for manually overriding the gain of said amplifier determined by said electrically driven gain control, and an electromechanical transducer for converting the output of said amplifier into audible sound.

2. A string-type electronic musical instrument having a fingerboard with continuously variable finger tone spac-

ing which comprises a transistorized L-C oscillator tone generator adapted to oscillate at a fundamental frequency, a variable resistance load on said tone generator which increases the frequency of oscillation thereof to a frequency above said fundamental frequency, said load including a pivoted bar resistor adapted to be tapped continuously along its length by contact with an electrically conductive string on application of finger-pressure thereto, said string being mounted on a fingerboard above said pivoted bar, a rheostat in series with said bar resistor and of substantially greater resistance than said bar resistor, said rheostat being adjustable to control the tonal spacing and range of tones generated on application of finger-pressure to said string along the length of said bar resistor, a transistorized audio amplifier for amplifying the output of said generator, and an electromechanical transducer for converting the output of said amplifier into audible sound.

3. A string-type musical instrument as set forth in claim 2 in which said L–C oscillator is a Hartley oscillator.

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