SIMULATED STRINGED ELECTRONIC MUSICAL INSTRUMENT HAVING GRADUAL SWITCH FOR ATTACK, DECAY, AND VOLUME CONTROL

6 Claims, 14 Drawing Figs.

U.S. Cl. .................................................. 84/1.13, 84/1.16, 84/1.26, 84/1.27, 338/69, 338/211

Int. Cl. .................................................. G10h 1/02, G10h 5/12

Field of Search ........................................ 84/1.01, 1.04, 1.13, 1.14, 1.16, 1.24, 1.26, 1.27; 338/69

ABSTRACT: An electrical musical instrument in which the
finger placement of the left hand determines the desired chord
and the right hand is used for activating tone generation, as by
downward pressure on simulated strings. The instrument con-
tains a voicing control or gradual switch comprising a leaf con-
tact and water-glycerine-graphite impregnated cloth resistor
which permits desired attack and decay effects as well as con-
trol of output volume by the manner in which the right hand is
utilized.
SIMULATED STRINGED ELECTRONIC MUSICAL INSTRUMENT HAVING GRADUAL SWITCH FOR ATTACK, DECAY, AND VOLUME CONTROL

This invention relates to musical instruments. More particularly, it relates to musical instruments, such as electronic guitars and violins, having a voice control, i.e., a device for determining the attack and decay characteristics of the tones generated thereby, as well as the output level of the musical instrument.

The invention will be illustrated with respect to two channels of an improved electronic musical instrument.

In the drawings:

FIG. 1 illustrates in schematic form a preferred embodiment of a musical instrument similar to an electronic guitar or violin and having playing strings, frets, and, for each string, a gradual switch for control of volume, and attack and decay characteristics;

FIG. 2-7 illustrates details of the gradual switch of FIG. 1;

FIGS. 8 and 9 illustrate details of an alternate gradual switch;

FIG. 10 illustrates details of a modified playing string;

FIGS. 11-13 illustrate details of alternate fret wires suitable for use in the apparatus of FIGURE 1; and

FIG. 14 illustrates details of a stiffened resistance unit construction suitable for use as the frequency determining element of the musical instrument of FIG. 1.

As illustrated in FIG. 1, the instant design may make use of a wire wound-tubular resistance unit 10, which typically may be one-quarter inch in diameter and about seven inches long. The circuit illustrated in FIG. 1 requires that the resistance unit have an overall resistance typically on the order of about 1000 ohms, which is readily accomplished using 0.004 inch diameter Nichrome wire. Adjustable sliding contacts 12, one for each fret 14, tap the resistance unit 10 and determine the frequency relationships of the tones generated by the instrument. In simulation of a guitar structure, an electrically conductive string 16 is suspended from its ends in the customary manner above the frets 14, which in turn are carried on a bar 20 which is pivoted at one end 21 and supported at the other end 22 on a normally closed leaf switch 24. A resistance unit 10 and the associated components as illustrated in FIG. 1 is provided for each string 16 of the instrument.

An alternative structure, also illustrated in FIG. 1, may utilize a wire wound resistance bar 10a with which direct contact is made by an electrically conductive string 16a to produce a range of continuously variable tones in simulation of an violin structure.

A tuning potentiometer 26 is provided to facilitate initial tuning and subsequent retuning of the instrument.

One end 30 of each resistance unit 10 is grounded during open-string operation of the instrument (by closing the normally open side of a biased single pole double throw switch 32), and the total resistance in this branch of the circuit determines the lowest tone generated by the circuit, this being low E (bass) in the case of the sixth string.

The tuning potentiometer 26 is adjusted to produce the lowest tone desired for each string, and then the individual sliding contacts 12 are set for each fret. In the event that further adjustment may be necessary to keep all required tones for each string on the length provided for the resistance unit 10, the range of the tones generated by the circuit may be adjusted in accordance with the teaching of my U.S. Patent No. 3,222,877 issued May 30, 1967.

Opening operation is accomplished by depression of a button 34 which actuates the single pole double throw switch 32. This switch, which normally is biased to the position shown in FIG. 1, is carried by a pivoted voicing pad 36.

The voicing pad 36 consists of a hinged plate 38, biased by a spring 42 to the normally "Off" position illustrated. Digital depression of the button 34 actuates the switch 32, which, as described above, causes generation of the lowest note on each bar corresponding to the open string tone of a conventional guitar. The switch 32, in its normal position, is electrically in series with the leaf switch 24. In the normal positions illustrated these switches short circuit the resonant tank circuit of a transistorized oscillator circuit 44, thereby deactivating it.

The leaf switch 24 is disposed under the end 22 of the bar 20 so that if the bar 20 is depressed or, alternatively, the corresponding open-string button 34 is depressed, the inactivating circuit is broken and the oscillator 44 becomes active.

The resistance unit 10 is a frequency-determining element. Under one edge of the hinged plate 38 of the voicing pad 36 is a gradual switch 50 which is positioned in a normally open or "Off" condition. Depressing the plate 38 of the pad 36 closes the gradual switch 50 and the output of the oscillator circuit 44 is fed through an amplifier stage 52, a voicing unit 54 or a frequency divider 56, and the gradual switch 50 to the primary of an input transformer 58 of a power amplifier 60, which in turn feeds a speaker 62. Digital pressure applied to the button 34 is transferred through a projection 39 to the pad 38 and thereby determines the resistance exhibited by the gradual switch 50, this resistance being inversely proportional to the pressure applied. Accordingly, the speed with which the pressure is applied to the button 34 determines the rate of attack, the speed with which the pressure is released determines the rate of decay of the output signal tone, and the extent of pressure determines the output level. Delivery of the open-string tone by depression of the button 34 is overridden by depression of the string 16 against a fret 14 by the left hand, since the effect thereof is to "short out" a part of the resistance unit 10, but the control of expression remains in the right hand. Thus, it will be seen that positioning the open-string button 34 to actuate the plate 38 of voicing pad 36 brings all of the expression activity to the right hand, a logical common location for the least confusion and least effort.

A separate output switch and level control 64 is associated with each circuit so that the output of each circuit can be rejected or accepted and regulated. (The control 64 is, in essence, a rheostat having an open circuit position adjacent to the maximum resistance position of the slider.) The frequency divider 56 serves to lower the output tone one octave and to impart the tonal quality of a saxophone to it. This optional circuit is provided in parallel with the voicing circuit 54, and a voicing unit is provided for optional use in parallel with each frequency divider. (The voicing unit is a filtering circuit conventional in electric organs used to simulate string tones, horn tones, and the like.)

The amplifier circuit 52 following each oscillator is operated as a sawtooth-wave output type, rich in harmonic content, to expand the voicing potential of the instrument.

Also shown in FIG. 1 is a modification in which a conductive wire 16a is urged by digital pressure directly against a wire wound resistance bar 10a, providing a fret-free violin-type structure.

Details of a suitable alternate string-supporting structure are illustrated in FIG. 10. In the construction of FIG. 10, the resistance bar 10 is stationary and the switch 24 is operated by downward pressure of the conductive string 16. A bias spring 18 normally keeps the string 16 taut and the normally closed leaf switch 24 is opened by means of a pivoted lever arm 17. This construction is particularly beneficial in connection with the apparatus modifications illustrated in FIGS. 11 and 12 because of the stationary nature of the bar 10.

In the modifications of FIGS. 11 and 12, the frets 14 are mounted on a bridge 206 under which is disposed a tapped resistance bar 10. In the modification shown in FIG. 11, the resistance bar 10 is contacted by means of a flexible spring brass contact 200, and in the modification illustrated in FIG. 12, adjustable sliding contacts 212 are similarly provided. In the construction of both FIGS. 11 and 12, each fret 12 is connected by a wire to the appropriate adjustable contact.

As shown in FIG. 11, in this modification a pair of adjustable screws 220 and 222 are recessed in the bridge 206 in a manner such that the settings of each of the screws 220 and 222 causes the spring brass contact 200 to flex and thereby move the contact position along the length of the bar 10.

In
the systems of both FIGS. 11 and 12, tuning can be done conveniently at each fret.

FIG. 13 is a view taken in cross-section along the lines 13-13 of FIG. 12.

FIG. 14 illustrates a suitable resistance unit 10a of extremely stiff design. In this construction, a metal core 240 is covered with an insulating film, such as paper, plastic tubing, varnish, or the like, over which Nickel resistance wire 242 is wound, the base and crimped to its underside over a wire terminal lead 76 which is soldered to the staple. The staple is fabricated of a wire plated with a precious metal so as to avoid oxidation or corrosion.

The portion of the cloth strip 70 in the proximity of the staple is saturated with a conductive medium composed of a mixture of equal parts by weight of glycercine and water which has finely divided graphite powder suspended therein. The ends of the cloth 70 are drawn together and folded over the staple 74 and the two original ends of the cloth 70 are cemented together and to the base 72 with rubber cement. The portion of the cloth strip 70 near the staple is again saturated (for about half the length of the double thick strip) with the same suspension of graphite powder in aqueous glycercine. A metallic contact tongue 80, fabricated of spring brass plated with precious metal to the base 72, is inserted from the staple 74. The tongue 80 is curved so that in its normal position it does not contact the cloth strip 70 until it is urged downwardly thereagainst by a screw 84 carried by the hinged plate 38 of the voicing pad 36.

In use, depression of the tongue 80 by the screw 84 on the voicing pad 36 causes the tongue 80 first to contact the cemented ends of the impregnated cloth 70, which action serves as a switch-closing action. Thereafter, continued depression of the tongue 80 causes a reduction in the resistance of the unit which, as indicated hereinabove, may diminish from an initial resistance of over 1,000,000 ohms to as low as approximately 20 ohms or less on complete depression (of one-eighth inch) of the tongue 80 along the full length of the cloth 70.

The squeezing action of the tongue 80 along the impregnated cloth strip 70 assists in maintaining the bulk of the impregnating fluid and suspended solids at the staple end of the cloth strip. This is a desirable condition as it prevents migration of the graphite, which becomes enmeshed in interstices in the cloth, with the fold therein maintaining a reserve thereof. The resilience of the soft cloth facilitates a gradual compression and reduction in resistance as the tongue 80 approaches the staple 74. It has been found that the normal value of resistance of the unit on full actuation thereof does not degrade the voicing of the tone supplied thereto and permits substantially complete passage of the tone supplied to the input of the main amplifier.

FIG. 8 shows in partial exploded form and FIG. 9 in assembled form details of construction of a simplified gradual switch which does not require the use of a separate switch. FIGS. 8 and 9, a soft cloth 170 is doubled about its length and cemented with rubber cement to the base of a rectangular metal frame 172 having side walls which project slightly above the upper surface of the cloth.

The contact element 180a is U-shaped in cross-section and gradually reduced in depth along its length. The contact element 180a is supported from a leaf spring 180 above the cloth FIGS. 8 and 9, and is free of contact therewith until depressed by the screw 84 carried by the hinged plate 38 of the voicing pad in the manner similar to the gradual switch of FIGS. 1-7.

The gradual switch construction of FIGS. 8 and 9 is advantageous in that there is more positive separation of the contact element 180a and the cloth 170 in the normal, open condition of the switch. On depression of the contact element 180a, the heel of the contact element is first imbedded in the impregnated cloth 170 and thereafter the balance of the contact element contacts the cloth, readily providing a range of resistance values from approximately 1 megohm to 20 ohms (in addition to the open switch, normal condition of the construction shown).

The cloth 170 is saturated with the conductive medium described hereinabove, the fluid being concentrated at the end of the cloth remote from the heel of the tapered contact element 180a, that is, at the end of the cloth last to be contacted by the contact element.

The instant construction produces a gradual switch action which is quiet in operation and which provides the extremely wide resistance range necessary for suitable operation of a musical instrument such as that described. The use of the impregnating fluid as a conductive medium permits simple application and much quieter operation than the use of graphite per se, which develops a cracking sound after use. Glycerine being highly hydroscopic, tends to help maintain the moisture content of the cloth strip 70, and in fact may absorb more moisture from the atmosphere without disadvantage. If after long use the cloth becomes somewhat dry, more liquid can be put on the staple end thereof for renewal of the original desirable properties.

The particle size of the graphite powder is not critical, except that it should not be larger than the interstices of the supporting cloth employed. Finely divided carbon powder may be used in lieu of graphite, with some gain in quietness but with a somewhat higher final resistance. Likewise, deflocculated graphite may be employed.

The cloth employed may be woven or may be of a felt construction, or of any other desired substantially porous long-lasting nature. It may be cotton (cellulosic), in which case it is desirable that the impregnating solution be slightly alkaline, as may be accomplished by the addition of alkaline buffers to the impregnating liquid, or it may be of animal origin (e.g. wool) in which case a somewhat acidic impregnating solution is desirable, which may be accomplished by the addition of an acidic buffer. Alternatively, fiberglass, nylon, or other synthetic fibers may be employed.

The impregnating liquid desirable is somewhat conductive in nature, suitably being characterized by a specific resistance on the order of 400,000 ohms to 1,000,000 ohms. Although an aqueous glycerine system has been illustrated, other hygroscopic liquids and humectants may be used. In addition, it has also been found that liquid silicones are quite suitable, and other liquids characterized by appropriate specific resistance characteristics and a sufficiently low vapor pressure that they do not readily evaporate, may be employed.

One gradual switch is used for all of the strings in the musical instrument illustrated. By virtue of the compactness of the switch illustrated, this is accomplished without difficulty. A further advantage of this system arises from the fact that the gradual switch illustrated is substantially completely free of any magnetic field effects and is readily shielded from any undesirably electrostatic effects.

I claim:
1. An electronic musical instrument having an electronic tone generator and an electronic power amplifier and a gradual switch disposed to transmit generated tones from said tone generator to said power amplifier, said gradual switch having a movable switch pole which on activation is gradually compressed against a porous retainer which is impregnated with fluid having suspended therein electrically conductive solid particles.

2. An electronic musical instrument as set forth in Claim 1 in which said porous retainer is woven cellulosic textile material.

3. An electronic musical instrument as set forth in Claim 1 in which said electrically conductive solid particles are graphite powder.

4. An electronic musical instrument as set forth in Claim 1 in which said fluid contains water.

5. An electronic musical instrument as set forth in Claim 1 in which said fluid contains glycerine.

6. A string-type electronic musical instrument having a transistorized electronic tone generator and electronic power amplifier and a gradual switch disposed to block or to transmit generated signals from said tone generator to said power amplifier, said gradual switch being actuated to transmitting condition following the initiation of tone generation by said tone generator and constituting an arcuate member of spring brass which on activation is gradually compressed against a porous cotton flannel retainer which is impregnated with an aqueous glycerine having suspended therein graphite particles of particle size smaller than the interstices in said cotton flannel, whereby the rate at which and the extent to which said spring brass member contacts said impregnated cotton flannel determines the rate as which and the extent to which the resistance of said gradual switch diminishes, thereby controlling the rate of attack and output volume of said tone from said musical instrument.