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ELECTRONIC MUSICAL INSTRUMENT

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2 Sheets-Sheet 1

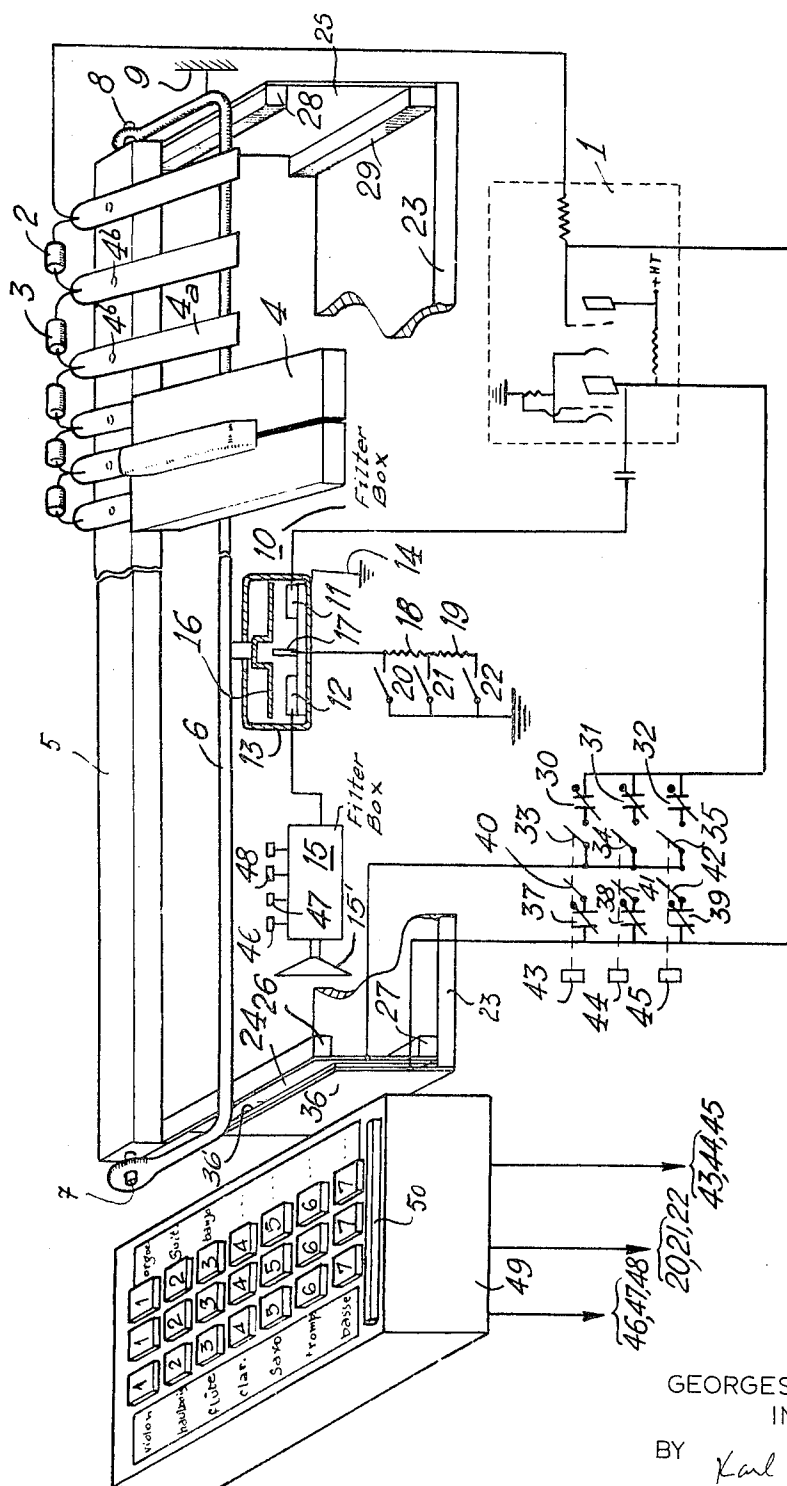


Fig. 1.

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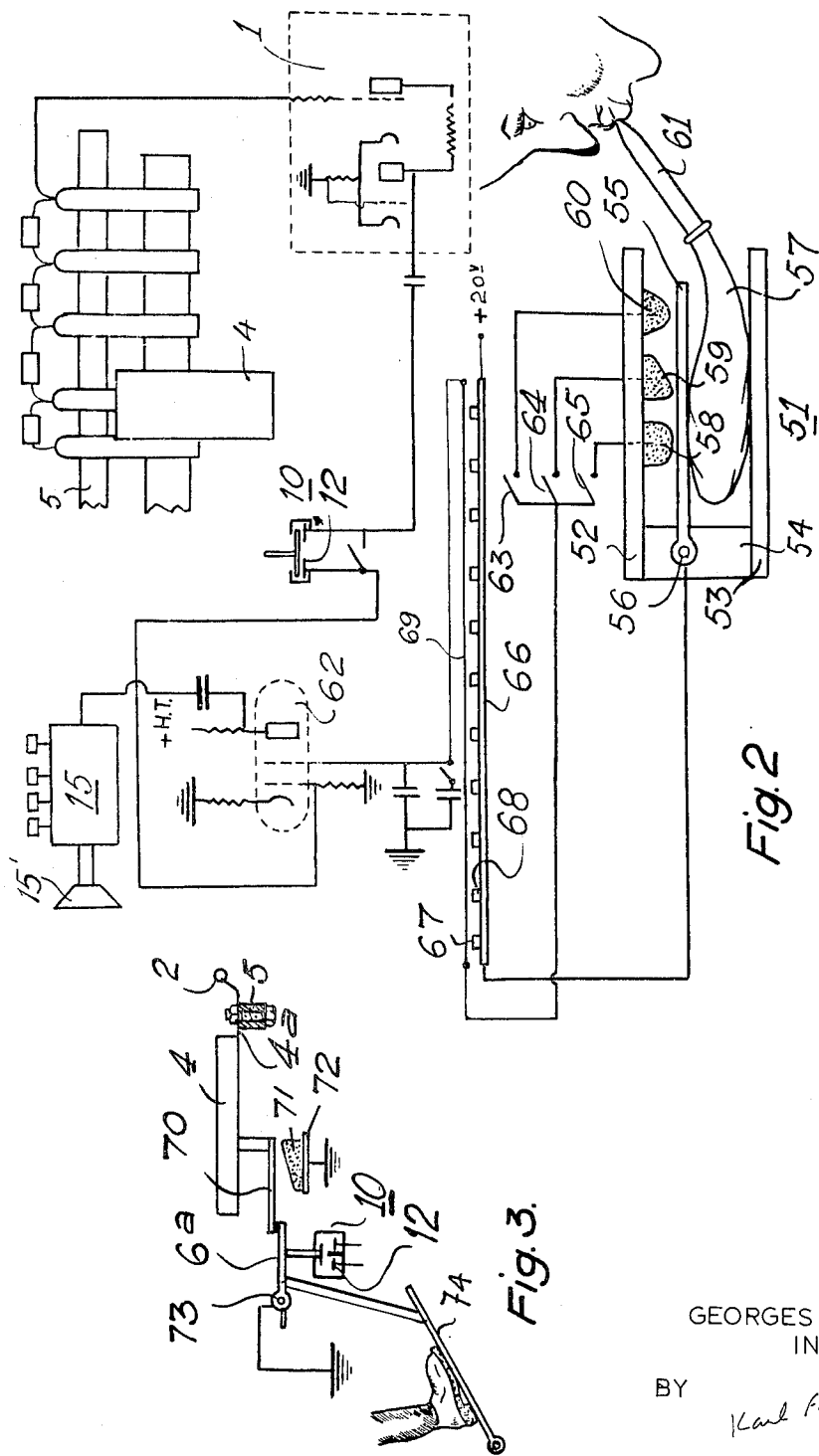
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1

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ELECTRONIC MUSICAL INSTRUMENT
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 5 Claims. (Cl. 84-1.19)

The present invention relates to a monodic electronic musical instrument designed to enable the player to obtain a wide range of tonal expression with instantaneous variation of the quality of such expression according to the desired timbre and effect.

One of the difficulties encountered with monodic electronic musical instruments that aim at imitating non-electronic instruments like the violin or the saxophone, for example, arises for the following reason:

To imitate a given monodic musical instrument such as the violin, for instance, not only is the timbre (harmonics content) involved, but also the qualities of attack and vibrato.

Should it then be desired to switch instantaneously from a "violin" to, say, a "saxophone" rendering, then it is necessary to modify not only the harmonics content but also the mode of attack and the quality of vibrato.

With the utilization of certain previously proposed improvements I have been able to provide a measure of personal expression by various means.

It was found, however, that the settings used for these means of expression (notably in respect of attack and vibrato) had to be modified in advance to enable the characteristics of a given non-electronic musical instrument to be more realistically and conveniently reproduced.

As an example, to render a timbre of the saxophone type, as opposed to that of a violin, the expressive effect provided by the keyboard must operate differently and the sensitivity of the manual vibrato arrangement must also be varied.

The present invention has for its object to facilitate separate adjustment and apportioning of each of the characteristic sound features of the non-electronic instrument it is desired to imitate, to wit: (a) the timbre (harmonics content); (b) the manner of attack (progressive, semi-progressive, percussive, explosive); or characteristic of a string or a wind instrument, etc.; and (c) the sensitiveness of the vibrato.

Another object of the invention is to arrange the means of adjustment in such a way that, with one hand only and with a single motion (simultaneous depression of a number of keys disposed in a special way), one can instantaneously obtain a given combination of features that simulate the type of rendering characteristic of, for example, a violin, a saxophone, or a guitar, the switch-over from one combination to another being accomplished rapidly and smoothly.

A further object of the present invention is to provide easily operating means for producing glissando effects.

Yet a further object of the invention is to provide means for readily producing various repetitive attack effects which may simulate castanets, bongos, banjos, mandolins, etc., while avoiding the impression of automation customarily encountered with this particular feature in conventional electronic musical instruments.

Still further particularities and advantages of the present invention will become apparent from the description which follows with reference to the accompanying drawing, given by way of example and not of limitation, whence there will emerge a clear understanding of how the present invention may be put into effect in its various aspects and modifications falling within the scope of this disclosure.

In the drawing:

FIG. 1 schematically illustrates a monodic electronic

2

musical instrument incorporating the principal features of my invention; and

FIGS. 2 and 3 schematically illustrate various improvements to the system of FIG. 1 in two alternate embodiments.

In the embodiment shown in FIG. 1, the oscillator 1, which could be of any type whatever, is shown to comprise a conventional multivibrator-type oscillation generator, of the type described in my prior U.S. Patent No. 2,562,429, with a resistive-capacitive frequency-control circuit described in detail hereinafter. The right-hand grid of this oscillator is connected to a chain of resistors 2, 3, etc., the grounding of individual resistors in said chain being obtained by depressing a corresponding key in the keyboard. For instance, depression of the key 4 places, through the intermediary of a metal strip 4a fixed at 4b to a common insulating bar 5 which also serves resiliently to urge the keys into their inoperative positions, the corresponding resistor in contact with a common contact rod 6 located beneath the set of keys. Rod 6 is elastically pivotable about pins 7 and 8 and is grounded at 9. Any other key that is depressed will lower this rod 6 in the same way, but the note emitted will differ according to which of the resistors in the chain is grounded via the rod 6.

As it moves down, rod 6 additionally operates a filter box 10. The latter contains two metal electrodes 11 and 12 housed in an electrically-shielded enclosure 13 which is grounded at 14.

Electrodes 11 and 12 are respectively connected to the left-hand plate of oscillator 1 and to the input of a filter box 15, both these electrodes being lined with asbestos as described in my aforementioned U.S. patent. A metal plate 16, which is rigidly connected to and operated by rod 6 though electrically insulated therefrom, is likewise accommodated in enclosure 13. An insulated metal partition 17 can be grounded, either directly, when contact 20 is closed, or indirectly, through the intermediate of a chain of resistors 18, 19, when contacts 21 and/or 22 are closed.

The set of keys is supported on a board 23 by means of two metal spring-plates 24, 25 and four parallel corner braces 26, 27, 28, 29, the braces 26, 28 being fixed to the bar 5 and the braces 27, 29 to the board 23. The keyboard is thus able to oscillate transversely in response to movement of the player's hand.

The lateral suspension spring plate 24 is very carefully insulated electrically, and is connectable to the left-hand plate of the oscillator 1 via an adjustable capacitor 30, 31 or 32 when a respective contact 33, 34 or 35 is closed. A further metal plate 36 is disposed adjacent the plate 24 from which it is insulated by a dielectric layer 36'. The plate 24 thus constitutes the moving plate and the plate 36 the fixed plate of a condenser whose capacitance varies according to the extent of lateral displacement of the keyboard unit. The plate 36 is directly connected to the right-hand grid of oscillator 1 and is furthermore connectable to the plate 24 via an adjustable capacitor 37, 38 or 39 according to which of the corresponding contacts 40, 41 and 42 (the functions of which will be explained hereinafter) is closed. Contacts 33 and 40, 34 and 41, and 35 and 42 are paired electrically and operated by switches or relays 43, 44 and 45, respectively.

The filter box 15, which is designed in any manner well known per se, receives musical-frequency oscillations from the electrode 12 of the progressive-attack box 10 and selectively transmits them to a loudspeaker 15' which converts them into acoustic waves. Filter box 15 comprises an impedance network of known type whose several sections can be cut in and out by means of switches or relays 46, 47, 48, etc. provided in suitable numbers.

An instrument-selector box 49, preferably located to

the left of the keyboard, comprises, for example, seven parallel and horizontal rows of three buttons each, numbered 1 to 7 from top to bottom, each button being adapted to be depressed vertically. A bar 50 operates in conventional manner and, on being lowered, enables all the depressed keys to be cleared simultaneously and to revert to their original raised positions. Opposite each horizontal row there is inscribed the corresponding instrument rendering. In this way the player knows that, by depressing the appropriate horizontal row of three buttons, he may obtain, for example a violin rendering, depression of these three keys causing directly or via relays, closure of one of the filter contacts in the box 15 (e.g. contact 21), closure of one of the expression-controlling contacts (e.g. contact 21) and closure of one of the dual contacts (e.g. 34, 41) which electrically adjust the amplitude of the hand-produced vibrato.

There will now be explained the working principles of the progressive-attack devices, the adjustable manual vibrato devices and the instrument-selector panel.

When the metal rod 6 is not lowered, the wave emitted by the generator 1 cannot pass by direct capacitive coupling between the electrodes 11 and 12 if the contact 20, which grounds the partition 17 directly, is closed. The capacitive coupling between these electrodes is limited to that provided by the plate 16 and is consequently negligible. With none of the keys depressed, the residual sound is therefore nil. Conversely, when one of the keys is depressed (and hence with it the rod 6), the plate 16 descends and engages the electrodes 11 and 12. The oscillation received at electrode 12 is therefore at a maximum. In this way, maximum difference in expressive effect is obtained as any one of the keys travels between its positions corresponding to initial depression and maximum depression respectively, this difference could be, for instance, as high as 40 decibels.

If, on the other hand, the contact 22 is closed instead of the contact 20, the partition 17 will no longer be at zero potential, as a result of which a louder residual sound will be heard when none of the keys is depressed. Thus, the difference in sound level between minimum and maximum depression of a key will in this case then become only 20 decibels, for example, and this may be a useful feature for faithful duplication of the sound produced by a non-electronic musical instrument.

This embodiment of the keyboard, affording controllable expression in response to the degree of depression of the keys, is preferred but may be modified without departing from the scope of the invention. By way of example, the asbestos electrodes 11 and 12 may be replaced by electrodes made of foam rubber rendered conductive by the incorporation of conductive particles. The manner whereby a vibrato, the sensitiveness of which can be previously adjusted, is obtained has already been described with reference to FIG. 1.

The adjustable capacitors 30, 31 and 32 have different ratings and are arranged in series with the variable condenser constituted by the plates 24 and 36; the latter is controlled by transverse oscillations of the keyboard in response to movement of the player's fingers. To a given degree of lateral displacement of the keyboard, in the mechanical sense, there correspond different overall variations of capacitance of the capacitor system 24, 36 in series with the adjustable capacitors 30, 31 and/or 32, depending on the ratings adopted for the latter, so that a frequency modulation of the output of oscillator 1 results with consequent variation of pitch.

To compensate for overall tuning differences introduced by the addition, in series, of capacitor 30, 31 or 32, tune-compensating capacitors 37, 38 and 39 are provided, and the contacts 33/40, 34/41 and 35/42 are respectively paired and operated (directly or by relays) by depressing the timbre buttons (43, 44, 45) shown on the panel of box 49 to the left of the keyboard in FIG. 1. Since the condensers 30-32 are in series with condenser 24/36

whereas the condensers 37-39 are in parallel therewith, the overall capacitance in a given position of the keyboard remains unchanged upon depression of these buttons but the effect of a keyboard shift upon the oscillator output will vary according to the selected button.

The preferred disposition of the timbre-control buttons, as described hereinabove, permits, with a single motion, instant realization of predetermined renderings without precluding the selection of a wide variety of other combinations which can be identified by ordinary three-digit numbers on a list supplied with the instrument. In a particularly advantageous but by no means limiting embodiment along these lines, the first two columns at right angles to the horizontal rows may be numbered in, say, black and the third column in red.

Seven easily distinguished instrument renderings are then marked off in black on the left, and it will be apparent that they refer to the first two digits in black along the corresponding horizontal row. As an example, the violin rendering can be obtained instantly and without hesitation by simultaneously depressing the black buttons giving the figure "11." In the same way, the oboe will be given by the figure "22," the trumpet by the figure "33" and so on. On the right-hand side of the panel, the names of other instrument renderings or other effects are inscribed in color. This tells the player that by depressing the three horizontal buttons in the second row, i.e. the key number "222," he can obtain a guitar rendering, that the number "333" will simulate a banjo and that the number "666" produces the effect of a tom-tom.

Other combinations are possible, however, and may be compiled on an appropriate list. Thus, in the particular example chosen, the code number for the bassoon would be "64," that for the horn "645," that for the mandolin "232," and so on.

There will now be described the improvements schematically illustrated in FIG. 2.

A first improvement to the progressive-attack device (box 10) has for its principal aim to insure more faithful reproduction of the attack effects characteristic of the type of mouthpiece used by such wind instruments as the trumpet.

In accordance with this improvement, a complementary expression device, designated by the reference numeral 51 is controlled by the player's breath and acts upon blocks of electrically conductive foam rubber. This device consists of two boards 52 and 53 braced by a prop 54. Between these boards there is displaceable a metal plate 55 hinged onto a pin 56, the plate 55 being inserted between the upper face of a leakproof, elastic and inflatable bag 57 and the lower faces of specially shaped blocks of foam rubber 58, 59, 60 rendered electrically conductive and fixed to the board 52. The neck of the bag 57 is equipped with a pipe 61 the outer end of which is formed into a mouthpiece for use by the player. As he blows into this mouthpiece, the player compresses air contained in the bag, and this air exerts pressure in varying degrees on the movable plate 55 which in turn compresses the blocks 58, 59 and 60, thereby causing their electrical resistance to vary.

The plate 55 is connected to a source of positive potential (e.g. 20 v.), and the blocks 58, 59 and 60 are respectively connectable to the screen grid of a tetrode 62 via one or more of the contacts 63, 64 and 65. The electrode 12 contained in the progressive-attack box 10 described hereinabove is connected to the input grid of the tetrode 62. Lastly, the plate of tetrode 62 is connected to the input of the filter box 15 described with reference to FIG. 1.

As long as the player does not blow into the bag, the plate 55 does not touch the blocks 58, 59 or 60, as a result of which no voltage is applied to the screen of the tetrode 62 whose cathode bias is so designed that, in the absence of a screen voltage, the musical-frequency

wave applied to the input grid does not appear on the tetrode plate. On the other hand, when the player blows into the bag, the most delicate variations in pressure provoke corresponding screen-voltage variations, as a result of which there is obtained, on the tetrode plate, the musical-frequency wave as applied to the input grid but with an amplitude dependent on the air pressure prevailing in the bag.

By amplitude modulation, this device enables the characteristic effects of wind instruments (tongue action, lip tremble) to be simulated, a feature it would be impossible to provide with manual means of expression control alone.

A further improvement in accordance with the invention is shown in FIG. 2 and is designed to permit easy reproduction of the characteristic sounds produced by castanets, bongos, drums, etc.

Before the keyboard there is arranged a metal strip 66 energized by a positive voltage (e.g. the same +20 v. as used to bias the plate 55), and on this strip are arranged, transversely and at intervals from one another, insulating ribs 67, 68, etc. about one millimeter thick. Above this assembly there is stretched a bare wire 69 connected to the tetrode screen and otherwise insulated.

If the player slides a finger along this wire 69 from left to right or from right to left, while at the same time maintaining his finger in firm pressure contact with the wire, periodic contact will be established between the wire and the metal strip, and this contact will be interrupted each time the finger passes over one of the insulating ribs. This in turn causes periodic interruption and restoration of the screen current of tetrode 62, and hence of the musical-frequency wave received on the plate thereof, the period of these intermittent breaks being a function of the rate of travel of the finger along the wire. The effect obtained in this way will be reminiscent of castanets, bongos, drums, banjos, or other rhythm instruments according to the speed at which the player slides his finger along the wire and, of course, according to the timbre previously selected by means of the contacts in the timbre box 49 carrying the instrument-selector panel.

Yet another improvement is concerned with producing a so-called "glissandro" effect without any attendant difficulty in ending up on a truly pitched note, and this improvement is illustrated in FIG. 3.

Beneath each key 4 of the keyboard there is disposed a bent rigid plate 70 which is electrically connected to each strip 4a and hence to each resistor 2, 3, . . . in the chain of resistors, respectively. This plate is normally grounded by a common contact rod 6a which is hinged onto two end trunnions 73 similar to the hinges 7 and 8 and is spring loaded into contact with the ends of all the electrode plates 70.

Beneath each of these plates 70, but not in contact therewith as long as the corresponding key is not depressed, is placed an electrically conductive foam-rubber block, this block being cut with a beveled face and bonded to a metal structure 72 connected to the common ground. The resistance of this block 71 is designed so that it is about one megohm when the block is inoperative, and a few ohms when the block is fully compressed between the movable electrode plate 70 and the grounded stationary electrode 72. When the player depresses one of the keys and steps on a pedal 74 to remove ground from the plate 70 thereof, this plate comes into contact with the surface of the corresponding conductive block 71 so that the circuit resistance, which was infinite prior to this contact, then becomes about one megohm. The sound obtained is consequently of very low pitch, and the frequency of this initial sound rises gradually as the player presses further on the key. When the key is fully depressed, the resistance of the block will have become negligible (a few ohms only) in relation to the resistance provided by the chain of resistors 2, 3, . . . connected to the right-hand grid of the oscillator 1, in

consequence whereof the frequency will gradually rise until it is equal to that of the true note assigned to the particular key under consideration. Thus, the musician can slide in this way from the frequency of one key on the keyboard to that of another key, and such sliding can be performed equally well from the higher register into the lower register, or vice-versa.

When the player desires to give a glissando rendering, he operates the pedal 74 to lower the rod 6a which in turn depresses the plate 16 in the musical-expression box 10.

Conversely, should he wish to revert to normal playing without glissando effects, he lifts his foot off said pedal 74. As a result, since the rod 6a stays in the raised position, the plate corresponding to any key operated on the keyboard will first make contact with the ground bus bar, thereby preventing glissando effects through shorting of the block 71.

Clearly, the blocks 71 can be of varied shape or be replaced by any other device providing variable resistance in response to degree of depression, a slider-type device being an example.

It is to be clearly understood that, without departing from the scope of the invention, many modifications may be made to the specific embodiments described hereinabove.

In particular, it is manifest that the blocks 58, 59, 60 in FIG. 22 and the blocks 71 in FIG. 3 may be shaped in any manner suitable for the realization of response curves that differ in respect of resistance variation in said blocks and, hence, will afford desired variations in the curve representing the degree of attack. In addition, these blocks may be used in any convenient number and combined according to specific requirements.

FIG. 2 furthermore shows an embodiment in which the progressive-attack mode and the special arrangement giving the castanet effect are combined in series. Obviously, however, they may be used independently of each other. Similarly, the set of electrodes 11 and 12 and the partition 17 in FIG. 1 could be replaced by the set of blocks 58, 59 and 60 in the design of the adjustable progressive-attack box 10, in which case the contacts 20, 21 and 22 would be replaced by the contacts 63, 64 and 65 respectively.

What I claim is:

1. An electronic musical instrument comprising oscillator means for generating oscillations in a range of musical frequencies, frequency-control means for said oscillator means, a support, a laterally movable keyboard on said support with a set of keys for individually actuating said frequency-control means and generating an oscillation characteristic of each key, electroacoustic transducer means for converting said oscillations into sound waves, and adjustable circuit means between said oscillator means and said transducer means for selectively altering the character of said oscillations, said circuit means including a capacitor with a movable plate secured to said keyboard and a fixed plate on said support adjacent said movable plate,

2. An electronic musical instrument comprising oscillator means for generating oscillations in a range of musical frequencies, frequency-control means for said oscillator means, a support, a keyboard on said support with a set of keys for individually actuating said frequency-control means and generating an oscillation characteristic of each key, electroacoustic transducer means for converting said oscillations into sound waves, and adjustable capacitive means between said oscillator means and said transducer means for selectively altering the character of said oscillations; said capacitive means including a pair of spaced-apart fixed electrodes, a conductive shield plate spacedly interposed between said fixed electrodes, a movable electrode normally remote from said fixed electrodes, key-controlled means for displacing said movable electrode toward a bridging posi-

tion proximal to said fixed electrodes to an extent determined by the displacement of an actuated key of said keyboard, and switch means for selectively connecting said shield plate to a source of constant potential.

3. An instrument according to claim 2, further comprising resistance means selectively insertable by said switch means between said shield plate and said source of fixed potential.

4. An instrument according to claim 2, further comprising foot-controlled means operable alternatively and supplementally to said keyboard means for displacing said movable electrode.

5. An electronic musical instrument comprising oscillator means in a range of musical frequencies, frequency-control means for said oscillator means, a support, a laterally movable keyboard on said support with a set of keys for individually actuating said frequency-control means and generating an oscillation characteristic of each key, electroacoustic transducer means for converting said oscillations into sound waves, and adjustable circuit means between said oscillator means and said transducer means for selectively altering the character of said oscillations, said circuit means including a capacitor controllable by a physical displacement of said keyboard relative to said support, said circuit means further includ-

ing several pairs of additional condensers selectively connectable partly in series and partly in parallel with said capacitor for varying the effect of a shift of said keyboard upon the character of said oscillations while maintaining the tuning of said oscillator means.

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