Oct. 15, 1957 H. LE CAINE 2,809,547

INTENSITY CONTROL DEVICE FOR ELECTRICAL MUSICAL INSTRUMENT

Filed Jan. 28, 1955 3 Sheets-Sheet 1

Fig. 1

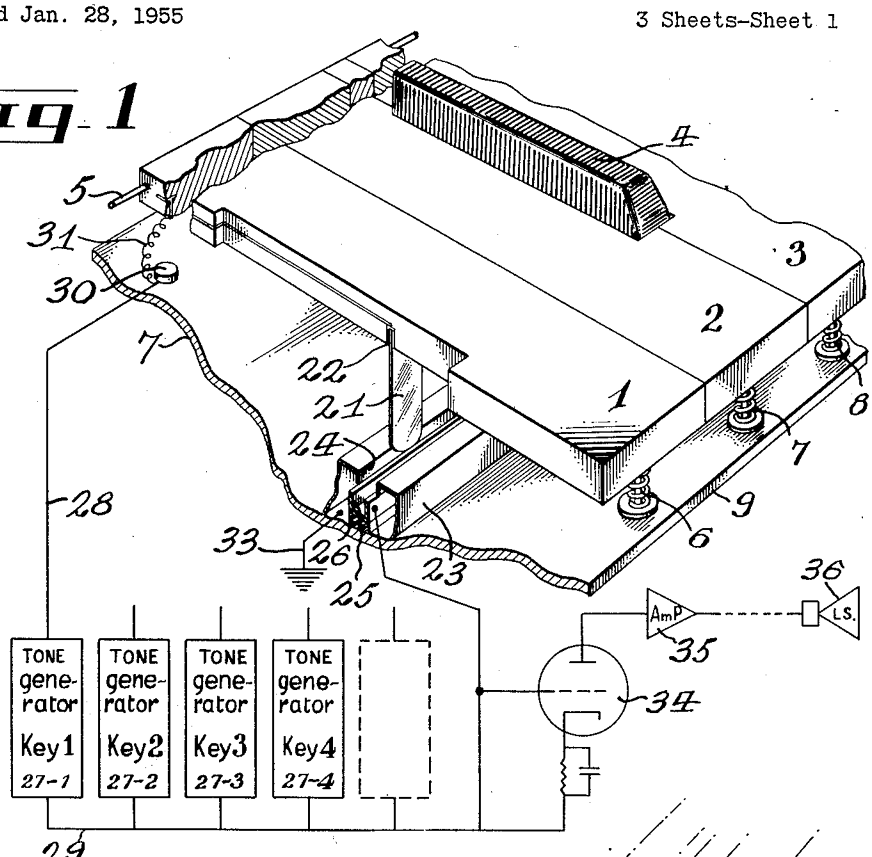
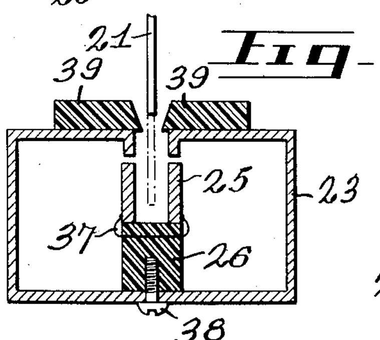


Fig. 2



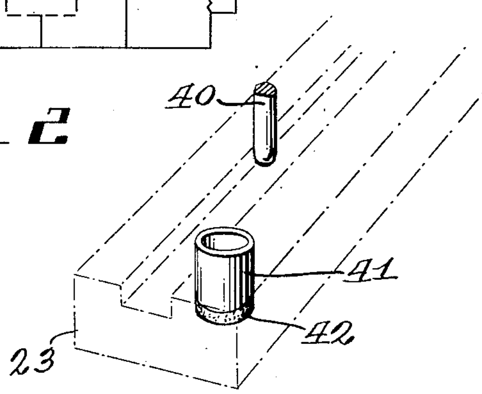


Fig. 3

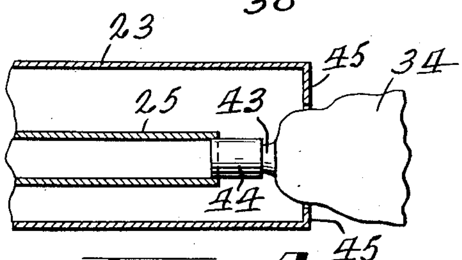


Fig. 4

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INTENSITY CONTROL DEVICE FOR ELECTRICAL MUSICAL INSTRUMENT

Filed Jan. 28, 1955 3 Sheets-Sheet 2

Fig. 5

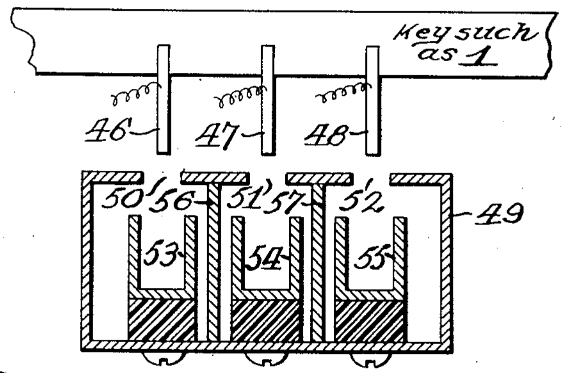
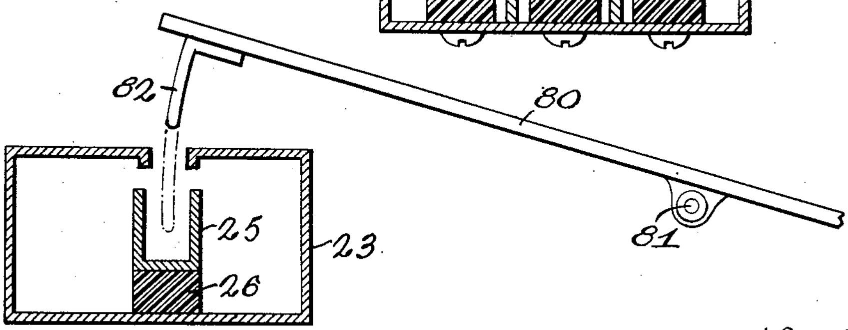


Fig. 8



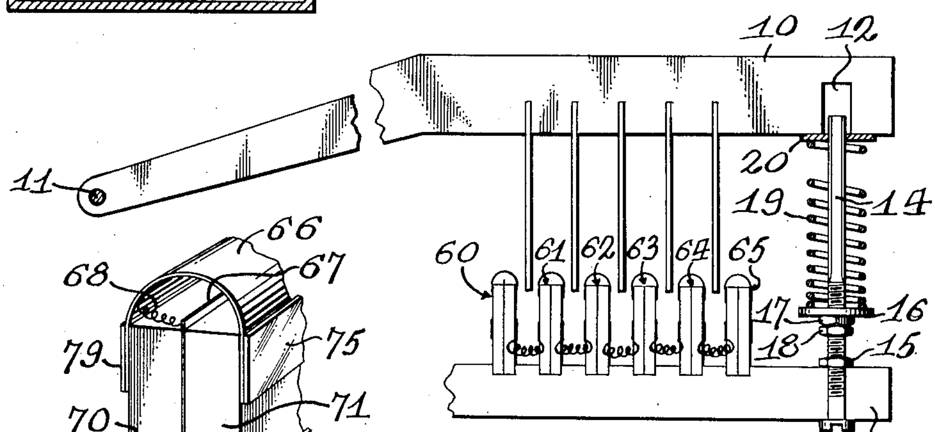


Fig. 6

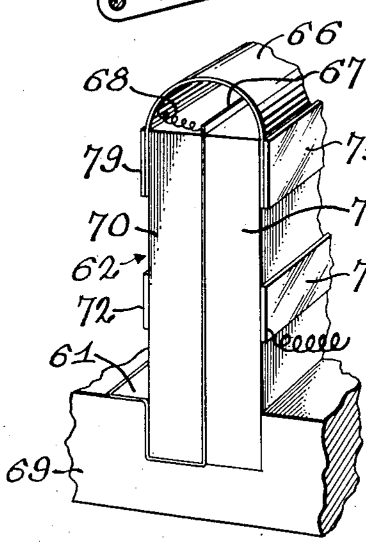


Fig. 7

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INTENSITY CONTROL DEVICE FOR ELECTRICAL MUSICAL INSTRUMENT

Filed Jan. 28, 1955 3 Sheets-Sheet 3

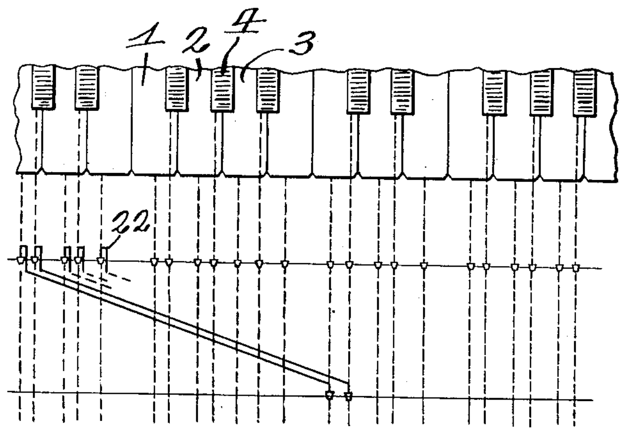

Fig. 9

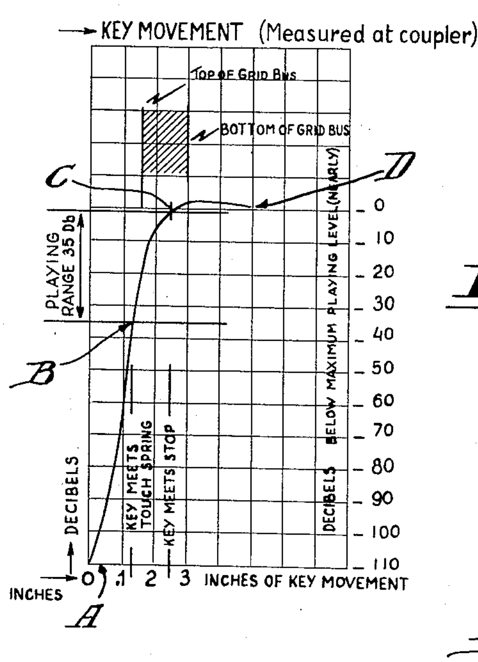

Fig. 10

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United States Patent Office

2,809,547

Patented Oct. 15, 1957

1

2,809,547

INTENSITY CONTROL DEVICE FOR ELECTRICAL MUSICAL INSTRUMENT

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Application January 28, 1955, Serial No. 484,777

6 Claims. (Cl. 84—1.26)

This invention relates to an improvement in the control of the intensity of an electrical voltage, and although not restricted thereto is particularly useful to control the level of a sound produced by an electronic musical instrument.

Several intensity control means have been used in the past in conjunction with keys of electronic musical instruments, for example, contacts, variable resistance devices and two-terminal variable capacitance devices. Of such prior art apparatus, the contacting devices having only a few contacts do not give a gradual variation in controlled sound, with the result that undesirable clicks, thumps and other discontinuities are generated, and these must be removed by other means. Prior art contacting devices which achieve a gradual variation by employing many contacts are complex and expensive to manufacture and these devices and variable resistance devices are also subject to maintenance problems due to dust, abrasion and wear.

Variable resistance and variable two-terminal capacitance devices, while capable of gradual control of the sound level, have a restricted range of attainable intensity values less than the full range of sound intensity which can be musically appreciated by the human ear. They are also bulky and not convenient for the ganging of several control means on one key, such as is required for couplers.

Reference is made to the following United States patents as representative of the prior art: Reissue Number 21,554, W. F. Curtis, September 10, 1946, and No. 2,270,789, G. G. Smith, January 20, 1942.

It is a principal object of this invention to remove disadvantages of prior art sound intensity control devices.

An accompanying object is to provide a simple control device capable of smoothly varying an electrical voltage over a range adequate for full musical appreciation of a resulting sound.

It is a further object to provide a control device which is light enough in weight and simple enough in operation to permit the ganging of several such devices on a single control such as a key in a musical keyboard without unduly increasing the manual pressure required to operate the control.

It is a further object to provide an electrical control device which is less subject to wear, abrasion and interference due to dust particles than devices which are presently used on electronic musical instruments.

Briefly the invention comprises a fixed electrode, a shield electrode or ground plane, and a movable electrode, the movable electrode being operated by a suitable control such as a key or swell pedal of an electronic musical instrument. An alternating or periodically varying voltage, normally having its frequency in the audio range, is connected to the movable electrode and a utilization circuit such as an amplifier-loudspeaker combination is connected to the fixed electrode means. It will be realized that the functions of the fixed electrode means and the movable electrode means could be interchanged so far as the circuit is concerned. The shield electrode preferably is connected to a low impedance part of the circuit which will normally be ground.

2

In the "rest" or "off" position of the control, the movable electrode will be remote from the fixed electrode and the shield electrode will be essentially between the aforementioned electrodes. In this condition the direct electrical capacitance between the fixed electrode and the movable electrode is many times smaller than the capacitance from either of them to the shield electrode. It will be seen that the device in the "rest" position functions as an attenuator, capable of attenuating the impressed alternating voltage by a large amount when the movable electrode is remote from the fixed electrode. The shield electrode is provided with an opening which serves the purpose receiving the movable electrode therethrough when the key is operated. With the movable electrode remote from the fixed electrode, the initial attenuation of the device when connected in a suitable circuit as will be described below may be arranged to be in the order of 80 decibels. As the key is depressed, the number of decibels of attenuation will first vary approximately linearly with displacement. As the key is depressed still further, the movable electrode begins to approach the fixed electrode and a gradual transition takes place to a mode of operation similar to that of a conventional variable capacitor. In the latter condition, the shield electrode becomes less important to the function of the device and the particular relation between attenuation and key position may be determined with wide limits by reference to the geometry of the fixed and movable electrodes means, and of course the structure may be so designed as to give desired attenuation.

The advantages of the invention outlined above for applications such as the keyboards of electronic musical instruments will become apparent in the embodiments described below.

A device for manually controlling the intensity of a musical sound may change the intensity suddenly, or alternatively, it may produce a gradual "attack." For example, a simple single contact switch connected in a circuit of the kind referred to will normally produce a sudden onset of sound which is usually not musically desirable. Devices providing gradual attack, of which the present invention is one, may be classified according to whether the nature of the attack may or may not be appreciably varied by any practical method of operating the control. If the attack may be varied, the intensity-control means may be said to have a "player-controlled" attack; while if not, the intensity-control means may be said to have a "predetermined attack." Devices which have a player-controlled attack may be further subdivided according to whether the resulting intensity is "distance-sensitive" or "pressure-sensitive." For example, on the swell pedal of an electronic organ it is common to arrange that the force with which the pedal reacts against the player's foot does not increase appreciably as the pedal is operated while the resulting sound intensity increases with the distance through which the pedal is displaced. Such a device may be described as distance-sensitive.

It may be mentioned that distance-sensitive controls may in a special case provide in effect predetermined attack. Predetermined attack is generally associated with some sort of "on-off device that may be applied to a conventional keyboard. In using a conventional keyboard the player would normally depress the keys to their full extent while playing, and a distance-sensitive device having a small travel (of the order of one-quarter inch) may be provided in association with the keys, and in this case, predetermined attack is in effect produced.

If, in contrast to a distance-sensitive device, the pedal pressure were arranged to increase approximately linearly with travel, then the device could be termed "pressure-sensitive." The justification for the terms is that in the case of a pressure-sensitive device the player would train himself to exert a given pressure to produce a predetermined sound intensity, whereas in the case of the distance-sensitive device, the player would learn to displace the pedal a given distance to produce a required sound intensity. In the present specification and the appended claims, the terms "gradual attack," "predetermined attack," "player-controlled attack," "distance-sensitive" and "pressure-sensitive" will be used in the sense described above.

Of the classes of gradual attack device referred to, each has its own advantages. For example, the swell pedal on an organ is usually distance-sensitive, since this is convenient for foot operation. The player-controlled pressure-sensitive device would be convenient for a single-note keyboard instrument, while the predetermined attack would be convenient for a multi-note keyboard instrument in which it is particularly desired that playing technique be not too difficult.

The present invention may be used to produce a predetermined attack, a player-controlled pressure-sensitive attack, or a player-controlled distance-sensitive attack. It will be realized that various modifications of the embodiments described are possible, and in particular embodiments which are intermediate between the classifications defined above, and all such embodiments are within the scope of the present invention.

The invention will now be described with reference to the accompanying drawings wherein preferred embodiments are shown. For the reasons mentioned in the last paragraph it is intended that all matter shown in the accompanying drawings or described herein shall be interpreted as illustrative and not in a limiting sense.

In the drawings wherein the same reference numerals denote like parts in all figures,

Figure 1 shows a general partly schematic view of a preferred embodiment of the present invention as applied to the keys of an electronic musical instrument;

Figure 2 shows an alternative form of one of the principal parts illustrated in Figure 1;

Figure 3 shows an alternative form of the device illustrated in Figure 2;

Figure 4 shows the manner in which a tube such as that denoted by **34** in Figure 1, may be connected directly to the fixed electrode denoted by **25** in Figure 1;

Figure 5 shows a cross-sectional view of another form of part of the device shown in Figure 1;

Figure 6 shows a fragmentary cross-sectional view of another form of part of the device shown in Figure 1;

Figure 7 shows an enlarged oblique fragmentary view of one element such as that denoted by reference numeral **68** in Figure 5;

Figure 8 shows a partly cross-sectional side elevation view of a device similar to that of Figure 1, but particularly adapted for use with a swell pedal of an electronic musical instrument;

Figure 9 shows a schematic view of a method of interconnecting electrodes to provide octave coupling; and,

Figure 10 shows a graph relating the travel of the movable electrode denoted by **21** to attenuation.

Referring first to Figure 1, keys of an electronic musical instrument are denoted by 1–4, keys 1–3 being "white" keys and key 4 being a "black" key. It will be understood that there would ordinarily be a considerably larger number of keys.

The construction of keys **1–4** themselves is quite conventional, but attention is directed to the manner in which the keys are supported. A pivot denoted by **5**, which may be common to all the keys is provided, pivot **5** being supported in any convenient manner. For maintenance reasons, which will appear below, it is important that the keys **1–4** will be capable of being rotated at least 90°

in a counter-clockwise direction about pivot **5**, as seen in Figure 1, but means for limiting rotation in the opposite direction is provided by springs denoted by **6–8** mounted on a support member denoted by **9**. A similar spring (not shown) is provided for key **4**.

The details of the relationship between keys **1–4**, springs **6–8** and member **9** can be seen with reference to Figure 6, where similar features are provided. Figure 6, which will be described in greater detail below has a key denoted by **10** pivotally mounted at pivot **11**. Near the extremity of key **10** facing the player and on the lower side of key **10** a recess denoted by **12** is provided. Below key **10** is a support member denoted by **13**, similar in function to support member **9**. A partly threaded shaft, denoted by **14** protrudes upwardly from support member **13**, held firmly on the latter by means of a nut denoted by **15**. A washer denoted by **16** is provided on shaft **14**, held in a predetermined vertical position by two nuts denoted by **17** and **18**, locked together on shaft **14**. A spring denoted by **19** similar to springs **6–8** is placed coaxially on shaft **14**, and spring **19** preferably has two portions, a closely-wound portion of small stiffness (toward the bottom) and a loosely-wound portion (toward the top). After a short compression, the coils of the closely-wound portion touch and the only remaining resiliency is provided by the loosely-wound portion. The loosely-wound portion, having few convolutions has comparatively large stiffness.

The effect of a spring of the kind described is to cause the initial attenuation to be removed by a comparatively small pressure from the player's finger, so that the remaining pressure range coincides with the range of intensities which are musically useful. The same result could be obtained by the use of two springs, the second or stiffer one of which may be referred to as a "touch spring," referred to on Figure 10. Where a second stiffer spring or "touch spring" is used it is reached only after an appreciable travel of the key.

The resistive moment of spring **19** may be changed by adjusting the position of nuts **17** and **18**. A washer denoted by **20** separates key **10** from spring **19**. It will be seen with the arrangement just described, key **10** will have a normal position, and pressure on the key will be met with slight resistance by spring **19**. A fully depressed condition is as limited by the position where the upper end of recess **12** comes into contact with the upper end of shaft **14**.

Returning to the discussion of Figure 1, the electrical elements associated with key **1** will now be described, and it will be understood that similar elements would be provided in association with each of the keys. Attached to key **1** is a movable electrode denoted by **21** which in this embodiment consists of a flexible brass strip approximately 0.010 inch thick. The flexibility, though not essential, relaxes the tolerance of construction. Movable electrode **21** is attached to key **1** being suitably fixed in a slot denoted by **22**.

Immediately below movable electrode **21** is a box-like shield denoted by **23** having a slot therein denoted by **24**. Shield **23** may be mounted on supporting member **9**. Inside shield **23** is a fixed electrode denoted by **25**, preferably mounted on shield **23** by means of an insulating strip denoted by **26**.

Fixed electrode **25** is preferably in the form of a pair of vertical parallel conducting members, electrically connected together. Such electrical connection may be made either by having fixed electrode **25** in the form of a U-shaped conducting member, or else one or more electrical junctions could be made at suitable points, the exact construction being merely a matter of design.

Attention is directed to the fact that the edges of slot **24** are turned downwardly. It has been found that an area of shield **23** should be provided adjacent to movable electrode **21** and fixed electrode **25** which has depth of the same order of magnitude as the travel of movable electrode 21. The edges of slot 24 could also be turned upwardly, or the top of shield 23 could be thick in section.

It will be seen that shield 23 and fixed electrode 25 extend under the various keys, and it is important to note that common shield 23 and fixed electrode 25 can be used for all of the keys, but each key will have at least one individual movable electrode similar to movable electrode 21.

A tone generator for generating the note corresponding to key 1 is shown at 27–1. Similar tone generators denoted by 27–2, 27–3 and 27–4 produce the notes corresponding to keys 2, 3 and 4, respectively. The connections of key 1 and tone generator 27–1, only, will be referred to in detail, it being understood that the other keys 2, 3 and 4 are similarly connected.

Tone generator 27–1 has a two-line output, on lines 28 and 29. Output line 28 is connected to movable electrode 21, and it is convenient to make such connection through the intermediary of a binding post denoted by 30.

A flexible lead denoted by 31 is connected between binding post 30 and movable electrode 21, and in order to allow the key 1 to be rotated counter-clockwise for maintenance purposes, it is preferable if lead 31 is carried along key 1 from the movable electrode 21 to a point adjacent pivot 5, before lead 31 passes to bind post 30. A sawed slot of the order of ⅛ inch deep along key 1 shown at 32 will suffice for carrying lead 31 so that the lead 31 will be prevented from becoming entangled with other parts of the apparatus.

Shield 23 is grounded as denoted by 33.

Fixed electrode 25 is connected to the input of a preamplifier stage, the central feature of which is an electronic tube denoted by 34, and which is quite conventional. Lead 29 from tone generator 27 is also connected to the preamplifier stage of which tube 21 is the central feature and the output of the preamplifier stage is connected to further amplification stages, only one of which is shown, denoted by 35. A loud speaker denoted by 36 is connected to the final output.

There will ordinarily be a plurality of tone generators such as tone generators 27–1, 27–2, 27–3 and 27–4, corresponding to each of the keys, but a common output through tube 34 to the loudspeaker 36 is satisfactory. It is unnecessary to show the manner of connecting a plurality of tone generators such as 27–2, 27–3 and 27–4 to their respective keys, and it will be appreciated that each of such tone generators would have one output lead going to the respective key, the other joining in a common connection such as 29.

Referring now to Figure 2, the construction of shield 23, fixed electrode 25 and insulating strip 26 will be readily apparent. In the form shown in Figure 2, fixed electrode 25 is in the form of two conducting strips attached, for example, adhesively to insulating strip 26 and the two conducting strips of fixed electrode 25 are joined by a lead denoted by 37. Insulating strip 26 is attached to the lower part of shield 23 by screws, one of which is shown at 38.

The downward limiting position of movable electrode 21 is illustrated in Figure 2, by means of the dotted lines.

It is important that movable electrode 21 does not touch shield 23, or the fixed electrode 25, and if a flexible movable electrode 21 is used, insulating guide members denoted by 39 will be found satisfactory. In electronic musical instruments, where lightness may be of importance, it is desirable to use as thin sections as possible of material used, and in this connection it has been found satisfactory to make movable electrode 21 approximately one-quarter of an inch wide and as thin as $\frac{1}{64}$th of an inch. With such dimensions and with the use of a conducting material such as brass, insulating guides 39 will be found helpful in insuring that movable electrode 21 always penetrates into shield 23 and fixed electrode 25 in the same position.

In Figure 3 another form of the previously described movable electrode 21 and fixed electrode 25 is shown. The movable electrode in Figure 3, is denoted by 40, and the fixed electrode by 41. Movable electrode 40 is a short cylindrical member preferably having a rounded tip facing fixed electrode 41 and electrode 41 is in the form of a hollow cylinder mounted on an insulating member denoted by 42 which is in turn mounted on shield 23. With a construction as shown in Figure 3, a fixed electrode is provided for each key and the various fixed electrodes could be joined together by means of suitable conducting leads therebetween.

Referring now to Figure 4, it has already been mentioned in connection with Figure 1 that tube 34 is connected to fixed electrode 25. It is desirable that the lead from fixed electrode 25 to tube 34 be shielded, and Figure 4 shows how the grid cap of tube 34 denoted by 43 may be completely enclosed in shield 23, entirely eliminating any wire lead between fixed conductor 25 and tube 34.

As seen in Figure 4, the direction of view is downwardly as shown in Figure 1, and attached to fixed conductor 25 is a grid cap socket denoted by 44 for receiving grid cap 43. It will be seen that the shield 23 fits around the cap end of the tube by means of inwardly turned edges denoted by 45, thus providing maximum shielding.

In Figure 5, the construction is very similar to that shown in Figure 1 except there are three movable electrodes denoted by 46, 47 and 48 respectively, and the shield, now denoted by 49 necessarly has three slots denoted by 50, 51 and 52. Because the top of shield 49 is thick in section the edges of slots 50, 51 and 52 are not bent as in Figures 1, 2 and 3. Three fixed conductors similar to that shown in Figure 1 denoted by 53, 54 and 55 are provided. Partitions in shield 49, denoted by 56 and 57 provide maximum shielding between fixed electrodes 53, 54 and 55.

Figure 6 has already been referred to in connection with spring 19 and its associated elements. In Figure 6, the construction is similar to that shown in Figure 5, except that the slots 50, 51 and 52 and associated parts have been replaced by a series of U-shaped members denoted by 60–65 the construction of which is shown in Figure 7.

As seen in Figure 7, where U-shaped member 62 is shown the shield 49 is replaced by conducting strips, one of which is denoted by 66. A central conductor, which may be of metal foil, denoted by 67 is suitably connected to strip 66, as by a lead denoted by 68. The central conductor 67 is connected to the corresponding elements of the other U-shaped members 60–65, through the supporting base, denoted by 69, preferably of conducting material.

The fixed electrodes denoted by 72 and 73 may be for convenience painted with conducting silver paint or the like on insulating supports of U-shaped members 60–65, denoted by 70 and 71 and such fixed electrodes are denoted by 72 and 73. Insulating strips denoted by 79 and 75 are attached to U-shaped member 62 and insulating strips 74 and 75 may be in the form of pieces of "fish-paper" adhesively attached to U-shaped member 62, and correspond in a general way to the insulating guides 39 of Figure 2.

In Figure 8, a foot pedal such as a swell pedal is denoted by 80 pivotally mounted at 81. In this case the construction and function are quite similar to that shown in Figure 1 except that the movable conductor, denoted by 82 has an arcuate form to be adaptable to the relatively large amount of motion and arcuate path of pedal 80. It will be understood that while the keys 1–4 shown in Figure 1 also follow an arcuate path when depressed, the displacement of keys 1–4 is relatively small and no arcuate construction of the movable electrodes is necessary.

It may be mentioned that a damping device on the keys will be found useful in certain applications which will be apparent to one skilled in the art.

In connection with a damping device, when the present invention is used to produce a predetermined attack, the nature of this attack is determined by the mechanics of the key. For example, the inertia of the key is of some importance as well as the physiology of the foot or finger. In some instances it is desirable to modify the motion resulting from the pressure of the player's finger or foot. If for example it is desired to have the intensity of the note fall off quite slowly after the player removes pressure from the key or pedal, a damping device will be of particular value.

Such a damping device may be in the form of a bellows having such characteristics that it is capable of filling rapidly through a valve when pressure is applied by the player, but empties slowly after release of the pressure. This will cause the pedal or key to return to its original position with a slight delay, and will obviously result in a slow decay of the note when the pressure is removed. The time constant could be as long as desired with means for rapidly terminating the decay. Thus an effect similar to the sustaining pedal of a piano is obtained.

Means could of course be provided for making such slow decay optional, as by opening or closing the valves, if any, of the damping device.

A damping device may be in various forms and other combinations of mechanical means such as springs could be used to achieve special attack and decay characteristics.

Referring to Figure 9, it is sometimes desirable to provide harmonic coupling, and an example of the connection of the additional electrodes for doing this is shown. The mounting of the various movable electrodes moved together could be in the sound key as in Figures 5 and 6. The scheme of the connections in this example is that each note is played with its harmonic. In the case shown in Figure 9 a connection to the second harmonic or octave of the note is struck. It should be mentioned that each movable electrode is connected to a suitable tone source in order to make up required harmonics. Following established practice, a single generator may supply more than one electrode; for example a single generator may supply the fundamental of one note and a higher harmonic of another. Alternatively, separate generators may be used for each electrode. It will be apparent that switching means could be provided to make such interconnection alternative, or to vary the specific harmonics desired.

Figure 10 is a graph indicating a typical relation between the attenuation of the alternating voltage produced by tone generator **27**, expressed in decibels, and the position of movable electrode **21**. The amplifier gain and other parameters of the complete musical instrument may be chosen so that the point B on the attenuation curve represents the threshold of audibility for a normal person located a suitable distance from loudspeaker **36**. There may be of course a large number of tone generators, such as **27**, operating at various frequencies, and each connected to separate movable electrodes similar to **21**, all of such movable electrodes acting in conjunction with the same fixed electrode **25**.

It is obviously unsatisfactory to have each tone produced in loudspeaker **36** just below the threshold of individual audibility when no music is desired because there would then be an undesirable rushing sound due to the cumulative effect of all the tone generators. The output of each tone generator such as **27** should accordingly be attenuated a further degree such as 20 decibels below audibility when sound from generator **27** is not required. The region of the curve A—B in Figure 10 may be used to provide such extra attenuation below the threshold of audibility.

A given small number of decibels increase in sound intensity is more important for loud sounds, and it is accordingly desirable in the case of a player-controlled device to obtain finer control at the loud end of the range. The sensitivity has a maximum below the upper threshold of audibility. The greater importance per decibel for loud sounds is due to the fact that they then stand out over the background.

Finer control at the loud end of the range is obtainable in the present invention as will be seen from the region C—D of the graph of Figure 10. As the movable electrode **21** approaches the fixed electrode **25**, the rate of increase of loudness of sound expressed in decibels falls off as shown in regions C—D. Hence in this region a given motion of movable electrode **21** produces a smaller change in loudness and, hence finer control may be achieved by the player.

The reduction of slope may be accentuated with little change to the portions A—C of the graph of Figure 10 by changes in the shape of the electrodes **21** and **25**, for example by increasing the amount of rounding or pointing of the tip of movable electrode **21**.

The operation will be apparent from the foregoing description, but for greater certainty will now be reiterated. As key **1** is depressed, and movable electrode **21** is moved toward and through slot **24**, the capacitance between electrodes **21** and **25** will increase and the alternating electrical voltage from tone generator **27** will be transferred to the grid of tube **34** with increasing intensity. The alternating voltage will be amplified by tube **34** and will reach and exceed the level required to produce an audible sound from loudspeaker **36**. Accordingly, the player has considerable control over the attack of the sound produced by the depressing of any of the keys, and the manner in which the present invention overcomes the serious disadvantages of prior art devices for accomplishing a similar purpose is apparent.

It will be apparent that in a device such as the one described herein, where musical sounds are to be produced, various alternatives for producing musical effects may be used. A particular construction will now be referred to where it is desired to increase the "brightness" of sounds with increasing loudness.

In the discussion of Figure 6, it has been assumed that as key **10** is depressed, the amount of attenuation between the various movable electrodes and their cooperating fixed electrodes will decrease by the same amount, having regard to the curve shown in Figure 10. It is, however, quite possible to arrange the construction of the device of Figure 6 so that the attenuation does not decrease by the same amount between each movable electrode and the cooperating fixed electrodes of each movable electrode, as the key **10** is depressed.

For example, the movable electrodes may be made progressively shorter or longer, in which case the rate of decrease in attenuation has a gradation from one movable electrode to the next or the key **10** is depressed.

If in a device as illustrated by Figure 6, successive movable electrodes control successively higher frequencies (such as harmonics), constructing the movable electrodes progressively longer, so as to increase the relative prominence of the higher frequencies will result in an increase of the "brightness" of the overall sound as the key **10** is depressed.

Providing movable electrodes of progressively varying length is a solution to the problem of increasing brightness, but it has the disadvantage that it is not a simple matter to quickly adjust the "brightness" produced by this particular construction. If adjustment is contemplated, the same effect may be produced by keeping the movable electrodes of the same length and allowing the fixed electrodes to be progressively farther away from key **10**. A convenient construction is to construct support member **13** so that it can be tiltable about an axis parallel to the pivotal axis of key **10**, and a convenient means for changing the angular position of support member **13**, such as a cam could be provided. Since the amount of angular motion required would be small, the motion of support member **13** would not interfere with the function of spring **19** relative to key **10**.

It will be seen that the invention herein described possesses considerable advantages and commercial possibilities, and represents a considerable step forward in the art of electrical musical instrument design.

I claim:

1. A multi-circuit capacitive keying means for an electrical musical instrument having a series of generators producing electrical oscillations in accordance with the requirements of a musical scale, a keyboard having playing keys, and an output system, said capacitive keying means comprising a plurality of insulator strips extending longitudinally of said keyboard and transversely of keys therein, each of said strips bearing upon one side a pair of conductive strips arranged in parallel longitudinally of the strip, one of said strips constituting a live, fixed electrode for connection to the output system and the other of said strips constituting a shielding electrode which may be grounded, the other side of some at least of said strips supporting conductive strip which may be grounded, said strips arranged in pairs with the sides bearing the live electrodes facing each other and interspaced in each pair, and a plurality of blade-like electrodes in groups, there being one group for connection with each key traversed by said insulator strips whereby the said group may be moved by the said key, there being in each group a blade-like movable electrode for each pair of insulator strips in the assembly adapted to pass between spaced insulator strips of each pair moving first between the said shielding electrodes and next between the said fixed, live electrodes upon depression of the said key, the said blades being connectable each to a generator in the said series.

2. A capacitive switch comprising a pair of separated insulating bodies having adjacent relatively smooth and flat parallel surfaces, a pair of adjacent conductive shield electrodes each mounted on a different one of said adjacent surfaces, a pair of adjacent fixed electrodes each mounted on a different one of said adjacent surfaces and separated from said shield electrodes, and a relatively flat blade-like electrode movable between said shield and fixed electrodes with said latter electrodes presenting relatively flat and smooth surfaces to said movable electrode.

3. A capacitive switch comprising a pair of separated insulating strips having adjacent parallel surfaces, a pair of adjacent plate-like conductive shield electrodes each supported on a different one of said adjacent surfaces, a pair of adjacent plate-like fixed electrodes each supported on a different one of said insulating strips and separated from the shield electrode supported thereon, and a relatively flat blade-like electrode having a leading edge movable from a non-operate position between said shield electrodes to an operate position between said fixed electrodes with both of said electrode pairs presenting relatively flat and smooth surfaces to said movable electrode.

4. A multi-circuit capacitive switch comprising a plurality of serially-disposed switch units each of which includes a pair of separated insulating strips having adjacent parallel surfaces, a pair of adjacent conductive shield electrodes each mounted on a different one of said adjacent surfaces and presenting a gap of uniform width between the pair of shield electrodes, a pair of adjacent fixed electrodes each mounted on a different one of said adjacent surfaces separate from the associated shield electrode and presenting a gap of uniform width between the pair of shield electrodes, and a blade-like electrode movable between said shield and fixed electrodes in said pair of gaps; a conducting shield disposed between and separating each of said switch units from the adjacent units in said series of switch units; and means ganging said movable electrodes for all of the switch units for simultaneous movement.

5. A capacitive switch having a high rate of attenuation, comprising a blade-like electrode movable in a substantially linear path from a non-operate position to an operate position, a pair of spaced plate-like shield electrodes adjacent the movable electrode in the non-operate position and sandwiching the path of movement of said movable electrode, each of said shield electrodes presenting a relatively flat surface substantially parallel to the path of movement of said movable electrode, a pair of plate-like fixed electrodes sandwiching the movable electrode in the operate position, each of said fixed electrodes being contained in a plate common also to the shield electrode on the same side of said path of movement and presenting a substantially flat surface to said movable electrode parallel to the path of movement of said movable electrode, and a pair of separated insulating bodies each supporting the shield and fixed electrodes located on one side of said path of movement from shield and fixed electrodes located on the other side of said path of movement.

6. A capacitive switch having a movable, bladelike electrode, spaced shielding members and spaced electrodes, said movable electrode having a normal range of movement between a position at which its end lies between the shielding members and a position at which its end lies between the live electrodes, the live electrodes having a working depth determined by the innermost penetrating position of the end of said movable electrode between said live electrodes, the depth of said shielding electrodes being at least substantially equivalent to the working depth of said live electrodes, and the depth of said shielding electrodes being greater than the distance between either shielding electrode and the movable electrode.

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