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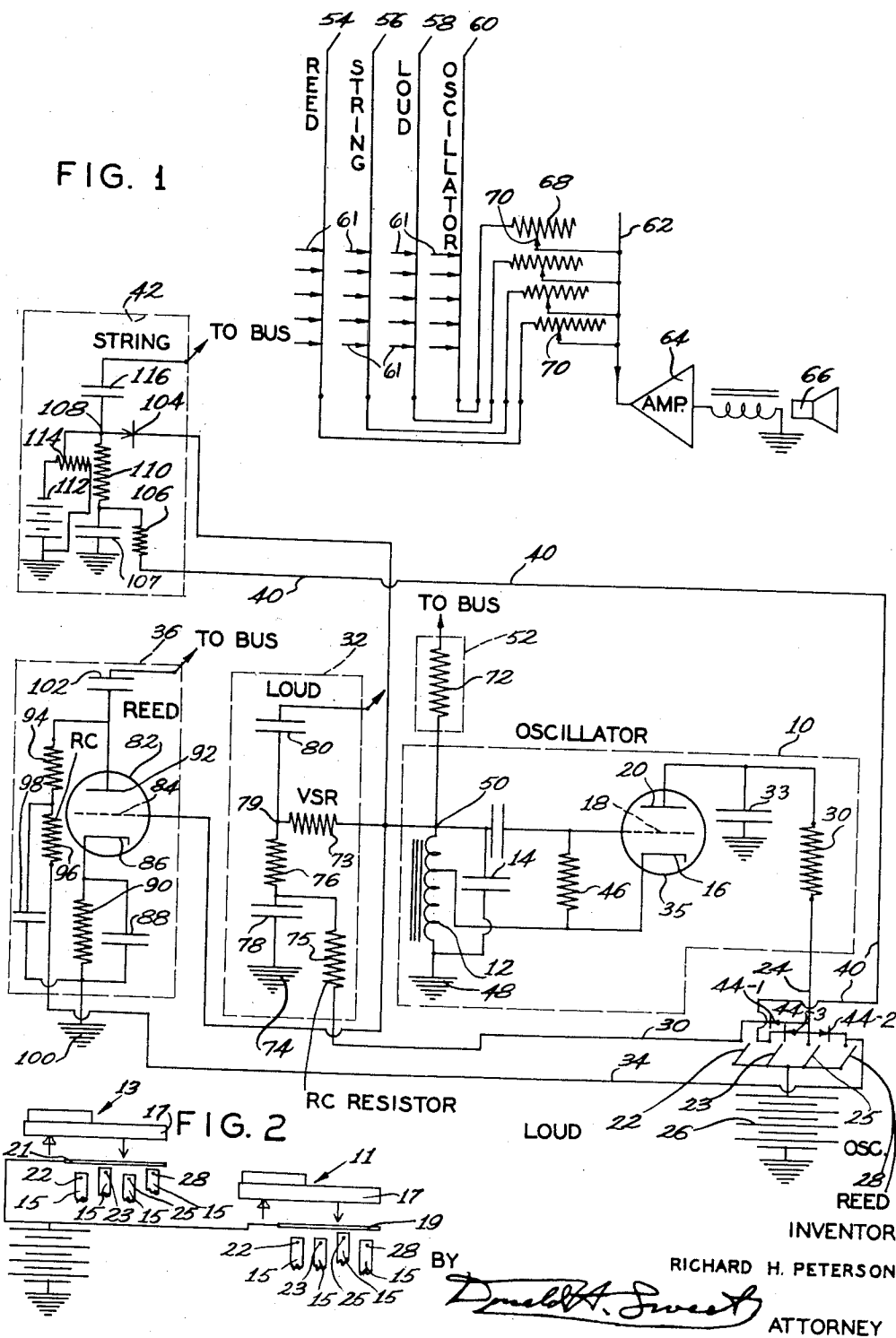
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KEYING MEANS FOR THE SELECTIVE CONTROL OF A TONE

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FIG. 1



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KEYING MEANS FOR THE SELECTIVE CONTROL OF A TONE

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My invention relates to electronic musical instruments. A wide variety of such instruments have been on the market for many years. A minority of these have been constructed on the principle of individually keyed, normally inoperative oscillators, one for each pitch to be produced. This system has many advantages with regard to naturalness and beauty of tone quality, especially in connection with the inception and discontinuance of the tone, commonly referred to by musicians as attack and decay.

A material disadvantage has been that, in order to have two different tone qualities available to the organist, under the control of two separate keyboards, there had to be a complete set, or bank, of individual oscillators, or tone generators, for one keyboard and another set for the other keyboard.

Because it is practically impossible to tune two oscillators to the same pitch with such precision that there will be no beat between them, the beat between oscillators of the same pitch is sometimes very objectionable, especially when all the sound is delivered through a single loud speaker.

A primary object of the invention is the production of a substantial number of different loudnesses and tone qualities under selective control from two or more different keyboards, all from the same set of oscillators, which oscillators are left inactive except when tone is being delivered from them. The esthetic value of the result is outstanding, and the saving in cost is substantial.

In the accompanying drawings:

Figure 1 is a schematic wiring diagram of an electronic musical unit; and

Figure 2 is a diagrammatic showing of two manuals, or key-boards, and the contacts activated thereby.

Referring first to Figure 1, I have illustrated a conventional Hartley oscillator 10 having a tuned circuit, of highly constant frequency, including the inductance 12 and capacitor 14. The activating triode is illustrated as a tube 35 with a cathode 16, grid 18 and plate 20. During playing of the instrument, the cathode 16 is kept continuously operative by conventional heating means. There is one such oscillator for each pitch to be produced by the instrument, and each oscillator has its plate operatively connected with an individual D.C. conductor 24 adapted to receive potential from a conventional source 26 through switches 25 controlled by keys 17 manipulated by the fingers of the player, to start and stop the tone delivery.

The switch 25 activates the conductor 24 directly. The switch 22 activates the conductor 30 leading to a coupling circuit 32, identified as "Loud." The switch 23 activates a conductor 34, leading to a coupling circuit 36, identified as "Reed." The switch 23 activates a conductor 40, leading to a coupling circuit 42, identified as "String."

I have illustrated four switches 25, 22, 28 and 23. Usually one set of switches 25 is used for the accompaniment under the control of one manual. The switches 22, 28 and 23 may be selectively included in the multiple

contacts made by the organist with another manual, or bank of keys. The keys 17 may be embodied in two or more playing manuals, or keyboards, and any one or more of the switches may be activated by any one or more of the manuals.

In Figure 2 the wiring is arranged to play soft flute notes, or accompaniment on the lower manual 11, and the melody in loud flute notes, and reed notes on the upper manual 13. The conventional slides 15 carry the cooperating contacts 22, 23, 25 and 28 for all the keys 17. Depression of a key 17 in the bank 11 will lower its contact bar 19 far enough to close switch 25, but the other three are too low for the contact bar to reach them. Depression of a key 17 in the bank 13 will move its contact bar 21 down to close switches 23 and 28, but the other two are too low for the bar to reach them. The organist sets the slides 15 in the pattern he desires from time to time to control the types of tone to be delivered.

The conductors 30, 34 and 40 are all also connected to the conductor 24 through one-way diode valves, or rectifiers, 44—1, 44—2, 44—3, arranged so that D.C. potential delivered in the first instance to conductor 24 cannot reach any of the other conductors, but D.C. potential delivered to any of the other conductors is also effective on conductor 24.

It will be obvious that when the conductor 24 does not receive potential, the plate 20 is inoperative and no oscillation takes place. The potential delivered to the conductor 24 reaches the plate 20 through a resistor 30, with a grounded capacitor 33 between the resistor 30 and the plate 20. When contact is first made, the capacitor 33 and resistor 30 constitute an R-C time-delay circuit, which controls the timing of the inception or "attack" of the tone produced. When the contact is opened to end the tone delivery, the capacitor 33 has to discharge itself through the tube 35 and part of the coil 12 to the ground 48 of the oscillator. It will be obvious that this permits any predetermined timing of the attack and any different predetermined timing of the decay of the tone.

The oscillation appears at the output terminal 50 and is, conventionally, a substantially perfect sine curve, so far as the wave shape is concerned.

Connected to the output terminal 50, I have indicated four different coupling circuits. These include the soft flute circuit 52; the circuit 32, which may be a loud flute circuit; the string circuit 42; and the reed circuit 36.

Each of these coupling circuits is connected to deliver its output to an intermediate bus bar. I have indicated a bus bar 54 for collecting the reed oscillations; a bus bar 56 for collecting the string oscillations; a bus bar 58 for collecting the loud flute oscillations; and a bus bar 60 for collecting the soft flute oscillations. The multiple connections at 61 come from the coupling units for the different notes.

The final delivery bus bar 62 is conventionally provided with an amplifier 64 and loud speaker unit 66. To deliver to the loud speaker the different types of tone in any desired predetermined blended relationship, each of the bus bars 54, 56, 58 and 60 is connected to the final delivery bus bar 62 through a variable resistor 68 adjustable by means of a contact 70. The contacts 70 are all arranged close together and accessible to the operator, so that he can manipulate them to adjust the relative loudness of each tone quality, or adjust them to predetermined combinations with conventional organ stops.

In the playing of a simple melody with accompaniment, for instance, the reed and string circuits would not be employed, and the organist will use only switches 25 and 22. The melody will be played on the keys operating the switches 22 and the accompaniment on the keys

operating the switches 25. The tone resulting from playing a particular note on either bank may be completely identical in quality, but the amplitude will be greater if switch 22 is used. When the organist happens to play the same identical note on both manuals, that particular note will appear with the loudness corresponding to switch 22. This is easily demonstrated on an actual instrument by closing switch 22 and holding it closed. It will then be readily observed that closing the corresponding switch 25 produces no detectable variation in the sound emanating from the loud speaker 66. But if switch 22 is opened when switch 25 is closed, the loudness drops down to the accompaniment intensity, corresponding to switch 25; whereas, if switch 25 is already open, the sound stops altogether.

The soft flute circuit 52 consists of a resistor 72, and the sine wave oscillation received from the output terminal 50 goes to the bus bar 60 with the wave shape unaltered.

The coupling circuit 32 includes a signal circuit and a D.C. circuit. The signal circuit consists of a voltage divider comprising the voltage-sensitive resistor 73 and a fixed resistor 76 connected through capacitor 78 to ground at 74.

The amplitude of the signal at point 79 will be a function of the ratio of the voltage-sensitive resistor 73 to resistor 76. The D.C. circuit is through conductor 30, resistors 75, 76, voltage-sensitive resistor 73, and coil 12, to ground at 48. When D.C. potential is delivered to conductor 30, it reduces the resistance of resistor 73 and increases the amplitude of the signal at 79 in the ratio of about twenty to one. This signal is delivered to bus 58 through capacitor 80.

The resistor 75 and capacitor 78 are an R-C time-delay circuit controlling the timing of the attack of the tone delivered by the circuit 32 when the switch 22 is closed. When the switch 22 is opened, the capacitor 78 has to discharge through the resistors 76 and 73, and the coil 12, to ground at 48. This provides for a predetermined decay of the tone at the end of the note, which can be independent of the attack. It will be obvious that both the attack and the decay of the tone from circuit 32 can be distinctively different from that of the same tone, when delivered through circuit 52. For instance, the decay of the oscillator can be made slow, and the decay of circuit 32 made more rapid. Then, the organist can play the melody with the tone ending more quickly, while the accompaniment note has a percussion quality.

It will be apparent that a plurality of notes constituting a musical accompaniment can be played on the keys 17 activating switches 25, while the melody that goes with the accompaniment can be played on the keys 17 activating switches 22. Thus, when the melody played with the keys 17 for switches 22 happens to include one of the same identical notes that are simultaneously being played with keys 17 for switches 25, that particular note will receive the added intensity of oscillation transmitted by the coupling circuit 32.

Referring now to the reed circuit 36, this includes a tube 82. The grid 84 is directly connected to the output terminal 50 and receives an oscillation of pure sine wave form. Bias is provided by resistor 90 and capacitor 88, such that the circuit is easily overloaded, so that a relatively square type wave form with a characteristic reedy sound is generated. The connections for rendering the plate 92 operative are similar to the connections for rendering the oscillator operative. The resistor 94 and an R-C time delay circuit including resistor 96 and capacitor 98 grounded at 100 receive D.C. potential from the reed switch 28 of the keyboard. The reed note is delivered through the capacitor 102 to the bus 54.

It will be obvious that any key 17 will activate its corresponding oscillator 10 and the coupling circuit 52. It may also activate one or more of the coupling circuits 32, 36 and 42. Furthermore, the keys in different

manuals can be manipulated simultaneously by one or more organists, so that the loud speaker will deliver simultaneously an accompaniment of any desired intensity and one or more melody notes of a different desired intensity, which may be obligato and of lesser intensity, or more commonly of greater intensity than the accompaniment. Thus, the ear may effectively listen to an accompaniment instrument, and a main voice instrument, and a different reed instrument, and a different string instrument, all at the same time. Each coupling circuit and its associated bus completes one of several alternative channels for delivering oscillations received from the oscillator 10 to the loud speaker 66, but the delivered form will differ, depending on the channel utilized.

The string circuit 42, per se, forms no part of my present invention. It comprises the rectifier 104 receiving the signal delivered by the oscillator at 50. It is normally biased so that no oscillation passes through it. When potential is delivered from switch 23 to conductor 40, R-C resistor 106 and capacitor 107, the point 108 will receive that potential through resistor 110 and be shifted to a potential level such that truncated fragments of the oscillation reaching the rectifier 104 will pass through the rectifier. A source of biasing potential 112 connected through an adjustable resistor 114 controls the working potential and the shape of the oscillation delivered through capacitor 116 to bus 56. The resistor 114 is not manipulated by the organist when playing. It is indicated as adjustable because at the factory or in making service adjustments of such an instrument, it may be altered to secure the desired tone quality from the string coupling circuit 42.

It will be obvious that the four coupling circuits illustrated merely indicate that any desired number of different channels, within reason, can all be connected to the same terminal 50, and each can distort the received oscillation to a predetermined wave form and tone quality and return it to the bus bar 62, to deliver a blended volume of music accurately constituting the equivalent of the output of a corresponding number of different organ stops. To achieve this result only one set of oscillators 10 is needed.

The rectifiers 44-1, 44-2, 44-3, in the direct current circuits that establish the operativeness of the coupling circuits electronically, reduce the need for mechanical contacts to establish the same operative relationships.

Others may readily adapt the invention for use under various conditions of service by employing one or more of the novel features disclosed, or equivalents thereof. If will, for instance, be obvious that transistors may replace any of the tubes disclosed. Any number of manuals may be provided, including the pedal clavier conventional in most organs.

As at present advised, with respect to the apparent scope of my invention, I desire to claim the following subject matter:

1. An electronic musical instrument comprising, in combination: a series of oscillators of constant pitch, one for each pitch to be generated; the generated pitches including each semi-tone of the entire diatonic, tempered musical scale; each oscillator being normally not in oscillation for lack of applied voltage, but otherwise ready to function; a plurality of banks, or manuals, of playing keys including a primary manual and a secondary manual; each of said manuals having a key for each oscillator; a switch associated with each key; a playing set of connections between each switch contact and the corresponding oscillator to render the oscillator operative; a loud speaker; a delivery set of connections establishing a plurality of alternative delivery channels for delivering signal oscillations from each oscillator to said loud speaker; said channels including a first channel for each oscillator for delivering one sustained form of oscillation; and a second channel for each oscillator, normally inoperative, for delivering a different sustained form of os-

cillation; said primary manual keys being connected to their corresponding oscillators to render the oscillators and their first delivery channels operative; said secondary manual keys being connected to render said oscillators and their first delivery channels and their second delivery channels operative; whereby the simultaneous activation of the same oscillator by a primary manual key and a secondary manual key, superposes the second oscillation on the first oscillation during the period of joint activation.

2. An electronic musical instrument according to claim 1, in which one of said alternative channels merely amplifies the oscillation, and another changes the wave shape and tone quality.

3. An electronic musical instrument according to claim 1, in which the connections for said keys include a primary, directly connected contact for the primary key; a secondary contact for the secondary key; a connection from said secondary contact to said secondary channel; and a valved electronic connection from said secondary contact to said primary contact; said valved connection permitting activating potential to pass from said secondary contact to said primary contact but not in the other direction; whereby closing of the primary contact activates the oscillator and its primary channel only, while closing of said secondary contact activates both the secondary delivery channel, and the oscillator and its primary channel.

4. In an electronic organ, in combination: a single set of independent oscillators, one for each semi-tone of the diatonic musical scale; independent individual tuning means for each oscillator; said oscillators being normally not in oscillation during playing periods, but conditioned for immediate oscillation; two sets of playing keys; a plurality of alternative electrical connections between each playing key and its oscillator; and selective player-operated means for rendering one or more selected sets of connections operative for all the keys of either set; said alternative connections each producing a different sustained volume or quality of tone from said oscillator; whereby preselected single oscillators or combinations of oscillators can be simultaneously stopped and started to combine into a musical performance, with one set of keys controlling the production of one sustained volume and quality of tone, and the other set of keys controlling the production of a different sustained volume and quality of tone from the same oscillator; said selective player-controlled means being a plurality of different electric contacts adapted to be selectively positioned in the path of a depressed key; and an electron-valve one-way cross connection between each key of one set and the corresponding key of the other set; whereby actuation of a key of one set produces a predetermined sustained musical tone; and actuation of the corresponding key of the other set produces the same sustained tone and also another different sustained tone of the same frequency, all from the same oscillator.

5. In an electronic organ, in combination: a single set of independent oscillators, one for each semi-tone of the diatonic musical scale; independent individual tuning means for each oscillator; said oscillators being normally not in oscillation during playing periods, but conditioned for immediate oscillation; two sets of playing keys; a plurality of alternative electrical connections between each playing key and its oscillator; and selective player-operated means for rendering one or more selected sets of connections operative for all the keys of either set; said alternative connections each producing a different sustained volume or quality of tone from said oscillator; whereby preselected single oscillators or combinations of oscillators can be simultaneously stopped and started to combine into a musical performance, with one set of keys controlling the production of one sustained volume and quality of tone, and the other set of keys controlling the production of a different sustained volume and qual-

ity of tone from the same oscillator; each oscillator having a normally inactive tuned tank circuit; said alternative electrical connection being a connection for delivering potential to generate oscillations in said tank circuit; said oscillator having a plurality of coupling circuits; each coupling circuit adapted to receive audio-frequency signal from said tank circuit and deliver said signal with modified amplitude or wave shape; selective electronic control means for rendering each coupling circuit operative or inoperative; and switch means accessible to the player for connecting the corresponding electronic control means of all said oscillators to the corresponding keys of either set of keys; there being a single, unitary, player-controlled operating means for simultaneously connecting all the electronic control means corresponding to the same form of modified signal.

6. An oscillator having a receiving terminal for receiving D.C. activating potential to initiate and maintain oscillation of said oscillator; said oscillator having a predetermined attack characteristic, and a predetermined decay characteristic; a coupling circuit operatively connected to said oscillator and having a terminal; an output circuit connected to said coupling circuit; a source of D.C. potential having a pair of terminals; and a playing key detachably connecting said source to said receiving and coupling circuit terminals.

7. In an electronic musical instrument, in combination: an independent, tuned oscillator; said oscillator having a receiving terminal for receiving D.C. activating potential to initiate and maintain oscillation of said oscillator; said oscillator having a predetermined attack characteristic, and a predetermined decay characteristic; a coupling circuit operatively connected to said oscillator to receive signal from said oscillator; said coupling circuit being normally open and inoperative to transmit the received signal; a source of D.C. potential having terminal means; playing key connecting means connecting said potential terminal means to said oscillator and coupling circuit, for delivering activating potential to said receiving terminal, and for closing said coupling circuit to render it operative to transmit a signal; and an output circuit connected to receive said signal from said coupling circuit.

8. A combination according to claim 7, in combination with an additional, second coupling circuit operatively associated with said oscillator; a second playing key connecting means connected with the D.C. potential and adapted to actuate said second coupling circuit and said oscillator; and player-controlled stop means for connecting one of said coupling circuits to a selected one of said playing keys; said coupling circuits modifying the transmitted signal in different ways.

9. A combination according to claim 8 in combination with a complete set of additional oscillators and associated sets of coupling circuits, one for each additional semi-tone within a predetermined series of adjacent semi-tones; and additional keys adapted to be connected to said D.C. potential; said additional keys completing two complete sets of keys, two for each oscillator; said player-controlled stop means being constructed and arranged to connect the corresponding coupling circuits of all said oscillators, to the corresponding playing keys of a selected one of said sets of keys.

10. A combination according to claim 9 in which one of said sets of playing keys is connected to one of said coupling circuits, and the other is connected to both.

11. A combination according to claim 9 in which said oscillators deliver formed signal of simple wave shape; and at least one of said coupling circuits increases the complexity of the wave shape of the signal.

12. A combination according to claim 9 in which each oscillator includes energy storage means for continuing the tone on a diminishing scale after the activating voltage is withdrawn; and at least one of said coupling circuits includes its own separate storage means for determining its own independent decay rate.

13. A combination according to claim 9 in which certain of said coupling circuits are connected to their oscillator terminals through one-way electron valves; whereby activating any such coupling circuit activates said oscillator also, but not any other similarly connected coupling circuit.

14. A combination according to claim 13, in which each oscillator has at least one coupling circuit which is always operative to transmit signal.

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