April 25, 1950 G. L. HALLER ET AL 2,505,182

CONTROL APPARATUS

Filed April 12, 1945 2 Sheets-Sheet 1

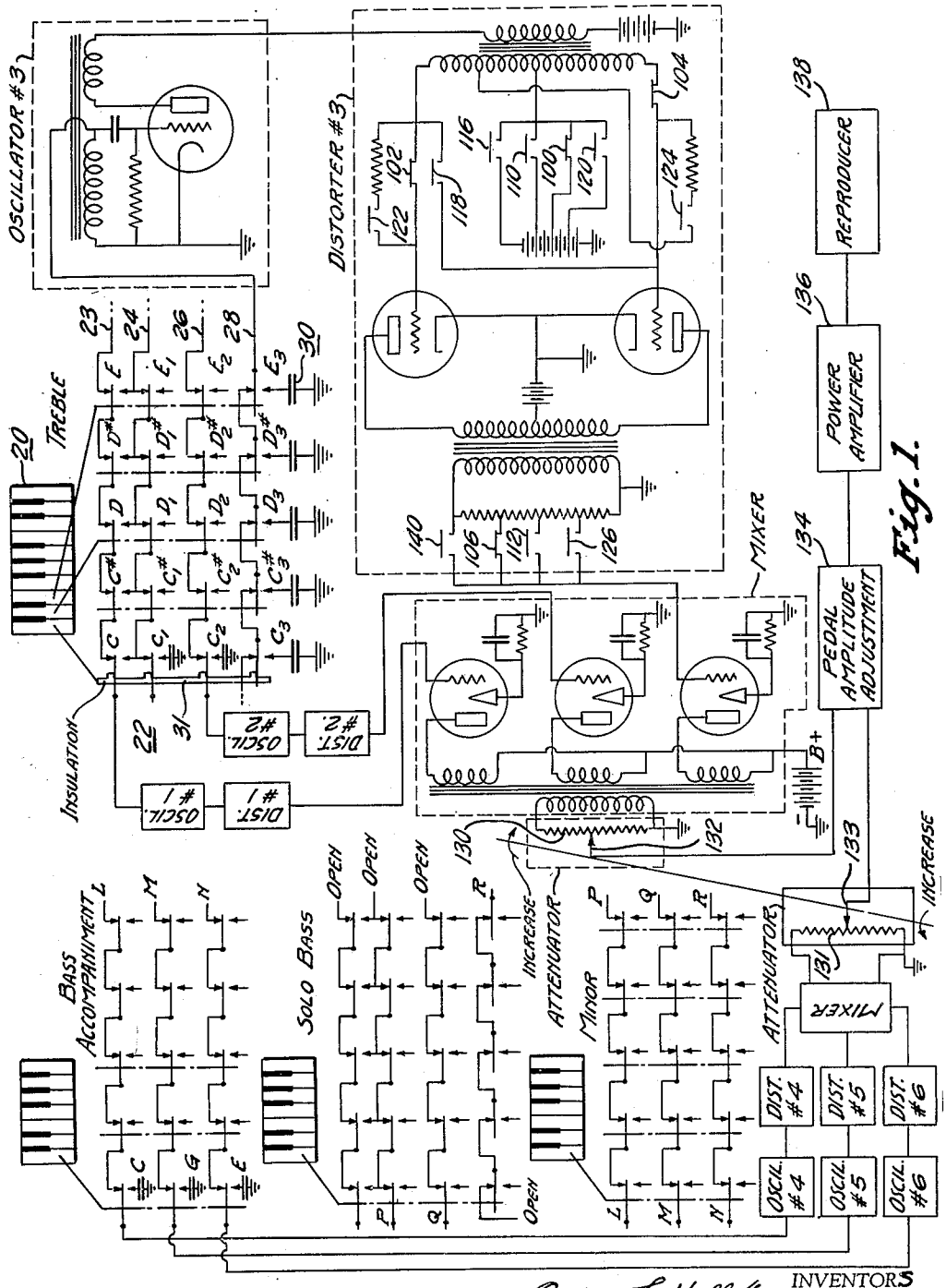


Fig. 1.

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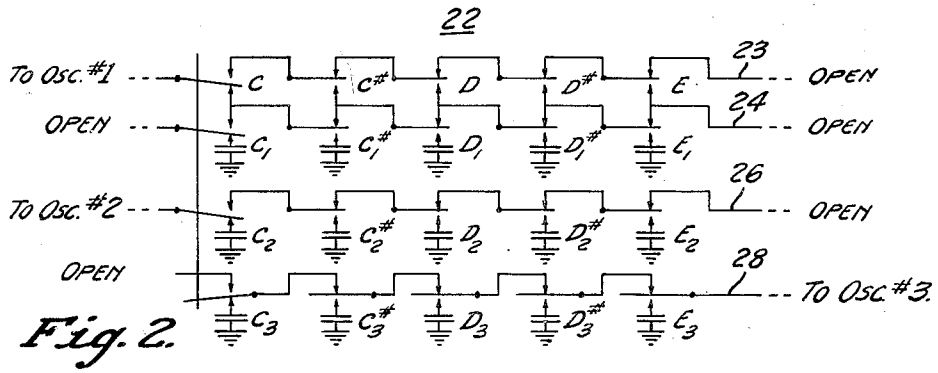


Fig. 2.

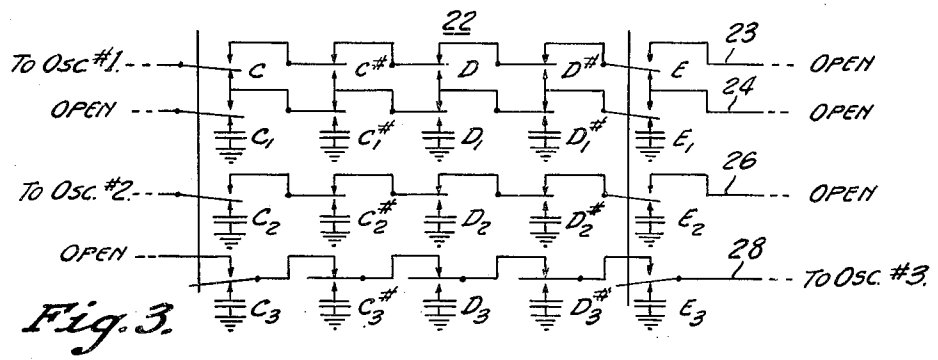


Fig. 3.

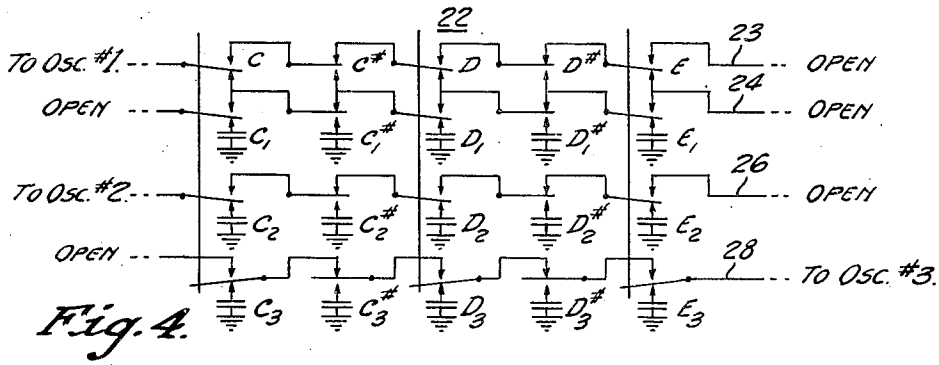


Fig. 4.

CHORD	OSC. #1	OSC. #2	OSC. #3.
C ONLY	OPEN	C_2	C_3
C, E	E_1	C_2	E_3
C, D, E	D_1	C_2	E_3

Fig. 5.

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UNITED STATES PATENT OFFICE

2,505,182

CONTROL APPARATUS

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Application April 12, 1945, Serial No. 588,018

15 Claims. (Cl. 84—1.01)

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This invention relates to sound reproduction and is particularly concerned with the reproduction of musical notes and chords through the medium of a simplified electronic instrument.

The reproduction of sounds, such as musical sounds, through the use of electrical circuits is well known. Instruments embodying this principle of operation have been in use for some time and have met with considerable success. These instruments usually utilize an oscillator circuit adjusted to a predetermined frequency for each musical note to be reproduced. Thus in an electric organ, for example, in order to obtain a full manual of notes it is necessary to use eighty-eight oscillator circuits each separately adjusted to the frequency of the note to be reproduced. Other electronic reproducing circuits utilize a restrictive system wherein the number of oscillator circuits are reduced but wherein only one tone can be reproduced at any one time regardless of the number of keys depressed.

In general, therefore, musical instruments of the electronic type include a tuned oscillator circuit corresponding to each note of the scale. The action of the oscillator circuits is controlled by switches operated by the keys of the manual. The output of the oscillator circuits feeds into a power amplifier which is connected to a reproducer that produces the audible sounds.

Our improved electronic reproducing system includes many novel arrangements which simplify the electrical system of the instrument and which also make the operation thereof more facile in that whole chords may be reproduced by depressing a single key. Further, the instrument provides improved tonal quality through the use of modifying or distorting circuits to accentuate harmonics.

It is therefore an object of the invention to provide a musical instrument that utilizes a dual keyboard which includes a "solo" manual wherein the depressing of a key or keys causes the instrument to reproduce the corresponding audible tone or tones and also an "accompaniment" manual wherein the depressing of a key causes the instrument to reproduce an audible minor or major chord.

Another object of the invention is to provide a basic switching system which will selectively operate control elements of one, two, three or more separate circuits either singly or simultaneously.

Another object of the invention is to apply the switching system in the foregoing object to the keyboard of an electronic musical instrument wherein one, two, three or more oscillator circuits can be operated singly or simultaneously as the case demands.

A further object of the invention is to provide an electronic musical instrument wherein the oscillators produce characteristic sine wave tones and wherein modification or distortion of these tones is accomplished through the use of distorter circuits which are controllable to produce the desired tonal quality.

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In carrying out the above object it is a still further object of the invention to provide a tone distorting circuit for tone control wherein the non-linear portion of the tube characteristics is controlled to accentuate even or odd harmonics by varying the balance or unbalance of a two tube circuit through control of the grid impedance and current.

Still another object of the invention is to produce a single amplitude balancing control which simultaneously operates reversed direction attenuators to balance the amplitude of one group of tones against another.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

Fig. 1 shows a wiring diagram of an electronic musical instrument including our novel switching system,

Figs. 2 through 4 show diagrammatically the switching system in different controlling positions, and

Fig. 5 is a chart illustrating the oscillator connections for three different chords.

Our invention is directed to a simplified system of control particularly adaptable to an electronic musical instrument wherein the keyboard of the instrument operates a switching system which, through its peculiar arrangement, energizes one, two or three oscillator circuits singly or simultaneously as the case requires. At the same time, the depressing of a given key on the manual causes the addition of a circuit element, such as a resistance or capacitance to an oscillator circuit to cause the circuit to produce oscillations of a frequency corresponding to the desired musical note.

The switching arrangement to be described in detail hereinafter controls three oscillator circuits on the treble or melody keyboard since three note chords are usually sufficient when accompanied by suitable bass chords which are produced by another keyboard control also to be explained hereinafter.

The switching control for the treble or melody keyboard is composed of a four bank interlocked system of switches corresponding in number to the multiple of four of the number of notes desired. Three of the banks of switches are in turn connected to oscillator circuits. A manual key corresponding to the desired note acts as an operating means for closing the various switches

whereby the required circuit element is added to the oscillator circuit to produce a desired frequency.

The switching system is interlocked in such a manner that only three separate frequencies can be produced regardless of the number of keys depressed. This interlocking control makes possible the selective use of the oscillator circuits to produce the desired notes and/or chords.

The bass or accompaniment chords are produced from a separate group of oscillators and are operated by means of a separate group of keys grouped in a separate keyboard. Three oscillators are used for the bass keyboard and switching system. This system is also interlocked so that the three separate switch banks are all actuated upon depression of any one key. In this manner, by proper choice of bias, the frequencies for an entire three note chord can be produced by the depression of a single key since one switch in each bank of switches will be closed to simultaneously tune each of the three oscillators to a given and different frequency. Thus if a C major accompaniment chord is desired, the depression of the C major key will close three switches, the first of which will tune one oscillator circuit to a frequency corresponding to the note C, the second of which will tune a second oscillator circuit to a frequency corresponding to the note E, and the third switch will tune the third oscillator circuit to a frequency corresponding to the note G. In this manner, the output of the three oscillators will correspond to the C major triad of C, E and G. Similarly each key of the bass keyboard corresponds to another chord by the simultaneous tuning of three oscillators to three notes corresponding to the desired chord.

These same three oscillators are also separately tunable from two other switching circuits. These switching circuits are separately controlled by separate keyboards. One of these keyboards is termed the solo bass keyboard which functions to tune the three oscillators to desired frequencies depending on the key depressed in a manner similar to the treble keyboard.

The other keyboard is termed a minor chord keyboard which permits the playing of minor chords of three notes upon depression of a single key in the same manner as the chords are reproduced by the bass keyboard system. The minor chord switching system may be a continuation of the bass keyboard if space permits or it can be a separate keyboard wherein the three banks of switches are connected in series with the switches of the bass keyboard, or if desired the three banks of switches can be connected directly to the three oscillators used with the bass and solo bass keyboards.

It is also apparent that each of the three accompaniment keyboards may be connected to separate groups of oscillators, in this case however, the system described heretofore is less expensive and produces the desired results with less equipment.

The output of each of the three oscillators used in connection with the treble keyboard and the output of each of the three oscillators used in connection with the accompaniment or bass keyboard may be fed to distorters which are used to control the tonal qualities of the oscillator output. These distorters may be biased to produce fundamental tones with any, or all, or any combination of the harmonics predominant, whereby calliope, flute, reed, or organ, tones etc., can be simulated. The particular tone may be chosen by the operation of a stop which simultaneously biases all of the distorters in a similar manner.

The output of the three distorter circuits controlled by the treble keyboard and the output of the three distorter circuits controlled by the bass, solo bass, and minor keyboards are then passed through two separate mixers, which are devices introduced into the circuit to prevent feed back or coupling from one oscillator to the other. These mixers can be of any well known design, one of which is shown in the drawing.

The output of the mixers is led through balance controls or amplitude attenuators which are simultaneously adjustable in reverse directions so that when the melody is desired to be accentuated the accompaniment is automatically reduced in volume and vice versa. The final output is fed to a suitable reproducer.

Detailed description and operation

Having described the general principles of the invention reference to Fig. 1 will yield a clear conception of the basic operation of the system wherein a treble or melody keyboard **20** is indicated in part only and is mechanically connected so that depression of a key or keys operates a plurality of switches **22** of the switching system. The switches **22** are arranged in four banks **23**, **24**, **26** and **28** in the present instance wherein three note chords are capable of being played. The switch banks **23**, **24**, **26** and **28** are mechanically interlocked whereby three oscillators designated as oscillators #1, #2 and #3 are selectively connected to various circuit elements **30** which produce the desired frequency output from the oscillators to be described in more detail hereinafter. The circuit elements **30** may be condensers of varying capacities or they may be resistances. In the present hookups the elements **30** are condensers of varying capacities which are each connected at one side thereof to one terminal of one of the switches in banks **24**, **26** and **28** and which are each grounded at the other side thereof. The condensers **30** are not shown for each switch in Fig. 1 for sake of clarity but it is understood that each switch will include one of such circuit elements in the operating hookup.

The switches in banks **23**, **24**, **26** and **28** are of the leaf spring type similar to the type used in conventional telephone jacks, and are interlocked by means of dielectric buttons or rods, one of which is shown at **31**. Thus when a key on the treble keyboard is depressed, it acts directly on a switch in bank **23** bearing a corresponding letter, the operation of a switch in bank **23** causes operation of the interlocked switches of the same letter designation in banks **24**, **26** and **28**.

Referring more particularly to Figs. 2 through 5, it will be noted on the chart, Fig. 5, that when the key of C is depressed the switches **22** will be in the position shown in Fig. 2. In this position, oscillator #1 is open circuited and therefore does not produce any usable output. This is explained by the fact that switch C, in bank **23**, is open circuited through bank **24** which is open circuited at the right end thereof and also by the opening of switch C_1. Oscillator #2 however is connected through switch C_2 in bank **26** to its circuit element **30** so that the circuit is tuned to the desired frequency corresponding to the note C. In this instance, it will be noted, that

bank 26 is open circuited at the right end thereof as in the case of banks 23 and 24.

Oscillator #3 is connected through switch C_3 in bank 28 to its circuit element so as to be tuned to a frequency corresponding to the note C. Thus oscillators #2 and #3 are producing a frequency output corresponding to the note C while oscillator #1 is open circuited. The switch bank 28 is set up in a manner opposite to the other banks 23, 24 and 26 and is connected to oscillator 3 at the right end thereof while the left end is open circuited when the switches 22 are in normal position. This particular arrangement of the switches 22 make possible the selective operation of particular switches to produce the desired chords.

Again referring to Fig. 5, when the keys corresponding to C and E are depressed, it will be noted that oscillator #1 will be tuned to a frequency corresponding to the note E, oscillator #2 to C and oscillator #3 to E. This particular operation is illustrated in Fig. 3 wherein oscillator #1 is connected to the proper circuit element to produce the E frequency through the closure of switch E_1, in bank 24. Oscillator #2 is connected to its circuit element through switch C_2 in bank 26 and oscillator #3 is connected through closure of switch E_3 in bank 28.

When the chord C, D, E is desired, as shown in Fig. 5, oscillator #1 is connected through switch D_1 in bank 24 to reproduce the note D. Oscillator #2 is connected through switch C_2 in bank 26 to reproduce the note C while oscillator #3 is connected through switch E_3 in bank 28 to reproduce the note E. These switch positions and connections may be easily traced in Fig. 4.

Thus the interlocking of the four switch banks 22 makes possible selective operation of the three oscillators to produce outputs of the desired frequency. The peculiar arrangement of switches 22 make the operation of oscillator #3 always dependent on the first closed switch from the right in bank #28, any other closed switches between the first closed switch and the left of the bank are inoperative to effect the oscillator. Conversely oscillator #2 is dependent for its operation on the first closed switch from the left in bank #26.

Oscillator #1 is dependent for its operation on the second closed switch from the left in bank 24 since closure of the first switch always opens circuits oscillator #1.

The operation of the solo bass keyboard is identical to that described in connection with the treble keyboard. The bass major and minor keyboards are three bank keyboards with interlocked switches, wherein each of the three interlocked switches corresponding to a chord are properly connected so as to tune the oscillators #4, 5 and 6 to three separate notes of the chord.

The outputs of oscillators 1, 2 and 3 are passed into corresponding distorters #1, #2 and #3 which are circuits used for distorting or modifying the tonal qualities of the output to simulate various instrument tones. For example, calliope, flute, organ, etc. The distorters #1, #2 and 3 are interlocked so that stops 100, 102, 104 and 106 of each distorter circuit is operated simultaneously.

Each distorter circuit has the property of generating groups of harmonics according to the switch combination used. The combination of closed switches 102, 100, 104 and 106 connects the two tubes of the distorter circuit as a push-pull amplifier with a grid-bias selected by the

switch 100. It is a well-known property of push-pull amplifiers that even harmonics will cancel leaving only odd harmonics, the production of which may be accentuated by biasing the amplifier tubes close to cutoff, which is a function of the tap of the grid bias battery connected by switch 100. A combination of rich odd harmonics produces a reedlike sound.

The combination of switches 110, 102, 104 and 112 would be the same as that of 100, 102, 104 and 106 above noted except that the use of a higher grid bias through switch 110 would make the sound more reedlike and use of switch 112 instead of switch 106 would give less amplitude.

The combination of switches 116, 118, 102 and 106 will connect the tubes in a push-push arrangement resulting in cancellation of fundamental and odd harmonics and leaving only a group of even harmonics.

The combination of switches 120, 122, 124 and 126 will result in feeding the grids of the tubes with in-phase but unequal voltages and a low grid bias (through switch 120); grid current will flow resulting in production of all harmonics but the feeding of grids in-phase will tend to reduce odd harmonics and fundamental notes to the level of the even harmonics so that a well balanced combination of all harmonics will be produced corresponding to the harmonic content of a diapason organ pipe.

The grid resistances may be, for example, 20,000 ohms and the grid transformer may be tapped at its center turn and at its three-quarters turn points to produce the results desired.

This circuit differs from the usual harmonic generating circuits in that it is flexible, designed to accentuate, not a single harmonic, but a particular group of harmonics and uses an unbalanced push-push amplifier.

It should be understood that similar distorters #4, #5 and 6 are used in connection with the bass, minor and solo bass keyboards which distorters are identical to the one illustrated and designated as distorter #3. Also that the distorers 4, 5 and 6 are interlocked with each other as are distorters #1, #2 and #3 so that when organ tones are desired the operation of a single stop 100 for example will close all related switches in all distorters. Thus in distorter #3, for example stop 100 is shown closed, this causes switches 102, 104 and 106 to also close to connect the circuit as desired. Similarly when stop 110 is closed, switches 102, 104 and 112 close. When stop 116 is closed, switches 118, 102 and 104 are closed and when stop 120 is closed, switches 122, 124 and 126 are likewise closed. Similar switching arrangements are present in all distorters. In this manner, each distorter circuit is connected in push-pull, push-push, etc., to accentuate various harmonics whereby simulation of various instrumental tones may be accomplished when desired as hereinbefore described. The distorter circuits may be controlled individually so that the bass, for example, may be connected for simulation of organ tones, while the treble may be connected to simulate the tone of some other desired instrument, etc., all these variations coming within the scope of the present invention.

The output of the distorters is fed to a conventional mixer, so designated, one of which is provided for the treble output and another for the output of the accompaniment circuits. These mixers prevent feed back and coupling between the three circuits connected thereto and produce an output of high fidelity. The mixers are

shunted at the output side thereof by resistances 130 and 131. Movable take offs 132 and 133 are provided which are operated by means of a manual balance control. In this connection it will be noted, that as the solo or treble output is increased, the bass or accompaniment output is decreased and vice versa whereby the balance of the two outputs may be controlled by a single operating means.

The take offs 132 and 133 feed to the pedal amplitude adjustment which contains a pair of attenuators so arranged that as the solo or treble output is increased, the bass or accompaniment output is increased and vice versa, for varying the volume of output from the reproducer. The pedal amplitude adjustment 134 is a control for the outputs of the bass and treble and regulates the volume of the treble and the bass outputs through a pair of attenuators (not shown) which are simultaneously movable in the same direction by movement of pedal adjustment 134 to increase or decrease the total volume output of the instrument.

The various elements of the amplifiers, distorters, mixers, etc., will not be described in detail since the functions thereof are well known to those skilled in the art. It is also manifest that other analogous elements which will perform similar functions may be substituted without deviating from the spirit of our invention.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a switching system for controlling three electrical instrumentalities, the combination comprising; a switch bank consisting of, a plurality of groups of four interlocked switches which are normally open with respect to controlling said instrumentalities, similarly positioned switches in each group being electrically connected in series with one another, a plurality of reactors controlled by said switches whereby said reactors will be selectively connected to an instrumentality, a plurality of separate operating means one of which is associated with each group of switches and each being effective upon manipulation thereof for closing simultaneously all four switches in its associated group, switches one and three in one end group being connected to two of the three instrumentalities to be controlled and switch four in the group at the opposite end from the group containing switches one and three being connected to the third instrumentality to be controlled, said switch bank being so arranged that instrumentality number two is controlled by the first means operated from said one end, instrumentality number one being controlled by the second means operated from said one end and instrumentality number three being controlled by the first means operated from said other end whereby said instrumentalities are so controlled regardless of the number of means operated intermediate said specific means mentioned.

2. In a switching system for controlling three separate oscillators whereby three different frequency outputs can be produced, the combination comprising; a switch bank consisting of, a plurality of groups of four mechanically interlocked switches all normally in one position all of said switches in any one group being operable simultaneously to another position similarly positioned switches in each group being electrically connected in series, switches two, three and four of each group being operable in said another position to bias their associated circuits; the first and second of said oscillators being connected to switches one and three respectively in the first group of switches from one end of the bank and the third oscillator being connected to switch four in the first group of switches from the opposite end of the bank whereby the first and second groups of switches from one side of the bank which are operated control the operation of the second and first oscillators respectively, while the first group of switches from the other side of said bank, which is operated, controls the operation of the third oscillator, said switch bank being so arranged that the aforementioned control is maintained irrespective of the number of groups of switches which are operated to closed position intermediate said aforementioned groups of switches.

3. In a switching system for controlling three separate oscillators whereby three different frequency outputs can be produced, the combination comprising; a switch bank consisting of, a plurality of groups of four mechanically interlocked normally open circuited switches all of said switches in any one group being operable simultaneously to a closed position, a plurality of reactors one of which is operatively associated with each switch in said bank and operatively connected in a circuit when said plurality of groups of switches are in closed position, said reactors being of similar electrical reactance for switches in any one group but of different electrical reactance for switches in different groups, the first and second of said oscillators being connected to switches one and three of the first group of switches from one end of the bank and the third oscillator being connected to switch four in the first group of switches from the opposite end of the bank whereby the first and second groups of switches from one side of the bank which are operated to closed position, control the connection between the second and first oscillators respectively and the associated reactors, while the first group of switches from the other side of said bank, which is operated to closed position, control the connection between the third oscillator and the associated reactors, said switch bank being so arranged that the aforementioned control is maintained irrespective of the number of groups of switches which are operated to closed position intermediate said aforementioned groups of switches.

4. In a switching system the combination comprising; a plurality of groups of switches, each group including at least four switches all of which are normally in one position and are simultaneously operable to another position, similarly placed switches in each group being serially connected together, a plurality of reactors adapted to be controlled by said switches, a plurality of operating means one of which is adapted to control each group of switches and being effective to move all of said switches in said group to said another position, at least three electrical devices controlled by said switches, said switches being so arranged that the first and second means operated from one end of the groups of switches controls the first and second devices, and renders ineffective all other means with respect to devices one and two, and the first means operated from the other end of the groups of switches controls

the third device and renders ineffective all of the other means with respect to said third device.

5. In a switching system, the combination comprising; four banks of switches each bank consisting of a plurality of series connected switches, a plurality of circuit elements, each of the switches in banks 2, 3 and 4 being associated with one of said circuit elements which is effective only when the cooperating switch is in closed circuit position with respect thereto, three mechanisms to be controlled, said mechanisms being connected to three of said banks, a plurality of means, one of which is provided for each switch in the first bank, for operating said switches, motion transmitting means for transmitting movement from switches in the first bank to similarly positioned switches in each of the three remaining banks, whereby operation of any one of said means is effective to operate simultaneously similarly positioned switches in each of the four banks, said switches being so arranged that the mechanism connected to the third bank is operatively connected to a circuit element by operation of the first means from the left side of the bank of switches, the mechanism connected to the first bank is operatively connected to a circuit element by operation of the second means from the left side of the banks of switches, and the mechanism connected to the fourth bank is operatively connected to a circuit element by operation of the first means from the right side of the banks of switches, said mechanisms being so connected irrespective of the number of intermediate operating means operated.

6. In a switching system, the combination comprising; four banks of switches each bank consisting of a plurality of series connected switches, a plurality of circuit elements, each of said switches in banks 2, 3 and 4 being associated with one of said circuit elements which is effective only when the cooperating switch is in closed circuit position with respect thereto, three mechanisms to be controlled, said mechanisms being connected to the first, third and fourth switch banks, a plurality of means, one of which is provided for each switch in the first bank, for operating said switches, motion transmitting means for transmitting movement from switches in the first bank to similarly positioned switches in each of the three remaining banks, whereby operation of any one of said means is effective to operate simultaneously similarly positioned switches in each of the four banks, said switches being so arranged that the mechanism connected to the third bank is operatively connected to a circuit element by operation of the first means from the left side of the bank of switches, the mechanism connected to the first bank is operatively connected to a circuit element by operation of the second means from the left side of the switches, and the mechanism connected to the fourth bank is operatively connected to a circuit element by operation of the first means from the right side of the bank of switches, said mechanisms being so connected irrespective of the number of intermediate operating means operated.

7. In an electronic musical device, the combination comprising; three normally open-circuited oscillators to be controlled, a switching bank selectively operable for controlling the frequency of said oscillators, a manual including a plurality of keys adapted to operate said switch bank, said switch bank including a plurality of switches each of which is connected at one side thereof to a condenser of a given capacity which, when placed

in circuit with one of said oscillators, will cause the said oscillator output to assume a predetermined frequency, an amplifier for amplifying the mixed output of said oscillators and a single reproducer for reproducing audible tones from said amplifier, said switch bank being so arranged that said oscillators can only be connected to produce three separate and different frequencies at any one time irrespective of the number of manual keys, that are operated, the first two of said oscillators being responsive to the first and second keys operated from one end of the manual while the third oscillator is responsive to the first key operated from the other end of the manual irrespective of the number of intermediate keys operated.

8. In an electronic musical device, the combination comprising; three oscillators to be controlled, a switch bank for controlling said oscillators, a manual including a plurality of keys adapted to operate said switch bank, said switch bank including a plurality of switches each of which is connected at one side thereof to a condenser of a given capacity which, when placed in circuit, with one of said oscillators will cause the oscillator output to assume a predetermined frequency, said switch bank being so arranged that said oscillators can be connected to produce a maximum of three separate and different frequencies at any one time irrespective of the number of manual keys, that are operated, the first two of said oscillators being responsive to the first and second keys operated from one end of the manual while the third oscillator is responsive to the first key operated from the other end of the manual irrespective of the number of intermediate keys operated, a mixer circuit for preventing feed back and coupling of the output of said three oscillators, an amplifier for amplifying the output of said oscillators and a reproducer for reproducing audible tones from said amplifier.

9. In an electronic musical device, the combination comprising; three oscillators to be controlled, a switch bank for controlling said oscillators, a manual including a plurality of keys adapted to operate said switch bank, said switch bank including a pluralty of switches each of which is connected at one side thereof to a condenser of a given capacity which, when placed in circuit with one of said oscillators, will cause the oscillator output to assume a predetermined frequency, said switch bank being so arranged that said oscillators can be connected to produce a maximum of three separate and different frequencies at any one time irrespective of the number of manual keys, that are operated, the first two of said oscillators being responsive to the first and second keys operated from one end of the manual while the third oscillator is responsive to the first key operated from the other end of the manual irrespective of the number of intermediate keys operated, a separate distorter connnected to the output of each oscillator and comprising, tone distorting circuits wherein the balance or unbalance of the circuits can be varied to accentuate even or odd harmonics for changing the tone characteristics of said output, all of said distorters being interlocked and simultaneously operable to various tonal modifications, a mixer circuit connected to the output of said distorters, an amplifier for amplifying the output of said oscillators, and a reproducer for reproducing audible tones from said amplifier.

10. In a musical device, the combination comprising; three switch banks each including a plu-

rality of normally open circuited switches, a keyboard, operating means for associating the keyboard with the switches whereby depression of a key will cause simultaneous movement of like positioned switches in each bank to closed circuit position, a plurality of electrical devices at least one of which is connected to each switch and which is adapted to be placed in circuit by depression of the key associated with the particular switch, the electrical devices connected to like positioned switches in each bank being of a different electrical reactance, three oscillators one of which is connected to each switch bank and adapted to be controlled by switches therein, whereby depression of a single key causes each of the three oscillators to produce oscillations of a different frequency for forming a chord, a mixing device for mixing said outputs and a single reproducer for said mixed output.

11. In a musical device, the combination comprising; a plurality of switch banks each including a plurality of open circuited switches, a keyboard, operating means for associating the keyboard with the switches whereby depression of a key will cause movement of like positioned switches in each bank to closed circuit position, a plurality of electrical devices; at least one of which is connected to each switch and is adapted to be placed in circuit by depression of the key associated with the particular switch, the electrical devices connected to like positioned switches in each bank being of a predetermined and different electrical reactance, a plurality of oscillators, one of which is connected to each switch bank and adapted to be controlled by the switches in said bank whereby depression of a single key causes each of the oscillators to be connected to different electrical devices, whereby each oscillator will produce simultaneous oscillations of a different frequency output for forming a chord, a mixing device for mixing the outputs of said oscillators and a single reproducer for said mixed outputs.

12. In an electronic musical device, the combination comprising; a plurality of switch banks each including a plurality of serially connected normally open leaf spring switches, a musical keyboard, linkage means associated with said keyboard and said switches for transmitting movement of keys on the keyboard to the switches whereby depression of a key will cause closure of all like positioned switches in each bank, a plurality of oscillator means equal to one less than the number of switch banks, each one of which is connected to a separate bank of switches, condenser means of varying capacity connected to each switch in the banks associated with the oscillator means and operative when the associated switch is in closed circuit position to be placed in circuit with the said oscillator means whereby closure of the switches changes the electrical reactance of the oscillator circuits so that the circuit produces selectively varying frequencies according to the selective operation of the keys on the keyboard, and a single reproducing means for reproducing audible tones from the output of said oscillators.

13. An electrical control system for modifying the intensity of combined output of two separate oscillator circuits comprising in combination; an oscillator circuit controllable to provide an output of a desired frequency, a second oscillator circuit controllable to produce an output of a desired frequency, two adjustable circuit elements one of which is connected to the output of each of said oscillator circuits said elements being capable of controlling the frequency of output of said circuits, a single control means for adjusting said elements simultaneously and in reverse directions whereby as the intensity of output of one of said circuits is increased, the intensity of output of the other of said circuits is decreased and vice versa.

14. An electrical control system for modifying the intensity of combined output of two separate oscillator circuits comprising in combination; an oscillator circuit controllable to provide an output of a desired frequency, a second oscillator circuit controllable to produce an output of a desired frequency, two adjustable circuit elements one of which is connected to the output of each of said circuits said elements being capable of controlling the frequency of output of said circuits, a single control means for adjusting said elements simultaneously in reverse directions whereby when the intensity of output of one of said circuits is increased, the intensity of output of the other of said circuits is decreased and vice versa, and amplitude control means for controlling the combined intensity of output from said two circuit elements whereby the amplitude of said total output may be increased or decreased as a whole.

15. An electronic musical instrument comprising in combination; an oscillator means operable for producing a melody frequency output, a second oscillator means operable for producing an accompaniment frequency output, adjustable circuit elements one of which is in circuit with each of said oscillator outputs, a single control means for said circuit elements, said control means being operable to simultaneously regulate said circuit elements in reverse directions whereby when the intensity of output of one of said oscillator means is increased, the intensity of output of the other of said oscillator means is decreased and vice versa, a single amplitude adjustment connected to the output of said circuit elements for regulating the amplitude of the combined outputs of said circuit elements whereby any desired amplitude of output may be obtained and a single reproducer for audibly reproducing said combined outputs.

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