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Stearns

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[54] MUSIC SYNTHESIZER KEYBOARD

[72] Inventor: **Richard E. Stearns,** Sharon, Mass.

[73] Assignee: **Tonus, Inc.,** Newton, Mass.

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[58] **Field of Search** 84/1.01, 1.17, 1.24, 1.19; 331/48, 56

[56] **References Cited**

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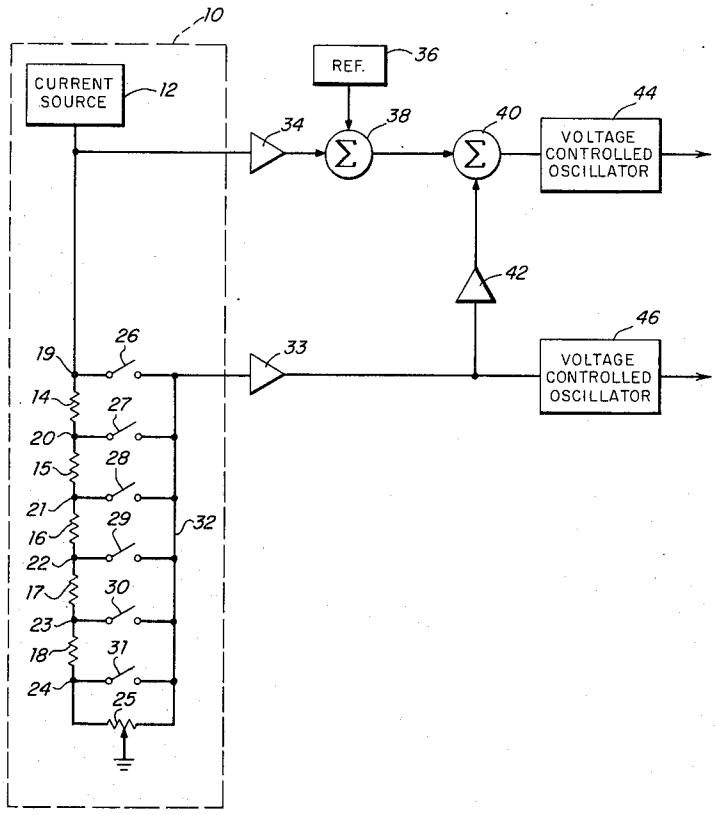
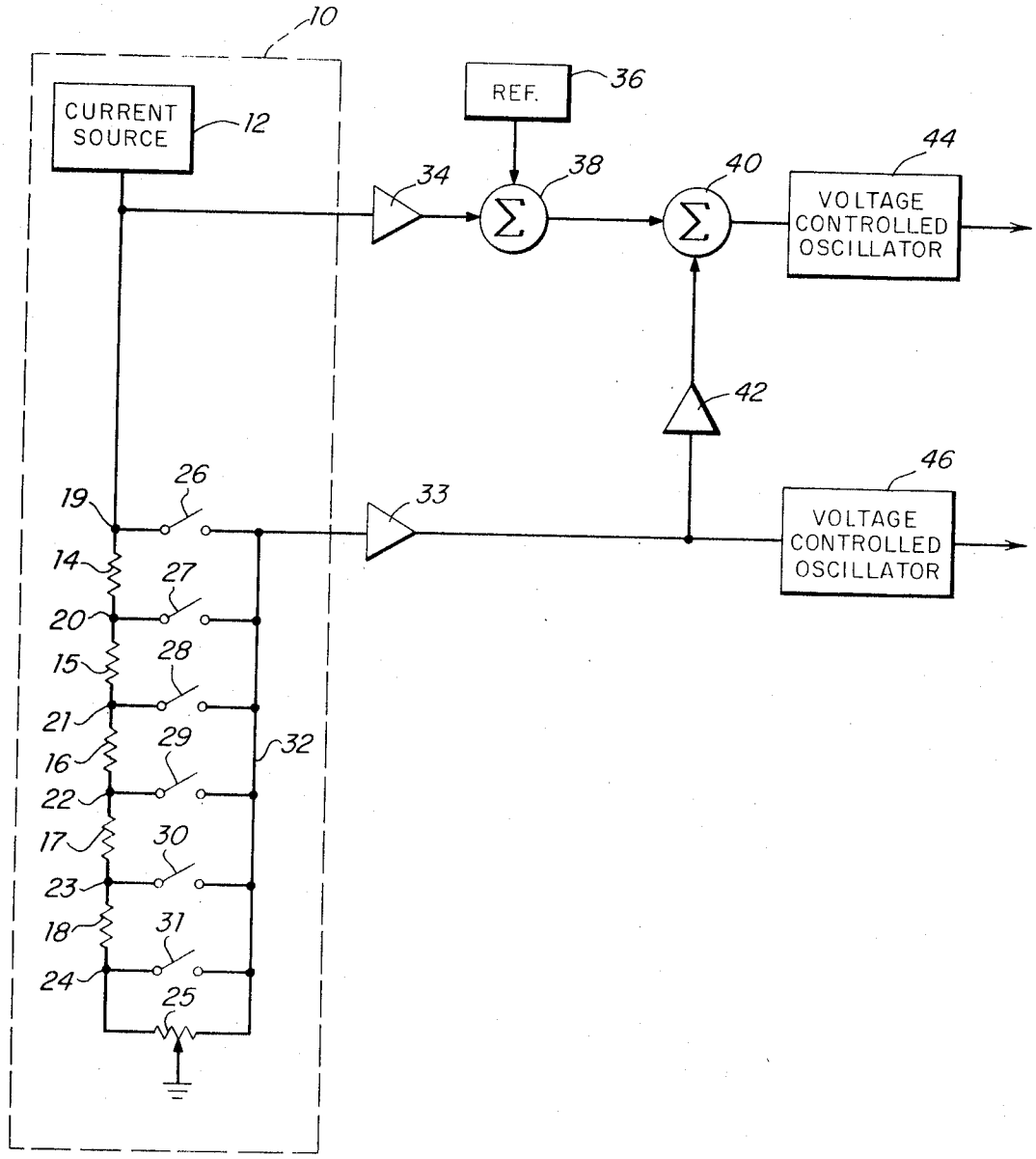
Primary Examiner—Thomas J. Kozma
Assistant Examiner—Ulysses Weldon
Attorney—Wolfe, Greenfield & Sacks

[57] **ABSTRACT**

The invention concerns a musical keyboard for providing a two-voiced output from a music synthesizer. The system includes a voltage divider which provides a plurality of values of potential and a plurality of switches each connected to a divider tap at a unique one of the potential values. The simultaneous closure of a plurality of switches applies the selected voltage to a pair of voltage-controlled oscillators so as to provide a two-voiced output determined by the two selected voltages having the greatest and least absolute amplitude values.

6 Claims, 1 Drawing Figure





RICHARD. E. STEARNS
INVENTOR.
BY Schiller & Pandiscio
ATTORNEYS.

MUSIC SYNTHESIZER KEYBOARD

This invention relates to electronic musical instruments and more particularly to music synthesizers. The so-called music synthesizers currently available today are monophonic, i.e. only one note at a time may be played. The usual keyboard system of these monophonic synthesizers comprises a series string of precision resistors driven by a constant current source. For the normal musical scale, the circuitry is adjusted to produce a 1/12 volt drop across each resistor in the string. Depression of a key connects a busbar to a point along the resistor string, applying the voltage at that point to the input of a buffer amplifier (Unity gain follower). The latter, in turn, drives a voltage-controlled oscillator to the appropriate frequency for the key depressed. If two keys are depressed simultaneously, only the note corresponding to the lower frequency key will sound.

A primary object of the present invention is to provide a plural-voiced music synthesizer. Another object of the present invention is to provide a synthesizer keyboard system capable of playing two notes simultaneously. Yet another object of the present invention is to provide a keyboard system capable of simultaneously playing the two selected notes corresponding to the highest and lowest frequency value significance of the keys played.

The above objects, advantages, and features of the present invention, as well as others, are accomplished by providing a music synthesizer keyboard system for providing a plural-voiced output and comprising means for providing a scaled sequence of signals of differing absolute values each corresponding to a respective key on said keyboard. Means are also provided, responsive to the signals, such that simultaneous selection of more than one of the signals will provide a two-voiced output determined by the two selected signals having the greatest and least absolute values.

Other objects of the invention will in part be obvious and will in part appear hereinafter. The invention accordingly comprises the apparatus possessing the construction, combination of elements, and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the present invention, reference should be made to the following detailed description taken in connection with the accompanying drawing wherein is shown a diagram of a network for use in a music synthesizer, partly in block form and particularly schematic.

The drawing is essentially of a network in which a manually operable keyboard is shown schematically within block **10** enclosed in broken lines. Means are included for providing a plurality of signals of differing absolute amplitudes, scaled preferably according to the frequency relationships of the standard musical half tone scale. Thus, for example, one of the signals may correspond to A above middle C (or, as will be seen later, has an amplitude which will control an appropriate oscillator to produce the requisite audio frequency of 440 cps) and other signals will then correspond to higher octaves or harmonics in which the A tone will be double, triple, etc. the lower frequency, as well-known in the art.

To this end there is provided a voltage divider comprising source **12**, preferably of constant current, connected to a string of series connected precision resistors **14**, **15**, **16**, **17**, and **18** scaled in ohmic values to provide the desired signal relation by way of the voltage drop across the resistors. The other end of the string of resistors is grounded or held at a fixed level. The number of resistors shown is merely exemplary and preferably is one less than the number of signals (or tones) desired. To provide access to the signals or voltages thus provided, tap **19** is disposed between source **12** and resistor **14**, and similar taps **20**, **21**, **22**, **23**, and **24** are respectively provided between resistors **14** and **15**, resistors **15** and **16**, resistors **16** and **17**, resistors **17** and **18**, and at ground or some arbitrary level set by variable rheostat **25**.

Connected to each of taps **19**, **20**, **21**, **22**, **23**, and **24** is a respective key-operated switch shown typically as mechanical single-pole, single throw switches **26**, **27**, **28**, **29**, **30**, and **31**, although any other type of switch can be employed as well. All of the output terminals of these switches are connected to a common bus **32** which in turn is connected to the input of amplifier **33**.

Tap **19** is also connected to the input of inverting amplifier **34**. Source **36** of reference potential is provided, and its output and the output of amplifier **34** are connected together to inputs of summing circuit **38**. The output of summing circuit **38** is connected to an input of another summing circuit **40**. The output from amplifier **33** is likewise connected to an input of summing circuit **40** through a buffer means such as amplifier **42**. The output from summing circuit **40** is connected to the control input of voltage-controlled oscillator **44**. The output of amplifier **33** is connected to the control input of voltage-controlled oscillator **46**. Summing circuits **38** and **40**, buffer amplifier **42**, amplifiers **33** and **34**, and voltage-controlled oscillators **44** and **46** may be selected from any one of a number of standard circuit configurations well-known in the art, and particularly the amplifiers and summing circuits can be appropriate types of well-known operational amplifiers.

Operation of the electronic music system **10** shown in the drawing will now be described. Source **12** supplies a preferably constant current to junction **19** to which the string of series-connected resistors **14**, **15**, **16**, **17**, and **18** of keyboard **10** is connected. These resistors provide a number of different voltages at each of taps **20**, **21**, **22**, **23**, and **24**. Closure of one of switches **26**, **27**, **28**, **29**, **30**, or **31** connects the corresponding tap to bus **32** and thus applies the voltage at that tap to the input of amplifier **33**. For example, closure of switch **27** applies the voltage at tap **20** to the input of amplifier **33**.

Reference source **36** is selected to provide a potential of the same absolute amplitude as the voltage at the head of the divider (i.e. at tap **19**) but of the opposite polarity to the output of amplifier **34**. Therefore, when only one switch, such as, for example, **27** is closed, the input signals to summing circuit **38** are equal and opposite so the output of circuit **38** is substantially zero. The voltage at tap **20**, which is less than that at tap **19** by the IR drop across resistor **14**, will thus be applied both to the input of oscillator **46** directly from amplifier **33** and to the input of oscillator **44** via amplifier **33**, buffer amplifier **42**, and summing circuit **40**. Assuming that amplifier **42** and summing circuit **40** exhibit a total gain of unity, oscillators **44** and **46** will have identical input signals and, if the oscillators too are identical, these inputs should provide the same frequency outputs.

When any two switches of keyboard **10** are closed simultaneously, the resistors between the two closed switches are shorted out, causing the voltage at tap **19** to drop by an amount equal to the sum of the voltage drops across each shorted resistor. This voltage appearing at tap **19** is applied to amplifier **34** and then summed in summing circuit **38** together with the voltage from reference source **36**. The output from summing circuit **38** will be the difference between the voltages from amplifier **34** and source **36**. Meanwhile, the voltage applied at the input of amplifier **33** is the voltage from the tap of lowest voltage connected to an actuated switch. The output voltage from amplifier **33** is simultaneously applied to oscillator **46** and via buffer amplifier **42** to summing circuit **40** where it is summed together with the difference voltage from summing circuit **38** to provide a voltage corresponding to the voltage from the tap of highest voltage connected to an actuated switch. This summed voltage from summing circuit **40** is applied to oscillator **44**. The result is that the oscillator **44** will provide a frequency output corresponding to the actuated key for the higher note, and oscillator **46** will provide a lower frequency output corresponding to the actuated key or switch for the lower note.

For example, one may assume that the resistors in the voltage divider and the output of the current source are such that

the voltage drop across the divider is one volt per octave of frequency of the output of oscillator **46** and thus 1/12 volt across each resistor in the divider. One can also assume that the voltages thus switched by switches **26, 27, 28, 29, 30,** and **31** respectively are capable of generating in oscillator **46** the audio frequencies in half tones from middle C down to G below middle C. Lastly, assume that the normal voltage of current source **12** is +4 volts, the voltage from reference source **26** is +4 volts, that all amplification and summing is with unity gain, that only amplifier **34** inverts and that oscillators **44** and **46** are identical.

The following table shows some examples of resulting outputs from the simultaneous closing of two selected keyboard switches with the same parameters given above. V_1 is the voltage appearing at tap **19** upon the simultaneous closure of the two switches. V_2 is the voltage appearing at the input of amplifier **33** upon the simultaneous closure of the same two switches. Δ is the output voltage of summing circuit **38** and represents the difference between the output voltage from amplifier **34** and the voltage provided by reference source **36**. The column labelled **V44** represents the voltages applied to oscillator **44** which is the sum of $V_2 + \Delta$, and the column labelled **T44** is the tone produced by oscillator **44**. The column labelled **V46** represents the voltages applied to oscillator **46**, **T46** being the tone of the note generated.

TABLE I

Closed switches		V_1	V_2	Δ	V44	T44	V46	T46
26	27	3 11/12	3 11/12	1/12	4	C	3 11/12	B
26	28	3 10/12	3 10/12	2/12	4	C	3 10/12	Bflat
26	29	3 9/12	3 9/12	3/12	4	C	3 9/12	A
27	28	3 11/12	3 10/12	1/12	3 11/12	B	3 10/12	Bflat
27	29	3 10/12	3 9/12	2/12	3 11/12	B	3 9/12	A
28	29	3 11/12	3 9/12	1/12	3 10/12	Bflat	3 9/12	A

It should be noted that the value of Δ is a direct measure of the number of half-tones (in this example) between the two notes sounded and, referred to the voltage representing the note of lower frequency so as to be summed therewith, provides a summed voltage which then must represent the note of higher frequency.

Adjustment of potentiometer **25** will result in shifting all of the voltages at the various taps by the same amount, therefore, can be used to tune a number of voltage divider systems to different octaves.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. In an electronic system, in combination:

means for providing a plurality of voltages of different values;

means for selecting at least two of said voltages substantially simultaneously;

means for providing a reference voltage;

means for deriving a difference signal from the values of said reference voltage and one of the selected voltages;

means for deriving an output signal from the values of said difference signal and the other of said selected voltages; and

means for generating two signals having frequencies in accordance respectively with the values of said output signal and said other of said selected voltages.

2. In a system as defined in claim **1**, wherein said means for providing said plurality of voltages comprises a voltage divider, and said means for selecting comprises a plurality of switching means each having an input terminal connected to a respective tap in said divider, the output terminals of all of said switching means being connected to a common bus.

3. In a system as defined in claim **2** wherein said difference signal is proportional to the voltage drop along said divider between the taps closest to opposite ends of said divider and connected to at least two corresponding switching means in closed condition.

4. In a system as defined in claim **1** wherein said output signal is a voltage and said means for generating two signals comprises a pair of voltage-controlled oscillators.

5. Electronic musical apparatus comprising, in combination:

a voltage divider having a plurality of taps each adapted to have a unique voltage thereon selected in order from a set of voltage levels which progressively increase in said order from a predetermined initial minimum amplitude,

a like plurality of key-operated switches each having an input terminal connected to a corresponding tap, all output terminals of said switches being coupled to a common bus,

a source of reference voltage,

means for summing said reference voltage with a first signal derived from the maximum voltage level on said taps when one or more of said switches are closed so as to produce a difference signal;

first and second oscillators for providing output signals having frequencies variable in accordance with variations in respective control signals;

means for applying to said first oscillator a first control signal derived from the lowest voltage level of the taps connected to closed ones of said switches;

means for summing said difference signal with said first control signal so as to derive a second control signal; and

means for applying said second control signal to said second oscillator.

6. Apparatus as defined in claim **5** wherein said difference signal is proportional to the voltage drop along said divider between the tap coupled to the closed switch corresponding to the maximum voltage level selected on the divider and the tap coupled to the closed switch corresponding to said lowest voltage level.

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