May 5, 1970 G. S. MOREZ 3,510,565

ELECTRONIC ORGAN WITH MUSICAL NOTES COMPRISING BEAT FREQUENCIES OF A REFERENCE GENERATOR AND NOTE GENERATORS UTILIZING MAGNETOSTRICTIVE OSCILLATORS

Filed July 17, 1967 3 Sheets-Sheet 1

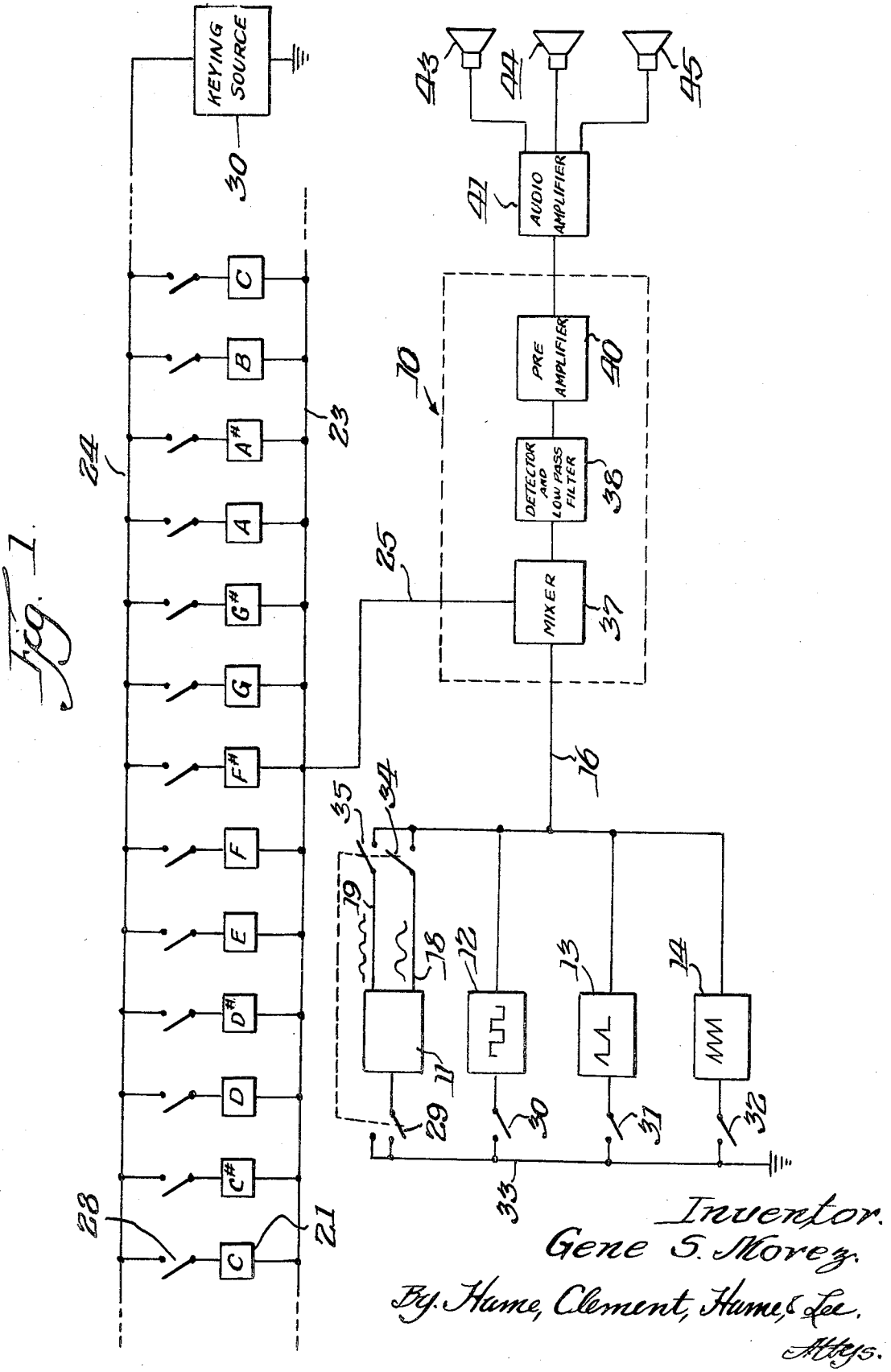


Fig. 1.

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Filed July 17, 1967 3 Sheets-Sheet 2

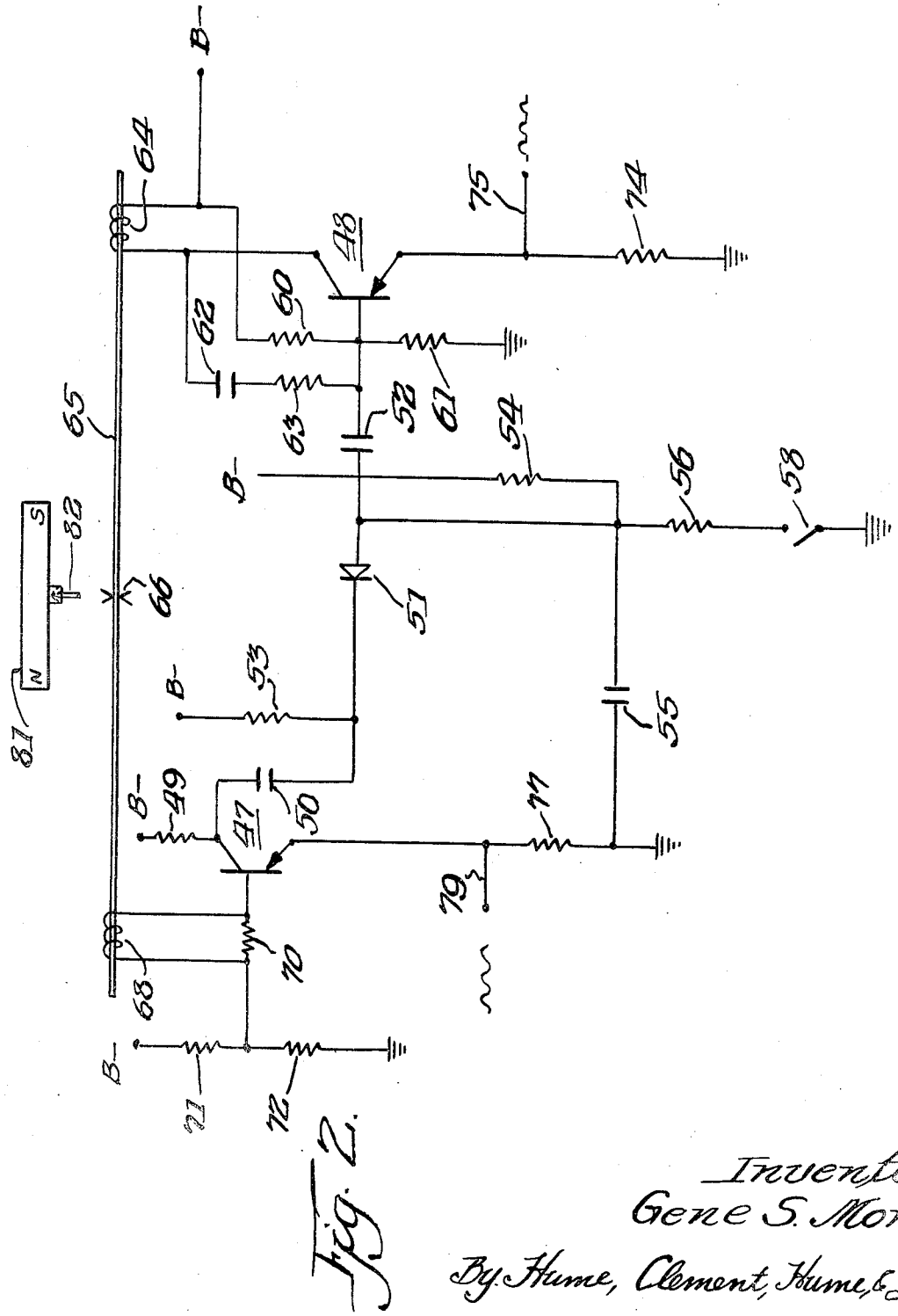


Fig. 2.

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Filed July 17, 1967 3 Sheets-Sheet 3

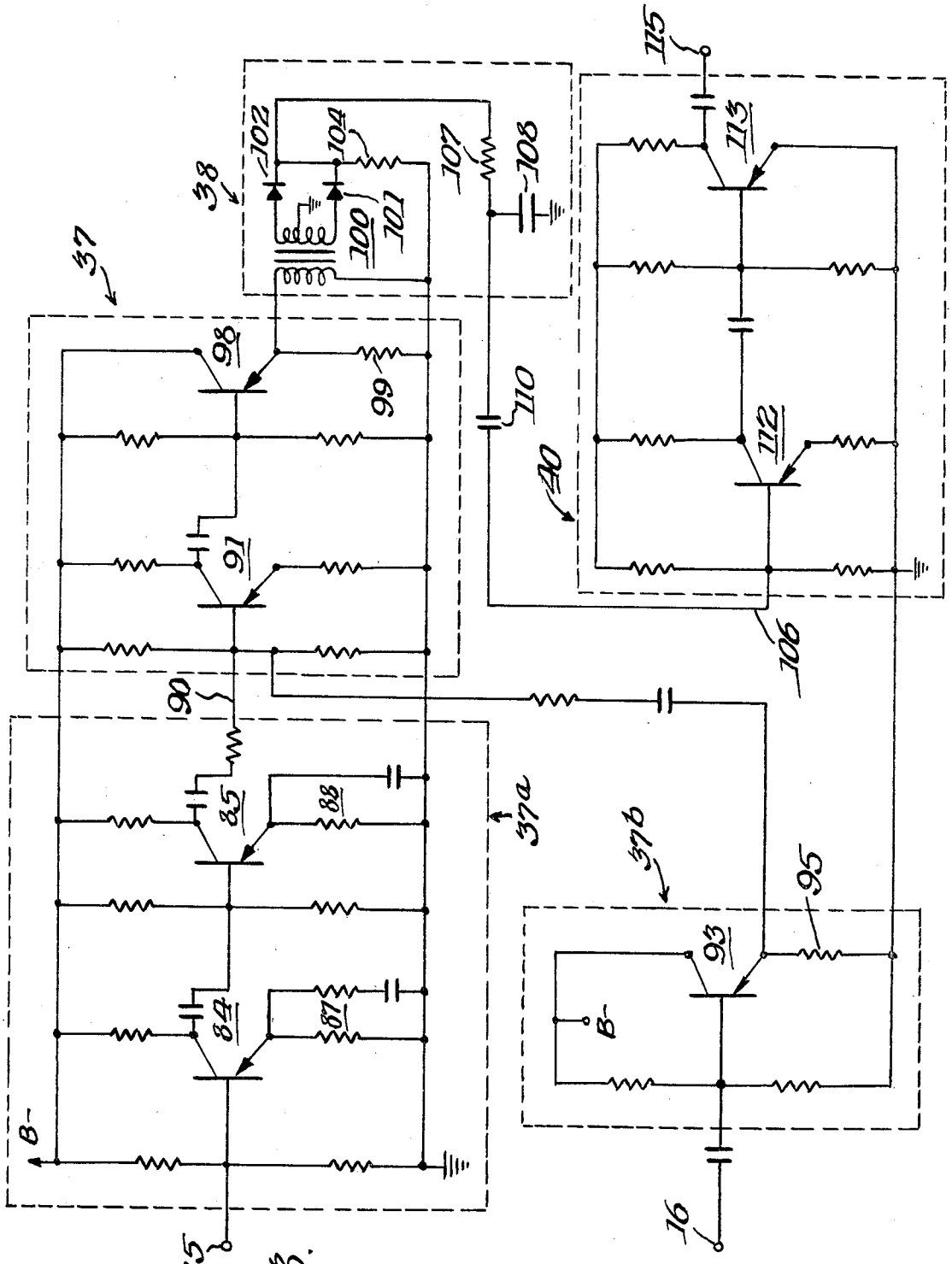


Fig. 3.

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ELECTRONIC ORGAN WITH MUSICAL NOTES COMPRISING BEAT FREQUENCIES OF A REFERENCE GENERATOR AND NOTE GENERATORS UTILIZING MAGNETOSTRICTIVE OSCILLATORS

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13 Claims

ABSTRACT OF THE DISCLOSURE

An electronic organ includes a reference frequency generator and a series of note generators with the beat frequencies of the reference generator and a given note generator corresponding to a note of the musical scale to be reproduced. All of the generators are magnetostriction oscillators and are so constructed as to selectively provide only a fundamental tone or additional harmonics thereof in a desired weighted proportion to thereby develop a series of minor beat frequencies simulative of the multiple source reproduction of a pipe organ. Structure for effecting vibrato, celeste and tremulant effects are also disclosed.

BACKGROUND OF THE INVENTION

The present invention relates to electronic musical instruments and, more particularly, to a new and improved electronic organ or the like for effecting a convincing simulation of the rich and distinctive tonal quality of a pipe organ.

In the operation of electrical music instruments, there is substantial difficulty in reproducing exactly the total audio effect produced by corresponding instruments of more conventional type. The electrical instruments usually seem to lack a richness or depth of tonal quality present in the conventional instrument which they are intended to simulate. A prime example of this is the electronic organ, in which the tonal quality, as compared with the conventional pipe organ, is usually relatively "flat." The difference in effect between the two instruments is due in large measure to the fact that the tones produced by an electronic organ are usually based upon a limited number of original sources, so that the multiplicity of minor beat signals produced by sounds in the individual pipes of a pipe organ are not present in the output of the electric organ. Other contributing factors are the absence of satisfactory simulations of "celeste," "vibrato" and "tremulant" effects which are so characteristic of pipe organ music. In addition to the foregoing, the note oscillators or other frequency determining elements of electronic organs are often overly susceptible to changes in ambient temperature, aging of components, or inevitable variations in value of the original components to the end that there is often experienced an undesired drifting or lack of sufficient frequency stability in the oscillators which constitute the electronic organ and, hence, fidelity of reproduction suffers. Furthermore, in conventional electronic organs oscillators of different frequencies often differ materially in construction thereby dictating individual, as opposed to bulk, assembly procedures. This, of course, complicates construction of the instrument and contributes correspondingly to its cost.

BRIEF DESCRIPTION OF THE INVENTION

It is therefore an object of the present invention to

provide a new and improved electronic musical instrument which overcomes the aforenoted deficiencies of the prior art.

It is a further object of the present invention to provide an electronic organ system the signal output of which is characterized by a broad range of harmonic beat signals accurately simulating of the natural tonal qualities of a pipe organ.

It is another object of the present invention to provide an electronic organ having oscillators of high frequency stability while being of such a nearly identical construction as to allow substantial economies in manufacturing procedures.

It is yet another object of the present invention to provide an electronic organ which is capable of selectively providing vibrato, celeste, tremulant and signal rise and decay characteristics which closely approximate the correspondingly effects of a pipe organ but yet which only require electronic means of relatively simple and economical construction.

Accordingly, the present invention is directed to an electronic musical instrument for simulating the tonal qualities of a pipe organ which instrument comprises reference frequency means including a magnetostriction oscillator tuned to a predetermined fundamental frequency. A plurality of note signal generators each comprise a magnetostriction oscillator tuned to a respective preselected fundamental frequency which corresponds to the sum of the predetermined reference frequency and the frequency of the note of the musical scale to be reproduced. Actuating means including a playable keyboard are provided for selectively energizing the note signal generators and the reference frequency means, while a heterodyning means is provided for combining the signal outputs from the note signal generators and the reference frequency means. Detection and low pass filter means are coupled to the heterodyning means for developing only the audio beat frequencies of the signals applied to the heterodyning means; these audio beat frequencies are coupled to audio reproduction means which, of course, develop an audio output of these signals.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of this invention which are believed to be noval are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken into conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIG. 1 is a block diagram of an electronic organ embodying the present invention;

FIG. 2 is a schematic diagram of a preferred oscillator construction for the note signal generators and at least one of the master oscillators of FIG. 1;

FIG. 3 is a schematic diagram of the portion of the organ circuitry enclosed within dashed block **10** of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a portion of an electronic organ comprising reference frequency means, here constituting a series of four master oscillators **11–14** each tuned to an identical predetermined fundamental frequency and each being connected by a common electrical bus to an output lead **16**. For reasons that will be explained more fully hereinafter, each of the oscillators is preferably of the magnetostriction type and, as schematically indicated in the drawing, each of

the oscillators provides an output signal of a different waveform, the respective waveforms having different weighted measures of harmonics of the fundamental frequency. Specifically, oscillators **11–14** provide a sine wave, a square wave, a short duty cycle pulse and a sawtooth wave output. Although for a wide range of selectivity a series of oscillators is desirable, it is sufficient to provide a single oscillator **11**, having a pair of output terminals **18**, **19** which respectively carry a pure sinusoidal waveform and a rectified component of this signal, as schematically indicated adjacent these terminals. A preferred magnetostriction oscillator construction for providing both such signal outputs will be described in further detail later herein.

The organ also includes a plurality of note signal generators which likewise are each comprised of a magnetostriction oscillator. For clarity, only one of these oscillators **21** has been labeled in the drawing, although it will be understood that the remaining oscillators are of substantially identical construction excepting only that they are tuned to respectively different preselected fundamental frequencies each of which frequencies bears a predetermined relation to the musical note indicated on the block representation of each generator. To further simplify the drawing, only a one octave range of note signal generators is illustrated. The illustrated generators correspond to one set or rank of pipes in a pipe organ and in a complete electronic organ there is provided one master oscillator or set of master oscillators for each such octave range of note generators. It will be understood that a full complement of such note generators and master oscillators as is necessary to provide for reproduction of the full musical scale are included in a complete electronic organ and that these additional elements are of similar construction to their counterparts herein and are connected to signal developing circuit **10** in like fashion. The series of note signal generators **21** are tuned to respective fundamental frequencies corresponding to the sum of the predetermined reference frequency of the master oscillator associated with the octave range and the frequency of a note of the musical scale to be reproduced. Thus, signal generators **21** in FIG. 1 are each tuned to a fundamental frequency equal to the sum of the note frequency labeled on the individual generator and the fundamental frequency of the associated master oscillator bank **11–14**.

Actuating means including a playable keyboard is provided for selectively energizing each of the note signal generators and the reference frequency means. In this regard, each of the note signal generators is connected between a pair of conductive buses **23** and **24** by a conventional single-pole, single-throw switch, only one of which **28** is labeled in the drawing. It will be recognized that these switches are disposed so as to be closed or actuated on depression of a corresponding key on the organ keyboard (not shown). The keys are, of course, arranged along the keyboard in proper order and are of conventional construction. Closing of an individual switch **28** connects the corresponding oscillator to a key source **30** which is effective to render that particular note oscillator operative. In its simplest form, keying source **30** may constitute a conductor coupled to ground. However, if it is desired to simulate certain other characteristics of a pipe organ, then source **30** may take one or more of several alternative forms. For example, source **30** may be a current source having an output current of comparatively small amplitude but which sinusoidally varies at a vibrato rate, usually between 5 and 8 cycles per second. In accordance with the invention, oscillators **21** are so constructed that a periodically small varying current applied thereto from source **30** is effective to result in a convincing vibrato effect being developed in the ultimate audio output.

The actuating means also include a series of "stops," only the key switch portions **29–32** of which are illustrated in the drawing. The movable stops are positioned adjacent the playable keyboard in conventional fashion and allow the player of the instrument to selectively energize the master oscillators by connection of an associated switch to ground bus **33**. Since, as previously stated, master oscillator **11** provides a pair of distinct output signals which are carried respectively by output leads **18** and **19**, switch **29** is ganged for operation with a pair of similar switches **34**, **35** which are connected in series between respective ones of the output leads of oscillator **11** and output terminal **16**. As shown in the drawing, switch **29** is in its open position and is movable between a first and second closed position, the first closed position being effective to only close contact **35** while its second closed position opens contact **35** and closes contact **34**.

The signals from note generators **21** and the reference frequency signals in the several master oscillators are coupled by corresponding output leads **25**, **16** to a heterodyning means or mixer **37** while additively combines these signals in conventional fashion. If desired, mixer **37** may also include a frequency selective amplifier for increasing the amplitude of the harmonics of the note signal generators or master oscillators relative to their primary signal frequency. At any rate, the combined signal from mixer **37** is conveyed to an amplitude detector and low pass filter **38** and from there to a pre-amp **40**. In accordance with conventional heterodyne detection principles, the output of detector **38** constitutes solely the difference or beat frequencies of the signals applied to mixer **37** along conductive leads **16** and **25**. Thus, if a pure sinusoidal waveform of the reference frequency is applied to lead **16** from oscillator **11** while a pure sinusoidal waveform from the labeled note generator **21** is applied to lead **25**, then the output of detector **38** will constitute solely the difference of these two frequencies, namely, the note C. On the other hand, either or both of the reference frequency and the note frequency sources may also include harmonics of their respective fundamentals. These harmonics combine to create a multiplicity of minor beat frequencies which are developed at the output of detector **38**. The harmonics are generally of a lesser amplitude than their corresponding fundamental frequencies and the detected beat frequencies of these harmonics will maintain this correspondence in amplitude. The minor beating of harmonics among themselves and with the fundamental tones are in a large measure responsible for the rich and distinctive quality of the pipe organ.

The output of pre-amp **40** is coupled to a conventional audio amplifier **41**. Only audio frequency information is coupled to amplifier **41** by virtue of the low pass filter included within detector **38**. Amplifier **41**, in turn, coupled to a series of loud speakers **43–45** which are arranged to create a spatial illusion similar to that of a series of ranks of organ pipes. If desired, the loud speakers may be preceded by filters such that each speaker reproduces only an assigned portion of the audio spectrum and the speakers again spaced to simulate the spacing of their corresponding pipe organ ranks.

Referring now to FIG. 2, there is shown a schematic diagram of a preferred magnetostriction oscillator construction of the invention which is useful in the note signal generator and master oscillator arrangements of FIG. 1. Specifically, this oscillator comprises a pair of transistors **47**, **48** of the PNP type having respectively a forward and a feedback signal translation path coupled therebetween. More specifically, the collector electrode of transistor **47** is coupled to a B— supply by a load resistor **49**. The collector electrode of transistor **47** is also coupled to the base electrode of transistor **48** by a forward signal translation path constituting a DC blocking capacitor **50** coupled in series with a diode **51** and a second DC blocking capacitor **52**. The cathode of diode **51** is coupled to capacitor **50** and also to a B— supply through a current

limiting resistor **53**. The anode of diode **51** is likewise connected to a B— supply through a current limiting resistor **54** and to ground through a discharge capacitor **55**. The anode of diode **51** is further connected by a signal attack time determining resistor **56** to a single-pole, single-throw switch **58** which may constitute the connection to keying source **30** in the case of the not signal generators or a portion of a stop switch in the case of a master oscillator.

Transistor **48** is provided with an operating bias for its base electrode from the center tap of a voltage dividing network constituting a pair of series resistors **60**, **61** which extend between B— and ground. The collector electrode of transistor **48** is returned to its base electrode through a phase connection network comprising a series combination of a capacitor **62** and a resistor **63**. The collector of transistor **48** is also coupled to a B— supply through a coil **64** which is magnetically coupled to a magnetostrictive element **65**. Magnetostrictive rod **65** is supported at its nodal point **66** and its opposite end communicates with the magnetic flux of a similar coil **68**. The end terminals of coil **68** are connected across a resistor **70** which is connected respectively between the base electrode of transistor **47** and the center junction of a voltage divider network constituting series resistors **71** and **72** extending between a B— supply and ground.

The oscillator is normally inoperative due to a negative bias applied to the anode of diode **51** through resistor **54**. However, closing of key switch **58** relieves this bias and permits the oscillator to function. The resultant initiation of current flow in the collector circuit of transistor **48** generates a magnetic field within coil **64** and ultimately causes a compressive wave to be propagated down the magnetostrictive rod **65**. When mounted at its nodal point **66**, rod **65** has a characteristic resonant frequency of vibration which is defined solely by the length of the rod; the rod heavily damps applied signals of other frequencies. Hence, the rod invariably vibrates at its resonant frequency and induces a corresponding alternating current into coil **68** which in turn applies this signal to the base of transistor **47**. The compressive wave of rod **65** is also reflected toward its source end adjacent coil **64** and reinforces the signal appearing on the collector of transistor **48**. Since, as stated, rod **65** tends to depress induced vibrations at other than its resonant frequency the frequency of oscillation is substantially independent of the value of any of the components in this circuit and is only dependent upon the physical parameters of the magnetostrictive rod and to a very minor extent upon changes in temperature. However, in accordance with the present invention, such temperature generated changes in resonant frequency have little or no effect on the frequency of the reproduced signal. This is because the magnetostrictive rods for the note generators and the master oscillators differ only by a relatively small amount in length. Thus, changes in temperature effect the rods of both oscillators to an almost identical degree and are effectively cancelled out in the mixing circuit **37**.

In accordance with the present invention, the oscillator of FIG. 2 provides a pair of output signals corresponding respectively to a pure sinusoidal wave-form at the selected frequency of oscillation and to a half-wave rectified component of this signal. These distinct outputs are obtained by the relatively simple expedient of including a diode **51** in the forward conduction path between transistors **47** and **48**. Thus, the signal applied to transistor **48** includes the primary frequency and harmonic multiples thereof, the DC components of the rectified signal being blocked by capacitor **52**. Since rod **65** is substantially only responsive to its natural resonant frequency, the presence of these harmonics does not impair the stability of the oscillator or detune it in any manner. However, the rectified waveform may be recovered across an emitter resistor **74** of transistor **48** and an output terminal **75** is provided for this purpose. On the other hand, a pure sinusoidal waveform is available across an emitter resistor **77** of transistor **47** and an output is taken therefrom at a terminal **79**. Thus, diode **51** serves both as a means for which to back bias or turn off the oscillator as well as a means to provide a signal having a primary component at the selected fundamental frequency but with extensive harmonic content.

The illustrated oscillator is also constructed to provide a predetermined time delay in its response to both closing and opening of the key switch **58** to thereby simulate the "attack" and "sustain" characteristics of a pipe organ. Specifically, capacitor **55** is normally charged to the B— potential but upon closing of switch **58**, the potential at the anode of diode **51** increases at a rate determined by the time constant of capacitor **55** and resistor **56**. Similarly, when switch **58** is opened, the time constant of elements **54**, **55** determines the interval necessary to effect a back on reverse bias of diode **51** and render the oscillator inoperative.

In addition to providing the foregoing features, the present invention provides means for rendering the magnetostrictive oscillator capable of providing a tremulant effect or a slight wavering in frequency of a note. This is accomplished by mounting a permanent magnet **81** about a rotational axis **82** in a position adjacent the magnetostrictive rod **65**, as indicated schematically in the drawing. Rotation of permanent magnet **81** at a predetermined slow rate, for instance, at two cycles per second or less alters the flux coupled to rod **65** and thus modulates the frequency of the oscillator in proportion to the rotational rate of the permanent magnet. A like result may be attained by using a flux gate coupled to coil **64**.

The magnetostriction oscillator here described also offers the advantage that at very low audio frequencies fine tuning may be readily accomplished by merely decentering the magnetostrictive element from its center or nodal point. In this regard, tuning of one master oscillator either slightly sharp or flat and then concurrently connecting this and one other master oscillator to mixer **37** provides a celeste or chorus effect in the ultimate audio reproduction.

The note signal developing circuit **10** of FIG. 1 is illustrated in detail in FIG. 3. Specifically, common output lead **25** of the note signal generators is coupled to the actual mixing or heterodyning state **37** through a frequency selective amplifier **37***a*, enclosed within a dashed outline in the drawing. It is the function of frequency selector amplifier **37***a* to increase the amplitude of the harmonic components of a note signal applied to lead **25** relative to the fundamental or primary note signal. This circuitry, if provided, is included within the box **37** of FIG. 1, and to indicate this it has been given the same primary reference numeral as the mixer. Specifically, amplifier **37***a* comprises a pair of PNP transistors **84** and **85** connected as series Class A amplifiers. The base electrodes of these transistors are provided with the usual operating biases from the center junctions of respective voltage divider networks while their collectors are coupled by individual load resistors to a B— operating supply. The emitter of transistor **84** is coupled by a frequency selective network **87** to a ground or reference potential. Network **87** comprises a resistor coupled in shunt to a serially connected resistor and capacitor. Similarly, transistor **85** is provided with a frequency selective network **88** coupled from its emitter electrode to a ground or other reference potential. This network comprises a resistor shunted by a bypass capacitor. As is well understood in the art, networks **87** and **88** have a progressively decreasing degenerative effect as the signals applied to their associated amplifiers progress upwards in frequency. Thus, the harmonics developed at output terminal **90** of frequency selective amplifier **37***a* are materially increased in amplitude relative to the lower fundamental note frequency.

Output terminal **90** of amplifier **37***a* is coupled to the base electrode of a PNP transistor **91** of mixer **37**. The

base of transistor **91** also receives an input from lead **16** of the master oscillator bank through an impedance matching stage **37***b*. Stage **37***b* is likewise a part of the basic mixer circuit and comprises a PNP transistor **93** having its base electrode coupled to lead **16** through a conventional DC blocking capacitor. Transistor **93** is connected to function as an emitter-follower and for this reason its collector electrode is directly connected to a B— supply while its emitter electrode is coupled through a load resistor **95** to ground. An output is taken across resistor **95** and is connected through a series resistor-capacitor network to the base electrode of transistor **91**.

Transistor **91** is connected to function as a conventional Class A amplifier and the output from its collector electrode is coupled to the base of a succeeding transistor **98** of the PNP type which is arranged in an emitter-follower configuration. The emitter of transistor **98** is coupled to ground by the parallel combination of a resistor **99** and the primary winding of a transformer **100**. The primary winding of transformer **100** comprises a portion of a conventional amplitude modulation detector **38**. Detector **38** further comprises a pair of similarly poled diodes **101** and **102** having their anodes connected to opposite terminals of a secondary winding of transformer **100**; the center tap of the secondary winding is connected to ground. The cathodes of diodes **101** and **102** are also connected to ground through a common load resistor **104**. The common cathode junction of the diodes is also coupled to an input lead **106** of preamplifier **40** through a low pass filter comprising a series resistor **107** and a shunt capacitor **108**, as well as a series DC blocking capacitor **110**.

The preamplifier comprises a pair of PNP transistors **112** and **113** connected to function as a pair of series amplifiers of the Class A type. An output terminal **115** of the preamp is connected to an audio amplifier **41** of FIG. 1.

In now considering the overall operation of the circuit of FIG. 1, it will be understood that each of the note signal generators **21** may be connected so as to provide, upon energization, either a pure tone or a half-wave rectified component of its tone frequency. It will further be appreciated that these note signal generators may permanently provide either of these signals or that conventional switch means may be positioned adjacent to the keyboard so as to allow the one playing the instrument an opportunity to select the desired signal output from the note generators. Of course, it is preferred that all the note generators provide at a given time only a sinusoidal output or only a complex waveform. At any rate, depression of the keys on the playable keyboard selectively energize the corresponding note signal generators to provide signal outputs which are carried by common bus **23** to a lead **25** of mixer **37**.

Similarly, for each octave range of note signal generators as shown in FIG. 1, there is provided a master oscillator complex which provides reference signals of various waveforms but of a single predetermined fundamental frequency. A selected one or more of these oscillators is rendered operative by closing its corresponding stop switch **29–32** to provide a reference signal of the fundamental frequency to mixer **37** through conductive lead **16**. The signals on lead **16** and **25** are combined or added in conventional fashion in the mixer and are conveyed ultimately to the amplitude modulation detector and low pass filter of block **38**. It is preferred that the nominal tuned frequencies of all of the oscillators be in the superaudible range, for example between 20 kHz. and 75 kHz., for ease in construction of the oscillator and for best frequency stability. In accordance with well understood heterodyne detection, only the difference or beat signal frequencies are developed at the output of the detector. By virtue of the frequency relation between the master oscillator and the tone signal generators of its corresponding octave or rank, the signals developed at the output of detector **38** correspond to the selected musical tone and a series of harmonics thereof which are present in a predetermined weighted relationship as established by the relative amplitude of the corresponding harmonics of the reference frequency and of the note frequency sources. The low pass filter within detector **38** bypasses all signals above the audio range so as to avoid overloading of amplifiers **40**, **41**. The fundamental tone and the harmonics are reproduced by loudspeakers **43–45**.

Thus, the present invention although using only a relatively few number of original sources provides a multitude of harmonics of a given tone which effects a convincing simulation of the multiplicity of minor beat signals produced by the sounds in the individual pipes of a pipe organ. Furthermore, the circuit of the invention utilizes magnetostriction oscillators of a novel circuit configuration which provides considerable economies of construction while also providing a reliability and frequency stability superior to prior art circuits. Furthermore, since all of the oscillators vary substantially identically in response to changes in environmental conditions and since applicant has coupled these oscillators in a unique mixing or heterodyning circuit, the changes in frequency attributable to environmental conditions is effectively cancelled out. In addition, the organ system of the invention provides a full range of characteristic organ effects at the option of the user.

While a particular embodiment of the present invention has been shown and described, it is apparent that the changes and modifications may be made therein without departing from the invention in its broader aspects. The aim of the appended claims, therefore, is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. An electronic musical instrument for simulating the tonal qualities of a pipe organ, comprising:

reference frequency means including a magnetostriction oscillator tuned to a predetermined fundamental frequency;

a plurality of note signal generators each comprising a magnetostriction oscillator tuned to a respective preselected fundamental frequency corresponding to to the sum of said predetermined reference frequency and the frequency of a note of the musical scale to be reproduced;

actuating means including a playable keyboard for selectively energizing said note signal generators and said reference frequency means;

heterodyning means of combining the signal outputs from said note signal generators and said reference frequency means;

detection and low-pass filter means, coupled to said heterodyning means, for developing only the audio beat frequencies of the signals applied to said heterodyning means; and

audio reproducing means coupled to said detection and filter means.

2. The combination according to claim **1** in which the signal output of each of said note signal generators also includes harmonics of said preselected frequency.

3. The combination according to claim **2** in which said heterodyning means includes a frequency selective amplifier for increasing the amplitude of said harmonic signal components relative to said preselected frequency signal.

4. The combination according to claim **3** in which each of said magnetostriction oscillators of said note generators comprises a pair of transistors having respectively a forward and a feedback signal translation path coupled therebetween, a diode coupled in said forward signal translation path and individual signal output terminals coupled to said transistors, and at least one of said output terminals being coupled to said actuating means, for respectively developing only said preselected frequency and a complex waveform constituting said preselected frequency as half-wave rectified by said diode.

5. The combination according to claim 4 in which said magnetostriction oscillators each include a magnetostrictive element supported at a nodal point and having a resonant frequency equal to said preselected frequency and in which said pair of transistors each include emitter, base and collector electrodes and in which said magnetostrictive element is coupled in said feedback path between a collector electrode of one of said transistors and a base electrode of the other of said transistors and said diode is coupled between a collector electrode of said other transistor and a base electrode of said one transistor and further in which said individual signal output terminals are coupled to respectively an emitter electrode of said other transistor and an emitter electrode of said one transistor.

6. The combination according to claim 5 in which said magnetostriction oscillators of both said note signal generators and said reference frequency means are substantially identical excepting that said magnetostrictive elements of said oscillators are of a length corresponding to the desired tuned frequency of the several oscillators.

7. The combination according to claim 6 in which all of said magnetostriction oscillators are tuned to superaudible frequencies.

8. The combination according to claim 2 in which said reference frequency means includes additional oscillator means for providing output signals of preestablished complex waveforms of differing harmonic content but having fundamental frequencies equal to said predetermined reference frequency.

9. The combination according to claim 8 in which said additional oscillator means comprises oscillators for providing output signals of respectively a square, a sawtooth and a pulse waveform, each of said output signals having a repetition rate equal to said predetermined reference frequency.

10. The combination according to claim 9 and further including permanent magnet means for varying the tuned frequency of said reference frequency means at a predetermined slow rate and within a range of ten cycles per second on either side of said tuned frequency.

11. The combination according to claim 10 in which all of said magnetostriction oscillators include a resistance-capacitance discharge circuit for providing a time delay decay in amplitude of a note simulative of that provided by a pipe organ.

12. The combination according to claim 11 and further including vibrato means for providing an alternating current to said note signal generators which varies in amplitude at a predetermined vibrato rate and in which all of said magnetostriction oscillators include time delay means for providing a predetermined delay in the responsiveness of a note simulative of the attack characteristics of a pipe organ.

13. In an electronic organ of the type comprising a reference frequency oscillator, a plurality of note signal generators each having a preselected fundamental frequency output corresponding to the sum of the reference frequency and the frequency of a note of the musical scale to be reproduced and a series of harmonies of said fundamental frequency in varying amplitudes, and a mixing and reproduction circuit for combining the signal outputs from said note signal generators and said reference means to provide audio signals corresponding to the beat frequencies of said reference means and said note signal generators, the improvement comprising:

a frequency selective amplifier for substantially equalizing the amplitude of said harmonics provided at the output of said note signal generators.

References Cited

UNITED STATES PATENTS

2,478,973	8/1949	Mahren	84—1.23 X
2,996,685	8/1961	Lawrence	84—1.15 X
3,398,230	8/1968	Park	84—1.25 X

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