United States Patent

[11] **3,609,204**

[72] Inventor **Richard H. Peterson**
11748 Walnut Ridge Drive, Palos Park, Ill. 60464

[21] Appl. No. **864,026**
[22] Filed **Oct. 6, 1969**
[45] Patented **Sept. 28, 1971**

[54] **VIBRATO SYSTEM FOR ELECTRICAL MUSICAL INSTRUMENT**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **84/1.25**
[51] **Int. Cl.** ..... **G10 h 1/04**
[50] **Field of Search** ..... 84/1.25, 1.24, 1.01, DIG. 4

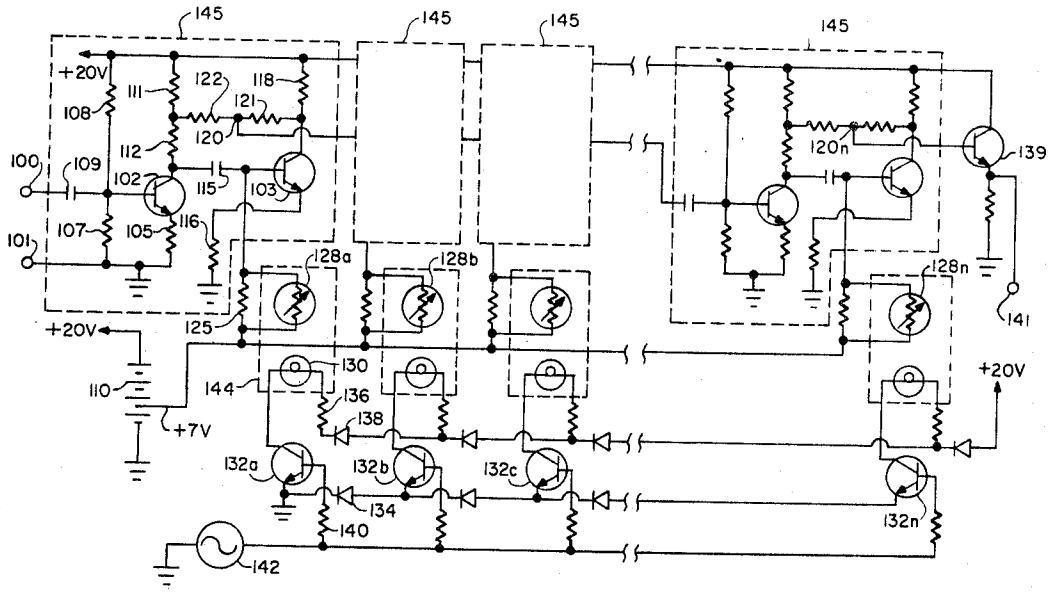
[56] **References Cited**

UNITED STATES PATENTS

3,160,695	12/1964	Bonham	84/1.25
3,256,380	6/1966	Meinema	84/1.25
3,288,907	11/1966	George	84/1.25
3,336,432	8/1967	Hurvitz	84/1.25
3,418,418	12/1968	Wilder	84/1.25
3,516,318	6/1970	Wayne	84/1.25

Primary Examiner—D. F. Duggan
Assistant Examiner—R. Skudy
Attorney—Donald H. Sweet

ABSTRACT: The invention relates to systems for imposing vibrato effects on electrical signals, as from the output of an electronic organ, electric guitar or other electrical musical instrument. A series of resistance-capacitance (RC) phase-shifting networks are connected in cascade, each of which, when enabled, is capable of producing a predetermined phase shift at any given frequency. The phase shift produced by all of the individual networks is cumulative. The individual phase-shifting networks are sequentially enabled seriatim, and then disabled seriatim, to produce a close approximation to true frequency modulation.



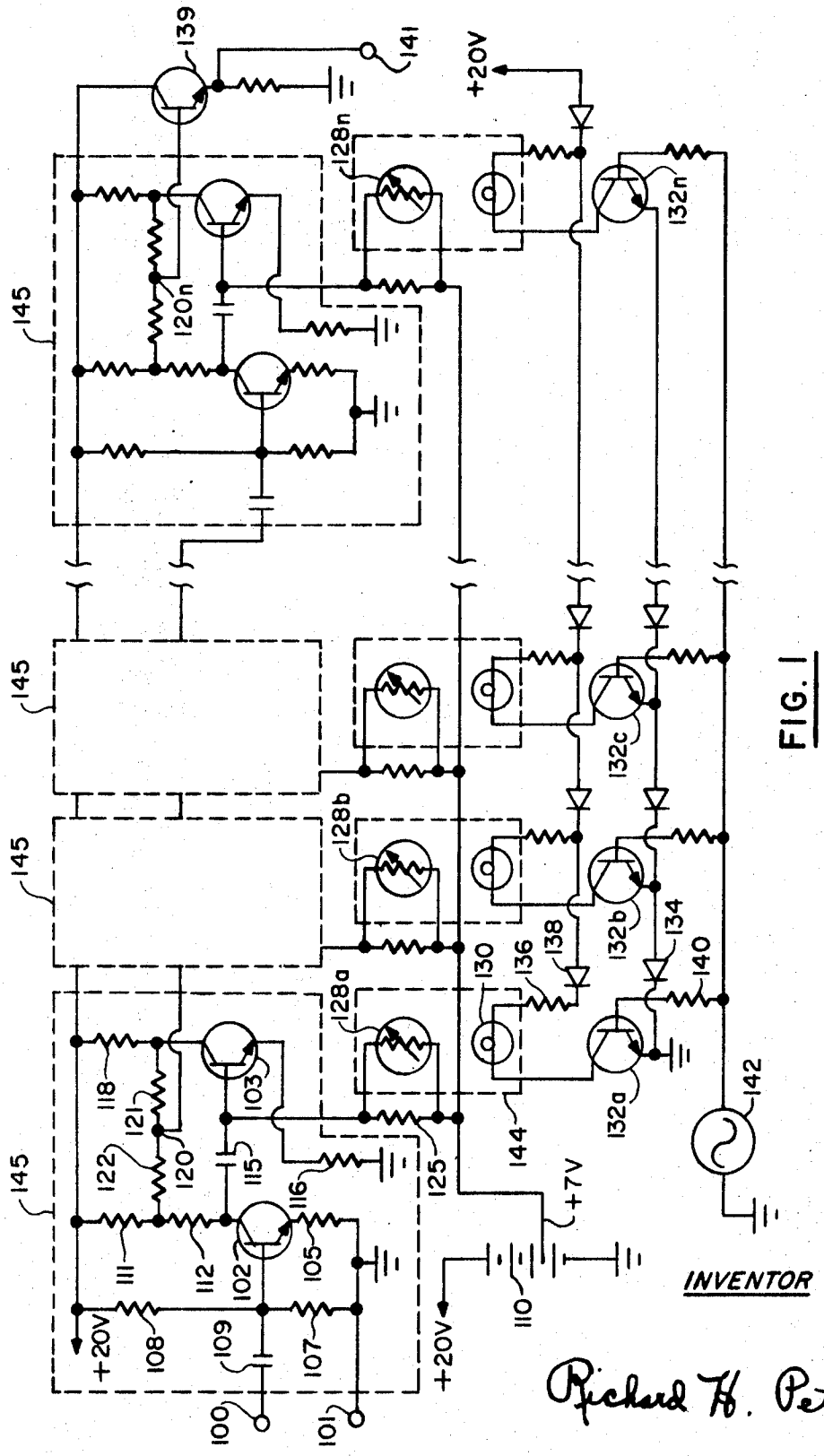


FIG. 1

INVENTOR

Richard H. Peterson

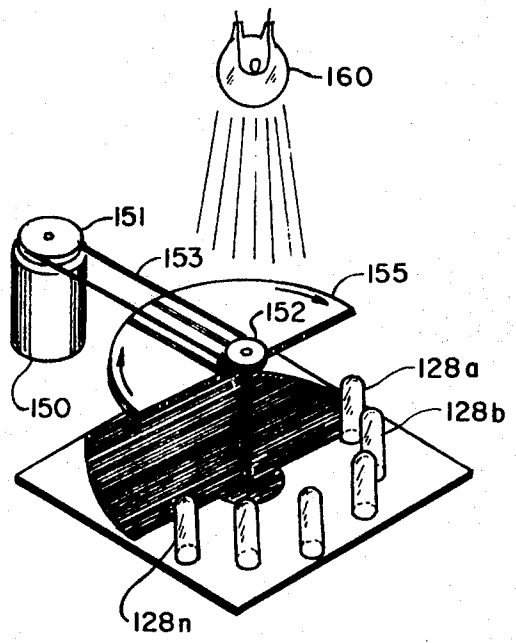


FIG. 2

INVENTOR

Richard H. Peterson

VIBRATO SYSTEM FOR ELECTRICAL MUSICAL INSTRUMENT

It is generally recognized that many kinds of music are enhanced by frequency modulation of the tones at a rate of about 5 to 7 cycles per second. It is common practice in musical instruments, such as electronic organs, to provide the vibrato effect by periodically shifting the frequency of the oscillators over the desired range of about plus or minus 2 percent. Some types of tone generators, however, are not capable of being easily shifted in frequency. In addition, where the tone generator itself is modulated it necessarily follows that all tones derived therefrom will have the same vibrato effect. It is common in electronic organs to derive many different stops from a common tone generator, and it is highly desirable that vibrato be selectively applied to the various stops and manual divisions.

It is therefore an object of the invention to provide a means for applying a vibrato effect to any musical tone signal regardless of its origin.

It is another object of the invention to provide a vibrato effect on certain signals derived from an electrical tone generator and

a different vibrato effect, or no vibrato at all, on other signals simultaneously derived from the same tone generator.

The above objectives are accomplished by the use of a series of RC resistance-capacitance phase-shifting networks connected in cascade, and by sequentially enabling the individual networks to become effective seriatim, and then ineffective seriatim, in a cycle of vibrato frequency.

In the accompanying drawings:

FIG. 1 is a schematic circuit diagram of a vibrato system according to the invention.

FIG. 2 is a mechanical, photoelectric, sequential switching device for use in one form of the invention.

Referring first to FIG. 1, terminal **100** is an input terminal to which any signal, to which it is desired to add a vibrato effect, is connected. This terminal is the input terminal of a phase shift network including transistors **102** and **103**, and having an output terminal **120**. Transistor **102** is a common emitter amplifier including emitter resistor **105** and bias resistors **107** and **108**. Signal from the input terminal **100** is applied to the base of transistor **102** through coupling capacitor **109**. The collector of transistor **102** is connected to a DC potential source **110** through resistors **111** and **112**. This amplifier has a small voltage gain and thus any signal applied to input terminal **100** will appear on the collector of transistor **102** slightly amplified. This amplified signal is applied to the base of transistor **103** through coupling capacitor **115**. Transistor **103** is a split load phase inverter including emitter resistor **116** and collector resistor **118**, which resistors may be of equal value. The signal appearing at the collector of transistor **103** will be reversed in phase from the signal at the collector of transistor **102**. Signals from the collector of transistor **103** from the junction of resistors **111** and **112** are applied to output terminal **120** through resistors **121** and **122**. Bias for transistor **103** is provided by way of resistor **125** connected to the plus 7-volt tap on power supply **110**. A variable impedance element **128*a*** is connected between the base of transistor **103** and the plus 7-volt terminal of the power supply.

The circuit just described constitutes the well-known resistance-capacitance phase shift network commonly called RC. It is capable of shifting the phase of any signal applied to input terminal **100** by an amount of up to 180° depending upon the frequency, and depending upon the reactance of the capacitor **115** and the resistance of the variable resistor **128**. By selecting the magnitude of these components such that the maximum possible phase shift of 180° occurs at the highest audio frequency which it is desired to pass, the phase shift at lower frequencies will be substantially proportional to frequency. If the impedance of resistive element **128** is cyclically varied at a vibrato rate, a vibrato will be applied to the signal having a frequency deviation of about 0.2 percent. This is not a sufficient frequency deviation to be a useful vibrato,

except for certain types of liturgical music where a very subtle vibrato is desired. The effect, however, can be multiplied to any desired degree by connecting additional similar phase shift networks in cascade. I have found that a series of from four to 12 networks can produce vibrato effects appropriate to almost any type of music.

If, however, the impedances of the elements **128*a–n*** are varied in synchronism, the vibrato will be extremely "choppy" and the envelope of the modulating frequency will not be sinusoidal at low frequencies even though the impedance of the devices **128** is caused to vary in a sinusoidal manner. To achieve a vibrato having the desired characteristics, and which for example may be sensibly totally equivalent to true frequency modulation, the impedances **128** are switched seriatim in such a fashion that at a given time in the modulating cycle the first impedance **128*a*** changes from a high-impedance state to a low-impedance state. Then at a time equal to 2 /2*n* times the period of the modulating frequency impedance **128b** switches from its high-impedance state to its low-impedance state; and at time 3 /2*n* times the period, impedance **128*c*** switches; and so on until all of the impedances are in their "on" or low-impedance condition. Then the cycle reverses and the impedances are switched off seriatim. The resultant collective phase shift applied to the input signal, although it occurs in a series of discreet increments, will sound the same as if the phase shift was applied gradually to all frequencies throughout the modulating cycle. I have discovered that with as few as four stages the smoothness is substantially identical to the smoothness of ordinary frequency modulation.

The output terminal **120*n*** is connected to the base of a transistor **139** connected as an emitter follower and having an output terminal **141**. The seriatim switchings of the impedances **128** is accomplished by the switching on and off of lamps **130** associated with each of the photoresistors **128**. Associated with each lamp **130** is a lamp-switching transistor **132**. The emitter of transistor **132*a*** is connected to ground and the emitter of each transistor **132** *b-c-d*, etc. is connected to a slightly higher potential as determined by the forward voltage drops across the series connected diodes **134**.

The collector circuit of each switching transistor includes its associated lamp **130**, resistor **136** and diode **138**. The diodes **138** are connected in series to the plus 20-volt power supply. The base of each of the transistors **132** is connected through a resistor **140** to the subaudio frequency oscillator **142** which produces an AC potential having a frequency of the desired modulating frequency. Whenever the base of a given switching transistor **132** is more positive than its emitter the transistor is switched to its conducting state and its associated lamp will light. Since the emitters of the transistors **132** are all at slightly different potentials, due to the voltage drops across the diodes **134**, the transistors will not switch simultaneously, but will switch in the desired sequential fashion. The diodes **138** are for the purpose of maintaining the voltage across all of the lamps uniform so that all of the lamps light with equal intensity. It is of course necessary that each photoresistor **128** be shielded from light from all but its own lamp and to accomplish this a light shield **144** is provided for each lamp and photoresistor combination.

FIG. 2 shows an alternate arrangement for causing the individual photoresistors **128** to switch in a suitable sequence. Light from a source **160** is associated with a shutter **155** which is rotated at a vibrato rate by the motor **150** by means of a drive belt **153** and pulleys **151** and **152**. The shutter is opaque, so that as it rotates one-half revolution it sequentially blocks off light to one photoresistor **128*a-b-c-n*** after another; and then during the other half revolution it sequentially exposes them in the same order.

To carry out the broad principle of the invention still other types of switching devices may be substituted as it is not necessary to use photoresistors. Reed relays and semiconductor switching devices for example have been successfully employed.

Others may readily adapt the invention for use under various conditions of service by employing one or more of the novel features disclosed or equivalents thereof.

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

1. A phase shift vibrato system for electrical musical instruments comprising:

a pair of input terminals and a pair of output terminals;

a series of individual RC phase-shifting networks connected in cascade between said input and output terminals, each network capable of producing a predetermined phase shift at any given audio frequency;

all of said individual phase-shifting networks acting in the same sense to produce a cumulative phase shift on signals appearing at the output terminals as compared with signals applied to said input terminals;

a plurality of first means associated respectively with said plurality of individual phase-shifting networks for changing the phase shift produced by said networks;

and second means for enabling said plurality of first means seriatim and then disabling said first means seriatim;

said second means operating at a vibrato rate.

2. A vibrato device for use with an electrical musical instrument comprising:

a pair of input terminals and a pair of output terminals;

a plurality of RC phase-shifting networks connected in cascade between said input and output terminals, each capable of producing a predetermined phase shift at any given audio frequency, and acting in the same sense to produce a cumulative phase shift in signals appearing at the output terminals as compared to signals applied to said input terminals;

means for sequentially modifying at a vibrato repetition rate, the phase-shifting characteristics of said plurality of phase-shifting networks such that each has its phase-shifting characteristic modified for a fraction of each vibrato cycle, said function being different for each of said phase-shifting networks.