April 22, 1969 H. O. SCHWARTZ ET AL 3,440,325

TRANSISTORIZED HARTLEY OSCILLATOR TONE GENERATOR CIRCUIT PRODUCING GLISSANDO AND VIBRATO EFFECTS BY VOLTAGE DETUNING

Filed Jan. 27, 1964

Fig. 1

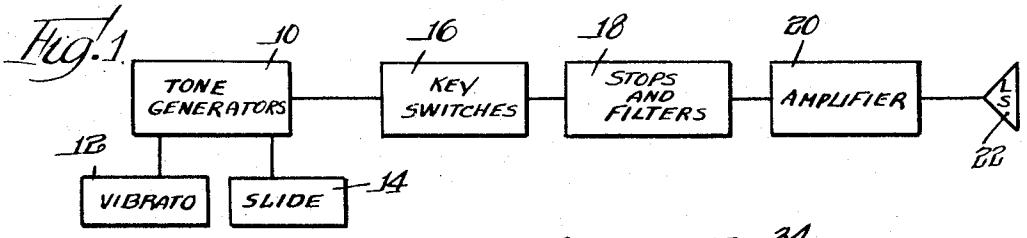


Fig. 2

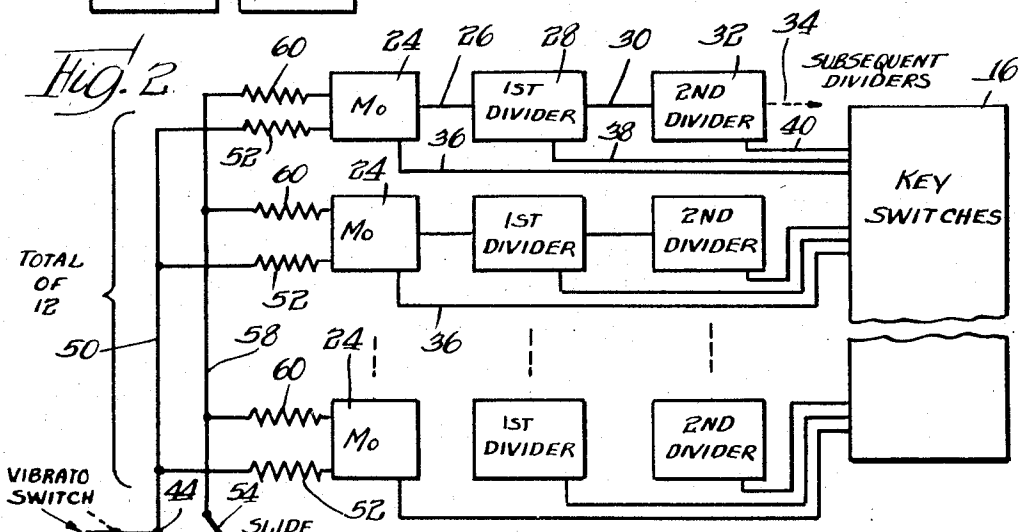
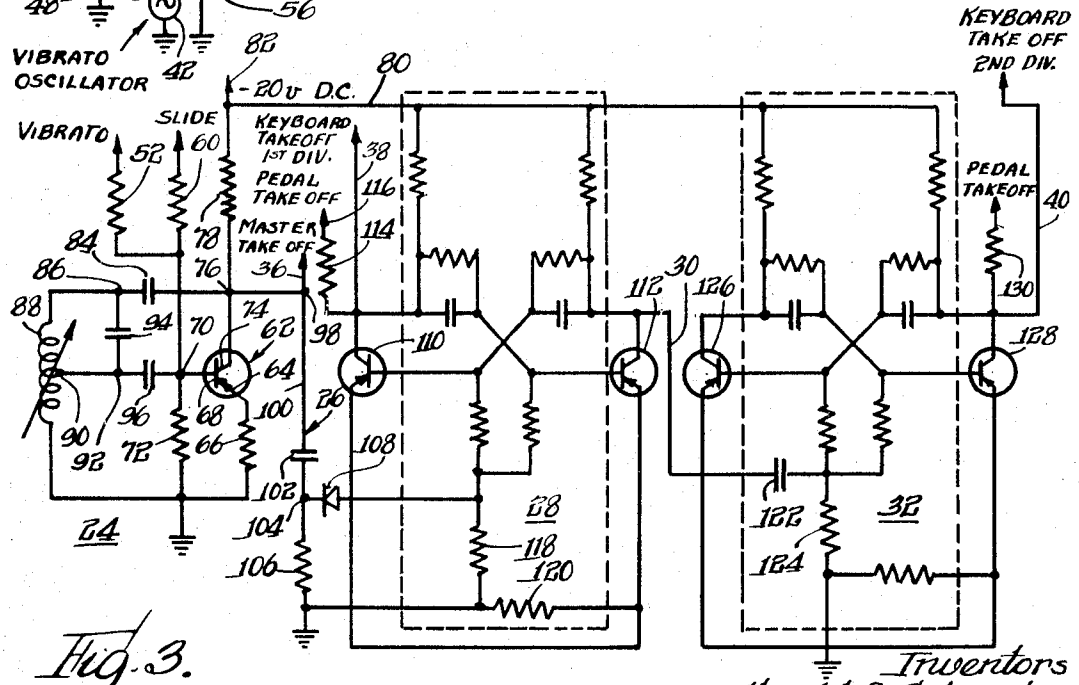


Fig. 3



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United States Patent Office

3,440,325

Patented Apr. 22, 1969

3,440,325

TRANSISTORIZED HARTLEY OSCILLATOR TONE GENERATOR CIRCUIT PRODUCING GLISSANDO AND VIBRATO EFFECTS BY VOLTAGE DETUNING

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Filed Jan. 27, 1964, Ser. No. 340,274

Int. Cl. G10h *1/04*

U.S. Cl. 84—1.25 4 Claims

ABSTRACT OF THE DISCLOSURE

An electronic musical instrument, such as an organ, having transistorized tone generators and having provision for varying the voltage applied to the base of each master oscillator to detune the oscillators to produce vibrato and glissando or slide effects.

This application relates to the electronic musical art, and more particularly to an improved oscillator for producing vibrato and glissando or slide effects.

Various types of electronic musical instruments are well known, particularly keyboard instruments generically referred to as electronic organs. Various tone generators are known therefor, some being monophonic in which only a single tone is generated at a time, and some being polyphonic, wherein a plurality of tones is sounded. The most desirable and practical type of such a keyboard instrument has been found to be one in which a complete octave of master oscillators is provided with various strings of controlled or slave divider oscillators for producing subharmonics or suboctaves thereof. It has been found that the musical tones produced by instruments of this type can be made more pleasing by the provision of means for producing a vibrato wherein the tone is frequency modulated. As stated otherwise, the nominal frequency of the tone is first made flat, and then sharp at a sub audio rate, preferably on the order of about seven cycles per second. It also has been discovered that certain types of music, as a Hawaiian guitar, can best be produced with the addition of means for producing a glissando or portamento effect, sometimes known as a slide.

Accordingly, it is an object of this invention to provide oscillator or tone generating means for an electronic musical instrument with means for producing a vibrato or a slide effect.

More particularly, it is an object of this invention to provide a transistor oscillator with means for controlling detuning thereof to produce vibrato and slide effects.

Other and further objects and advantages of the present invention will be apparent from the following description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a block diagram of an electronic musical instrument constructed in accordance with the present invention;

FIG. 2 is a diagram illustrating the tone generators in somewhat greater detail, somewhat combining the features of a block diagram and of a wiring diagram; and

FIG. 3 is a fragmentary wiring diagram of the oscillators constructed in accordance with the present invention.

The general organization of an electronic musical instrument constructed in accordance with the present invention will be seen with reference to FIG. 1. There is a series of tone generators designated generally by the numeral **10**, each of which has connected thereto a vibrato **12** and a slide **14**. The tone generators lead through a series of key switches **16** respectively controlled by the keys of one or more manuals of an instrument, and also by a pedal board, if so desired. The electronic oscillations corresponding to the tones which are passed or controlled by the key switches are applied to appropriate stops and filters **18**, and the filtered oscillations are applied to an amplifier **20**. The amplifier is connected to a loudspeaker **22** or the like for converting the amplified electronic oscillations into audible musical tones.

Referring now to FIG. 2, there will be seen a plurality of master oscillators **24**. Conveniently, there are 12 such master oscillators, comprising the top octave, including semi-tones. Each master oscillator **24** is coupled at **26** to a first divider **28**. The first divider **28** in each instance is connected at **30** to a second divider **32**. As will be appreciated, each divider halves the frequency of oscillations provided to it, thereby providing the same note one octave lower. As is illustrated in FIG. 2, there is one master oscillator, a first divider, and a second divider for each note, thus providing three octaves of tone. As will be appreciated, the number of dividers can be strung out indefinitely, depending on the number of octaves desired, and a coupling for subsequent dividers is indicated at **34**.

As will be appreciated, all of the master oscillators and dividers comprise the tone generators **10** indicated in FIG. 1. Each master oscillator is connected at **36** to the key switches, while the first dividers are connected at **38**, and the second dividers at **40** to the key switches.

A vibrato oscillator is indicated generally at **42**, and is shown as being grounded on one side. The opposite side of the vibrato oscillator is connected to a junction **44**, and this junction is connected to a normally closed vibrato switch **46**, the other side of which is connected to ground at **48**, whereby to short out or bypass the output of the vibrato oscillator. The junction **44** also is connection to a vibrato bus **50**, and the vibrato oscillations appear on this bus when the switch **46** is open. It will be appreciated that the vibrato oscillator operates in the range of five to seven cycles per second in accordance with standard practices. The speed may be variable over a limited range, and the amplitude of the vibrato oscillations also may be variable, as is known. Connections are made from the vibrato bus **50** through isolating resistors **52** to each master oscillator to impose the vibrato oscillations thereon, and through the frequency dividers subsequently to provide vibrato on the divider oscillators also.

A slide switch **54** has a grounded fixed contact **56**, and the switch **54** is connected to a slide bus **58**. This bus is connected through isolating resistors **60** to the master oscillators. The exact operation of the slide mech-

anism will be explained hereinafter, but it will be understood that it is provided to obtain sliding effects, often known as portamento or glissando.

The master oscillator comprises a p-n-p- transistor **62** (FIG. 3). The emiter **64** is grounded through a resistor **66**. The base **68** is connected to a junction **70** which is grounded through a resistor **72**. The junction **70** also is connected to the vibrato and slide isolating resistors **52** and **60**.

The collector **74** is connected to a junction **76**. This junction is connected through a resistor **78** to a bias voltage supply line **80** supplied from suitable power supply as indicated by the arrowhead at **82**, and maintained at −20 volts D.C. The junction **76** also is connected through a capacitor **84** to a junction is connected to one end of a tunable inductance **88**, and the other end of the inductance **88** is grounded. The inductance **88** is provided with a tap **90** near the center thereof, and this tap is connected to a junction **92**. A capacitor **94** is connected between the junction **92** and the junction **86**, thus being connected in parallel with substantially half of the inductance **88**. A capacitor **96** is connected between the junction **92** and **70**.

It will be seen that the master oscillator **24** thus comprises a transistorized Hartley oscillator.

The junction **76** is connected to a further junction **98**, and this is connected to a master take off, which for example may comprise the wire **36** leading to the key switches. In this connection, it will be understood that the specific manner of switching is not particularly important to the subject of the oscillators and the vibrato and slide, as herein shown and described. The junction **98** also is connected to the coupling **26** which comprises a wire **100**, a capacitor **102** connected to a junction **104**, a grounded resistor **106** connected to this junction, and a diode **108** likewise connected to the junction **104**.

The first divider oscillator **28** comprises a transistorized flip-flop divider or Eccles-Jordan circuit. The capacitor **102** and resistor **106** act with the diode **108** to provide a more or less square wave input to the divider **28**, and this triggers the divider to operate on every other cycle to produce a frequency half that of the master oscillator. As will be appreciated, the diode **108** provides for applying a synchronizing pulse from the master oscillator to the first divider without the possibility of any signal from the first divider appearing on the master take off.

The first divider comprises a pair of p-n-p- transistors **110** and **112** cross coupled in the usual manner. It is believed that it is not necessary in view of the state of the art to go into the specific connections that are well illustrated in the drawing, nor to assign circuit values thereto, since these will be apparent to anyone skilled in the art. However, it should be noted that the collector of the transistor **110** is connected to a keyboard take off for the first divider, and this may be the same as the wire **38**. This collector also is connected through a resistor **114** to a pedal take off **116**. As will be appreciated, further dividers are used in accordance with conventional practice to provide the pedal tones. It may also be worthy of note to observe that the diode **108** is connected to the top of the grounded resistor **118**, and through similar resistors to the bases of the transistors **110** and **112**. It will also be observed that the emitters are connected through a common grounded resistor **120**.

A connection is made from the first divider to the second divider by means such as a wire **30**. This leads from the collector of the transistor **112** through a capacitor **122** to the top of a grounded resistor **124**, the second divider **32** being similar to the first and in the form of an Eccles-Jordan or flip-flop circuit having a pair of p-n-p- transistors **126** and **128**. Since the output of the first divider **28** is inherently a square wave, it is unnecessary to provide a wave shaping network in the connection from the first divider to the second divider. The second divider also is inherently provided with a square wave output which is taken from the collector of the transistor **128**, as through the wire **40** leading to the key switches, or otherwise to suitable keying mechanisms. An additional pedal take off is provided from the collector of the transistor **128** through a resistor **130**.

The master oscillator **24** produces a substantially sine wave output, and it is for this reason that the square wave producing network comprising the capacitor **102**, resistor **106** and diode **108** must be used in known manner to provide a pulse or square wave properly to trigger the first divider **28**.

It is recognized that transistor oscillators are inherently voltage sensitive. This characteristic is taken advantage of in the present invention wherein the vibrato oscillator **42** causes the bias on the base **68** of the transistor **62** to rise above its normal value, and alternately to drop below its normal value. This causes the oscillator cyclically to be detuned sharp and flat, thereby producing a true frequency vibrato. This in turn, causes the divider oscillators to have a cyclic sharpening and flatting to produce a true frequency shift vibrato therein. It will be apparent that the amount of frequency shift is dependent on the amount of voltage deviation, and that the frequency shift will be proportional to the frequency due to the divider action of the divider oscillators.

The detuning with voltage variation also is taken advantage of in connection with slide or portamento. When the slide switch **54, 56** is closed, the biasing of the base is changed so that the voltage thereon is lowered. This causes all of the oscillators in the instrument to be detuned flat, and preferably the biasing is such that all oscillators are detuned a half tone flat. As soon as the switch **54, 56** is reopened, the voltage comes back up to normal, and the generators return to their normal frequencies, thereby providing a sliding, or portamento or glissando effect from the flattened tone to the nominal frequency thereof. This is effective in producing a tone in the nature of a Hawaiian guitar.

Although the physical location of the vibrato and slide switches has not been specifically shown, the vibrato switch is conveniently placed adjacent one of the organ manuals along with the remainder of the stop tablets. The slide switch is normally in an open position, and conveniently is placed on the conventional swell pedal for operation by a sidewise movement of the foot.

It is to be understood that the specific example of the invention as herein shown and described is for illustrative purposes only. Various changes in structure will no doubt occur to those skilled in the art, and will be understood as forming a part of the present invention in-so-far as they fall within the spirit and scope of the appended claims.

The invention is hereby claimed as follows:

1. A tone generating circuit for an electronic musical instrument comprising a tuned circuit master oscillator having an inductance and a capacitor and including a transistor having a base element, a collector element, and an emitter element, and a string of divider oscillators connected to and controlled by said master oscillator, said master oscillator being susceptible to frequency shifting by voltage variations on one of said elements other than said collector element; said tone generating circuit further including means biasing said one element to a predetermined potential, means for applying a vibrato voltage to said one element of said master oscillator to shift the bias of said one element above and below said predetermined bias to provide a frequency shift vibrato, and means connected to said one element of said master oscillator and including a manually operable switch for varying the voltage on said one element of the master oscillator in one direction only from said predetermined bias to produce a flat frequency shift of said oscillator to effect a slide or glissando effect.

2. A tone generating circuit as set forth in claim **1** wherein said one element comprises said base element.

3. A tone generating circuit as set forth in claim **2**

wherein the means for varying the voltage on the transistor base in one direction only comprises resistance means and means for selectively connecting said resistance means to control the self bias of said transistor base.

4. A tone generating circuit as set forth in claim **1** wherein said master oscillator produces a sine wave output and said divider oscillators produce substantially square wave outputs, and including means connecting the output of said master oscillator to the first of said string of divider oscillators including a square wave producing circuit to produce a synchronizing pulse from said master oscillator to said first divider oscillator, said square wave producing circuit including a resistor, a capacitor, and a diode, said diode further preventing feeding back of divided frequency.

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U.S. Cl. X.R.

84—1.01, 1.04, 1.24