April 16, 1968 J. MARKOWITZ 3,378,624

ELECTRICAL MUSICAL INSTRUMENT WITH TREMOLO

Filed June 25, 1964

FIG. 1

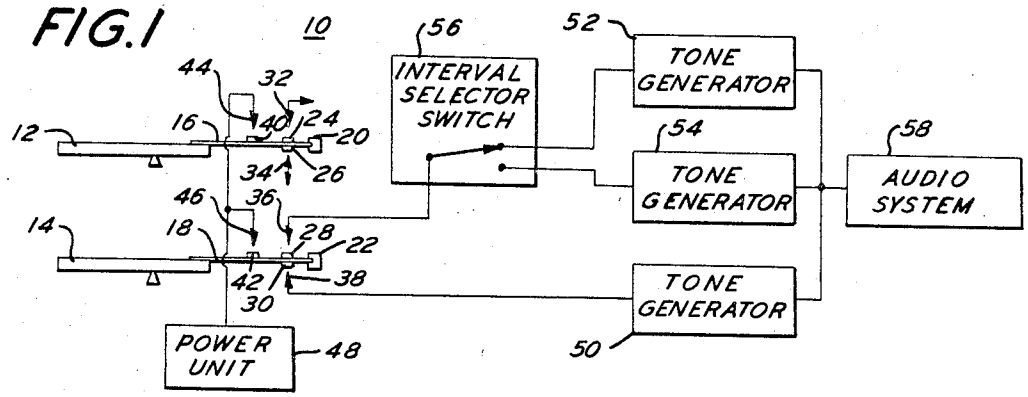
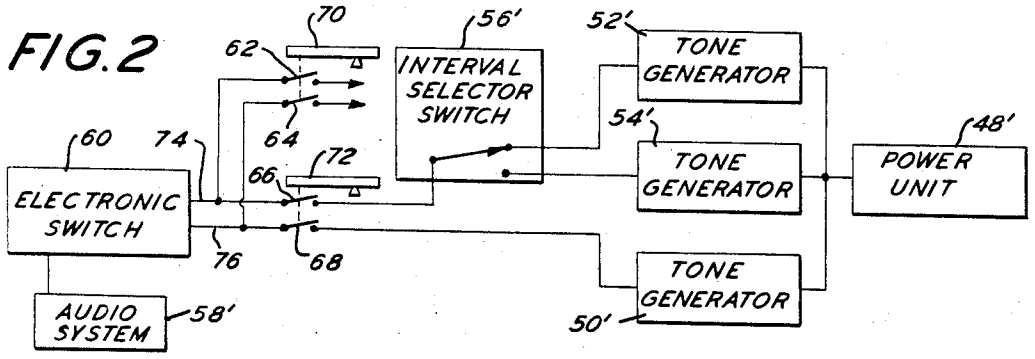


FIG. 2



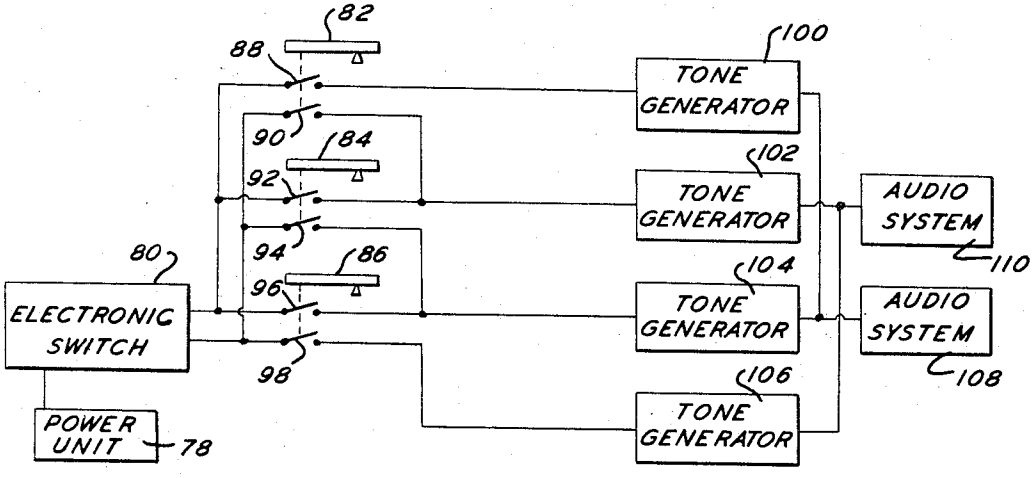


FIG. 3

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United States Patent Office 3,378,624
Patented Apr. 16, 1968

3,378,624

ELECTRICAL MUSICAL INSTRUMENT WITH TREMOLO

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Filed June 25, 1964, Ser. No. 378,022
14 Claims. (Cl. 84—1.25)

ABSTRACT OF THE DISCLOSURE

An electronic musical instrument for producing tremolo having at least a pair of electronic tone generators, each set to generate a different audio frequency, a loudspeaker audio system for transducing said audio frequencies into sound, a switch connected in circuit with the tone generators to alternately complete the circuit between a power source and the audio system, and keys comprising a portion of the keyboard for controlling the switch.

This invention relates to an electrical musical instrument. More particularly it relates to an electrical musical instrument of the keyboard type which will produce the musical effect known as "tremolo."

The "tremolo" effect, referred to herein, may be described as a rapid alternate reiteration of two notes spaced apart by a frequency interval, usually in octave, a sixth or a third. Tremolo is usually executed by the right hand as part of the melodic line. The term "tremolo" as used herein is not to be confused with the "tremolo" effect as used on instruments of the organ type, in which case the effect is a low frequency (about 6–7 c.p.s.) amplitude, frequency or combination amplitude and frequency modulation of the steady state signal.

The execution of the tremolo effect requires considerable dexterity and training for effective execution. Consequently, it would not be attempted by a beginner. Accordingly, this invention concerns an electrical musical apparatus by which an amateur performer, with a minimum of experience, can execute the musical effect of tremolo by merely holding down one key on the keyboard of a musical instrument.

It therefore is an object of this invention to provide a novel apparatus for producing the tremolo effect.

It is another object of this invention to provide a novel electrical musical instrument with tremolo effect.

It is still another object of this invention to provide a novel apparatus for producing the tremolo effect which includes selector means for selecting the frequency interval.

It is a further object of this invention to provide a novel apparatus for producing tremolo effect which is adapted to be incorporated into a manually keyed electrical musical instrument.

It is yet another object of this invention to provide a novel apparatus for producing the tremolo effect which also includes a stereophonic effect.

Other objects will appear hereinafter.

FIGURE 1 is a schematic diagram of a portion of a musical instrument of the keyboard type incorporating the tremolo feature of this invention.

FIGURE 2 is a schematic diagram of a second embodiment of an apparatus for producing tremolo effect.

FIGURE 3 is a schematic diagram of a part of a musical instrument incorporating both the tremolo effect and a sterophonic effect.

Referring now to the drawing, wherein like numerals

indicate like elements, there is shown in FIGURE 1 two musical instrument keys and electronic apparatus associated with one of the keys for producing the tremolo effect designated generally as **10**.

The two keys **12** and **14** are shown in cross section and represent a portion of a complete keyboard. It is to be understood that each key of the musical instrument could be connected to a similar group of tone generators with the same frequency interval and all may feed into a common audio system.

Flat cantilever springs **16** and **18** are attached to the respective ends of keys **12** and **14**, opposite to the struck end. Weights **20** and **22** are attached to the free ends of the springs **16** and **18**. When keys **12** and **14** are struck in the normal manner, the weighted cantilever springs **16** and **18** will oscillate, the rate of oscillation being adjusted in the design of the spring and weight. For purposes of this invention, the design rate of oscillation should be a frequency of approximately ten cycles per second. It it to be understood, however, that if desired other frequencies may b eused.

Contactors **24**, **26**, **28** and **30** are positioned on the springs **16** and **18** so that when the springs oscillate electrical contact is alternately made between upper and lower contactors **32**, **34**, **36** and **38** and the springs. Springs **12** and **14** may be made of an electrically conductive material or may have an electrical conductor attached thereto. In effect the springs **16** and **18** and the upper and lower contactors **32**, **34**, **36** and **38** form single-pole double-throw switches.

In practice, it may be found to be difficult to provide such switches with a normally neutral or open circuit mid-position. In other words, contactor **26** may be assumed to be in contact with contactor **38**, when the keys **12** or **14** are in their normal "up" position. To overcome this problem, each switch has been provided with a third contact **40** and **42** which makes contact with contactors **44** and **46** only when the keys **12** and **14** are depressed. As shown, contactors **44** and **46** are wired in series with the spring and power line leading to power unit **48**. By providing this additional contact for each switch the note is prevented from sounding when the key is not depressed. Further, the note tone generator will not receive voltage once the key has been released.

It has been found that if contacts **40** and **42** are adjusted to make contact with contactors **44** and **46** before springs **16** and **18** go into oscillation, a pulse of sound will initially issue from the audio system. This produces a very rapid key response which is invaluable in the performance of fast musical passages.

The single-pole double-throw contact switch, associated with each key on the keyboard is utilized to switch between a tone generator normally associated with a particular key and another tone generator which will have a predetermined musical (frequency) interval relationship with the first oscillator. Thus, as shown in FIGURE 1, when key **14** is struck, the oscillating contactors **28** and **30** will alternately permit power pulses to energize tone generators **50** and **52**. Tone generators **50** and **52** may generate frequencies differing by a certain musical interval such as an octave, a third or a sixth, or even an adjacent frequency.

Tone generator **52** and tone generator **54** are connected to contactor **36** by an interval selector switch **56**. By designing tone generator **52** and **54** to be at different musical intervals relative to tone generator **50**, it is possible to change the interval relationship between the alternating pulsed tone generator merely by adjusting in-

terval selector switch 56. More than two tone generators may be associated with an interval selector switch with more than two positions, thereby providing a greater selection of the tremolo effects. The signal generated by tone generators 50, 52, and 54 is applied to a commonly connected audio system which transduces the signal into sound.

Interval selector switch 56 represents a section of a multi-contact type unit since each tone generator in the system would require a set of contacts. Tone generators 50, 52 and 54 represent an electronic means of producing electric signals which are transduced into sound corresponding to the sound produced by an equivalent mechanical musical instrument. Tone generators 50, 52 and 54 may include damped or undamped oscillators and associated electronic circuitry for producing the desired electric signals or tones. The circuitry employed in tone generators 50, 52 and 54 would be known to those skilled in the art, and therefore, need not be described herein. The audio system 58 may include amplifiers and one or more loudspeakers. On the other hand, it may include any transducer device which converts electrical signal into sound.

Referring to FIGURE 2, there is shown an arrangement for producing the tremolo effect which differs from the arrangement depicted in FIGURE 1 in that electronic means are utilized to accomplish the function performed by the mechanically oscillating springs and associated contacts. The tone generators, audio system, interval selector switch and power unit represent the same elements shown in FIGURE 1. To illustrate this, primed numerals have been assigned to like elements.

Electronic switch 60 is connected in series between the audio system 58' and the key contactors 62, 64, 66 and 68 associated in pairs with the keys 70 and 72. Electronic switch 60 may be a conventional multi-vibrator circuit adapted for use as a tone generator switching unit. As thus, adapted, electronic switch 60 preforms the function of switching between the lines 74 and 76, connecting key contacts 62, 64, 66 and 68 to electronic switch 60.

As shown, each key of the instrument, represented by keys 70 and 72, closes their mechanically associated contacts when struck. With key 72 in its depressed or struck position, the electronic switch 60 will alternately connect the audio system 58' to the tone generators 50' and 52' or 50' and 54'. As described with regard to FIGURE 1, the tone generators 50', 52' and 54' have a predetermined musical interval relationship. The power unit 48' is commonly connected to tone generators 50', 52' and 54' and continuously energizes the tone generators 50', 52' and 54'.

It will be noted that the embodiment shown in FIGURE 2 differs from the embodiment of FIGURE 1 not only by the substitution of the electronic switch 60 for the oscillating springs and associated contactors but also by the inversion of the position of power unit 48' and audio system 58'. This has been done merely to show that such inversion is possible. If desired the power unit 48' and audio system 58' could be connected as shown in FIGURE 1. In either case, the tremolo effect produced is the same.

The tremolo effect produced by the apparatus shown in FIGURES 1 and 2 can be made even more striking by utilizing a second audio system. This second audio system is connected so that each of the interval related tone generators or groups of tone generators which is being pulsed by a key, feeds its own associated audio system. Therefore, in addition to the reiteration or tremolo effect previously described, a stereophonic quality is achieved because of the spatial relationship between the two audio systems.

In FIGURE 3 there is shown a tremolo producing apparatus which utilizes a second audio system. The power unit 78 and electronic switch 80 are like the power unit and electronic switch used in FIGURE 2 and perform the same function. That is, electronic switch 80 is used to switch power unit 78 between two contacts which are provided on each of the instrument keys 82, 84, and 86. In FIGURE 3 the upper key contacts 88, 92 and 96 complete the input circuits to tone generators 100, 102 and 104 normally associated with keys 82, 84 and 86. The contacts 90, 94 and 98 connect to the tone generators 102, 104 and 106 respectively which are a predetermined musical interval higher than the tone generators connected to the upper contacts 88, 92 and 96. Tone generators 100 and 104 are connected to audio systems 108 and tone generators 102 and 106 are connected to audio system 110.

By way of example, each of the tone generators 100, 102, 104 and 106 may be at one octave intervals in progressively higher order, according to the numbers used. By connecting the output of tone generators 100 and 104 to audio system 108 and the output of tone generators 102 and 106 to audio system 110, the playing of any one key will result in an alternative reiteration of tones an octave apart and sounding alternately from audio system 108 and audio system 110. Of course, intervals other than an octave could be used.

It should also be understood that all of the tone generators which are utilized in a given instrument may be from a single sequence of tone generators comprising a musical scale, so that in effect tone generators are "borrowed" from different portions of this musical scale in exactly the same manner as an accomplished pianist utilizes desired notes from the keyboard for producing a tremolo. On the other hand, although not as economical, it may be more desirable to have available separate tone generators for the selected upper half of a given desired tremolo combination.

To further clarify FIGURE 1 as compared to FIGURE 2, it should be noted that FIGURE 1 shows the type of electronic musical instrument in which the keys control the supply voltage into the oscillator. On the other hand, FIGURE 2 shows the type of electronic instrument where the supply voltage is continuously applied to the tone generators and where the audio is keyed. As has been described, the principles of this invention can be applied to either.

While the arrangements shown in the drawings indicate the reiteration of two single tone generators for tremolo, it should be understood that the same system can be applied to reiteration of a plurality of tone generators for each of the two tremolo components. Devices such as expression pedals, tone controls, couplers, etc. have been purposely omitted from this disclosure, but these and many other elements of electrical musical construction, which are well known to those versed in this art, can be applied for additional effects.

Thus, it can be seen that a novel and improved electrical musical instrument for producing the tremolo effect has been described. The instrument is simple to operate because to produce the tremolo it only requires that a single key be depressed or struck. If extended tremolo effect is desired, the key need be merely held in a depressed position. The effect thus produced is true and cannot be distinguished from the tremolo produced by an expert player. Further, the interval selector switch provides a means whereby the effect may be adjusted to the desired frequency interval. The apparatus also may be adapted, in accordance with the teaching herein, to produce tremolo together with a unique stereophonic effect.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. Apparatus comprising at least two tone generating means for generating tones at different frequencies, audio means for transducing tones generated by said tone gener-

ating means into sound, switch means for alternately connecting said tone generating means in circuit between a power source and said audio means at a predetermined rate of alternation, and key means for selectively actuating said switch means, said switch means comprising spring means mounted on said key means, connector means for coupling said spring means into the circuit, at least two contact means adjacent said spring means, each of said contact means being connected in circuit with a tone generator, whereby operation of said key means causes said spring means to oscillate and alternately make contact with the contact means.

2. Apparatus comprising at least two tone generating means for generating tones at different frequencies, audio means for transducing tones generated by said tone generating means into sound, switch means for alternately connecting said tone generating means in circuit between a power source and said audio means at a predetermined rate of alternation, and key means for selectively actuating said switch means, said switch means comprising an electrically conductive cantilevered spring mounted on said key means, connector means for coupling said spring means to a source of power, contactor means adjacent opposite sides of the free end of said cantilever spring, each one of said contactor means being connected in circuit with a tone generating means, whereby the striking of said key causes said spring to oscillate between said contactor means alternately making contact therewith.

3. Apparatus in accordance with claim 2 wherein said connector means comprises a contact positioned to be in contacting relation with said spring only when said key means is struck.

4. Apparatusa comprising at least two tone generating means for generating tones at different frequencies, audio means for transducing tones generated by said tone generating means into sound, switch means for alternately connecting said tone generating means in circuit between a power source and said audio means at a predetermined rate of alternation, and key means for selectively acuating said switch means, at least one of said tone generating means including at least two tone generators for generating tones at different frequencies, and selector means connected between said switch means and said two tone generators for selectively connecting one of said two generators in circuit with the other of said two tone generating means.

5. Apparatus comprising a plurality of tone generating means for generating tones at different frequencies, audio means connected in circuit to transduce tones generated by said tone generating means into sound, key means for selecting from among said tone generating means two tone generators at different frequencies, and switch means for alternately connecting said selected tone generators in circuit to produce a tremolo effect.

6. Apparatus comprising at least two tone generating means, first audio means for transducing tone generated by said tone generating means into sound, said first audio means being connected to selected ones of said tone generating means, second audio means for transducing tones generated by said tone generating means into sound, said second audio means being connected to selective remaining ones of said tone generating means, switch means for alternately connecting a source of power to said selected ones of said tone generating means and to said remaining ones of said tone generating means at a predetermined rate of alternation, and key means for selectively actuating said apparatus.

7. In an electrical musical instrument having a keyboard, means for producing a tremolo effect, said means comprising a plurality of pairs of tone generating means, each one of said tone generating means in said pair being adapted to generate a tone that differs in frequency from the tone generated by the other tone generating means in said pair, audio means associated with said tone generating means for transducing said generated tones into sound, switch means associated with each pair of tone generating means, said switch means being adapted to alternately connect a source of power to each one of said tone generating means in said pair at a predetermined rate of alternation, and key means associated with said switch means for selectively connecting said switch means to said pairs of tone generating means, said key means comprising at least a portion of said keyboard.

8. Apparatus in accordance with claim 7 wherein at least one of said tone generating means comprises at least two tone generators, said tone generators being adapted to generate tones at different predetermined frequencies, and selector means coupled between said switch means and said tone generators for selecting the frequency of the tone to be generated by said tone generating means.

9. Apparatus in accordance with claim 7 wherein said switch means is an electronic switch.

10. Apparatus in accordance with claim 7 wherein said switch is a multi-vibrator.

11. In an electrical musical instrument having a keyboard, means for producing a tremolo effect, said means comprising a plurality of pairs of tone generating means, each one of said tone generating means in said pair being adapted to generate a tone that differs in frequency from the tone generated by the other tone generating means in said pair, audio means associated with said tone generating means for transducing said generated tones into sound, key means associated with each pair of tone generating means, said key means comprising at least a portion of said keyboard, spring means mounted on said key means, said spring means being adapted to oscillate at a predetermined rate when said key means are struck, a pair of contactor means positioned adjacent said spring means to make alternate periodic contact with said spring means when oscillating, each one of said contacts being connected to one of said generating means in an associated pair.

12. In an electrical musical instrument having a keyboard, means for producing a tremolo effect, said means comprising a plurality of pairs of tone generating means, each one of said tone generating means in said pair being adapted to generate a tone that differs in frequency from the tone generated by other tone generating means in said pair, first audio means associated with one of the tone generating means in each of said pairs of tone generating means, second audio means associated with the other of the tone generating means in each of said pairs of tone generating means, said first and second audio means being adapted to transduce into sound the tones which are generated by said associated tone generating means, switch, means associated with each pair of tone generating means, said switch means being adapted to alternately connect a source of power to each one of said tone generating means in said pair at a predetermined rate of alternation, and key means associated with said switch means for selectively connecting switch means to said pairs of tone generating means, said key means comprising at least a portion of said keyboard.

13. Apparatus comprising at least two tone generating means for generating tones at different frequencies, audio means for transducing tones generated by said tone generating means into sound, switch means for alternately connecting said tone generating means to said audio system at a predetermied rate of alternation, key means for selectively actuating said switch means, and a power source connected to said tone generating means for energizing said tone generating means.

14. In an electrical musical instrument having a keyboard, means for producing tremolo effect, said means comprising a plurality of pairs of tone generating means, each one of said tone generating means in said pair being adapted to generate a tone that differs in frequency from the tone generated by the other tone generating means in said pair, audio means associated with said tone gen-

erating means for transducing said generated tones into sound, switch means associated with each pair of tone generating means, said switch means being adapted to alternately connect said audio means to each one of said tone generating means in said pair at a predetermined rate of alternation, key means associated with said switch means for selectively connecting said switch means to said pairs of tone generating means, said key means comprising at least a portion of said keyboard, and a power source for energizing said tone generating means.

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