Feb. 9, 1937. H. F. WATERS 2,070,344

ELECTRIC MUSICAL INSTRUMENT

Original Filed Aug. 14, 1931

Fig. 1.

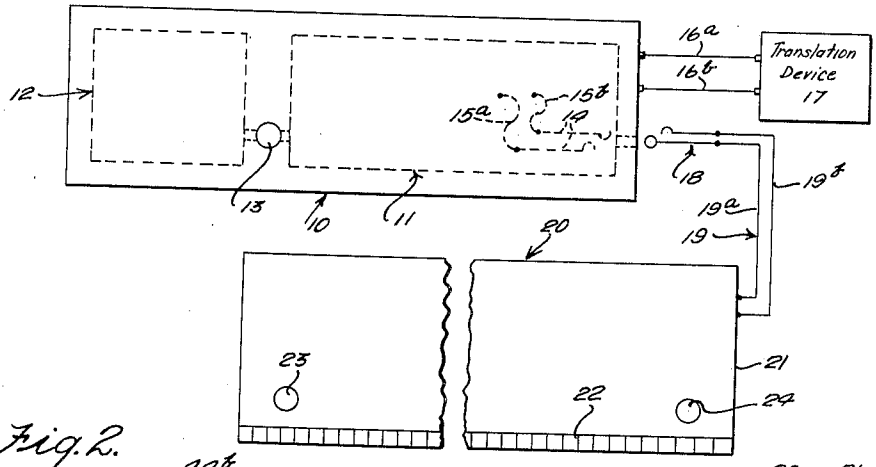


Fig. 2.

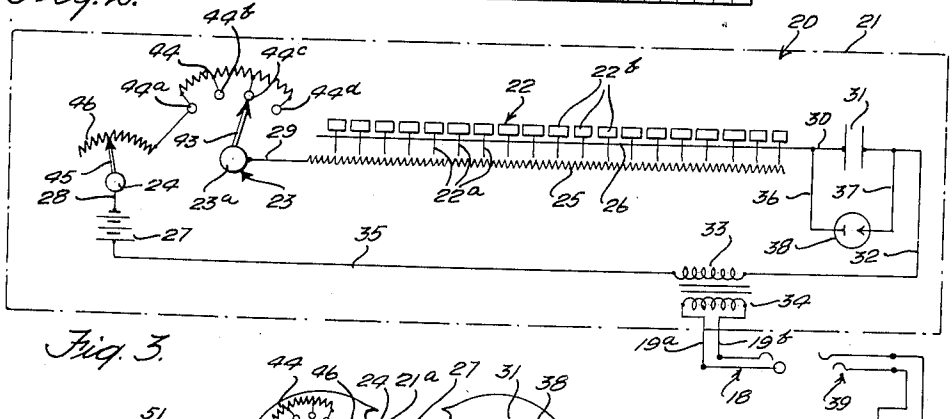


Fig. 3.

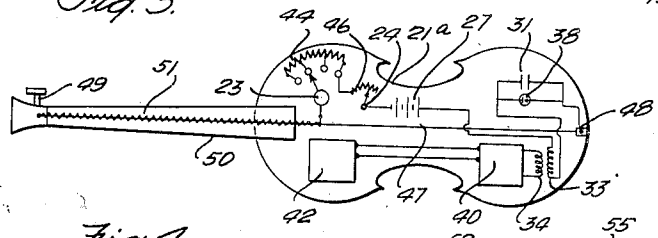
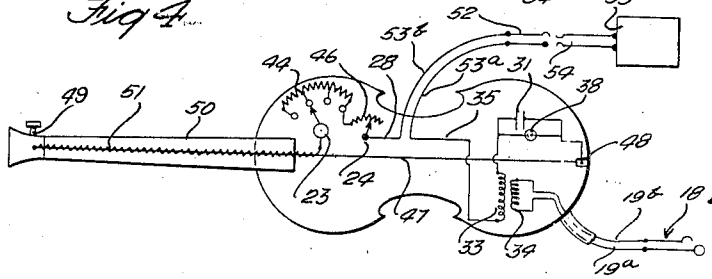


Fig. 4.



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ELECTRIC MUSICAL INSTRUMENT

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17 Claims. (Cl. 84—1)

This invention relates to electric musical instruments, and more particularly to a musical instrument that may be operated in conjunction with a radio receiver or with an electric phonograph.

Among the objects of my invention are to provide an electric musical instrument which is simple, practical and of inexpensive construction; one that will be easy to operate, capable of simple and dependable control, and well adapted to meet the varying requirements of production of music, capable of being readily and conveniently adapted to the production of music in accompaniment or in conjunction with another musical instrument or music-reproducing instrument; one in which the range of available notes may be readily and dependably shifted, and correction or determination of pitch may be easily and quickly effected with a high degree of accuracy.

The invention accordingly consists in the combinations of elements, arrangements of parts and features of construction as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing in which are shown several of the various possible embodiments of my invention:

Figure 1 is a diagrammatic representation of my musical instrument coacting with, for example, a radio receiver or an electric phonograph;

Figure 2 is a diagrammatic representation, particularly of a preferred form of electrical circuit and devices illustrating certain features of my invention,

Figure 3 is a plan view, partly broken away, of an embodiment in the form of a violin of certain features of my invention, and,

Figure 4 is a plan view, partly broken away, of another embodiment in the form of a violin of certain features of my invention.

Similar reference characters refer to similar parts throughout the various views of the drawing.

Referring to the drawing:—In Figure 1 is shown a radio receiver or electric phonograph, generally indicated at **10**, including one or more stages of audio-frequency amplification diagrammatically indicated at **11**, and radio-frequency tuning and detecting means (in the case of a radio receiver) or electromagnetic pick-up means (in the case of an electric phonograph) diagrammatically indicated at **12**. The audio-frequency amplifier **11** may be used either with or without the radio receiver or phonograph pick-up means **12**, by manipulation of a control switch generally denoted **13**. An external connection to the audio-frequency amplifier **11** is provided by a jack construction **14** connected to amplifier **11** by wires **15a** and **15b**.

Directly connected to the output of the audio-frequency amplifier **11** by means of interconnecting wires **16a** and **16b**, is a loud-speaker or other translating device **17**. For connection with the jack **14** and hence to the audio-frequency amplifier **11** and the energy-translating device **17**, is a plug construction **18** with its leads **19a** and **19b** connected to my electric musical instrument diagrammatically indicated at **20**. The instrument **20** preferably comprises a box-like container **21** having along one edge thereof an exposed keyboard **22** adapted for manual manipulation of its individual keys, and also exposed control knobs **23** and **24** for respectively controlling the keyboard shift and pitch-correcting mechanisms to be more clearly described hereinafter. Within the container **21** and electrically connected to the keyboard **22** and the keyboard shifting control **23** and pitch correcting control **24**, there is enclosed the mechanism of the electric musical instrument **20** which, together with certain of its possible coactions with the devices **10** and **17**, will be described more fully hereinafter.

Considering now certain of the devices embodied in the instrument **20** of Figure 1, reference may first be made to Figure 2 in which the cabinet or the casing **21** is diagrammatically indicated together with the parts that are therein contained or associated therewith. The keyboard **22** of Figure 1 is diagrammatically indicated in Figure 2 in the form of a suitable number of individual keys arranged preferably like the keys of a piano, each including a contact member **22a** adapted, in any suitable manner, to engage and contact with a resistance wire or other suitable conductor of relatively low conductivity indicated at **25**. The contacts **22a** carried by the individual keys are interconnected by a conductor **26**. Thus, as the keys of the keyboard **22** are depressed, the amount or ohmic value of the effective resistance in the circuit in which the keyboard **22** is included may be correspondingly varied.

The electrical portions of the keyboard **22** are connected in an electrical circuit which, while referring to Figure 2, may be traced as follows:—From one terminal of a suitable source of electrical energy, such as a battery **27**, conductor **28**, pitch-regulating or pitch-correcting control **24**, keyboard shifting control **23**, conductor **29**, re-

sistance 25 with which a contact 22a may engage upon depression of the corresponding key, conductor 26, conductor 30, a condenser 31, conductor 32, the primary winding 33 of a suitable transformer of which the secondary winding is indicated at 34, and then by way of conductor 35 and back to the other side or terminal of battery 27.

Bridged across condenser 31, by conductors 36—37, is a gaseous discharge tube or device 38 through which the condenser 31, upon being suitably charged, may discharge. The terminals of the secondary winding 34 of the transformer 33—34 are connected by conductors 19a and 19b to the tip and sleeve respectively of the plug 18 (see also Figure 1).

As already above described, plug 18 may be inserted into jack 14 (see Figure 1) for coaction with the audio-frequency amplifier 11 and the loud-speaker 17. Or I may use plug 18 to coact with a jack 39 (see now Figure 2) associated with a separate audio-frequency amplifier diagrammatically indicated at 40, the output of which is transmitted by conductors 41a and 41b to a suitable translating, recording or like device 42 which may also take the form of a loud-speaker.

As the keys 22b of the keyboard 22 are depressed in appropriate sequence much in the same manner as the keys of a piano may be actuated for producing music or the like, the circuit of condenser 31, outlined above, is closed and the condenser becomes charged until the potential across its terminals is sufficient to break down the gaseous conduction gap between the electrodes of the discharge tube 38. This action takes place relatively rapidly and as soon as the condenser 31 has been discharged, it is charged, again to break down the gap in the device 38 and again to discharge. This charging and discharging repeats itself during the interval of time that the particular key remains depressed and its repetition is at a rate dependent upon the voltage applied to the condenser 31 for charging the latter. The parts are preferably so proportioned and the average voltage so selected that this repetition takes place at an audio-frequency rate.

As a consequence of this repeated action, the current through the primary winding 33 of transformer 33—34 undergoes variations at a corresponding frequency or rate, producing in the secondary winding 34 a current or potential that likewise varies at this audio-frequency rate and which is amplified by the amplifier 40 and translated into sound of corresponding pitch by the translating device 42 where the latter functions, for example, as a loud-speaker; or, with the arrangement of Figure 1, the output of transformer 33—34 is amplified by the amplifier 11 and translated by the device 17.

If, however, a different key 22b is depressed, the circuit of condenser 31 is again closed but due to the inclusion in this circuit of a different portion or fraction of the resistance 25, the voltage applied to the condenser 31 is now different and the rate of charge and discharge of the condenser takes place now at some other or different audio-frequency rate, corresponding in turn to the production of a different note in the musical scale. Thus the keyboard 22, which may be provided with as many keys as is desired, may be manually operated to cause the production of notes in any desired sequence and thus to play any tune or melody or the like as may be desired.

Insofar as certain features of my invention are concerned, it is to be understood that the oscillation generator, above described as of the condenser charge and discharge type, is to be understood to be merely illustrative and that any other suitable form of oscillation generator may be employed.

In order to simplify the construction and to make it possible to use a minimum or relatively small number of keys, such as a number equivalent to several octaves, thus giving the keyboard itself a relatively small or narrow range, while at the same time to make it possible to cause this small range keyboard to have a much greater range than is inherent in itself, I have provided the keyboard shifting control 23 above briefly mentioned in connection with both Figures 1 and 2. This control includes a contact arm 43 preferably manually controlled in any suitable manner as by means of a rotatable knob 23a; contact arm 43 coacts with fixed contacts 44a, 44b, 44c and 44d connected by suitable conductors to equi-distantly spaced points in a suitable resistance 33 and, as above pointed out, the control 23 is in the above described condenser charging circuit.

By means of the control arm 23a and its coacting parts, I may include in this circuit one or more or none of the sections of the resistance 44, each section being of such a resistance value that it causes a shift of the complete range of the keyboard 22 by exactly one octave. Illustratively I have shown three such sections of resistance to effect a shift along the musical scale of from one to three octaves of the complete or inherent range of the keyboard 22 itself.

In operating the instrument, as by suitably fingering the keyboard 22, I may, during the playing of any selection, extend the range of the keyboard 22 where and when necessary and either upwardly or downwardly of the musical scale by correspondingly and appropriately setting the control 23. Or, if it is desired to play any given selection that falls within the inherent range of the keyboard 22 at a lower or higher standard in the musical scale, I first set the control 23 to the point desired and then proceed with the manipulation of the keyboard 22.

Where my musical instrument is arranged as in Figure 2 to coact with its own amplifier 40 and loud-speaker 42, or where it is arranged as in Figure 1 to utilize the amplifier 11 and the translating device or loud-speaker 17 of a radio receiving set or, by way of further example, of an electric phonograph, and it is desired to play the instrument or to accompany even the music reproduced by the phonograph from a record, or by the radio receiving set as the latter receives, detects, amplifies and translates broadcast music, this keyboard shifting control 23 makes it possible to carry on the accompaniment not only throughout the entire range of scale of the particular piece being accompanied even though the keyboard 22 may be of limited range, but also to select or determine at will whether the accompaniment being played is one or more or no octaves higher or lower. Particularly under these circumstances, pitch governing control 24, already above mentioned in connection with both Figures 1 and 2, as well as when my instrument is used alone, is of great importance; this control 24 includes a manually operable variable resistance taking the form preferably of a contact arm 45 operated by the control knob 24 and in slidable engagement with a resistance 46 so that

relatively fine changes in resistance in the above described condenser-charging circuit may be made. By means of the control **24**, my instrument may be properly and quickly pitched or brought into tune. Also by means of the control **24** I may readily and conveniently maintain the proper tune or pitch of the instrument as against such pitch-changing factors as, for example, variation or change in the voltage of the source **27**, temperature changes in the circuit or parts thereof, or even changes in the operating characteristics of the condenser **31** or of the discharge tube **38** or both.

In Figure 3 I have shown a possible modified form of certain features of my invention and more particularly I have there shown my musical instrument in the form of a violin; the cabinet **20** of Figures 1 and 2 has been given the form or shape of a violin casing **21a** and within the casing are contained, all as diagrammatically indicated in Figure 3, the condenser-charging circuit and its parts, comprising the battery **27**, the pitch governing control **24**, the octave shifting control **23**, condenser **31** with its discharge device **38**, the transformer **33—34**, and also the amplifier **40** and the loud-speaker **42**. The manual control of the emitted notes however is achieved by fingering as in a violin, a single string **47** of conducting material suitably anchored at its right hand end as at **48** and connected at its left hand end to a suitable tensioning device **49**. The conducting string **47** overlies the arm **50** of the violin and the latter carries, exposed on its upper surface, a resistance **51** which underlies the conducting string **47**. Resistance **51** and the string **47**, when the latter is depressed, are connected in series with each other and also in series with the above described condenser-charging circuit, being positioned electrically in the same position as is the keyboard **22** of Figure 2.

As the string **47** is fingered to depress it and cause it to contact with different portions of the resistance **51**, the pitch of the emitted note is correspondingly changed in a manner and by an action that will now in view of what has been above set forth in connection with Figures 1 and 2, be clear. In Figure 4 I have shown the musical instrument also in the form of a violin but I have associated therewith a cord **19a** and **19b** and plug **18** leading from the secondary winding **34** of the transformer so that the violin instrument may be associated with a radio receiving set or an electrically reproducing phonograph for utilization of the amplifier and loud-speaker thereof or for accompanying the music produced by these instruments. I have also shown the plug **52** and its associated cord **53a** and **53b** leading from the conductors **28** and **35** so that the instrument may be connected to an external source of energy supply generally denoted **55** as by plugging into the jack structure **54**. The external source of supply **55** may be in the form of a battery or it may be a rectifier within or without a radio receiver cabinet.

Various of the advantages and methods of control and use as described in connection with Figures 1 and 2 may be achieved and carried out with the arrangements of either Figures 3 or 4 or both, as is believed will be clear in view of what has been set forth above in connection with Figures 1 and 2.

Thus it will be seen that there has been provided in this invention an electric musical instrument in which the various objects hereinbefore noted, together with many practical advantages, have been successfully achieved. Furthermore, it will be seen that the apparatus is characterized by a wide and convenient flexibility of control and use and that such results and advantages as these are achieved in a thoroughly practical, inexpensive, and dependable manner. It will be seen also that the construction is simple, practical and well adapted to the varying conditions of actual use.

As many possible embodiments may be made of my invention, and as many changes might be made in the embodiments hereinbefore set forth, it is to be understood that my disclosures are to be taken in an illustrative and not in a limiting sense.

I claim:

1. In an electrical musical instrument, in combination, means for producing electrical impulses at an audio-frequency rate, means for sequentially changing the rate of said impulses throughout a desired range of operation, and means for uniformly shifting the range of operation of said last mentioned means at least an amount equivalent to one complete octave of the musical scale.

2. In an electrical musical instrument, in combination, an oscillation generator, a keyboard control therefor arranged to vary the frequency of the electrical oscillations developed by said generator and to cause the sounding by a suitable translating device connected thereto of a plurality of audible notes of predetermined respective pitches, and means for shifting the range of the keyboard control of said generator by an amount equivalent to a complete octave of the musical scale.

3. In an electrical musical instrument, in combination, an oscillation generator, a keyboard control therefor arranged to vary the frequency of the electrical oscillations developed by said generator and to cause the sounding by a suitable translating device connected thereto of a plurality of audible notes of predetermined respective pitches, means for shifting the range of the keyboard control of said generator so as to result in a corresponding shift in the audible range of the output of the translating device along the musical scale one or more complete octaves, and means for regulating the frequency of said oscillation generator so as to correct the pitch of the audible energy output of said translating device.

4. In an electrical musical instrument, in combination, an oscillation generator comprising an electrical condenser and a glow-discharge tube shunted thereacross, a keyboard control therefor comprising an electrical resistance element, means including a variable electrical resistance connected to said keyboard control electrical resistance element for shifting the range of the keyboard control of said generator so as to result in a corresponding shift along the musical scale in the audible energy output of a translating device associated with said oscillation generator by one or more complete octaves, and means including a variable resistance for adjusting the action of said last-mentioned means for determining the frequency of said generator and correspondingly the pitch of the audible output energy of said translating device.

5. In an electrical musical instrument, in combination, an oscillation generator comprising an electrical condenser having a glow-discharge tube shunted thereacross, a translating device responsive thereto, a keyboard control for said generator comprising an electrical resistance element con-

nected thereto arranged to cause the sounding by said translating device of a plurality of audible notes of predetermined respective pitches, and means comprising a variable electrical resistance connected with said keyboard control electrical resistance element and with said oscillation generator for correcting the frequency of the electrical oscillations developed by said generator and the pitch of the audible energy output of said translating device.

6. In an electrical musical instrument, in combination, means comprising an electrical condenser and a glow-discharge tube connected thereto for producing electrical energy varying at an audio-frequency rate, translating means responsive to the energy produced by said first-mentioned means, means operable at will for causing changes in the frequency of the energy produced by said first-mentioned means throughout a desired range, and means for altering the position of this desired range in the energy spectrum by one or more complete octaves of the musical scale.

7. In an electrical musical instrument, in combination, means for producing electrical energy varying at an audio-frequency rate, translating means responsive to the energy produced by said first-mentioned means, means operable at will for causing changes in the frequency of the energy produced by said first-mentioned means, and means for shifting the range of operation of said last-mentioned means an amount equivalent to at least one octave in the musical scale.

8. In an electrical musical instrument, in combination, means for producing electrical energy varying at an audio-frequency rate, translating means responsive to the energy produced by said first-mentioned means, means operable to cause changes in the frequency of the energy of said first-mentioned means so as to cause responsive changes in the audible output energy of said translating device in accordance with different notes in the musical scale and means for shifting the frequency range of said first-mentioned means an amount equal to at least one octave of the musical scale.

9. In an electrical musical instrument, in combination, an oscillation generator comprising an electrical condenser and a glow-discharge tube shunted across said condenser, means operatively associated with said generator for producing numerous musical notes of different respective pitches, and means for collectively changing the pitch of the note-producing means by an amount equivalent to one or more octaves of the musical scale while maintaining the pitch intervals thereof.

10. In an electrical musical instrument, in combination, means including an electrical condenser and a glow-discharge tube shunted thereacross for producing electrical energy varying at an audio-frequency rate, electrical resistance means for changing at will and sequentially the audio-frequency output of said means, said second-mentioned means including two coacting members, one of which is in the form of a string adapted to be fingered like a violin string, and means for shifting the range of operation of said first-mentioned means by one or more octaves of the musical scale.

11. In an electrical musical instrument, in combination, means including an oscillation generator for producing a plurality of individual musical notes throughout a desired range in the musical scale, and means for altering collectively the positions in the musical scale of said note producing means by at least one octave of the musical scale.

12. In an electrical musical instrument, in combination, means including an oscillation generator comprising an electrical condenser and a glow-discharge tube shunted thereacross, an electrical resistance element connected to said means having a keyboard control therefor arranged to cause the sounding of a plurality of notes of predetermined respective pitches, and pitch regulating means for said instrument comprising an electrical resistance element serially connected with said first-mentioned electrical resistance element whereby said instrument may be accurately tuned.

13. In an electrical musical instrument, in combination, an oscillation generator including an electrical condenser and a glow-discharge tube connected thereto, electrical resistance means connected to said generator for producing numerous individual notes of different pitches, and electrical resistance means connected to said last-mentioned means for collectively correcting the pitches of the numerous notes against the effect of variables in the generator circuit.

14. In an electrical musical instrument, in combination, an oscillation generator comprising an electrical condenser and a glow-discharge tube connected thereto, means including an electrical resistance element for producing numerous notes of different pitches, and means including an electrical resistance element for collectively modifying the pitches of numerous notes to harmonize the instrument with another instrument.

15. In an electrical musical instrument, in combination, means including an electrical condenser and a glow-discharge tube for producing electrical impulses at an audio-frequency rate, means including an electrical resistance element for sequentially changing the rate of said impulses throughout a desired range of operation, and means including an adjustable electrical resistance element serially connected with said last-mentioned means for shifting the range of operation of said means whereby the distance between the limits of operation remains substantially constant.

16. In an electrical musical instrument, in combination with an oscillation generator including an electrical condenser and a glow-discharge tube connected therewith, means including an electrical resistance element for sequentially producing a number of musical notes of different pitches, and electrical resistance means for collectively changing the pitches of said musical notes while maintaining their pitch differences.

17. In an electrical musical instrument, in combination with an oscillation generator comprising an electrical condenser and a glow-discharge tube connected therewith, electrical means including an electrical resistance element for producing a number of musical notes of different pitches, said means including two coacting members one of which comprises a group of electrical contactors corresponding to the numerous musical notes and the other of which comprises the resistance element.

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