

March 12, 1935.

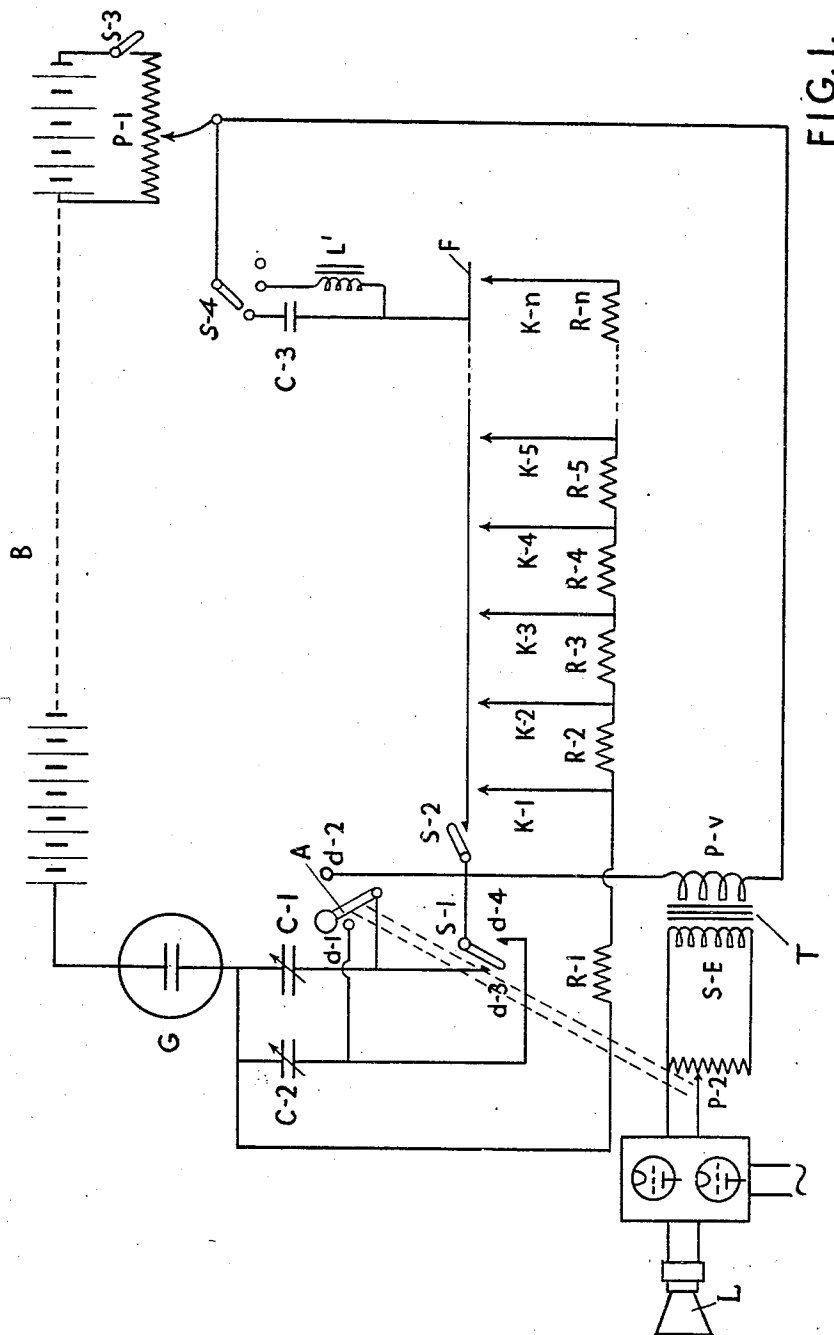
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1,993,890

ELECTRICAL MUSICAL INSTRUMENT

Filed July 30, 1932

4 Sheets-Sheet 1



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ELECTRICAL MUSICAL INSTRUMENT

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4 Sheets-Sheet 2

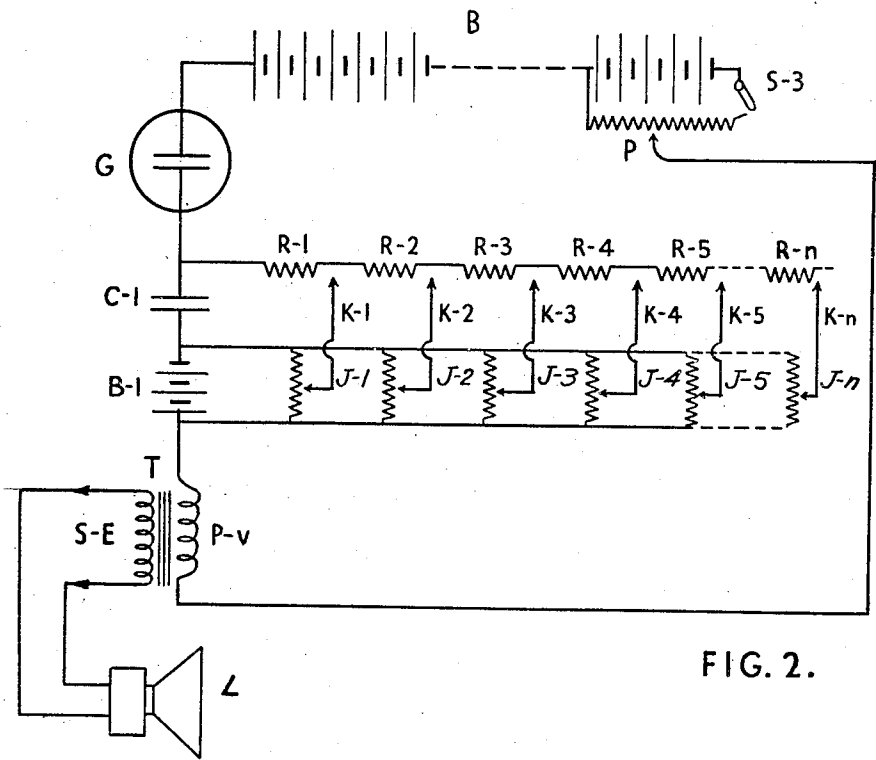


FIG. 2.

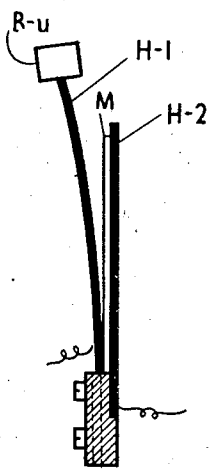


FIG. 3

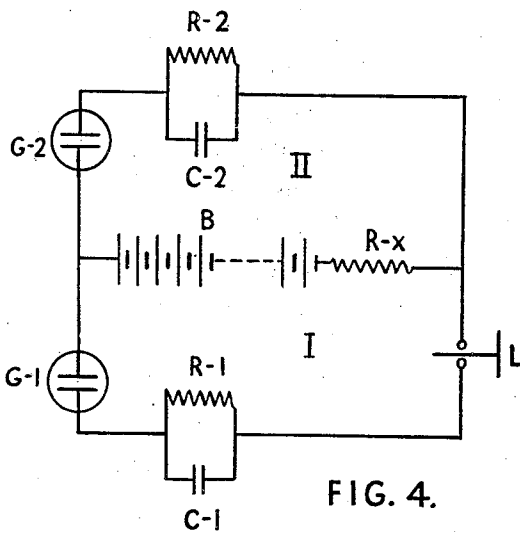


FIG. 4.

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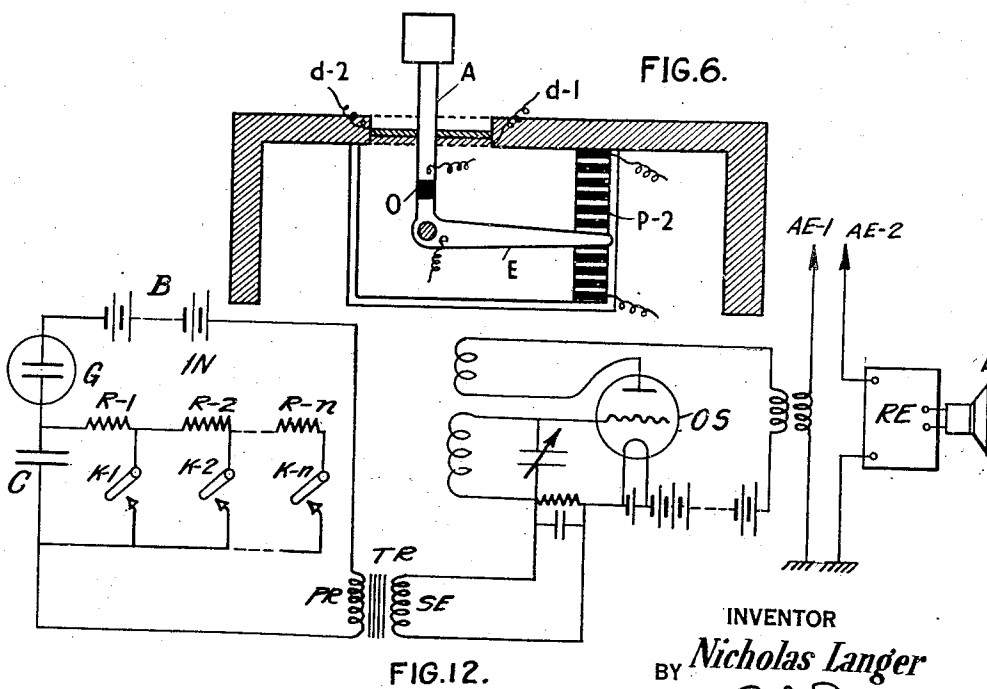
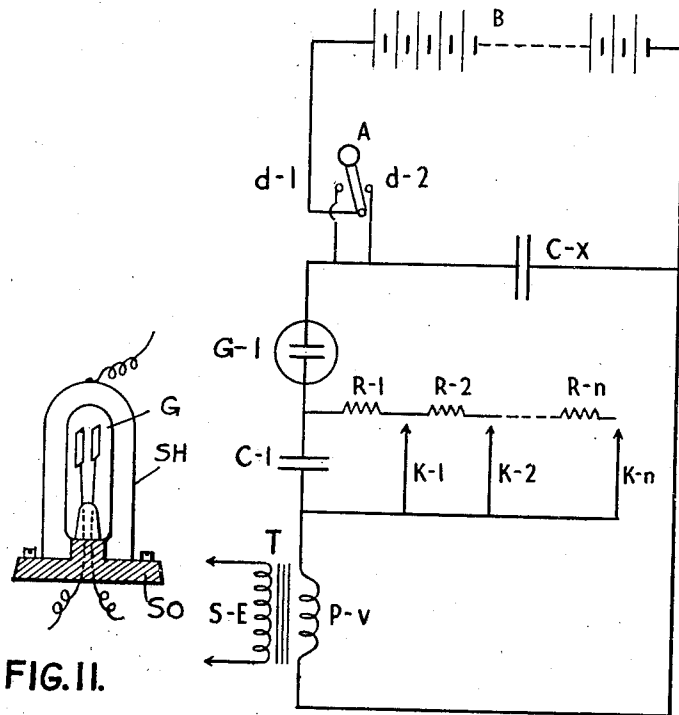
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ELECTRICAL MUSICAL INSTRUMENT

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4 Sheets-Sheet 3



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ELECTRICAL MUSICAL INSTRUMENT

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4 Sheets-Sheet 4

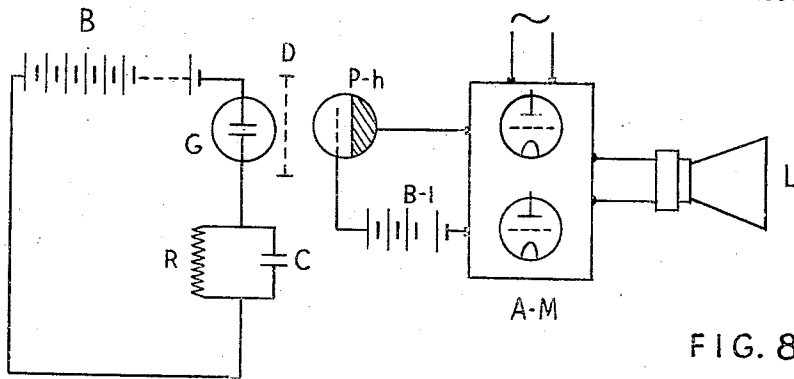


FIG. 8.

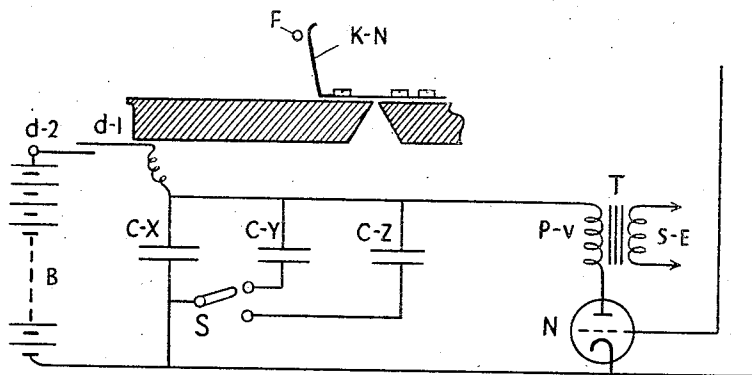


FIG. 9

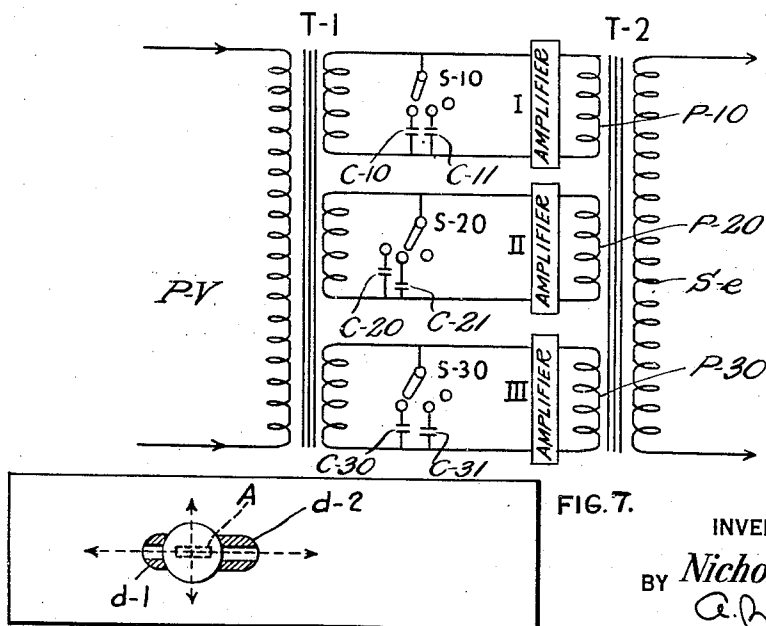


FIG. 7.

FIG. 10

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1,993,890

ELECTRICAL MUSICAL INSTRUMENT

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Application July 30, 1932, Serial No. 626,456

12 Claims. (Cl. 84-1)

The present invention relates to an improved electrical musical instrument of the type in which sounds are produced by means of electrical oscillations artificially established in circuits containing glow-discharge lamps.

It is an object of the present invention to provide an improved electrical musical instrument of the type described hereinabove embodying a plurality of keys connected to resistances which are connected in series.

It is the further object of the present invention to produce and imitate sound effects characteristic of known musical instruments using strings, reeds and other mechanically vibrating members and to produce music which simulates that produced by any of the aforesaid instruments.

It is another object of the invention to produce electrical oscillations of a very constant frequency and of an even volume throughout the entire musical range, which oscillations are especially adapted to be converted into musical sounds.

It is also within the contemplation of the invention to provide an instrument capable of coacting with electrical amplifiers of the thermionic type and ordinary radio sets to give the necessary or desired volume.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with accompanying drawings in which:—

Fig. 1 is a diagrammatic view depicting a complete circuit of an electrical musical instrument embodying the present invention;

Fig. 2 is a view similar to Fig. 1 showing an embodiment of my improved electrical musical instrument in which every note can be tuned independently of the others;

Fig. 3 shows a device for imitating the vibrational effect characteristic of string instruments and the human voice;

Fig. 4 illustrates an electric circuit for obtaining the same imitation of the vibrational effect by an automatic electrical arrangement;

Fig. 5 is a circuit for producing an imitation of the quality of instruments in which the strings are plucked as in the banjo, mandolin, etc.;

Figs. 6 and 7 are fragmentary sectional views of a control device, which is the part of the instrument in Fig. 1 which permits a simultaneous control of volume and of either the tremolo or banjo effect with only one hand of an operator;

Fig. 8 is an electric circuit showing the transfer of the electrical oscillations set up in my electrical instrument to a thermionic amplifier by

means of a photo electric cell without any wire connection;

Fig. 9 illustrates an electric circuit and arrangement for imitating the tone quality of a piano;

Fig. 10 is an electric circuit for producing several tone qualities simultaneously with the aid of only one glow-discharge lamp;

Fig. 11 is a diagrammatic view of a glow-discharge tube with a shield; and

Fig. 12 is a schematic view of a modified circuit.

Referring more particularly to Fig. 1 a circuit of my improved electrical musical instrument is shown which permits the production of a great variety of tone effects. For example, a great number of notes of different pitch, a variation of the quality of tone, a close imitation of banjo and mandolin effects, a true vibrato and efficient control of the volume can be obtained.

For the sake of simplicity and clarity only one glow-discharge lamp is shown in the circuit, so that only one note of musical frequency can be produced at a time. Obviously a multiplicity of such circuits can be arranged to cause the production of several musical notes simultaneously. In this case, of course, a number of the elements or parts of the circuits can be common, as, for instance, the battery, the output transformer, the volume and tone control, etc., as one skilled in the art will readily understand.

Essentially the electric circuit consists of a current source B, a glow-discharge lamp G, a variable condenser C—1; the transformer T and fixed resistors R—1 to R— n which can be connected by means of keys K—1 to K— n across C—1. For convenience this part of the circuit, which will be hereinafter called the "main circuit", is indicated in the drawings by thicker lines.

Resistances R—1 to R— n are all in series and one or any number of them can be connected across condenser C—1 by operating the corresponding key. When in this manner, one or more resistors are connected across condenser C—1, oscillations will be produced, the frequency of which depends on the capacity of C—1, the resistance connected across C—1 by the operated key, and the electromotive force of the current source B. By choosing suitable values for these factors it is possible to produce any musical frequency desired. For instance, an electromotive force of about 110 volts, a condenser C—1 of about 0.001 microfarads and a resistance R—1 of about 1 megohm will produce an oscillation of about 5/600 of a second. By giving suitable

values to R—2, R—3 . . . R—*n* in relation to R—1, any proportion between the successive notes can be procured. Of course, it is advantageous to choose such values which will produce the consecutive notes of the tempered scale. Although there are only five resistors depicted in Fig. 1, any number of them can be connected in series up to say about 40 to 50 or more. Approximate values for the resistances in this case are R—1 equals 1,000,000 ohms, R—2 equals 70,000 ohms, R—3 equals 75,000 ohms, R—4 equals 78,000 ohms, R—5 equals 84,000 ohms, etc. The advantage of having all the resistors in series is easily understood from the consideration that the proportion of the frequencies produced by the keys depends only on the proportion of the resistor values as those skilled in the art will readily appreciate. Changes in the capacity of C—1 or in the voltage of current source B, will affect every note in the same degree so that all of them may become higher or lower, but their relation to each other will always remain the same. In other words, the instrument will stay in tune. This applies also to the case when the resistors increase or decrease in resistance due to ageing, temperature differences and the like, because it is very likely that all the resistors of the same make and construction will be affected in the same way.

It is to be noted that another important advantage of the described series arrangement of the resistors is that in case there are several keys depressed at the same time, only the note of the highest pitch will be heard because if, for instance, K—1 and K—3 are depressed simultaneously only R—1 will be connected across C—1, while R—2 and R—3 are short circuited and will not influence the pitch of the oscillations produced. This makes it possible for the operator to rest his fingers on the keys, or in case an inexperienced operator happens to strike two or more keys at the same time no irrational notes will be produced but only the note corresponding to the highest key depressed. A further advantage is that by having one finger resting on a key and by depressing a higher key with another finger in rapid succession, the two notes can be produced so quickly after each other that they give the impression of being heard simultaneously. Although at any particular moment only one note is being emitted, polyphonic music has been successfully imitated by my improved electrical instrument. In passing it is to be observed that the oscillations produced are transferred by means of the transformer T to a thermionic amplifier and then to a sound producing contrivance L. The other parts of the circuit serve for adjusting the quality (color), pitch, and finally the volume of the oscillations produced.

Referring to the supplementary parts of the electrical circuits, a potentiometer P—1 shunted across part of the current source makes it possible to change the electromotive force in the circuit and thus the pitch of the oscillations established by the operation of any of the keys. The same effect can be obtained by varying C—1, but the changing of the electromotive force has the very important advantage that all the notes along the whole range are affected in the same degree and the relative proportion of the frequencies remains unchanged. This enables the operator to transpose a melody into any musical key desired by simply turning the potentiometer P—1, which is a very important advantage from the musical point of view. The various posi-

tions of the potentiometer raise or lower the pitch of every note of the instrument a certain fixed amount (octave, fifth, third, etc.) which can be marked and thus add to the usefulness of the instrument.

The known vibrato or tremolo effect of string instruments consists in slight periodical variations of the pitch imitating the vibrato of the human voice. A small capacity C—2 can be intermittently added to C—1 by moving the control lever A to and fro and alternately closing contact *d*—1. In this case the desired small variations of frequency are obtained by small changes of the capacity in the circuit, but, of course, the same effect can be obtained by varying the resistance or the electromotive force in the circuit, either by hand, or automatically. A few other methods for producing the aforesaid effect will be described hereinafter.

The same control lever A is used for producing an imitation of the tone quality of a banjo or mandolin. In order to produce this effect referred to in the following as banjo or mandolin effect, a switch S—1 is put into the right side position. In this case the contacts *d*—1 and *d*—2 will be connected to each other and the main circuit will be interrupted at *d*—3 and is completed only when lever A makes contact with *d*—1 or *d*—2. In other words when any one of the keys will be depressed this fact in itself will not produce any oscillations unless the circuit is completed at *d*—1 or *d*—2 by moving the lever A to the left and the right. At any interruption a little click will be heard in the speaker, and this with the interruptions of the note will give a striking imitation of a mandolin or banjo according to the circumstances, whether the original quality is rich or poor in the higher harmonics. Obviously the same effect can be obtained by interrupting the main circuit at other points either by hand or by some kind of automatic mechanical interrupter, buzzer, etc.

The original quality obtained by the glow-discharge lamp oscillator is very rich in the higher harmonics. Many other different tone colors containing more or less of the higher harmonics can be obtained by connecting capacities, resistors or inductances across a suitable part of the circuit as for instance across the primary of the output transformer a by-pass condenser offering less resistance to the higher frequencies produces a mellow, flute-like quality, whereas resistors or inductances have the tendency of distorting the oscillations and producing higher frequencies. A switch S—4 can be used for connecting alternately a number of different organs, condensers and inductances (C—3 and L') across the primary of the transformer and to produce different qualities. The volume of the output is controlled by a high resistance potentiometer P—2, connected advantageously across the secondary of the output transformer, so that the resistance variations while varying the volume do not affect the impedance of the main (primary) circuit and thus the pitch of the oscillations produced. The same control lever can be used for controlling the volume, and to produce either the tremolo or banjo effect simultaneously. A more detailed view of this combined control device can be seen in Fig. 5, the method of connections being the same as shown in Fig. 1.

The control lever A can be moved in a slot in two directions perpendicular to each other. The movement in the first direction, in the plane of the drawing, moves a sliding arm E on the potenti-

ometer P—2 and varies the volume. It is to be noted that the control lever A consists of two parts insulated at O, the upper part being made out of a flexible material, such as a flat strip of spring steel which permits little movement of the lever perpendicular to the former, and which makes contact alternately with *d*—1 and *d*—2. This design makes it possible for the operator to control the volume of the oscillations by moving lever A in the slot and to produce at the same time the vibrato or the banjo effect according to the position of S—1. The finest shades in volume and expression can thus be obtained by the use of only one hand.

The circuit shown in Fig. 1 is that of an instrument with fixed tuning. This means that although it is possible to move the whole range up and down by means of the potentiometer P—1, the frequency relations of the notes to each other determined by the resistors R—1 to R—*n* remain constant for a practically unlimited time so that under normal circumstances no retuning will be necessary.

For special purposes, orchestra work for example, it may be advantageous to tune the individual notes of the instrument. The simplest expedient would be to make the resistors R—1 to R—*n* variable. These resistances, however, are of the order of 100,000 ohms and adjustable resistors of this type are not only unreliable but are at the same time rather expensive. A practical arrangement for tuning every note independently is shown in Fig. 2. This arrangement contemplates a circuit which is nearly identical with the one shown in Fig. 1. The difference is that in Fig. 1 all the keys when depressed, make contact with the same contact wire F, which has the potential of the slide arm P—1. On the other hand in Fig. 2 a separate current source B—1 is provided across which a number of wire wound potentiometers P—1 to P—*n* are connected, one for every key. It is easily seen that by means of J—1 to J—*n*, the working voltage of each key can be individually adjusted and thus the note produced thereby can be varied within necessary limits. Generally a voltage of about 2–3 volts is sufficient to give a tuning range of 1 or 2 tones up or down.

In the vibrato arrangement illustrated in Fig. 1 a small condenser C—2 is alternately connected to C—1 causing a little variation of the frequencies produced. Of course, the pitch jumps from one frequency to the other. In contrast to the foregoing is the case of the vibrato of the string instruments where the finger of the operator is vibrated on the strings with the result that a continuous transition occurs between two slightly different pitches. In Fig. 3 a modification of the vibrato arrangement is shown which permits a continuous variation of the capacity of the tremolo condenser and thus of the frequency of the oscillations.

Reference characters H—1 and H—2 designate two brass plates which are provided with mica insulation between them to form a variable condenser of very low capacity. Plate H—1 is a strip of spring brass with a button B—*u* fastened at the one extremity. When the button is vibrated by the hand of the operator, the capacity of this small condenser will be alternately increased and decreased. If this condenser is wired in the same way as C—2 shown in Fig. 1, it is possible to obtain a perfect imitation of the continuous vibrato of the string instruments or of the human voice.

The speed of the vibrato variations of the fre-

quency is left to the taste of the operator. This gives the greatest possibility for individual expression, but for special purposes, particularly for creating polyphonic music, etc., the automatic production of the vibrato effect is preferable. Fig. 4 depicts an arrangement for this purpose. In the drawings circuit I is the skeleton of the glow-discharge lamp oscillator, consisting of the battery B, glow discharge lamp G—1, condenser C—1, resistance R—1, sound producing contrivance L, a fixed resistance R—*x* of adequate value, (say 10–40,000 ohms). The circuit II (G—2, C—2, R—2) is identical with I and the only difference is that a large condenser and high resistance are used to give a very low frequency of a few oscillations a second. Every time when G—2 is lighted, there will be a small additional drop of voltage through the resistance R—1 so that the working voltage of circuit I will be diminished. The result will be that the voltage and consequently the frequency in circuit I will be subject to small fluctuations in rhythm with the slow oscillations in circuit II. In other words, the desired effect can be obtained with the aforesaid arrangement.

Many interesting refinements are possible also in connection with the banjo effect. In Fig. 5 the familiar circuit containing current source B, glow-discharge lamp G—1, condenser C—1, resistors R—1 to R—*n* and interrupter A with the contacts *d*—1 and *d*—2 can be seen again. The high capacity condenser C—*x* (2–10 microfarads) is connected across current source B, but the connection is interrupted when moving A. In the latter case the glow-discharge lamp is supplied with current from C—*x*, but of course its charge being quickly exhausted, the electromotive force in the circuit is gradually decreased and, in consequence of this decrease, the frequency of the oscillations produced will be gradually decreased until contact is made again at *d*—1 or *d*—2. This arrangement produces a note which starts from one frequency which becomes quickly lower and finally returns to the original frequency. This very curious and unique quality when used discriminately gives interesting imitations of tone effects obtained by strings plucked or hit by various mechanical means.

A number of different tone qualities can be produced simultaneously by one glow-discharge lamp oscillator, as depicted in Fig. 10. This figure depicts an arrangement showing the production of three different qualities. A transformer T—1 may be substituted, for instance, for transformer T in Fig. 1, which is to be connected in the output circuit of the oscillator. Transformer T—1 has one primary P—*v*' and three secondaries S—10; S—20; S—30 constituting 3 different circuits, I, II, and III, each of which has a separate tone control switch S—10, S—20, S—30, connecting different capacities C—10, C—11; C—20; C—21, C—30; C—31, inductances and resistors or combinations thereof across the circuit. In this manner the original quality may be modified by suppressing or stressing the higher harmonics. Transformer T—2 is an output transformer with three primaries P—10; P—20; P—30 and one common secondary winding S—*e*, which recombines these three different qualities and leads them to the common amplifier and the sound producing contrivance. Obviously this arrangement is not limited to three qualities and can be subject to many different modifications. The shunt condensers,

resistors, etc., cause considerable losses in energy so that it is advisable to provide at least one stage of audio frequency amplification separately for each tone color. Although the circuit indicated in Fig. 10 is perfectly practical, better results and tone qualities can be obtained if the circuits carrying the different tone qualities (I, II, III) are amplified separately and connected to individual sound producing contrivances, and not recombined into one common output circuit as indicated by T—2 in Fig. 10.

Not only the glow-discharge lamp oscillator but practically all electrical musical instruments produce continuous notes, having about the same volume as long as they are sounded. The reason for this is that all electrical musical instruments produce undamped oscillations. In contrast to the foregoing notes, a group of known musical instruments and among them the most popular the piano produce damped oscillations, a note struck on the piano rapidly decreases in volume and fades away completely after a while. Of course, the electrical imitation of the characteristic piano quality is of very great practical importance. For producing this effect, it is possible to use volume controls across the output of the instrument, which when controlled by mechanical means decrease the volume of every note a short time after the corresponding key has been depressed. A much better arrangement is shown in Fig. 9 which is based upon purely electrical processes. In this arrangement between the output of the oscillator (producing the electrical oscillations of musical frequency) and the amplifier proper, there is an "intermediate" amplifier tube N arranged, the amplification factor of which can be influenced for example by varying the plate voltage.

Every key of the instrument apart from the contacts K—*n* and F for connecting the oscillator (glow-discharge lamp, etc., see Fig. 1) to the rest of the circuit, is arranged to have another set of contacts *d*—1 and *d*—2 fixed on one extremity of the key. Every time the key is depressed, the contact is closed but only for a very short time because *d*—1 will pass over *d*—2 and will touch it only for a moment. This momentary contact, however, is sufficient to charge up the large fixed condenser C—*x* (5–20 microfarads) from the current source B. At the same time contacts K—*n* and F will be closed and will start the musical oscillations of the desired pitch. The plate potential of the amplifier tube N will be supplied from the condenser C—*x* but of course the current supply being shut off, the voltage will decrease very quickly until the charge in the condenser is completely exhausted. This means of course that the amplification of the tube and thus the volume will also decrease from a maximum to zero within a short time. The duration in other words, the damping of the notes thus produced can be adjusted for example by varying the capacity C—*x*, adding C—*y* or C—*z* by means of the switch S. Obviously the same results can be achieved in many other ways than by varying the plate voltage of N. In many cases it might be more advantageous to change the grid bias or filament of the tube, some of the modern tubes having more than one grid, being especially adapted for this.

The possibilities for producing different tone colors are by no means exhausted by the methods described hereinabove many variations and combinations suggest themselves to those familiar with the art.

As is the case with every musical instrument the stability of the frequencies produced is of extreme importance, in other words the musical instrument has to stay in tune for a very long time.

If the elements are of good quality and the improvements described herein are made use of, the glow-discharge lamp will produce oscillations of a remarkable stability. Apart from the electromotive force, the capacity and resistance in the glow-discharge lamp circuit, the frequency also depends on the critical lighting and extinction voltages of the lamp. This in turn is slightly changed when the electrodes of the lamp are illuminated by an external source of light. The illumination facilitates the emission of negative electrons from the cathode and lowers the resistance of the lamp, as is the case with the photo electric cells. For this reason it is advisable to cover the glow-discharge lamp with an opaque shield which if made of metal will at the same time protect the lamp against outside electrical and magnetic fields.

Fig. 11 shows an example of a shield SH covering the glow-discharge lamp G and fastened to the base of the lamp SO which is made of an opaque, non-transparent material. The wire connection at the top of the shield, of course, only functions in the event that the shield is metallic and can be used to connect the shield to a point of constant potential.

Experience also shows that a constant potential should be maintained on the electrodes of the lamp in order to obtain maximum stability. In other words, the circuit; lamp—current source—and fixed condenser, should always be closed even when the instrument is not used. The exact reasons for this are not yet entirely clear and have not been established. Very probably the tube is oscillating at an extremely slow rate, (one oscillation every 10–15 minutes) even when no resistance is connected across the condenser, because the insulation resistance of the pitch condenser (C—1; Fig. 1) is never infinite and represents an extremely high resistance across the condenser. Thus the conditions for the production of oscillations are fulfilled even when no one of the keys is depressed. Very probably these slow oscillations maintain an equilibrium in the arrangement of gas ions and electrons favorable to the stability of the oscillations.

In consequence of this the on—off switch of the instrument has to be arranged so as not to interrupt the main circuit of the oscillator but nevertheless to stop the production of oscillations. This condition is fulfilled in the circuit depicted in Fig. 1. The switch S—3 interrupts one side of the potentiometer P—1, S—2 interrupts the common lead of the resistors F, but the main circuit is left undisturbed. S—2 and S—3 may be united in the same two circuit switch so that they are always worked simultaneously.

Reference has been made several times to the circumstance that the frequency of the glow-discharge lamp oscillator depends principally on the electromotive force, the capacity and the resistance in the circuit. In consequence of this the same frequency can be produced by very different values of these, as for instance, by a larger capacity and low resistance and vice versa. The output (volume), however, is by no means identical under these different conditions; and appears to be larger, the greater the capacity of the condenser. This gives an excellent possibility to produce uniform volume for widely different

ferent frequencies of the musical range, this being especially important when a great number of glow-discharge lamp oscillators are used. All that is necessary is to use condensers of the same capacity in each of the circuits and to obtain the desired differences in pitch for instance, by means of different resistors. This condition is fulfilled in Fig. 1 where C—1 is common for the whole range and only the resistance in circuit is varied by depressing the different keys.

The oscillations produced by the glow-discharge lamp oscillator need generally to be amplified in order to obtain the necessary volume in the sound producing contrivance. The method of transferring the energy from the oscillator to the amplifier is very important. The coupling used should be extremely loose, otherwise there will be a reaction from the amplifier to the oscillator changing the impedance and the frequency response of the circuit. As a result of this the instrument might be in tune with a certain amplifier and entirely out of tune with another. The fact that the oscillations of the glow-discharge lamp are accompanied by periodic emissions of light from the electrodes can be advantageously used for coupling the oscillator to the amplifier without any electrical connection existing between them (Fig. 8).

Oscillations are set up in the circuit B, G, C, R in the usual manner. In the proximity of the glow-discharge lamp G is situated the photo electric cell Ph which is illuminated by every discharge of G. The weak photo electric currents set up in Ph due to the periodic discharges in the lamp G are amplified and converted into sound by the sound producing contrivance L. Every electric connection between the oscillator and the amplifier has been thus eliminated, giving an absolute freedom from reaction from the amplifier, or from the transfer of contact making and breaking clicks from the oscillator. Obviously several photo electric cells can be illuminated by the same glow-discharge lamp and vice versa the oscillations produced by a multiplicity of glow discharge lamps can be picked up by one photo electric cell. Filters, diaphragms and the like arranged as D between G and Ph can be used for making variations in the transfer of light energy for changing volume, tone color, etc.

For the amplification of the electrical oscillations of musical frequency as produced by the glow-discharge lamp oscillator any audio frequency amplifier can be used, or the audio-frequency part of any radio receiver. Eventually the generator of musical frequencies can be used, first to modulate a small radio-frequency oscillator; the instrument and the radio-frequency generator together produce a radio-frequency current modulated by the musical frequencies much in the same way as is done at a radio transmitting station. The resulting signal can now be impressed upon the radio receiver either by wireless (having the set in proximity of the oscillator) or by means of a wire connection between the output of the audio-radio oscillator combination and the aerial-ground posts of the radio receiver.

In the left part of the drawings the usual arrangement of a glow-discharge lamp electrical musical instrument consisting of glow-discharge lamp, G, condenser, C, source of current, B, a plurality of resistors, R—1 to R—n with associated switching keys, K—1 to K—n can be seen.

The middle part of the drawings shows a generator of radio-frequency oscillations, the audion tube OS is arranged in one of the conventional

circuits, oscillations set up in the plate circuit of the tube are partly fed back to the oscillatory circuit on the grid, partly transferred to the aerial AE—1. These radio frequency oscillations are modulated by the output of the musical instrument IN, the output being coupled to the grid circuit of OS through the transformer TR, and thereby varying the grid bias of the oscillator. In consequence of this, in the aerial AE—1 a modulated radio frequency current will be existing when the electrical musical instrument is played. This signal will be picked up by the aerial AE—2 of the radio receiver, RE, arranged in the proximity of AE—1, and the sound-producing means L will emit sound corresponding to the switching keys operated in the electrical musical instrument. Obviously any other electrical musical instrument can be substituted in the place of the instrument of the glow-discharge lamp type; and like-wise any of the known and various methods of generating high frequency currents and modulating same by an audio frequency current can be used. In order to insure maximum efficiency, the oscillator OS and the receiver RE have to be tuned to the same wave-length. The advantage of this method is that any radio receiver, without any change whatever can be used for the amplification, that both the radio and the audio-frequency amplification of the receiver are made use of, and that in addition a wire connection between the instrument and the amplifier (in this case the radio receiver) is not absolutely necessary.

It will be observed that the present invention provides an electrical musical instrument in which sounds are produced by means of electrical oscillations produced in oscillating circuits which are controlled to vary the sound produced.

I claim:

1. An electrical musical instrument comprising a main electrical circuit containing a source of current, a glow-discharge lamp and a condenser in series with said source of current; an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of any two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistances from the main circuit and being capable of actuation for shunting a plurality of said series resistances across said condenser thereby completing the main circuit and causing current to flow through said lamp; and sound-producing means connected in said main circuit and capable of emitting sound, the pitch of the emitted sound being the highest when one resistance is operating and being the lowest when all of the series resistances are operating and intermediate when a plurality of resistances are operating.

2. An electrical musical instrument comprising a main electrical circuit containing a source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer, all in series with said source of current; an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of any two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plurality of said series resistances across said condenser thereby completing the main circuit and causing current

to flow through said lamp; and sound producing means connected to the secondary winding of said transformer and being capable of emitting sound of a different pitch for every switching key operated, the sound being the highest when only one resistance is connected across the condenser and being the lowest when all the series resistances are connected across the condenser.

3. An electrical musical instrument comprising
 10 a main electrical circuit containing a source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer, all in series with said source of current; an auxiliary circuit
 15 operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of any two
 20 adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plurality
 25 of said series resistances across said condenser and thereby completing the main circuit and for causing current to flow through said lamp; means
 30 located in the main circuit for varying the voltage of the source of current; sound-producing means connected to the secondary of the transformer and being capable of emitting sound of different
 35 pitch for every switching key operated, the pitch of each musical note varying with a variation of the voltage of the source of current and the musical intervals between the various notes remaining substantially constant.

4. An electrical musical instrument comprising
 35 a main electrical circuit containing a source of current, means for adjusting the voltage of said source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer, all in series with said source of current; an aux-
 40 iliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of two
 45 adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plural-
 50 ity of said series resistances across said condenser and for causing current to flow through said lamp, a second auxiliary circuit containing a con-
 55 denser and an electrical contact capable of connecting and disconnecting said condenser across the main circuit condenser thereby causing small variations of the capacity thereof; sound-produc-
 60 ing means operatively associated with the secondary of the transformer and being capable of emitting sound of different pitch for every switching key operated, the pitch of the emitted sound being varied when the capacity of the main circuit con-
 65 denser is varied by connecting the auxiliary circuit condenser thereto.

5. An electrical musical instrument comprising
 65 a main electrical circuit containing a source of current, means for adjusting the voltage of said source of current, a glow-discharge lamp, a con-
 70 denser and the primary of a transformer, all in series with said source of current; an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in se-
 75 ries, a switching key for each of the said resistances located between each common point of two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plurality

of said resistances across said condenser and for causing current to flow through said lamp; a second auxiliary circuit containing a condenser; and an electrical contact capable of connecting and disconnecting said condenser across the main circuit condenser thereby causing small variations of the capacity thereof; a circuit interrupting contact in the main circuit capable of rapidly opening and closing the same, sound-producing means operatively associated with the transformer and being capable of emitting sound of different pitch for every switching key operated, the emitted sound starting and stopping in rapid succession when the main circuit interrupter is operated.

6. An electrical musical instrument comprising a
 15 main electrical circuit containing a source of current, means for adjusting the voltage of said source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer, all in series with said source of current; an auxiliary cir-
 20 cuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of two adjoining
 25 resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plurality of said series resistances across said condenser and for causing
 30 current to flow through said lamp; a second auxiliary circuit containing a condenser and an electrical contact capable of connecting and disconnecting said condenser across the main circuit
 35 condenser; a switch arranged between the second auxiliary circuit and the main circuit permitting to switch over said electrical contact in series with the main circuit for rapidly opening and closing
 40 same; sound-producing means operatively associated with the transformer and being capable of emitting sound of different pitch for every switching key operated, the pitch of said emitted sound being varied when said electric contact is con-
 45 nected and operated in the second auxiliary circuit, and the emitted sound starting and stopping in rapid succession when said electric contact is operated in the main circuit.

7. An electrical musical instrument comprising
 50 a main electrical circuit containing a source of current, means for adjusting the voltage of said source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer, all in series with said source of current; a mul-
 55 tiplicity of impedances capable of being selectively connected across primary or secondary winding of said transformer for changing frequency response of same; an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a
 60 switching key for each of the said resistances located between each common point of two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistances from the main circuit and being ca-
 65 pable of actuation for shunting a plurality of said series resistances across said condenser and for causing current to flow through said lamp; a second auxiliary circuit containing a condenser and an electrical contact capable of connecting and disconnecting said condenser across the main
 70 circuit condenser; a switch situated between the second auxiliary circuit and the main circuit permitting to switch over said electrical contact in series with the main circuit for rapidly opening and closing same; sound-producing means op-
 75 eratively associated with the transformer; a

volume-control device intermediary to the transformer and the sound-producing means controlling the transfer of electrical energy to same; said sound producing means being capable of emitting a sound of different pitch for every switching key operated, the tone color of the emitted sound varying when the impedance across the transformer winding is varied; and the volume of the emitted sound varying when the adjustment of said volume control device is varied.

8. An electrical musical instrument comprising a main electrical circuit containing a source of current, means for adjusting the voltage of said source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer, all in series with said source of current; a multiplicity of impedances capable of being selectively connected across primary or secondary winding of said transformer; an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of these resistances located between each common point of two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plurality of said series resistances across said condenser; a second auxiliary circuit containing a condenser and an electrical contact capable of connecting and disconnecting said condenser across the main circuit condenser; a switch arranged between the second auxiliary circuit and the main circuit permitting to switch over said electrical contact in series with the main circuit for rapidly opening and closing same; sound-producing means operatively associated with the transformer; a volume control device intermediary to the transformer and the sound-producing means; and a control lever movable in two different directions, said lever controlling the aforesaid volume-control when moved in the one direction and operating the aforesaid electrical contact when moved in the other direction.

9. An electrical musical instrument comprising a main electrical circuit containing a source of current, a glow discharge lamp, a condenser and the primary winding of a transformer all in series with said source of current; an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistance from the main circuit and being capable of actuation for shunting a plurality of said series resistances across said condenser and for causing current to flow through said lamp, an-

other condenser being capable of control for continuous variation connected across the main circuit condenser capable of changing the resultant capacity of both condensers continuously; sound-producing means operatively associated with the secondary of the transformer and being capable of emitting sound of different pitch for every switching key operated, the pitch of said emitted sound being continuously varied when the capacity of the condenser associated with the main circuit condenser is continuously varied.

10. An electrical musical instrument comprising a main electrical circuit containing a source of current, a glow-discharge lamp, a condenser and the primary winding of a transformer all in series with said source of current, an auxiliary circuit operatively connected with said main circuit containing a plurality of resistances in series, a switching key for each of the said resistances located between each common point of any two adjoining resistances and one side of the condenser, said key being normally open to disconnect the resistances from the main circuit and being capable of actuation for shunting a plurality of said series resistances across said condenser and causing current to flow through said lamp; an on-off switch capable of interrupting the auxiliary circuit thereby making inoperative the switching keys and at the same time leaving the main circuit undisturbed; and sound-producing means operatively associated with the transformer and being capable of emitting sound of a different pitch for every switching key operated when the aforesaid on-off switch is completing the auxiliary circuit and being inoperative when by said switch the auxiliary circuit is interrupted.

11. An electrical musical instrument comprising a circuit containing a glow-discharge lamp, a condenser, a resistance and a source of current; means for producing oscillating electrical currents in said circuit; control means for said oscillating producing means for varying the frequency of the oscillations and including a plurality of manually operative elements; and means for collectively varying the effect of the manually operative elements.

12. An electrical musical instrument comprising a plurality of circuits containing glow-discharge lamps, condensers, resistances and sources of current; means for producing oscillating electrical currents in said circuits; control means for said oscillating producing means for varying the frequency of the oscillations and including a plurality of manually operative elements; means for collectively varying the effect of the manually operative elements; and means for regulating the pitch.

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