

June 16, 1936.

N. LANGER

2,044,360

ELECTRICAL MUSICAL INSTRUMENT

Original Filed April 5, 1933

2 Sheets-Sheet 1

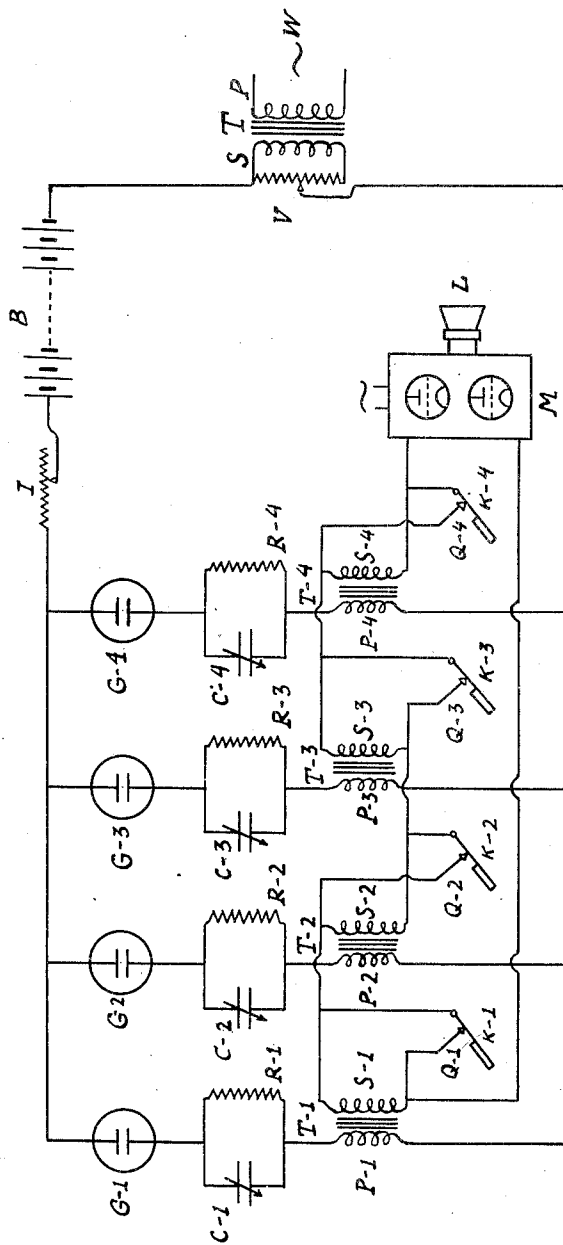


Fig. 1.

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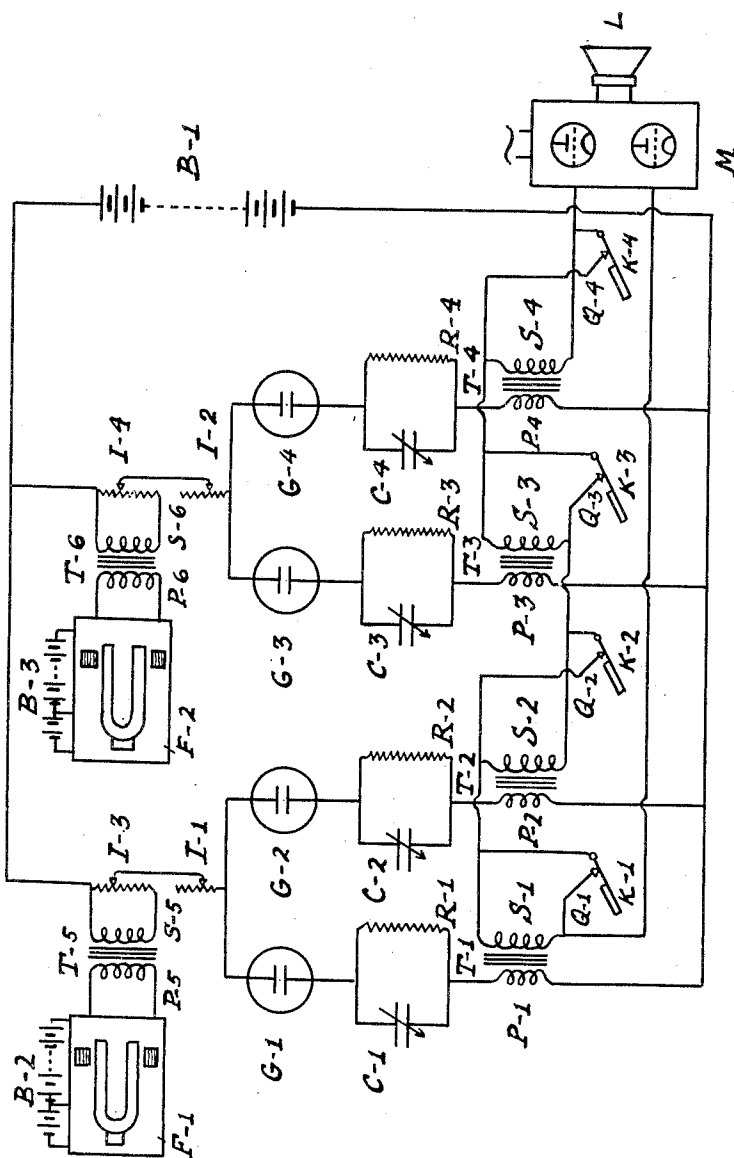


Fig. 2.

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2,044,360

ELECTRICAL MUSICAL INSTRUMENT

Nicholas Langer, New York, N. Y., assignor of
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Original application April 5, 1933, Serial No.
664,487. Divided and this application October
14, 1935, Serial No. 44,880

11 Claims. (Cl. 84—1)

The present invention relates to improved electrical musical instruments containing glow-discharge lamps. The present application is a division of my co-pending application Ser. No. 664,487 filed April 5, 1933, now Patent No. 2,017,542, granted October 15, 1935.

A primary object of the present invention is to eliminate substantially all of the instability of the tuning of electrical musical instruments containing glow-discharge lamps and to provide arrangements for keeping in tune indefinitely.

It is another object of the present invention to use alternating current sources of very constant frequency such as oscillating audion tubes controlled by quartz crystals, magnetostriction oscillators, tuning fork oscillators and the like for stabilizing the frequency of glow-discharge lamp oscillators individually or in suitably arranged groups.

It is a further object of the present invention to provide an improved electrical musical instrument of very stable tuning which is simple and inexpensive in construction and is reliable and fool-proof in operation.

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

Fig. 1 is a fragmentary diagrammatic view of a circuit of an improved electrical musical instrument embodying the invention in which an external alternating current source of constant frequency is used to stabilize the frequency of oscillations produced by a group of glow-discharge lamps.

Fig. 2 depicts diagrammatically the circuit of an electrical musical instrument embodying the present invention in which a number of glow-discharge lamp oscillators arranged in groups are controlled by a master oscillator in each group.

I have discovered that undesirable variations in the frequency of glow-discharge lamp oscillators were due largely to variations in the critical voltage (break-down and extinction voltage) of the lamp, while other factors governing the frequency such as the electromotive force, the capacity and resistance can easily be kept constant. As a result of numerous experiments I have found that the discharge through a glow-discharge lamp at the right moment, even with small variations in the characteristics of the lamp, can be easily obtained by applying a weak alternating current voltage of suitable value, frequency and phase to the electrodes of the lamp.

According to my discovery, the auxiliary weak

alternating current when added to the constant electromotive force of the current source and when pressing approximately the same frequency as the glow-discharge lamp oscillator tends to build up a discharge through the lamp every time it reaches one of its maximum (peak) voltages, either the positive or the negative peak depending upon the method of connections. In this manner, the impressed weak alternating current voltage, which only has to be a fraction of the voltage of the direct current source will have a marked stabilizing effect on the frequency of the glow-discharge lamp oscillator. Tests have shown that even considerable variations of the condenser capacity or of the resistance or of the characteristics of the lamp will not change the frequency. Moreover, it has also been found that it is not absolutely necessary to have the frequency of the glow-discharge lamp oscillator and of the impressed alternating current exactly the same because it was found that one of the frequencies may be a multiple of the other.

In carrying the invention into practice, the alternating current voltage to be impressed is taken from an external source of current as, for example, tuning fork oscillator, magnetostriction oscillator, quartz crystal oscillator, and the like.

Referring to Fig. 1 an arrangement of the foregoing kind may be seen in which four glow-discharge lamp oscillators, consisting essentially of lamp G—1, condenser C—1, resistor R—1; lamp G—2, condenser C—2, resistor R—2; lamp G—3, condenser C—3; resistor R—3 and lamp G—4, condenser C—4, resistor R—4, are operated from a common current source B. The four oscillators are preferably tuned in multiples of the same frequency, for instance, in octaves. In other words, if the circuit G—1, C—1, R—1 is tuned to the frequency f , the others are tuned, for instance, to $2f$, $4f$, and $8f$.

A coupling between the individual oscillators may be effected by means of a variable impedance I which is common to all circuits. The amount of alternating current voltage impressed by one oscillator upon the other can be adjusted by making the aforesaid coupling tighter or looser according to the principle disclosed in my co-pending application Ser. No. 664,487. It is to be observed, however, that this coupling impedance is not absolutely necessary to obtain the desired stabilizing effect which according to the present invention is provided by impressing an alternating current voltage taken from an external source upon the oscillators.

The output of the individual oscillators is taken

off by means of the transformers T—1 to T—4. Each oscillator has the primary winding P—1 to P—4 of one of these transformers in series, while all the secondaries S—1 to S—4 of the trans-
 5 formers are connected in series with each other and to the input side of the thermionic amplifier M which is operatively associated with sound producing means L.

The switching keys K—1 to K—4 keep the con-
 10 tacts Q—1 to Q—4 normally closed and the secondaries S—1 to S—4 of the transformers short-circuited so that, although the four oscillators are each continuously producing an oscillation, none of these oscillations can reach the ampli-
 15 fier. As soon, however, as any one or several of the keys are depressed, the corresponding secondary winding will have its short-circuited lead opened and the output of the associated oscillator will go to the amplifier, thereby producing
 20 a musical note, when only one key is depressed, and a musical chord, when several keys are depressed.

In case the oscillators associated with lamps G—2, G—3, and G—4 are tuned in multiples of
 25 the frequency of lamp G—1, preferably in octaves, they will always maintain a constant frequency relation. The reason for this is that the voltage drop in impedance I is proportional to the total current drawn by all the glow-discharge lamp
 30 oscillators and acts as an alternating electromotive force which is opposed to current source B and which will facilitate the discharge through the glow-discharge lamps in the right moment
 35 when a minimum has been reached. The four oscillations will be always in phase with each other and will maintain their constant frequency relationship even in case condensers C—1 to C—4 or resistors R—1 to R—4 are slightly changed on
 purpose.

Of course, even when the oscillations have their
 40 frequency relations maintained constant by means of the stabilizing impedance, they might change their absolute frequency together. In order to eliminate these possible variations, ac-
 45 cording to the principles of the present invention an auxiliary alternating current voltage is impressed on the circuit through the transformer T, the amount of this voltage being capable of adjustment by means of the potentiometer V
 50 across the secondary winding S of the transformer. The alternating current source W can be any of the oscillation generators known for their constancy in the radio art, as for example a quartz crystal controlled thermionic tube oscilla-
 55 tor or a so-called magnetostriction oscillator. It is preferred, however, to produce a constant alternating current voltage by means of a tuning fork which is maintained in continuous oscillations electrically. An oscillator of the tuning fork
 60 type is much more simple and economical in operation than any of the previously mentioned methods and is less expensive and less bulky than prior oscillators. These features are of con-
 65 siderable importance because generally twelve "master oscillators" tuned to a different note of the tempered scale are necessary for a complete electrical musical instrument. In view of the fact that all of these oscillation generators of stable frequency are well-known to those skilled
 70 in the art a description thereof will not be necessary.

The complete arrangement of an electrical musical instrument according to the invention may be seen in Fig. 2 which shows for the sake
 75 of simplicity and clarity only four glow-discharge

lamp oscillators. The essential parts of the oscillators are lamp G—1, condenser C—1, resistor R—1; lamp G—2, condenser C—2; resistance R—2; lamp G—3, condenser C—3, resistor R—3; and lamp G—4, condenser C—4, resistor R—4.
 5 A variable impedance I—1 provides a "tight coupling" between the circuits G—1 and G—2, variable impedance I—2 between G—3 and G—4, although, as described hereinabove, the impedance may be omitted, if desired, in which case the
 10 stabilization of the oscillators is exclusively provided by means of the auxiliary alternating current voltage impressed on the several circuits. G—2 preferably produces the octave of the note produced by G—1 and G—4 the octave of G—3.
 15 A tuning fork "master oscillator" F—1 and F—2 operated by the batteries B—2 and B—3 respectively is provided for each group. The output of each tuning fork is taken off through the trans-
 20 formers T—5 and T—6 and the secondary windings thereof S—5 and S—6 have an impedance I—3 and I—4 connected across them. By providing a sliding contact the exact amount of the auxiliary alternating current voltage to be ap-
 25 plied to the glow-discharge lamps can be adjusted. It is evident that this auxiliary current should be kept as low as possible, otherwise, it might interfere with the oscillations to be stabilized. The natural frequency of F—1 is pre-
 30 ferably the same as of one of the circuits associated to G—1 or G—2 and of F—2 the same as one of G—3 or G—4.

It is to be observed that the essential feature of the present method is to provide a fairly "loose coupling" between an auxiliary source of
 35 alternating current of constant frequency and a group of glow-discharge lamp oscillators to secure an absolute constancy of tuning. Although the so-called "galvanic coupling" indicated by a variable resistance or potentiometer is shown in the
 40 drawings it is evident that the method by means of which the desired amount of coupling is obtained is insignificant. Any other adjustable means of coupling may be used, such as inductive, capacitive or resistance (galvanic) coupling
 45 or combinations thereof.

The output of the individual glow-discharge lamp oscillators is connected in the same way as in the circuits shown in Fig. 1. Small trans-
 50 formers T—1 to T—4 are connected with their primary winding P—1 to P—4 in series with each of the glow-discharge lamp oscillators and complete the circuit with the current source B—1 which is common to all oscillators. Since these
 55 circuits are constantly closed, an alternating current of different and constant frequency will exist in each of the secondary windings S—1 to S—4 which are all in series and connected to the input side of the thermionic amplifier M. A con-
 60 tact (Q—1 to Q—4) normally closed is associated with each of the secondaries S—1 to S—4 and keeps them short-circuited so that the output cannot reach the amplifier. As soon, however, as any of the switching keys K—1 to K—4 are
 65 operated, the corresponding short-circuiting lead will be interrupted and a musical note will be heard in the sound producing means L associated with the amplifier, and a musical chord will be heard when several keys are operated simultane-
 70 ously.

For the purpose of describing the number of tuning fork oscillators and glow-discharge lamp
 oscillators needed for a practical instrument, the frequency range of a piano will be taken as an
 75 example. This range is a little over 7 octaves, 75

or 7 times 12 equals 84 notes. It is preferable to use an arrangement which provides twelve tuning fork oscillators, each being tuned to a different note of the tempered scale in the same octave such as: C, C sharp, D, D sharp, E, F, F sharp, G, G sharp, A, A sharp, B. Each of these tuning fork oscillators is associated with a group of seven glow-discharge lamp oscillators which are all tuned to the same note of the scale, but in different octaves. This involves twelve tuning fork oscillators and eighty four glow-discharge lamp oscillators.

What I claim is:—

1. An electrical musical instrument comprising a circuit, a glow-discharge lamp oscillator in said circuit, a source of direct current for said circuit, a source of alternating current having a constant frequency in a simple numerical relation to the frequency of said glow-discharge lamp oscillator, and coupling means for impressing said alternating current on said circuit to stabilize the frequency of said glow-discharge lamp oscillator.

2. An electrical musical instrument comprising a circuit, a glow-discharge lamp oscillator in said circuit, a source of direct current supplying electrical energy for said oscillator, a source of alternating current having a constant frequency in a simple numerical relation to the frequency of said glow-discharge lamp oscillator, adjustable coupling means for impressing regulated portions of said alternating current on said oscillator to stabilize the frequency thereof, and a sound producing means capable of emitting sound in accordance to the resultant of said oscillations.

3. An electrical musical instrument comprising a plurality of circuits, a glow-discharge lamp oscillator in each of said circuits, a common source of direct current for all of the said circuits, a source of alternating current having a constant frequency in a simple numerical relation to each of the frequencies of said glow-discharge oscillators, coupling means for impressing said alternating current on each of said glow-discharge lamp oscillators to stabilize the frequency thereof, and sound producing means capable of being selectively connected to said glow-discharge oscillators to produce musical sounds.

4. An electrical musical instrument comprising a plurality of circuits, a glow-discharge lamp oscillator in each of said circuits, a common source of direct current for all of the said circuits, a source of alternating current having a constant frequency in a simple numerical relation to each of the frequencies of said glow-discharge lamp oscillators, coupling means for impressing said alternating current on each of said glow-discharge lamp oscillators, means for regulating said coupling in such manner as to maintain the frequency of said oscillators constant by means of the alternating current impressed thereon, and sound producing means capable of being connected to said glow-discharge lamp oscillators to emit musical sounds.

5. An electrical musical instrument comprising a plurality of circuits, a glow-discharge lamp oscillator in each of said circuits, a common source of direct current for all of the said circuits, a source of alternating current having a constant frequency in a simple numerical relation to each of the frequencies of said glow-discharge lamp oscillators, coupling means for impressing said alternating current on each of said glow-discharge lamp oscillators to maintain constant the frequency thereof, sound producing means capable

of emitting sound in accordance to the oscillations produced by said oscillators, and switching means for selectively connecting said oscillators to the said sound producing means.

6. An electrical musical instrument comprising a plurality of circuits, a glow-discharge lamp oscillator in each of said circuits, a common source of direct current for all of the said circuits, a source of alternating current having a constant frequency in a simple numerical relation to each of the frequencies of said glow-discharge lamp oscillators, coupling means for impressing said alternating current on each of said glow-discharge lamp oscillators whereby the frequency of said oscillators will be maintained constant, a sound producing means capable of being selectively connected to said glow-discharge lamp oscillators to produce musical sounds, and an amplifier intermediate to said oscillators and said sound producing means.

7. An electrical musical instrument comprising a plurality of glow-discharge lamp oscillators, a common source of direct current for all of the said oscillators, coupling means providing tight coupling between said oscillators to maintain constant their relative frequencies, a source of alternating current having a constant frequency in a simple numerical relation to the frequencies of said oscillators, coupling means providing loose coupling between said oscillators and said common alternating current source to maintain constant the absolute frequencies of said oscillators, and sound producing means capable of being selectively connected to said oscillators to emit musical sounds.

8. An electrical musical instrument comprising a plurality of glow-discharge lamp oscillators tuned in octaves, a common source of direct current for all of the said oscillators, a master oscillator producing an alternating current of constant frequency and in simple numerical relation to each of the frequencies of said oscillators, means for impressing a regulable portion of the output of said master oscillator on all of said oscillators to stabilize the frequencies thereof, and a sound producing means capable of being selectively actuated by said oscillators to emit sound.

9. An electrical musical instrument comprising a plurality of groups, a multiplicity of glow-discharge lamp oscillators in each of said groups, a master oscillator for each of said groups producing a constant alternating current having a frequency in simple numerical relationship to each of the frequencies of the oscillators in the group, coupling means for said master oscillators for impressing an adjustable portion of their output on said oscillators in the associated groups to stabilize the frequency thereof, a source of direct current in common for all of said oscillators, a sound producing means electrically associated with said oscillators, and switching means intermediate to said oscillators and said sound producing means for selectively introducing the output of said oscillators in said sound producing means to produce musical sounds.

10. An electrical musical instrument comprising 12 groups, a plurality of glow-discharge lamp oscillators tuned in successive octaves of a note of the tempered scale in each of said groups, a master oscillator for each of said groups producing a constant alternating current having a frequency in simple numerical relationship to each of the frequencies of the oscillators in the group, coupling means for said master oscillators for impressing an adjustable portion of their output

- on said oscillators in the associated groups to stabilize the frequency thereof, a source of direct current in common for all of said oscillators, a sound producing means electrically associated with said oscillators, and switching means intermediate to said oscillators and said sound producing means for selectively introducing the output of said oscillators in said sound producing means to produce musical sounds.
- 10 11. An electrical musical instrument comprising a plurality of circuits, a glow-discharge lamp oscillator adapted to produce electrical oscillations in each of said circuits, the frequencies of said oscillators being adjusted to have simple numerical relations, coupling means associated with all these circuits providing "tight coupling" between same thereby stabilizing their frequency relations; a source of direct current; and a source of alternating current comprising a tuning fork electrically maintained in continuous vibrations, in common for all circuits, said alternating current of a constant frequency equalling the frequency of one of the glow-discharge lamp oscillators being impressed through an adjustable coupling on all glow-discharge lamp oscillators thereby assuring constancy of their absolute frequencies; a thermionic amplifier; a switching key for each glow-discharge lamp oscillator located between the oscillator and the common amplifier and being capable of permitting or stopping transfer of said oscillations to the amplifier; and sound producing means operatively associated with said amplifier and being capable of emitting a musical sound for every switching key operated and a musical chord when a plurality of keys are operated.
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