Nov. 17, 1931. N. LANGER 1,832,402

ELECTRICAL MUSICAL INSTRUMENT

Filed April 21, 1930 2 Sheets-Sheet 1

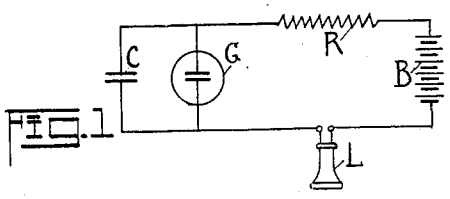


FIG. 1

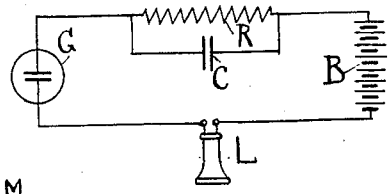


FIG. 2

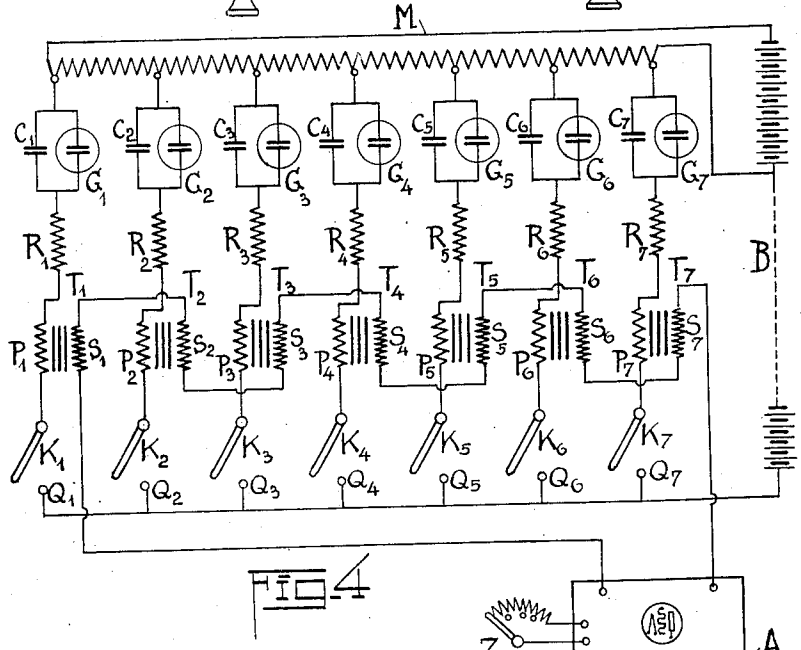
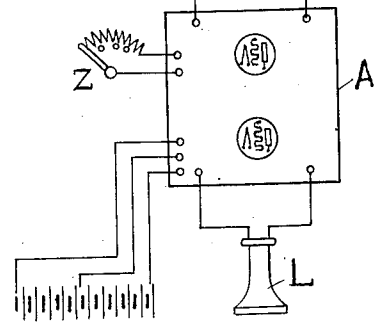


FIG. 4



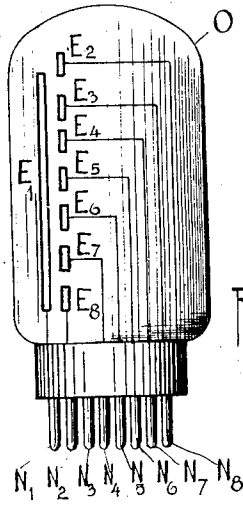


FIG. 3

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Nov. 17, 1931. N. LANGER 1,832,402

ELECTRICAL MUSICAL INSTRUMENT

Filed April 21, 1930 2 Sheets-Sheet 2

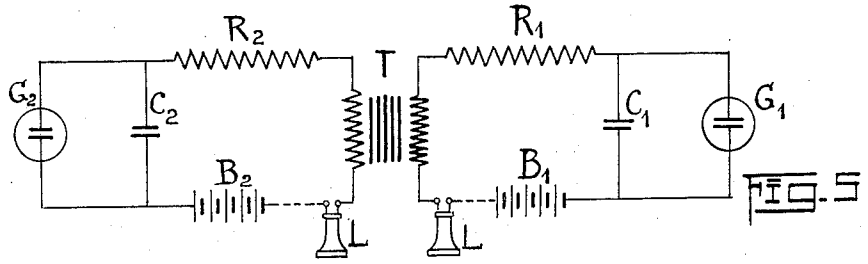

FIG. 5

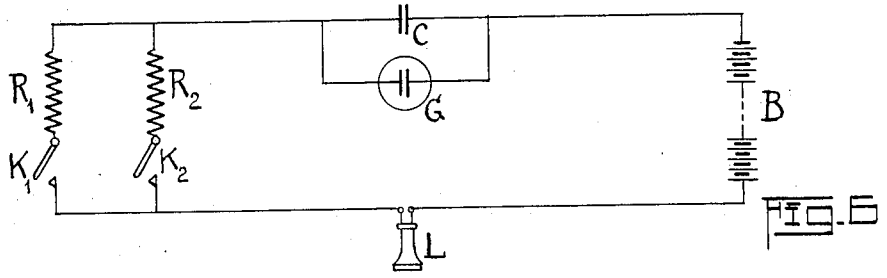

FIG. 6

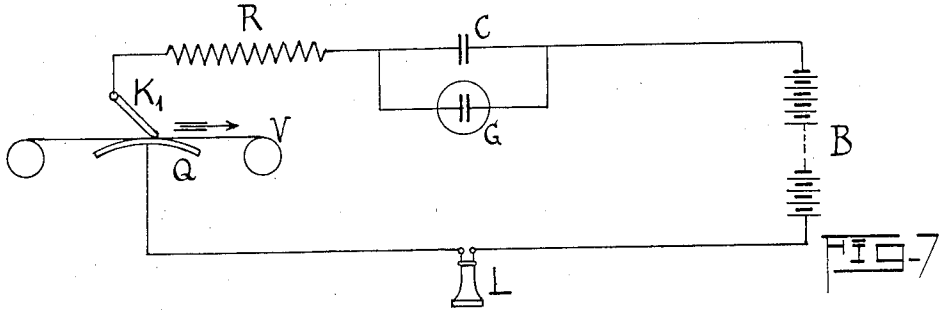

FIG. 7

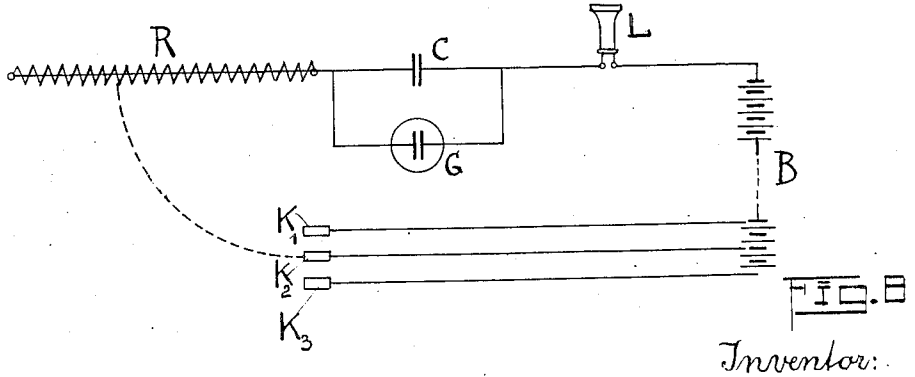

FIG. 8

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Patented Nov. 17, 1931 1,832,402

UNITED STATES PATENT OFFICE

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ELECTRICAL MUSICAL INSTRUMENT

Application filed April 21, 1930, Serial No. 446,158, and in Hungary November 28, 1929.

My invention relates to electrical musical instruments of the type in which sounds are produced by means of electric oscillations.

It is an object of my invention to improve an instrument of this type. To this end I provide instead of the usual thermoionic valves glow-discharge lamps in connection with a source of current and a sound-producing contrivance.

Sound production in musical instruments by means of electric oscillations is an old problem but as heretofore performed, to wit, by means of thermoionic valves it involves the drawback that the cost and the space requirements are prohibitive, for in instruments in which thermoionic valves are employed, it is necessary to provide as many valves, each with its oscillatory circuit and other accessories, such as capacities, inductances and the like, as there are sounds of various pitches to be produced.

Another drawback of instruments having thermoionic valves is the difficulty of producing oscillations of adequate constancy, and therefore the many attempts to provide a suitable musical instrument with thermoionic valves have failed.

By using glow-discharge lamps instead of thermoionic valves, I obtain a very cheap, simple and small instrument. The production of electric oscillations by means of glow-discharge lamps is old, but it has never been suggested to use such glow-discharge lamps in connection with a musical instrument.

Glow-discharge lamps as manufactured at present are not quite suitable for the production of electrical oscillations of adequate constancy, as the gas atmosphere in the lamps is partly absorbed by the electrodes, and therefore subjected to slight alterations. Besides electrostatic fields outside of the lamps and temperature variations may cause variations in the frequency of the oscillations. However these difficulties can be overcome by improving the manufacturing methods, particularly by saturating the electrodes thoroughly with the gas, before the bulb of the lamp is sealed. By these means the constancy of the oscillations is maintained.

The influences of electrostatic fields and temperature are eliminated by grounded metal sheets surrounding the lamps.

In the drawings affixed to this specification and forming part thereof various diagrams of connections for an instrument embodying my invention, and a glow-discharge lamp adapted for use in such an instrument are illustrated diagrammatically by way of example.

In the drawings

Fig. 1 is a diagram showing a glow-discharge lamp with a condenser and a resistance inserted in the lamp circuit, with the condenser and the resistance connected in series,

Fig. 2 is a diagram showing a similar circuit, with the condenser shunted across the resistance,

Fig. 3 illustrates a glow-discharge lamp,

Fig. 4 is a diagram of an instrument showing in combination seven of the circuits illustrated in Fig. 1,

Fig. 5 is a diagram showing the combination of two circuits, each with a glow-discharge lamp, for producing vibrating sounds,

Fig. 6 is a diagram showing a lamp combined with two resistances,

Fig. 7 is a diagram showing a circuit for a musical instrument which is operated by a tuned sheet, and

Fig. 8 is a diagram showing a circuit for an instrument in which a string instrument is imitated.

Referring now to the drawings and first to Fig. 1, B is a battery in a circuit containing a resistance R, a condenser C and a sound-producing contrivance L, which may be a telephone, a loudspeaker or the like, and which will be referred to hereinafter as "the telephone" for the sake of brevity. G is a glow-discharge lamp which is connected in parallel with the condenser C and the resistance R.

The condenser C may be designed for .0001 to 2.00 microfarads, the resistance R for .01 to 5.0 megohms and the battery B may supply direct current of 60 to 200 volts.

The condenser C is charged from the bat-

tery B through the resistance R and, when the potential gradient between the terminals of the condenser has attained the lighting voltage of the lamp G, the current is discharged through the lamp, and a sound is produced in the telephone L. The discharges through the lamp follow each other in rapid succession, and the frequency of the discharges, and consequently also the pitch of the sound which is produced in the telephone, are a function of the capacity of the condenser, the ohmic value of the resistance R, the voltage of the battery B and the properties of the lamp G. For a given lamp the pitch of the sound becomes higher when the voltage of the battery B is increased or the capacity of the condenser C or the ohmic value of the resistance R is reduced. By suitably determining the voltage, the capacity or the resistance it is possible to produce sounds of any desired pitch.

Referring now to Fig. 2, this circuit contains the same elements as described with reference to Fig. 1, but the condenser C is shunted across the resistance R. This circuit is an inversion of the circuit illustrated in Fig. 1. In the circuit shown in Fig. 1 the condenser is gradually charged through the resistance and discharged instantaneously through the lamp G, while in the circuit Fig. 2 the condenser C is charged instantaneously and discharged gradually through the resistance R.

As mentioned above, glow-discharge lamps offer the advantage of being cheaply and readily manufactured on a quantity production basis.

Another advantage of glow-discharge lamps is that there are so many variables available for varying the pitch of the currents produced. Thus the capacity, the resistance and the voltage may be varied independently of each other, as described.

It is quite practicable to combine seventy or more glow-discharge lamps with their circuits in a musical instrument without incurring prohibitive cost or making the instrument inconveniently large. Each lamp with its circuit corresponds to a sound of a given pitch and the circuits are connected to the same source of current and the same sound producing contrivance by suitable keys which are preferably designed like the keys of a piano.

Preferably the glow-discharge lamps are subdivided into groups with the lamps of each groups arranged together in a glass bulb, as illustrated in Fig. 3, where O is the glass bulb, E′ is a single electrode and E^2—E^8 are individual electrodes corresponding to seven glow-discharge lamps. N^1 to N^8 are the contact pins of the several electrodes.

Fig. 4 shows seven circuits such as illustrated in Fig. 1, each with a condenser $C^1 \ldots C^7$, a lamp $G^1 \ldots G^7$ and a resistance $R^1 \ldots R^7$.

B is the battery, and M is a potentiometer circuit which is connected with the several lamp circuits so as to independently regulate the voltage for each circuit and to vary the frequency of the oscillations produced in each circuit. The resistances R of the several circuits are not connected directly with the telephone, transformers $T^1 \ldots T^7$ being inserted between the resistances and the telephone, with the primary windings $P^1 \ldots P^7$ connected with the resistances and the secondary windings $S^1 \ldots S^7$ connected in series with each other and with the telephone L, or preferably with an amplifier A, as the currents produced by the lamps are very weak. $K^1 \ldots K^7$ are keys connected with the primary windings P of the several transformers and $Q^1 \ldots Q^7$ are contacts in the circuit of the battery B, which are adapted to be connected with the keys.

The object of providing transformers between the several circuits and the telephone is to prevent reaction of the several circuits on each other, as might occur with the circuits connected directly with the telephone, in which case with several circuits operating at the same time, the sounds produced by them would be somewhat distuned, which is obviously objectionable in a musical instrument.

The intensity of the sounds produced is regulated by the variable resistance Z at the amplifier A which is preferably operated by a pedal.

As a rule sounds of various pitches require various degrees of amplification, as the human ear is not as sensitive for low-pitched sounds as it is for high-pitched ones. Preferably an instrument is subdivided into three or four groups within its range of pitches, with a shunt resistance intermediate each group and the amplifier for compensating the differences of pitch. From the compensating resistances the current from each group is taken to a transformer having a primary winding for each group and a secondary winding common to all primary windings. From this secondary winding the oscillations are transmitted to the amplifier. The instrument may be supplied with current from any system, and if it is supplied from an alternating current system, the current is rectified before getting to the instrument.

An instrument of the type described not only affords all the musical possibilities of a key instrument like a piano, but also the possibility of producing sounds of various timbres. The variation of the timbres may be effected in various ways, for instance by means of loudspeakers or the like of various timbres which are operated together or in succession. Besides, as in an organ, it is possible to couple the several circuits so as

to operate any number of circuits by operating a single key. In this manner, for instance, the harmonics to the fundamental oscillation may be produced. Other novel and very interesting musical effects may be obtained by other variations of the circuits.

Referring now to Fig. 5, two circuits are here combined for the production of vibrating sounds, as in a string instrument. In string instruments the vibrating effect is brought about by touching the strings with the finger in rapid succession so as to raise and lower the pitch of the sound. The circuits 1 and 2 each include a glow-discharge lamp, a source of current B, a condenser C, and a telephone L. T is a condenser intermediate the two circuits and each circuit contains a primary winding 11 and 22, respectively, of the transformer. The two circuits are identical except for the fact that the circuit 2 is tuned for normal pitch, while the circuit 1 is tuned to a very low pitch at only 10 to 15 oscillations per second. The circuit thus produces alternating current of very low frequency which is transferred to the circuit 2 through the transformer T and causes slight periodical fluctuations of the direct current from the battery B in the circuit 2. As mentioned above, the pitch of the sound produced is influenced considerably by the voltage and, as the voltage in the circuit 2 is varied, small periodical variations of the frequency are produced, that is, a vibration effect is obtained.

As mentioned above, the cost and size of the instrument are not prohibitive, notwithstanding the fact, that normally a lamp G is provided for each pitch, making about 84 lamps for an electric piano. It may, however, be desirable to cut down the number of lamps. Means for effecting this are illustrated in Fig. 6. Instead of a single resistance R two resistances R—1 and R—2 are provided, each with a key K—1 and K—2, respectively. With two resistances it is possible to produce sounds of two pitches with a single lamp G in the circuit. Obviously means must be provided for preventing simultaneous operation of the keys K—1 and K—2 and preferably the keys are spaced from each other for a distance corresponding to a semitone, as this interval is required very rarely.

It is not necessary that keys of the normal type should be provided for an instrument according to my invention but preferably the keys are so designed that they are not depressed. Such keys may be fixed insulated metal plates or contacts of different colours, for instance nickel plates corresponding to the white and copper plates corresponding to the black keys of a piano. The plates are connected with the respective circuits and to one terminal of the battery B, while the body of the operator is connected to the other terminal of the battery, and the instrument is played by touching the keys exactly like the keys of a piano, however without depressing them. This operation is possible, as the resistance of the human body can be neglected as compared with that of the resistances R in several circuits. There is no danger from the current, as it is only .2 to .3 milliamp. and the operator does not even feel it.

Fig. 7 shows a lamp circuit as described in combination with a key K—1, which is operated by a tune sheet V. The tune sheet is moved by two rollers 8 and 9 across a contact Q10, and contact is made when the key K—1 enters a hole in the tune sheet.

In Fig. 8 the resistance R of the lamp circuit is arranged like the chord of a normal chord instrument. A resistance of this kind may be obtained by winding about a thread of silk a very thin filament of nichrome, about .05 mm. thick. A chord resistance made in this manner and of the usual length amounts to 200,000 to 300,000 ohms. K—1, K—2 and K—3, are contacts connected with the battery B. In operation the operator touches the resistance R with the fingers of the one hand while with the other hand he touches one of the contacts 12, 13, 14. In order to obtain an effect which is still more similar to that of a chord instrument, I may provide three or four chord resistances Rs, each with a lamp circuit of its own.

In accordance with this invention I can also obtain sound records for talking machines and for wireless transmission directly from the instrument. The instrument is operated initially by electric energy and therefore it is not necessary to transform the energy into sound waves for recording or transmitting, but the oscillations may be recorded or transmitted directly. In this manner the necessity of converting sound waves into electric energy and with it one of the worst causes of distortion is eliminated.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

In the claims affixed to this specification no selection of any particular modification of the invention is intended to the exclusion of other modifications thereof and the right to subsequently make claim to any modification not covered by these claims is expressly reserved.

I claim:—

1. An electrical musical instrument comprising a circuit and a source of current, a condenser, a resistance, a glow-discharge lamp, and a sound-producing contrivance, all in said circuit.

2. An electrical musical instrument comprising a circuit and a source of current, a

resistance in series with said source of current, a condenser, a glow-discharge lamp and a sound-producing contrivance, all in said circuit.

3. An electrical musical instrument comprising a circuit and a source of current, a resistance, a condenser shunted across said resistance, a glow-discharge lamp and a sound-producing contrivance all in said circuit.

4. An electrical musical instrument comprising a circuit and a source of current, a resistance, a condenser, a glow-discharge lamp, a grounded shield surrounding said lamp, and a sound-producing contrivance, all in said circuit.

5. An electric musical instrument comprising a plurality of circuits, a source of current, a sound-producing contrivance and a glow-discharge lamp and a resistance and a condenser in each circuit, and a glass bulb surrounding the electrodes of said glow-discharge lamps.

6. An electrical musical instrument comprising a plurality of circuits, each including a glow-discharge lamp and a resistance and a condenser, a source of current, a sound-producing contrivance, and means for connecting said contrivance with all said circuits.

7. An electric musical instrument comprising a plurality of circuits, each including a glow-discharge lamp and a resistance and a condenser, a source of current, a sound-producing contrivance, means for connecting said contrivance with all said circuits, and an amplifier intermediate said circuit and said contrivance.

8. An electric musical instrument comprising a plurality of circuits, each including a glow-discharge lamp and a resistance and a condenser, a source of current, a sound-producing contrivance, means for connecting said contrivance with all said circuits, an amplifier intermediate said circuit and said contrivance said circuits being subdivided into groups, and means for equalizing the output of said groups arranged between said circuits and said amplifier.

9. An electric musical instrument comprising a plurality of circuits, each including a glow-discharge lamp and a resistance and a condenser, a source of current, a sound-producing contrivance, means for connecting said contrivance with all said circuits, an amplifier intermediate said circuit and said contrivance, and means for adjusting said amplifier.

10. An electric musical instrument comprising a plurality of circuits, each including a glow-discharge lamp and a resistance and a condenser, a source of current, a sound-producing contrivance, a key-board connected with said circuits, and means for connecting said source with each circuit through the medium of said key-board.

11. An electric musical instrument comprising a plurality of circuits, each including a glow-discharge lamp, a source of current, a plurality of sound-producing contrivances, means for connecting said contrivances with all said circuits, and means for operating said contrivances alternately and simultaneously.

12. An electric musical instrument comprising a circuit, a source of current, a glow-discharge lamp adapted to produce oscillating currents, a sound-producing contrivance, a condenser a plurality of resistances connected to said condenser and to said lamp, and means for alternately connecting said resistances with said lamp, all in said circuit.

13. An electric musical instrument comprising a plurality of circuits, a glow-discharge lamp and condenser in each of said circuits, a source of current for said circuits, a sound producing contrivance, a key board including a set of fixed and insulated plates each metal plate being connected with one of said circuits in such a manner that when touched with the fingers of an operator the circuit in question will be closed and the sound producing contrivance will be activated.

In testimony whereof I affix my signature.

NICHOLAS LANGER.