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FREQUENCY STABILIZED GLOW-DISCHARGE TUBE OSCILLATOR AND ELECTRICAL MUSICAL INSTRUMENT EMPLOYING THE SAME

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Fig. 1

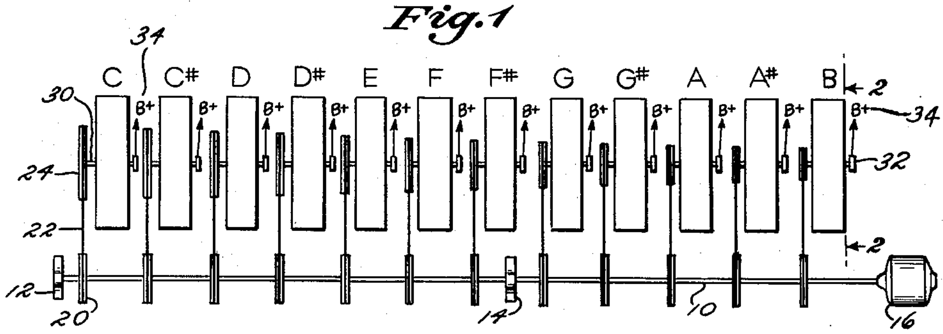


Fig. 2

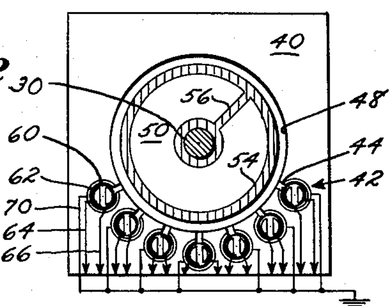


Fig. 3

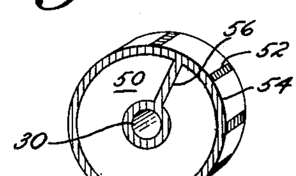


Fig. 4

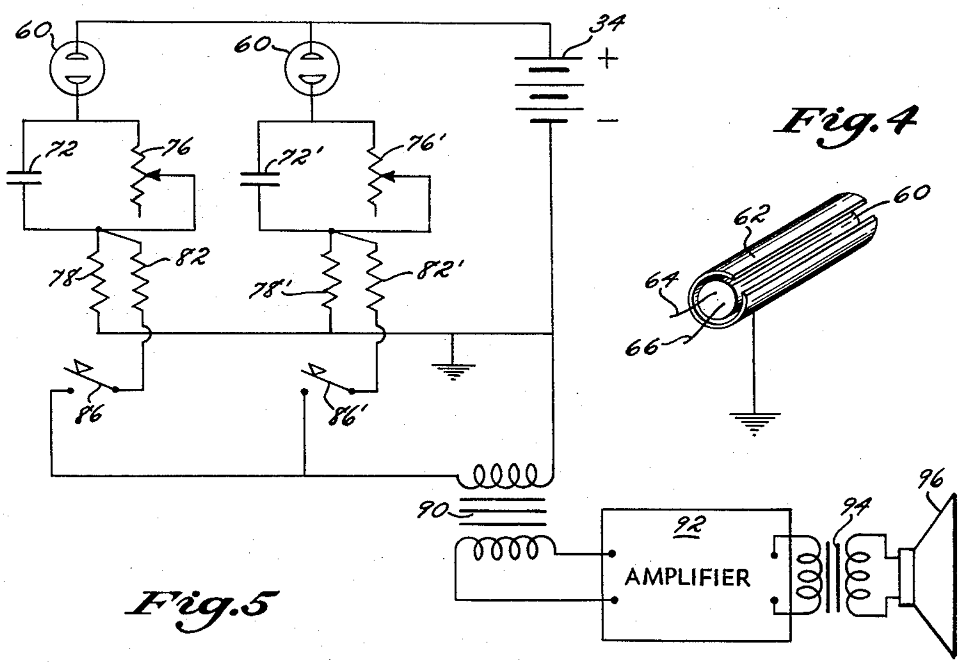
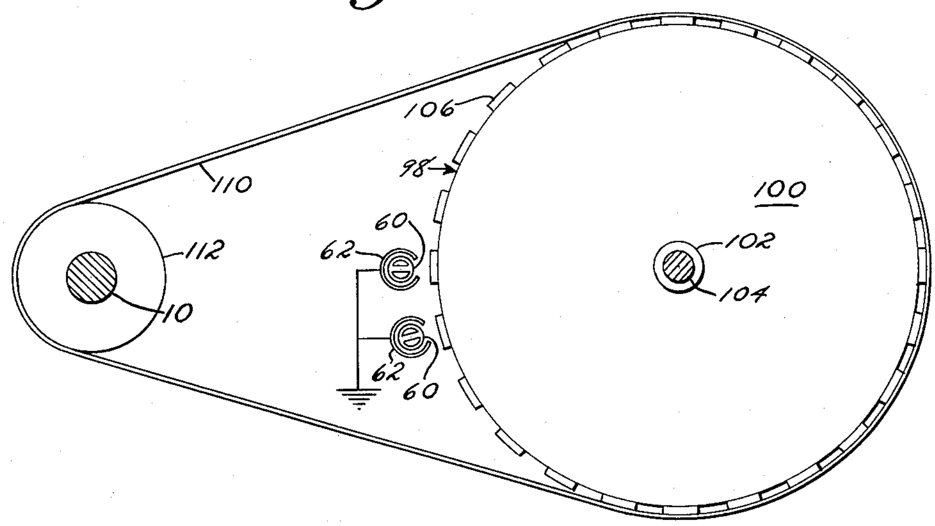


Fig. 5

INVENTOR.
ALVIN S. HOPPING
BY Herbert Smith Sylvester

Fig. 6



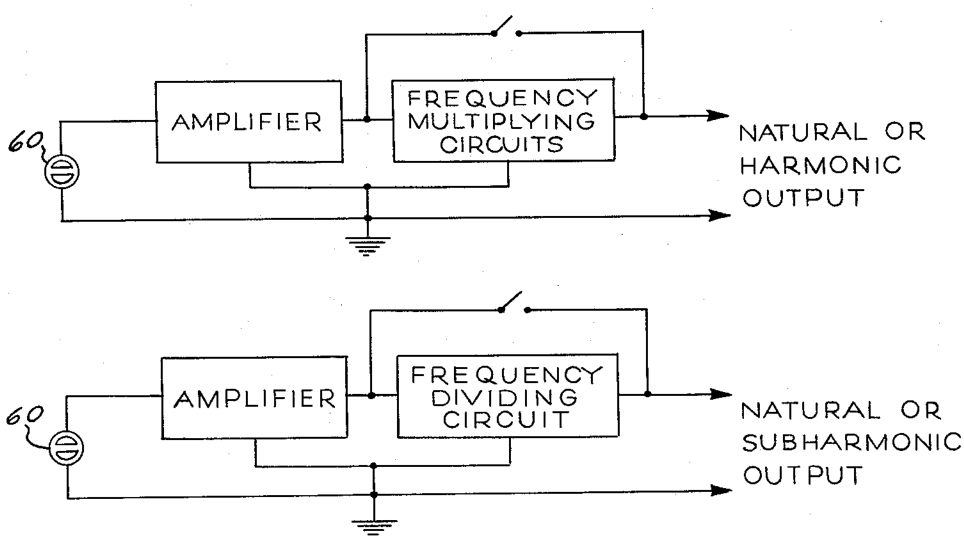


Fig. 7

INVENTOR.
ALVIN S. HOPPING
BY Herbert Smith Sylvester

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FREQUENCY STABILIZED GLOW-DISCHARGE TUBE OSCILLATOR AND ELECTRICAL MUSICAL INSTRUMENT EMPLOYING THE SAME

Alvin S. Hopping, Nolan's Point, Lake Hopatcong, N.J.

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13 Claims. (Cl. 84—1.01)

The present invention relates to glow-discharge tube oscillators, to electrical musical instruments employing the same, and to glow-discharge tube oscillators which are frequency stabilized.

It has previously been proposed to construct electric musical instruments such as "electronic organs" in which glow-discharge tube oscillators are employed for producing electrical oscillations at musical frequencies. Such instruments are economical and simple to construct, but unfortunately simple glow tube oscillators are not adequately stable and must be stabilized as to their frequency of oscillation.

Previously proposed stabilizing systems involve the use of piezo-electric crystal controlled master oscillators, tuning forks, and the like, which require the use of driving and amplifying systems with complex and expensive electronic circuits, and which in turn may be subject to "drift" on aging, changes in line voltage, and other factors.

In accordance with the present invention, a frequency stabilized glow-discharge tube oscillator comprises a glow-discharge tube, an external electrode adapted to bear a static charge which causes discharge of said tube when in proximity thereto, and means for cyclically moving said external electrode from a remote position into discharge proximity of said tube at a constant rate of repetition.

The invention will be further described in connection with the accompanying drawings which are to be considered as exemplary of the invention and do not constitute limitations thereof.

In the drawings:

FIG. 1 illustrates a view, in elevation, of the mechanical system of a musical instrument in accordance with the present invention in which a plurality of moving electrodes are driven past a plurality of stationary glow-discharge tubes at constant relative speed corresponding to the tonal relationships of the musical scale;

FIG. 2 is a view, in elevation, taken along the line 2—2 of FIG. 1 showing the stationary members thereof and a movable rotor;

FIG. 3 illustrates, in perspective, the rotor of FIG. 2;

FIG. 4 illustrates, in perspective, details of one of the glow-discharge tubes and its associated housing as employed in the structure of FIG. 2;

FIG. 5 is a circuit diagram of an illustrative musical instrument employing the frequency stabilized glow-discharge tube oscillator system of FIGS. 1–4;

FIG. 6 illustrates, in elevation, a view of an alternative flow-discharge tube oscillator in which static charges imparted to external electrodes uniformly spaced about the periphery of a belt-driven rotor by the drive belt therefor serve to ignite neon tubes in close proximity thereto, and

FIG. 7 shows block diagrams of systems which may be used with the oscillators of FIG. 6 to feed the amplifier of FIG. 5 in lieu of the oscillator system of FIGS. 1–4 illustrated therewith.

In FIG. 1 a main shaft **10** is supported by journals **12** and **14** and is driven by a synchronous motor **16**. Mounted on the shaft **10** are twelve drive pulleys **20** of uniform diameter, the number of pulleys being determined by the number of tones in the musical scale. Each drive pulley **20** is connected through a belt **22** to a driven pulley **24**, the driven pulleys being proportioned such that

their relative speeds of rotation are in the same ratios as the tones of the musical scale, as indicated in FIG. 1.

The driven pulleys **24** are mounted on individual metal shafts **30** which are connected through slip rings **32** to a positive D.C. supply **34**.

As better illustrated in FIG. 2, the metal shaft **30** passes through the center of a stationary insulator block **40** provided with a plurality of keyhole-shaped cavities **42** which have their keyway or channel **44** opening on a large central circular opening **48** in each block **40**. The number of cavities **42** in each block corresponds to the number of octaves to be produced by the instrument.

Mounted on the shaft **30** in the central circular opening of each block **40** is a cylindrical rotor **50** adapted to spin with the shaft. The body of the rotor is fabricated of a non-conductive material, and the rotor carries, uniformly spaced around the periphery of its cylindrical surface, a plurality of conductive bands or segments **52**. The segments are each connected to a circular conductive ring section **54** on the surface of one end face of the rotor **50**, which in turn is connected to the metal shaft **30** by a conduit **56**. Thus, each segment **52** is charged to the positive voltage of the D.C. supply (B+) **34** through the metal shaft **30** and the slip rings **32** illustrated in FIG. 1. (Journals for shafts **30** are not shown.)

Disposed within each keyhole-shaped cavity **42** is a neon tube **60** partially surrounded by a slotted metal shield **62**. The slot in the metal shield faces the center of the rotor **50**, i.e., is oriented towards the channel or keyway **44** in the cavity **42**. The leads **64** and **66** from the electrodes of each neon tube **60** run to a terminal strip at the base of each block **40**. Likewise, each shield **62** is grounded by a conduit **70**.

FIG. 5 shows the schematic of an electrical musical instrument in which a representative two of the frequency stabilized neon tubes **60** located in adjacent cavities of the block of FIG. 2 are employed.

The circuit includes a high voltage D.C. source **34** of the polarity indicated, capacitors **72** and **72'**, high resistance tone-adjusting rheostats **76** and **76'** in parallel with each of said capacitors respectively, and load resistors **78** and **78'** which complete the D.C. path to the negative terminal of the power supply. Coupling resistors **82** and **82'** are wired to normally open switching keys **86** and **86'** which, on being closed, permit selective withdrawal of a signal from the oscillator or oscillators desired. A signal so withdrawn is coupled, through a transformer **90**, to an amplifier **92**. The output of the amplifier is coupled, in the usual manner, through an output transformer **94** to a speaker **96**.

The constants of the two oscillator circuits and the settings of the rheostats **76** and **76'** are chosen such that the two oscillators would, if permitted to run freely, operate in a harmonic or octave relationship with respect to each other and at rates which are slightly below the frequency or a subharmonic of the frequency at which the charged segments **52** on the rotors **50** pass each neon tube **60** as the rotors are spun by the synchronous motor **16** to which they are coupled.

In operation, each block **40** contains a bank of neon tubes **60** wired in a neon tube oscillator circuit as illustrated, and a rotor **50** which is spun at a constant speed by the synchronous motor drive system. Each of the blocks **40**, rotors **50**, and drive pulleys **20** is identical, the angular velocity of each rotor being determined by the diameter of the driven pulleys **24** which, as mentioned hereinabove, are so proportioned such that the rotors spin at speeds which are in the same ratios as the tones of the musical scale. Of course, since the ultimate controlling factor is the frequency with which the charged segments **52**, which constitute moving external electrodes for the neon tubes **60**, travel past each neon tube, equivalent action can be obtained by use of rotors having conductive segments at properly proportioned intervals, in which case driving belts may be dispensed with and the rotors mounted on a common shaft directly coupled to a constant speed drive, or, as an alternative, a single extended cylindrical drum having an appropriate pattern of conductive strips on its surface may be used.

As was indicated hereinabove, each passage of a charged segment 52 past a neon tube 60 does not necessarily result in a discharge thereof, but rather, discharge is periodically pulsed by such passage, the interval between firings being determined by the free running or natural frequency of the oscillator circuit. This natural frequency may be controlled, of course, by adjustment of the rheostat 76. Naturally, in the instant musical instrument, these resistances and the electronic systems associated with each neon tube are selected and adjusted such that the neon tubes in each block fire at rates corresponding to frequencies which are one octave removed from each other, i.e., a first neon tube is adjusted to fire on each passage of a charged segment, a second neon tube in the same block is adjusted to fire on each second passage of a charged segment, and so forth.

The oscillators of FIGS. 6 and 7 constitute neon tubes 60 each partially shielded from external electric fields and light sources by slotted metal shields 62 which are grounded. The slot in each metal shield faces the center of a rotor 98, the rotor comprising a compressed, resin impregnated wood-fiber body 100 mounted on a sleeve bearing 102 free to spin on a stationary shaft 104.

Cemented to the peripheral surface of the rotor 98 is a series of uniformly spaced rectangular polystyrene segments 106. The rotor 98 is driven by a belt 110 suitably of rubber or silk which rides over the polystyrene segments 106. The belt 110 is, in turn, driven by a drive pulley 112 mounted on a shaft 10. The shaft 10 is driven by a synchronous motor (not illustrated in FIG. 6). Additional oscillators may be operated by the shaft 10, using glow tubes 60 and rotors 98 and/or drive pulleys 112 of varying diameters in order to achieve the desired range of output frequencies.

The drive pulley 112 is fabricated of compressed wood fibers.

It has been found that when the rotor 98, which carries the polystyrene segments 106 on its cylindrical surface, is driven by the rubber drive belt 110, which rides on the segments, the polystyrene segments 106 accumulate static charges of greater magnitude than the charge required to cause ionization of the neon tube. As a result, each tube ionizes as each charged segment 106 passes the slot in the shield 62 about each neon tube 60 even in the absence of any other externally applied stimulus.

As shown in FIG. 7, the output from the neon tubes 60 of FIG. 6 may be amplified and, optionally, passed through frequency multiplying or dividing circuits, to provide a natural or harmonic or sub-harmonic output with which to feed the amplifier of FIG. 5 in order to provide a complete electrical musical instrument.

It will be appreciated, of course, that a plurality of oscillators may be coupled together to provide chords and a range of octaves, and the like. Furthermore, although reference has been made herein to static-charge carrying segments which are rectangular in shape, segments of other shapes may be employed which may vary the discharge characteristics, e.g., waveform and harmonic content, of the instant glow discharge tubes.

Finally, it will be seen that the entire musical instrument of the instant invention will remain "in tune" and retain a constant pitch or relationship thereof throughout its range as long as a constant speed mechanical drive is available, and that in view of the ready availability of synchronous motors and constant frequency alternating current, the instant invention provides for a very high degree of reliable frequency stabilization, and thus also for the construction of eminently satisfactory electrical musical instruments.

It is to be understood that the invention herein illustrated and described is to be limited only by the scope of the appended claims and that various changes may be made in details of construction without departing from the true spirit of the invention. Thus, if desired, continuous belts imprinted with charged conductive strips may be used as moving external electrodes, or conversely, if desired, the neon or glow discharge-tubes may be employed as the travelling members and the charged external electrodes may be stationary. Likewise, alternate static charge retaining and generating materials may be used if desired, e.g., celluloid in lieu of polystyrene segments may be employed, and/or rubber rimmed drive wheels may be used in place of the drive belts illustrated.

What is claimed is:

1. A frequency stabilized electrical musical instrument comprising a first glow-discharge tube oscillator, a second glow-discharge tube oscillator which has a natural free running frequency in harmonic relationship with said first glow-discharge tube oscillator, an external electrode adapted to bear a static charge which causes discharge of said glow-discharge tubes when in proximity thereto, means for cyclically moving said external electrode into discharge proximity of each of said tubes at a constant rate of repetition which is slightly greater than the free-running frequency of said first glow discharge tube oscillator to cause oscillation of said first glow-discharge tube oscillator at said constant rate and of said second glow-discharge tube oscillator at a rate in a harmonic relationship thereof, means for amplifying the output of said first and second oscillators, and means for converting the output of said amplification means into sound.

2. A frequency stabilized electrical musical instrument comprising a plurality of rotors driven by a constant speed electric motor, each of said rotors carrying on its surface a plurality of uniformly spaced electrode segments adapted to carry a static charge, a stationary neon discharge tube associated with each of said rotors, means for conferring on said electrode segments a static charge sufficient to cause ionization of said neon tube, an amplifier for amplifying electrically the signal generated by said neon tube on ionization thereof, and a transducer for converting the output of said amplifier into sound.

3. A frequency stabilized electrical musical instrument as set forth in claim 2 having a plurality of neon tubes associated with each rotor.

4. A frequency stabilized electrical musical instrument as set forth in claim 2 having means for rotating said rotors at speeds differing in the same ratios as the frequencies of the tones of the musical scale.

5. A frequency stabilized electrical musical instrument as set forth in claim 2 in which said constant speed electric motor is a synchronous motor.

6. A frequency stabilized glow-discharge tube oscillator which comprises a stationary neon-discharge tube, a rotor carrying a plurality of polystyrene segments on its peripheral surface, said segments being sequentially disposed in close proximity to said tube on rotation of said rotor, a silk drive belt for said rotor which contacts said segments, and means for driving said belt at a constant speed at which said belt develops on said segments a static charge in excess of the charge necessary to cause ionization of the gas within said neon-discharge tube on passage of said segment thereby in the course of rotation of said rotor.

7. A frequency stabilized glow-discharge tube oscillator which comprises a stationary glow-discharge tube, said tube being part of an oscillator, a rotor carrying an electrode, said electrode being in close proximity to said tube and being adapted to carry a static charge which triggers discharge of said tube when in close proximity thereto, and means for spinning said rotor at a constant speed at which said electrode is carried by said rotor past said tube

to cause discharge thereof at a frequency greater than the natural free running frequency of said oscillator.

8. A frequency stabilized glow-discharge tube oscillator which comprises a stationary glow-discharge tube, a rotor carrying an electrode having a static charge thereon which ionizes said tube when in close proximity theretor, and means for spinning said rotor at a constant speed whereby said tube is ionized at a constant rate of repetition, the entire ionization stimulus for said glow-discharge tube being supplied by the static charge on said electrode.

9. A frequency stabilized glow discharge tube oscillator which comprises a stationary glow-discharge tube, a rotor carrying an external electrode on its peripheral surface, said peripheral surface being in close proximity to said tube and said electrode being adapted to carry a static charge which triggers discharge of said tube when in close proximity thereto, and a belt for driving said rotor at a constant speed which belt contacts said electrode and develops a static charge thereon, whereby said tube is discharged each time said rotor carries said electrode thereby.

10. A frequency stabilized glow-discharge tube oscillator which comprises a stationary glow-discharge tube, a rotor carrying an external electrode on its peripheral surface, said peripheral surface being in close proximity to said tube and said electrode being adapted to carry a static charge which triggers discharge of said tube when in close proximity thereto, said glow discharge tube being encased in a grounded electrostatic shield having a slot therein, said slot being oriented toward the center of said rotor, and means for spinning said rotor at a constant speed whereby said tube is discharged each time said rotor carries said electrode thereby.

11. A frequency stabilized glow-discharge tube oscillator which comprises a stationary glow-discharge tube, a rotor carrying an electrode, said electrode being in close proximity to said tube and being adapted to carry a static charge which triggers discharge of said tube when in close proximity thereto, and driving means for driving said rotor at a constant speed, said driving means contacting said electrode and developing a static charge thereon, whereby said tube is discharged when said rotor carries said electrode thereby.

12. A frequency stabilized glow-discharge tube oscillator which comprises a stationary neon-discharge tube, a rotor carrying a plurality of non-conductive electrodes adapted to carry a static charge, said electrodes being sequentially disposed in close proximity to said tube on rotation of said rotor, and means, in contact with said electrodes, for spinning said rotor at a constant speed at which said means develops on said segments a static charge in excess of the charge necessary to cause ionization of the gas within said neon-discharge tube on passage of said electrodes thereby in the course of rotation of said rotor.

13. A frequency stabilized glow-discharge tube oscillator which comprises a glow-discharge tube, a movable external non-conductive electrode adapted to carry a static charge which causes discharge of said tube when in proximity thereto, and means for cyclically moving said external electrode from a remote position into discharge proximity of said tube at a constant rate of repetition.

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