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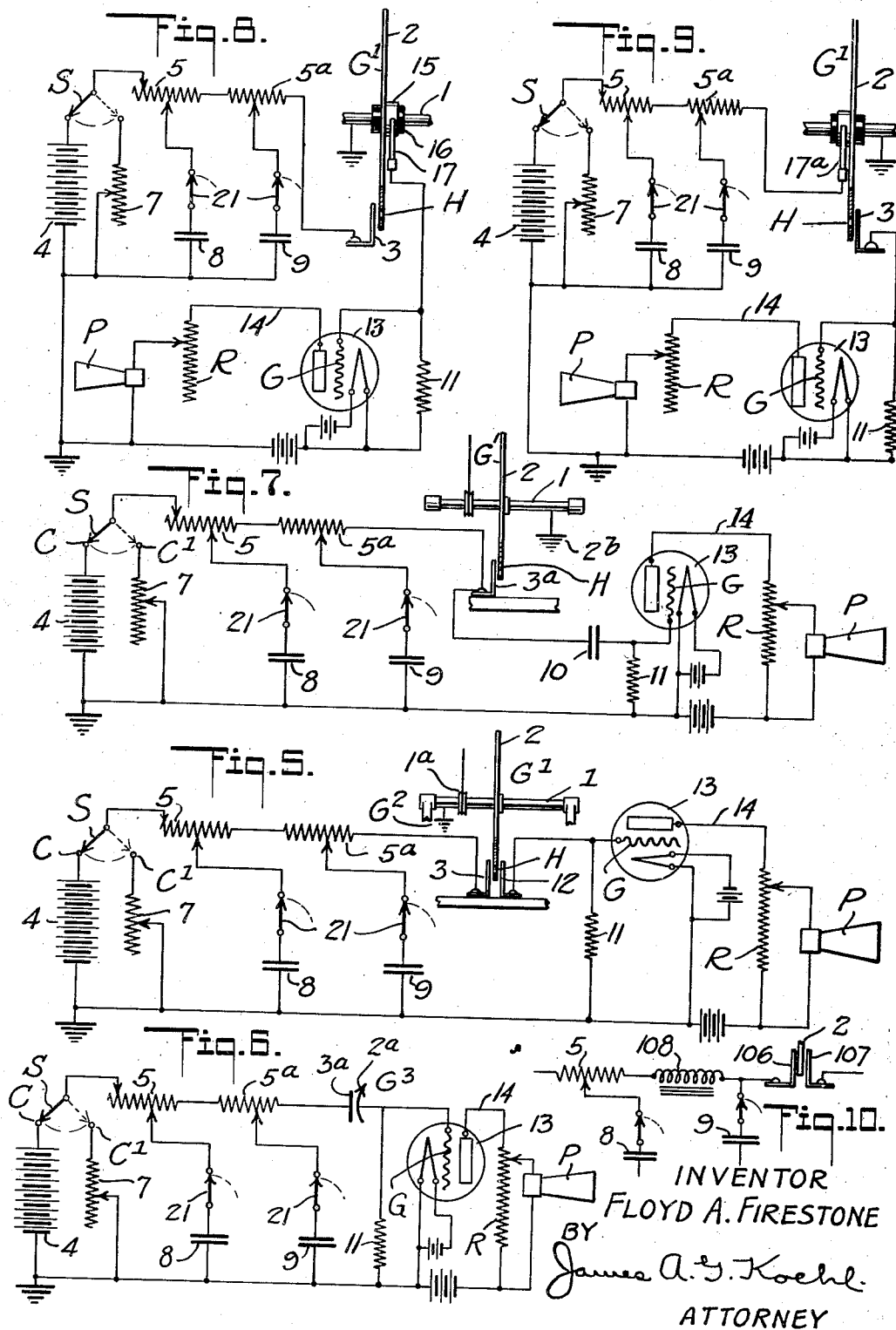
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ELECTRICAL MUSICAL INSTRUMENT

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ELECTRICAL MUSICAL INSTRUMENT

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This invention relates to an electrical musical instrument of the same general class as the one broadly claimed in Letters Patent of the United States No. 1,953,753 issued to me on April 3, 1934, and has particular reference to certain new and novel features of construction, forms, shapes, arrangements and combination of parts described generally either in whole or in part but not shown or claimed in said patent.

A feature of the invention disclosed and broadly claimed in said prior patent resides in the use of a plurality of rotary capacity reactance devices adapted to produce alternating voltages corresponding with the tones of a musical scale then selectively impressed upon an amplifying circuit and the amplified currents converted into audible sound. The patent teaches the use of means by which these capacity reactance devices can be connected in a control circuit and the growth and decay of the voltages controlled to enable many very desirable tonal possibilities to be realized.

A further feature claimed broadly in said prior patent relates to an arrangement of rotary capacity reactance devices, each comprising two plates formed and related to each other to enable the electrostatic capacity thereof to vary according as a grounded conductor is rotated between them at an assigned speed.

This invention disclosed and claimed in the aforesaid prior patent provides for any one or more of the rotary capacity reactances being placed in operation upon depressing the keys of the key manual of an organ console; the compounding of the different tonal components being effected by certain multiple switches actuated by said keys. The invention provides means for varying as to loudness the relation of one tone to another, such for instance, a fundamental relative to any one or more of its harmonics. The growth and decay of a tone is made possible by certain variable resistances and other impedances in the circuit between a polarizing source and said rotary capacity reactances, the mathematical theory being that where these impedances are fixed condensers, the effective value of the alternating current passed to the primary inductor of any rotary capacity reactance will be in accordance with the time required to charge said condensers, hence the control of the growth and decay of a tone is entirely according to the elapsed time between the beginning and ending of the charging of the reactances, on the one hand, and the discharging interval on the other hand.

As distinguished from the invention disclosed

and claimed in my aforesaid prior patent, the invention disclosed and claimed herein has for its essential objects those stated as follows, to wit:

(1) To provide means by which the rate of growth of a tone may be made more nearly equal to the rate of decay thereof;

(2) To provide means by which the rate of growth of a tone may be controlled to any desired extent relative to a desired or predetermined rate of decay thereof;

(3) To provide means by which current of a given frequency can be selectively diverted as and when desired from one portion of a control circuit to another according as one musical result or another is desired as a function of time;

(4) To provide means by which the growth and decay of a note can when ever desired, be made more instantaneous than was heretofore possible;

(5) To provide means by which, as a function of time, there can be any desired growth and decay of any note relative to any other note;

(6) To provide means by which any note elicited by actuation of any particular key of any manual of the instrument may be controlled to enable (a) a predetermined rate of growth and decay, (b) all or as many notes as desired to be made as fast or as slow as desired, and (c) notes elicited upon actuation of the keys of one manual to be made fast and those elicited upon actuating the keys of another manual to be made slow;

(7) To provide means whereby as many differences in relative time durations for holding and letting go of the notes may be had as desired;

(8) To provide a rotary capacity reactance device consisting of but two relatively rotatable members connected between a polarizing source and the grid of a vacuum tube amplifier;

(9) To provide a rotary capacity reactance device consisting of but two relatively rotatable members in which one thereof provides a primary inductor and is formed to produce a multiplicity of frequencies conforming to different tonal components, and the other thereof serving as a common support for all inductors which are inductively complementary to the frequency determining areas of the primary inductor. While I suggest a specific order of relationship of these members, wherein a particular one is the primary and the other the secondary, that this order can be reversed as provided for herein;

(10) To provide simple but exceedingly effective means by which the relative phase of the

tonal components may be shifted. In my experiments, I discovered that when a strong fundamental and one of its harmonics are impressed on one ear in various relative phases and sound pressures, the tone quality and the loudness of the combination depended upon the relative phase of the two components. In a certain phase relation the loudness of the combination was 3.5 db. less than the loudness of the fundamental alone. Varying the phase changed the loudness of the combination 10 db. and this may be explained by assuming that the ear mechanism distorts the pure components of a complex sound pressure, producing subjective harmonics which may either constructively or destructively interfere depending on the relative phases of the components. It is therefore, an important object of my invention to provide in combination with means for synthetically producing musically correct growth and decay of a tone, a means by which the primary and secondary inductors of the rotary capacity reactance device will secure a phase shift of any harmonic relative to the fundamental, whereby the loudness level and quality of a tone will be musically correct and the tone made more pure and of greater smoothness than was heretofore possible.

(11) To provide a combination of instrumentalities in which each thereof depends upon the other for production of musical tones of the greatest possible purity. To this end, it is generally recognized that with the various forms of magnetic pickup devices heretofore employed for producing frequencies conforming to the different tonal components, it was impossible to depend upon them for the production of pure tones because it is mechanically impossible to provide rotary wave form producing members that are dependably uniform, in spite of the greatest possible care in their making. Where use is made of rotary capacity reactance device, great purity of tone is made possible, and less care need be used in their manufacture and when the primary and secondary elements are properly shaped and formed, a dependable pure wave can be produced. These features plus the fact that respective means are provided for shifting the phase relation of the tonal components, and for controlling the growth and decay of a tone insure faithful reproduction of all tones.

The above and other objects of the invention will be clearly understood from the following detailed description and claims taken in connection with the accompanying drawings in which—

Figure 1 is a schematic view of a typical portion of an instrument embodying the invention;

Figure 2 is a view in elevation of a set of rotary capacity reactance devices mounted upon a single shaft and provided with means by which the relative phase of the currents representing the different tonal frequencies can be varied;

Figure 3 is a view taken substantially in the plane of line 3—3 of Figure 2;

Figure 4 is a section taken on line 4—4 of Figure 3, and

Figures 5—10, inclusive, are diagrammatic views of different forms of circuits and slightly modified forms and arrangements of rotary capacity reactance devices.

In Figure 5 of the accompanying drawings, the control circuit therein illustrated has its output side connected with the input side of an amplifying circuit, preferable, but not necessarily as shown in Figures 1^b and 4 of my aforesaid prior patent. A rotary capacity reactance de-

vice capable of producing sufficient alternating voltage to actuate the grid G of the vacuum tube amplifier 13 is shown at G¹ and is connected to the polarizing battery 4. This device is substantially the same as the one disclosed in said prior patent and as shown in Fig. 5, same consists of a metallic disc 2, fixed to a rotatable shaft 1 and adapted to be driven at an assigned, or predetermined speed by the means 1^a. Around the disc is a row of equally spaced holes H or the equivalent thereof. Two metallic plates 3 and 12 constitute stators or inductors at the opposite sides of said disc and are disposed close to the annular series of holes H so as to be successively aligned therewith during rotational motion of said disc. Incident thereto, and assuming a charging current is being delivered to the primary plate 3, the electrostatic capacity between plates 3 and 12 and through said holes H will vary, the potential of the plate 12 being always greater when said plate is opposite any one of said holes than when it is opposite an imperforate or solid part of said disc, the latter connected in the control circuit and grounded as shown at G². Thus, an alternating voltage will be periodically developed or produced on the inductor 12 which will have the frequency with which the holes pass said plate. The voltage thus produced is taken into the conventional vacuum tube 13 and may be converted into audible sound by any suitable well known electrical sound producer P shown in Figure 1.

The control circuit in which said generator is connected includes the adjustable resistances 5 and 5^a in series, the resistance 5^a connecting with the primary plate 3 and the resistance 5 with a switch S. Said switch schematically represents a key of the manual of the instrument and is adjustable from a charging position at fixed contact C to the discharging position at fixed contact C¹, the latter connected to ground through adjustable resistance 7. The circuit includes a source of potential 4 for delivery of a charging current to the plate 3 through aforesaid contact C when switch S is in said full line position shown in Fig. 5.

Connected in parallel in the control circuit are fixed condensers 8 and 9, such that when the switch S is in a charging position, the current flow from battery 4 will be through adjustable resistance 5, to condenser 8 whose potential rises slowly until energy passes through adjustable resistance 5^a, thence to condenser 9, the potential of which will also rise slowly. In this manner, a very even rate of "attack" or rising voltage supply is obtained at plate 3. A corresponding alternating voltage at plate 12 is thereby impressed upon the grid of said amplifier 13. When the switch S is placed in the dotted line position shown in Figure 5, the device G¹ is discharged at approximately the same rate as it was charged until the voltage value at plate 3 is again at zero.

In the line of each of the condensers 8 and 9 is a switch 21 which may be controlled at will from the console of the instrument, so that one or both said condensers can be selectively placed in open or closed circuit. By reason of the adjustable resistance 5 and 5^a and the adjustable resistance 7 across the control circuit, it manifestly follows that said resistances can be actuated to very accurately govern the rate at which the generator is charged and discharged. When used selectively in conjunction with the condensers 8 and 9, an exceedingly large number of changes in the elapsed time between starting and stopping of the charging of the device G² and be-

tween the starting and stopping of the discharging of said device can be had. It is possible with proper relative adjustment of the resistances, to proportion the rate of attack relative to any desired rate of decay of a note or contrariwise, and as each device G^1 is adapted to be separately controlled, the period of time for the decay and attack of one note may be made to be quite different from that of any other note, a feature of considerable importance, when the invention is used in connection with a plural manual instrument. So accurately may this be done, that the respective elapsed times may be almost, if not exactly equal throughout the scale should this be desired by the player, or the device G^1 can be made to function so that the time interval for the sounding of any fundamental tone may be in any desired proportion relative to the period of time for the sounding of any of the harmonics of the fundamental. If the condensers 8 and 9 are placed in open circuit, the only resistance offered the flow of current to and from the device G^1 will be through the resistances in the line between the battery and said device.

The control circuit shown in Figure 6 of the drawings is substantially the same as the circuit shown in Figure 5, the difference being in the provision of a rotary capacity reactance device G^3 consisting of primary stator plate 3^a and rotary secondary disc 2^a, the latter connected in circuit with the grid G of amplifier 13 and the former with the adjustable resistance 5^a.

In the form shown in Figure 7, the disc 2 has its shaft 1 grounded at 2^b and the primary plate 3^a is connected with adjustable resistance 5 and with the grid of the amplifier 13 through a blocking condenser 10. The circuit used in this form is in all other respect like those first referred to.

In the form shown in Figure 8, the disc 2 is insulated from the grounded shaft 1 as at 16 and has a slip ring 15 against which the collector brush 17 of the grid circuit of vacuum tube 13 bears. A primary stator plate 3 is adapted to be connected through adjustable resistance 5^a with either the battery 4 or the adjustable resistance 7 according as the primary plate 3 is to be charged or discharged. The circuit is otherwise functionally the same as any one of the circuits first referred to.

In Figure 9, the arrangement is substantially the same as that shown in Figure 8, the main difference being in the use of the brush 17^a and disc 2 employed as a primary inductor, the plate 3 being the secondary inductor, whereas, in the form shown in Figure 5, the brush 17 and coacting disc 2 mutually provide a secondary inductor.

In each of the circuits herein disclosed, a grid leak 11 is provided across the circuit as is well known in the art of radio.

The term "generator" employed herein shall be understood to mean two or more suitably shaped and relatively rotatable areas insulated from each other and forming a varying capacity reactance, whereby an alternating voltage conforming to the frequency of a note in a musical scale can be selectively impressed upon the circuit of a vacuum tube system and converted into audible sound of suitable loudness. Said device distinguishes from generators of the magnetic scale and other forms of tone generators of the prior art in that it insures that the output voltage shall always be proportional to the capacity of the generator, it being possible to readily control the

capacity from minimum to maximum, whereby the attack on the tones and decay thereof can be regulated to suit the musical taste of the player. The plate circuit 14 of the amplifier 13 can be coupled in the control circuit and with the loud speaker through a suitable rheostat R.

In Figure 3, the disc 2 is formed with concentric rows of holes H, there being one such row of holes for a fundamental tone and one each for such of the harmonics as are desired to be used. In practice, the discs of a series or set in use will generate the fundamental frequencies designated by the following numbers: 1, 2, 4, 8, 16, 32, 64, 128 and 256. The rest of the rows are used for providing such number of harmonics of the fundamental tone as are desired. In my prior patent, I teach the grouping of such discs in sets of three, each driven at 16.00 revolutions per second, the arrangement being such that all the C's of the scale and all their necessary harmonics can be produced. I also show such arrangement of discs in Figure 2. A similar group driven at a speed of 16.95 revolutions per second will produce all the frequencies required for all the C sharps of the scale and their harmonics. The frequencies of all the notes of the musical scale and all their necessary or desired harmonics can be produced by twelve similar generator groups running at the following speeds in revolutions per second; 16.00; 16.95; 17.96; 19.02; 20.15; 21.35; 22.62; 23.97; 25.39; 26.90; 28.50; and 30.19, all in the relation of the frequencies of the equally tempered scale, each being larger than the one just preceding by the twelfth root of 2.

In Figures 2, 3 and 4 the circumferentially adjustable secondary inductors I are crescent shaped, being bounded by the two circular arcs A—B and having a total length approximately equal to the distance between two circumjacent holes H. The fixed primary inductors I¹ each consist of a plate of any shape but essentially considerably larger than the secondary plates and disposed adjacent to and directly opposite thereto so that the primary is at one side of the disc and the secondary at the opposite side thereof. Each secondary plate can be moved circumferentially either clockwise or counterclockwise relative to its coacting primary plate, whereby the relative phases of the generated currents can be varied. A pair of inductors shaped and related to each other as herein taught will give a wave in which the harmonic content is less than 5% which is the least amount of harmonic the ear can detect and therefore represents a tone which is for the intended purpose a pure tone.

As shown in Figures 2, 3 and 4, the entire series of pairs of primary and secondary inductors for each disc is supported by a radially disposed fixed support 100, comprising parallel spaced arms of hard insulating material, and on the inner face of one arm and in longitudinally series formation at one side of the disc are the primary conductors I¹. In similar manner, the secondary conductors I are mounted on the inner face of the other arm and are thus disposed at the opposite side of the holes H and opposite said primary inductors. The secondary inductors carry studs 101 which are passed through arcuate slots 102 in the arm 103, the slots being concentric relative to the axis of the disc 2. Nuts 104 or other equivalent retaining devices are carried by said studs and adapted to be advanced into clamped engagement with arm 103, whereby said secondary inductors will be held in fixed positions of circumferential adjustment

relative to said primary inductors. It obviously follows that by mounting said respective pairs of primary and secondary inductors upon a common fixed support a relative fixed phase shift can be obtained. Should, however, each pair of primary and secondary inductors be mounted separately and for circumferential movement relative to each other so that they are capable of adjustment representing either a 180% lag or 180% lead, the phases can be shifted relatively, and such arrangement will provide for their adjustment as and when desired from the console of the instrument. In either such example the relative circumferential shifting of the primary and secondary inductors will secure a phase shift of any harmonic relative to the fundamental and the loudness and quality of the tone thereby beneficially influenced musically and a tone of great purity and smoothness thereby produced. Although the invention has been illustrated and described in connection with certain specific circuit arrangements it is to be understood that it is not to be limited either to the particular arrangement as a whole, or to particular details, but only by the scope of the appended claims, which latter, I shall expect to be broadly construed to cover a large range of modifications because of the correspondingly large number of hook-ups herein disclosed, any one of which is the electrical equivalent of the other. I have illustrated a variety of circuits merely to show the many known ways of controlling the time intervals between charging and discharging of any generator of the series employed.

In Figure 1 six rotary capacity reactances are illustrated. The key circuit is the same as the one disclosed in my prior patent and it will suffice to say that each key such as the one shown at 105 will include as many circuit making and breaking contact devices as are required to simultaneously close as many reactance assemblies as there are components of a tone to be compounded and to open the circuit to enable the assemblies to be discharged as elsewhere set forth herein. The assemblies shown in this view are six in number and while each assembly may include a separate rotary disc, all the frequencies for the fundamental and its harmonics can be formed on a single disc as shown in Figure 2.

In Figure 10 a portion of the output side of a control circuit is shown, and I suggest that in the line to the primary inductor 106 of the rotary capacity reactance device 107, there be interposed an iron core inductive reactance 108. This is preferably used to take the place of the adjustable resistance nearest the secondary inductor. Such resistance would specifically be the one indicated at 5^a in any one of the control circuits first described. However, this reactance may be used in association with any series multiple arrangement of resistances 5 and 5^a and pressure retarding or blocking condensers 8 and 9. In the figure, a condenser 9 is connected in shunt and disposed between inductor 106 and said reactance. The condenser 8 is connected with adjustable resistance 5 in series with said reactance 108.

It is to be borne in mind that all switches in the control circuit will be controlled from the key manual or manuals of the instrument and may either be preset or can be controlled by the player as and when desired while the organ is being played. The switches associated with the keys of one manual may be preset to for slow growth and decay and those associated with

another manual set for a fast growth and decay. By reason thereof, and bearing in mind that the switches can be separately actuated, it follows that a great variety of effects can be had.

It therefore follows that the rate of attack and delay for any one quality on one manual can be regulated and pre-set so that the proper attack and delay for a quality will be introduced when a tappet is pressed that brings that quality into play. Certain qualities such as diapasons and soft flutes will have a slow rate of attack and others such as the clarinet and oboe will have a faster rate of attack while still others such as marimba or vibraharp will have a rapid attack.

The rate of attack and delay may be different for a quality on one manual than it is for another quality on another manual. That is to say, a clarinet with a fast attack may be used on one manual while a flute with a slow attack may be used simultaneously on the other manual.

In the same quality, the partials of that quality may have different rates of attack and delay so that certain of the components of that quality will be percussive and will drop off suddenly, while certain remaining components will have a slow attack and will have a longer delay. This will be found to be particularly useful in chimes in which certain of the sub tones will have a long delay while the higher harmonics will drop out rapidly after a sudden percussive attack when the key is depressed. Certain other qualities such as diapason may be subject to such treatment in moderation.

Thus it is possible to have a quality on one manual in which the components vary relative to each other, while on another manual another quality may be used which has a uniform attack and delay on all partials of that quality in which the components may vary in the rate of attack as on the first manual.

Regarding the form of rotary capacity reactance device shown in Figure 7, I wish particularly to direct attention to the fact that direct current is conducted to the inductor 3a from the direct current source 4 and that the grid G of the tube 13 is directly connected with said inductor 3a by a metallic conductor. Bearing in mind that the metal disc 2 is inductively related to the inductor 3a and is driven at a constant predetermined speed, and that it is formed as in all other examples of the invention with an annular series of openings H, it is evident that said disc functions as a converter and that the direct current delivered to the inductor is changed into pulsating direct current, the frequency of which will determine the tone generated at the sound producer P.

Regarding the series multiple circuits employed in each form of the invention, it is important to note that in addition to its being made possible to cut into and out of the circuit any one or more of the capacity condensers 8 and 9, it is possible to selectively control the rate at which these condensers can be charged and discharged by merely adjustably connecting said condensers with said resistances 5 and 5^a. The resistances thus serve the dual capacity of a means for placing in the line between source 4 and rotary reactance device G² any amount of resistance desired and to cause the condensers to be charged and discharged as quickly or as slowly as desired. This is, of course, assuming that the switches 21 are in closed circuit positions.

It is to be understood that the condensers 8 and 9 may be of different capacities to thereby

increase the range of usefulness of the instrument for the purposes set forth herein.

What is claimed is:

1. In an electrical musical instrument, a capacity reactance device comprising stator and rotor elements adapted to be driven at a constant relative speed and having respective surfaces for producing voltages conforming to the vibrational frequencies of a fundamental tone and its harmonics; and means by which the elements can be shifted relatively circumferentially to vary the relative phases of the produced voltages.
2. In an electrical musical instrument, rotary capacity reactance devices for producing alternating current voltages conforming to the vibrational frequencies of the fundamental tones of a musical scale and the harmonics thereof; a polarizing source for said devices; a circuit common to said devices; a circuit having a vacuum tube amplifier, the grid of which is connected with said common circuit and adapted to be actuated by current impressed thereon; an electrical sound producer connected in circuit with said amplifier; means by which a phase shift can be made between a fundamental frequency producing device and any one or more devices for producing frequencies conforming to the harmonics of said fundamental frequency; means in said common circuit between the aforementioned polarizing source and said frequency producing devices for controlling the rate at which any one of said devices can be charged and discharged; and means by which said controlling means can be placed in either open or closed circuit with said polarizing source.
3. In an electrical musical instrument, an electrical sound producer; an electrical circuit for controlling the operation of said sound producer; and a capacity reactance device comprising a pair of stator elements and an intermediate rotor element formed to control the effective capacity reactance of said circuit at predetermined tone frequencies; one of said stators having inductors facing one side of the rotor; the other stator having inductors facing the other side of the rotor and disposed opposite the first inductors and being capable of circumferential adjustment relative to said first inductors so that the relative phase of the frequencies produced by said reactance can be varied.
4. In an electrical musical instrument, an electrical sound producer; an electrical circuit for controlling the operation of said sound producer; and a capacity reactance device comprising a pair of stator elements and an intermediate rotor element formed to control the effective capacity reactance of said circuit at predetermined tone frequencies; one of said stators having inductors facing one side of the rotor; the other stator having inductors facing the other side of the rotor and disposed opposite the first inductors and being capable of circumferential adjustment relative to said first inductors so that the relative phase of the frequencies produced by said reactance can be varied, the first and second named inductors being shaped so that the harmonic content of any generated frequency is inaudible.
5. In an electrical musical instrument, means for electrostatically producing an alternating current of the frequency of a predetermined sound wave, said means comprising oppositely disposed stators, adapted respectively to be connected in circuit with a sound producer and with a polarizing source; and a rotary shield disposed between said stators and spaced apart therefrom

and having portions for alternately exposing said stators to each other; and means enabling the positions of said stators to be shifted relative to each other and to said stator exposing portions of said rotary shield to thereby control the phase of the produced current.

6. In an electrical musical instrument, an electrostatic tone generator embodying a current conductor adapted to be electrically connected to the grid of an electron tube; a rotatable shaft having fixed thereto and insulated therefrom a metallic disc, disposed substantially parallel to and spaced apart from said conductor and having a portion in concentric relation to the axis of rotation of the shaft formed so that as the shaft is rotated at an assigned, constant speed, the electrostatic capacity between said member and the conductor will vary periodically with resulting production of alternating voltage by the generator, the frequency of which conforms to a predetermined musical tone.

7. In an electrical musical instrument employing a space discharge tube having input and output circuits and a loud speaker coupled to the output circuit so as to be actuable to convert variable currents into audible sound of controlled volume; generators for producing variable currents at different tone frequencies; an electrical network including a polarizing source for said generators; adjustable series impedances through which voltage is supplied a generator; condensers in parallel with the respective impedances of a generator; and means actuable from a console for selectively rendering active relative to a generator, one or more of the condensers and for adjusting the impedances to govern the rate at which the generator builds up its voltage through said supply impedances.

8. In an electrical musical instrument employing a space discharge tube having input and output circuits and a loud speaker coupled to the output circuit so as to be actuable to convert variable currents into audible sound of controlled volume; generators for producing variable currents at different tone frequencies; an electrical network including a polarizing source for said generators; means by which the relative phases of the currents can be varied; adjustable series impedances through which voltage is supplied a generator; condensers in parallel with the respective impedances of a generator; and means actuable from a console for selectively rendering active relative to a generator, one or more condensers and for adjusting the impedances to govern the rate at which the generator builds up its voltage through said impedances.

9. In an electrical musical instrument employing a space discharge tube having input and output circuits and a loud speaker coupled to the output circuit so as to be actuable to convert variable currents into audible sound of controlled volume; generators for producing variable currents at different tone frequencies; an electrical network including a polarizing source for said generators; means for predetermining the electrical value of voltage supplied a generator from said source; adjustable series impedances through which voltage is supplied said generators; condensers in parallel with the respective impedances of a generator; and means actuable from a console for selectively rendering active relative to a generator, one or more condensers and for adjusting the impedances to govern the rate at which the generator builds up its voltage through said impedances.

10. In an electrical musical instrument employing a space discharge tube having input and output circuits, an electrical sound producer actuable by current in the output circuit and an electrical network including a polarizing source; alternating current generators adapted to be polarized from said source; series impedances in said network between each generator and the source; condensers in parallel in said network; means by which the condensers can be selectively connected with a corresponding number of impedances and charged therethrough; and key controlled means for connecting the impedances with said source upon depression of said key and in series with a resisted discharge path when the key is raised.

11. In an electrical musical instrument employing a space discharge tube having input and output circuits and a loud speaker actuable by current in the output circuit; means for producing a variable current of predetermined waveform in said output circuit, said means comprising in combination with a polarizing source, a continuously variable capacitance device including an electrode having a planar capacity area of substantially crescent configuration and a rotational scanner disposed in spaced parallel relation to said capacity area to provide a thin air dielectric between same and the scanner and serving periodically to coat with the scanner electrostatically to produce in the input circuit variable current of said predetermined waveform.

12. An electrical musical instrument comprising a work circuit having means for converting alternating voltage into audible sound; a condenser having capacity areas of substantially crescent shape, and means formed, disposed and adapted simultaneously to scan said areas to thereby cause continuous cyclic capacitance changes and production of alternating voltages at said areas of respectively different tone frequencies, each substantially of sinusoidal waveform; and keying means enabling selective conduction of alternating voltages to said work circuit from any one or more of said electrodes.

13. An electrical musical instrument comprising a work circuit having means for converting amplified alternating voltage into audible sound; a condenser having capacity areas, each substantially of crescent shape, and means formed, disposed and adapted simultaneously to scan said areas to thereby cause continuous cyclic capacitance changes at the areas and production of alternating voltages of respectively different tone frequencies, each substantially of sinusoidal waveform; and means by which preselected voltages can be conducted to said work circuit at predetermined relative intensities.

14. A device for producing alternating voltage of predetermined tone frequency and substantially sinusoidal waveform comprising a capacitance reactance; means for polarizing said reactance, said reactance including substantially crescent shaped pattern areas of electrical conductive material; and continuously driven means for sequentially scanning said areas.

15. A device for producing alternating voltage of predetermined tone frequency and substantially sinusoidal waveform comprising a capacitance reactance; means for polarizing said reactance, said reactance including a metallic pattern substantially of crescent shape and continuously driven means having scanning portions spaced apart from each other and sequentially scanning said pattern to periodically vary the capacitance of the reactance according to a substantially sinusoidal waveform and produce a corresponding alternating voltage; an electrical network having an electron tube amplifier provided with input and output circuits; an electrical sound producer connected in the output circuit and responsive to actuation of the amplifier; keying means for causing conduction of the voltage to the input circuit; and means in the network for controlling the growth and decay of a tone at said sound producer.

16. In an electrical musical instrument, alternators having relatively movable planar parts, respectively of precalculated shapes and forms, said parts coacting to produce alternating voltages of different tone frequencies; means for synthesizing such of the produced voltages as are desired for the production of a desired complex waveform; means for controlling the relative intensities of said voltages; and means for shifting the phase relation of said voltages.

17. In an electrical musical instrument employing a space discharge tube having input and output circuits, an electrical sound producer actuable by current in the output circuit, an electrical network, means for delivering electrical impulses at different tone frequencies to said input circuit through said network, said network including series and parallel connected paths, impedance means in said series connected path, condensers in said parallel connected paths, key controlled means for selectively controlling the aforesaid delivery of impulses to said input circuit, and means for rendering said condensers selectively effective for controlling the curve characteristics of impulses in the output circuit of said space discharge tube.

18. In an electrical musical instrument employing a space discharge tube having input and output circuits, an electrical sound producer actuable by current in the output circuit, an electrical network, means for delivering electrical impulses corresponding to musical tones to the input of said space discharge tube through said network, said network including series and parallel connected paths, impedance elements in said series connected path, condensers in said parallel connected paths and key controlled means for selectively controlling the impression of electrical impulses upon said input circuit from said network and means in selected parallel connected paths for rendering the condensers therein effective for selectively controlling the operating characteristics of said network.