Aug. 17, 1937. C. KIWUL 2,089,968

ELECTRICAL MUSICAL INSTRUMENT

Filed Dec. 17, 1935 3 Sheets-Sheet 1

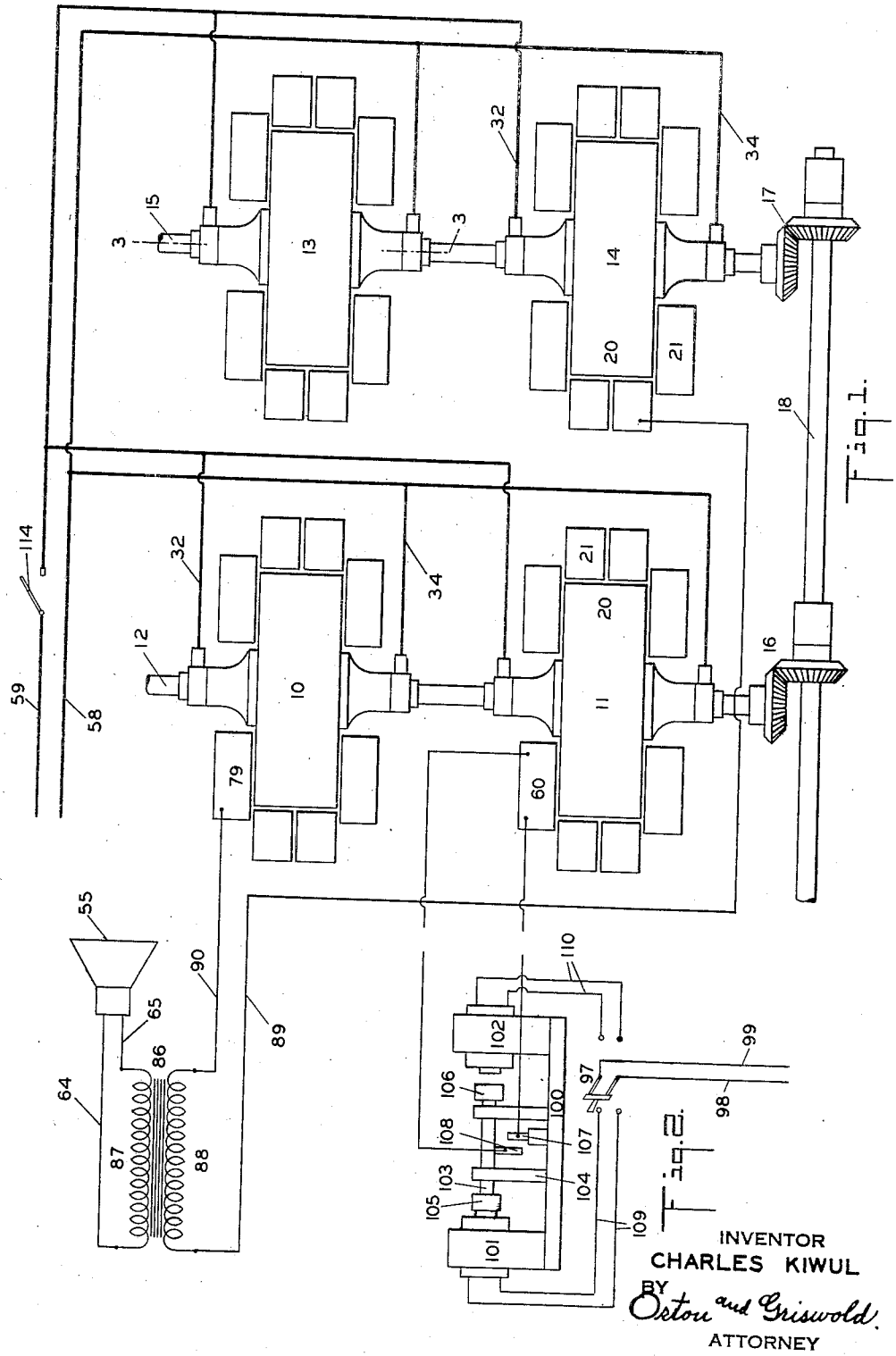

Fig. 1.

Fig. 2.

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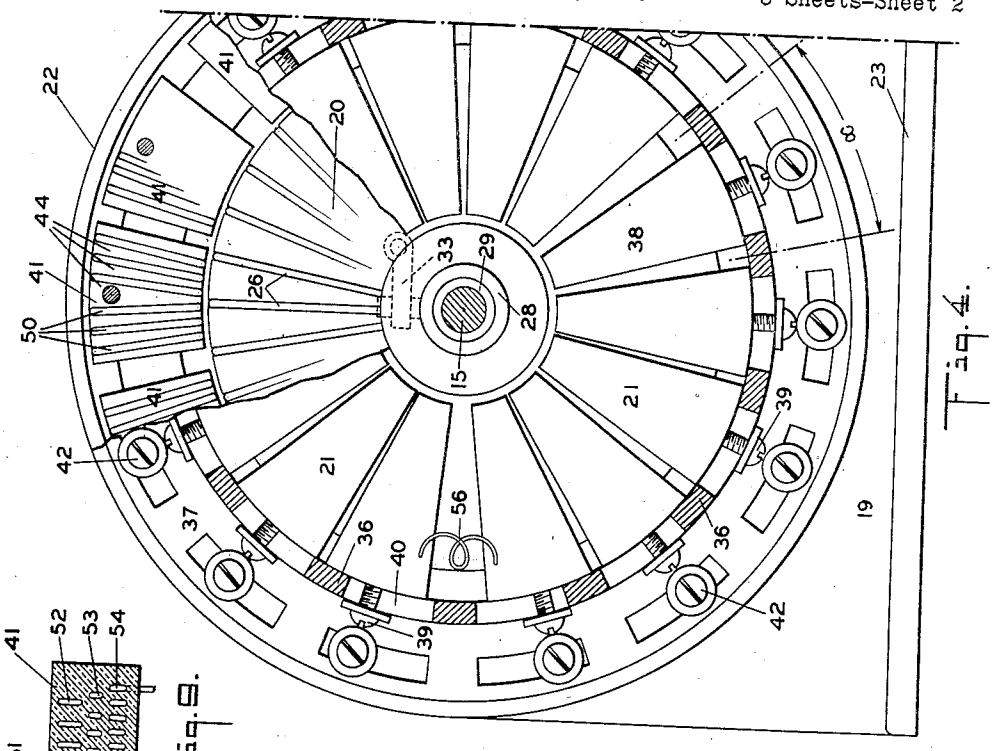

Fig. 4.

Fig. 5.

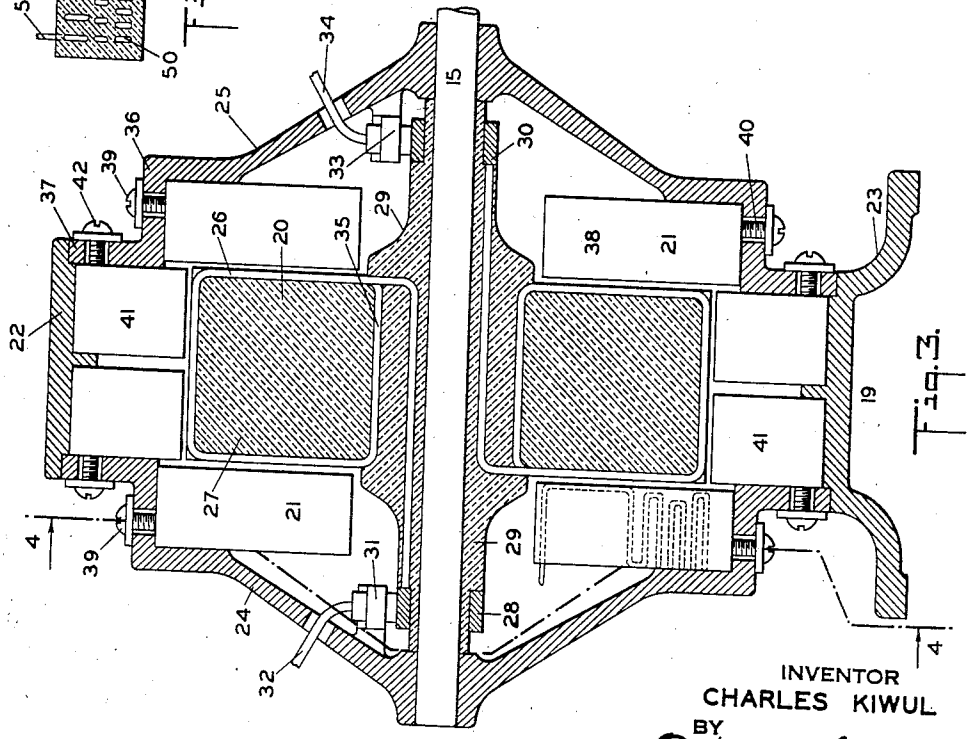

Fig. 7.

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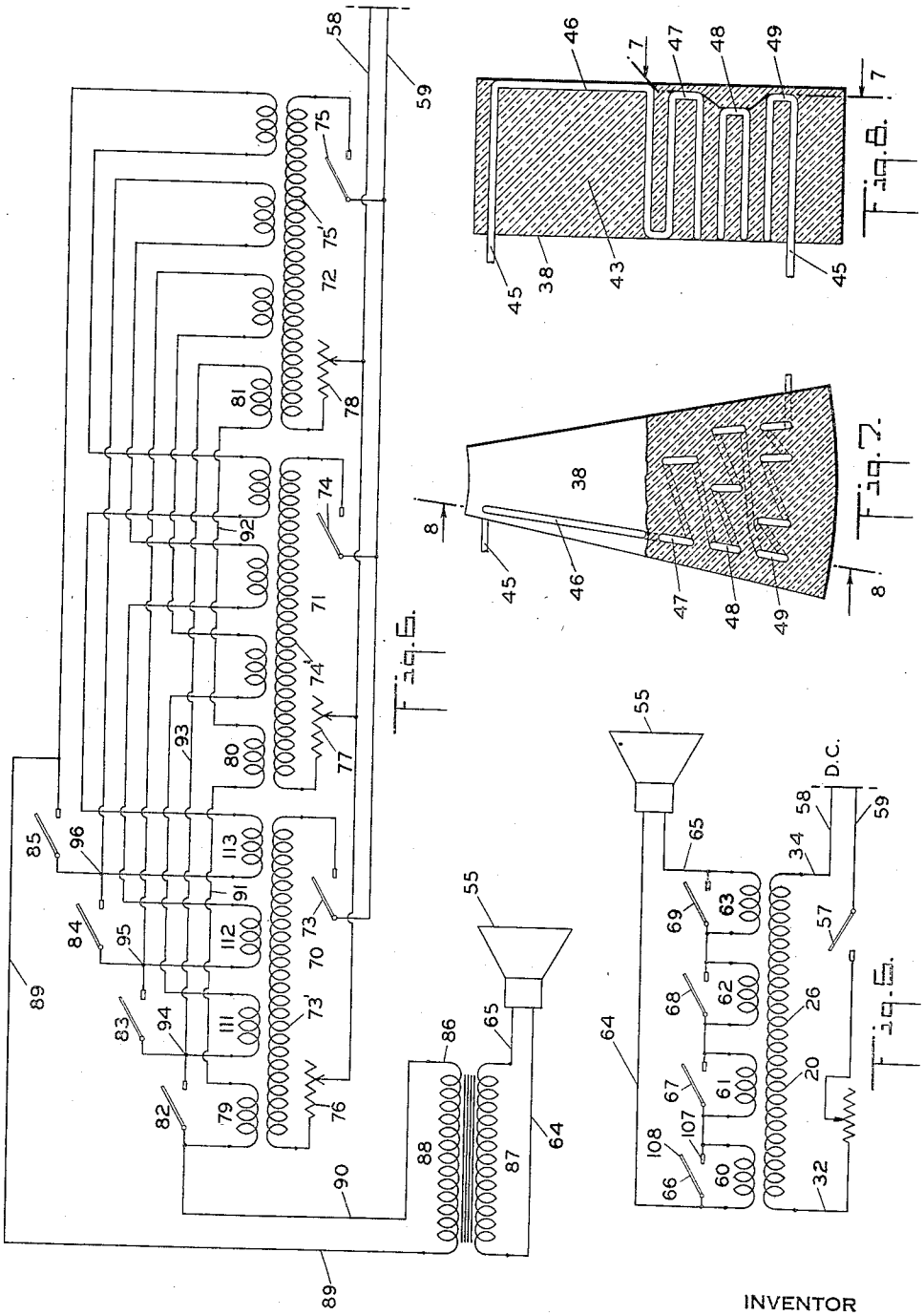

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UNITED STATES PATENT OFFICE

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ELECTRICAL MUSICAL INSTRUMENT

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Application December 17, 1935, Serial No. 54,815

27 Claims. (Cl. 84—1)

The invention relates to an electrically operated musical instrument of the type in which electric generators of the rotative induction type generate electromagnetic wave frequencies corresponding to given fundamental frequencies and to harmonics of the same and for selectively combining and translating these frequencies into sound waves to give musical tones of different loudness, pitch and timbre.

The primary object of the invention is to improve, simplify and to render more efficient musical instruments of the above recited class and particularly to eliminate foreign noises in the electrically produced notes from the instrument.

In one form of such instrument now known the produced electric currents controlling the production of audible fundamentals and harmonics thereof are led a part of their way along individual paths in parallel with each other and are then combined so as to go over a common path forming the audible sound generating on the loud speaker circuit and the instrument played by the opening and closing of switches in the output circuit leading to the loud speaker. Efforts have been made with such an arrangement to filter out the higher frequencies produced in order to eliminate clicks and other foreign noises caused by arcing when the different control switches in the output circuit are in process of being closed or opened. However these efforts to silence these arcing noises have not proven successful in practice. Accordingly, the present invention features an organization of wave frequency producing agencies which are so coupled permanently into the loud speaker circuit as to avoid arcing and the similar objectionable results now prevalent in known arrangements and at the same time to obtain the desired control of the resulting note which can be attained in the illustrated embodiment of the invention herein disclosed simply by selectively short circuiting out of the loud speaker those inductive circuits, the particular frequencies or combinations of which are not desired in the resulting note produced by the loud speaker.

The present disclosure also features certain other additional advantages, such for instance as the exclusion of magnetic material from proximity to the field and armature winding of the several generators to thus defeat generation of any eddy and other undesired currents which have heretofore marred the desired purity of tone; the providing of readily replaceable and relatively adjustable armatures, each designed to produce in any desired degree of refinement tones of a particular pitch and timbre and any one of which armatures may be replaced by a similar armature to provide a different tone; the providing of armatures which permit of any desired grouping of wave frequencies to produce some peculiar note or sound; the formation of a rotor which in its method of winding will utilize the entire surface for active induction and thus tend to form a compact construction as a whole, and the providing of conveniently actuated mechanism which can be remotely controlled from the manual or control keyboard for selectively introducing or removing from the loud speaker circuit some particular tonal quality such, for instance, as the violin effect or any desired number of such undesired tones, harmonics or other sonorous effects.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form embodying the invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

In the accompanying drawings:

Fig. 1 is a plan view looking down upon a part of a complete musical instrument illustrating a preferred embodiment of the invention and showing in heavy lines the electrical connections leading to the field windings and showing in light lines the external parts of the armature windings leading to the loud speaker circuit and showing also in light solid lines the connection leading to one of the armatures;

Fig. 2 is a view in side elevation of one of the locking circuit closers, of which there is one for each armature winding or set of armature windings in the instrument and showing symbolically a controlling stop therefor at the manual or playing station and showing in fine lines the electric connections with one of the sets of armatures of Fig. 1 and the electric connections between the controlling stop and circuit closer;

Fig. 3 is a vertical sectional view taken transversely of the axis of one of the generators, taken for instance on the line 3—3 of Fig. 1;

Fig. 4 is a view largely in side elevation of the left hand side of Fig. 3 partly in section along the line 4—4 of Fig. 3 and parts broken away in vertical section to show some of the block armatures and the armature windings;

Fig. 5 is an explanatory view showing the wir-

ing of one of the generators in its simplest form;

Fig. 6 is a schematic view showing the wiring of three of the generators each with its playing key and with four different armature windings and showing four stop controls, one for each set of the similarly wound armatures of the three generators;

Fig. 7 is a view partly in section of one of the segmental side armatures parallel to the view shown in Fig. 4 and taken on the line 7—7 of Fig. 8;

Fig. 8 is a longitudinal sectional view taken on the line 8—8 of Fig. 7; and

Fig. 9 is a sectional view similar to Fig. 7 of a block form of armature.

It will be understood that in the complete instrument there will be included a plurality of generators of alternating or pulsating electric currents of the frequencies capable of producing the musical scale and that each generator supplies current to produce a tone of a pitch different from that of every other generator, that is, one generator for each musical tone included within the scope of the instrument. Altogether in standard makes of such instruments there will be seventy-two to eighty-four such generators used and thus capable of producing seventy-two to eighty-four distinct fundamental notes. The generators are grouped into sets for convenience in driving them from a single shaft and to effect economy in space disposition with each set geared to a main drive shaft so that they will all have the same constant speed, but it is within the scope of the disclosure to drive one or more sets of generators at different speeds and obviously the generators will be of different sizes to accommodate the different windings necessary to produce the notes of the musical scale.

In the fragmentary showing of one such instrument disclosed in Fig. 1 there are disclosed four generators of which generators 10 and 11 are disposed in tandem and have their rotors fixed to an auxiliary or secondary shaft 12 and another set of generators 13 and 14 have their rotors secured to an auxiliary shaft 15, both shafts being connected through beveled gearing 16 and 17 with a main drive shaft 18 operated from a motor or other source of power.

As the several generators are of similar construction the detailed description of one of them as particularly shown in Figs. 3 and 4 will be sufficient for the others. In general each generator includes a supporting frame 19 in which is rotatably mounted a field wound rotor 20 and a plurality of fixed armatures 21. The supporting frame 19 includes an annular housing ring 22 integral with a wide spreading foot or pedestal 23. Two side panels or spiders 24 and 25 are fitted into opposite sides of the ring 22. These side panels form a bearing for one of the auxiliary shafts 12—15 and which shaft has the rotor 20 secured thereto to rotate therewith.

The rotor is provided with a field winding 26 which consists of one continuous conductor, wound in one or more layers about the core or winding mounting 27. One end of the winding 26 is connected to a ring 28 secured to one end of the hub 29 of the core forming part of the rotor. The opposite end of the field winding is secured to a ring 30 secured to the opposite end of the hub. By means of brushes 31 and a conductor 32 engaging ring 28 current from a source of electric energy is led through wiring hereinafter described to the ring 28 and by means of brushes 33 and a conductor 34 engaging ring 30 the circuit is completed back to the source.

The windings of the field rotors illustrated are similar to the conventional ring type armature windings but it is obvious that other conventional forms of rotor windings are capable of producing the wave frequencies in the armatures as herein featured. In the instant case, for instance as illustrated in Fig. 3 the wire forming the field winding 26 extends from ring 28 partially through the hub, then radially and outwardly to the outer face of the core 27, then axially along the cylindrical surface of the core, then radially and inwardly toward the center, then in reverse direction and at a slight angle to the axis through a channel 35 at the hub portion and hence again radially towards the outer periphery of the rotor until the entire rotor is wound with the turns of the windings substantially equidistantly spaced apart and the final turn leads to the ring 30.

The armatures 21 of each generator are arranged in four parallel planes perpendicular to the shaft 12 and are of two types; one of segmental form as shown in Figs. 4, 7 and 8 grouped in wheel-spoked fashion as shown in Fig. 4 about opposite sides of the rotor; and the other of block form as shown in Figs. 1, 4 and 9 grouped about the periphery of the rotor. These armatures 21 are adjustably and demountably secured to the frame 19. For this purpose the side panels 24 and 25 have their outer portions each defined by an annular flange 36 from the inner edge of which projects an integral flat ring-like outstanding flange 37. The two outer side sets of armatures 38 of the segmental form are secured by means of screws 39 inserted through slots 40 spaced apart in the flange 36. This construction permits of a circumferential adjustment of the armatures as shown in the unequal spacing illustrated in Fig. 4 thus providing means to regulate the phase of the induced electro-motive forces. The slots 40 are of slightly greater width than the diameter of the screws 39 so that by an axial adjustment as shown in Fig. 3 the armature may be adjusted to vary the degree of loudness in the final note. The intensity of the electro-motive force may be varied by introducing variable resistances in the several field circuits of the individual rotors as hereinafter noted in discussing Fig. 6. The length of the slots 40 are selected to permit the armature assemblies to be mounted so that the current of one assembly or generator may be either in phase or out of phase with other similar currents in another assembly or another generator. Similarly the armatures of the block type 41 are demountably secured and readily replaceable by means of screws 42 engaging on the outstanding flange 37.

The present disclosure features the construction of the rotor cores 27 as well as the cores 43 and 44 respectively of the armatures 38 and 41 of non-magnetic material and which preferably, but not necessarily, should be formed of a material which is a non-conductor of electricity to avoid the formation of eddy currents and other foreign currents near the field or near the armature windings hereinafter described and otherwise so constructed that the inductive action between the field rotors and the armatures is due solely to the current carrying rotor winding moving past the stationary armature windings.

In a device of this character, the inductor action starts instantly and completely when one or more switches or keys at the manual controlling the current supplied to the respective rotor windings are depressed and this action stops

abruptly and completely when the keys are released although all of the rotors, or at least those having their associated switches or keys closed are always in motion when the instrument is in use.

The armatures of each type are of similar construction to others of the same type except for size and variations in windings as hereinafter noted so that the detailed description of one of each type will apply with the necessary changes in generator windings to every other armature of the same type. Each armature winding consists of one or a plurality of individual groups of windings designed so that each armature will produce a compound set of wave frequencies and a resulting intensity of sound from the loud speaker different from that produced by every other armature.

In general each generator is designed to produce tones of a different fundamental frequency from that of every other generator. In other words each armature is designed to produce an induced current not only of the fundamental frequency of the tone which the particular associated generator is designed to produce but also a set of frequencies which are multiples of the fundamental frequency and thus supply the harmonics necessary to give to the tone its desired timbre. Further the armatures of all generators or at least all of a set of generators have the same number of sections of like timbre. In Fig. 4 for instance, assuming an equal number of armatures on each side of the rotor, there are fifteen armatures for that particular generator on each side face and it can thus produce tones of thirty different timbres.

Referring first to one of the side or segmental armatures **38** shown in Figs. 4, 7 and 8 a single wire **45** is wound on the core **43** in such a way that it forms a set of inductively active sections connected in series and arranged so that the electro-motive forces produced in any part of the winding are all in one direction. The inductively active sections are shown to be four in Figs. 7 and 8 of which a single length of wire indicated at **46** forms the fundamental and which length **46** extends into a core of two turns as best shown in Figs. 7 to form section **47**, then into three turns to form section **48** and finally into a coil comprising four turns of wire to form the section **49** so that this particular armature is capable of producing four different wave frequencies, one of which **46** is, as above noted, a fundamental frequency and the other three are harmonics of the fundamental.

The block type armatures **41** may be wound in one of two ways. Referring to the winding shown in side elevation at the top of Fig. 4, a single conductor **50** is wound spirally about the block core **44**. It will be understood that this winding produces only one wave frequency. Referring to the other type of armature winding as shown in Fig. 9 a conductor **51** is wrapped successively about three sections of a core **44** as shown to form groups of inductively active sections shown at **52**, **53** and **54** to produce respectively the fifth, sixth and eighth harmonics. In the construction of these armatures the different windings are each wrapped about composite sections of the core, the windings are connected in series and the composite sections are then cemented together into one integral block.

From this construction it is seen that when the rotor turns a unit angular distance equal to the angle of distance between two adjoining armature coils (alpha) one full cycle of impulse is induced in winding **46** which is the fundamental frequency winding for its associated generator and at the same time two cycles are induced in **47**, three in **48**, four in **49**, five in **52**, six in **53** and eight cycles in **54**.

As is particularly shown in Fig. 8 the inductive active sections of the windings for the fundamental frequency and for the harmonics are shown of different lengths and are differently spaced from the rotor so as to get the proper relative intensity of the induced current to produce a tone of a particular timbre which any particular armature is designed to produce.

All of the windings of all the armatures are connected in series to form one continuous permanently closed output circuit in which is included one or more loud speakers **55**. The windings embedded in or encircling the several armature cores are connected one after the other by flexible connectors **56** designed to permit the desired spacing of the armatures **38** shown in Fig. 4.

Referring to the interconnecting wiring external to and connecting the several generators with the loud speaker reference is made to Fig. 5 as an illustration of the simplest form of connection. In this figure the wiring of one of the generators is shown and includes field winding **20** connected through a main control switch **57** with a source of electric energy herein represented by leads **58** and **59** connected to the source of direct current. Inductively associated with the rotor field windings **20** are four armatures **60—63** connected in series with one end connected by lead **64** to one side of the loud speaker **55** and the other end connected by lead **65** to the other side of the loud speaker. The armatures are designed to be shunted out of the output circuit selectively by the corresponding circuit closers **66—69**.

From this construction it is seen that with the field winding active any one or more of the armatures designated generally as **21** and specifically as **60—63** in Fig. 5 may be selectively short circuited out of the loud speaker circuit leaving the remaining armatures to impose its or their particular combination of wave frequencies on the loud speaker circuit, whereby each armature produces its own distinctive set of waves to act on the loud speaker and to be converted thereby into sonorous vibrations. With all of the circuit closers **66—69** closed, all of the armatures will impose collectively their respective wave frequencies simultaneously on the loud speaker circuit. Should it be desired to eliminate any particular tonal effect the circuit closer governing the armature which produces that effect is moved into closed position. For instance assume that armature **60** produces a violin effect, then by closing its associated circuit closer **66** the violin effect is removed from the resulting notes produced by the loud speaker.

Referring to the more complicated scheme of wiring shown in Fig. 6, all of the armatures for producing the same timbre are connected into a group which includes the armatures of the same timbre of all of the generators and these groups are connected into one continuous output circuit. More specifically there is disclosed three generators **70**, **71** and **72** which may be, for instance, generators **10**, **11** and **13**, their respective field windings **73'**, **74'** and **75'** corresponding to the windings **26** hereinbefore described are connected in parallel with the current source leads **58** and **59**. Control switches **73**, **74** and **75** corresponding to the switch **57** of Fig. 5 permits a selective control operable from the manual or playing station

for selectively energizing the field windings of those generators, the notes of which are desired. It is also suggested that variable resistance 76, 77 and 78 be inserted in each of the field circuits to control the loudness of resulting notes produced by each generator. In this form of wiring, only four armatures are illustrated in Figs. 5 and 6 but four is sufficient to illustrate the principle of wiring shown by these figures. The wiring is so arranged that an armature having a certain tonal value, such for instance as that of the violin, is connected in series with every other armature having the same tonal value. Assume for illustration that armature 79 of generator 70, armature 80 of generator 71 and armature 81 of generator 72 are similarly wound to produce say the violin effect. These three armatures are connected in series and form part of the output circuit. This particular group of armatures may be short circuited out of the output circuit by means of a control switch 82 so that by closing switch 82 the violin effect may be removed from the note produced by the loud speaker. Similarly each of the other three armatures of each generator is connected in series with the other similarly wound generators and are introduced or removed from the output circuit by the selective opening or closing of their associated switches 83, 84 and 85. It is suggested that a transformer 86 be included in the output circuit with its secondary 87 forming part of the conductor 65 and its primary 88 connected by leads 89 and 90 to the assembly of connected armatures. Tracing one of the circuits in Fig. 6 for illustration conductor 90 leads to one end of armature winding 79 and to one side of the short circuiting switch 82. The other end of winding 79 is connected by conductor 91 to one end of armature winding 80. The other end of winding 80 is connected by conductor 92 to one end of armature winding 81. The other end of winding 81 is connected by means of conductor 93 back to the other side of switch 82. With switch 82 open as shown in Fig. 6 the wave frequencies produced by the connected armature windings 79, 80 and 81 are imposed on the output circuit and pass at intersection point 94 into the second set of connected armature windings controlled by switch 83, then passes at intersection point 95 into the third set of connected armatures controlled by switch 84, then passes at intersection point 96 into the fourth set controlled by switch 85 and then through conductor 89 back to the secondary of the transformer.

From this construction it is seen that all of the armatures are contained in the output circuit and that this output circuit is free of any switches or other breaks which heretofore imposed objectional clicks, static and foreign noises in the notes produced by the loud speakers. The switches 82—85 simply introduce or remove at will the selected armature windings which are desired in or out of the output circuit.

Reference is made to Fig. 2 for a more complete disclosure of any one of the circuit closers 66—69 of Fig. 5 or 82—85 of Fig. 6. Assume for instance that Fig. 2 is a complete showing of switch 66 in Fig. 5. It will be understood that these circuit closers which are preferably located close to the armatures which they control are in turn controlled at the manual or playing station which, not infrequently is forty or fifty feet away from the assembly of the generators. In the showing in Fig. 2 a stop at the manual of the console is indicated by the two-way switch 97 which is connected to a source of direct current indicated by the leads 98 and 99. Mounted on a support 100 are a pair of electro-magnets 101 and 102 between which is mounted a slide bar 103 carried in brackets 104 and at opposite ends of which are armatures 105 and 106 coacting respectively with the electro-magnets 101 and 102. Mounted on the support 100 is a fixed contact 107 and mounted on the bar 103 is a coacting movable contact 108. Conductors 109 lead to the electro-magnet 101 from one side of the switch 97 and conductors 110 lead from the other side of the switch to the electro-magnet 102.

From this construction it will be noted that by pulling the manual stop to shift the switch to the right in the showing in Fig. 2 the circuit is completed through the right electro-magnet, the bar 103 with its associated armatures is drawn to the right thus moving contact 108 into a circuit closing engagement with contact 107 and thus closing its associated switch 66. Similarly shifting the manual stop to connect the source 98—99 with the left electro-magnet 101 will energize the same, and act on armature 105 to shift the rod 103 and with it the movable contact 108 into its open circuit position shown in Figs. 2 and 5, thus restoring wiring 60 into the output circuit to contribute its effect on the loud speaker. It is understood, of course, that there is a circuit closing arrangement such as shown in Fig. 2 for each of the other armature short circuiting switches. In this way the player can introduce and remove at will from the resulting note produced by the several generators those particular sounds which he desires present or removed for the time being.

As it is difficult at present to make a loud speaker which will produce equally well all frequencies within the audible range, it is suggested that instead of using only one loud speaker in the output circuit, a better practice would be to group the generators into sets of different pitch producing capacities and to utilize for each set that particuler type of loud speaker best suited for that particular pitch or group of pitches. Accordingly it may be assumed that in the showing in Fig. 6, for instance, the three generators 70, 71 and 72 and which, as noted before, may be regarded as the generators 10, 11 and 13 of Fig. 1 produce relatively low frequency vibrations and that the associated loud speaker is particularly designed to produce the correspondingly low pitch notes. Likewise it may be assumed that generator 14 is a symbolic representation of another set of generators capable of producing a relatively high frequency vibration and that this set has a loud speaker corresponding to that shown at 55 and particularly designed to produce the correspondingly high pitch notes.

In operation and assuming that the device illustrated is an organ, that is a device capable of functioning as does a pipe organ, the player at the console operates the player keys conventionally and which in turn opens and closes selectively the different circuit closers which control the rotary field windings of the different generators as for instance by opening and closing the field switches such as 57, 73, 74 and 75. Depressing the key which closes control switch 73, for instance, would cause a note to sound which is composed of the four frequencies introduced into the loud speaker circuit by the four armatures 79, 111, 112 and 113 (Fig. 6). In this way a musical piece can be played by conventionally operating the banks of playing keys usually found in conventional forms of pipe or-

gans. As before noted should it be desired to modify the tonal effect of any note or a group of notes, a stop of which there is one for each similar timbre group, is pulled or pushed to move a controlling circuit closer, such as **97**, into position to introduce or remove at will the selected timbre group or groups into or from the resulting note subsequently played by the manipulation of the player keys controlling the switches like **57**, **73**, **74** and **75**.

The instrument is turned on or off by means of a main switch **114** in the main leads **58—59** and the device is preset to give the requisite loudness and intensity of sound by suitable adjustments of the variable resistances in the field winding circuits.

By means of a device of this character it is seen that the switches or stops such as **66—69** in Fig. 5 or **82—85** in Fig. 6 may be opened or closed without making any break in the output circuit and thereby there is eliminated the reason why clicks and static noises have occurred heretofore in similar forms of electrically operated musical instruments.

A variable resistance **115** may be included in one of the main supply lines, such as the lead **32** in Fig. 5 so that by varying the resistance the player can at will cause a fading or a swelling in the volume of the sound produced and in this way vary the intensity or volume of the resulting music.

I claim:

1. In an electrically operated musical instrument, the combination of a plurality of sets of electric generators of the rotor type, each generator provided with a rotor having windings, each set including a secondary shaft for driving the rotors of its associated set, a main driving shaft geared to the several secondary shafts to drive all the rotors in unison, a source of electric energy connected to all of the windings of the several rotors through a variable resistance interposed between the source and the said rotors, a plurality of rotor field switches, one for each generator for controlling the energizing of its associated generator, each generator including a plurality of coacting armatures with each armature having a winding to produce a different set of wave frequencies from that of every other armature in the associated generator, and with a winding of an armature of one generator producing as a component part of its set of wave frequencies the same wave frequency as is produced by an armature of one or more other generators and said similarly wound armatures connected in series, means forming an output circuit including a loud speaker and a plurality of circuit closers, one for each armature and operatively connected to short circuit out of the output circuit the windings of any group of armatures which produce the same wave frequency while leaving in circuit the remaining armatures not so short-circuited.

2. In an electrically operated musical instrument, an electric generator including a supporting frame, a shaft mounted for rotary movement in the frame, a rotor secured to the shaft to turn therewith and including a core of non-magnetic material and a winding encircling the core and means for connecting the winding to a source of electric energy, a plurality of coacting armatures demountably secured to the frame, grouped about the rotor and encircling the axis of rotation of the shaft, certain of the armatures having a segmental form and disposed in two planes on opposite sides of the rotor and certain others of the armatures being of block form and disposed in two planes about the peripheral edge of the rotor, the windings of all of the armatures being connected in series, means forming a loud speaker circuit including a loud speaker and said series connected armature windings, a plurality of circuit closers, one for each armature for short circuiting its associated armature winding out of the loud speaker circuit and a plurality of remote controls, one for each circuit closer for selectively actuating its associated circuit closer and thus control the armatures removed from the loud speaker circuit.

3. In an electrically operated musical instrument, an electric generator including a supporting frame, a shaft mounted for rotary movement in the frame, a rotor secured to the shaft to turn therewith and including a core of non-magnetic material and a winding encircling the core and means for connecting the winding to a source of electric energy, a plurality of coacting armatures demountably secured to the frame, grouped about the rotor and encircling the axis of rotation of the shaft, certain of the armatures having a segmental form and disposed in two planes on opposite sides of the rotor and certain others of the armatures being of block form and disposed in two planes about the peripheral edge of the rotor, the windings of all of the armatures being connected in series, means forming a loud speaker circuit including a loud speaker and said series connected armature windings, a plurality of circuit closers, one for each armature for short circuiting its associated armature winding out of the loud speaker circuit.

4. In an electrically operated musical instrument, the combination of a plurality of electric generators of the inductive type, each generator including a rotor having a single winding connected to a source of electric energy and each generator including a plurality of fixed armatures, each armature provided with a group of windings connected in series and acting to produce its own distinctive set of electric wave frequencies including a wave of a fundamental frequency and other waves which are multiples of said frequency coacting with the fundamental wave to produce a fixed timbre for each armature, the windings of each armature being different collectively from that of every other armature of its associated generator, one winding of one of the armatures of one of said generators being the same as the winding of one of the armatures of another generator whereby each of said two armature windings produce the same wave frequency, means for converting the waves from all of the generators into sonorous vibrations and a single manually actuated control for simultaneously connecting to said converting means the said last named two windings.

5. In an electrically operated musical instrument, the combination of a plurality of electric generators of the inductive rotor type, means forming a power circuit including a source of electric energy, the field windings of each of said generators, and a manually controlled variable resistance to control the volume of the resulting sound from the instrument, each generator including a plurality of armatures, each armature provided with a winding to give a particular resulting note to each armature different from that produced by every other armature in the associated generator, and certain of the windings of different generators producing the same resulting

timbre effect, means for converting the frequencies from the several armatures into sonorous vibrations and a control for simultaneously short-circuiting from said converting means those windings which produce the same timbre effect from the different generators.

6. In an electrically operated musical instrument, the combination of a plurality of electric generators each including a rotor forming a rotating field, power means for rotating all of the field forming rotors in unison, each generator including a plurality of fixed armatures with each armature wound to produce a combination of wave frequencies of different degrees of loudness of which one wave frequency is the same in all of the armatures of one generator and each armature having at least one other wave frequency of the combination being different from that produced by each other armature of its associated generator, the windings of the armature of each generator being connected in series, a transformer having its primary in circuit with said armature windings, a loud speaker permanently in circuit with the secondary of said transformer and control means for selectively short circuiting at will one or more of the armature windings out of the primary of the transformer.

7. In an electrically operated musical instrument, the combination of a plurality of electric generators of alternating or pulsating current type, each wound to produce its own distinctive set of wave frequencies and each including a rotating field winding and a plurality of fixed armature windings, means forming a loud speaker circuit permanently connected in series with all of the armature windings and control means for removing from the loud speaker circuit the wave frequencies produced by one or more of the armatures while retaining in the circuit the frequencies produced by all of the armatures remaining in circuit.

8. In a device of the class described, the combination of a plurality of electric generators of the inductive rotor type, each generator including a field rotor winding and a plurality of fixed armature windings, all of the armature windings being connected in series with a loud speaker, a source of direct current, means connecting the rotor windings in parallel with said source and a plurality of control switches one between each rotor winding and said source.

9. In a device of the class described, the combination of a plurality of electric generators of the inductive rotor type, each generator including a field rotor winding and a plurality of fixed armature windings, all of the armature windings being connected in series with a loud speaker, a source of direct current, means connecting the rotor windings in parallel with said source and a plurality of control switches one between each rotor winding and said source and control means for selectively short-circuiting any armature out of series without interrupting the connection of the remaining armature with the loud speaker.

10. In a device of the class described, the combination of a plurality of electric generators of the inductive rotor type, each generator including a rotor field winding, and a plurality of coacting fixed armatures connected in series, each generator wound to produce a set of wave frequencies different from the set of wave frequencies produced by every other generator, a plurality of playing circuit closers, one for each field winding operable in playing the device, control means for selectively short-circuiting any one or more armatures out of this series circuit thereby to change the set of wave frequencies of its associated generator and means permanently in circuit with all of the armatures for translating the wave frequencies from all of the generators for the time being in circuit therewith into sound waves.

11. In a device of the class described, the combination of an electric generator of the inductive rotor type including a rotor field including a winding connected to a source of electric energy and a plurality of coacting fixed armatures, each armature provided with a plurality of windings connected in series, each of said armatures wound to produce an alternating electro-motive force distinct from that produced by each other armature, mountings for both the field and armature windings formed of non-magnetic material to minimize the formation of eddy and other foreign currents in proximity to the field and armature windings and means for converting the electro-motive force from each armature into audible vibrations and each armature acting thereon to produce its own particular pitch and timbre.

12. In a device of the class described, the combination of an electric generator including a rotor having a winding adapted to be connected to a source of electric energy to energize the rotor field, and a plurality of coacting fixed armatures, each armature divided into fractional sections and each section provided with a winding, the windings of each section being permanently connected in series and forming an electro-motive force different from that formed by every other section and each comprising a fundamental frequency and a frequency constituting a harmonic of its associated fundamental frequency, means forming a loud speaker circuit in series with the windings of all of the armatures and control means for short circuiting out of the loud speaker circuit any desired number of armature windings.

13. In an electrically operated musical instrument, a generator including a rotor comprising a core of non-magnetic material having a winding connected to a source of electric energy and a plurality of fixed armatures inductively associated with the rotor, each armature comprising a core of non-magnetic material and having a set of windings connected in series and producing a frequency of wave formation different from that produced by each other armature, means providing a loud speaker circuit, the windings of the several armatures being in series with each other and with the loud speaker circuit and manually actuated means for short circuiting at will the wiring of any one or more armature windings out of the loud speaker circuit.

14. In an electrically operated musical instrument, the combination of an electric generator of the inductive rotor type including means forming a rotating field having a single winding connected to a source of direct current electric energy and a plurality of fixed armatures associated therewith, each armature provided with a group of windings connected in series of which each winding is different from every other winding of the group and coacts to produce its own distinctive set of electric waves, the group of windings of each armature being different from the group of windings of every other armature whereby each armature produces its own distinctive set of waves and each armature producing the same fundamental wave together

with harmonies of said same fundamental wave, means for converting said waves into sonorous vibrations and manually actuated control means for selectively disconnecting any one or more of the armature windings from said last named converting means.

15. In a device of the class described, the combination of an electric generator comprising a rotor including a mounting of non-magnetic material and a winding therefor comprising a single conductor wound circularly and uniformally about the entire exposed surface of the rotor thereby to utilize practically the entire surface of the rotor for active induction and a plurality of coacting armatures encircling the axis of rotation of the rotor and each armature wound to produce a set of wave frequencies different from the set produced by every other armature and certain of the armatures wound to include the same fundamental frequency, the windings of all of the armatures being connected in series, means forming an electric circuit including an instrument for converting the wave frequencies of the several armatures into sound waves, timbre control means including a plurality of circuit closers, one for each armature for selectively introducing and removing any desired armature winding into and from said electric circuit thereby to control the timbre of the note resulting from the energizing of the armatures for the time being included in the circuit and playing control means including a circuit closer in the rotor winding for controlling the energizing of the rotor field and thus controlling the operation of the generator.

16. In an electrically operated musical instrument, the combination of an electric generator of the inductive type including a movable field and a plurality of fixed armatures, means forming a closed loud speaker circuit free of switches and other breaks, said closed circuit including a loud speaker and the windings of the several armatures, each armature winding acting to contribute its own peculiar tone to the loud speaker effect and timbre control means for selectively short circuiting out of the loud speaker circuit any one or more of the armature windings while permitting the balance of the windings to remain in the loud speaker circuit.

17. In an electrically operated musical instrument, an electric generator having a rotating field and means forming an output circuit including a plurality of fixed armatures coacting inductively with the field, each armature wound to produce a set of frequencies different from the set of frequencies produced by every other armature, means also forming part of said output circuit for converting the wave frequencies of said armatures into sound waves and a plurality of circuit closers, one for each armature for connecting and disconnecting its associated armature at will from said converting means.

18. An electrically operated musical instrument including a plurality of armatures each wound to produce a set of wave frequencies different from that produced by the other armatures, means for connecting the armatures in series to form an output circuit, each of said armatures imposing on the circuit the combination of wave frequencies generated by that particular armature, parts of certain of the armatures being similarly wound and the windings connected together in series to produce as a component part of said combination the same wave frequency, control means for short circuiting said certain armatures at will out of the output circuit, and a loud speaker included in the output circuit.

19. In an electrically operated musical instrument, the combination of an alternate or pulsating current generator for producing simultaneously a fundamental wave frequency and a plurality of secondary wave frequencies capable of producing a fundamental note and certain of said different wave frequencies capable of producing a definite timbre, another similar alternate current generator for producing a fundamental wave frequency of its own and a plurality of secondary wave frequencies capable of producing a note different from the first named note, certain of said secondary wave frequencies of the second generator capable of producing the same definite timbre, means for converting all of said wave frequencies into audible sound and a single control means for introducing and removing at will from said last named means the said definite timbre produced by both of the generators.

20. In a device of the class described, the combination of an electric generator including a rotative field provided with windings and a plurality of armatures, each armature wound to produce a different form of compound frequency wave, each compound wave including the same fundamental frequency and one or more multiples of said fundamental frequency capable of producing harmonics thereof, and which compound waves distinguish from each other in the number of said multiples of the fundamental frequency present and means for translating said compound frequency waves into audible sound.

21. In an electrically operated musical instrument capable of producing musical notes of various pitch and timbre, the combination of a plurality of sets of generators, each generator including a rotating field winding connected to a source of electric energy and one or more fixed armatures, the armatures of each generator wound to produce a fundamental note and one or more harmonics of the fundamental note, the windings of the armatures of each set being connected in series, a plurality of loud speakers, one for each set and each loud speaker connected in series with the armatures of its associated set of generators, and each set of generators wound to produce in its associated loud speaker a note having a pitch different from that produced by every other set of generators.

22. In a device of the character outlined, the combination of a plurality of electric generators of the inductive rotor type, each generator including a rotor core of non-magnetic material and a field winding on the core and a plurality of armatures, each armature formed with a core of non-magnetic material and an armature winding thereon, a loud speaker, all of said armature windings and said loud speaker being connected in series, a source of direct current, said field windings of the generators being connected in parallel with each other to said source and a plurality of control switches, one for each generator and located between the source and the field rotor winding of the generator.

23. An electric generator including a rotor field winding and a plurality of fixed armature windings, each armature winding being wound different from that of every other armature winding and thus capable of producing a wave formation different from that produced by every other armature winding, the wave formation caused by

each armature winding including the same fundamental frequency and one or more multiples of said fundamental frequency and each wave formation distinguishing from each other in its capacity to form in the produced note a loudness in one of said multiples different from the loudness produced in another of said multiples and means for translating said wave formation into sonorous notes.

24. In an electrically operated musical instrument, the combination of a rotative field and a set of fixed armatures, a field switch for the rotative field, each armature of the set being wound differently from that of every other armature of that set, means forming a control circuit, said means including a control switch, a loud speaker and the windings of all of the armatures arranged in series and means including a variable resistance in the circuit which includes the rotative field for controlling the volume of the sound produced by the loud speaker.

25. In an electrically operated musical instrument, the combination of an electric generator of the inductive rotor type and including a rotor provided with a field winding and an armature provided with an armature winding and a loud speaker connected in series with the armature winding, said armature winding organized to cause the loud speaker to sound a musical note consisting of a fundamental frequency and another frequency which is a harmonic of the fundamental frequency.

26. In a device of the class described, the combination of a plurality of electric generators, each generator including a rotative field winding and a plurality of fixed armatures, each armature of any one generator being wound to produce a different form of compound frequency wave from the wave produced by each other armature of that generator, control means for selectively energizing the field windings of any one of the generators and means for translating said compound frequency waves into audible sound.

27. In a device of the class described, the combination of a plurality of electric generators, each generator including a rotative field winding and a plurality of armatures, each armature of any one generator being wound to produce a different form of compound frequency wave from the wave produced by each other armature of that generator, means for selectively grouping together in circuit certain of the armature windings, a manual for playing the device, said manual provided with a plurality of manually actuated circuit controlling keys, one for the field winding of each generator and means for translating said compound frequency waves into audible sound.

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