

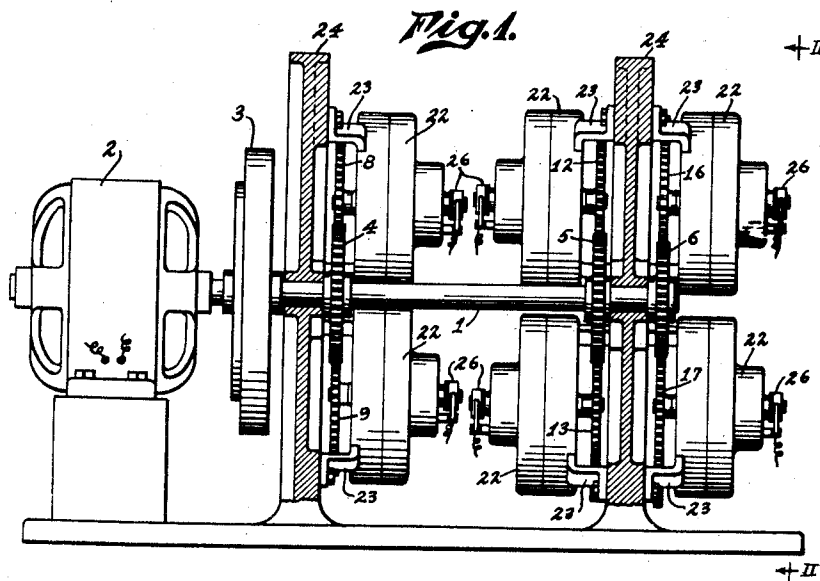
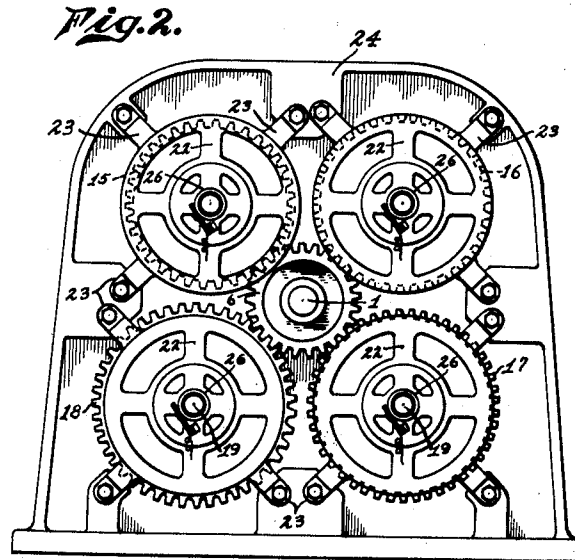
Feb. 9, 1937.

V. H. SEVERY

2,069,780

MULTIFREQUENCY GENERATOR

Original Filed July 24, 1933 6 Sheets-Sheet 1



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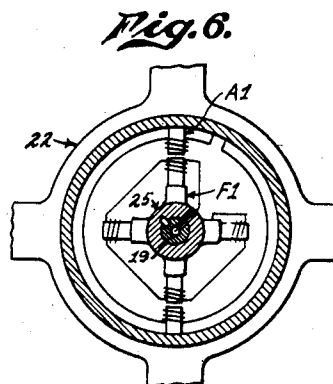
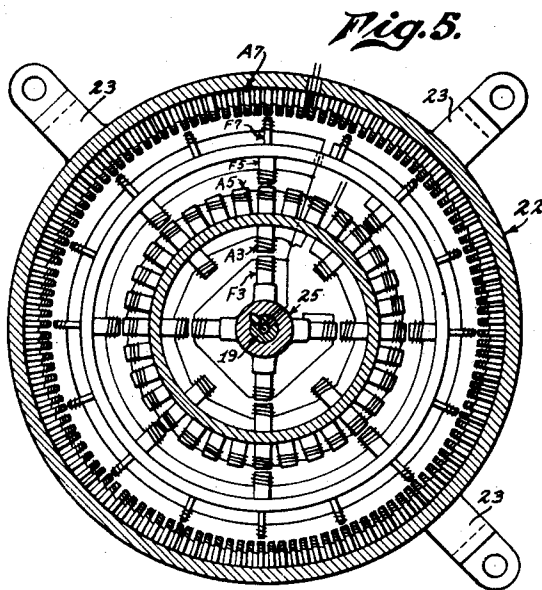
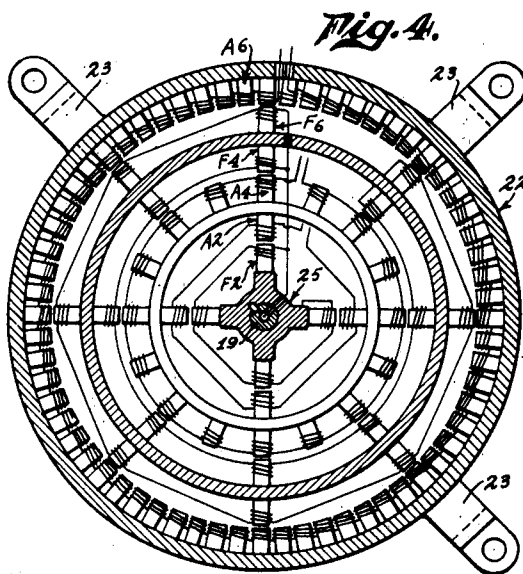
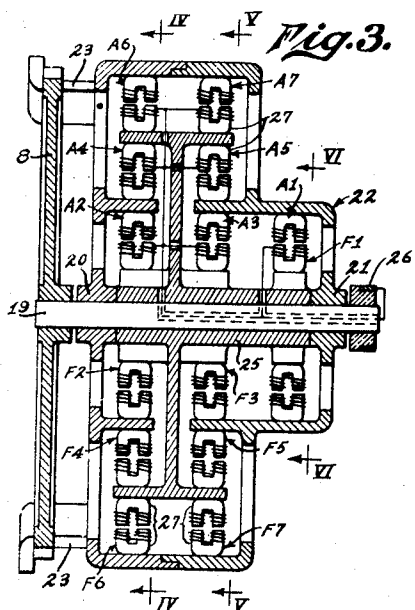
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MULTIFREQUENCY GENERATOR

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MULTIFREQUENCY GENERATOR

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Fig. 7.

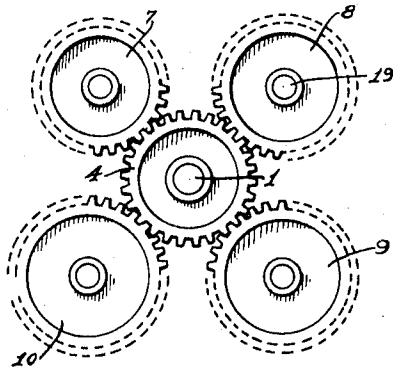


Fig. 8.

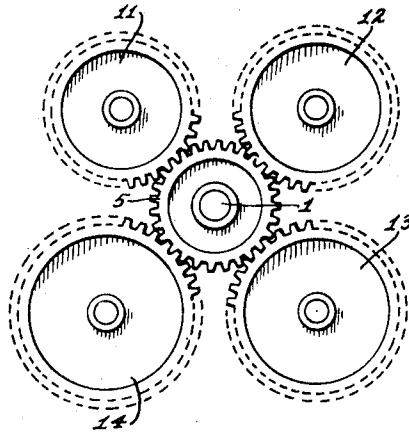
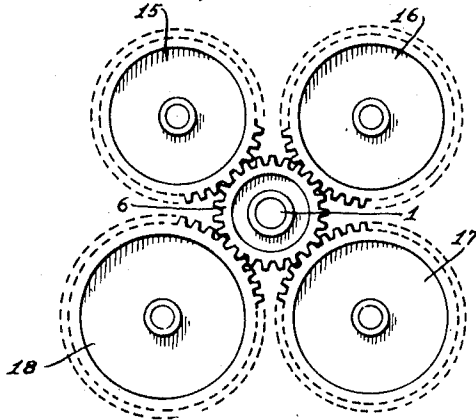


Fig. 9.



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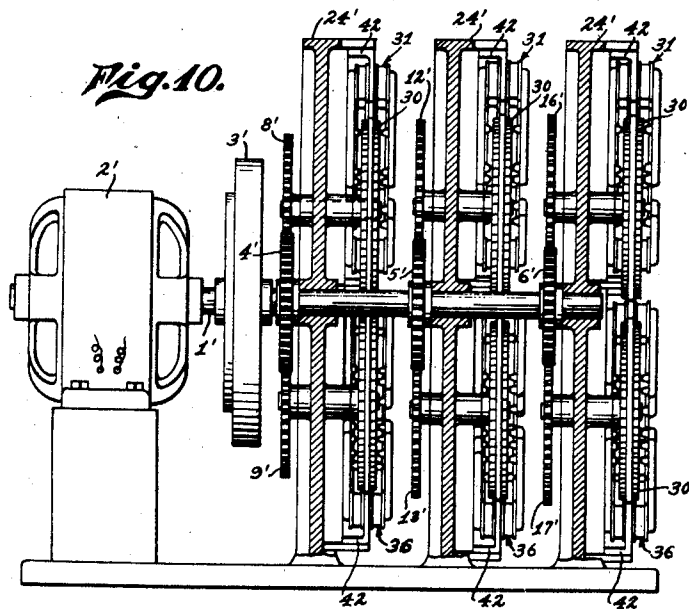
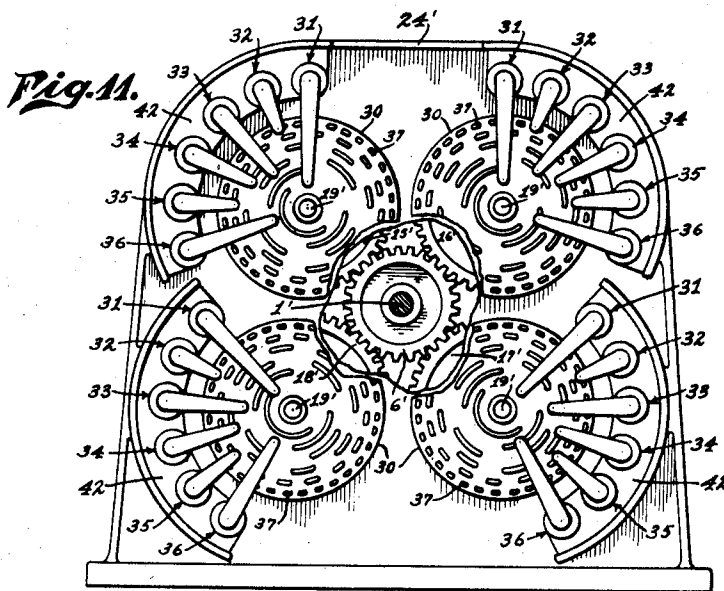
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MULTIFREQUENCY GENERATOR

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MULTIFREQUENCY GENERATOR

Original Filed July 24, 1933 6 Sheets-Sheet 5

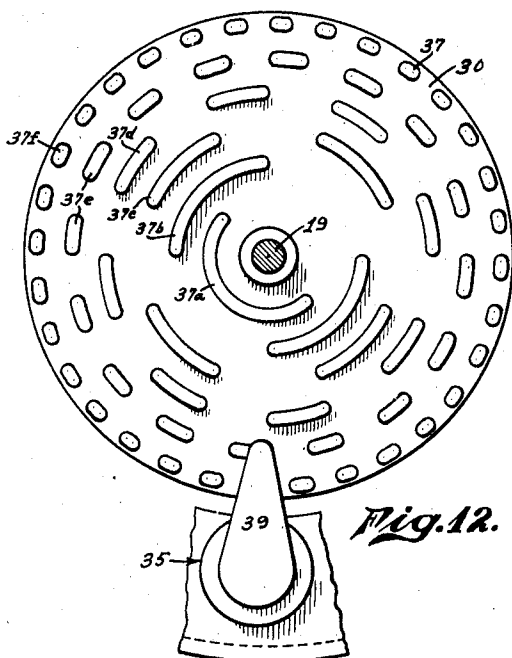


Fig. 12.

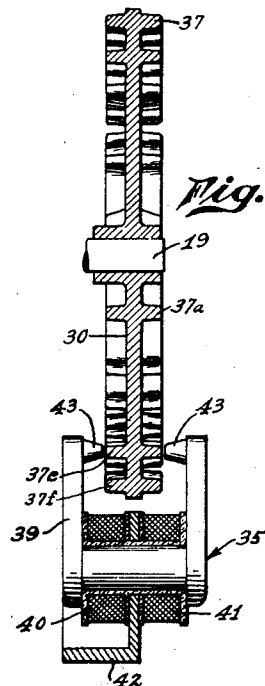


Fig. 13.

Fig. 16.

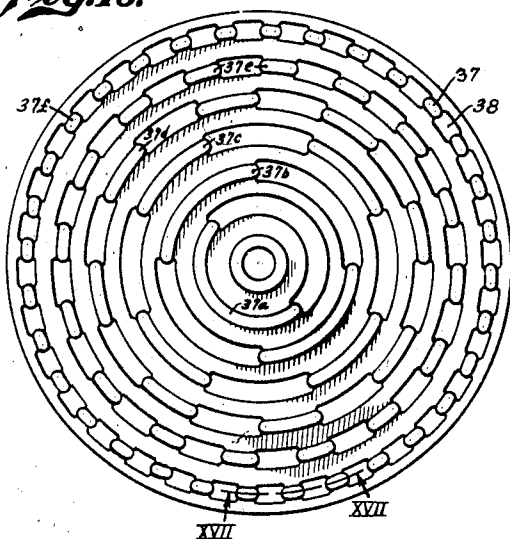


Fig. 14.



Fig. 15.

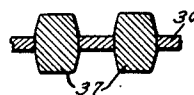
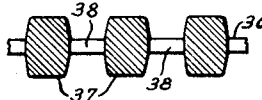


Fig. 17.



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MULTIFREQUENCY GENERATOR

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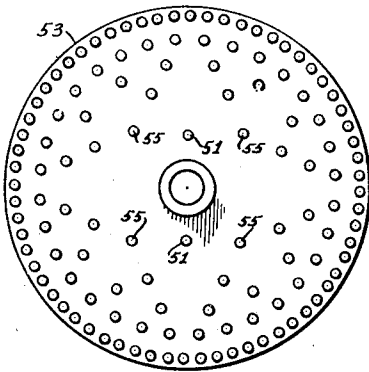
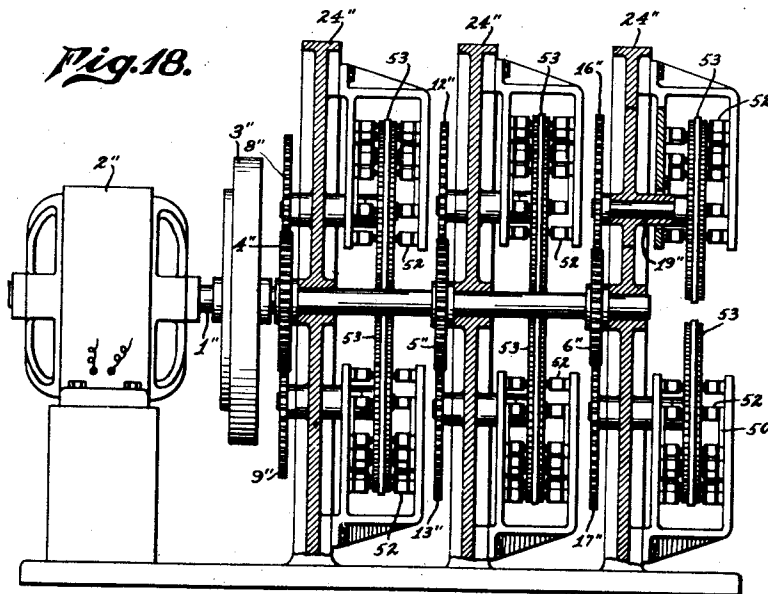
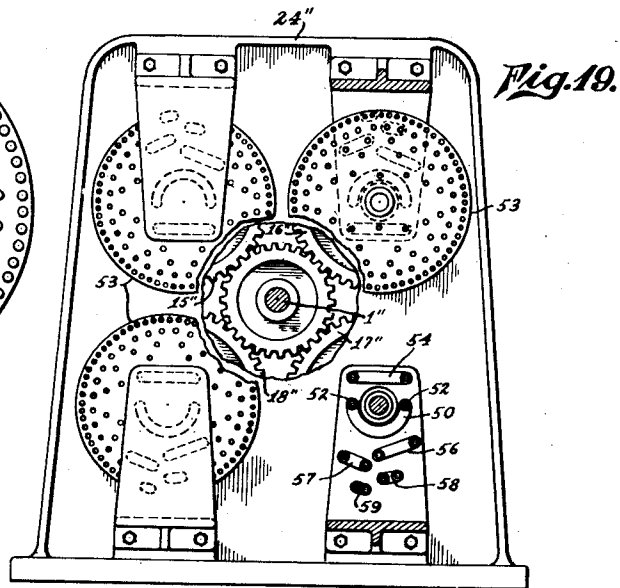


Fig. 20.



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UNITED STATES PATENT OFFICE

2,069,780

MULTIFREQUENCY GENERATOR

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mesne assignments, to Creative Industries,
Inc., a corporation of Nevada

Application July 24, 1933, Serial No. 681,881
Renewed October 2, 1935

6 Claims. (Cl. 84-1)

This invention relates to electrical generators and particularly A. C. generators for producing a great many distinct currents of different frequencies corresponding to different musical notes whereby they may be used for energizing electrically actuated musical instruments, such as electric pianos, organs, etc.

An object of the invention is to produce from a single machine a large number of currents of different frequencies, the ratios of which each to the other remain absolutely constant at all times.

A feature of the invention is a generator of the inductor type having a plurality of field and armature windings or sets of windings cooperating with a single rotor for producing a plurality of distinct alternating or pulsating currents, the frequencies of which are different multiples or harmonics of a desired fundamental frequency.

Another feature is a generator having a plurality of rotor elements and cooperating stator elements in which each rotor and cooperating stator produces a plurality of separate currents and frequencies bearing harmonic relation to each other, and in which the various rotors are geared together to run at different relative speeds, the ratios of which are approximately the same as the ratios of the frequencies of the different musical notes within an octave.

Other features of the invention reside in the particular design of my generator and will be apparent from the following detailed description with reference to the drawings, in which:

Figure 1 is a side elevation partly in section of a twelve-unit machine, in accordance with the invention;

Figure 2 is a cross section of the same machine taken in the plane II—II of Figure 1;

Figure 3 is a detail longitudinal vertical section through one of the twelve units of the machine shown in Figures 1 and 2, the section being taken in the plane of the axis of the unit;

Figure 4 is a cross section of the unit shown in Figure 3 taken in the plane IV—IV of Figure 3;

Figure 5 is a cross section in the plane V—V of Figure 3;

Figure 6 is a cross section in the plane VI—VI of Figure 3;

Figures 7, 8 and 9 are diagrams illustrating how the three sets of gears in the machine of Figure 1 are proportioned and positioned to rotate the twelve different units of the machine from a common shaft at desired relative speeds;

Figure 10 is a side elevation partly in section of an alternative form of construction to that shown in Figure 1;

Figure 11 is an end view of the machine shown in Figure 10 with a portion of the end wall broken away to show the gears;

Figure 12 is a detail face view of one of the inductor discs in the machine of Figure 10, showing one of the inductor magnets;

Figure 13 is a cross section of the inductor disc and inductor magnet shown in Figure 12;

Figures 14 and 15 are detail cross sections showing alternative constructions of the inductor disc illustrated in Figures 12 and 13;

Figure 16 is a face view of a modified form of inductor disc;

Figure 17 is a sectional detail of a portion of the disc shown in Figure 16, taken along the line XVII—XVII in Figure 16;

Figure 18 is a side elevation partly in section of still another modification of the machine shown in Figure 1;

Figure 19 is an end view partly in section, and with a portion of the end wall broken away to show the gears, of the machine shown in Figure 18; and

Figure 20 is a face view of one of the inductor discs of the machine shown in Figures 18 and 19.

Referring first to Figures 1 and 2, my machine consists of twelve separate generating units mounted on a common frame and adapted to be driven through gears from a common shaft 1, which in turn is revolved at constant speed by a motor 2 through a speed governing clutch 3. The speed governing clutch may be eliminated and the shaft 1 driven directly from the motor 2 if the latter is a synchronous machine supplied with actuating current of constant frequency.

The twelve individual generating units are identical in design and are arranged in groups of fours, the units in each group being positioned in planetary fashion about the shaft 1 and all the units in a group having drive gears meshing with a common gear on the shaft 1.

The three groups are spaced apart longitudinally along the shaft 1 and the units in the different groups driven by the three gears 4, 5 and 6, respectively, on the central shaft 1.

In a manner to be fully described later, each of the twelve generator units is constructed to deliver a plurality of alternating currents which bear harmonic relation to each other. Thus, each unit produces separate currents of seven different frequencies, such that if all the frequencies are divided by the lowest frequency, the numbers obtained are 1, 2, 4, 8, 16, 32 and 64, respectively. It follows that if a unit is driven

at such speed as to make any one of the currents produced thereby correspond in frequency to a musical note, the remaining currents will correspond in frequency to musical notes separated from the first note by one or more octaves. More specifically, if the speed of rotation of one unit is such that the lowest frequency produced thereby is that of the note C in the lowest octave in the musical scale, the frequencies of the other currents produced by that unit will be those of the note C in the successive higher octaves in the musical scale.

By so gearing the twelve units to the central shaft 1 that their relative speeds are proportionate to the frequencies of the different notes within a musical octave, the eighty-four currents produced by the entire machine could be made to correspond exactly in frequency to eighty-four notes in the musical scale. An approximation to this desired result that is sufficiently accurate for practical purposes is obtained in the machine shown by proportioning the gears and the speed of shaft 1 as follows:

The three gears 4, 5 and 6 on the main shaft 1 have eighty-four teeth, eighty teeth and sixty-nine teeth, respectively. Referring now to Figure 7, the gears 7, 8, 9 and 10 on the four generator units driven by gear 4 have eighty-four teeth, eighty-nine teeth, ninety-four teeth and one hundred teeth, respectively. Therefore, the ratios of the speeds of these four generators relative to the speed of the main shaft 1 will be

$$\frac{84}{84}, \frac{84}{89}, \frac{84}{94} \text{ and } \frac{84}{100}$$

respectively. If shaft 1 is rotated at 969.96 R. P. M., the speeds of the generator rotors connected to gears 7, 8, 9 and 10, respectively, will be 969.96, 915.5, 877.44 and 814.8 R. P. M., respectively, and if the low frequency armature of each generator unit is designed to produce two cycles of alternating current during each revolution of its rotor, those windings on the four units will develop alternating currents of frequencies (in cycles per second) of 32,331, 30,498, 28,892 and 27,158, respectively. These frequencies correspond approximately to the frequencies of the notes C, B, A $\sharp$ and A in the lowest octave of the musical scale. Since the remaining six windings on each of the four generator units driven from gear 4 produce currents of harmonic frequencies with respect to the lowest frequency produced by that generator, the four generators supply currents of twenty-eight different frequencies corresponding to the notes C, B, A $\sharp$ and A in seven successive octaves of the musical scale.

Referring now to Figure 8, the gear 5 has eighty teeth and the gears 11, 12, 13 and 14 meshing therewith have 101, 107, 113 and 120 teeth, respectively. The ratios of the speeds of the four generator rotors driven by these gears to the speed of shaft 1 will, therefore, be

$$\frac{80}{101}, \frac{80}{107}, \frac{80}{113} \text{ and } \frac{80}{120}$$

respectively, and when shaft 1 is rotated at a speed of 969.96 R. P. M., gears 11, 12, 13 and 14 will rotate at speeds of 768.31, 734.59, 686.72 and 646.66 R. P. M., respectively, and the associated generator units will develop currents of frequencies (in cycles per second) of 25,609, 24,173, 22,889 and 26,554, respectively, together with the first six harmonics of those currents. These frequencies correspond approximately to the frequencies

of the notes G $\sharp$, G, F $\sharp$ and F in the first seven octaves of the musical scale.

Referring now to Figure 9, the gear 6 has sixty-nine teeth and the gears 15, 16, 17 and 18 meshing therewith have, respectively, 110, 116, 123 and 130 teeth. Therefore, the speeds of the four generator units driven by gears 15, 16, 17 and 18, respectively, relative to the speed of the main shaft 1, will be

$$\frac{69}{110}, \frac{69}{116}, \frac{69}{123} \text{ and } \frac{69}{130}$$

and, when shaft 1 is rotated at 969.96 R. P. M., gears 15, 16, 17 and 18 will rotate at speeds of 608.45, 577, 544.14 and 514.84 R. P. M., respectively, and the associated generator units will develop currents of frequencies (in cycles per second) of 20,281, 19,231.5, 18,137.5 and 17,160.5, respectively, together with the first six harmonics of those currents. These frequencies correspond approximately to the frequencies of the notes E, D $\sharp$, D and C $\sharp$ in the first seven octaves of the musical scale.

It is apparent from the foregoing description that the combination of twelve identical generator units geared to a common shaft in the manner described can be made to generate currents corresponding in frequency to the twelve notes in a single octave, and that by designing each unit to produce several harmonics of its fundamental frequency, currents corresponding in frequency to the notes in several octaves may be obtained. The machine disclosed covers seven octaves but obviously this number may be increased or decreased as desired.

It should be noted here that it is impracticable to obtain by the use of gear-connected generators, currents corresponding exactly in frequency to all the notes in the standard musical octave. However, the discrepancies in frequency are so slight with the machine described that they cannot be detected by one listening to music produced with current from the machine.

The important thing in producing music is to maintain the same notes in the different octaves in exact harmonic relation, and to maintain the frequencies of the different notes within each octave always in the same ratio to each other. It is impossible for the relative frequencies of the different currents produced by my machine to vary although the frequencies of all the currents may be varied in unison by varying the speed of the driving shaft.

The individual generator units may be constructed in various ways and several modified forms of construction will now be described in detail with reference to Figures 3 to 6, and 10 to 18.

Referring first to Figures 3 to 6, (the unit shown in Figure 3 being the upper left unit in Figure 1) the gear 8 for driving that unit is fixed to a shaft 19 which is journaled in bearings 20 and 21 in a frame member 22, which is supported by brackets 23 bolted to a main frame standard 24 (Figures 1 and 2), in which the main shaft 1 is journaled.

The frame member 22 supports seven independent armatures A1, A2, A3, A4, A5, A6 and A7, the pole faces of each armature being positioned in a ring or circle adjacent the pole faces of a cooperating field structure F1, F2, F3, F4, F5, F6, and F7, mounted on a rotor frame 25 which is keyed to shaft 19 for rotation therewith. All the field windings are connected together between the frame of the machine and a slip ring 26 on the shaft 19 so that they may be excited from

an external source of direct current through brushes bearing on the shaft 19 and the slip ring 26, respectively. All the armature windings in each set are connected together but are maintained distinct from the windings of the other sets whereby the currents of different frequencies developed in the different sets of armature windings are delivered to different independent external circuits.

The frequency of the current generated in any set of armature windings is determined by the number of field magnets and armature windings in that set, the way in which successive field magnets are poled, and the speed of rotation of the rotor. Since the frequencies of all the currents generated are directly proportional to the speed of the rotor, the relative frequencies or number of cycles of alternating current generated in each set of armature windings during a single revolution of the rotor is determined solely by the number of field magnets and armature windings in a set, and the manner in which they are poled.

Thus, armature A1 comprises two pairs of diametrically opposite pole pieces (each pair of pole pieces constitute the ends of a horseshoe core) similarly wound, and field F1 comprises four magnets, successive ones of which are oppositely poled. With this arrangement, two cycles of alternating current are generated in armature A1 during each revolution of the rotor. It is to be understood that the diagrams in the drawings are schematic and that in an actual machine the pole pieces of an armature and field are shaped to produce current of sinusoidal wave form.

The armature A2 and field F2 are designed to generate four cycles during each revolution. Hence, four field magnets and four armature cores, all similarly poled, are employed. With this arrangement a complete cycle of current is generated each time a field magnet passes an armature pole and, since there are four poles, four cycles of alternating current are generated in the winding F2 each revolution.

Field F3 comprises four magnets and armature A3 has eight poles, all similarly wound, thereby producing eight cycles during each revolution.

Field F4 comprises eight magnets and armature A4 has sixteen poles, all similarly wound, thereby producing sixteen cycles during each revolution.

Field F5 comprises eight magnets and armature A5 has thirty-two poles, all similarly wound, thereby producing thirty-two cycles during each revolution.

Field F6 comprises eight magnets and armature A6 has sixty-four poles, all similarly wound, thereby producing sixty-four cycles during each revolution.

Field F7 comprises sixteen magnets and armature A7 has one hundred twenty-eight poles, all similarly wound, thereby producing one hundred twenty-eight cycles during each revolution.

It will be apparent from the foregoing description that currents of fundamental frequency and the first six harmonics of the fundamental will be generated by the respective armatures A1, A2, A3, A4, A5, A6, and A7, the exact frequencies depending upon the speed of rotation. Since the armature and field structures of the twelve units in the complete machine are identical, the machine will generate alternating currents of eighty-four different frequencies corresponding closely to the frequencies of the notes in the musical scale when the different units are geared to the common shaft 1 in the manner previously

described, and shaft 1 is rotated at 969.96 revolutions per minute.

As shown in Figure 3, the individual field magnets and armature cores are of the horseshoe type to provide low reluctance magnetic circuits and, to reduce the losses, the armature cores are preferably of laminated construction.

Obviously, if desired, the seven armatures could be positioned side by side within a single cylindrical casing, and the seven field structures also mounted side by side upon a simple cylindrical rotor frame. However, this would unnecessarily increase the overall length of the machine and it has been found convenient to mount the various armatures and fields in the manner shown clearly in Figures 3, 4 and 5, in which three armatures and fields are mounted in concentric relation in one plane. A second group of three armatures and fields are mounted in concentric relation in a second plane and the extra armature and field are mounted in still a third plane.

The machine disclosed in Figures 10 and 11 is identical with that shown in Figures 1 and 2 except that the construction of the individual generating units is different. Corresponding parts in Figures 10 and 11 bear the same reference numerals as Figures 1 and 2 with the prime mark added.

The individual generating units in the machine of Figures 10 and 11 are of the inductor type, each comprising a rotor disc 30 with which are associated a plurality of field and armature windings 31, 32, 33, 34, 35 and 36. Each rotor disc 30 is mounted on the shaft of its associated unit, which shaft is journaled to rotate in the frame of the machine and be driven by gears from the central shaft 1' exactly as described in connection with Figures 1 and 2.

Referring to Figures 12 and 13, the disc 30 of each generator unit has a plurality of projecting shoulders 37 arranged in circles thereon, these shoulders being of magnetic material and constituting inductor elements of the generator. The disc 30 itself may be of magnetic material such as iron, the projecting shoulders 37 being formed integrally therewith, as shown in Figure 13, or the disc may be of non-magnetic material and the inductor elements 37 inserted therein, as shown in Figures 14 and 15. When the disc 30 is of magnetic material, the disc may be cut away between successive shoulders 37 in the same ring to provide apertures 38, as shown in Figures 16 and 17.

Each generating unit in the particular machine disclosed in Figures 10 to 17 is designed to produce currents of six different frequencies, all of which are harmonics of a fundamental frequency. To this end, the six different armature and field assemblies 31 to 36 are provided which cooperate with projections 37 arranged in six concentric circles on the disc 30. The inductors 37 in these six different rows are identified in Figure 13 by the suffix letters a, b, c, d, e and f, the inner ring comprising a single inductor 37a, the next ring comprising the two inductor elements 37b, the next ring comprising four inductor elements 37c, the next ring comprising eight inductor elements 37d, the next ring comprising sixteen inductor elements 37e and the outer ring comprising thirty-two inductor elements 37f.

Each of the armature and field elements 35 (referring to Figure 13) comprises a yoke 39 of magnetic material having a pair of windings 40 and 41 mounted thereon, one of these windings consti-

tuting a field winding adapted to be constantly energized from a suitable source of direct current, and the other winding 41 constituting an armature winding in which current impulses are generated when the flux in the yoke 39 is varied. Each field and armature assembly 35 may be conveniently supported from the frame of the machine by a bracket 42 encircling the base of the yoke between the windings 40 and 41.

The magnetic circuits of the yokes 39 include the inductor segments 37 on the disc 30 and each yoke 39 is associated with a particular ring of segments on the disc 30. Furthermore, the tips of each yoke are provided with magnetic pole pieces 43, the tips of which are positioned closely adjacent the associated segments 37 on disc 30. As shown in Figure 11, the legs of the different yokes 39 are of different lengths to bring the pole pieces of each yoke opposite the associated segments on the disc. Thus, the legs of the yoke in armature and field assembly 31 are relatively long to bring the pole pieces of that yoke opposite the segment 37a in the inner ring. The legs of the yoke of assembly 32 are short to bring the pole pieces of that yoke opposite segments 37f in the outer ring on the disc. The legs of the yoke in assembly 33 are of length to bring the pole pieces of that yoke opposite the segments 37c in the third ring from the center of the disc. The legs of the yoke in assembly 34 are of length to bring the pole pieces of that yoke opposite the segments 37d in the fourth ring from the center of the disc and the legs of the yoke in assembly 35 are of length to bring the pole pieces of that yoke opposite the segments 37e in the fifth ring from the center of the disc.

When the field windings on the yokes are energized from a source of direct current, the yokes are magnetized and when the disc 30 is rotated the reluctances of the magnetic circuits of the yokes are alternately increased and decreased as the segments 37 pass between the pole pieces 43 of the yokes. As a result of these variations in the reluctances of the magnetic circuits of the yokes, the magnetic flux therein is alternately increased and decreased between predetermined values and each time the flux changes current pulses are induced in the armature windings 41. These pulses are of relatively short duration in the particular machine described because the segments 37 are substantially square at the ends, thereby causing the change in flux in the associated yokes to take place in a very short period of time.

Each pulse of current induced in an armature winding 41 is unidirectional but successive pulses are of the opposite polarity. Thus, as the forward edge of a segment 37 enters between a pair of pole pieces 43, the flux in the yoke increases, inducing a pulse of current of one polarity in the armature winding 41 and, as the rear edge of the segment leaves the pole pieces, the flux in the yoke is reduced, inducing a pulse of current of the opposite polarity in the armature winding 41. As the machine is to be used to generate currents for operating musical instruments which respond to current impulses, irrespective of their polarity, it is immaterial whether successive impulses are of the same or opposite polarities.

The segments 37 in each ring on disc 30 are equal in length and the spacing between consecutive segments is substantially the same as the length of the segments. Therefore, the impulses produced in each armature winding occur at uniformly spaced intervals and, as two impulses

are produced by each segment, there are twice as many impulses in each armature winding during each revolution of the disc as there are segments in the associated ring. Thus, the armature winding associated with segments 37a delivers two impulses during each revolution of the disc, the armature winding associated with segments 37b delivers four impulses, the armature winding associated with segments 37c delivers eight impulses, the armature winding associated with segments 37d delivers sixteen impulses, the armature winding associated with segments 37e delivers 32 impulses and the armature winding associated with segments 37f delivers sixty-four impulses. It follows that if the discs of the twelve different generating units of the machine shown in Figure 10 are driven by the central shaft 1' at the same speeds as the rotors of the machine in Figure 1 (by employing the same gear ratios shown in Figures 7, 8 and 9 and driving the central shaft 1' at a speed of 969.96 R. P. M.) the seventy-two armatures on the machine will deliver seventy-two trains of impulses corresponding in frequency to the seventy-two notes in a six octave musical scale.

Obviously, by increasing the size of disc 30 and adding an additional ring containing sixty-four segments, the machine can be made to cover seven octaves.

The amplitude of the impulses induced in the armature windings 41 depends upon the variations in the flux produced in the associated yokes by the segments 37. To obtain as large a variation as possible, the segments 37 are so dimensioned as to substantially fill the space between pole pieces 43 on the yokes, leaving only sufficient space for the necessary clearance, and the discs are so designed as to leave little or no magnetic material between pole pieces 43 when a segment has moved away from the pole pieces. When the disc 30 itself is made of magnetic material and the segments 37 formed integrally therewith, the disc is made as thin as possible to reduce the amount of magnetic material between pole pieces 43 except when a segment 37 is between the pole pieces. Higher efficiencies are obtained by making the disc 30 of non-magnetic material and using inserts for the segments 37, as shown in Figures 14 and 15, or by cutting away the disc between successive segments in each ring, as shown in Figures 16 and 17.

Figures 18, 19 and 20 show a modified form of inductor machine which is exactly similar to the machine shown in Figures 10 and 11 except for the armature and field construction and the construction of the discs. Thus, the twelve units of the machine shown in Figure 18 comprise disc rotors similar to the disc shown in Figure 12 except that the segments are all of the same size and are of substantially the size of the pole pieces of the associated field magnets and armature cores. The discs are all driven at different speeds from a central shaft 1' through gear trains as described in connection with Figures 7, 8 and 9.

The armature and field construction of the machine shown in Figures 18 and 19 differs from that of the machine shown in Figures 10 and 11 in that, instead of utilizing armature and field windings on common yokes which straddle the discs, the field windings are mounted on individual cores on one side of the disc and the co-operating armature windings are mounted on separate cores on the opposite side of the disc.

Each field comprises two windings on a horse-shoe core, the poles of which are juxtaposed to one of the rings of segments on the disc, the pole pieces being spaced apart circumferentially a distance equal to the distance between two different segments in the disc. Thus, referring to the lower right hand unit in Figure 19, the field magnet associated with the inner ring of segments on the disc comprises a core 50 which is curved to extend about the shaft on which the disc is mounted to bring the pole pieces of the magnet at diametrically opposite points, this for the reason that the discs shown in Figure 23 have two diametrically opposite segments 51 in the inner ring. As shown in Figure 18, the coils or windings 52 on core 50 are positioned on the ends of the core, which extend at right angles toward the disc 53. The associated armature comprises a similar core and winding assembly juxtaposed to the field magnet core 50 on the opposite side of the disc. When the disc 53 is rotated, the two segments 51 in the inner ring pass between the juxtaposed pole faces of the field magnet and the armature core twice during each revolution, and couple the field and armature cores together, thereby increasing and decreasing the flux in the armature core twice during each revolution and inducing a complete cycle of alternating current in the armature winding each time. The net result is two impulses of alternating current are developed in the armature winding associated with the segments 51 in the inner ring of the disc during each revolution of the disc.

A field magnet 54 is positioned so that its two pole pieces are traversed simultaneously by two successive segments of the four segments 55 in the second ring from the center of disc 53. Therefore, the armature winding, the pole pieces of which are juxtaposed to the pole pieces of the field armature 54, has induced therein an impulse of alternating current four times during each revolution of the disc 53. The field magnets and armatures associated with the segments in the remaining rings of the disc 53 are similarly positioned with respect to the segments in the remaining rings on the disc 53. Thus, the third ring of segments from the center of the disc comprises eight segments and the poles of the field magnet 56 are juxtaposed to that ring and spaced apart a distance equal to the distance between successive segments in the ring; the field magnet 57 has its pole pieces juxtaposed to successive segments in the fourth ring from the center in which there are sixteen segments; the pole pieces of the magnet 58 are spaced apart a distance equal to the segments in the fifth ring which contains thirty-two segments and the pole pieces of the magnet 59 are spaced apart a distance equal to the spacing between the segments in the outer ring which contains sixty-four segments; the armatures juxtaposed to field magnets 54, 56, 57 and 59 have cores similarly shaped to the cores of their associated field magnets.

During each revolution of the disc 53 as many impulses of alternating current are induced in each armature winding as there are segments in the ring associated with that winding. The net result is that the machine shown in Figures 18, 19 and 20, when driven at suitable speed, produces seventy-two different trains of impulses corresponding in frequency of recurrence to the seventy-two notes in six octaves of a musical scale.

Although three specific forms of the invention

have been illustrated and described, it is to be understood that other variations may be made in the construction of the machine without departing from the spirit of the invention and that the scope of the invention is to be limited only as set forth in the appended claims.

I claim:

1. A multi-frequency generator for producing electric impulses corresponding in frequency to the different notes in a musical octave comprising a plurality of similar independent rotary generating units adapted to produce the same number of impulses during a revolution, a common drive shaft, gears on said shaft, and a gear on each generating unit meshing with one of said gears on said shaft, said generating units being divided into groups, the units in each group being arranged about said central shaft and their gears meshing with the same gear on said shaft, the different groups being spaced longitudinally along said shaft and the gears on units in different groups meshing with different gears on said shaft, the gears on the different units in each group having different numbers of teeth and the number being such with respect to the teeth on the associated driving gear on the main shaft that the different units are rotated at speeds the ratios between which correspond to the ratios between the frequencies of different notes in a musical octave.

2. A multi-frequency generator for producing electric impulses corresponding in frequency to the twelve different notes in a musical octave, comprising twelve similar independent rotary generating units, all adapted to produce the same number of impulses during a revolution, a common drive shaft, three gears on said shaft having 69, 80 and 84 teeth, respectively, a gear on each generator unit meshing with one of said three gears on said shaft, said generator units being divided into three groups of four units each, the four units in each group being arranged about said central shaft and their gears all meshing with the same gear on said shaft, the four units driven from the 69-tooth gear having 110, 116, 123 and 130 teeth, respectively, the units driven from the 80-tooth gear having gears with 101, 107, 113 and 122 teeth, respectively, and the units driven from the 84-tooth gear having gears with 84, 89, 94 and 100 teeth, respectively, whereby the twelve different units are rotated at speeds, the ratios between which correspond at least approximately to the ratios between the frequencies of the different notes of the twelve different notes in a musical octave.

3. A rotary generator for generating a plurality of trains of electric impulses of different frequencies comprising a stationary frame consisting of a substantially cylindrical shell and a pair of cylindrical inner members of smaller diameter than the shell and positioned concentrically therewithin, the inner members being spaced apart longitudinally and supported at their outer edges from said shell, a plurality of armatures secured to the inner surface of said shell and having pole faces projecting radially inwardly therefrom, other armatures secured to the outer and inner surfaces of said cylindrical portions and having pole faces projecting radially therefrom, outwardly and inwardly, respectively, a rotor rotatably supported in said frame and comprising a hub portion within said inner cylindrical portions of said frame, a flange portion concentrically positioned between said outer shell and said inner cylindrical portions and a disc portion joining said hub and flange portions

of said rotor, and extending radially between the inner ends of said inner cylindrical portions, and a plurality of sets of field magnets secured to said hub portion and flange portion of said rotor, the pole faces of each set of field magnets being closely positioned to and in concentric relation with the pole faces of one of said armatures, and different armatures having different numbers of poles whereby they have induced therein currents of different periodicities.

4. A multi-frequency inductor generator comprising a disc rotor having a plurality of inductor elements of paramagnetic material extending laterally through said disc, said elements being divided into sets positioned in concentric rings on said disc and the number of elements in each ring being different from the numbers in the other rings, and a plurality of sets of stationary field and armature elements, the field and armature element of each set comprising a U-shaped yoke of paramagnetic material having a field winding and an armature winding thereon, the legs of the yokes straddling the disc rotor and having pole pieces facing the opposite faces of the disc, the legs of the different yokes being of different lengths whereby the pole pieces of different yokes are juxtaposed to the inductor elements in said different concentric rings, all of said field magnets being connected together for excitation from a single source and the different inductor windings and the different armature windings having independent terminals for supplying electric impulses of different frequencies to independent external circuits.

5. A generator as described in claim 4 in which the disc is of paramagnetic material formed integrally with the inductor elements thereon, and

openings are provided in the disc between the armature elements in each ring.

6. A multi-frequency inductor generator comprising a disc rotor having a plurality of inductor elements of paramagnetic material extending laterally through said disc, said elements being divided into sets positioned in concentric rings on said disc and the number of elements in each ring being different from the number of elements in the other rings, a plurality of stationary field magnets positioned on one side of said disc, the pole faces of each magnet being juxtaposed to a different ring of inductor elements on said disc, and the poles of each magnet being spaced apart a distance equal to the spacing between successive inductor elements in the associated ring, and a plurality of armature elements on the other side of said disc from said field magnets, each armature element being associated with one of said field magnets and comprising a core having pole pieces juxtaposed to the pole pieces of the associated field magnet, whereby rotation of said disc successively carries said inductor elements in each concentric ring on said disc between the pole pieces of one of said field magnets and its associated armature element to vary the magnetic coupling therebetween and induce a current in the armature winding of frequency depending upon the number of inductor elements in the associated ring on the disc, and the speed of the disc, there being a different number of inductor elements in each ring whereby currents of different frequencies are generated in the different armature windings.

VICTOR H. SEVERY.