My invention relates to generators, or means for producing electrical currents of predetermined frequency, and particularly, to such means when adapted to be used for musical instruments.

More specifically, my invention relates to generators required for use in the type of electric organ described in my United States Letters Patent No. 2,089,204.

The object of my invention is to provide a means for obtaining induced currents of different frequencies of oscillation from the same generator, and thus make possible the reducing of the number of generators required in a complex electrical musical instrument and the reduction of the space required for the same. This object I accomplish by providing multiple stationary elements for each rotating element and by having the multiple stationary elements arranged in groups, the members of each of such groups being so spaced, in reference to the peripheral poles of the rotating element, that rotation of the latter will produce a different frequency of oscillation in each group.

The form in which I construct the stationary and rotating elements for accomplishing the above mentioned and incidental objects of my invention will be apparent from the following description with reference to the accompanying drawings.

In the drawings, all of which are more or less diagrammatic—

Fig. 1 illustrates a simple form of generator, similar to that illustrated in my United States Patent No. 2,089,204, application for which was filed January 27, 1936, but, for the purpose of simplicity, shown with only a single stationary element; Fig. 2 illustrates a generator also similar to that referred to in my United States Patent No. 2,089,204, but with the poles on the periphery of the rotating element comprising permanent magnets instead of wound or electro-magnets; Figs. 3 and 4 illustrate a modification of the generator of Fig. 1 in which a double rotor or metal spool is substituted for the single rotating disk, Fig. 3 being a plan view and Fig. 4 a vertical section on the line 4—4 of Fig. 3; Fig. 5 illustrates how I carry out the principle of my invention by using a rotating element or disk similar to that shown in Fig. 1, by providing multiple stationary elements similar to the single stationary element shown in Fig. 1, and by arranging and connecting the stationary elements in groups, adjacent the circle described by the extremities of the rotating element, whereby oscillations of different frequencies are obtained simultaneously from the single rotating elements;

Fig. 5a is similar to Fig. 5 but illustrates a slightly different construction of the stationary elements;

Fig. 6 is a side elevation of a generator similar to that shown in Fig. 6 having multiple groups of stationary elements, but made with a rotating spool instead of a single rotating disk, the construction of the rotating and stationary elements being similar to that of Figs. 3 and 4;

Fig. 7 is a vertical section corresponding to the line 7—7 of Fig. 6; and Fig. 8 is a further diagrammatic side elevation similar to that of Fig. 6 but illustrating the possible use of a larger number of groups of stationary elements for the purpose of obtaining a larger number of currents of different frequencies from a single rotating element.

In each of the figures it is assumed that the rotating element is rotated at a uniform rate of speed by any suitable means (not shown).

Referring first to Fig. 1, the rotating element comprises a disk a of fiber or other suitable material rigidly attached to a shaft c'. An iron ring a1 is mounted on the periphery of the disk a, and the outer periphery of the ring a1 is formed with a number of equal sized and equally spaced iron poles or wound fingers a2. Between the poles a2 are stub radial projections a4. The poles a2 are wound serially and identically with the wire a5. One end of the wire a5 is attached to an iron ring a6 while the other end of the wire a6 is similarly attached to an iron ring a7. The rings a6 and a7 are mounted on the disk a, but are insulated from each other. A pair of brushes b1 and b2 bear on the rings a6 and a7, respectively. These brushes are connected to a source of direct current (not shown) by means of conductors b3 and b4. Thus the current passing thru the wire a5 converts the poles a2 into a plurality of similar electro-magnets. The stub radial projections a4 constitute poles of opposite fields to those of the extremities of the wound poles a3. It is possible, however, to omit the stub radial projections a4 entirely.

In Fig. 1, c indicates the stationary element or secondary coil which is wound with the wire c'. As the disk a rotates, the revolving electro-magnets a3 will produce oscillations in the stationary element or secondary coil c in accordance with Lenz's law. The frequency of the oscillations thus produced will depend upon the speed with which disk a is rotated and upon the number of magnetic poles a3 on the periphery of the disk a.
of the rotating element. The wire $c'$ of the stationary element or secondary coil $c$ is connected to the apparatus for which the current of a predetermined frequency is desired, for example, to a transformer in the electric organ described in my United States Patent No. 2,089,204.

In Fig. 2 a series of equal sized, equally spaced, permanent magnets $d'$ are mounted radially on the periphery of a disk $d$, the disk $d$ being made of material similar to the disk $a$ in Fig. 1, and the disk $d$ being rigidly attached to a shaft $d_2$. In this figure $e'$ and $e_2$ are the stationary elements or coils, each of which is similar to the stationary coil $c$ of Fig. 1. The winding of the coils $e'$ and $e_2$ is identical and this winding is connected to the conductors $e_3$ and $e_4$, as indicated. The stationary coils $e'$ and $e_2$ are so placed, with respect to the tips of the revolving magnets $d'$, as to be influenced simultaneously.

Any number of stationary secondary coils may be used in this manner in place of the single coil $c$ shown in Fig. 1. When such coils are arranged in the manner explained with reference to Fig. 2, increasing the number of coils does not affect the rapidity of the resulting number of oscillations but does serve to increase the strength of the oscillations produced in the stationary element.

Thus rotation of the disk $d$ of Fig. 2 produces oscillations of a particular frequency, depending upon the speed of rotation and upon the number of the magnetic poles on the periphery, just as occurs with the rotation of the disk $a$ of Fig. 1, the only difference in the two constructions being that no outside source of electric current is required in the construction shown in Fig. 2.

Instead of the simple rotating disk of Fig. 1, I have found it practical also to use a compound rotor or metal spool of the type illustrated on Figs. 3 and 4, in which the flanges $f'$ and $f_2$ of the spool constitute parallel disks rotating in unison and connected by the metal drum $f$. The peripheries of the flanges $f'$ and $f_2$ are identically formed with equally sized, equally spaced, radial fingers $f_4$ (illustrated in Fig. 4). Metal rings $f_5$ and $f_6$ are attached to the flanges $f'$ and $f_2$, respectively, but insulated from the flanges $f'$ and $f_2$. A wire $f_7$ is wound upon the drum $f_3$, the ends of the wire being connected to the rings $f_5$ and $f_6$. Brushes $f_8$ and $f_9$ contact the rings $f_5$ and $f_6$, respectively, which brushes are connected, thru the medium of conductors $f_{10}$ and $f_{11}$, to a source of direct current (not shown).

It will be apparent from Fig. 3 that the passageway of current thru the wire winding on drum $f_3$ will produce an electro-magnet and that the flanges $f'$ and $f_2$ will constitute opposite poles of the electro-magnet thus formed.

For the stationary element $g$ in this construction illustrated in Fig. 3, I use a pair of parallel bars $g'$ and $g_2$ rigidly connected to the ends of a metal shaft $g_3$ corresponding in length to the length of the drum $f_2$. The wire $g_4$ is wound on the shaft $g_3$. Thus the parallel bars or fingers $g'$ and $g_2$ lie in the same planes with the flanges $f'$ and $f_2$, respectively, and rotation of the flanges $f'$ and $f_2$ will produce induced oscillations in the wire $g_4$, similar to those produced in the stationary coil $c$ of Fig. 1.

It would be possible in this construction to omit one of the flanges, for example $f'$ and the corresponding finger $g'$ and obtain the induced oscillations in the wiring $g_4$ from the rotation of only one fingered flange, but I have found it preferable with this spool form to use the two flanges as illustrated.

In Fig. 5 the rotating element $h$ is to be understood as similar to that in Fig. 1, but, for the sake of simplicity, is shown with only four peripheral poles or winding poles $h'$. The stationary elements, however, are arranged in three separate groups. The first group consists of only the single stationary or secondary coil $j'$ similar to the coil $c$ of Fig. 1, but, because of the large space between the peripheral poles $h'$, is preferably made with a broader cooperating surface $j_2$ to prevent too great a comparative interval between impulses as the poles $h'$ successively pass by the surface $j_2$. The second group of stationary elements contains two coils $j_3$ and $j_4$ so spaced that the revolving poles $h'$ influence each alternately and at equally spaced intervals of time. The windings of these coils are connected to the primary coils $j_5$ and $j_6$, respectively, of a transformer $j_1$. The secondary coil of this transformer $j_8$, is connected to the instrument or apparatus for which the oscillations of predetermined frequency are desired. With this arrangement the oscillations received thru such secondary coil $j_8$ of the transformer $j_1$ will be double the frequency of those obtained from a single stationary element $j'$. Similarly, the third group of stationary elements is composed of four such elements, namely, $j_9$, $j_{10}$, $j_{11}$ and $j_{12}$ equally spaced in the circular path about the periphery of the rotating element $h$ in such manner that only one of them will be influenced at a time and there will be equal intervals between the induced successive impulses. These elements $j_9$, $j_{10}$, $j_{11}$ and $j_{12}$ causing the third group, are each connected to a primary coil of the transformer $j_{13}$ in a manner similar to that already described. The secondary coil $j_{14}$ of the transformer $j_{13}$ is connected to the instrument or apparatus the same as the secondary coil $j_8$ of the transformer $j_1$. Thus, it will be evident from Fig. 5 that with each complete rotation of the element $h$, with its four peripheral poles $h'$, four impulses will be obtained thru the winding of the stationary coil or element $j'$; eight impulses will be obtained thru the coil $j_8$ of the transformer $j_1$, and 16 impulses will be obtained thru the secondary coil $j_{14}$ of the transformer $j_{13}$. Thus, impulses or oscillations of three different frequencies are obtained from a single rotating element or generator, and by using this means for carrying out my invention in the electric organ described in my Patent No. 2,089,204, it is possible to obtain vibrations for one note, another note an octave above, and a further note two octaves above, simultaneously from the same single rotating disk or element. This may be carried out even still further in the manner to be indicated later.

The two groups of multiple stationary elements represented by $j_3$, $j_4$ and $j_9$, $j_{10}$, $j_{11}$, $j_{12}$ in Fig. 5 might also be constructed in the manner illustrated in Fig. 5a, in which $s'$ and $s_2$ correspond to $j_3$ and $j_4$ of Fig. 5 and $j_3$, $s_4$, $s_5$, $s_6$ correspond to $j_9$, $j_{10}$, $j_{11}$, $j_{12}$ of Fig. 5. But $s'$ and $s_2$ are integral and require only the single winding $s'$, and since $s_4$, $s_5$, $s_6$ are integral requiring only the single winding $s$. In other words, referring to Fig. 5a, as the rotating element $f$ rotates, the same number of oscillations is obtained thru the wire $s_7$ as would be obtained thru the coil $j_8$ in Fig. 5, and, similarly, the same number thru wire $s_8$ of Fig. 5a as thru the coil $j_{14}$ of Fig. 5.
It would, of course, be possible, by following the method illustrated in Fig. 2, to have permanent magnets on the periphery of the rotating element \( t \) of Fig. 5a. Also it would be possible to have the rotating element \( t \) of unmagnetized iron and have the stationary elements of Fig. 5a constitute permanent magnets, but, with such construction, it would be necessary to employ amplifiers for the resulting current obtained.

In Fig. 5 I have represented the rotating element \( h \) as similar in construction to the rotating element \( a \) in Fig. 1. However, in place of the single rotating disk, for each \( k \) it is possible and practical to use a rotating spool following the construction already described with reference to Fig. 3. Figs. 6 and 7 illustrate such construction used with the same grouping of the stationary elements as illustrated in Fig. 5. Thus, in Figs. 6 and 7 the rotating element comprises a rotating spool having flanges \( k' \) and \( k'' \) connected by a drum \( k3 \) which is wound with the wiring \( k4 \), the wiring being connected to the insulated rings \( k5 \) and \( k5' \), on which brushes bear, as already described with reference to Fig. 3. The flanges \( k' \) and \( k'' \) are equipped with identical, equally spaced, peripheral radial fingers \( k8 \).

Each of the stationary elements \( m' \), \( m2 \), \( m3 \), \( m4 \), \( m5 \), \( m5' \) and \( m7 \) is constructed similarly to the stationary element \( g \) of Fig. 3. The transformers to which the groups of multiple stationary elements are connected are not shown in Figs. 6 and 7, but are to be understood as arranged in the manner shown in Fig. 5.

In Fig. 8 the construction is similar to that of Fig. 6, but the flanges of the rotating element or spool \( o \) have a greater number of radial fingers \( o' \) than the rotating element illustrated in Fig. 6. Also there are four groups of stationary elements instead of the three groups of Fig. 6. The construction of the stationary elements, however, is the same, the only change being in the number and arrangement. Accordingly, in Fig. 8 the stationary elements \( p2 \) and \( p3 \) together constitute a group and are connected to a transformer (not shown) similar to the manner illustrated in Fig. 5; \( p4 \), \( p5 \), \( p6 \) and \( p7 \) constitute another group; and \( p8 \), \( p9 \), \( p10 \), \( p11 \), \( p12 \), \( p13 \), \( p14 \) and \( p15 \) constitute a still further group. It will be noted that the last mentioned group, \( p8 \) to \( p15 \), extends about the perimeter of the rotating flanges for a distance greater than that corresponding to the space between two consecutive fingers \( o' \). However, the tips of the members \( p8 \) to \( p15 \) of this group of stationary elements are so arranged that only one of the elements of this group will be influenced at a single instant. Thus, in Fig. 8, element \( p15 \) will be influenced first as \( o \) rotates in a clockwise direction, \( p8 \) will next be influenced, then \( p14 \), then \( p8 \), and so on. Each complete rotation of the rotating element \( o \) of Fig. 5, since this element is shown with the flanges having 16 peripheral fingers, will cause the stationary element \( p' \) to furnish 16 impulses or oscillations, the second group \( p2 \), \( p3 \) to furnish 32 oscillations, the third group \( p4 \) to \( p7 \) to furnish 64 oscillations and the fourth group \( p8 \) to \( p15 \) to furnish 128 oscillations.

Obviously it is possible to provide various other arrangements and combinations of the elements of my generator, and to make further modifications in the structure of the rotating or stationary elements, without departing from the principle of my invention. I have suggested in the above description several practical forms in which my invention may be carried out for the purposes desired. It is not my intention, however, to limit my invention to the particular designs or specific forms of construction described or illustrated. I claim:

1. In a device for producing a plurality of electrical currents of predetermined frequencies of oscillation, a rotating member having a plurality of similar, equally-spaced projections of magnetic material on its periphery, the outer extremities of said projections being all in the same plane, a serial winding on said projections, means electrically connecting said winding to a source of electrical current, said winding so arranged as to cause said projections to constitute magnets of similar strength and polarity, a plurality of groups of stationary elements composed of magnetic material and located adjacent the circular path of said projections of said rotating member and adapted to be excited by the movement of said projections, the elements in a single group being similar and equally-spaced, but the number and spacing of elements being different in each group, means, including windings, for obtaining and collecting induced electrical oscillations from the excitation of the elements in each group, whereby combinations of induced oscillations of different frequencies for notes of different pitch, will be produced simultaneously through said groups by the rotation of said rotating member.

2. In a device for producing a plurality of electrical currents of predetermined frequencies of oscillation, a rotating member having a plurality of similar, equally-spaced fingers composed of magnetic material on its periphery, said fingers so arranged that their outer extremities will be in the same plane, a winding on said fingers, means electrically connecting said winding to a source of electrical current, said winding so arranged as to cause said fingers to constitute magnets of similar strength and polarity, a plurality of groups of stationary elements, said elements composed of magnetic material and located adjacent the circular path of said fingers, said rotating member and adapted to be excited by the movement of said fingers, the elements in a single group being similar and equally-spaced, but the number and spacing of the elements being different for each group, a winding on each element, a transformer for each group of elements, the windings in each group connected to primary coils of the transformer, whereby combinations of induced oscillations of different frequencies for notes of different pitch will be produced simultaneously through said transformers by the rotation of said rotating member.

3. In a device for producing a plurality of electrical currents of predetermined frequencies of oscillation, a rotating member having a plurality of similar, equally-spaced projections of magnetic material on its periphery, said projections so arranged that their outer extremities will be in the same plane, a serial winding on said projections, means electrically connecting said winding to a source of electrical current, said winding so arranged as to cause said projections to constitute magnets of similar strength and polarity, a plurality of stationary elements composed of magnetic material located adjacent the circular path of said projections of said rotating member and adapted to be excited by the movement of said projections, said stationary elements arranged in groups, all the elements in a single group being similar and equally-spaced, but the...
number and spacing of said elements being different for each group, the elements of each group being connected to a magnetic core, windings on said cores, whereby induced oscillations of different frequencies will be produced simultaneously in said latter-mentioned windings by the rotation of said rotating member.

4. In a device for producing a plurality of electrical currents of predetermined frequencies of oscillation, a rotating member composed of magnetic material having a plurality of similar, equally-spaced fingers on its periphery, a winding on said member, means electrically connecting said winding to a source of electrical current, said member, fingers and winding so arranged as to cause said fingers to constitute magnets of similar strength and polarity, a plurality of groups of stationary elements of magnetic material located adjacent the circular path of said fingers of said rotating member and adapted to be excited by the movement of said fingers, all the elements in a group being similar and equally-spaced, but the number and spacing of said elements being different in each group, windings connected to said groups for converting the excitation of said elements into induced oscillations produced in each group of stationary elements, whereby induced oscillations of different frequencies for notes of different pitch will be produced simultaneously through said groups by the rotation of said rotating member.

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