G. B. SINCLAIR & G. I. FISKE.

PULSATION DEVICE FOR MUSICAL INSTRUMENTS.

APPLICATION FILED NOV. 16, 1911.

1,167,663.

Patented Jan. 11, 1916.

4 SHEETS—SHEET 1.

Fig. 1

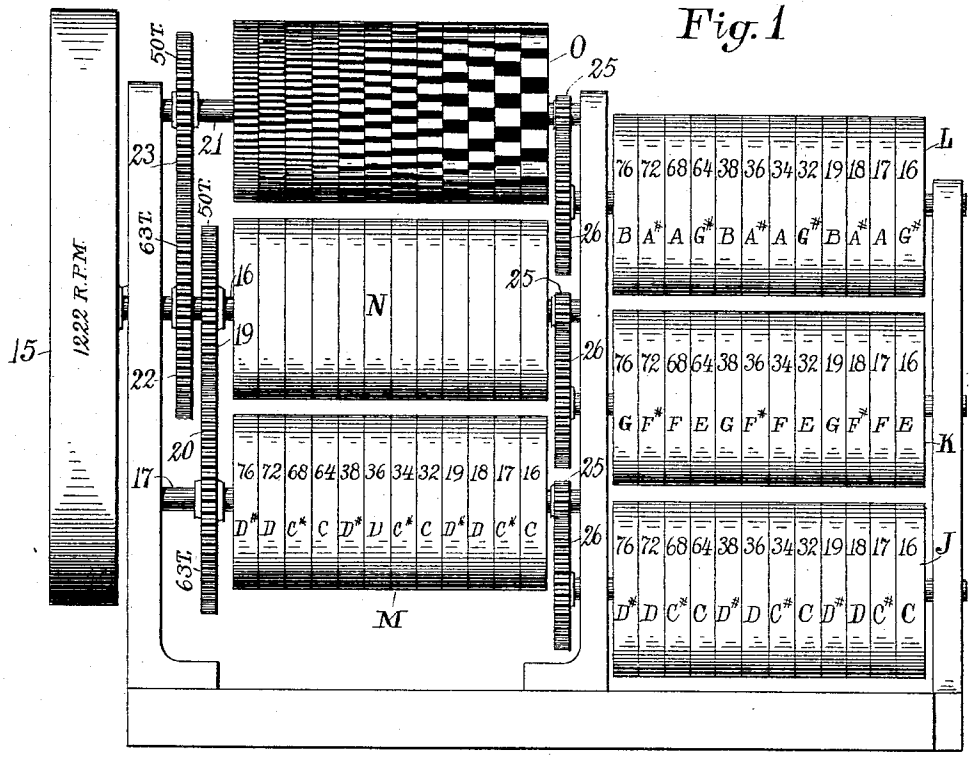
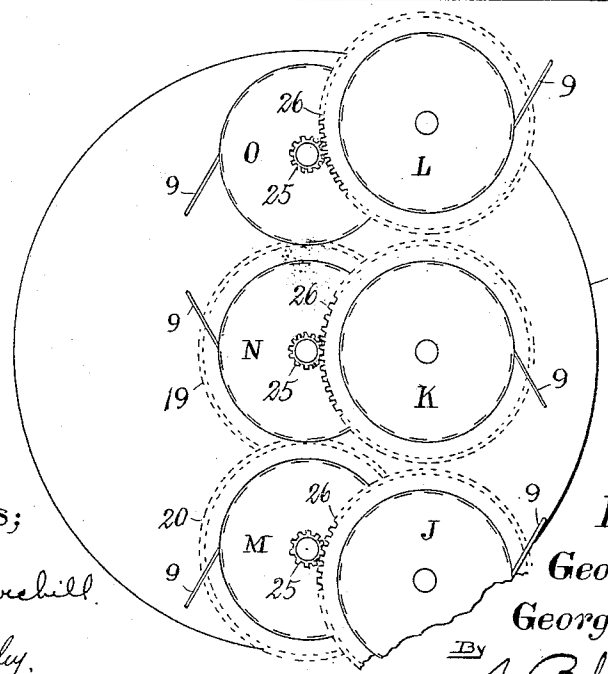


Fig. 2



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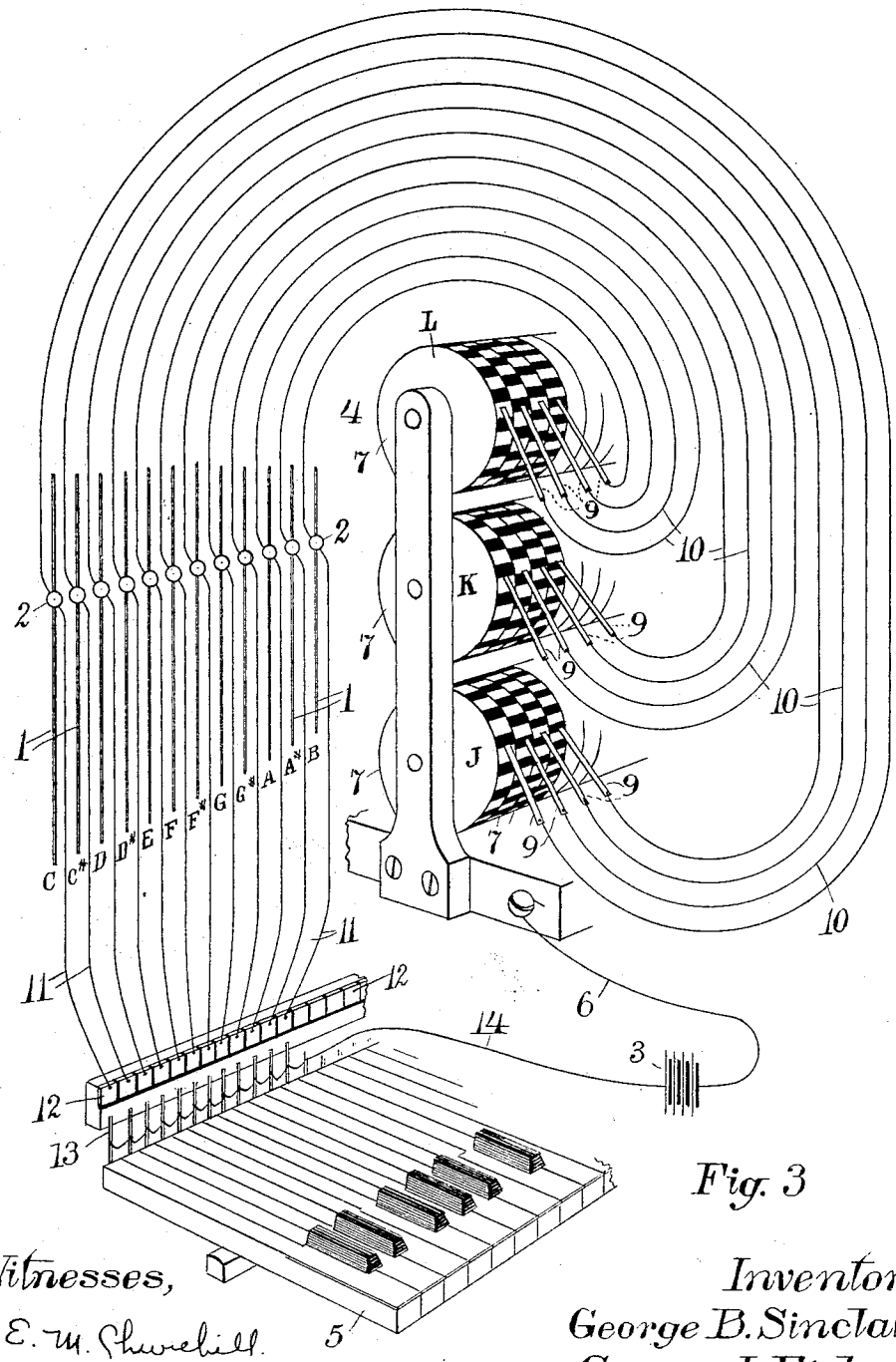


Fig. 3

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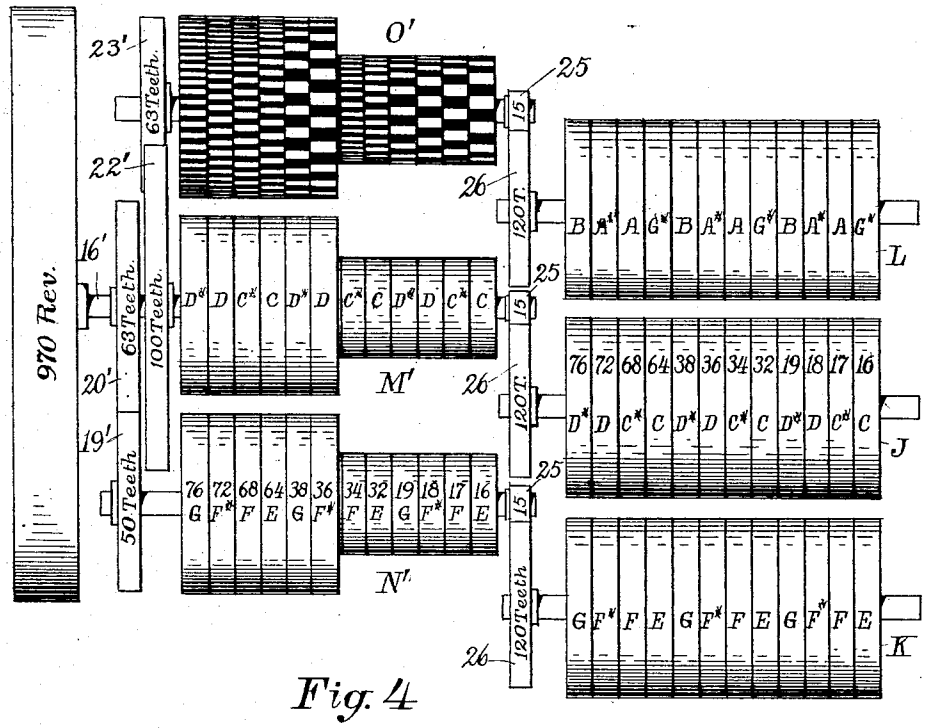


Fig. 4

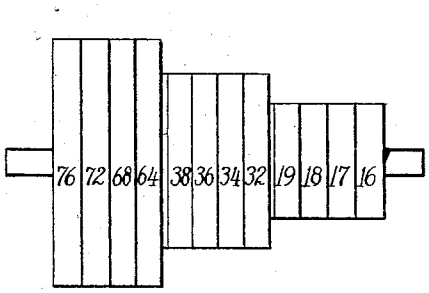


Fig. 5

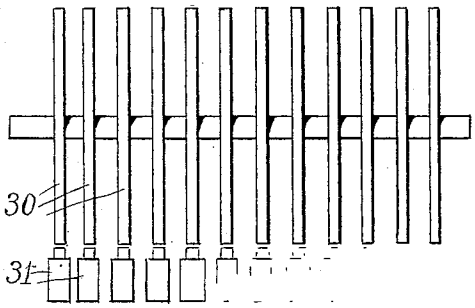


Fig. 6

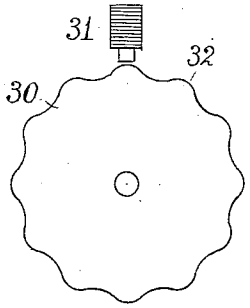


Fig. 7

Witnesses;

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4 SHEETS—SHEET 4.

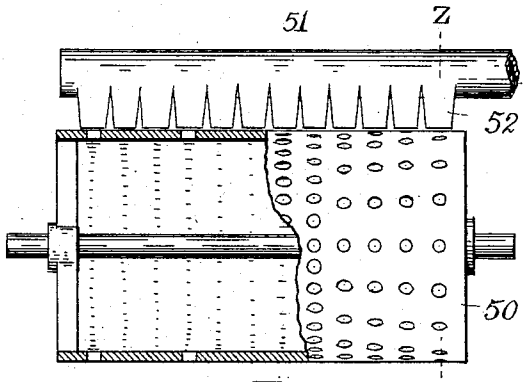


Fig. 8.

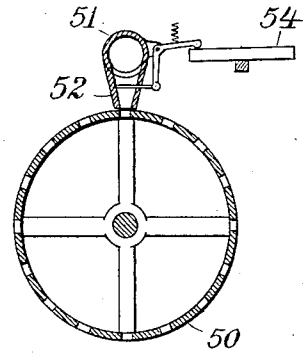


Fig. 9.

Witnesses;

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UNITED STATES PATENT OFFICE.

GEORGE B. SINCLAIR, OF MEDFORD, AND GEORGE I. FISKE, OF BOSTON, MASSACHUSETTS, ASSIGNORS, BY MESNE ASSIGNMENTS, TO CHORALCELO MANUFACTURING COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

PULSATION DEVICE FOR MUSICAL INSTRUMENTS.

1,167,663. Specification of Letters Patent. Patented Jan. 11, 1916.

Application filed November 16, 1911. Serial No. 660,584.

To all whom it may concern:

Be it known that we, GEORGE B. SINCLAIR, of Medford, in the county of Middlesex and Commonwealth of Massachusetts, and GEORGE I. FISKE, of Boston, in the county of Suffolk and said Commonwealth, have invented certain new and useful Improvements in Pulsation Devices for Musical Instruments, of which the following is a specification.

In musical instruments wherein sonorous bodies are electromagnetically vibrated, or where tones are produced by interruptions in currents of air, gas, electricity or ponderable matter, one of the highly important features is that of the construction of rotary pulsation-producing devices wherein correctly-intervaled pulsations are secured for every note in the scale, and especially in the equally tempered scale.

In Patent No. 814,878, is disclosed a rotary member whose periphery is given correctly spaced teeth for the larger part thereof, but followed by a blank space of indeterminate length to allow for the fractional number of teeth which otherwise occurs in connection with many of the notes of the tempered scale.

One of the objects of our invention is the construction of a pulsation producing device whose rotary circular members can all be cut with uniformly spaced teeth throughout their entire peripheries, and which will yet give impulses corresponding so closely to the theoretically perfect notes of the equally tempered scale, as to be identical therewith in the mode of musical use, and substantially identical therewith in the musical effects produced by such use.

In the drawings forming part of this specification, Figure 1 is an elevation of a pulsation-producing mechanism embodying our invention. Fig. 2 is an elevation of the same, but from a point of view at right angles to that of Fig. 1. Fig. 3 is a perspective diagrammatic view of one octave of an electric musical instrument embodying our improvements. Fig. 4 is a side elevation of a slightly different form of the invention. Fig. 5 is a side view of one of the pulsation members still further altered. Fig. 6 is an elevation of a form of the invention applied to a type of instrument wherein pulsatory induced currents are generated. Fig. 7 is a detail view of one of the elements of the last-named instrument. Fig. 8 is a face view, partly broken away, showing an embodiment of the basic idea of our invention for producing pulsatory currents by gaseous fluids. Fig. 9 is a cross section of the same on the line Z—Z in Fig. 8.

Referring first to Fig. 3, the reference numeral 1 designates a series of sonorous bodies, as piano strings, tuned to the notes of the tempered scale; 2, electromagnets to which properly timed electric pulsations are delivered for the vibration of said strings; 3, a source of current; 4, current interrupting devices for the production of such pulsations, and 5 the keyboard controlling the same. The circuits controlled by said keyboard consist of a common wire 6 from one pole of said source to the pulsator frame; the metal-work of said frame to the toothed disks or rings 7; thence the brush 9 whose circuit has been closed by the depression of a key, a wire 10 to the associated electromagnet 2, a wire 11 to a contact 12, a brush 13 controlled by said key, and a common lead wire 14 back to said source.

It is to the construction and arrangement of the toothed rings, disks or pulsators to which our invention pertains. One form of this is fully set forth in Fig. 1, where the entire number of groups of disks or pulsators is illustrated, and shown as driven by a shaft 16 which carries a fly-wheel 15, one group of pulsators being mounted on shaft 16 and the other groups of pulsators being mounted on individual shafts driven by shaft 16 through suitable gearing. Each of said groups consists preferably of twelve rigidly united disks or pulsators 7 in electric connection with their supporting shaft and consequently with the framework of the machine, said groups being preferably duplicates in numbers of disks, and in numbers of teeth on corresponding disks. On each of said groups, termed rotors hereinafter, the numbers of teeth are 16, 17, 18 and 19 for the first four disks; then double these numbers for the next four disks, and double the latter for the third four disks. By proportioning the gearing between the various rotors in accordance with ratios which we have discovered to give almost absolutely correct pulsa-

tions, all the notes of an instrument having any desired number of octaves are produced. See Fig. 1.

To make up a single octave after the manner shown in Figs. 1 and 3, corresponding parts of three rotors are employed, the lowest octave of the instrument being produced by the pulsators having the numbers of teeth 16, 17, 18 and 19, in the three rotors J, K and L; said pulsators in the rotor J giving the notes C, C#, D, D#; the rotor K giving E, F, F# and G; and the rotor L giving G#, A, A# and B. In the same manner, the pulsators having the tooth-numbers 32, 34, 36 and 38 give the next higher octave; and the pulsators having the numbers of teeth 64, 68, 72 and 76 give the third octave.

For the fourth octave, the pulsators having the tooth-numbers 16, 17, 18 and 19 of the rotors M, N and O are in like manner employed. The fifth octave comprises the tooth-numbers 32, 34, 36 and 38 of said rotors M, N, and O; and the sixth octave comprises the tooth-numbers 64, 68, 72 and 76. For the accomplishment of this, the rotor N is fixed on the shaft 16 of said fly-wheel 15, and is connected with the shaft 17 of the rotor M by gears 19, 20 having 50 and 63 teeth, respectively. The shaft 16 is connected with the shaft 21 of the rotor O by gears 22, 23 having 63 and 50 teeth, respectively.

Each of the shafts 16, 17 and 21 carries a pinion 25 which meshes with a gear 26 turning one of the rotors K, J or L, the ratio between each of said pinions and its intermeshing gear being as one to eight; each pinion having preferably 15 teeth, and each gear 120. Consequently, the pulsations produced by each of the pulsators 7 of the rotors M, N and O, will be exactly three octaves higher than the pulsations produced by the corresponding pulsators on the rotors J, K and L, thereby making the six octaves usually desired for an instrument of this type.

It remains to see that the pulsations produced by the pulsators 7 having 16, 17, 18 and 19 teeth (Figs. 1 and 3) in three associated rotors, will compose an octave in the equally tempered scale as also the groups of four pulsators having 32, 34, 36 and 38 teeth, and also the pulsators having 64, 68, 72 and 76 teeth. Now, the theoretical ratio of the notes C to E in the tempered scale, is 1 to 1.25992; while the ratio of 50 to 63—the numbers of teeth on the gears connecting the shaft 16 to the shafts 17 and 21—is exactly 1 to 1.26; a ratio which for all practical purposes agrees with the theoretical one above given; and which is a major third. Hence the pulsations produced by any pulsator are a major third from the pulsations produced by a corresponding pulsator on a rotor geared in said ratio to the rotor carrying the first-named pulsator; so that the four pulsators having 16, 17, 18 and 19 teeth on one rotor, as J, will produce vibrations a semi-tone apart, or the notes C, C#, D, D#; and from the pulsator having 19 teeth on rotor J to the pulsator having 16 teeth on the rotor K will be a semi-tone; and so also, from the pulsator having 19 teeth on the rotor K to the pulsator having 16 teeth on the rotor L. The same relationship exists between the pulsators on the rotors M, N and O; and, although there are exceedingly minute differences between the perfect major third and that produced by our arrangement, yet in no case is any such difference greater than a quarter of one per cent. In other words, no string vibrating 437 times per second will vary more than one vibration in that interval from the theoretical number.

In an instrument such as is illustrated in Fig. 3 the strings are tuned to vibrate with frequencies identical with those produced by respective corresponding pulsators and though consequently it is not tuned with theoretical perfection to the equally tempered scale, it approximates such tuning so closely as to be played in the same manner to produce the same effects as if so tuned. The pulsations for the entire gamut of the instrument illustrated are therefore produced as follows: Starting with the pulsator in the rotor J having 16 teeth as the lowest note in the scale, we go from C to D# on said rotor; thence from E to C on the rotor K, and from G# to B on the rotor L; thence back to the pulsator having 32 teeth on the rotor J for the C of the next higher octave, to D#; thence from E to G on rotor K, and from G# to B on the rotor L; and so on back and forth through all the rotors until finally the highest B is reached on the rotor O. Of course, if desired, another pulsator can be added to the rotor M for the C above said highest B, the teeth thereof being 128.

In the construction set forth in Fig. 4, and which is on some accounts preferable to that previously described, the first change is in the gearing. Here, instead of having the intermediately speeded rotor mounted on the same shaft with the flywheel 15, we place the slowest of the three on said shaft, since a slower movement of the flywheel we find to be much better for the speed controlling means connected therewith.

The rotor N′, which corresponds with the rotor N first described, is connected with the rotor M′ by the spur gear 20′ on the shaft 16′ meshing with the gear 19′; the gear 20′ having 63 teeth, and the gear 19′ having 50 teeth. A gear 22′ on said shaft has 100 teeth and meshes with a gear 23′ having 63 teeth and turning with the rotor O′. The ratio 100 to 63 is approximately the square of the ratio 63 to 50. Thus the

rotor N′ rotates at a speed 1.26 that of rotor M′ and the rotor O′ rotates at a speed 1.25976 that of rotor N′. The effect of this gearing arrangement is thus substantially the same as that secured with the arrangement previously described, the theoretically correct ratio being 1.25992, as heretofore stated. The gears 25 and 26 are unchanged, and the only alteration in the rotors J, K and L is their change of position in order to keep the rotor J connected with the slowest rotor M′ of the other three, and the rotors K and L connected with the rotors N′ and O′ respectively.

The intervals between the teeth on the pulsator rings are filled in with insulating material and the whole finished off to a true cylindrical surface having alternate conducting and non-conducting surfaces arranged in circumferential rows. This construction is well known in the art. We have found that where pulsators having few teeth are run at relatively high rotary speeds the insulation between the teeth wears away unduly fast. This wear is due to the wide expanse of the insulating material and to the high peripheral speed, and causes defective contact with the brushes 9 and noisy operation. To reduce this wear we make each of the fast-turning rotors M′, N′ and O′ of two or more different diameters, the pulsator rings having small numbers of teeth being of smaller diameter thus reducing the absolute dimension of the tooth interval and reducing similarly the peripheral speed.

Rotors having two diameters such as shown in Fig. 4 accomplish the desired result. This arrangement brings the change of diameter between rings of the same octave, and it is perhaps theoretically better to have the change of diameter occur between adjacent rings of different octaves because there occur the greatest changes in number of teeth. Such an arrangement is illustrated in Fig. 5 where the rotor has three different diameters, corresponding to the three different octaves. Either arrangement may be adopted as occasions may demand.

We do not find it necessary thus to vary the diameters of the rotors J, K and L, since their considerably slower motion keeps them from the above-recited trouble. Otherwise the construction set forth in Fig. 4 does not differ from that of Figs. 1 and 3.

Our invention has thus far been shown as applied to current-interrupting devices in electric musical instruments, but it can also be arranged for any impulse producing device, whether said impulses be electric, gaseous, fluid, magnetic or otherwise. In Figs. 6 and 7, we show a group of twelve disks 30 composing a single rotor, each disk having an electromagnet 31 associated therewith which is supposed to be wired to an electromagnet 2 in the same way as is illustrated in Fig. 3 for the make-and-break pulsators. These disks are to be magnetized so as to induce correctly timed fluxes in said magnets 31, and for this purpose they are formed with the same numbers of undulations 32 as there are teeth on corresponding pulsator rings above described.

Our invention can also be adapted for the production of properly timed blasts of air or other fluids for musical purposes. In Fig. 8 is shown a single rotor 50 illustrating the arrangement disposed for the generation of music by the passage of timed holes past suitably controlled air blasts, in accordance with the well-known siren. Here the rotor is illustrated as a hollow cylinder pierced with twelve sets of holes arranged in groups of four similarly to the pulsators set forth in Figs. 1 and 4. The air or other gas is admitted to engage each set of pulsator-holes through a conduit 51, and directed by an orifice 52 controlled by a key 54, as shown in Fig. 9. The numbers of holes in each circumferential row should be the same as are the numbers of teeth in the rotors first described,—as 16, 17, 18 and 19 for the first four rows of holes; 32, 34, 36 and 38, for the next four, and 64, 68, 72 and 76 for the last four rows of holes.

We do not claim to be the joint inventors of this specific form of siren, but illustrate the same in order to show how our invention can best be applied to such a type of musical instrument.

The fundamental idea of the invention is the placing of the pulsators corresponding to the semi-tones forming an octave, in groups of several pulsators each, each group being on a different rotor and the rotors being geared together in ratios closely approximating the correct theoretical ratio. Successive octaves are made up in the same way, all pulsators for notes an octave apart being on the same rotor or on rotors forming a single series. In each such series the rotors are preferably geared together with ratios which are some power of two, thus providing the desired octave intervals by the mere addition of duplicate rotors with the correct gearing ratio.

The preferred embodiments of the invention are based on grouping the semi-tones forming the octave according to musical thirds. Thus the pulsators for the semi-tone intervals making up a single octave are parts of three identical rotors geared together in some simple ratio closely approximating the theoretically correct ratio 1.25992. Successive octaves are built up by placing pulsators for notes an octave apart on the same rotor, or on a similar rotor geared thereto with a gearing ratio which is some power of two. The resulting instrument is then

tuned with a close approximation to equal temperament. The octaves are perfect and the thirds are virtually so. Other intervals vary somewhat from theoretical perfection but the error is not distinguishable in the resultant effect. The device is commercially desirable because it has few parts and many of these are duplicates. It is compact, simple to construct, requires no elaborate adjustment and is positive in its action.

In the claims we use the term "tuned to an equally tempered scale" etc. in a broad sense as covering approximations sufficiently close for musical purposes. The presence of slight inaccuracies of tuning is admitted, but the invention resides in the mechanical features characteristic of the pulsator arrangement and not in refined questions of harmonics beyond the requirements of ordinary use.

What we claim as our invention and for which we desire Letters Patent is as follows, to wit:—

1. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; a plurality of rotors; a plurality of pulsators for vibrating successive ones of said sonorous bodies a semi-tone apart, said pulsators embracing an octave interval, and a plurality of successive ones thereof being mounted on each rotor; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

2. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; a plurality of rotors; a plurality of pulsators for vibrating successive ones of said sonorous bodies a semi-tone apart, said pulsators being arranged in groups embracing octave intervals, and a plurality of successive pulsators of each group being mounted on each rotor; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

3. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; a plurality of identical rotors each including a plurality of pulsators for vibrating corresponding ones of said sonorous bodies, the twelve pulsators corresponding to the semi-tones of an octave being divided between said rotors in groups each consisting of a plurality of successive pulsators; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

4. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; a plurality of identical rotors each including a plurality of pulsators for vibrating corresponding ones of said sonorous bodies, the twelve pulsators corresponding to the semi-tones of each successive octave being similarly distributed between said rotors in groups each consisting of a plurality of successive pulsators; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

5. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; three rotors each provided with four pulsators for vibrating corresponding ones of said sonorous bodies, the twelve pulsators corresponding to the successive semi-tones of an octave being arranged in groups of four successive pulsators on each rotor; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

6. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; three rotors each provided with a plurality of pulsators for vibrating corresponding ones of said sonorous bodies, the twelve pulsators corresponding to the successive semi-tones of each octave being arranged in groups of four successive pulsators on each of the three rotors; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

7. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; a plurality of sets of rotors the rotors of each set being geared together in a ratio which is a power of two; a plurality of pulsators for vibrating successive ones of said sonorous bodies a semi-tone apart, said pulsators being arranged in groups embracing octave intervals, and a plurality of successive pulsators of each group being mounted on each set of rotors; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said sets of rotors.

8. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; a plurality of identical sets of rotors the rotors of each set being geared together in a ratio which is a power of two, and each rotor including a plurality of pulsators for vibrating corresponding ones of said sonorous bodies, the twelve pulsators corresponding to the semi-tones of each successive octave being similarly distributed between said sets of rotors in groups each consisting of a plurality of successive pulsators; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and

gearing of suitable ratio between said sets of rotors.

9. The combination of a plurality of sonorous bodies tuned to the equally tempered scale; three sets of rotors the rotors of each set being geared together in a ratio which is some power of two, each set provided with a plurality of pulsators for vibrating corresponding ones of said sonorous bodies, the twelve pulsators corresponding to successive semi-tones of each octave being arranged in groups of four successive pulsators on each set of rotors; electromagnetic means for forming an operative connection between said pulsators and their respective sonorous bodies; and gearing of suitable ratio between said rotors.

10. An impulse producing mechanism for musical instruments, comprising in combination a set of rotors, each rotor including a plurality of impulse producers; gearing between said rotors of such ratio as to connect them in the relation of musical thirds in a substantially equally tempered octave; and a second set of rotors geared to said first set in multiple relation.

11. An impulse-producing mechanism for musical instruments comprising in combination three impulse-producing rotors geared together with a speed ratio of 1 to 1.26 between each rotor and that moving next faster, each rotor adapted for the production of impulses at frequencies equal to the vibrational frequencies of certain notes in an equally tempered octave and to simple multiples of such frequencies; and three similar rotors each geared to a respective one of the first named rotors to rotate at one eighth their respective speeds.

12. An impulse producing mechanism for musical instruments comprising in combination six rotors each having twelve pulsators, four of the pulsators of each rotor having respectively 16, 17, 18 and 19 teeth, four others having respectively 32, 34, 36 and 38 teeth and the other four having respectively 64, 68, 72 and 76 teeth, gearing interposed between the first and second and between the second and third of said rotors, said gearing having a speed ratio of 1 to 1.26 between each said pair of rotors; and gearing having a speed ratio of 1 to 8 interposed between the first and fourth, between the second and fifth and between the third and sixth rotors.

13. As an article of manufacture a pulsation-producing rotor for use in musical instruments arranged to produce pulsations with frequencies having the ratios 16, 17, 18 and 19 and multiples thereof.

14. As an article of manufacture a rotor for producing electrical pulsations for use in musical instruments arranged to produce frequencies having the ratios 16, 17, 18 and 19 and multiples thereof.

In testimony that we claim the foregoing invention, we have hereunto set our hands this 24th day of August, 1911.

GEORGE B. SINCLAIR.
GEORGE I. FISKE.

Witnesses:
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BURTON P. GRAY.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."