June 20, 1939. A. A. KUCHER 2,163,096

MUSICAL SYSTEM

Filed July 21, 1936 4 Sheets-Sheet 1

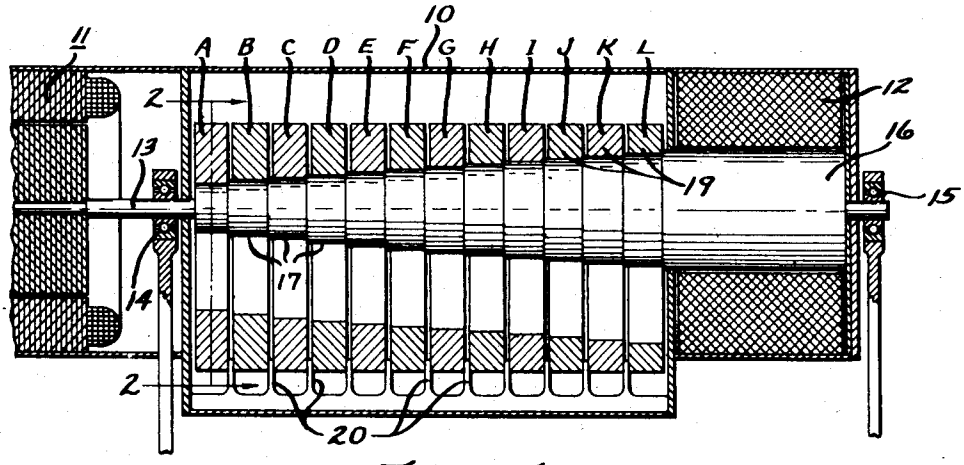


Fig. 1

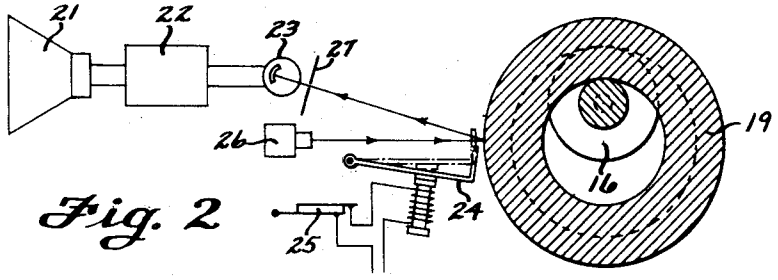


Fig. 2

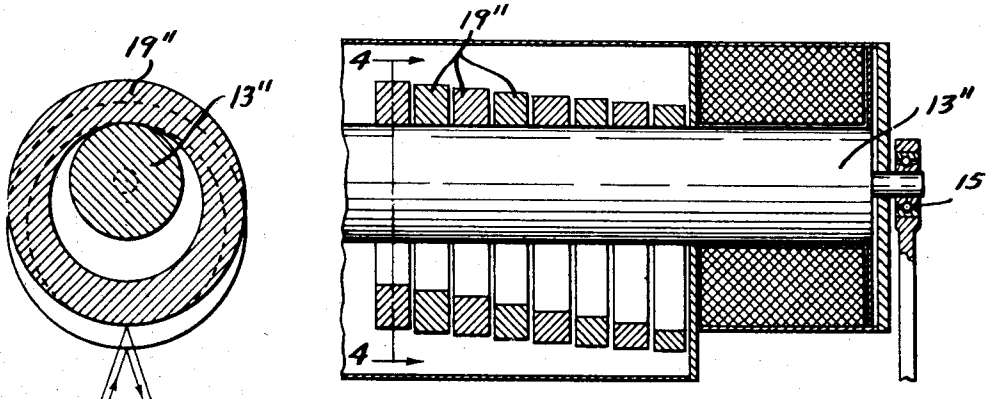


Fig. 3

Fig. 4

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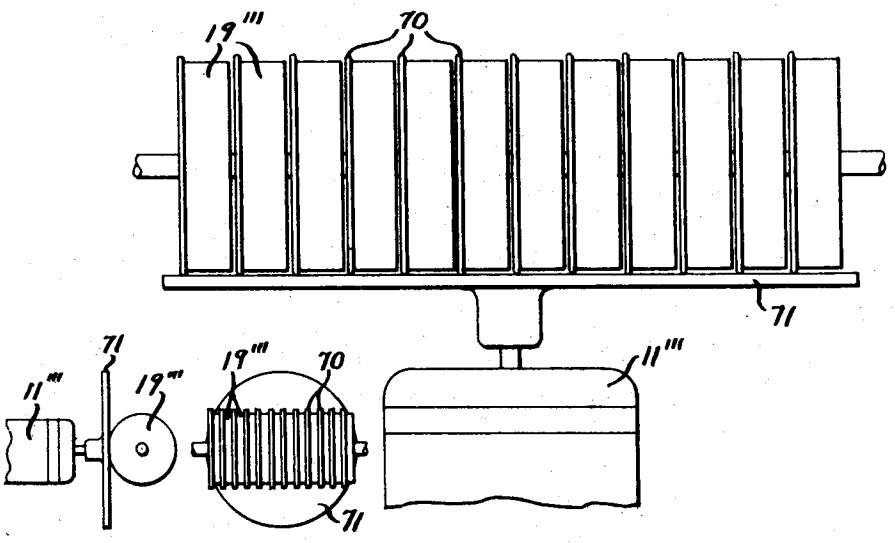


Fig. 6 Fig. 7 Fig. 5

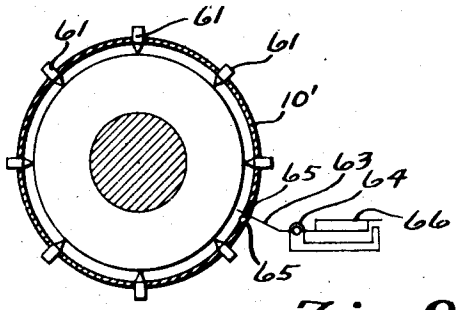


Fig. 9

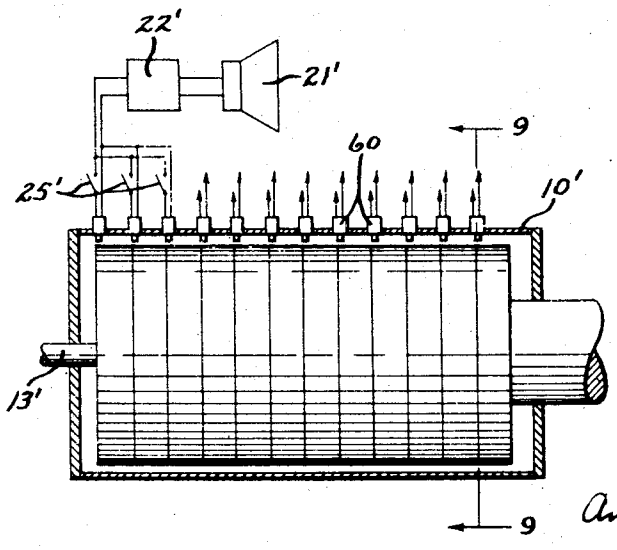


Fig. 8

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MUSICAL SYSTEM

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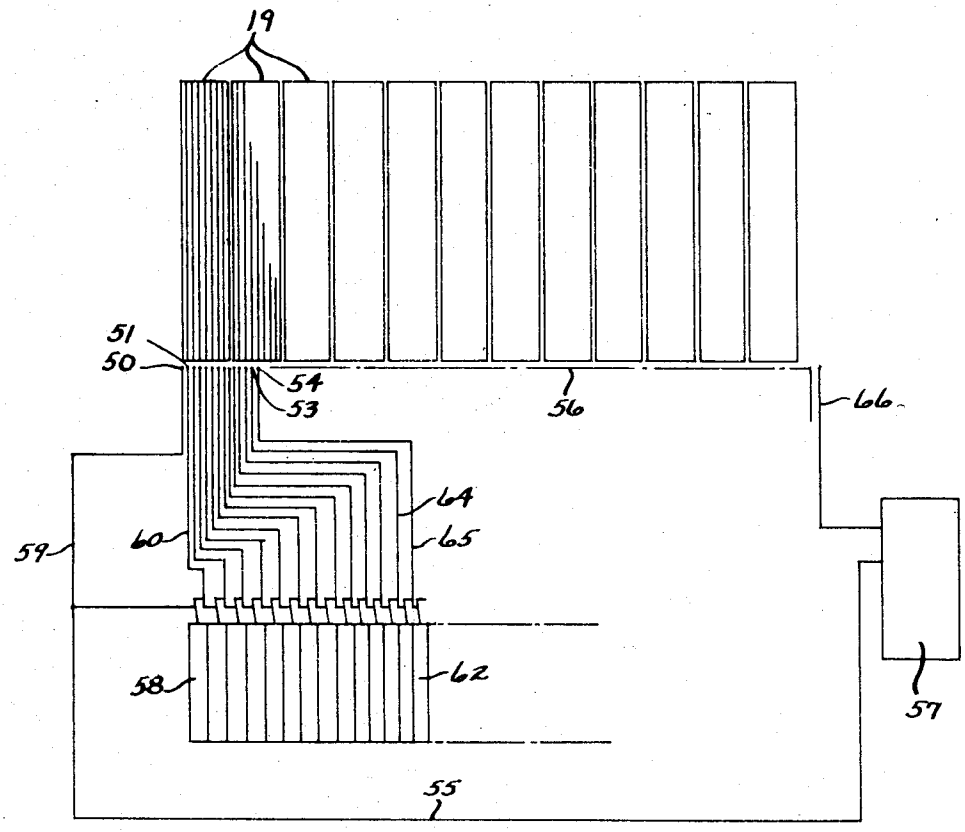


Fig. 10

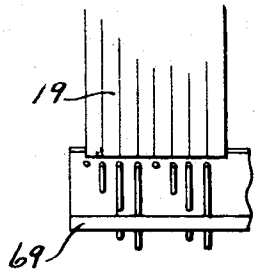


Fig. 11

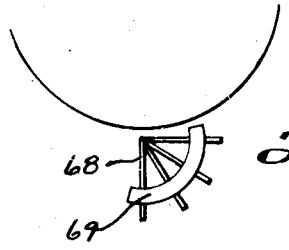


Fig. 12

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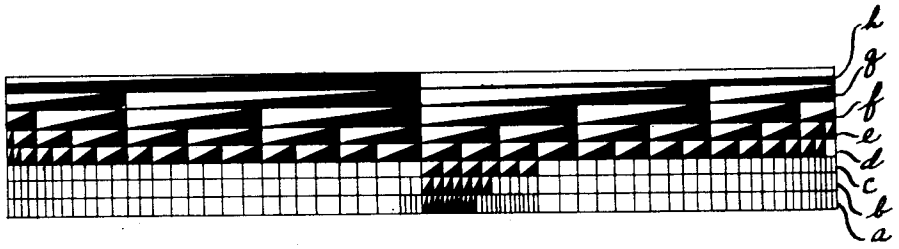


Fig. 13

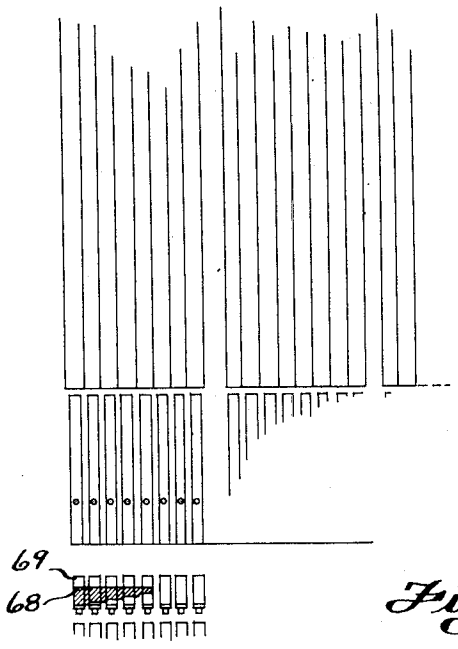


Fig. 14

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UNITED STATES PATENT OFFICE

2,163,096

MUSICAL SYSTEM

Andrew A. Kucher, Dayton, Ohio

Application July 21, 1936, Serial No. 91,726

10 Claims. (Cl. 84—1)

My invention relates to the art of reproducing sound and particularly to the art of reproducing musical notes and tones.

Generally speaking, my invention contemplates the use of a plurality of wheels or bands, each carrying on its peripheral surface the wave form patterns of eight fundamental notes of the musical scale arranged in octave relation. These wheels, and consequently the wave form patterns, rotating at a speed calculated to produce perfect pitch of the notes patterned thereon, produce impulses or frequencies which may be transmitted to a sound reproducing device either by means of a light sensitive circuit or by a magnetic pick-up circuit.

The primary object of my invention is to provide an improved system such as just described. Incident to this primary object of my invention are numerous more specific objects, the attainment of which all materially contribute to the achievement of the primary object. These more specific objects, all of which will be apparent from the following specification, claims and drawings, include the following:

(1) To provide improved wheels or bands wherein the wave form patterns are carried on the peripheral surfaces thereof, and to employ as many of said wheels as there are octave groups.

(2) To provide a frictionless drive common to all of the wheels whereby they may be driven at speeds calculated to produce perfect pitch of the notes patterned thereon.

(3) To provide a magnetic drive common to all of the wheels or bands.

(4) To provide an improved source of light in the form of individual spark gaps for each wave form pattern.

(5) To provide improved circuits containing magnetic pick-ups or light sensitive cells for transmitting impulses from the wave form patterns to a reproducing device.

(6) To provide improved methods of impressing the wave form patterns on the periphery of the units.

(7) To provide a compact unit, relatively inexpensive to manufacture and capable of producing notes and tones of theoretical perfect pitch.

Further objects will appear from the following specification and claims, reference being had to the accompanying drawings wherein:

Fig. 1 is a cross section of a portion of my improved system showing twelve units mounted on steps constituting shafts of varying diameters;

Fig. 2 is a section taken on the line 2—2 of Fig. 1 with certain other elements of my improved system shown diagrammatically;

Fig. 3 is a cross section of a portion of another embodiment of my invention showing the units mounted on shaft of uniform diameter;

Fig. 4 is a section taken on the line 4—4 of Fig. 3 with certain other elements shown diagrammatically;

Fig. 5 is a plan view of another embodiment of a portion of my invention;

Fig. 6 is an end elevation of the apparatus shown in Fig. 5;

Fig. 7 is a front elevation of the apparatus shown in Fig. 5;

Fig. 8 is a view in elevation of the apparatus shown in Fig. 1 with an improvement in the arrangement of magnetic pick-ups;

Fig. 9 is an end view of the apparatus shown in Fig. 8;

Fig. 10 is a diagrammatic view of twelve units as in Fig. 1, in combination with an improved source of light;

Fig. 11 is an elevation of an improved arrangement of the system of arcs shown in Fig. 10;

Fig. 12 is an end elevation of the arrangement shown in Fig. 11; and

Fig. 13 is a plan view of the periphery of one of the wheels used in the embodiments of my invention;

Fig. 14 is a top view of a portion of the apparatus shown in Fig. 2 modified to include an improved light valving arrangement.

In the drawings I have illustrated various modified forms of my improved system all employing twelve similar wheels or bands, each wheel carrying the wave form patterns of eight fundamental notes of the scale in octave relation. The peripheral surface of one of such wheels is shown in Fig. 13, and carried thereon are eight wave form patterns arranged in the form of tracks extending circumferentially of the wheel. These tracks are designated by the reference characters *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* and have frequencies in octave relation. All of the wheels are similarly constructed and carry the same patterns.

The wave form patterns may be formed on the peripheral surface of the wheel in different ways. For example, they may be etched or embossed on the peripheral surface, and, if a magnetic pick-up means is to be used, the peripheral surface may be made of magnetic material such as iron. Or such wave forms, when etched or embossed, may be polished to reflect light upon a photo electric cell or cells. Or the wave form patterns may be formed in photographic film shaped into the form of a wheel or mounted on the peripheral surface of the wheel. Or, if desired, the wave form patterns may be formed in opaque material by perforations; all, of course, depending upon the type of apparatus used in transmitting the impulses from the wave form patterns to the reproducing device.

The wave form patterns are in octave relation and consequently the speed of the unit or units may be calculated to produce perfect pitch of all of the notes patterned thereon.

With reference to Figs. 1 and 2, I have shown therein an embodiment of apparatus wherein wave form patterns similar to those of Fig. 13 may be used to produce all of the frequencies of the musical scale. Such apparatus is shown as including a frame 10 carrying a motor 11 provided with a shaft 13. The shaft 13 is mounted in the bearings 14 and 15 and, intermediate the enlargement 16 formed on its right hand end and the motor 11, the shaft is provided with a plurality of steps 17 forming in effect shafts of different diameters. In the particular embodiment shown, a means 12 is provided for magnetizing the steps 17. This means is shown in the form of an electromagnet and the enlargement 16 constitutes the core thereof. However, it should be understood that the steps 17 may be in the form of permanent magnets themselves and in such case, the electromagnet may be dispensed with.

On each of the steps 17 is suspended a wheel or band 19 held in position by the magnetic pull exerted on the wheels by reason of the magnetic field created in the shaft 13 by the electromagnet 12. To prevent displacement of the wheels while the shaft is rotating, the frame 10 carries guides 20 in the form of a comb extending between the wheels 19.

In the particular embodiment now being considered, the wheels 19 are made of magnetic material such as iron and the wave form patterns may be formed therein in any of the ways described in connection with Fig. 13.

The apparatus so far described operates as follows. The electromagnet 12 sets up a magnetic field in the shaft 13 thereby causing the wheels 19 to be held securely against the steps 17 of the shaft 13. The operation of the motor 12 will cause rotation of the shaft 13 and its steps 17 and consequently the wheels 19 will roll about the steps 17 without slippage. Due to the fact that the steps are of different diameters, the wheels 19 will roll at different speeds. Since all of the wave form patterns are in octave relation on any one wheel, the speed thereof can be calculated to produce perfect pitch of all of the notes patterned thereon.

With respect to the apparatus shown in Fig. 1, the proper speed of all of the wheels may be attained by the use of wheels and steps of the following dimensions:

Wheel	Diameter of step on which wheel is mounted	Inner diameter of wheel
A	.61978	2.2725
B	.67142	2.3241
C	.72307	2.3758
D	.79332	2.44607
E	.86572	2.51846
F	.94449	2.5971
G	1.03884	2.6915
H	1.13984	2.7926
I	1.25923	2.91197
J	1.39847	3.0512
K	1.56090	3.2137
L	1.75000	3.40277

In the above specific example, the dimensions of the remaining parts may be as follows:

Outside diameter of wheels	3.875
Diameter of armature shaft	.5
Diameter of magnet core	1.875
Width of each wheel	.300
Distance between each wheel	025
Speed of motor shaft R.P.M.	1800

With the wheels carrying wave forms in the ratio of 2, 4, 8, 16, 32, 64, 128, and 256 respectively, the apparatus when constructed in accordance with the above dimensions, and operated at the specified speed, will produce frequencies corresponding to all of the notes of the musical scale, and these frequencies may be transmitted to a sound reproducing device in different ways as hereinafter more fully disclosed.

In Fig. 2, I have shown diagrammatically a system containing a light sensitive cell or cells as the means for transmitting the impulses to the sound reproducing device. This circuit contains the loud speaker 21, the amplifier 22, light sensitive cell 23, a light slit 27, and a source of light 26 common to all of the wheels 19. An individual shutter 24, each with its individual key control 25, is provided for each wave form pattern so that by depressing one or more keys, light is admitted to and reflected by one or more wave form patterns as the case may be. The reflected light passes through the slit 27 to the cell or cells 23.

In place of the source of light 23 common to all of the patterns, I may use the arrangement shown in Figs. 10, 11 and 12. In Fig. 10, the wheels are shown diagrammatically at 19 and opposite each wave form pattern is located a spark gap. Several such gaps have been shown, but since each gap is similar to each other gap, all of them have not been shown. One such gap includes the points 50 and 51 and another the points 53 and 54. All of the gaps are connected in key shunt relation; that is to say, each gap is short circuited by its key except when the key is depressed. To use other words, depressing of a key causes the spark to jump the gap controlled by that key.

When key 58 is depressed, current flows from the source of high tension, high frequency alternating current 57 through the leads 55, 59 and 60 and back through the remaining keys and the lead 56 to the source 57. Thus, a spark jumps the gap 50—51 and this spark serves as the source of light for the wave form pattern located opposite the gap 50—51.

If both keys 58 and 62 are depressed at the same time, then current flows from the source 57 through leads 55, 59 and 60, thence through the keys to the line 64 and back to the source 57 through the lines 65 and 56. In this case, sparks jump both the gaps 50—51 and 53—54 and serve as the sources of light for the wave form patterns opposite the gaps 50—51 and 53—54.

The circuit is so arranged that sparks may jump from one to twenty gaps at the same time, depending upon how many of the keys are depressed.

It should be understood that the spark gap system just described constitutes the source of light in a light sensitive circuit, as described in connection with Fig. 2, for transmitting impulses from the wave form patterns to a light sensitive cell or cells. Such a circuit would include the light sensitive cell or cells, the loud speaker, the amplifier, etc. No shutters would be required, however, since the light is present only when desired.

Since high tension, high frequency alternating current is continuously produced by device 57, a bleeder spark gap 66 is provided to prevent short circuiting of the spark gap system when none of the keys are depressed.

To prevent jumping of the spark at places other than at the gaps, the leads to the gaps may be

arranged as shown in Figs. 11 and 12. A frame arranged in the form of an arc 69 extends the width of the wheels 19 and the leads 68 to the various gaps are supported therein in staggered relation so that they are spaced apart a greater distance throughout their length than at their terminals.

I have, likewise, shown an improved embodiment of an electrical magnetic pick-up circuit for transferring the impulses to the reproducing device, which pick-up device may be used in place of the light sensitive circuit described in connection with Fig. 1. Such an apparatus is shown in Figs. 8 and 9 wherein the frame 10' is mounted to oscillate about the shaft 13'. The frame 10' carries a plurality of electromagnets 60, one for each wave form pattern, and all of the magnets are connected in parallel with an amplifier 22' and a reproducing device 21' and each of the parallel circuits are each controlled by its individual key 25'. The magnets are arranged in groups and the groups 61 are spaced circumferentially of the frame 10' as shown in Fig. 9. The frame 10' is mounted to oscillate with respect to the shaft 13' in order to cause pitch modulation. Any conventional means for causing this oscillation may be used. In the present embodiment, I have provided a spring 63, pivoted at 64 and having its free end held between the pins 65 mounted on the frame 10' and its right hand end actuated by the key 66. In the present embodiment, the key 66 is shown as a special key for causing this oscillation. However, if it is desired to provide for the oscillation of the frame whenever any of the keys 25', the free end of the spring may be secured to a cross member adapted to be moved by depressing one or more of such keys.

With this arrangement, depressing the key 66, or one or more of the keys 25' if such keys are arranged to actuate the spring, will move the free end of the spring downwardly. This will cause the other end of the spring to vibrate or oscillate and consequently the frame will oscillate thereby producing a verbretto effect.

In Figs. 1 and 2 the variation in the speed of the units is brought about by varying the diameter of the driving shaft. The same ultimate result may be obtained by varying the inside diameter of the wheels while maintaining the diameter of the driving shaft uniform throughout its length. Such apparatus is shown in Figs. 3 and 4 wherein the driving shaft 13'' is uniform throughout its driving length and the inner diameters of the wheels 19'' are varied. Such apparatus is otherwise similar to the apparatus of Figs. 1 and 2 and it may be used in combination with any of the circuits for transmitting the impulses to a reproducing device, as described in connection with Figs. 1 and 2. By way of illustration, I have shown the use of a light sensitive circuit in Fig. 4, consisting of the source of light 26'', the slit 27'' and the cell or cells 23''.

The combination of apparatus shown in Figs. 3 and 4, for example, the source of light illustrated in Figs. 13 and 14 or the magnetic pick-up circuit of Figs. 10, 11 and 12, has not been illustrated, but is obviously within the scope of my invention.

In Figs. 5, 6 and 7, I have shown an arrangement wherein the wheels are mechanically driven in place of the magnetic drive of the previous embodiments. In these figures, the wheels 19''' are mounted on individual bearings on a stationary shaft. Each wheel has formed on its peripheral surface a sharp edge 70 adapted to frictionally engage the rotating disc 71. In this embodiment, the disc constitutes the driving member directly connected to the armature shaft 13''' of the motor 11''', and the sharp edge 70 constitutes the connection between the driving and driven members. Since each wheel has its sharp edge engaging the disc 71 at a different distance from the center of the disc, it follows that the speed of each wheel will be different. The ratio of the driving to the driven speed is calculated to produce the desired frequencies.

In all of the previous embodiments, I have referred to the use of individual keys for each frequency. I may arrange these keys so that actuation of one key will produce partial actuation of the shutters, sparks, or pick-ups controlled by other keys so as to obtain harmonic combinations of varying intensities. In Fig. 14, I have shown such an arrangement wherein the reference character 68 represents an element attached to the key 69 and adapted to partially engage adjacent shutters when the key 69 is depressed. In this manner, when the shutter or gap controlled by the key 78 is actuated, several other adjacent shutters or gaps are thereby partially actuated. In this manner harmonic combinations are formed and since the actuation of the shutters or gaps is only partial, the intensity of the harmonic combinations thus formed varies.

The forms of my improved musical instrument as herein described, are small compact units, economical to manufacture and result in the production of notes and tones of perfect pitch. The number of bearings or wearing parts is reduced to a minimum, assuring perfect pitch without adjustment of either driving or driven members.

It should be understood, however, that other forms of my invention are possible, all within the scope of the appended claims.

I claim as my invention:

1. The combination comprising a plurality of wave form patterns, a sound reproducing device, means for transmitting impulses from said wave form patterns to said sound reproducing device, and means for causing movement of the wave form patterns relative to said transmitting means, said last named means consisting of a shaft, means for driving the shaft, and a magnetic connection between the said shaft and the wave form patterns.

2. The combination comprising a plurality of wave form patterns, a sound reproducing device, magnetic pick-up means cooperating with said wave form patterns and forming a part of a circuit for transmitting impulses from said wave form patterns to said sound reproducing device, and means for causing said wave form patterns to move relative to said magnetic pick-up means, said last named means consisting of a shaft, means for driving the shaft, and a magnetic connection between said shaft and the wave form patterns.

3. The combination comprising a plurality of wave form patterns, a sound reproducing device, a photo-electric circuit for transmitting impulses from said wave form patterns to said sound reproducing device, said circuit including a source of light, and means for causing relative movement of said wave form patterns with respect to said source of light, said means comprising a shaft, means for driving the shaft, and a magnetic connection between said shaft and the wave form patterns.

4. The combination comprising a plurality of

wheels each carrying on its peripheral surface the wave form patterns of notes of the musical scale arranged in octave relation, a sound reproducing device, means for transmitting impulses from said wave form patterns to said sound reproducing device and means for causing relative movement of said wheels with respect to each other and of all of said wheels with respect to said transmitting means, said last named means consisting of a shaft, means for driving the shaft, and a magnetic connection between said shaft and said wheels.

5. The combination comprising a plurality of wheels, each carrying on its peripheral surface the wave form patterns of notes of the musical scale arranged in octave relation, means for driving said wheels at different speeds including a single shaft having portions of different diameters, each of said wheels being supported on a different one of said portions, a magnetic connection between all of said wheels and said shaft, a sound reproducing device, and means for transmitting impulses from said wave form patterns to said sound reproducing device.

6. The combination comprising a plurality of wheels, each carrying on its peripheral surface the wave form patterns of notes of the musical scale, means for driving all of said wheels so that each of said wheels rotates at a different speed than each other wheel, said last named means including shaft common to all of said wheels, a sound reproducing device, means for transmitting impulses from said wave form patterns to said sound reproducing device, and means for causing said wheels to rotate with said shaft, said last named means consisting of a magnetic connection between said shaft and all of said wheels.

7. The combination comprising a plurality of wave form patterns, a sound reproducing device, means for transmitting impulses from said wave form patterns to said sound reproducing device, means for causing movement of the wave form patterns relative to said transmitting means, said last named means including a driving member and a magnetic connection between said driving member and said wave form patterns.

8. The combination comprising a plurality of wave form patterns, a sound reproducing device, a magnetic pick-up means cooperating with said wave form patterns and forming a part of a circuit for transmitting impulses from said wave form patterns to said sound reproducing device, and means for causing said wave form patterns to move relative to said magnetic pick-up means, said last named means consisting of a driving member and a magnetic connection between the driving member and the wave form patterns.

9. The combination comprising a plurality of wave form patterns, a sound reproducing device, a photo-electric circuit for transmitting impulses from said wave form patterns to said sound reproducing device, said circuit including a source of light, and means for causing relative movement of said wave form patterns with respect to said source of light, said last named means including a driving member and a magnetic connection between the driving member and the wave form patterns.

10. The combination comprising a plurality of wheels each carrying on its peripheral surface the wave form patterns of notes of the musical scale arranged in octave relation, a sound reproducing device, means for transmitting impulses from said wave form patterns to said sound reproducing device and means for causing relative movement of said wheels with respect to each other and of all of said wheels with respect to said transmitting means, said last named means consisting of a driving member and a magnetic connection between the driving member and the wave form patterns.

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