Jan. 8, 1957 J. W. McBRIDE 2,776,591

ELECTROMAGNETICALLY OPERATED MUSICAL INSTRUMENT

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Fig. 1.

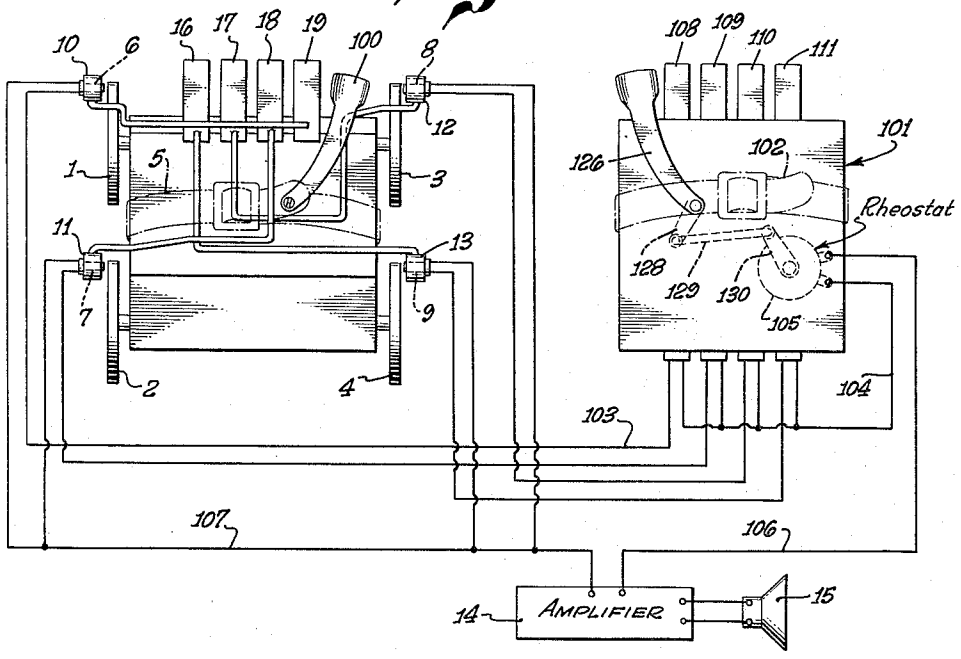
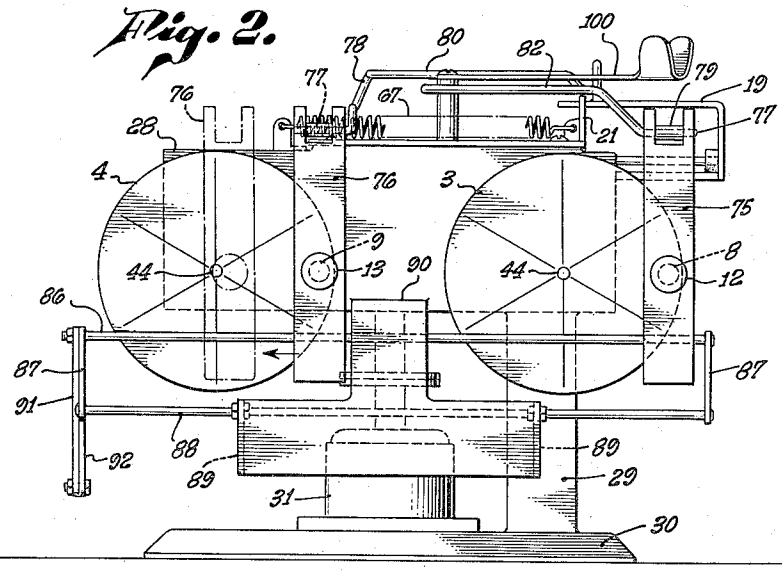


Fig. 2.



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Fig. 3.

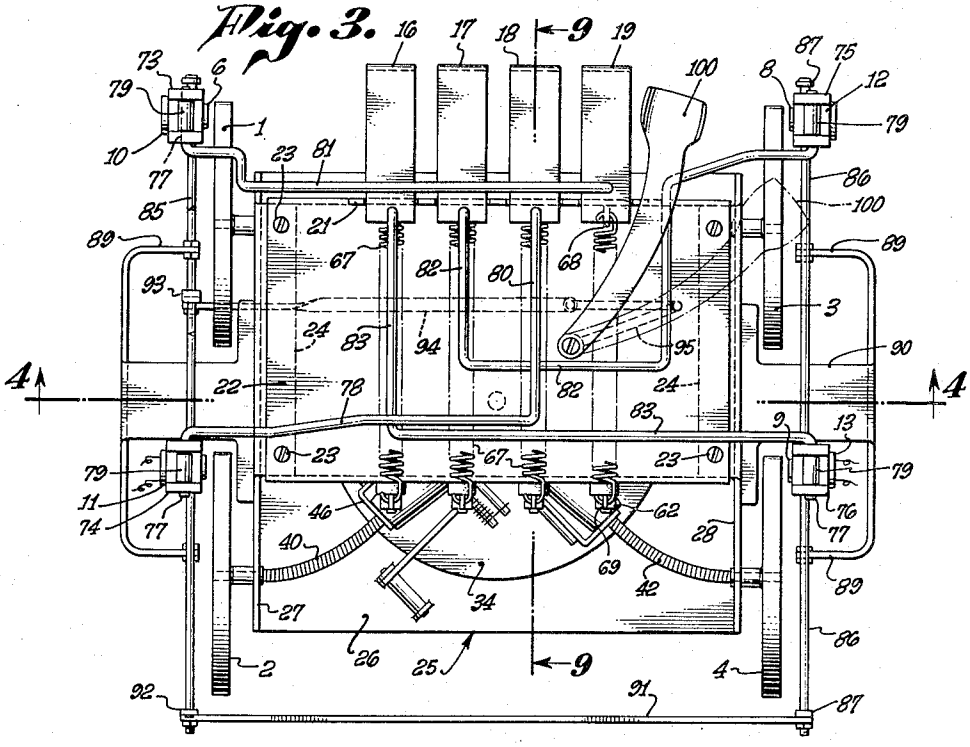
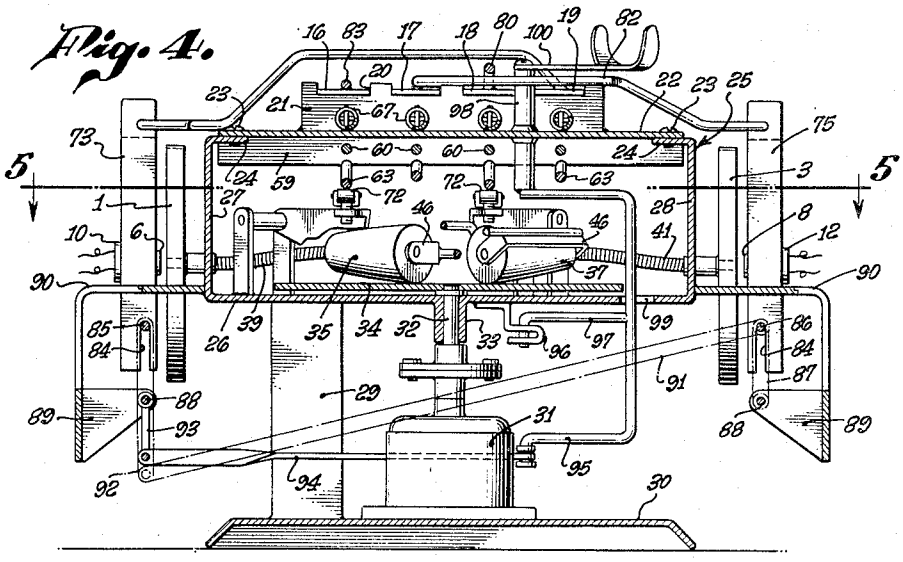


Fig. 4.



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ELECTROMAGNETICALLY OPERATED MUSICAL INSTRUMENT

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Fig. 5.

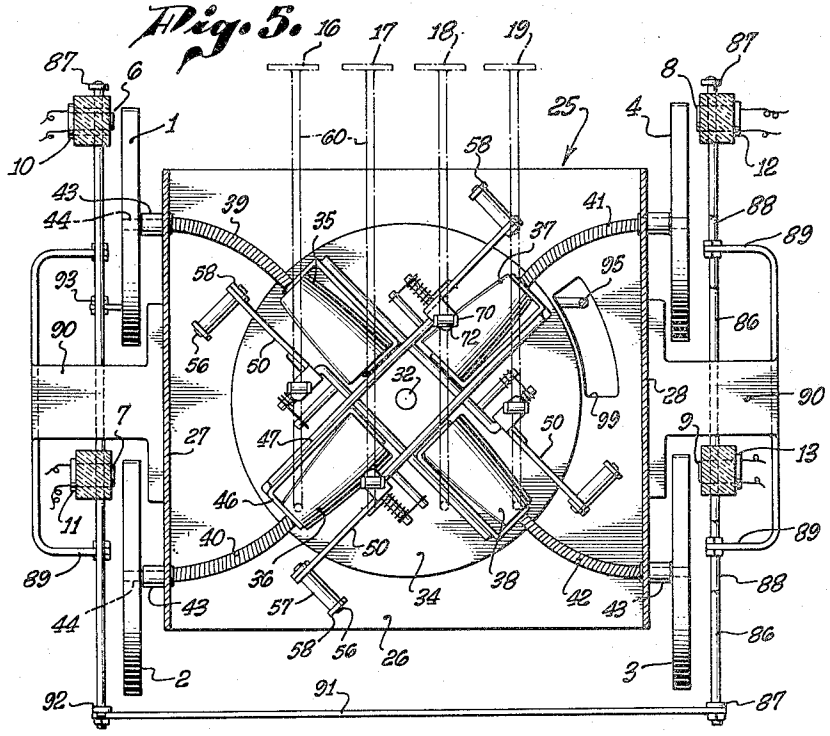


Fig. 6.

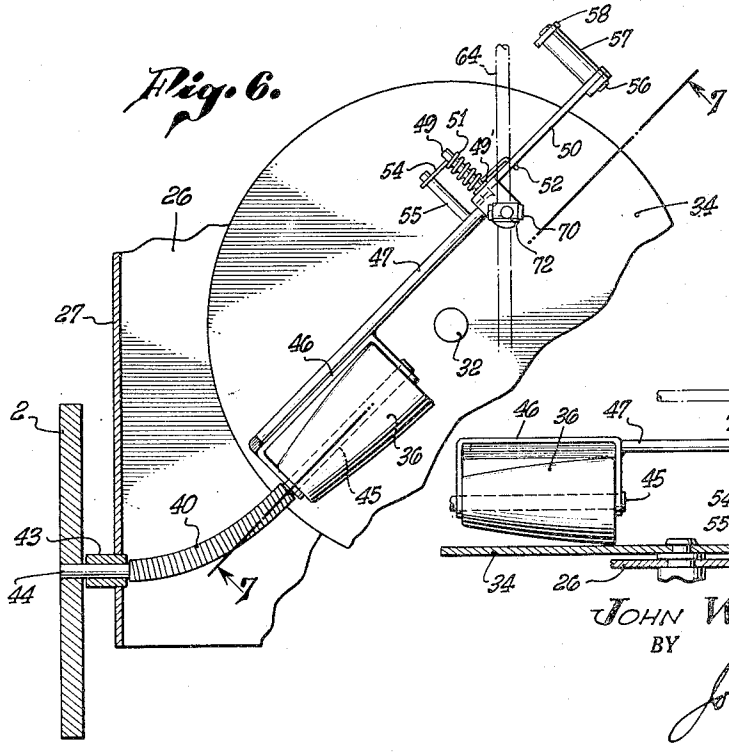


Fig. 7.

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Fig. 8.

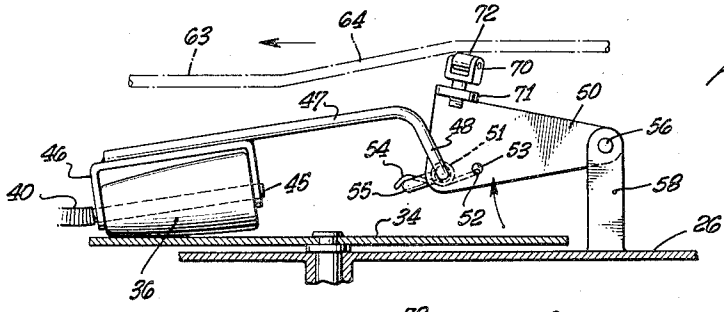


Fig. 9.

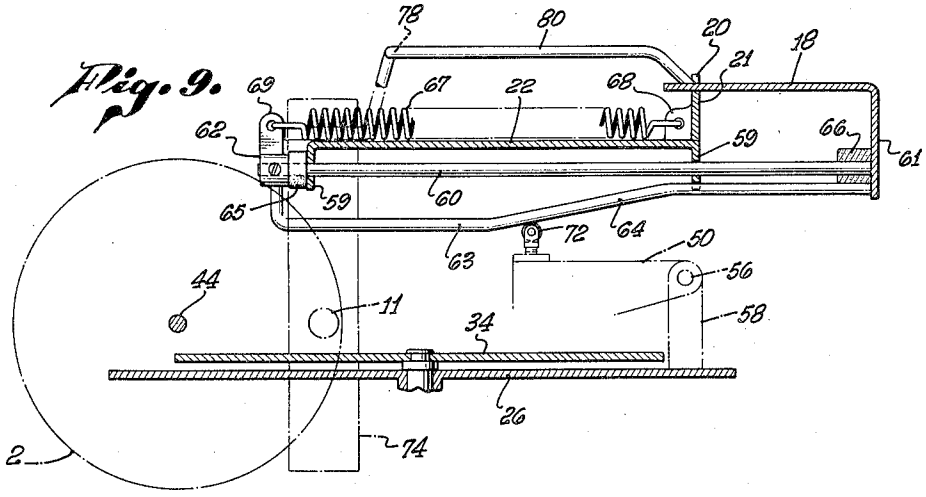
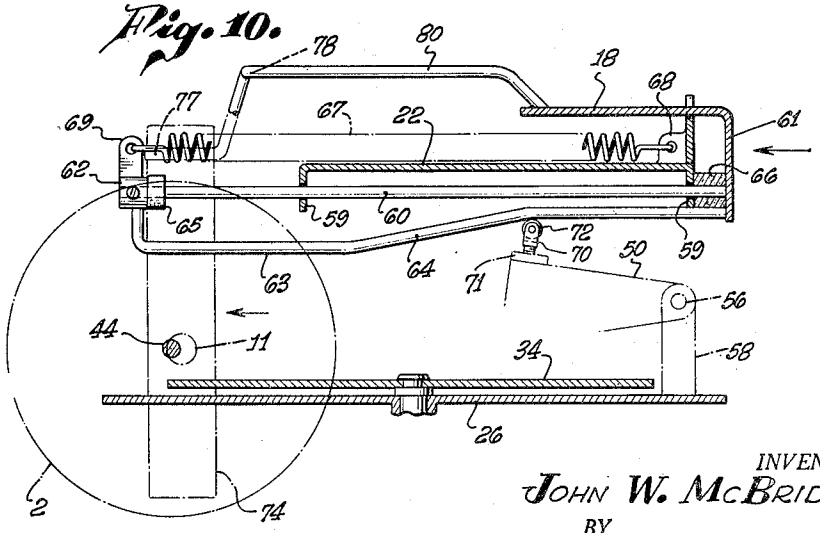


Fig. 10.



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Fig. 11.

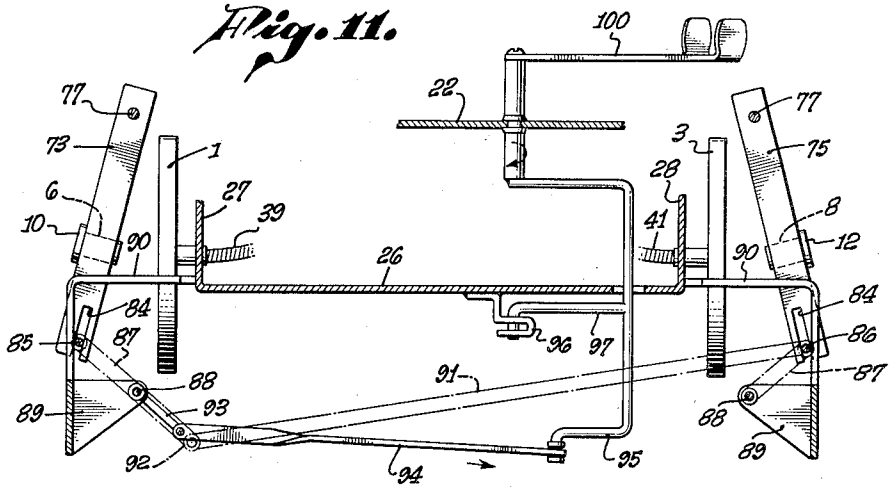


Fig. 12.

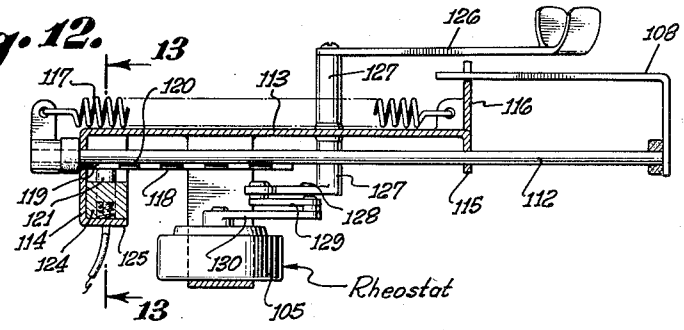


Fig. 14.

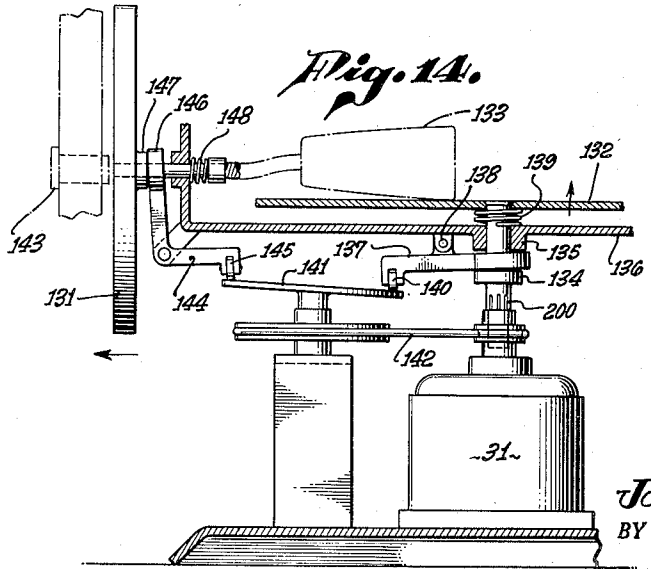
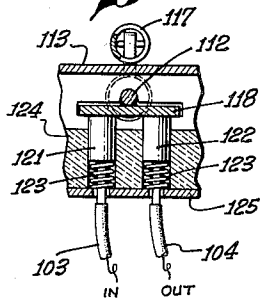


Fig. 13.



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Fig. 15.

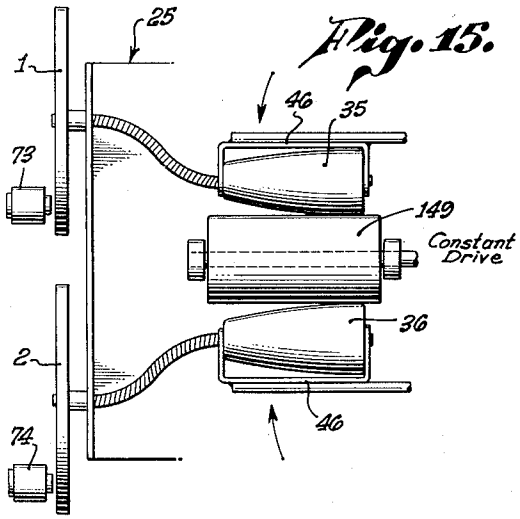


Fig. 16.

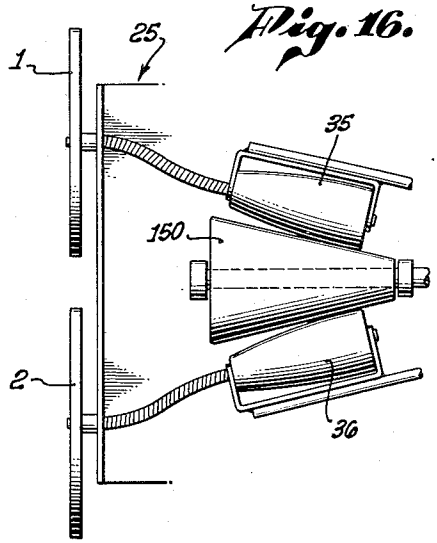


Fig. 17.

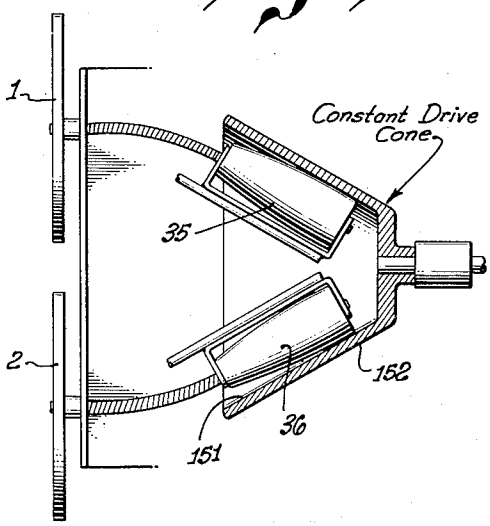


Fig. 18.

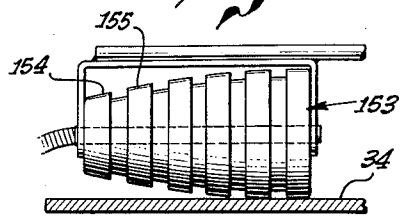
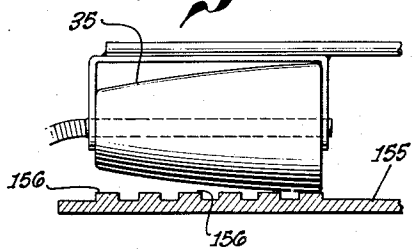


Fig. 19.



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Fig. 20.

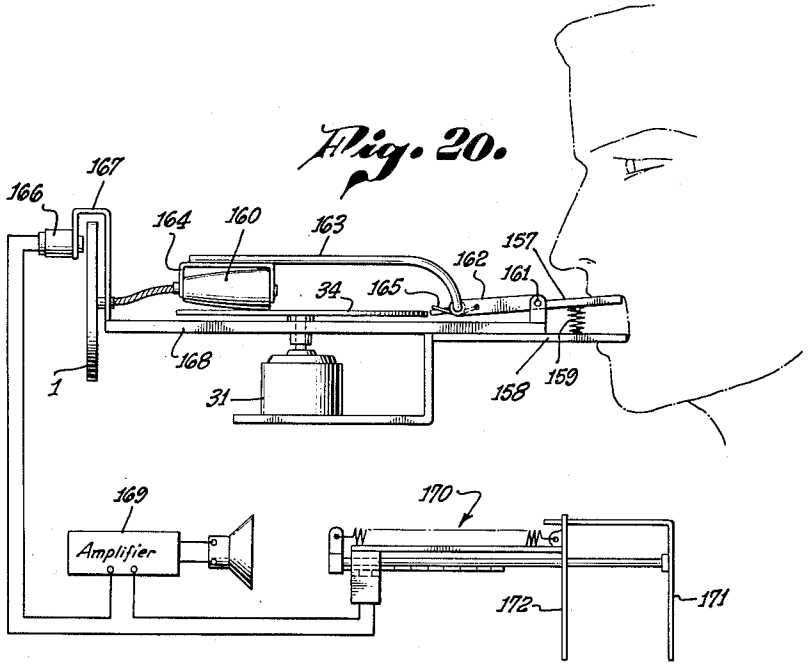


Fig. 21.

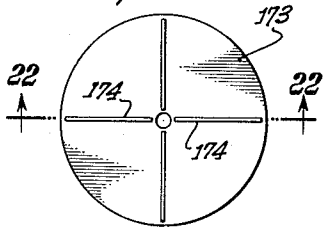


Fig. 24.

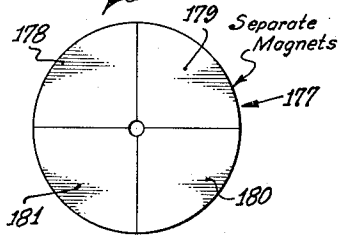


Fig. 26.

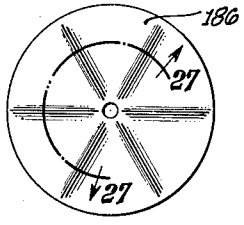


Fig. 22.

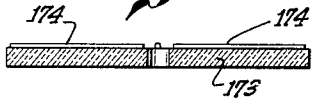


Fig. 25.

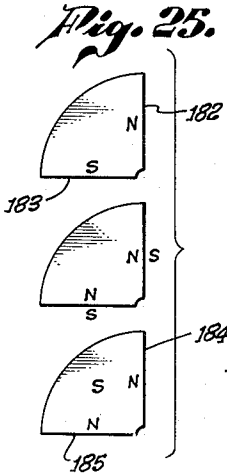


Fig. 27.

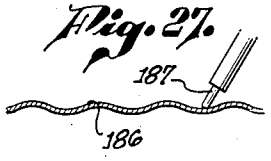
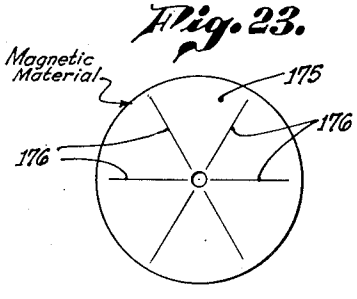


Fig. 23.



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United States Patent Office 2,776,591 Patented Jan. 8, 1957

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ELECTROMAGNETICALLY OPERATED MUSICAL INSTRUMENT

John W. McBride, Burbank, Calif., assignor to Bantar, Incorporated, Burbank, Calif., a corporation of California

Application February 17, 1951, Serial No. 211,462

14 Claims. (Cl. 84—1.27)

This invention relates to musical instruments, and particularly to instruments that may be used by persons having no special dexterity.

Thus, the instrument may be embodied in such form that even a physically handicapped person may perform on the instrument. Accordingly, artistic expression is placed within the reach of such persons, and their handicaps or lack of skill do not in any way harmfully affect their performances.

It is one of the objects of this invention to provide an instrument of this character.

In order to accomplish these objects, a series of rotatable tone wheels made of magnetic material are provided, each cooperating with an electric pick-up coil. As the tone wheel rotates, it produces a varying magnetic flux through the core of the pick-up coil. This varying flux in turn produces electrical impulses in the coil that may be converted in a well-known manner into sound. The pitch or tone of the sound depends upon the rate of rotation of the wheel, and is directly proportional thereto.

By the aid of manually movable elements, the speed of any one or more of the tone wheels can be controlled to produce the desired tone; and, at the same time, the volume of the tone produced by the tone wheels may be controlled.

It is another object of this invention to provide a simple and effective mechanism of this character.

It is still another object of this invention to provide a compact instrument capable of being operated by the fingers of one hand, while the instrument is supported in the hand, as by a strap passing around the back of the hand.

It is still another object of this invention to provide improved forms of magnetic tone wheels.

It is still another object of this invention to provide an instrument that can be played by the aid of both hands, one of the hands supporting the instrument as by a strap, and operating the tone wheel mechanism; and the other of the hands similarly supporting a control mechanism for producing vibrato effects, or the like.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several embodiments of the invention. For this purpose there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic representation of an instrument and its controls incorporating the invention;

Fig. 2 is a front elevation of the mechanism incorporating the invention;

Fig. 3 is a top plan view thereof;

Fig. 4 is a sectional view, taken along a plane corresponding to line 4—4 of Fig. 3;

Fig. 5 is a sectional view, taken along a plane corresponding to line 5—5 of Fig. 4;

Fig. 6 is an enlarged fragmentary view, similar to Fig. 5, and illustrating the driving mechanism for one of the tone wheels, the drive being at minimum adjusted speed;

Fig. 7 is a sectional view, taken along a plane corresponding to line 7—7 of Fig. 6;

Fig. 8 is a view, similar to Fig. 7, illustrating another position of the tone wheel drive, corresponding to maximum adjusted speed;

Fig. 9 is a sectional view, taken along a plane corresponding to line 9—9 of Fig. 3;

Fig. 10 is a view, similar to Fig. 9, illustrating another position of the apparatus;

Fig. 11 is a fragmentary view, similar to Fig. 4, illustrating the volume adjustment mechanism in a different position;

Fig. 12 is a view, mainly in section, of the control mechanism shown in the righthand portion of Fig. 1;

Fig. 13 is a sectional view, taken along a plane corresponding to line 13—13 of Fig. 12;

Fig. 14 is a fragmentary view, similar to Fig. 4, but illustrating a modified form of the invention;

Figs. 15, 16, and 17 are views similar to Fig. 5, but illustrating modified forms of the mechanical drives for the tone wheels;

Figs. 18 and 19 are fragmentary views, similar to Fig. 7, illustrating further modifications of the drive mechanism;

Fig. 20 is a view, similar to Fig. 1, illustrating a form of apparatus especially adapted to be operated by physically handicapped persons;

Fig. 21 is a plan view of one form of tone wheel that may be used in conjunction with the invention;

Fig. 22 is a sectional view, taken along a plane corresponding to line 22—22 of Fig. 21;

Fig. 23 is a plan view, similar to Fig. 21, of a modified form of tone wheel;

Fig. 24 is a plan view of a further modification of the tone wheel;

Fig. 25 is a diagram illustrating modified forms of magnetic sectors for the tone wheel;

Fig. 26 is a plan view of a still further modification of the tone wheel; and

Fig. 27 is a developmental sectional view, taken along a cylindrical surface corresponding to line 27—27 of Fig. 26.

Sound is produced of appropriate pitch and timbre by each of a plurality of tone wheels adapted to be driven at an independently adjusted speed. As shown most clearly in Fig. 5, there are four such tone wheels, 1, 2, 3, and 4. These tone wheels, and the mechanism associated with the tone wheels for controlling their speed, are arranged in a compact manner and are capable of being supported, for example, in the palm of the hand, as by the aid of the hand grip band 5 indicated in Fig. 1.

In the form shown in Figs. 1 to 11, inclusive, the tone wheels may be of magnetic material or of magnets, so arranged as to produce variations in magnetic flux passing through the cores 6, 7, 8, and 9 of the pick-up coils 10, 11, 12, and 13. These pick-up coils and the corresponding cores are arranged generally so that their axes are substantially parallel with the axis of rotation of the corresponding tone wheel. For example, as viewed in Figs. 2 and 3, the face of the tone wheel 1 is opposed to the polar area of the core 6. Accordingly, as the tone wheel 1 rotates, the varying magnetic properties of the tone wheel 1 as it sweeps past the pole face of core 6 induces electromotive forces in the correspond-

ing coil 10. These impulses may be amplified through an amplifier 14 (Fig. 1) and made effective, for example, by the aid of a loud speaker 15. All this is well known, and no further description thereof is necessary.

The features of the present invention relate to the compact arrangement of the operating mechanism for independently controlling the speed of any of the tone wheels 1, 2, 3, and 4, as well as for controlling the intensity of the electrical impulses produced in the pick-up coils 10, 11, 12, and 13.

When the device is supported in the palm of the hand, the four fingers of the hand may be used for manipulating four keys 16, 17, 18, and 19. These keys are shown most clearly in Figs. 3 and 4. They are appropriately guided adjacent the top of the instrument, as by the aid of the slots 20 at the upper edge of the plate 21 (Figs. 3 and 4). The keys are further guided and restrained in a manner to be hereinafter described.

The plate 21 is formed integrally with a base 22 that is attached, as by screws 23, to the flanges 24 of a frame 25. This frame has a lower wall 26 and, at the opposite edges, the upright walls 27 and 28. The frame 25 is shown, in this instance, as supported by a pedestal 29 on a base 30.

The base 30 also serves to support a small electric motor 31 that provides motive power for the tone wheels 1, 2, 3, and 4. This motor 31 has a vertical axis, and is coupled to a shaft 32 (Fig. 4) that is journalled in a bearing boss 33 extending downwardly from the wall 26. At the upper end of this shaft, a friction driving disc or wheel 34 is provided. In the position shown in Figs. 4, 5, 6, 8, 9, and 10, this friction driving wheel or disc 34 has an upper exposed friction surface cooperating simultaneously with four driven friction wheels or rollers 35, 36, 37, and 38. As best seen in Fig. 5, these wheels have axes that are radial to the axis of driving wheel 34, although not necessarily normal to this axis. In the present instance, these wheels are of generally conical configuration, the friction surface being in the form of a convex surface of revolution. Each of the wheels 35, 36, 37, and 38 is coupled to a corresponding tone wheel by the aid of the flexible shafts 39, 40, 41, and 42. Accordingly, as hereinafter explained, the axes of these rollers 35, 36, 37, and 38 may be tilted without interfering with the driving mechanism. Each of the tone wheels is rotatably supported by the aid of bearing sleeves, such as 43 (Fig. 6), joined to the wall 27 or 28 of the frame 25. A stub shaft 44, joined to the tone wheel, extends through the wall 27 or 28, and is appropriately joined to the outer extremity of the corresponding flexible shaft.

Similarly, the inner end of each flexible shaft is joined to the driven wheel shaft 45, indicated in Figs. 6 and 7.

Each of the friction driven wheels 35, 36, 37, and 38 is supported in such a way as to make it possible to tilt the wheel about its convex outer surface. Thus, in one extreme position, illustrated in Fig. 7, the driven wheel 36 is indicated at minimum speed, since the larger end of the wheel 36 is being driven at a relatively small radius from the axis of the wheel 34. However, in the position of Fig. 8, the axis of wheel 36 has been tilted in a counterclockwise direction. In this position, the driving contact between the wheel 36 and the disc 34 is at a considerably greater distance from the axis of the disc 34, and the diameter of the driven surface is reduced. For both of these reasons, the ratio of transmission is increased, and the wheel 36 rotates at a faster rate. The position of Fig. 7 illustrates the minimum speed position, while Fig. 8 illustrates a maximum speed position.

Since the mounting of each of the wheels 35, 36, 37, and 38 is similar, the following description of the control mechanism for wheel 36, and its associated flexible shaft 40, will be effective as description for the control mechanism for all of the other driven wheels 35, 37, and 38.

The shaft 45 which carries the roller 36 (Figs. 6 and 7) is mounted for rotation on the opposite arms of a bearing standard 46. In order to avoid mechanical interference with other parts of the mechanism, the arms of this standard are oblique to the vertical. This standard 46 is supported by a rod 47 having a downwardly extending right-hand end 48. This end 48 is connected to a pivot pin 49 that extends through a pivoted support 50. An appropriate stop, such as collar 49', is provided to restrain the pin 49 from axial movement.

As shown most clearly in Fig. 5, the axes of the friction wheels 35, 36, 37 and 38 are equiangularly disposed about the axis of the shaft 32 that drives the friction disc 34. The corresponding pivoted supports 50 are also similarly spaced. In order to provide a clearance for the arms 47 with respect to each other, two of the rods 47, associated with rollers 36 and 37, are disposed above the two rods 47 that are associated with the wheels 35 and 38. In order properly to position these rods without interfering one with another, the arms of standards 46 for the wheels 35 and 38 are horizontal, as indicated most clearly in Figs. 4 and 5. In this way, the rods 47 for these wheels 35 and 38 can pass underneath the other two rods.

The rod 47 is continuously urged in a counterclockwise direction by a spring 51 that is wound around the pin 49. One end 52 of this spring is received in an aperture 53 in the support 50. The other end 54 engages a stub 55 projecting laterally of the arm 47.

When the pivoted support 50 is allowed to move upwardly, the driven friction wheel 36 may assume the position of Fig. 8. The force of spring 51 raises rod 47 about a fulcrum corresponding to the point of contact of roller 36 with wheel or disc 34. The support 50 simultaneously swings in a clockwise direction about its pivot pin 56, extending through the hub 57 of the support 50, as well as through the ears of a pair of parallel standards 58. This angular movement of separation between rod 47 and support 50 is limited by limiting upward movement of this support in a manner to be hereinafter described.

When the support 50 is moved downwardly toward the position of Fig. 7, the wheel 36 is tilted to cause the inner edge of the wheel to be active on the friction surface of disc 34.

The key 18 is associated with the support 50 to limit the upper position of this support and thereby to control the speed at which the corresponding tone wheel 2 is rotated. The key structure may be best described in connection with Figs. 3, 4, 9, and 10.

Thus, the base 22 has downwardly turned flanges 59 through which the guide rods 60 associated with each of the keys extend. The right-hand end of the guide rod 60 is joined to the downwardly extending finger piece 61 that is connected to the key 18. Connected to the left-hand end of the guide rod 60 is a collar 62. This collar serves as a support for the left-hand end of a cam structure 63 formed, in this instance, of a round rod. The other end of the cam structure is joined to the lower edge of the finger piece 61. This cam structure includes a sloping portion 64 forming the cam surface proper. Cushioning collars 65 and 66 of yielding material are provided at the left-hand end and at the right-hand end of the guide rod 60.

The key 18 is urged to the right by the aid of a tension spring 67. The right-hand end of the tension spring is anchored to an ear 68 of the upright 21. The left-hand end is anchored to an ear 69 joined to the collar 62. Accordingly, in the normal inactive position, the cam member 64 serves to hold the pivoted support 50 in the position of Figs. 7 and 9 by contact with a cam follower roller 72. A clevis 70 is mounted in an ear 71 of the pivoted support 50 for supporting the follower roller 72. As shown most clearly in Fig. 5, the clevis 70 is arranged so that the axis of the roller 72 is normal

to the movement of the key 18, although the pivoted support 50 is oblique to this movement.

As the key 18 is urged toward the left, as viewed in Fig. 9, the cam member 64 permits the pivoted member 50 to move angularly in a clockwise direction and ultimately to assume the positions of Figs. 8 and 10. Through this movement, the friction wheel 36 has tilted from the position of Fig. 7 to the position of Fig. 8. Since the key 18 may be stopped at any intermediate position, the friction roller 36 may also be stopped at an intermediate position at which the roller 72 contacts an intermediate portion of the cam 64.

The inward movement of the key 18 thus controls the rate at which the tone wheel 2 is operated.

The tone wheels 1, 3, and 4 are similarly controlled by the other keys 16, 17, and 19. Each of the keys 16, 17, and 19 operates a cam member, such as 64, to limit upward movement of the corresponding pivoted support 50.

The pick-up coils 10, 11, 12, and 13, cooperating with the tone wheels 1, 2, 3, and 4, respectively, are so supported that, when any of the keys 16, 17, 18 and 19 is operated, the corresponding pick-up coil is moved inwardly of the radius of the corresponding tone wheel. In this way, the relative linear speed between the tone wheel and its associated pick-up coil is maintained substantially constant, with attendant reduction of abnormal effects.

Thus, for example, as shown in Fig. 9, the pick-up coil 11, associated with the tone wheel 2, is shown as near the outer periphery of this tone wheel. The key 18 is in the position where the angular velocity of the tone wheel 2 is at a minimum, as indicated most clearly in Fig. 7. The linear velocity of wheel 2 with respect to the coil 11 is a function of the distance between the axes of shaft 44 and of coil 11, as well as the rate of angular velocity.

Now, when the key 18 is moved inwardly, as shown in Fig. 10, the angular velocity is at a maximum. In this position, the coil 11 is moved inwardly toward the axis of shaft 44. Accordingly, although the angular velocity has increased, the linear velocity has not been increased, due to the inward movement of the coil 11.

The coils 10, 11, 12, and 13 are mounted on adjustable supporting arms 73, 74, 75, and 76. Two of these arms are shown clearly in Fig. 2. Arm 74 is shown in phantom lines in Figs. 9 and 10. It is shown as supported upon the extension 77 of a rod 78. This extension projects in a direction parallel to the face of the tone wheel 2. The main portion of the rod 78 is elevated somewhat above the extension 77, as indicated most clearly in Figs. 9 and 10. A collar 79 (see Fig. 2) disposed between bifurcations of each arm, serves to restrain these arms against substantial axial movement with respect to the extension 77. The right-angle bend 80 of the rod 78 is permanently attached to the inner end of key 18 (Figs. 3, 9, and 10). Accordingly, as the key 18 is moved inwardly to the position indicated in Fig. 10, the support 74 is also moved inwardly by the aid of the rod 78.

Similar connections for the other arms 73, 75, and 76 are provided. Thus, a rod 81 (Figs. 3 and 4) serves to move the support 73 when key 19 is operated. A rod 82, connected to key 17, controls the position of the support 73 and, finally, a rod 83 is connected to key 16 for controlling the position of the support 76. These rods 78, 80, 81, 82, and 83 are appropriately bent so as not to interfere mechanically (see particularly Fig. 4).

The lower end of each of the supporting members 73, 74, 75, and 76 is provided with a slot 84 (Figs. 4 and 11). Entering into the slots of the supports 73 and 74 is a rod 85. A similar rod 86 enters into the slots 84 of the supporting arms 75 and 76. As shown most clearly in Figs. 4 and 5, these rods 85 and 86 can be moved to tilt the corresponding supports so as to move the coils 10, 11, 12, and 13 laterally away from the tone wheels 1, 2, 3, and 4. In this way, reduction in volume of the electrical impulses is obtained.

For this control purpose, rock shafts 88 are provided, one for each side of the apparatus (Fig. 4), and mounted on brackets 89 formed on the suports 90. These supports are attached to the walls 27, 28 of frame 25 (Fig. 5). Rods 85 and 86 are rigidly supported above these shafts 88 by the aid of arms 87, connecting the ends of the rods 85 and 86, respectively, with the ends of shafts 88 (Figs. 2, 4, and 5). These rods 85 and 86 are engaged in the corresponding slots 84 in the ends of supports 73, 74 and 75, 76. Obviously, angular movement of the shafts 88 in opposite directions will cause movement of the rods 85 and 86 outwardly, as indicated in Fig. 11; and the supporting arms 73, 74, 75, and 76 are correspondingly moved outwardly.

Pivotal movement of the shafts 88 is simultaneously effected by a linkage mechanism disclosed most clearly in Figs. 2, 4, and 11. Thus, there is a connecting link 91 (see, also, Figs. 3 and 5) that extends from the rod 86 to an arm 92 that is connected to shaft member 88 on the opposite side of the apparatus. Accordingly, when the rocker structure, including the rod 85, is moved in a counterclockwise direction, as indicated in Fig. 11, the rocker structure including the rod 86 is moved in a clockwise direction.

Movement of the rocker structure is accomplished by the aid of a crank arm 93 (Figs. 3 and 4) mounted on shaft 88. A link 94 is attached to this arm. This link 94, in turn, is pivoted to a crank member 95. This crank member 95 is pivotally mounted in a bearing standard 96 by the aid of arm 97. The upper end of the crank 95 is journalled in the bosses 98 supported above and below the base 22 (Fig. 4). The crank 95 has a vertical portion extending through a slot 99 in the frame 25.

Attached to the upper end of the crank 95 is a finger key 100 adapted to be controlled by the thumb, or other finger. When this key 100 is turned in a clockwise direction, as viewed in Fig. 3, the crank 95 moves the link 94 to the right, and toward the position of Fig. 11. This, in turn, causes the pick-up coil supports 73, 74, 75, and 76 to swing away from their respective tone wheels. Accordingly, by appropriate angular positioning of the lever key 100, the degree of separation of the pick-up coils from the tone wheels can be controlled.

The circuits for the pick-up coils are indicated diagrammatically in Fig. 1. Each of them is connected to a control mechanism 101 that may be supported in one of the hands of the operator, as by the aid of a hand grip band 102. The complete circuit for pick-up coil 10, for example, includes the conductor 103, the control mechanism, conductor 104, rheostat 105, connection 106, the amplifier system 14, and back to the coil 10 by way of conductor 107.

The other coils 11, 12, and 13 are similarly arranged, all of them leading to the control device 101 and to the rheostat 105. The conductors for this control system may be in a common cable leading to the amplifier and loud speaker 15 that may be located at a considerable distance from the performer.

The control mechanism 101 includes four keys, 108, 109, 110, and 111.

One of the key mechanisms, such as the mechanism associated with key 111, is indicated in Figs. 12 and 13. This key is guided, as by the rod 112, in a manner similar to the guiding keys 16, 17, 18, and 19. For this purpose, the supporting base 113 is provided with the depending flanges 114 and 115. An upright wall 116 is provided with slots for the accommodation of the upper part of the sliding keys. As before, a tension spring 117 is used to urge the key toward the right, as viewed in Fig. 12.

The rod 112 carries a plate 118 having conducting strips 119 and insulation strips 120 alternating along

the plate 118. Cooperating with these strips are a pair of contact buttons 121 and 122 which are electrically connected to the leads, such as 103 and 104, in the circuit of one of the pick-up coils, such as 10. These contact buttons 121 and 122 are urged against the lower side of the plate 118, as by the compression springs 123 located in bores in an insulation base 124. This base 124 is supported on an inwardly turned flange 125 of the main support 113.

As the key 108 is moved inwardly, the circuit for coil 10 is alternately made and broken by the alternating strips 119 and 120 as they pass over the buttons 121 and 122. The reciprocation of key 108 thus produces a tremulant effect. The other keys 109, 110, and 111 are similarly used to control the pick-up coils 11, 12, and 13.

Volume control is also available by the aid of the mechanism 101. This is accomplished by the aid of a lever key 126. This key is connected to a shaft that is journalled by the aid of standards 127 on the support 113. The lower end of the shaft carries an arm 128. This arm is connected, as by a link 129, to the arm 130 of the rheostat 105. Movement of the lever 126 accordingly determines the amount of resistance in series in the pick-up coil circuits.

In the modification illustrated in Fig. 14, a tremolo or vibrato effect is produced by a mechanical arrangement. Thus, for example, the tone wheel 131 is shown as rotated by the aid of the friction disc 132 and a driven friction wheel 133. The shaft of the motor 31, in this instance, is splined to shaft 200 upon which the disc 132 is mounted. This shaft 200 is provided with a collar 134. Between the collar 134 and the boss 135 of the frame 136 there is interposed the bifurcated end of a lever 137 pivoted as on a pin 138. A compression spring 139, disposed between the support 136 and the lower side of the disc 132, urges the disc upwardly.

At the left-hand end of lever 137 there is provided a roller 140 engaging a cam member 141. This cam member is, in this instance, in the form of a sloping disc rotated by motor 31, as by the aid of the belt 142. Accordingly, as the cam 141 rotates, the lever 137 is reciprocated at a rate corresponding to the speed of rotation of the cam 141. This, in turn, causes alternates depression and elevation of collar 134 and, therefore, of shaft 200 and disc 132. When the lever operates to reciprocate the disc 132 in this manner, this reciprocation causes a slight cyclic variation in the rate of rotation of the tone wheel 131.

A further control may be effected by the cam 141 to move the tone wheel 131 toward and from the pick-up coil 143. For this purpose a shift lever 144 is provided. One arm of the lever carrier a follower roller 145 contacting the upper surface of the cam disc 141. The other arm of the lever is provided with a forked end 146 for engaging the collar 147 of the tone wheel 131. A compression spring 148 urges the tone wheel 131 constantly toward the right. However, as the cam disc 141 rotates, the tone wheel 131 is cyclically moved toward and from the pick-up coil 143.

In the form thus far described, the tone wheels are rotated by the aid of a friction disc, such as 34 or 132. It is possible to drive the tone wheels otherwise.

Thus, in Fig. 15, the tone wheels 1 and 2 are driven by the aid of the friction driven wheels or rollers 35 and 36. These friction wheels, however, engage a cylindrical friction driving wheel 149 which is driven from a constant speed source. As before, the brackets 46 for the driven wheels 35 and 36 may be tilted by operation of manually depressible keys for varying the rate of rotation. As these wheels 35 and 36 are tilted to cause the cylinder 149 to engage the smaller diameter of these wheels 35 and 36, the speed of the tone wheels 1 and 2 increases.

In the form shown in Fig. 16, an arrangement similar to Fig. 15 is illustrated. In this case, the friction driving wheel 150 is in the form of a cone engaging the surfaces of the driven wheels 35 and 36. In this instance there is a greater variation of speed between the extreme tilted positions of these wheels 35 and 36.

In the form shown in Fig. 17, the driven friction wheels 35 and 36 engage the interior conical surface 151 of a constant speed friction driving member 152. In the position shown, the speed is a minimum; and, as the wheels 35 and 36 are tilted to cause engagement of these wheels with the areas of the conical surfaces 151 that approach the large end of the cone, the speed is increased.

In the forms thus far described, the changes in speed of the tone wheels are continuous. Thus, for every angular position of the friction driven wheels, there is a definite corresponding speed.

In the form shown in Fig. 18, the driving disc 34 is shown as having a continuous flat friction driving surface. The driven wheel 153, however, is provided with discontinuous anular portions 154, 155, etc. These annular portions contact the disc 34 in succession as the wheel 153 is tilted. Accordingly, there are definite ratios of transmission effective in succession as the tilting occurs.

In the form shown in Fig. 19, the friction driving disc 155 is shown as having a series of annular raised areas 156. These separate bands or annular areas operate in succession as the friction driven member 35 is tilted.

The mechanisms described hereinabove may be made in such manner as to permit operation other than by the aid of the hands. For example, in the form shown in Fig. 20, the rate of rotation of the tone wheel 1 can be varied by movement of the arm 157 toward the support 158. A finger amputee can operate the device by his jaws, inserting the arm 157 and the edge of the support 158 in the oral cavity. Thus, by moving the jaws together and apart, the tilting of the driven friction member 160 is effective. A compression spring 159 urges the arm 157 in a counterclockwise direction about its pivot 161. The arm 157 is joined to another arm 162, to which is pivoted a rod 163. Rod 163 carries the standard 164 in which the wheel 160 is pivotally mounted. A spring structure 165 tends to move the rod 163 and the arm 162 apart. The spring 159 urges the arm 157 to a position where the speed is a minimum. As the arm 157 is urged toward the arm 157, the spring 159 is compressed and the arm 162 is elevated. This causes tilting of the rod 163 and consequent tilting of the friction roller 160 to increase the ratio of transmission.

The pick-up coil 166 may be appropriately supported by a bracket 167 on the main supporting structure 168. The pick-up coil may be connected to an amplifier system 169, as well as to a control mechanism 170. This is similar to the mechanism illustrated in Fig. 12. However, the operating key 171, as well as the support 172, are downwardly extending so that they can be urged together, as by the action of the knees, or the like.

The tone wheels 1, 2, 3, and 4 may take a number of different forms. For example, in the form shown in Figs. 21 and 22, the tone wheel 173 may be made generally of non-magnetic material. On its active face, the tone wheel has radial extending bars 174. Four of such bars are shown in this instance. These bars may be made of magnetic material, or may be permanently magnetized. As they sweep across the corresponding polar area of the core of the pick-up coil, electrical impulses are generated.

In the form shown in Fig. 23, the tone wheel 175 may be made of magnetic material. In this form, the magnetic properties along one radius vary slightly from the magnetic properties along an adjacent radius. There may be a cyclic variation as different angular positions are chosen of the radius about the axis of the tone wheel. For example, the radii 176 may indicate regions of high permeability, while radii 176*a* may indicate regions of reduced permeability. These effects may be produced by appropriate fabrication of the wheel from comminuted or powdered magnetic material held together by a binder.

Fig. 24 illustrates a tone wheel **177** made up of a plurality of separate magnetic sectors **178, 179, 180,** and **181.** These sectors may be permanent magnets. For example, each of the sectors may have a north pole along one radial face **182,** as indicated in the upper portion of Fig. 25, and a south polar area at the radial face **183.** In the intermediate figure of Fig. 25, the upper quadrantial surface may be north and the lower quadrantial surface may form a south polar area.

In the lowermost diagram of Fig. 25, the two radial areas **184** and **185** are indicated as north polar areas, gradually shifting to a south polar area at the center portion of the quadrential surface.

In place of a pick-up coil, use may be made of a stylus operating a pick-up coil. Thus, the tone wheel **186** in Figs. 26 and 27 is indicated as having a series of regular radi-arranged hills and dales. These hills and dales cooperate with a contacting stylus **187** operating in a well understood manner.

The inventor claims:

1. In a musical instrument: a rotary friction driving wheel; a driven wheel having a surface of revolution formed by a convex element and in contact with the driving wheel; means for tilting the driven wheel so as to select the portion of said surface that is in driving relation to the driving wheel, for adjusting the speed of the driven wheel; and a tone wheel coupled to the driven wheel; said tilting means including: a pair of pivotally joined arm sections; means for rotatably supporting the driven wheel by one of the arm sections; means forming a pivot support for the other arm section; means resiliently urging the arm sections for relative angular movement in one direction; and a manually operable key having a cam for urging the arm sections in a direction opposite that of the resiliently urging means.

2. In a musical instrument: a rotary friction driving wheel; a driven wheel having a surface of revolution formed by a convex element and in contact with the driving wheel; means for tilting the driven wheel so as to select the portion of said surface that is in driving relation to the driving wheel, for adjusting the speed of the driven wheel; and a tone wheel coupled to the driven wheel; said tilting means including: a pair of pivotally joined arm sections; means for rotatably supporting the driven wheel by one of the arm sections; means forming a pivot support for the other arm section; means resiliently urging the arm sections for relative angular movement; a manually operable key having a cam for urging the arm sections in a direction opposite that of the resiliently urging means; and a spring for urging the key to one of its extreme positions.

3. In a musical instrument: a rotary friction driving wheel; a plurality of driven wheels in contact with the driving wheels; each of the driven wheels having a friction surface of revolution formed by a curved element; a flexible shaft for each driven wheel; tone wheels respectively driven by said shafts; a jointed arm for each driven wheel; pivot means for each of the jointed arms; and a plurality of manually operable keys for respectively moving the arm to adjust the position of the corresponding driven wheel with respect to the driving wheel.

4. In a musical instrument: a rotary friction driving wheel; a plurality of driven wheels in contact with the driving wheels; each of the driven wheels having a friction surface of revolution formed by a curved element; a flexible shaft for each driven wheel; tone wheels respectively driven by said shafts; a jointed arm for each driven wheel; pivot means for each of the jointed arms; and a plurality of manually operable keys for respectively moving the arm to adjust the position of the corresponding driven wheel with respect to the driving wheel; said keys having parallel rectilinear movement.

5. In a musical instrument: a magnetic tone wheel; means for rotating the tone wheel about an axis; the tone wheel having an annular operative portion extending transversely of said axis; a pick-up coil cooperating with the tone wheel; an arm supporting the coil; a rod pivotally supporting said arm on an axis transverse to the axis of the tone wheel; means for moving said support in a direction parallel to the said arm axis to move the coil along said operative portion; and means for moving the arm about its axis.

6. In a musical instrument: a magnetic tone wheel; means mounting the tone wheel for rotation about its axis as well as for axial movement; means for rotating the tone wheel; a pick-up coil cooperating with the tone wheel; and means producing relative cyclic movement between the face of the tone wheel and the coil, including a rotary cam, and a shift collar reciprocated by the cam and connected to the tone wheel for causing axial reciprocation of the tone wheel.

7. In a musical instrument: a support; a plurality of keys adapted to be manipulated by the fingers of the hand, and guided for independent parallel movement on said support; a driving member having an annular friction surface rotatably mounted on said support; a plurality of driven members each engaging said friction surface and angularly spaced thereabout; adjustable standards for the driven members, the standards being independently adjustable to move the driven members to vary the ratio of transmission between the members; a plurality of rotary tone wheels carried by the support and coupled to said driven members respectively; and means carried by the keys for adjusting the position of the standards in accordance with the position of said keys.

8. In a musical instrument: a support; a plurality of keys adapted to be manipulated by the fingers of the hand, and guided for independent parallel movement on said support; a driving member having an annular friction surface rotatably mounted on said support; a plurality of rollers each engaging the friction surface and angularly spaced thereabout; adjustable standards mounting the rollers for rotation about axes extending substantially in planes radial to the axis of said driving member; the standards being adjustable to tilt the axes of said rollers in said radial planes to vary the ratio of transmission between the members; a plurality of rotary tone wheels connected to the rollers; resilient means urging the standards in one direction; cam means carried by the keys; and cam follower means positioning the standards in accordance with the position of the respective keys.

9. In a musical instrument: a support; a driving disc mounted on the support for rotation about an axis; a plurality of magnetic tone wheels carried by the support for rotation, the axes of rotation of the wheels being parallel to each other, the axis of rotation of each wheel extending in a plane normal to the axis of rotation of said driving disc; variable ratio transmission elements coupled respectively to the wheels and cooperating with said disc; keys carried by the support for rectilinear movement in a direction perpendicular to all of said axes; pick up coils for the respective tone wheels; means supporting the coils for movement radially of said tone wheels in a direction parallel to the direction of movement of said keys; and connections between the keys and the coils for radially adjusting the coils in accordance with the extent of depression of said keys.

10. In a musical instrument: a magnetic tone wheel; means for rotating the tone wheel about an axis; the tone wheel having an annular operative portion extending transversely of said axis; a pick-up coil cooperating with the tone wheel and opposed to said operative portion; a support for the coil upon which the coil is movable toward and away from the axis of the tone wheel along the operative portion; movable means for increasing the speed of the tone wheel in accordance with the extent of movement of said movable means; and means operated by said movable means to move said coil toward said axis in an amount determined by the extent of movement of said movable means.

11. In a musical instrument: a support adapted to be held in the hand; a plurality of movable keys mounted on the support and projecting laterally therefrom for manipulation by the fingers of the operator; a plurality of tone wheels carried by the supports for rotation; a rotary friction driving member; a plurality of rotary driven members spaced about the driving member and each engageable with said friction surface; means rotatably coupling the tone wheels with the respective driven members; a plurality of supports for the driven members respectively, and each adjustable to move the driven members with respect to the driving member to vary the ratio of transmission between the driven member and the driven members; and a plurality of means operated by movement of the respective keys to adjust the position of said supports.

12. In a musical instrument: a rotary magnetic tone wheel of disc configuration; a support movable in a direction parallel to the plane of the tone wheel; an arm pivotally mounted on the support for angular movement about an axis parallel to said plane; a pickup coil carried by the arm and opposed to the tone wheel; movement of said support causing movement of the pickup coil along the wheel toward and away from the axis of the tone wheel; angular movement of the arm causing the pick-up coil to move toward and away from the plane of the tone wheel; a variable ratio transmission for rotating the tone wheel; a movable key for adjusting the ratio of transmission; means connecting the key and the movable support for causing movement of the pickup coil inwardly toward the axis of the tone wheel upon an increase in angular speed of the tone wheel; and a mechanism for adjusting the angular position of the arm about the axis of the arm.

13. In a musical instrument: a rotary magnetic tone wheel of disc configuration; a support movable in a direction parallel to the plane of the tone wheel; an arm pivotally mounted on the support for angular movement about an axis parallel to said plane; a pickup coil carried by the arm and opposed to the tone wheel; movement of said support causing movement of the pickup coil along the wheel toward and away from the axis of the tone wheel; angular movement of the arm causing the pickup coil to move toward and away from the plane of the tone wheel; a variable ratio transmission for rotating the tone wheel; a movable key for adjusting the ratio of transmission; means connecting the key and the movable support for causing movement of the pickup coil inwardly toward the axis of the tone wheel upon an increase in angular speed of the tone wheel; said arm having a slot located along the length of the arm spaced from the axis of the arm; a rod extending parallel to the direction of movement of said support, and extending through the slot

and in engagement with the edges of the slot throughout all adjusted positions of the support; a rocker arm for the rod for angularly moving the rod about an axis parallel to the direction of movement of the support and for adjusting the position of the arm about the axis of the arm; and manually operable means for rotating the rocker arm.

14. In a musical instrument: a magnetic tone wheel; means for rotating the tone wheel about an axis; the tone wheel having an annular operative portion extending transversely of said axis so that different areas of the operative portion move at different relative linear rates; a pick-up coil cooperating with the tone wheel and opposed to said operative portion; a support for the coil upon which the coil is movable toward and away from the axis of the tone wheel along said operative portion; and common means for varying the speed of the tone wheel to determine the tone produced throughout the musical range of the instrument and for moving said coil toward and away from the axis of the tone wheel for maintaining the relative linear velocity between the pick-up coil and the tone wheel substantially constant.

References Cited in the file of this patent

UNITED STATES PATENTS

383,680	Westinghouse et al.	May 29, 1888
637,202	Ganges	Nov. 14, 1899
861,069	Wood	July 23, 1907
994,037	Schwartz	May 30, 1911
1,169,458	Bullard	Jan. 25, 1916
1,218,324	Severy	Mar. 6, 1917
1,665,331	Thomson	Apr. 10, 1928
1,785,915	Robb	Dec. 23, 1930
1,817,704	Osbourne	Aug. 4, 1931
1,941,870	Severy	Jan. 2, 1934
1,990,023	Eremeeff	Feb. 5, 1935
2,047,733	Harrison	July 14, 1936
2,115,659	Wienecke	Apr. 26, 1938
2,118,347	Hardenberg	May 24, 1938
2,130,251	Richards	Sept. 13, 1938
2,148,759	Legrand	Feb. 28, 1939
2,273,768	Fisher	Feb. 17, 1942
2,373,560	Hanert	Apr. 10, 1945
2,412,604	Dolan	Dec. 17, 1946
2,478,539	Leitner	Aug. 9, 1949
2,498,138	Shepard et al.	Feb. 21, 1950
2,521,560	Batcheller	Sept. 5, 1950
2,539,130	Grudin	Jan. 23, 1951
2,544,722	Pattyn	Mar. 13, 1951
2,549,145	Vagtborg	Apr. 17, 1951
2,563,647	Hammond	Aug. 7, 1951