H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED JAN. 3, 1911.

1,028,495.

Patented June 4, 1912.

6 SHEETS—SHEET 1.

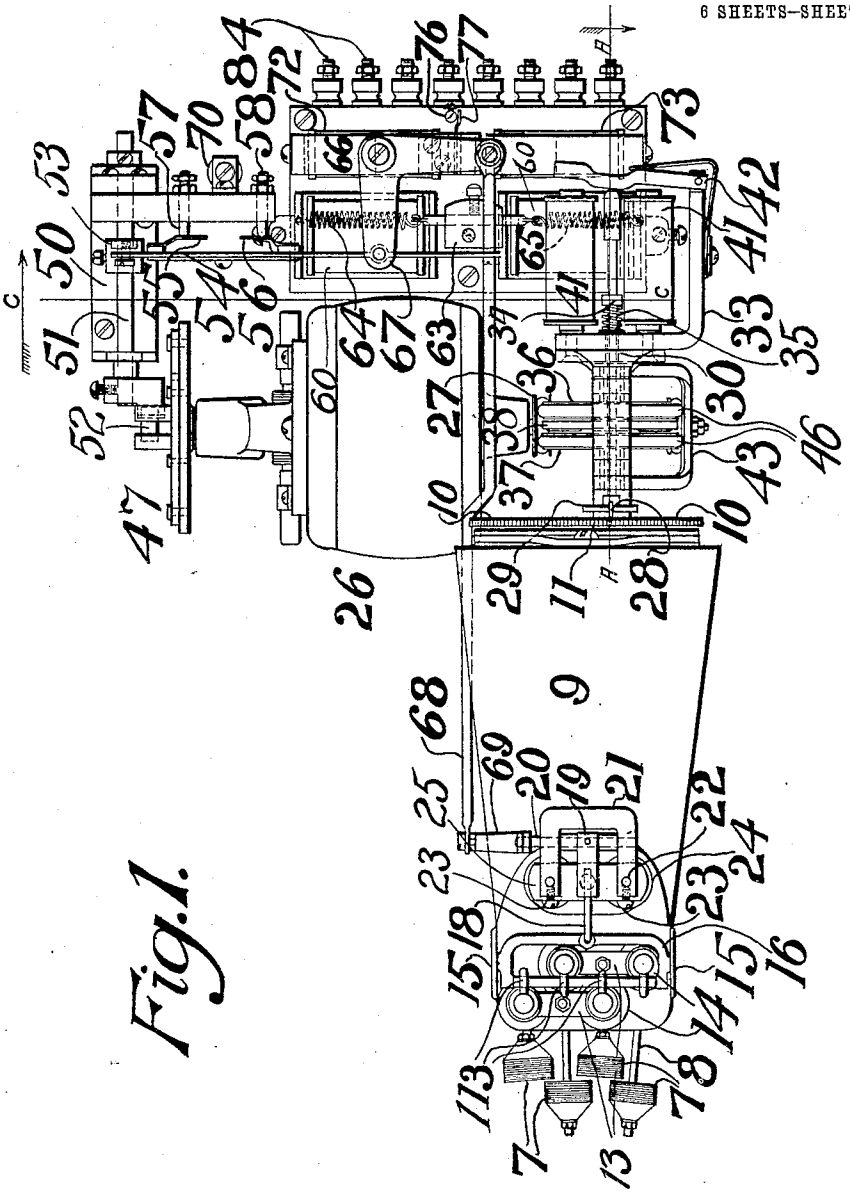

Fig. 1.

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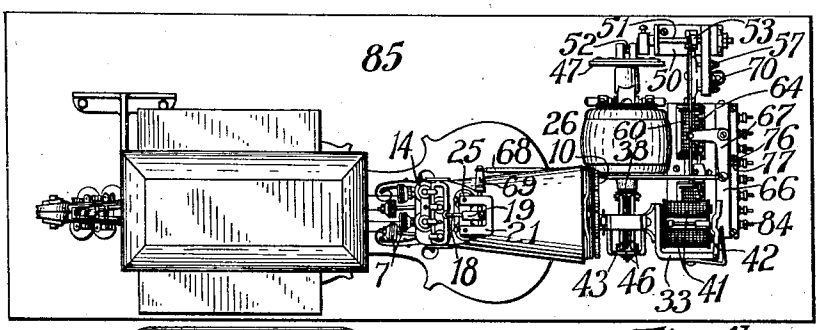
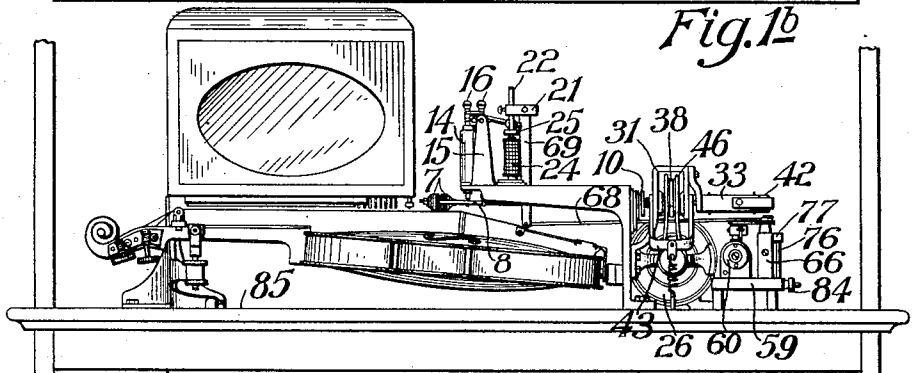


Fig. 1b



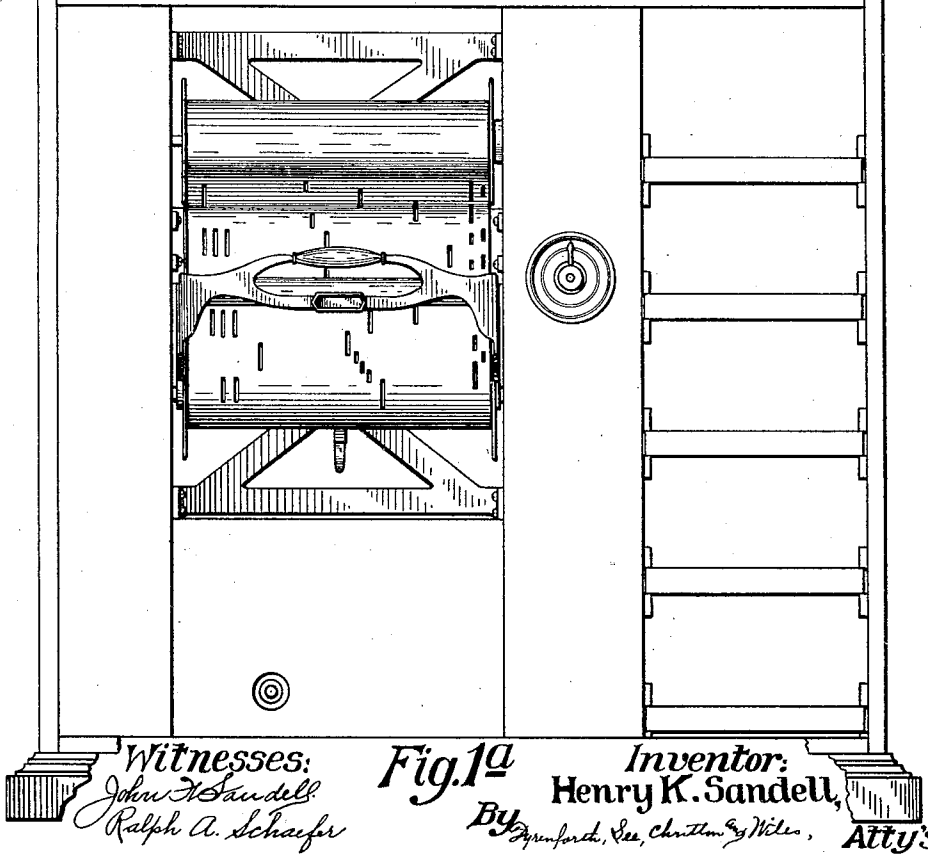


Fig. 1a

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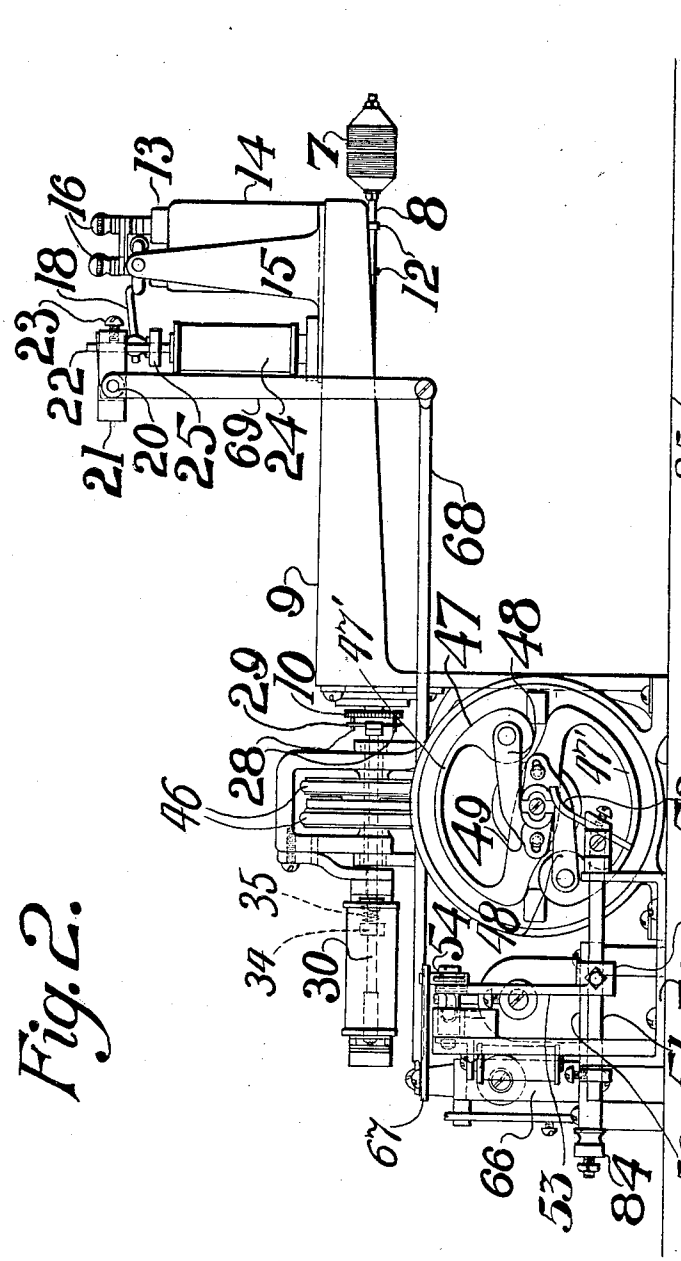

Fig. 2.

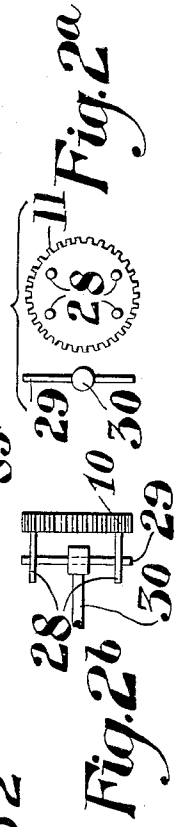

Fig. 2a

Fig. 2b

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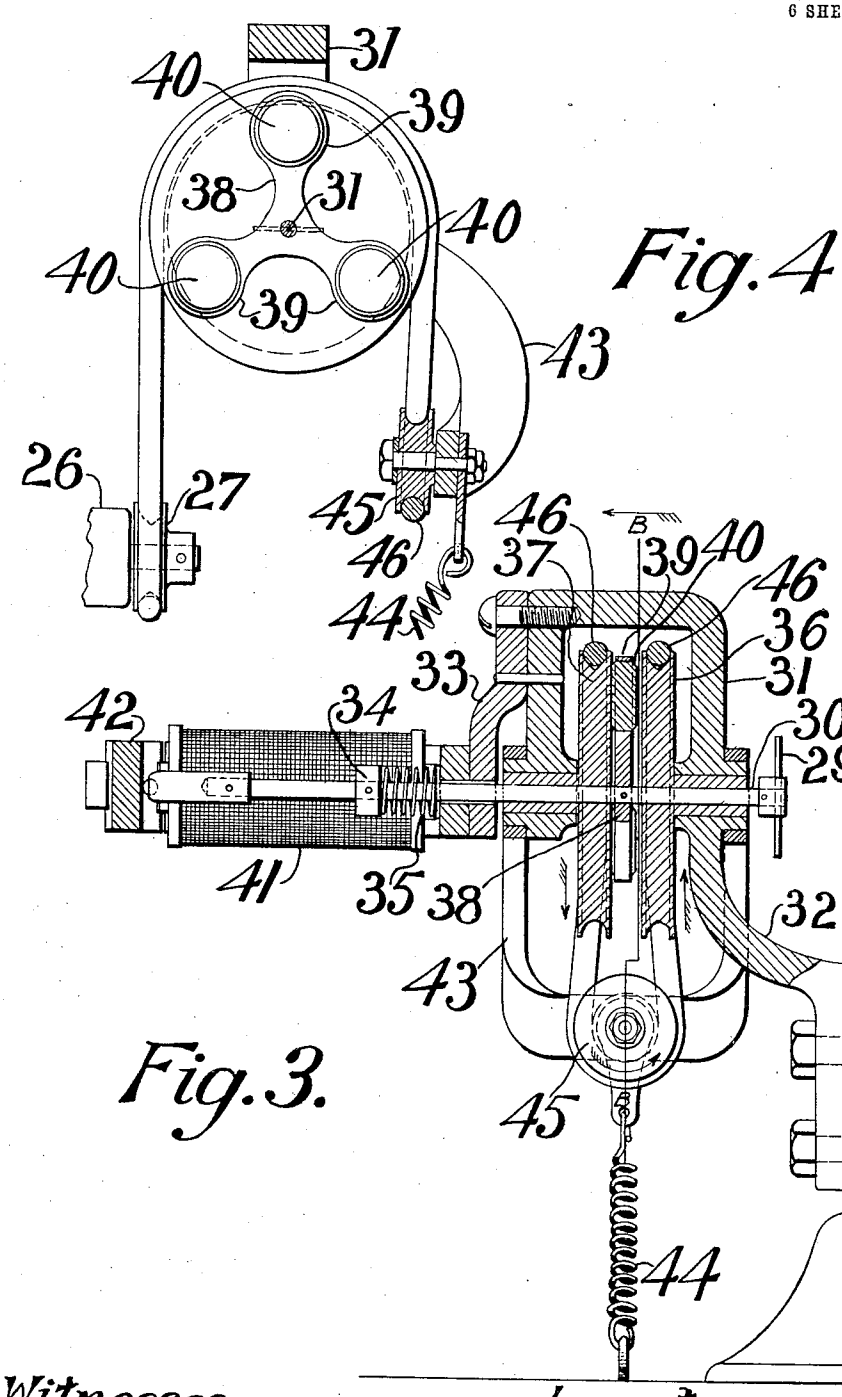

Fig. 4

Fig. 3.

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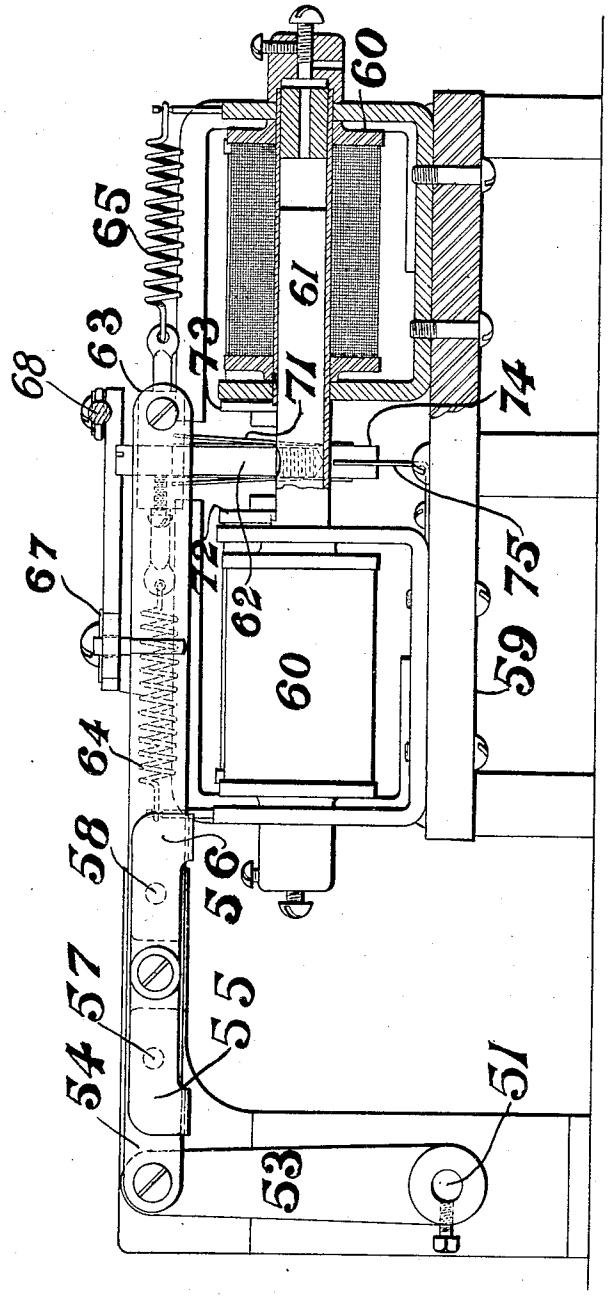
6 SHEETS—SHEET 5.

Fig. 5.



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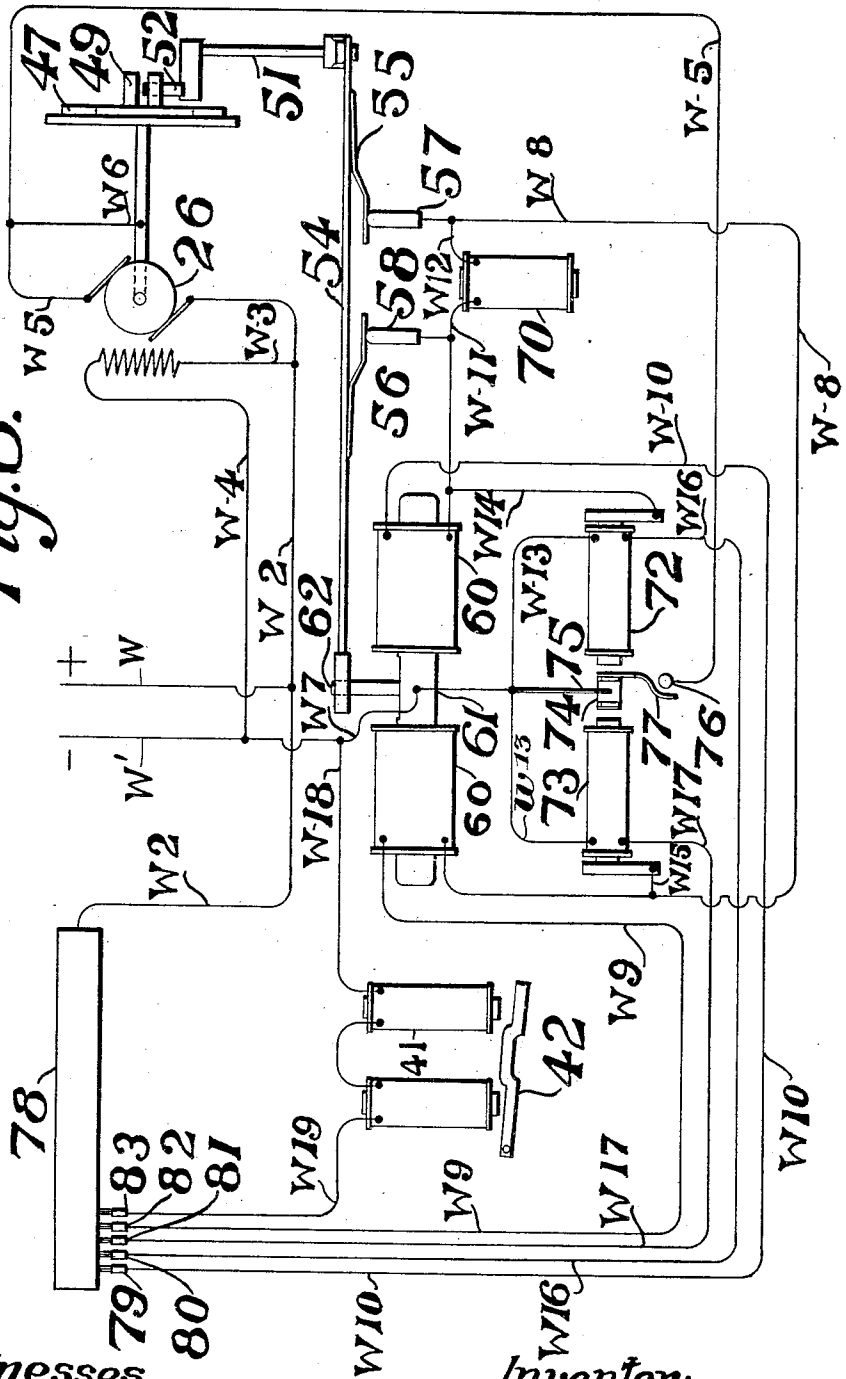
6 SHEETS—SHEET 6.

Fig. 6.



Witnesses

J. G. Anderson

R. A. Schaefer

Inventor:

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UNITED STATES PATENT OFFICE.

HENRY K. SANDELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO MILLS NOVELTY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

ELECTRIC SELF-PLAYING VIOLIN.

1,028,495. Specification of Letters Patent. Patented June 4, 1912.

Application filed January 3, 1911. Serial No. 600,470.

To all whom it may concern:

Be it known that I, HENRY K. SANDELL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Electric Self-Playing Violins, of which the following is a specification.

My invention relates to improvements in the type of self-playing stringed instruments exemplified in United States Letters Patent No. 807,871, granted to me December 19, 1905; and it relates, more particularly, to improved devices for enhancing the expression in music executed by the instrument to simulate more closely the performance of human playing, especially in loudness and softness of tone and graduation from one to the other, and in reversing the action of the sounders to the end of imitating the up and down movements of the violin-bow in the hand of the human violinist.

Primary objects of my present improvements are to provide comparatively simple constructions of the mechanisms which I have devised for the expression-purposes referred to, and to render the playing mechanisms of the instrument compact by housing them in the same compartment in the case with the instrument.

In the accompanying drawings, Figure 1 is a plan view showing the four rotary sounders of the instrument and my improved mechanisms controlling their operations for the expression-purposes referred to; Fig. 1[a] is a front elevation of the entire machine; Fig. 1[b] is a top plan view of the upper portion of the mechanism; Fig. 2 is a view of the same in side elevation; Fig. 2[a] shows a face-view of the sounder-driving gear with pins projecting from it, and an end view of the sounder drive-shaft carrying arms to engage the pins, and Fig. 2[b] shows the same by a side view in their relative operating positions; Fig. 3 is an enlarged section on line A—A, Fig. 1, illustrating the sounder-reversing mechanism; Fig. 4 is a section on line B—B, Fig. 3; Fig. 5 is an enlarged view on line C—C, Fig. 1, showing parts in section and illustrating the solenoid-mechanism for controlling and regulating the soft and loud playing of the sounders, and Fig. 6 is a diagram of the circuits containing the several mechanisms.

The sounders 7, one for each string of the violin (not shown), are provided on the forward ends of rotary shafts 8 extending along the under, concave side of the horizontal arm of an angular bracket 9, in the vertical member of which the shafts are journaled near their rear ends, where they carry gears 10 intermeshing in pairs and actuated by a central driving-gear 11, these shafts being carried, near their forward ends, in eyes 12 on the lower ends of rods depending, through the hollow magnet-cores, from the spring-supported armatures 13 of electromagnets 14 in vertical position on the bracket-arm; all as in the aforesaid patent. In standards 15 at opposite ends of the electromagnets 14 is journaled to rock in its bearings, a head 16 or shaft, shown of general D-shape, with a finger 18 extending rearwardly and centrally from it to engage with the under side of the free-end portion of a tongue 19 secured at its opposite end on a rock-shaft 20 journaled in the arms of a rectangular bracket 21, which is rigidly fastened to posts 22, passing through the bracket-arms, by set-screws 23 working in the ends of said arms. These posts rise from the cores of an electromagnet 24 on the bracket 9, and pass through and form guides for the spring-raised armature 25, to which the rear end of the finger 18 is connected. Energizing the magnets 14 to attract their armatures 13 causes the rods carrying the eyes 12 to depress the constantly rotating sounders against the violin-strings.

The degree of loudness and softness of the tone depends on the degree of pressure-contact of the sounders against the strings, and this is regulated by the extent of depressing the sounder-shafts, which extent is controlled by the position of the front bar of the rock-shaft or head 16 relative to the fingers 113 projecting horizontally over it from the respective armatures 13. Thus, when the D-shaped shaft 16 occupies its normally horizontal position, it does not obstruct the fingers 113, so that the sounders may be depressed for loud playing; but with that shaft turned to raise its front-bar in the path of these fingers, they obstruct depression of the armatures 13 and, therefore, that of the sounders, the extent of obstruction and consequently the degree of pressure-contact of the sounders against the

strings and of resultant loudness or softness of tone depending on the extent to which the said bar is elevated. The position of the bar is controlled by that of the armature 25, which, in its lowest position under attraction by its electromagnet 24, raises the front bar of the rocking shaft 16 to its highest position for staccato or spring-bow playing; and the extent of raising that bar is regulated by the position of the tongue 19 relative to the armature 25, so that when the free end of the tongue is in its most elevated position it does not disturb the head 16 from its normal position, and the lower the tongue the lighter will be the contact of the sounders with the strings. As will also be seen, when the magnet 24 is energized in a manner to vibrate its armature, the sounders play against the strings with a staccato effect, produced by the reversing mechanism hereinafter described; and the tongue may be moved to graduate the tones produced by the sounders, from louder to softer and softer to louder playing. The turning, referred to, of the rock-shaft 20 for actuating the tongue to regulate the expression in playing, is performed by solenoid-controlled mechanism hereinafter described.

An electric motor 26 rotates the sounder-shafts through the medium of reversing mechanism: The motor-shaft carries on one end a peripherally grooved pulley 27. On the back of the sounder-driving gear 11 are four projecting pins 28, disposed on the face of the gear in pairs, the members of which are diagonally opposite each other, as shown in Fig. 2a. For driving the gear 11 in one direction or the other, diagonally-opposite pins 28 are engaged by the arms presented by a small resilient metal bar 29 secured midway between its ends to the end of a shaft 30 to extend transversely thereof and between the four pins 28. The shaft 30 is journaled in bearings in a vertical yoke-like head 31 or frame on an arm 32 extending rearwardly and upwardly from the vertical member of the bracket 9 (Fig. 3), and it extends loosely through a frame 33 secured to the rear face of the head 31 and has confined about it between a collar 34 and the frame, a spiral spring 35 tending to retract the shaft. The shaft 30 also carries loosely upon it, in the head 31, two similar peripherally grooved pulleys 36 and 37 and has secured to it, between the pulleys, a friction-driving head 38, shown in the form of three arms terminating in disk-like heads 39, each faced on both sides with disks 40 of friction-material, such as leather (Fig. 4). In the frame 33 are supported, in horizontal position, the spools of an electromagnet 41, the armature 42 of which is pivotally fastened at one end to the frame to extend horizontally across the magnet-cores to engage, when attracted, with the rear headed end of the drive-shaft 30, which extends centrally between the magnet-spools lengthwise thereof. Pivotally hung on the frame 31 is a yoke 43 having a spiral-spring connection 44 with the bed of the motor 26 and carrying, adjacent to the pulleys 36, 37 but to extend transversely of their peripheries, a peripherally-grooved pulley 45. An endless drive-belt 46 is looped under the pulley 27, its side-sections are passed, respectively, over the pulleys 36 and 37, and it is looped under the pulley 45, being maintained taut by the spring 44; so that rotation of the motor-shaft drives the pulleys 36, 37. The spring 35 retracts the shaft 30 normally to engage the friction-head 38 with the pulley 37 and causes it to drive the shaft in one direction, and whenever the electromagnet 41 is energized the resultant attraction of the armature 42 engages it with the end of the shaft to move it lengthwise in opposition to the spring and shift the friction-head into engagement with the pulley 36, whereby the shaft is driven in the opposite direction. The shaft 30, by engagement of the bar 29 with either pair of diagonally-opposite pins 28, drives the gear 11 in one direction or the other, and changing the friction-head from one to the other of the pulleys 36, 37, instantaneously reverses the rotation of the sounders 7. In fact, the reversal would be too sudden if the drive-shaft were directly connected with the gear 11, so the connection therewith is made indirect through the medium of the pins 28 and spring-arms of the bar 29, to provide sufficient lost motion in reversing the shaft to permit the gear to stop momentarily while the shaft, in its initial reverse turning, disengages the arm 29 from one pair of the diagonally-opposite pins 28 and engages it with the other pair thereof.

The end of the motor-shaft opposite that on which the pulley 27 is provided carries a governor-device 47 (Fig. 2) of general S-shape, having curved spring-arms 47^1 terminating at their free ends in heads connected by links 48 at opposite sections of a longitudinally-split hub 49 surrounding the shaft-end. This governor is shown and described in United States Letters Patent No. 796,935 granted to me October 8, 1905. Adjacent to the governor is a frame 50, in which is journaled a rock-shaft 51 carrying on one end a flat brush 52 (Fig. 2) contacting with the split governor-hub to regulate the supply of electric current to the motor by rocking the shaft to vary, by tilting the brush, the extent of its surface-contact with the hub-surface.

An arm 53 rises from the rock-shaft 51 and has pivotally connected with its upper end one end of a horizontal longitudinally-reciprocating bar 54 provided on one face

with adjacent spring contact-fingers 55 and 56 to engage respectively with contact-studs 57 and 58 in their path. On a bed 59 (Fig. 5) adjacent to the sounder-driving motor 26 are supported in alinement with each other, but spaced apart at their opposing ends, two solenoids 60 having a common core 61 with which, in the space between the coils, the opposite end of the bar 54 is connected by a finger 62 rigidly depending from a head 63 on that end of the bar, from opposite sides of which head spiral springs 64 and 65 connect it, and thus the reciprocating bar 54, with the ends of the stationary frame on the bed upon which the solenoid-coils are supported. A support 66, which may be a pair of vertical arms connected at their upper ends by a cross-bar, rises from the bed 59 to extend adjacent to and parallel with the solenoids, and has a bell-crank 67 fulcrumed at its angle thereon, one arm of the bell-crank being pivotally connected with the reciprocating bar 54, and the other arm being pivotally connected with one end of a horizontal link 68 having its opposite end connected with the lower end of a crank-arm 69 depending from the sounder-controlling rock-shaft 20.

A resistance coil 70 is supported adjacent to the contact-studs 57, 58. The support carries in alinement with each other, with a space 71 (Fig. 5) between their adjacent pole-ends, two electromagnets 72 and 73 with a common armature 74 on a leaf-spring 75 rising from the bed 59 to support the armature oscillatorily in the space 71, adjacent to which rises a contact-post 76 in the path of a curved contact-finger 77 (Fig. 1) projecting from the armature.

The wire-connections from the source of electric-current supply with the described mechanisms requiring to be energized, and which are shown in the circuit-diagram illustrated in Fig. 6, and hereinafter described, are made at binding posts 84 on the bed 59, which is of insulating material. The springs 64, 65 tend to retain the solenoid-core and bell-crank 67 in their normal positions, whereby the tongue 19 is maintained normally in its horizontal position. By energizing one solenoid to move the core in one direction, as toward the right in Fig. 5, it moves the bar 54 lengthwise to turn the bell-crank to pull the link 68 and actuate the crank-arm 69 to depress the tongue 19 to obstruct more or less the rise of the finger 18, thereby diminishing the extent of pressure of the sounders against the strings; and energizing the other solenoid to produce movement of the solenoid-core, and with it the arm 54, in the opposite direction causes the bell-crank to turn the rock-shaft 20 in the direction to raise the sounder-controlling tongue. In these reciprocating movements of the bar 54, it may make and break contact between the finger 55 and stud 57, by the movement of the bar in one direction, and between the finger 56 and stud 58 by the opposite movement of the bar; and these movements of the bar by the solenoids also rock the shaft 51 to vary the extent of surface-engagement of the brush 52 with the governor-hub 49 and thereby increase or reduce the speed of the motor. The governor performs this function by expanding its hub with resultant contraction of its arms, for more current, and contracting its hub for less current by resultant expansion of its arms.

As will be understood, to increase the loudness of playing, the sounders, under their described control by the solenoids, are depressed more or less hard against the strings; but whenever a sounder is so depressed its speed of rotation must be increased to prevent it from "scratching" against its respective violin-string. It then becomes necessary to increase the motor-speed. The primary medium through which the described expression-mechanisms are actuated is, of course, a traveling music-sheet (not shown), preferably of the perforated variety, which is fed across a contact-roller, forming one terminal of an electric circuit containing branches, of which the terminals are contact-brushes adjacent to the roller to make contact therewith through the perforations in the sheet for closing the circuit to actuate the playing mechanism according to the arrangement of the perforations; all as set forth in said first-named patent. For present purposes the diagram of Fig. 6 shows the contact roller 78 with brushes 79, 80, 81, 82 and 83 forming the terminals, to contact with the roller, of only four branches of the electric circuit which contains the sounder-driving motor 26.

The motor-field circuit is traceable on the positive line-wire w to the wire w^2 and thence by wires w^3 and w^4 to the return or negative line-wire w^1. The armature circuit, forming a branch of the field-circuit, is traceable on the wire w, the wire w^2 (one end of which connects with the roller 78 and the other with one of the motor-brushes), wire w^5 leading from the other motor-brush, to the contact-post 76, with a branch w^6 forming a return-wire from the governor 47. From the post 76 the armature-circuit continues on the contact-finger 77, armature-carrying spring 75 and wire w^7 to the finger 62 on the reciprocating bar 54 and to the return-wire w^1. One solenoid-circuit is traceable on the bar 54, spring 55, stud 57, wire w^8 to one solenoid 60, and wire w^9 leading from that solenoid and terminating in the contact-brush 82. The other solenoid-circuit is traceable on a wire w^{10} leading from the opposite solenoid and terminating in the contact-brush 79, spring 56

and stud 58 to wire w^{11} having one end connected with the other solenoid and its opposite end connected with one terminal of the resistance-coil 70, which is connected at its opposite terminal, by a wire w^{12}, with the wire w^8. The electromagnets 72 and 73 are connected by a wire w^{13} branching from the wire w^7; and wires w^{14} and w^{15} connect the cores of these magnets respectively to the wires w^{11} and w^8. A wire w^{16} leading from the magnet 72 terminates in the contact-brush 80, and a wire w^{17} leading from the magnet 73 terminates in the contact-brush 81.

The reversing magnet 41 is included in circuit with the roller 78 by a wire w^{18} leading from the wire w^1 to one spool of that magnet and a wire w^{19} leading from the other spool and terminating in the contact-brush 83. With current on and driving the motor 26 to rotate the sounders, each time a perforation in the music-sheet registers with the brush 83, the magnet 41 will be energized to attract its armature 42, causing the latter to move the rotating shaft 30 forward to engage the friction-head 39 with the pulley 36 and rotate the sounders accordingly; and when that perforation clears the said brush, thereby deënergizing the magnet 41, the spring 35 retracts the shaft to disengage the friction-head from the pulley 36 and engage it with the pulley 37 to reverse the sounders.

Each time a perforation in the music-sheet registers with the brush 79, by resultant contact of the latter with the roller 78, one solenoid-circuit is closed over wire w^{10} through the solenoid 60 to which that wire leads and thence to the return wire w^{11}, stud 58, spring 56 and bar 54, and thence over wire w^7 to line wire w^1. The resultant energizing of the respective solenoid moves the core and with it the bar 54 toward the right (Fig. 6) thereby turning the bell-crank 67 and with it, through the link 68 and crank-arm 69, the rock-shaft 20 to raise the tongue 19, so that the armature 13 of the particular sounder-magnet 14 that is energized in the playing may be depressed for louder playing; and such louder playing is accompanied by the required increased speed in the rotation of the sounder, since the described movement of the bar 54 turns the rock-shaft 51 to augment the extent of surface-contact of the brush 52 with the governor-hub 49 to increase the supply of current to the motor and augment its speed.

Whenever a perforation in the traveling music-sheet permits the brush 82 to contact with the roller 78, the other solenoid-circuit is closed over the wire w^9 through the solenoid 60 to which it leads, thence over wire w^8 through stud 57 to spring 55, bar 54, finger 62 and over wire w^7 to line-wire w. The resultant energizing of the respective solenoid moves the core and with it the bar 54 toward the left (Fig. 6), thereby turning the bell-crank 67 and rock-shaft 20 to depress the tongue 19 and limit the extent of depression of the particular sounder-magnet energized, to produce softer playing; and such softer playing is accompanied by slower rotation of the sounder, since the movement of the bar so turns the rock-shaft 51 as to decrease the extent of surface-contact of the brush 52 with the governor-hub.

The normal extent to which a solenoid moves the bar 54 in either direction is just sufficient to cause a contacting part of the bent spring 55 or 56 to clear its respective stud 57 or 58 and open the respective solenoid-circuit; the purpose being to so produce the expression in playing that the louder and softer effects shall be moderate and variation from one to the other gradual.

Very loud playing ensues when the brush 80 contacts with the roller through a music-sheet perforation, since thereby the magnet 72 is energized by closure of the circuit over wire w^{16} through that magnet over wires w^{13} and w^7 to line-wire w^1. Thus energizing the magnet 72 attracts the armature 74 to engage the contact-finger 77 with the post 76 and close the motor-circuit over wire w^5, through the armature to wire w^2 and line-wire w, thereby throwing the full current from the line into the motor to instantaneously speed it to its limit. By the attraction of the armature 74 it makes contact with the core of the magnet 72, which is connected with wire w^{14}, whereby the circuit is closed through the respective solenoid with the result of throwing into the latter the full current from the line and moving the bar 54 toward the right to its full limit of movement and thereby causing the consequent abnormally-great movement of the bell-crank 67 to raise the tongue 19 to its greatest height and permit full pressure of any playing sounder against its string.

Very soft playing ensues when the brushes 81 and 82 contact with the roller through perforations in the music-sheet, since thereby the magnet 73 is energized by the resultant circuit closure over wires w^{17}, w^{13} and w^7 to line-wire w^1. By thus energizing the magnet 73 and attracting the armature 74 the current flows over wires w^8 and w^{15}, through the core of that magnet and the armature, over wire w^7 to line-wire w^1, thus throwing the full line-current into the left-hand solenoid and moving the core and the bar 54 toward the left to their limit of movement, with the result of turning the bell-crank so far as to cause it to effect depression of the tongue 19 to its limit of depression and produce the lightest sounder-pressure against the strings. The purpose of the resistance-coil 70 is to prevent sparking when separation takes place between a

spring 55 or 56 and its respective stud 57 or 58, since the connection between the wires w^8 and w^{12}, and w^{11} prevents all of the current from being cut out of the solenoid by each separation.

It will be noted that the motor 26 is used solely for driving the sounders, thus differing from said former patent for the violin-player, wherein the motor which rotates the sounders also drives the music-sheet feeding-mechanism. This departure is an important feature of improvement inasmuch as it permits the expression-controlling mechanism to be simplified, as it is by the described construction and arrangement thereof, besides affording compactness to the mechanism by enabling it all to be housed in the one compartment containing the violin, as will be understood by reference to said patent, with the further advantage of rendering it readily accessible. This compartment is indicated in Fig. 2 by the line 85.

The term "violin" employed in the foregoing description and in the appended claims is intended to include all string-instruments of the viol class.

What I claim as new and desire to secure by Letters Patent is—

1. In an electric self-playing violin, the combination with the rotary sounders, of a motor for solely driving them, electric mechanism for moving the sounders relatively to the strings of the instrument, electric expression-controlling mechanisms for the sounders, all of said mechanisms being housed in the same compartment with said motor and sounders controlling mechanism located extraneously of said compartment and means connecting said last mentioned controlling mechanism with the sounder moving and controlling mechanism in the housing.

2. In an electric self-playing violin, the combination with the rotary sounders, of a motor for solely driving them, electric mechanism for moving the sounders relatively to the strings of the instrument, electromagnet-controlled mechanism for reversing the rotation of the sounders, solenoid-controlled mechanism constructed and arranged to regulate the extent of said movement of the sounders, all of said mechanisms being housed in the same compartment with said motor and sounders, controlling mechanism located extraneously of said compartment and means connecting said last mentioned controlling mechanism with the sounder moving and controlling mechanism in the housing.

3. An electric self-playing violin comprising rotary sounders, a motor for solely driving them, electric mechanism for moving the sounders relatively to the strings of the instrument, electric expression-controlling mechanisms for the sounders, all of said mechanisms being housed in the same compartment with said motor and sounders, and means whereby said sounder moving and controlling mechanism may be controlled extraneously of the housing.

4. In an electric self-playing violin the combination with rotary shafts having sounders on their advance-ends, one for each string, of gears on the opposite ends of said shafts intermeshing in pairs, a drive-gear meshing with the inner members of said pairs, a longitudinally-movable spring-retracted rotary drive-shaft engageable at its forward end, by movement against the resistance of its retracting-spring, with the drive-gear, a reversible friction-drive device on the drive-shaft, an electric circuit, a motor in said circuit geared to the drive-shaft, and an electromagnet in said circuit having its armature engageable with the drive-shaft in opposition to its retracting-spring, for the purpose set forth.

5. In an electric self-playing violin the combination with rotary shafts having sounders on their advance-ends, one for each string, of gears on the opposite ends of said shafts intermeshing in pairs, a drive-gear meshing with the inner members of said pairs and provided with pins on its rear face forming pairs with the members of each pair diagonally opposite each other, a longitudinally movable spring-retracted rotary drive-shaft provided on its advance-end with arms to engage said pins, a reversible friction-drive device on the drive-shaft, an electric circuit, a motor in said circuit geared to the drive-shaft, and an electromagnet in said circuit having its armature engageable with the drive-shaft in opposition to its retracting-spring, for the purpose set forth.

6. In an electric self-playing violin the combination with rotary shafts having sounders on their advance-ends, one for each string, of gears on the opposite ends of said shafts intermeshing in pairs, a drive-gear meshing with the inner members of said pairs, a longitudinally-movable spring-retracted rotary drive-shaft engageable at its forward end with the drive-gear, a motor with its shaft extending at right-angles to said drive-shaft, a pair of belt-pulleys loosely supported on said drive-shaft, and a friction-head secured thereon between said pulleys, a spring-pressed belt-pulley adjacent to said loose pulleys, an endless drive-belt looped about said motor-shaft and spring-pressed pulleys and passing over said loose pulleys, and means engaging with said spring-retracted shaft to move it in opposition to its retracting-spring, for the purpose set forth.

7. In an electric self-playing violin, the combination with the rotary sounders, of an electric motor for driving them, electric

mechanism for moving the sounders relative to the strings of the instrument, electric expression mechanism for regulating the extent of said movement of the sounders, comprising a pair of solenoids having a common core, a bar connected with said core to reciprocate with it, and connections between the bar and said regulating mechanism for controlling the latter by the action of the solenoids, an electric governor on the motor-shaft, a contact-roller and contact-brushes engaging therewith, and an electric circuit having branches containing said motor, said sounder-moving and expression mechanisms and said governor, for the purpose set forth.

8. In an electric self-playing violin, the combination with the rotary sounders, of an electric motor for driving them, electric mechanism for moving the sounders relative to the strings of the instrument, electric expression-mechanism for regulating the extent of said movement of the sounders, an electric governor on the motor-shaft, a pair of electromagnets having a common oscillatory armature, a contact-finger on said armature, a contact-post adjacent to said finger, and an electric circuit having branches containing said motor, said sound-moving and expression-regulating mechanisms and said governor, for the purpose set forth.

9. In an electric self-playing violin, the combination with the rotary sounders, of an electric motor for driving them, an electric circuit containing said motor, a pair of electromagnets having reciprocating armatures connected with the sounder-shafts for raising and lowering the sounders relative to the strings, fingers extending from the armatures, a rocking head extending into the path of said fingers, a finger extending rearwardly from said head, a second electromagnet having a reciprocating armature with which said finger is connected, a rock-shaft carrying a tongue extending at its free end into the path of said finger, and solenoid-controlled mechanism included in branches of said circuit and connected with said rock-shaft for actuating the tongue thereon, for the purpose set forth.

10. In an electric self-playing violin, the combination with the rotary sounders, of an electric motor for driving them, electric mechanism for moving the sounders relative to the strings of the instrument, a rocking-head coöperating with said mechanism to regulate the extent of movement of the sounders, a finger extending from said head, an electromagnet having a reciprocating armature with which said finger is connected, a rock-shaft, a tongue on the rock-shaft extending into the path of said finger, a bell-crank having one arm connected with the rock-shaft, a longitudinally reciprocating bar with which the other arm of the bell-crank is connected, a pair of solenoids having a common core with which said bar is connected, contact-springs on the bar and contact-studs in the path of said springs, an electric governor on the motor-shaft, a contact-brush coöperating with the governor, a second rock-shaft connected with the governor-brush and said bar, a pair of electromagnets having a common oscillatory armature with a contact-finger thereon, a contact-post in the path of said finger, a contact-roller and contact-brushes engaging therewith, and an electric circuit having branches containing the motor and its governor and said electromagnets and solenoid, for the purpose set forth.

HENRY K. SANDELL.

In the presence of—
J. G. ANDERSON,
R. A. SCHAEFER.