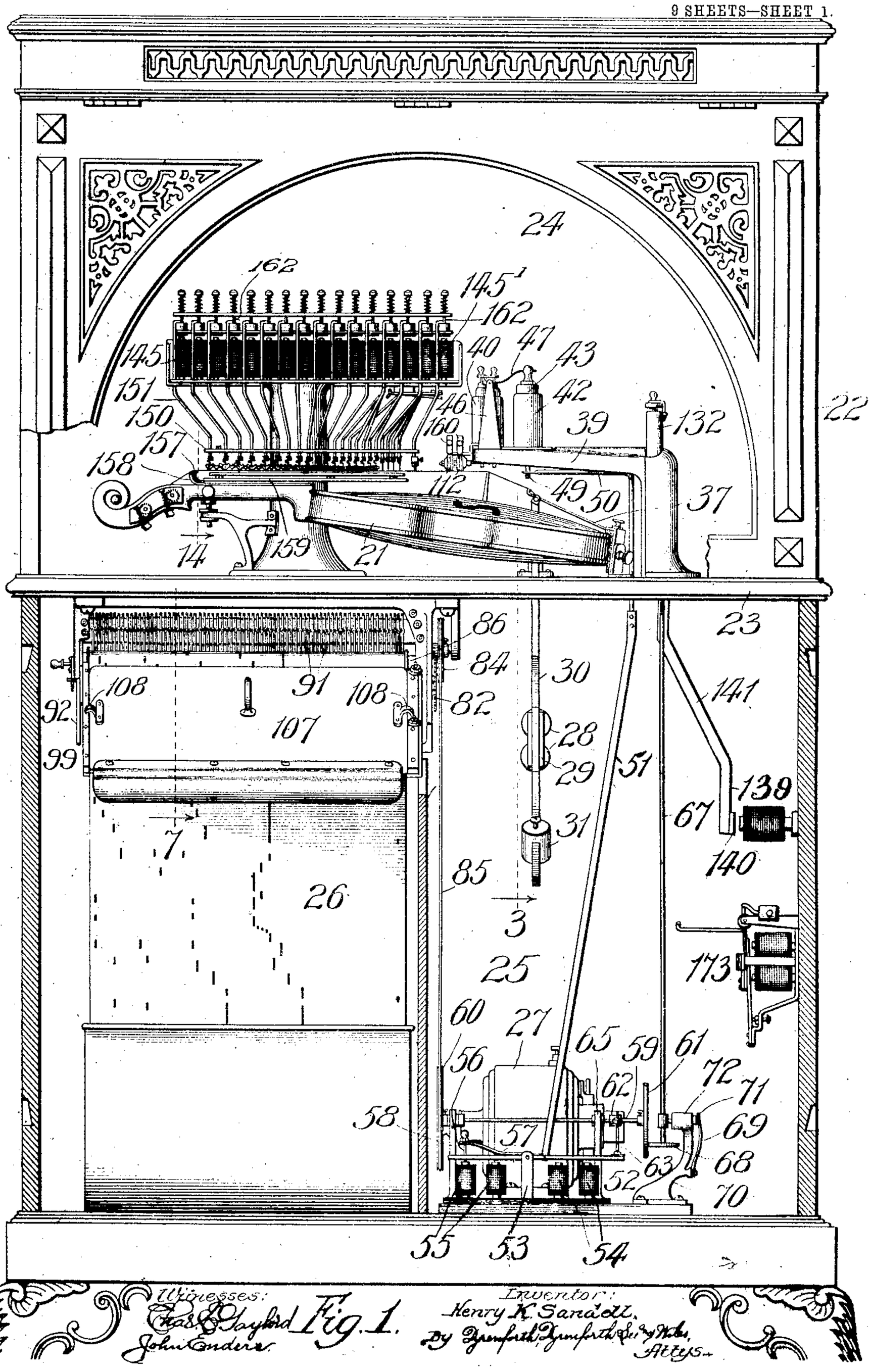
No. 855,021. PATENTED MAY 28, 1907.

H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 1.



Witnesses:
Chas. L. Gaylord
John Enders

Fig. 1.

Inventor:
Henry K. Sandell.
By Dumforth, Dumforth & Dumforth, Atty's.

No. 855,021. PATENTED MAY 28, 1907.

H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 2.

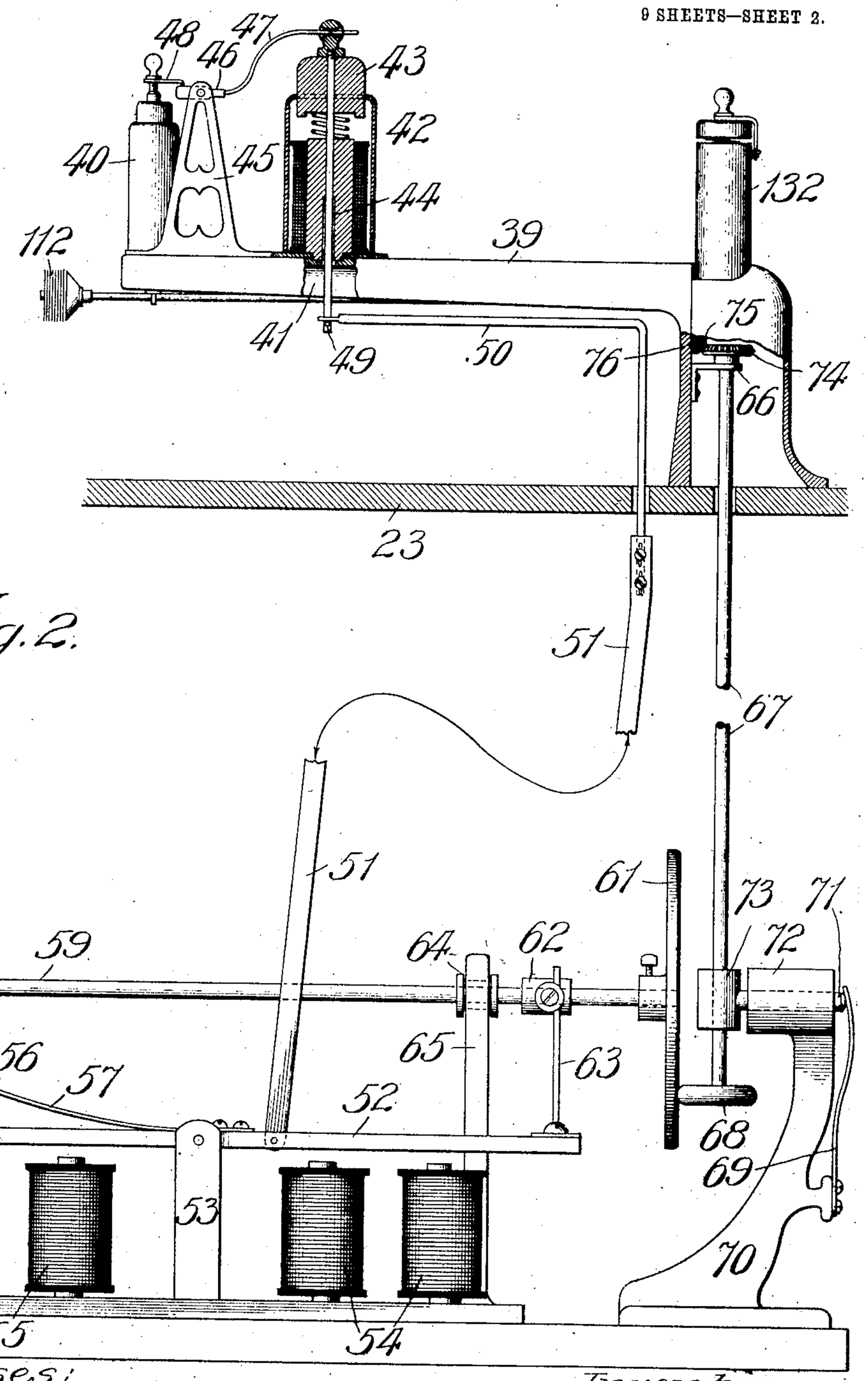


Fig. 2.

Witnesses:
Chas. E. Taylord.
John Endres.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles,
Attys.

No. 855,021. PATENTED MAY 28, 1907.

H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 3.

Fig. 15.

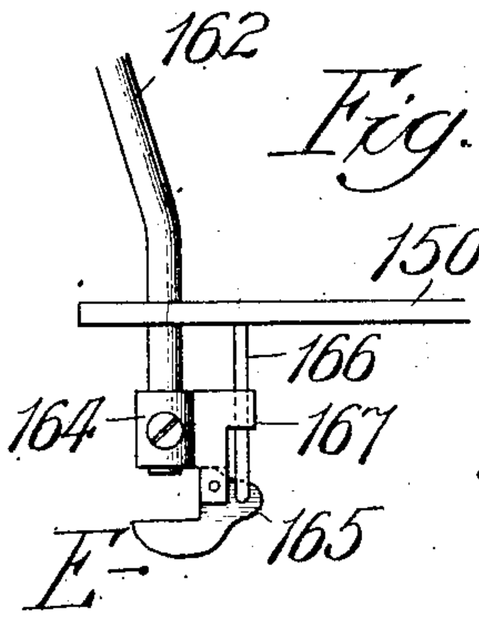


Fig. 4.

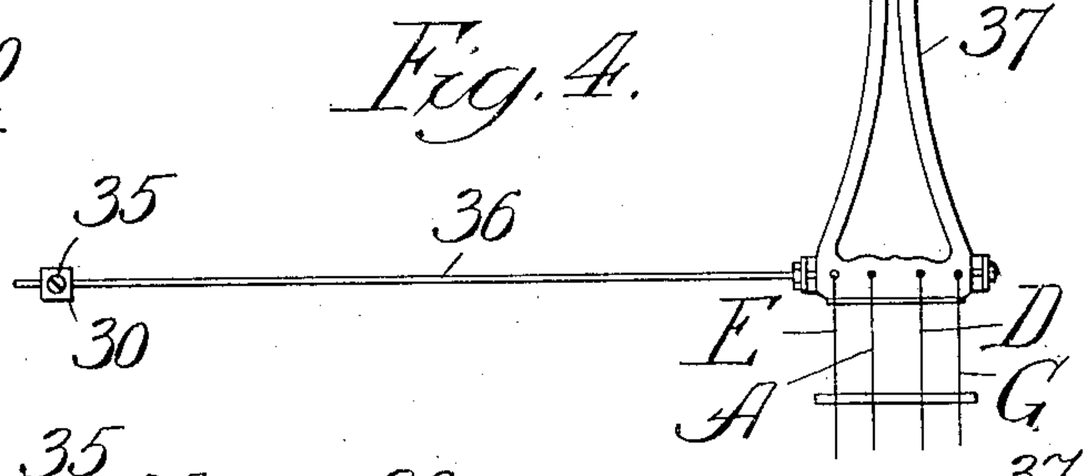


Fig. 3.

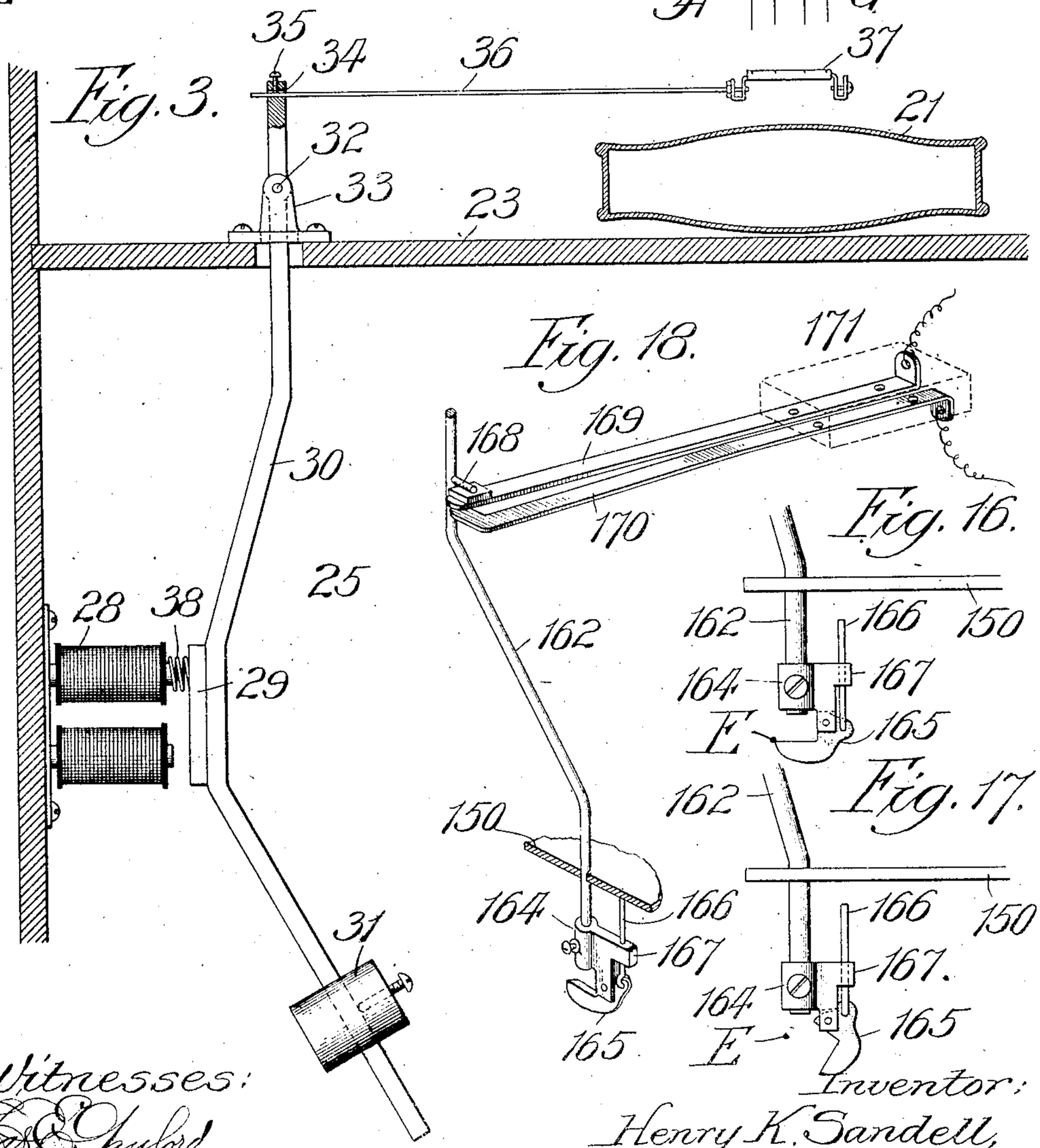


Fig. 18.

Fig. 16.

Fig. 17.

Witnesses:
Chas. E. Taylord.
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wells.
Attys.

No. 855,021. PATENTED MAY 28, 1907.

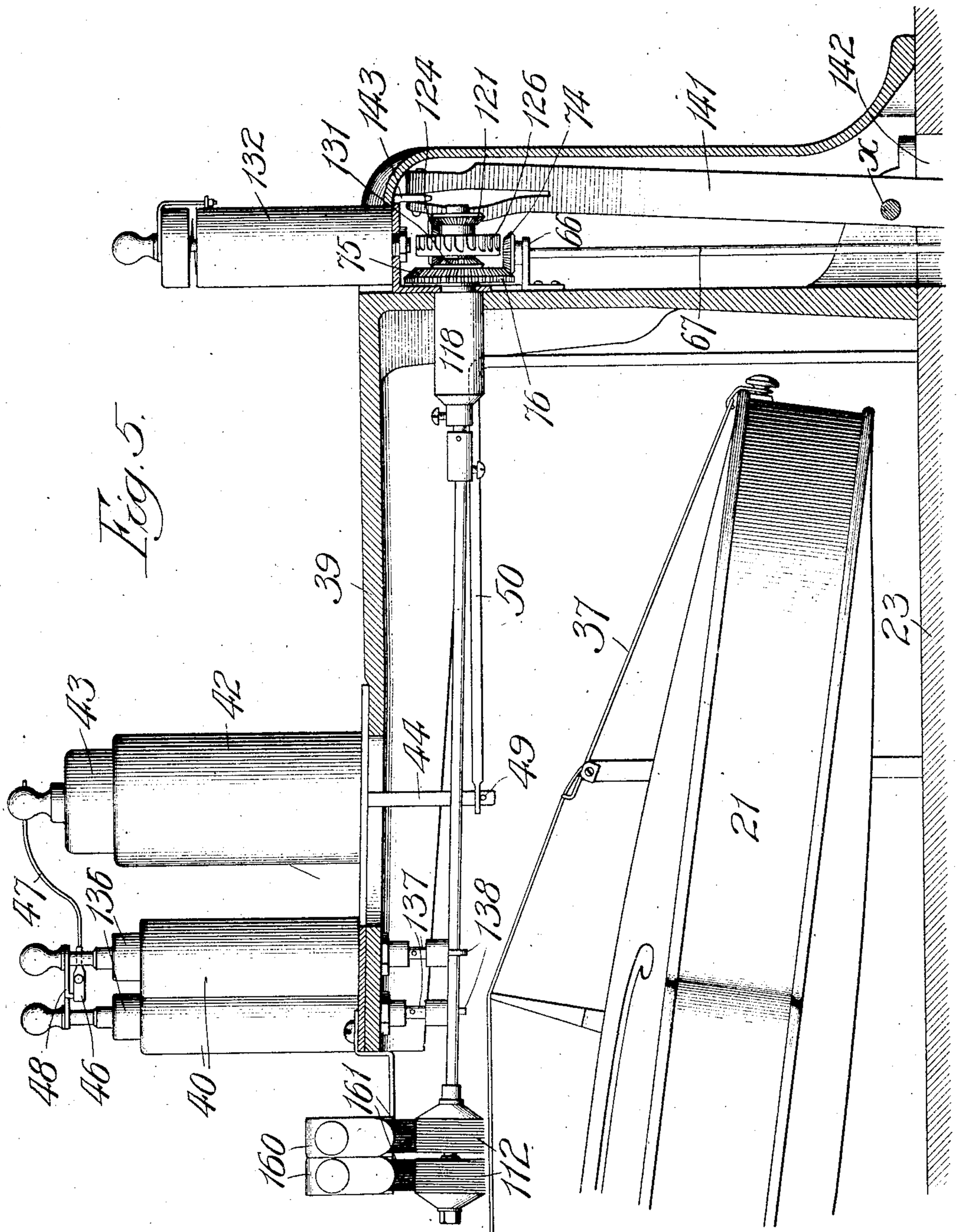
H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 4.

Fig. 5.



Witnesses:
Chas. E. Gaylord.
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles,
Attys.

No. 855,021. PATENTED MAY 28, 1907.

H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 5.

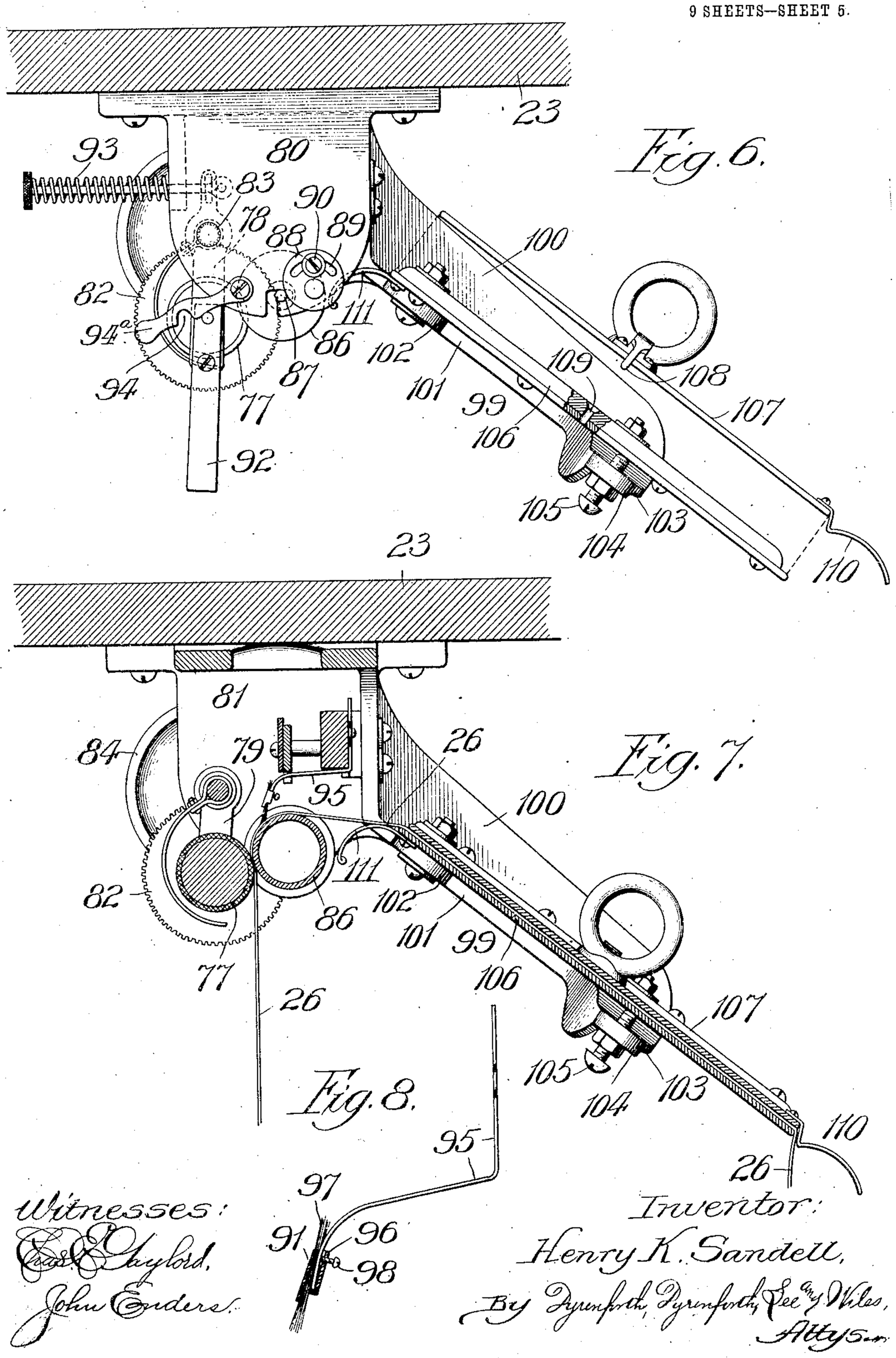


Fig. 6.

Fig. 7.

Fig. 8.

Witnesses:
Chas. L. Gaylord.
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles,
Attys.

No. 855,021. PATENTED MAY 28, 1907.

H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 6.

Fig. 10.

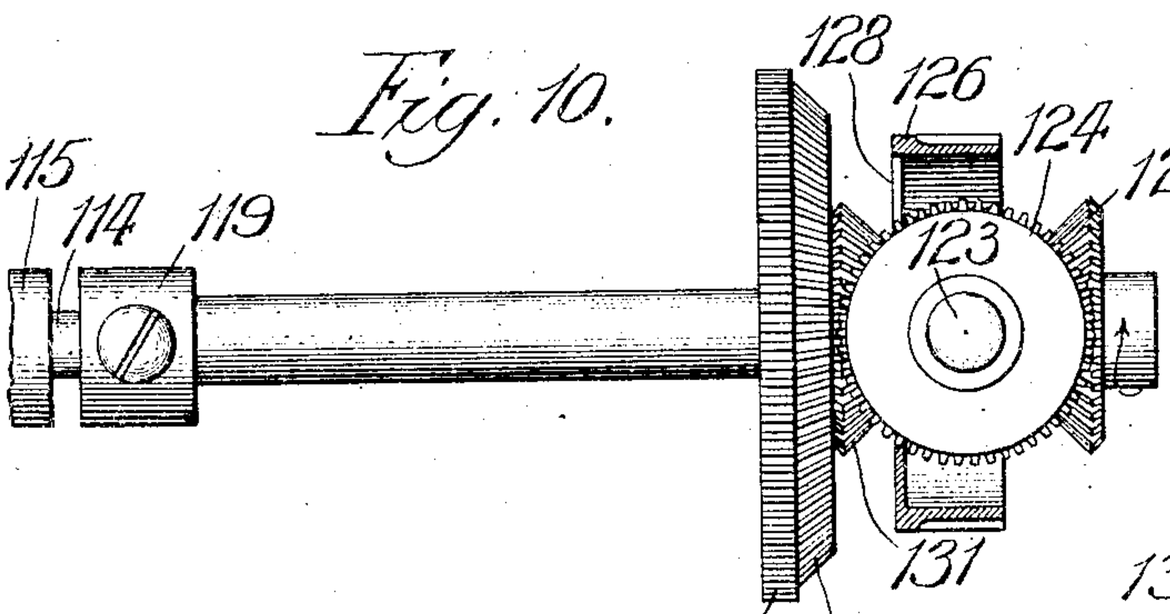


Fig. 11.

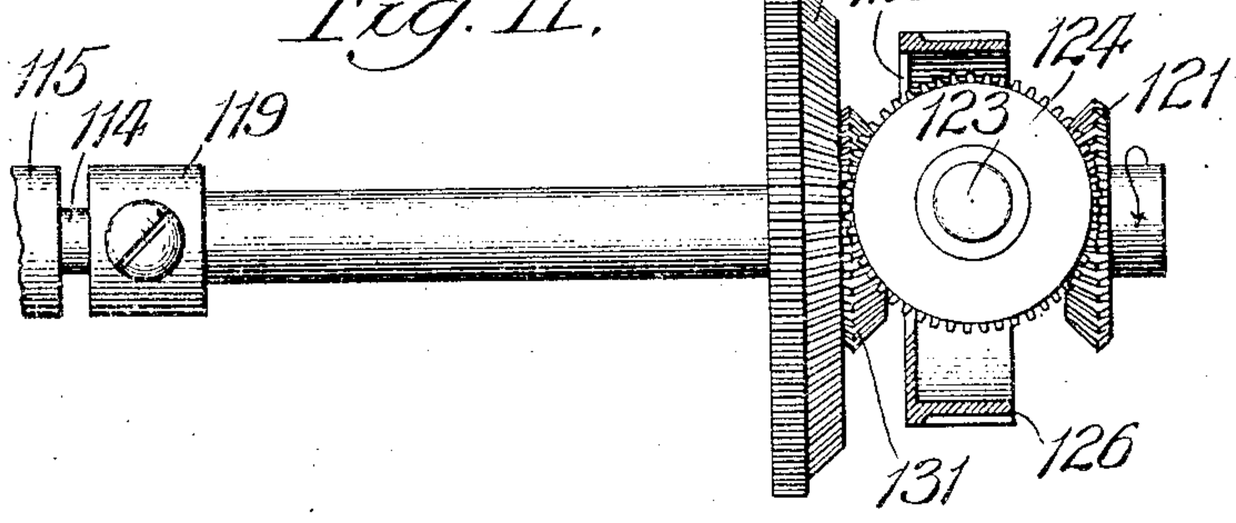


Fig. 9.

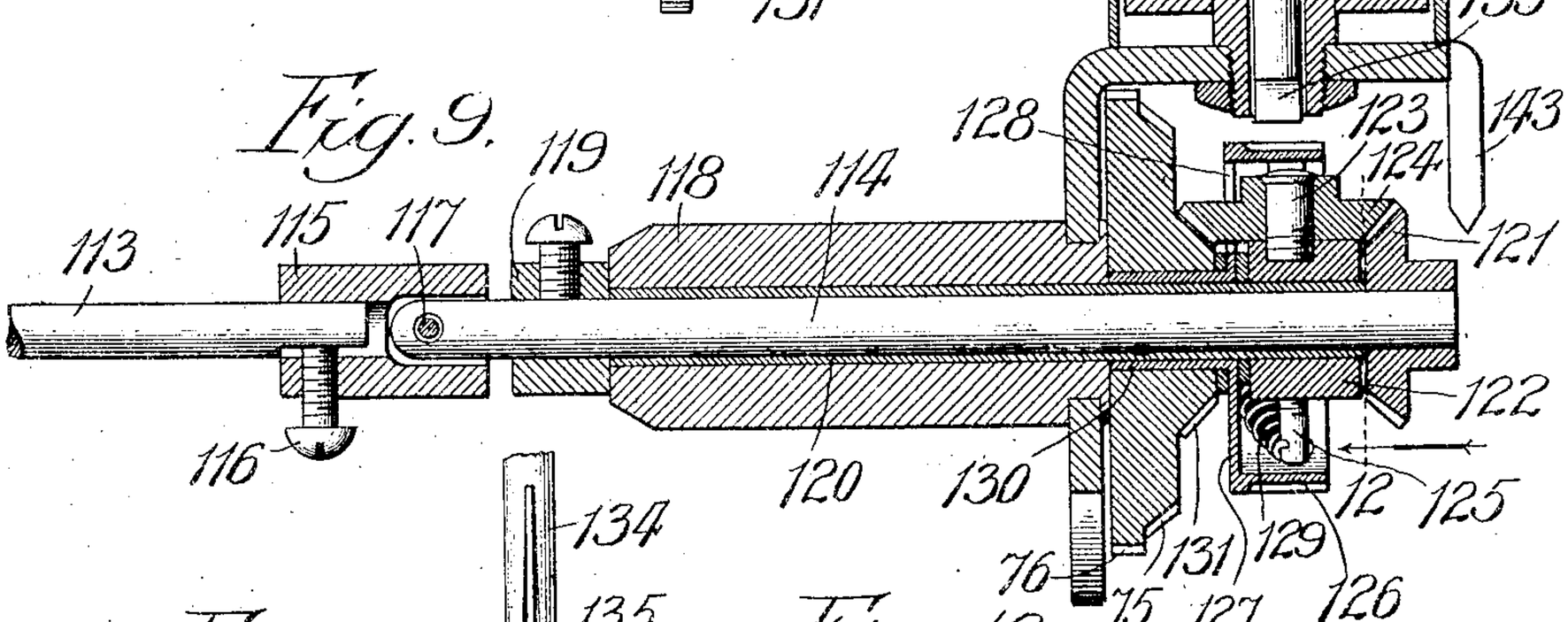


Fig. 12.

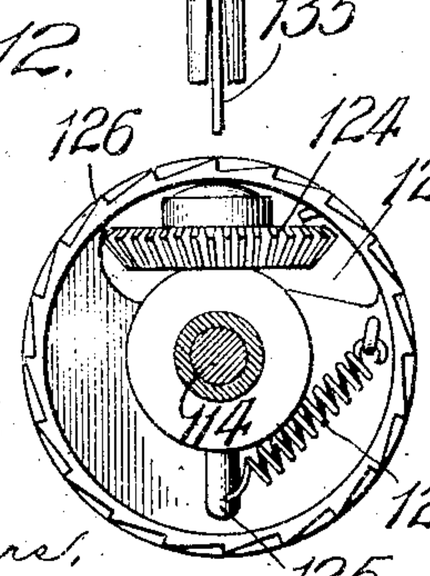
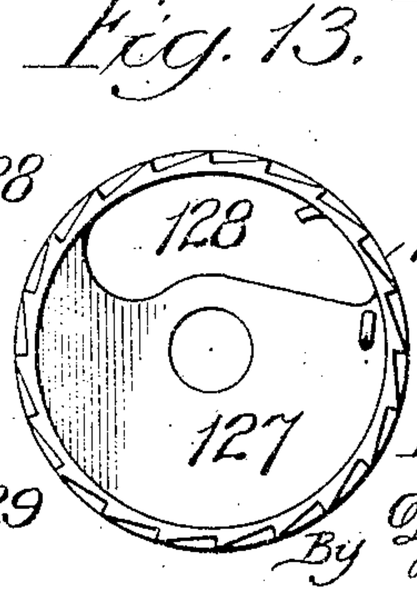


Fig. 13.



Witnesses:
E. F. Gaylord,
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles,
Attys.

No. 855,021. PATENTED MAY 28, 1907.

H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 7.

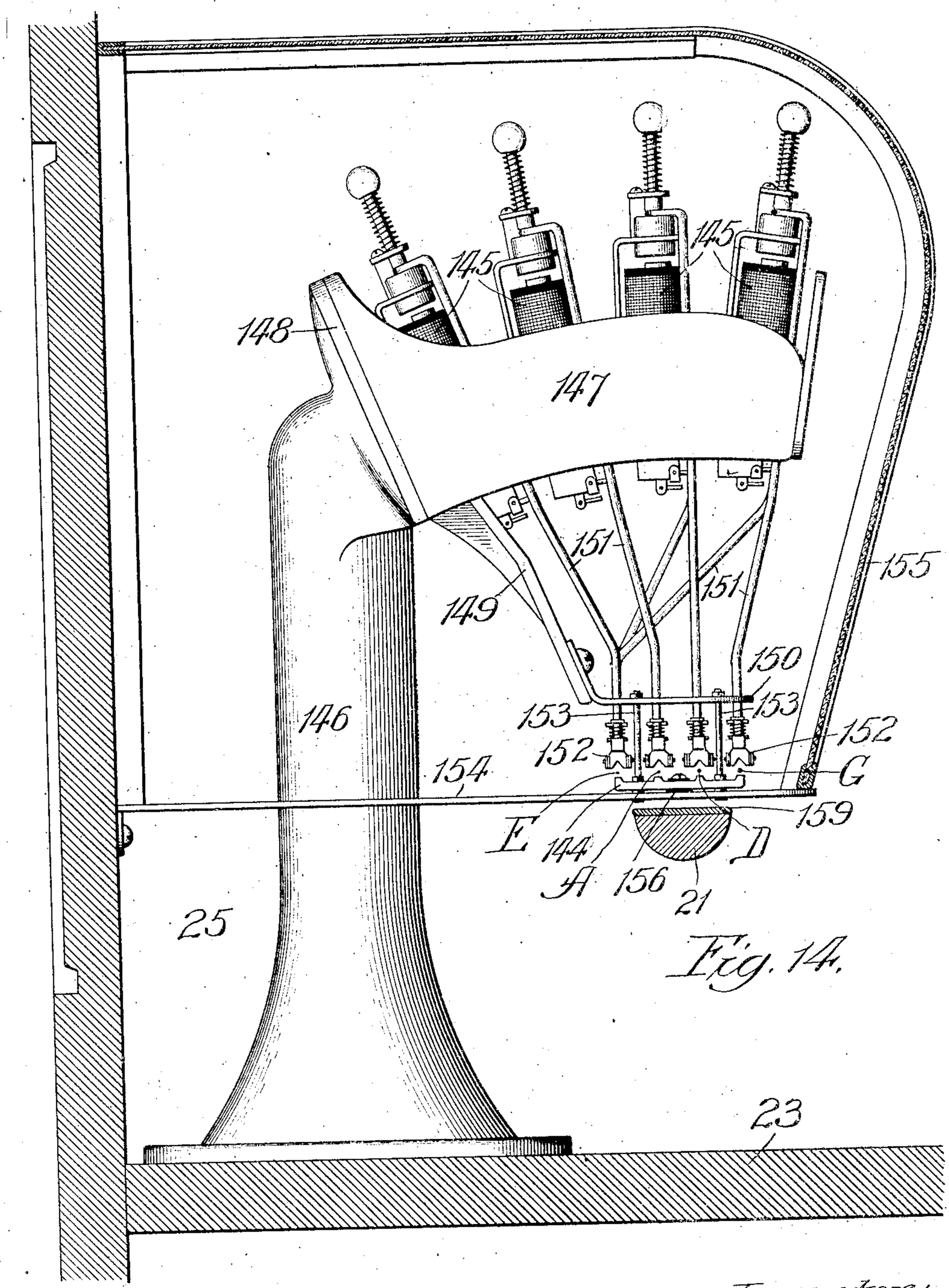


Fig. 14.

Witnesses:
Chas. E. Gaylord.
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles
Attys.

No. 855,021. PATENTED MAY 28, 1907.

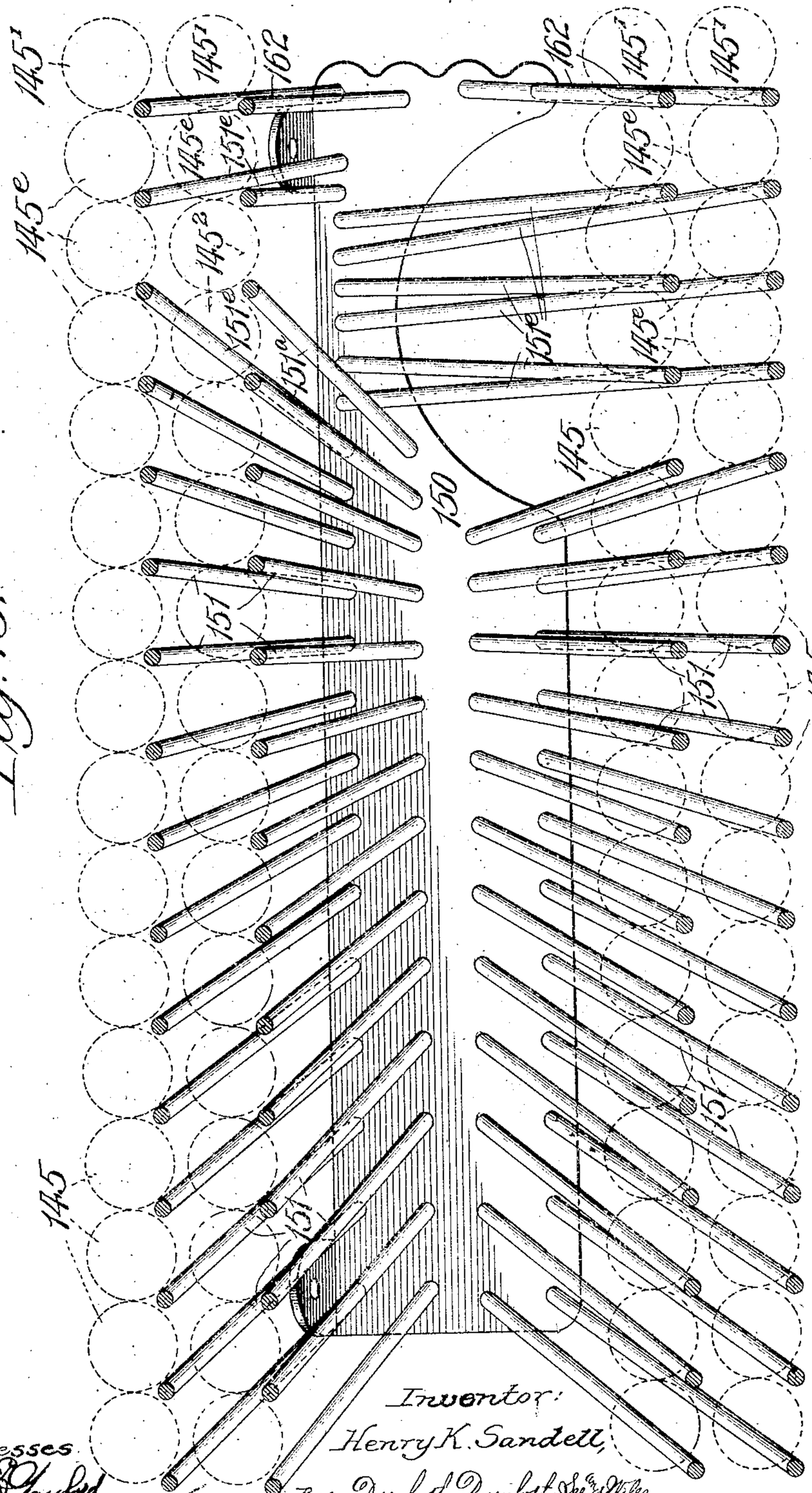
H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

9 SHEETS—SHEET 8.

Fig. 19.



Witnesses
Chas. E. Gaylord.
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles,
Attys.

No. 855,021. PATENTED MAY 28, 1907.

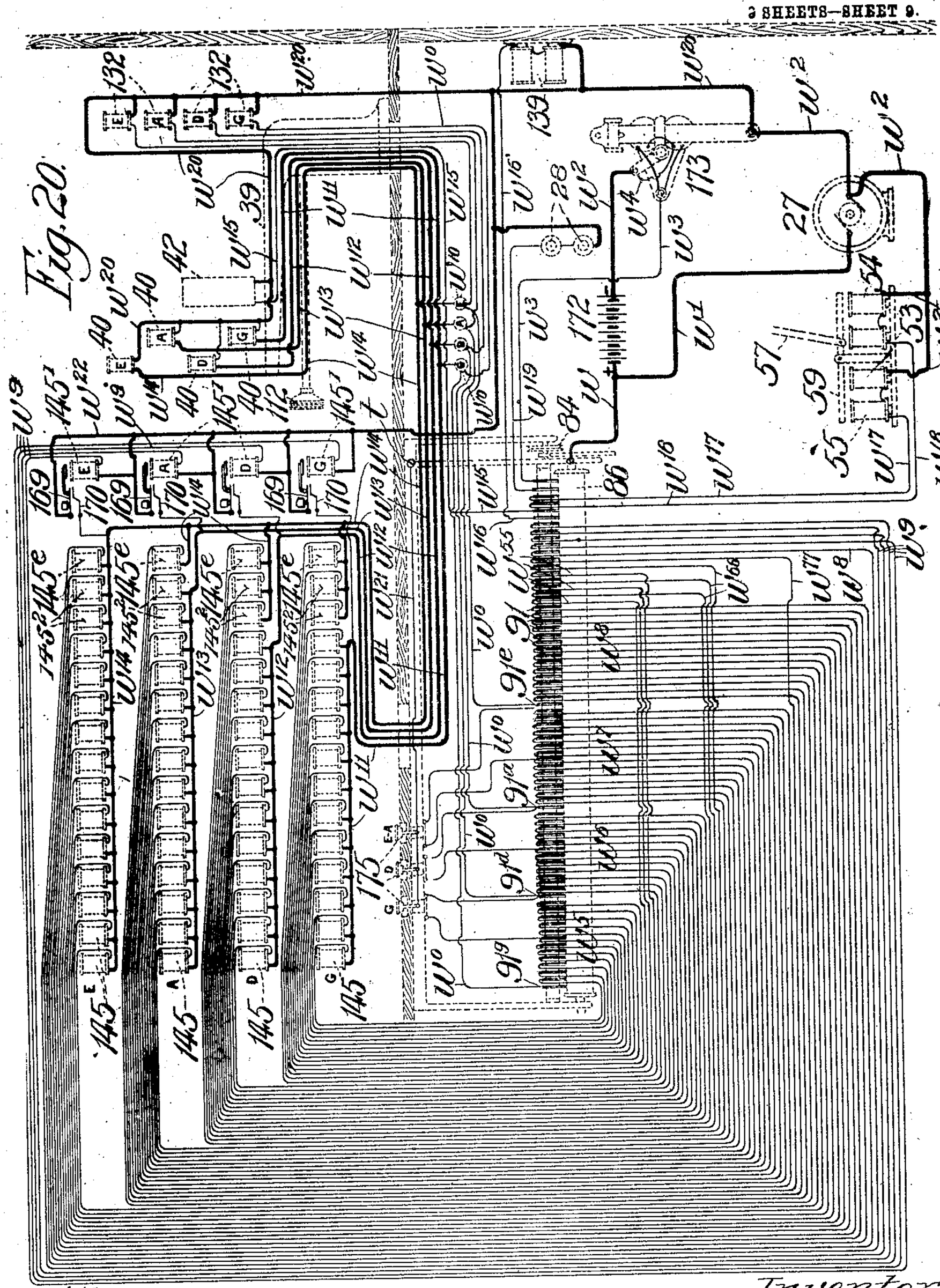
H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED OCT. 29, 1906.

3 SHEETS—SHEET 9.

Fig. 20.



Witnesses:
E. L. Gaylord.
John Endere.

Inventor.
Henry K. Sandell,
By Dyrenforth, Dyrenforth, Lee & Wiles,
Attys.

UNITED STATES PATENT OFFICE.

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

ELECTRIC SELF-PLAYING VIOLIN.

No. 855,021. Specification of Letters Patent. Patented May 28, 1907.

Application filed October 29, 1906. Serial No. 341,060.

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.

This invention relates, primarily, to improvements in the self-playing musical string-instrument which forms the subject of United States Letters Patent No. 807,871, dated December 19, 1905; and the object is to improve the mechanical playing of the instrument by causing it to resemble more closely human playing thereof.

Referring to the accompanying drawings—Figure 1 shows the entire machine by a view in front elevation; Fig. 2 is an enlarged broken view in elevation, partly sectional, showing means for automatically varying the speed of rotation of a sounder-shaft in accordance with variations in the pressure of the sounder against its string; Fig. 3, a similar view of means for shaking the strings of the instrument to produce the vibrato effect in playing; Fig. 4, a broken plan view showing details of the mechanism represented in Fig. 3; Fig. 5, an enlarged broken view in longitudinal sectional elevation, showing the rear portion of the violin and the playing mechanism that co-operates therewith, including the sounder-reversing device; Fig. 6 shows the construction of the guide-table for the perforated music-sheet, by an edge-view, partly broken, and the sheet-feed with its adjusting mechanism, in end elevation, and Fig. 7 is a section of the same taken at the line 7 on Fig. 1, viewed in the direction of the arrow and enlarged; Fig. 8 is a sectional view showing the preferred form of contact-device; Fig. 9, a broken enlarged view of the reversing device, including its controlling electro-magnet, in sectional elevation; Fig. 10, a broken view showing the reversing device in elevation, partly sectional, but omitting the electro-magnet, and representing the device in its normally locked condition; Fig. 11, a similar view of the same, but showing the device in its unlocked reversing condition; Fig. 12, a section taken at the line 12 on Fig. 9 and viewed in the direction of the arrow; Fig. 13, a face-view of the ratchet-element of the reversing device; Fig. 14, a section taken at the line 14 on Fig. 1, viewed in the direction of the arrow and enlarged; Fig. 15 (Sheet 3), a broken view showing a picker-device in elevation in its normal condition relative to a string; Fig. 16, a similar view of the same in its condition of partial depression, wherein it is engaging the string; Fig. 17, a similar view of the same in its condition of complete depression after sounding the string, and Fig. 18, a perspective view of the same showing a supplemental circuit opening and closing device with which it is equipped; Fig. 19, a plan diagram of the perforate guide-plate for the rods which terminate in the fingering and picker-devices, and showing dotted the electro-magnets which actuate the rods; and Fig. 20 is a diagram illustrating the electric circuit and its branches containing the operating mechanisms of the machine.

At 21 is represented a violin contained in a suitable casing 22 and supported therein on a partition 23 dividing the casing into an upper compartment 24, inclosing the instrument and the fingering and sounding devices for playing it, and a lower compartment 25, housing the perforated music-sheet 26 and its feeding and guiding mechanism, and a motor 27 for driving the feed and the rotatory sounder-shafts, all generally as disclosed in said former patent.

Of the playing mechanisms of the machine, the rotatory sounders with the electro-magnets for raising and depressing them relative to the strings, and the electro-magnet-actuated fingering devices, as also the feeding mechanism for and the circuit-closing action of the perforated music-sheet, may be, as shown in the drawings, generally the same as those of said former patent and need not, therefore, be described herein in detail.

The several mechanisms hereinafter described are, for the most part, designed to contribute to enhancement of the similarity of the playing of the instrument to human violin playing. One of the more important adjuncts to this end is a device for producing, at proper times, the vibrato effect which the human player produces by vibrating his finger against the string which is under depression; and means for this purpose are most clearly illustrated in Figs. 3 and 4; in the compartment 25 is fastened on a wall of the casing an electro-magnet 28, the armature 29 of which is vibratorily carried by a bent lever 30 provided on its lower end with an adjust-

able weight 31 and passing through an opening in the partition 23, above which it is pendulously hung from a fulcrum, at 32, on a support 33 upon the partition. The upper end of this lever contains a transverse opening 34, in which is adjustably confined, by a set-screw 35, one end of a rod 36, which extends toward the tail-piece 37 of the violin and has its other end adjustably connected therewith. The connection with the rear end of the violin of the tail-piece, in the usual manner, adapts it to be deflected laterally at its forward end, while under the tension of the strings of the instrument, for the purpose of vibrating them. By momentarily energizing the magnet 28 to attract the armature 29 against an interposed spring 38, after the magnet is de-energized, the lever 30 will continue to vibrate for a time under the opposing forces of the weight 31 and spring 38, with the result of slightly vibrating the tail-piece and varying the tension, and therefore the pitch, of the strings to produce the vibrate effect in playing. The spring 38 is so set as to normally hold outward the adjacent part of the lever 30 and thereby cause the upper end of the lever to exert, through the rod 36, a slight lateral strain on the tail-piece to exert a strain on the violin-strings under which they are at normal pitch. After the armature 29 has been initially attracted under the momentary influence of the magnet 28, as described, in the subsequent vibrations of the lever 30, its movements toward the magnet, under the stress of the weight 31, compress the spring with the effect of turning the upper end of the lever in the direction to decrease the tension exerted in the lateral direction on the violin-strings and thus slightly lower their pitch; and the contrary movement of the lever, under the recoil-force of the spring 38, carries its lower portion beyond the position it occupies with the spring at rest, thereby turning the upper end of the lever beyond the normal position referred to, with the effect of exerting, through the rod 36, increased tension on the strings of the instrument. This is important, since the strings are thus vibrated both below and above the normal pitch referred to, which is necessary to produce properly the "shake" effect in playing.

As in the aforesaid patent, the present construction also involves means, as an adjunct of the sounding devices, for varying their pressure against the strings for the purpose of regulating the degrees of and graduations in loudness of playing; but variation in the degree of pressure of a rotating sounder against a string of the violin with the sounder rotating at unvarying speed, tends to impair the quality of the resultant tone. To obviate this defect, means, shown in preferred form in Fig. 2, are provided for automatically increasing the speed of rotation of the depressible sounder-shaft with increase in the pressure of the sounder upon it against a string, and decreasing the speed with decrease in such pressure: On the forward free end of the horizontal arm 39 are supported in a row transversely thereof the four similar electro-magnets 40, as in the aforesaid former patent, and behind these magnets is supported, over an opening 41 through the arm, a single larger electro-magnet 42 having a spring-supported armature 43 on a reciprocable rod 44 passing vertically through the magnet-core and extending below the arm 39. Between the magnets 40 and 42 a pair of brackets 45 rise from the arm 39 and have journaled in their upper ends a rocker-plate 46 connected from near its transverse center by a bent arm 47 with the head of the rod 44, and extending at its forward edge into the path of lugs 48, one of which projects backward and rigidly from the upper end of the vertically reciprocating armature-carrying rod of each magnet 40, and by the lower end of which rod a sounder-shaft is carried for raising and depressing it by the movements of the armature of that magnet. As will, therefore, be seen, when, by the attraction or rise of the armature 43, the forward edge of the plate 46 is raised or lowered, the extent of depression of the armatures of the magnets 40, when energized, is decreased or increased by the obstruction presented to the lugs 48 in encountering the edge of the rocker-plate at a lower or higher plane in their path. About the lower end of the rod 44 is looped, and sustained by a stop 49, a rod 50 extending lengthwise under the arm 39 and bent downward to project loosely through the partition 23, below which it is adjustably connected with a bar 51, or rod extending obliquely to and pivotally connected with an armature 52. This armature is pivotally supported between its ends on a bearing 53 to extend over the poles of two electro-magnets, 54 and 55, supported at opposite sides of said bearing. A spool of one of the magnets 55 has a post 56 rising from its core through the armature 52 to confine one end of a leaf-spring 57, the other end of which is fastened to the armature near its pivotal support. In a bearing 58 is journaled one end of a rotatable shaft 59 carrying a drive-pulley 60, the other end of this shaft carrying a friction-disk 61, and, adjacent thereto, a sleeve 62 connected by a vertical rod 63 with the adjacent end of the pivotal armature 52. The shaft 59 is journaled at one end in a bearing 64 confined in a vertical guide 65 to permit the shaft, in rotating, to be guidingly reciprocated vertically at the end thereof on which the friction-disk is mounted. In a bearing 66 on the inner front wall of the upright housing from which the horizontal arm 39 extends over the rear portion of the violin, is journaled a vertical shaft 67 provided on its

lower end with a friction-wheel 68 extending at a right-angle to the disk 61 to engage with the surface of the latter. This engagement is yieldingly maintained by a spring 69 fastened at one end to a support 70 and bearing at its free end against the adjacent end of a pin 71 reciprocably confined in the head 72 of said support to bear at its opposite end against a sleeve 73 through which the shaft 67 passes. On the upper end of the shaft 67 is mounted a beveled gear 74 meshing with a similar gear 75 on the rear end of a sounder-shaft, as that which carries the D-string sounder. This sounder-shaft carries, adjacent to the gear 75, a gear-wheel 76, and each of the other three sounder-shafts carries a similar gear-wheel (not shown), to form a train of these gears 76, whereby rotation of the shaft 67 drives the sounder-shafts in successively contrary directions.

As will therefore be seen, when the magnet 42 is energized to attract its armature 43, the forward edge of the rocker-plate 46 is raised to decrease the extent of depression of the sounders against the violin-strings, or lift them entirely off the strings. This action is entirely independent of that of the magnets 54 and 55. With the shaft 59 constantly rotating, engagement of the disk 61 with the wheel 68 actuates the shaft 67 to drive the four sounder-shafts. By energizing the magnet 54 to attract the adjacent part of the armature 52, depression of the latter draws downward upon the bar 51 to cause the rod 50 to depress the armature-rod 44 and the armature 43 mechanically, with the result of raising the forward edge of the rocker-bar 46 and the effect of decreasing the limit of downward movement of the sounders. The accompanying result of so attracting the armature 52 is to produce, through the connecting rod 63, depression of the shaft 59, thereby bringing the engagement of the disk 61, nearer its center of rotation, with the wheel 68 and accordingly decreasing the speed of rotation of the sounder-shafts to correspond with the lighter engagement of the sounders with the strings of the instrument. On the other hand, when the magnet 55 is energized to attract the adjacent end-portion of the armature 52, the resultant rise of the opposite end of the latter, because of the connection therewith of the bar 51, raises it and the rod 50, freeing the spring of the armature 43 to raise it and depress the forward edge of the rocker-plate, thereby permitting any armature or armatures of the magnets 40, when energized, to be depressed as far as the lowered rocker-plate will permit, to depress the sounder-shafts to engage the sounders with greater pressure against the violin-strings and increase the loudness of playing. This increase in loudness is attended by increase of the speed of rotation of the sounder-shafts, since the attraction by the magnet 55 of the adjacent end of the armature 52 raises its opposite end and, through the connecting-rod 63, lifts the free end of the rotating shaft 59 to bring the disk 61 further from its center of rotation into engagement with the wheel 68 and therefore increase the speed of rotation of the shaft 67 and of the sounder-shafts to compensate for the louder playing of the sounders.

With both magnets 54 and 55 de-energized, the spring 57 maintains the armature 52 and the parts controlled by it in the normal condition represented in Fig. 2.

The mechanism of the machine involves, also, means shown and described in my pending application Serial No. 303,172, filed February 27, 1906, for feeding and guiding the perforated music-sheet, and a desirable construction thereof is most clearly illustrated in Figs. 6 and 7: the spring-pressed feed-roller 77, journaled in pivotal hangers 78 and 79 on the similar brackets 80, 81 depending from the partition 23, carries a gear-wheel 82 with which meshes a pinion 83 on the shaft of a drive-pulley 84 having a belt-connection 85 (Fig. 1) with the pulley 60 on the shaft 59, and the belt 85 also suitably gears the pulley 60 with the shaft of the motor 27 to be driven thereby. The other roller, 86, is the electrical contact-roller, journaled at its ends in said brackets, the journal-bearing in the bracket 80 being a horizontally elongated slot 87, shown as extending from a vertical slot rising from the lower edge of the bracket. Adjacent to this bearing is eccentrically journaled on the bracket 80 a disk 88 containing an arc-shaped slot 89, through which a set-screw 90 works in the bracket. The eccentric disk 88 bears at its edge against the adjacent journal of the roller 86, whereby turning the disk in one direction presses it against that journal to move the latter and the roller 86 toward the roller 77, and turning the disk in the opposite direction permits the said journaled end of the roller 86 to be moved in its bearing in the contrary direction under the spring-pressure against the contact-roller of the feed-roller 77. Preparatory to turning the eccentric adjusting disk, it is freed by loosening the screw 90, to be tightened for securing the head in any adjusted position. Thus, when, from wear on the journals of the feed-rollers, or other cause, their required parallelism is impaired, setting the roller 86 through the medium of the eccentric disk will restore the parallelism for producing the necessary straight feeding of the music-sheet, which passes between the two rollers and under the row of electrical contacts 91, which bear against the contact-roller through perforations in the sheet for closing the circuit to actuate the fingering devices and depress the rotating sounders, as described in said patent.

From the journal-end of the friction-

roller 77 presented in Fig. 6 there depends a handle 92 fixed to said journal-end, whereby turning the handle in opposition to the spring 93 swings the friction-roller by its hangers 78 and 79 away from the companion-roller 86 to separate it therefrom when desired to disengage it from the sheet 26; and when thus swung, the roller 77 may be releasably locked in that position by engaging its protruding journal-end with a recess 94 in an arm 94ª pivoted at one end on the bracket 80, and affording a releasable gravity-catch for said journal-end.

A desirable construction of the contacts 91 is that illustrated in Fig. 8, each consisting of a suitably supported spring-finger 95 carrying on its free end a metal sleeve 96, in which the contact-proper, in the form of a bunch of fine wires 97, is adjustably confined by a set-screw 98 working in the sleeve. This brush-form of the contact-proper renders it highly flexible and insures its engagement, through a registering perforation in the traveling music-sheet, with the surface of the contact-roller, even though a portion of the brush may extend over the edge or edges of the perforation; whereas, with a mere spring-finger forming the contact, if by any slight disarrangement its free end should extend over either or both edges of a perforation in the sheet, it would fail to meet the surface of the contact-roller. And the adjustability of the brush adapts it to be set, as its contacting end wears away, toward the roller to compensate for the wear; thus greatly prolonging the usefulness of the contact-brush.

In Figs. 6 and 7 are shown means, co-operating with the feed-rollers, for enhancing the smoothness of travel of the music-sheet by moving it toward the rollers between the regular flat surfaces, of substantially like areas, of a pair of plates forming a guide-table 99: From the bracket 81 a sheet-guiding arm 100 inclines downwardly and is formed with an inwardly projecting plate-seating base-flange 101, provided near one end with a perforated lug 102 and at its opposite end with a lateral extension 103 describing a right angle with the arm 100, at the junction with which it forms an offset to cause the extension to occupy a somewhat lower plane than the arm. The extension terminates at its free end in an apertured head 104, through which works a set-screw 105. A base-plate 106 is bolted near one edge-portion, to bear against the inner side of the arm 100, through the lug 102, and lower down through the flange 101, and bears near its center upon the set-screw 105, the base-plate extending both downwardly and laterally beyond the extension 103 and being free along its left-hand edge. The set-screw 105 is provided for straining the base-plate back into true or level position relative to the feed-rollers in the event of sagging toward its free lateral edge. With the base-plate co-operates a top-plate 107, shown in position, superimposed upon the inclined base-plate, in Fig. 7, and represented in Fig. 6 as undergoing placing into position. The top-plate is provided on the center of its upper side with a handle, shown as a ring, by means of which to manipulate it for its removal and replacement; and on each edge, in alinement with the handle, it carries a depending stud, like the one represented at 108, to enter a hole 109 provided to receive it in the edge-portion of the base-plate and thereby guide the placing of the top-plate properly upon the base-plate and hold it in place. An apron 110, extending from the lower end of the top-plate, guides the music-sheet between the two plates, and an apron 111 on the upper edge of the base-plate guides the sheet from between the plates across the contact-roller 86. The weight of the top-plate thus loosely imposed upon the sheet and the even surfaces of the two plates between which the sheet passes, cause it to travel smoothly and regularly.

The playing mechanism of the machine also, preferably, involves a device for instantaneously reversing the direction of rotation of the sounders, which, according to the aforesaid patent, are adapted to rotate only in one direction. One of these devices is provided for each sounder, and as they are alike, description of one, with particular reference to Figs. 1, 2 and 9 to 13 inclusive, will suffice: For co-operation with the reverser-device the rotary shaft of each sounder is composed of a forward section 113 and a rear section 114, these sections entering at their adjacent ends into the opposite ends of a sleeve 115, wherein the flattened end of the forward section is rigidly secured by a set-screw 116, while the end of the sleeve which receives the section 114 is enlarged internally and that section is fastened in the sleeve by a pivot-pin 117, whereby the sleeve and the forward section have a limited vertically swinging movement on the rear section throughout the axial rotation of the latter. This section has its bearing in a stationary sleeve 118 extending horizontally through the front wall of the aforesaid housing from which the arm 39 extends. This housing, which is formed of thin metal, is slightly resilient, for a purpose hereinafter explained. In the sleeve 118, against the forward end of which a collar 119 is fastened by a set-screw, is stationarily confined about the shaft-section 114, a cylindrical tube 120, which protrudes into the housing but beyond which, in the housing, the rear shaft-section protrudes and carries rigidly secured on its end a beveled pinion 121. Adjacent to this pinion the tube 120 is loosely surrounded by a hub 122, from which

radiates a stud 123 having journaled upon it a beveled pinion 124 like and meshing with the pinion 121; and the hub carries, diametrically opposite the stud, a pin 125 serving the purpose hereinafter explained. At 126 is shown an annular ratchet open at its side adjacent to the pinion 121, but having a face 127 covering its opposite side and containing a slot 128. The ratchet, which is connected at its face 127 with the pin 125 by a light spiral spring 129, has a sleeve 130 extending from a central opening in said face and loosely surrounding the tube 120, while this sleeve is loosely surrounded by a ratchet-wheel 76 having the beveled gear 75 formed on one face and also the beveled pinion 131, which is like and meshes with the pinion 124, that projects through the slot 128 for the meshing purpose. The gears 76 of all the four sounder-shafts form a train, driven by the motor 27 to rotate these shafts, as hereinbefore explained. As will be understood, only one of the gears 76 carries a beveled gear 75 to mesh with the similar gear 74 on the shaft 67. The spring 129 yieldingly holds the pinion 124 in engagement with an end of the slot 128, to lock that pinion and ratchet together, as represented in Figs. 10 and 12, so that rotation of a gear 76 causes the pinion 131 to rotate the pinion 124, and with it the ratchet 126, about the tube 120, while this rotation of the pinion 124 causes it to revolve the pinion 121 and thus revolve the entire sounder-shaft. By arresting rotation of the ratchet 126, however, the strain of the rotating pinion 131 against the pinion 124 forces the latter against the resistance of the locking spring 129, to disengage the last-named pinion from the end of the slot 128, thereby unlocking it to enable it to rotate freely about the stud or axis 123. Thus freed, and with the ratchet thus held stationary, the pinion 124 is rotated about its axis 123 and rotates the pinion 121, and with it the shaft-sections 114 and 113 in the direction contrary to that of the rotation of the gear 76; thereby reversing the rotation of the sounder. For arresting the ratchet, an electro-magnet 132 is provided on the top of the said housing, the magnet having a spring-cushioned armature 133 carrying a plunger-rod 134 extending vertically through the magnet-core and terminating in a blade 135 which registers with the ratchet, whereby when the magnet is energized through closure of the circuit by a certain contact 91 engaging the roller 86 at a perforation in the traveling music-sheet brought into registration with such contact, the resultant attraction of the armature will drive the plunger-rod against the ratchet and stop its rotation until the magnet is deënergized. This occurs by the perforation clearing the contact, to open the circuit and results in the rise of the armature, under the recoil force of its cushioning spring, and the withdrawal of the plunger-rod from engagement with the ratchet, whereupon the spring 129 again forces the pinion 124 against the ratchet at the end of its contained slot, thereby locking the ratchet to cause the pinion 121 and sounder-shaft to rotate correspondingly with the gear 76, as already described. This reversing device is extremely sensitive and instantaneously responsive, so that the axially reversing action it induces of the sounder against an open string of the instrument may, in accordance with the length of the perforation through which the circuit-closure is effected as described, be rapid or slow in imitation of the reciprocating movements with the ordinary violin-bow.

Provision is made, by the construction illustrated in Figs. 1 and 5, for deflecting simultaneously the four rotatory sounders 112 toward the violin-strings, so that when any one is depressed by its controlling electro-magnet against a string for playing it, the pressure of the sounder against the string will be augmented and the resultant sound accordingly rendered louder. As in the construction set forth in said patent, the sounder-shafts are supported toward their forward ends by the upright electro-magnets 40 on the forward end of the arm 39, the armature 136 of each magnet being carried on a vertically reciprocable rod 137 passing through the magnet-core and terminating at its lower end in an eye 138, through which the sounder-shaft passes to be supported toward its forward end. Obviously, then, by deflecting downward, from its normally horizontal position, the arm 39 and with it the magnets 40, the sounders will be correspondingly depressed to a lower plane, from which to be actuated by the rods 137 against the strings of the instrument. To accomplish this purpose, a double-spool electro-magnet 139 is supported on one side of the casing-compartment 25, its armature 140 being carried on the lower end of a lever 141 passing, through an opening 142 in the partition 23, into the aforesaid housing, wherein it is fulcrumed at *x*; and the upper forked end of the lever embraces and is riveted to a bracket 143, which is securely fastened to and extends backward from the front wall of the housing, and to which the sleeves 118 of the reversing devices are fastened. By turning the lever on its fulcrum, the force of turning it will spring the resilient housing to deflect the arm 39 and thus depress the sounders to a lower plane from which to be pressed against the violin-strings by the rods 137 of the electro-magnets 40, as explained in the aforesaid patent. This springing of the housing is produced by attracting the armature 140 under energizing of the magnet 139, which occurs whenever the proper contact 91

engages the surface of the contact-roller through a perforation in the traveling music-sheet brought into registration with such contact.

To avoid marring of the tone-quality in playing, which results from supporting the finger-board 144 of the violin directly upon its neck, whereby the action of the fingering devices against the board compresses the instrument upon its supports, the finger-board is supported in raised position out of contact with the neck, as represented in Figs. 1 and 14.

The frame which supports the four rows of fingering-device electro-magnets 145, and involving the hollow post 146, the curved and flanged end-pieces 147 on a back 148 and connected at intervals by bars, with the depending arms 149 carrying the horizontal perforated plate 150 through which the armature-actuated rods 151 reciprocate, said rods carrying on their lower ends the fingering-mechanism 152, are all as in the patent. The finger-board 144, however, is rigidly suspended by bolts 153, at suitable intervals, from the plate 150 and supported in raised position over the neck of the violin. The bolts pass at their lower ends through the base of a frame 154 supported in the compartment 25 and carrying a transparent housing 155, which envelops and shields the mechanism of the fingering and picker-devices. Sound-deadening strips 156, of felt, or the like, are interposed at intervals between the frame-base and finger-board above it, and the frame 154 bears at its forward end upon a cushion 157, of felt, or the like, seated in the upwardly curved forward end 158 of a metal plate 159 extending lengthwise upon the neck, and over the edge of which end are stretched the strings of the instrument leading to its tuning-keys.

Suitable means are provided, as shown at 160 in Figs. 1 and 5, for holding cakes of rosin, 161, in contact with the rotatory sounders 112.

Similar picker-finger devices, one for each string of the instrument, are proivded for pizzicato playing, to supplement the other fingering devices of the aforesaid patent; and each comprises the following-described construction, shown in Figs. 1 and 15 to 19, inclusive: An electro-magnet 145^1 is located in line with the respective series of the magnets 145 at the end thereof nearest the rear end of the instrument, the armature of this magnet being carried by a rod 162, like the rods 151 and passing through its proper opening in the plate 150. Below this plate the rod carries, adjustably, the picker-device consisting of a head 164, on which is pivoted a finger 165 having loosely connected with its heel-portion a stop-rod 166 extending upward and reciprocably through a guide-extension 167 of the head to abut at its free end against the bottom of the plate 150. Figs. 15 to 17, inclusive, show this device in the different positons of its action. Thus, under attraction of the armature of the magnet 145^1, the rod 163 is lowered to depress the finger 165 from its normal position (Fig. 15), wherein the rod abuts against the plate, to the position represented in Fig. 16, wherein the finger has encountered and is just clearing a string, as the string E, to sound it, and whence the continued descent of the rod carries the finger downward and gravity turns it to the position in which it is represented in Fig. 17, the finger being so pivoted as to tend to assume that position by gravity. In this last-named position, the picker-finger hangs from its pivot, as shown, but is again brought to the normal position by the turning action upon it of the rod in encountering the plate 150, as it does in being raised by the recoil-force of the armature-spring when the magnet is de-energized. The rod 162 carries, near its upper end, a laterally projecting stud 168 to extend across one of two contact-making springs 169 and 170 suitably supported on a block 171 and included in the electric operating circuit of the apparatus, as and for the purpose hereinafter described. In the descent of the rod, the stud closes the circuit by bringing together the contact-springs, which separate, by their resilience, when freed from the stud 168 by the rise of the rod.

According to the arrangement disclosed in the aforesaid patent, each row of the fingering-device magnets consists of twelve magnets, to correspond with the number of tones in the chromatic scale. It is desirable to increase the number of the fingering devices, and accordingly of their controlling magnets for fingering the E-string, by ten, and the number thereof for fingering the A-string, by two; and it is found expedient to distribute these twelve additional magnets by adding three for the E-string to the end of its series of magnets nearest the rear end of the violin, by adding two for the A-string and one more for the E-string to the same end of the electro-magnets over the A-string; by adding three more magnets for the E-string to the same end of the row of magnets over the D-string, and by adding three more of the E-string magnets to the row of magnets over the G-string. This, of course, necessitates extending each rod controlled by an E-string magnet contained in any row of fingering-device magnets other than that directly over an E-string, to a fingering-device over the last-named string. The added fingering-devices on the ends of the rods so extended are separate from each other, in the sense that there is no link-connection from one to the other as there is between the other fingering-devices in each row thereof, as shown in said patent, though they are otherwise like the latter. This arrangement is represented diagrammatically in Fig. 19, wherein the electro-

magnets added to the rows thereof over the E, D and G strings are denoted by the character 145^e and the plunger-rods they control by the character 151^e, those added to the row over the A-string, for fingering that string, are denoted by the character 145^a with their plunger-rods denoted by 151^e, and that for the E-string added to the A-string row is denoted by the character 145^e with the plunger-rod it controls denoted by the reference-character 151^e.

Following is the explanation of the electric-circuit arrangement illustrated in the diagram presented by Fig. 20: Seventy-four contacts are provided in a row, to bear against the contact-roller 86, one end of which is connected by a wire w with the positive pole of a generator, indicated at 172. Thus four contacts, denoted as 91^g, 91^d, 91^a and 91^e, are provided, respectively, for the open G, D, A and E strings of the violin, one for each of the sixty fingering-device magnets 145, one for each of the four picker-device magnets 145^1, one for the depressor-magnet 139, one for the magnet 42 which actuates the rocker-plate 46, one for each magnet 54 and 55 for varying the speed of rotation of the sounder-shafts, one for the magnet 28, which actuates the pendulous lever 30 to vibrate the violin-strings, and one for the magnet of the cut-out device 173, which may be the same as that of the said patent.

The circuit is traceable as follows: from the positive pole of the generator over the wire w to the roller 86, a branch w^1 of the wire w leading through the motor-brushes to one side of the cut-out 173, from which a wire w^2 leads to the negative side of the generator. The last contact 91, at the extreme right-hand end of the row of contacts, is connected with the cut-out by a wire w^3, which connects through the cut-out magnets by a wire w^4 to the wire w^2. On the completion of a piece, a certain perforation in the music-sheet registers with the spring-contact 91 at the extreme right-hand end of the series of contacts co-operating with the roller 86, permitting that contact to bear, through the said perforation, against the said contact-roller, though this engagement is only momentary, since the perforation is necessarily small and the inertia of the sheet-driving mechanism carries the perforation beyond the contact in its path, to interpose the insulating paper between it and the roller. When the aforesaid momentary contact-engagement occurs, the motor is cut out of the circuit.

Each of the contacts in the first group of thirteen thereof at the left-hand side of the diagram, except the open-string contact 91^g, is connected by a separate branch w^5 of the circuit with a different one of the twelve fingering-device electro-magnets 145 in the G-string series of these magnets; and wires w^{55} that lead from three others of the contacts 91 connect them, respectively, with the three electro-magnets 145^e of the E-string fingering-devices that are added, as aforesaid, to the end of the series of G-string fingering-device magnets. Of the next group of thirteen contacts, each, except the one for the open string 91^d, is connected by a separate branch-wire w^6, with a different one of the twelve fingering-device magnets 145 of the D-string series thereof; and wires w^{66} that lead from three others of the contacts 91 connect them, respectively, with the three electro-magnets 145^e of the E-string fingering-devices that are added, as aforesaid, to the end of the series of D-string fingering-device magnets. Of the next group of fifteen contacts, each, except the one for the open string 91^a, is connected by a separate branch-wire w^7 with a different one of the twelve fingering-device magnets 145 and the two added magnets 145^a of the A-string series; and a wire w^{77} leading from another contact 91 connects it with the electro-magnet 145^e of the E-string fingering-devices that is added, as aforesaid, to the end of the series of A-string fingering-device magnets. Of the remaining contacts, fourteen succeeding the open-string contact 91^e and the one immediately succeeding the contact having the branch-connection w^{77}, are each connected by a branch-wire w^8 with a different one of the fifteen fingering-device magnets of the E-string series thereof. The four contacts 91 immediately succeeding the one having the branch-connection w^8 are each connected by a branch w^9 with one side of a different picker-device magnet 145^1. The open-string contacts 91^g, 91^d, 91^a and 91^e are connected by branch-wires w^0, respectively with one side of the reverser electro-magnets 132 for the G, D, A, and E string sounder-shafts. With these last-named branches are connected resistances, indicated at w^{10}, these resistances being also connected, respectively, with the lines w^{11}, w^{12}, w^{13}, and w^{14}, to reduce the current-supply to the sounder-shaft magnets 40 so that they shall receive the same amount of current, when operated upon open strings, as they receive when operated in series with fingering device magnets.

It will be observed that when an open string contact, as 91^g, controlling a reversing magnet 132, is closed while a fingering-device magnet 145 is energized, more than the normal current will pass through the respective sounder-magnet 40. This is desirable, however, for it is preferable to have increased energy in a sounder-magnet each time the sounder it controls is reversed, since thereby the reversing of the sounder is rendered more distinct or emphatic in the playing, as in the case of reversing the movement of the bow in human violin-playing.

All the magnets 145 for actuating the G-string fingering-devices have a common part or wire w^{11} leading to one side of the G-string sounder-shaft magnet 40; all the magnets 145 for actuating the D-string fingering-devices have a common part or wire w^{12} leading to one side of the D-string sounder-shaft magnet; similarly, all the magnets 145 and 145^2 for actuating the A-string fingering-devices have a common part or wire w^{13} leading to one side of the A-string sounder-shaft magnet; and similarly, all the magnets 145 and 145^c for actuating the E-string fingering-devices have a common part or wire w^{14} leading to one side of the E-string sounder-shaft magnet. The opposite sides of the magnets 40 as also the corresponding or negative sides of the electro-magnets 42, 132 and 139 are connected with the return-wire w^{20}, which leads to the cut-out 173. The positive side of the magnet 42 for actuating the rocker-bar 46 is connected by a branch-wire w^{15} with a contact 91, while the adjacent contact to the left on the diagram is connected by a branch-wire w^{16} with the positive side of the housing-springing magnet 139. Other contacts are connected by branch-wires w^{17} and w^{18}, respectively, with the positive sides of the sounder-shaft speed-changing magnets 55 and 54, the opposite sides of which are connected by a wire w^2 with the wire w^1 leading to the cut-out; and the last contact but one in the series is connected by a branch-wire w^{19} to the magnet 28 which controls the vibrating device said magnet being also connected to the return-wire w^{20}. The resistances w^{10} for the several open strings are furthermore connected, respectively, with the common parts or wires w^{11}, w^{12}, w^{13} and w^{14}, as indicated in the diagram. The contact-bars 170 of the several picker-device magnets are, as indicated in Fig. 20, respectively connected with the wires w^{11}, w^{12}, w^{13} and w^{14}, and the companion contact-bars 169 are each connected with the shunt-wire w^{22} which leads to the return-wire w^{20}; so that whenever the members of any pair of the bars 169, 170 are pressed together by energizing a magnet 145^1 to attract a bar 169, a shunt-circuit is formed from the respective common part to the return-wire w^{20}, thereby shunting the particular sounder-device magnet 40, which should not, for obvious reasons, be operative, when the respective violin-string is being picked for pizzicato playing.

As and for the particular purpose set forth in said patent, the eighth, fourteenth, twenty-first, twenty-seventh, thirty-fourth and forty-second contacts, counting from the left-hand end of the series thereof, are each connected with a tuning adjunct, indicated at 175 and included in a branch w^{21} having metallic connection at i with the contact-roller 86.

As will be observed, in the diagram of Fig. 20 all the heavy lines denote return-wires.

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

1. In combination with a stringed instrument, means constructed and arranged to normally maintain the strings under tension, said means comprising a vibratory attachment operating to produce variation in the tension of the strings above and below their normal tension, for the purpose set forth.

2. In combination with a stringed instrument, a pendulous vibratory lever connected with the strings of the instrument, and means for vibrating said lever, for the purpose set forth.

3. In combination, a stringed instrument having flexibly supported upon it a tail-piece to which the strings of the instrument are fastened, a vibratory attachment connected with said tail-piece constructed and arranged to normally exert tension upon the strings, and means for actuating said attachment to vibrate the tail-piece and thereby vary the tension on the strings above and below their normal tension, for the purpose set forth.

4. In combination, a stringed instrument having flexibly supported upon it a tail-piece to which the strings of the instrument are fastened, a pendulous lever connected with said tail-piece, and means for vibrating said lever, for the purpose set forth.

5. In combination, a stringed instrument having flexibly supported upon it a tail-piece to which the strings of the instrument are fastened, a pendulously supported lever spring-pressed in one direction and carrying a weight opposing the force of said spring, a connection between said lever and tail-piece, and means for actuating said lever to vibrate the tail-piece, for the purpose set forth.

6. In a self-playing stringed instrument, the combination with a string, of a sounding-device comprising a rotatably mounted shaft and a sounder thereon adapted to sound said string, said sounding-device including an electro-magnet; a plurality of fingering-devices each provided with an electro-magnet and adapted to finger said string when its magnet is energized; an electric circuit having branches, certain of said branches including said fingering-device magnets, each branch including one only of said fingering-device magnets, and the common part including the sounding-device magnet, whereby each of said fingering-device magnets is included in series with said sounding-device magnet; a vibratory attachment connected with said string and carrying an armature, and an electro-magnet for actuating said armature, included in a branch of said circuit.

7. In a self-playing stringed instrument,

the combination with a string, of a sounding-device comprising a rotatably mounted shaft and a sounder thereon adapted to sound said string, said sounding-device including an electro-magnet; a plurality of fingering-devices each provided with an electro-magnet and adapted to finger said string when its magnet is energized; an electric circuit having branches, certain of said branches including said fingering-device magnets, each branch including one only of said fingering-device magnets and the common part including the sounding-device magnet, whereby each of said fingering-device magnets is included in series with said sounding-device magnet; the tail-piece of said instrument, and a vibratory attachment for the string, comprising an electro-magnet included in a branch of said circuit, a pendulously supported weighted and spring-pressed lever carrying near one end an armature adjacent to said last-named magnet, and a connection between the opposite end of said lever and said tail-piece.

8. In an electric self-playing stringed instrument, the combination with a casing supporting the parts, of a circuit having branches, a motor, an electrical contact-roller in said circuit, contact-fingers co-operating with said roller, and means for feeding a perforated music-sheet across said roller and contact-fingers; sounder-devices for the springs, each including an electro-magnet having an oscillatory armature connected with a sounder-device; fingering-devices for the strings, each including an electro-magnet; lugs on the armatures of the sounding-device magnets and means for varying the extent of depression of said armatures, comprising a rocker-plate supported to extend in the path of said lugs and an electro-magnet in said circuit having an oscillatory armature connected with said plate to rock it by the movements of said armature.

9. In a self-playing stringed instrument, the combination with a string, of a sounding-device comprising a rotatably mounted shaft and a sounder thereon adapted to sound said string; means for rotating said shaft and means for oscillating it to engage the sounder with said string and withdraw it therefrom; a pressure-varying device constructed and arranged to co-operate with the sounder-shaft to vary the degree of pressure of the sounder against the string; and a speed-changing device constructed and arranged to co-operate with said pressure-varying device and said shaft-rotating means to vary the speed of rotation of the latter with variation in the pressure of the sounder against said string.

10. In a self-playing stringed instrument, the combination with a string, of a motor, a sounding-device comprising a rotatably-mounted shaft and a sounder thereon adapted to sound said string; means for oscillating said shaft to engage the sounder with said string and withdraw it therefrom; a pressure-varying device constructed and arranged to co-operate with the sounder-shaft to vary the degree of pressure of the sounder against the string; a speed-changing device for said shaft, comprising a rotatable shaft geared to said motor and carrying a friction-disk on one end, an oscillatory bearing in which the last named shaft is journaled, means for oscillating said shaft-end, and a rotary shaft carrying on one end a friction-wheel engaging with said disk and geared at its opposite end with said sounder-shaft; and means co-operatively connecting said pressure-varying and speed-varying devices.

11. In an electric self-playing stringed instrument, the combination with a string, of a motor, a circuit having branches; a sounding-device comprising a rotatably mounted oscillatory shaft and a sounder adapted to sound said string and including an electro-magnet in a circuit-branch, having an oscillatory armature connected with said sounder-shaft and carrying a lug; means for varying the extent of depression of said armature, comprising a rocker-plate supported to extend in the path of said lug and an electro-magnet in a branch of said circuit having an oscillatory armature connected with said plate to rock it; and a speed-changing device for said sounder-shaft, comprising a pair of electro-magnets in branches of said circuit, a pivotal armature extending over the poles of said pair of magnets, a rotatable shaft geared to said motor and carrying a friction disk on one end, an oscillatory bearing in which the last named shaft is journaled, a connection between said pivotal armature and said disk-carrying shaft, a vertical rotary shaft carrying on its lower end a friction-wheel engaging said disk and geared at its opposite end with said sounder-shaft to rotate the latter, and a connection between the armature of said rocker-plate actuating magnet and said pivotal armature.

12. In an electric self-playing stringed instrument, the combination with a casing supporting the parts, of a circuit having branches, a motor, an electrical contact-roller in said circuit, contact-fingers co-operating with said roller, and means for feeding a perforated music-sheet across said roller and contact-fingers; sounding-devices for the strings of the instrument, each including an electro-magnet having an oscillatory armature, and each comprising a rotatably mounted oscillatory shaft connected with said armature and a sounder on said shaft adapted to sound a string; a series of fingering-devices for each string, each including an electro-magnet and adapted to finger a string when its magnet is energized; said fingering-device magnets being included in branches of

which each branch includes one only of said fingering-device magnets and the common part of each said series including a sounding-device magnet, whereby each of said fingering-device magnets in a series thereof is included in electric series with a sounding-device magnet; lugs on the armatures of said sounding-device magnets; means for regulating the extent of depression of said armatures, comprising a rocker-plate supported to extend in the path of said lugs and an electro-magnet in a branch of said circuit having an oscillatory armature connected with said plate to rock it; a speed-changing device for the sounder-shafts, comprising a pair of electro-magnets included in branches of said circuit, a pivotal armature extending over the poles of said pair of magnets, a rotatable shaft geared to said motor and carrying a friction-disk on one end, an oscillatory bearing in which the last named shaft is journaled, a connection between the oscillatory end of said disk-carrying shaft and said pivotal armature, a vertical rotary shaft carrying on its lower end a friction-wheel engaging said disk and geared at its upper end with said sounder-shafts to drive them, and a connection between the armature of said pressure-regulating magnet and said pivotal armature.

HENRY K. SANDELL.

In presence of—
J. H. LANDES,
W. B. DAVIES.