No. 807,871. PATENTED DEC. 19, 1905.

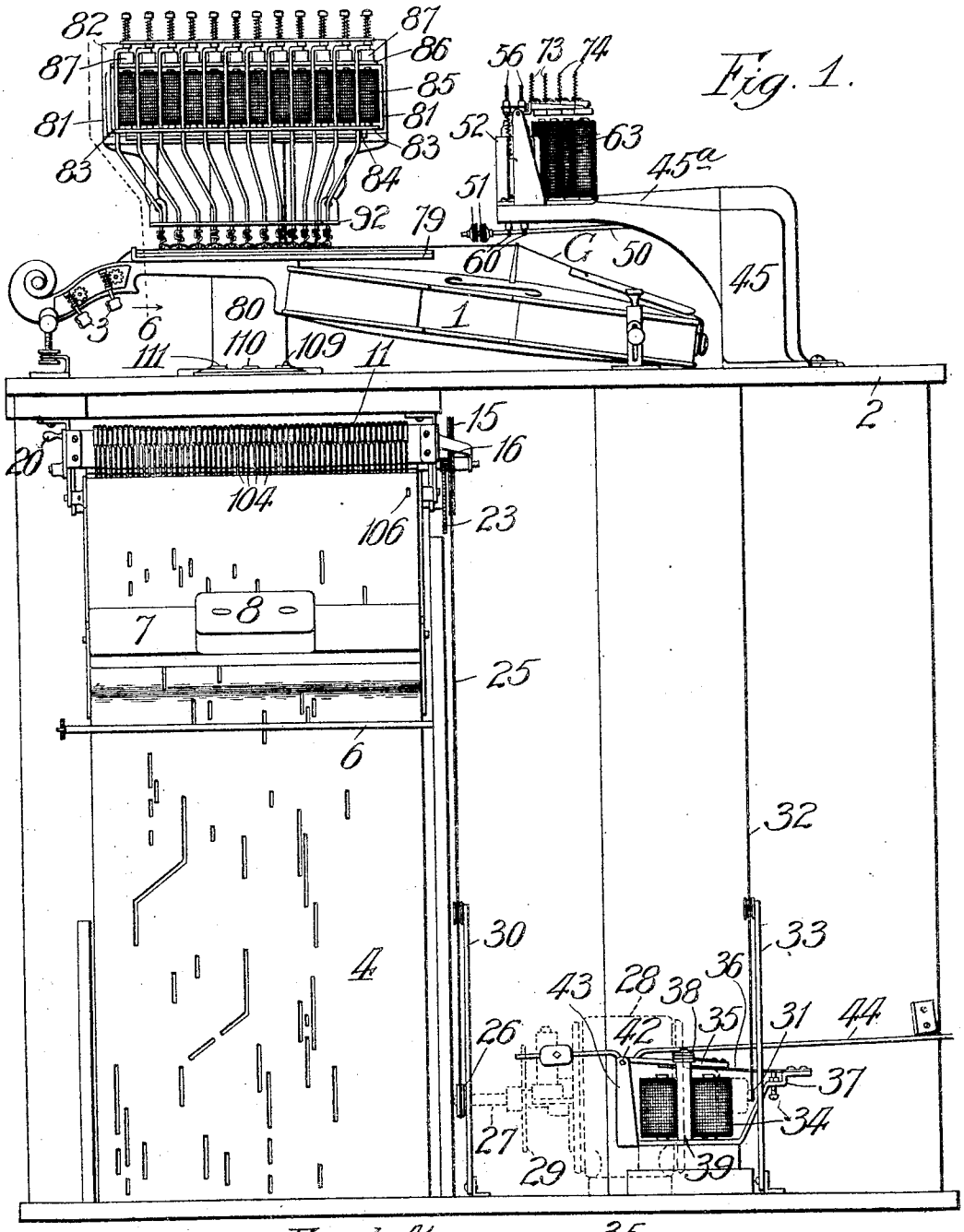
H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED MAR. 27, 1905.

10 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
E. C. Gaylord.
John Enders.

Fig. 1b

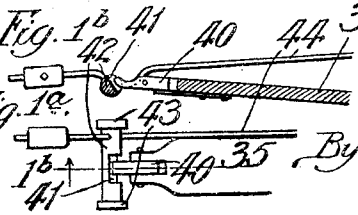


Fig. 1a.

Inventor:
Henry K. Sandell,
By Dyrenforth Dyrenforth & Lee,
Att'ys.

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10 SHEETS—SHEET 2.

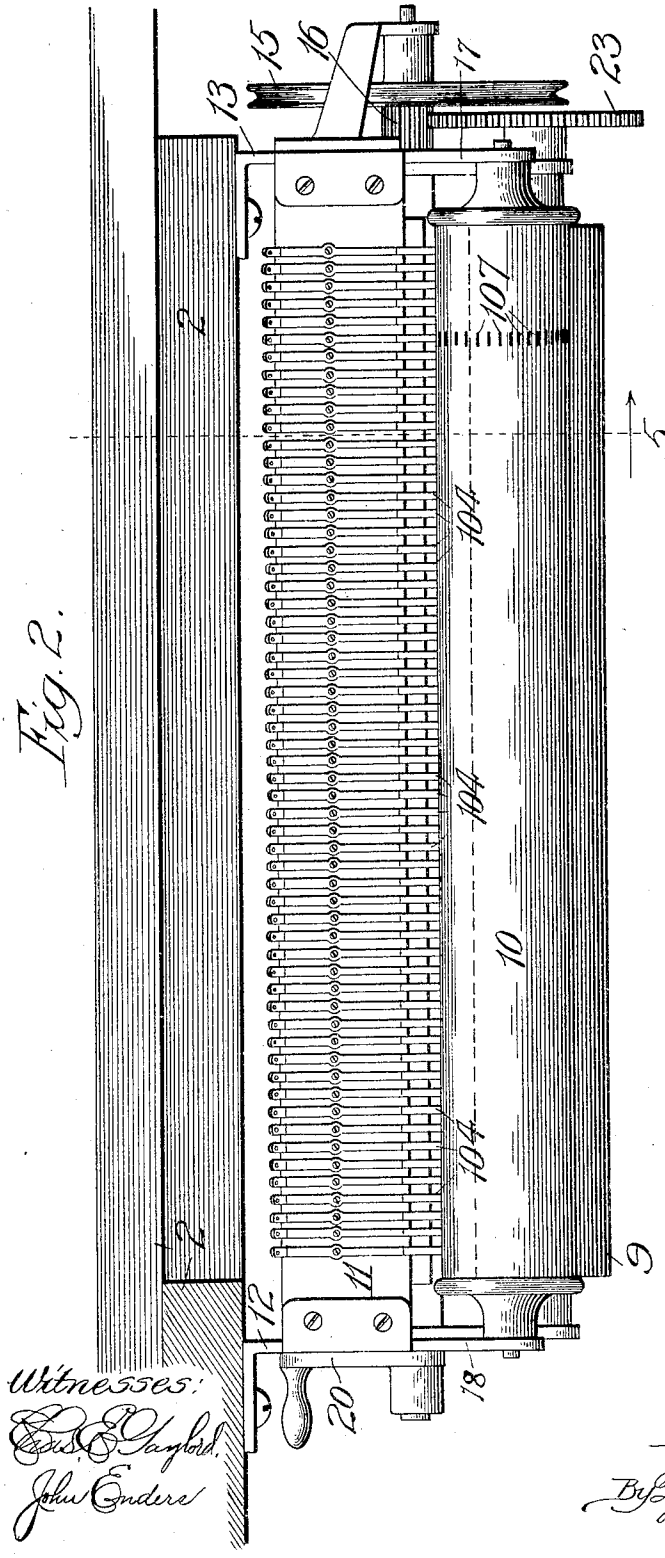

Fig. 2.

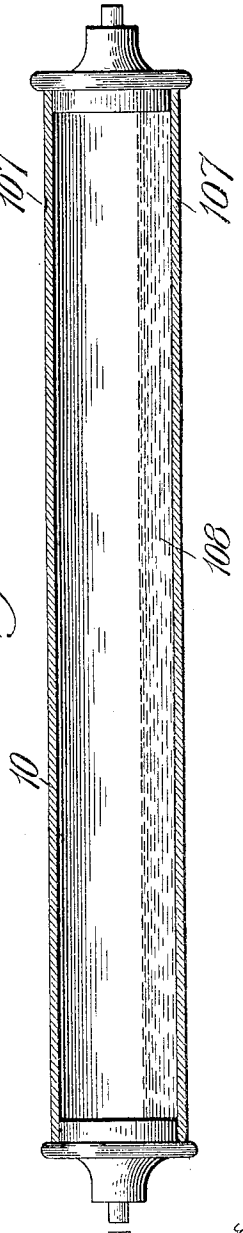

Fig. 3.

Witnesses:
Louis B. Gaylord.
John Enders

Inventor:
Henry K. Sandell,
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10 SHEETS—SHEET 3.

Fig. 4.

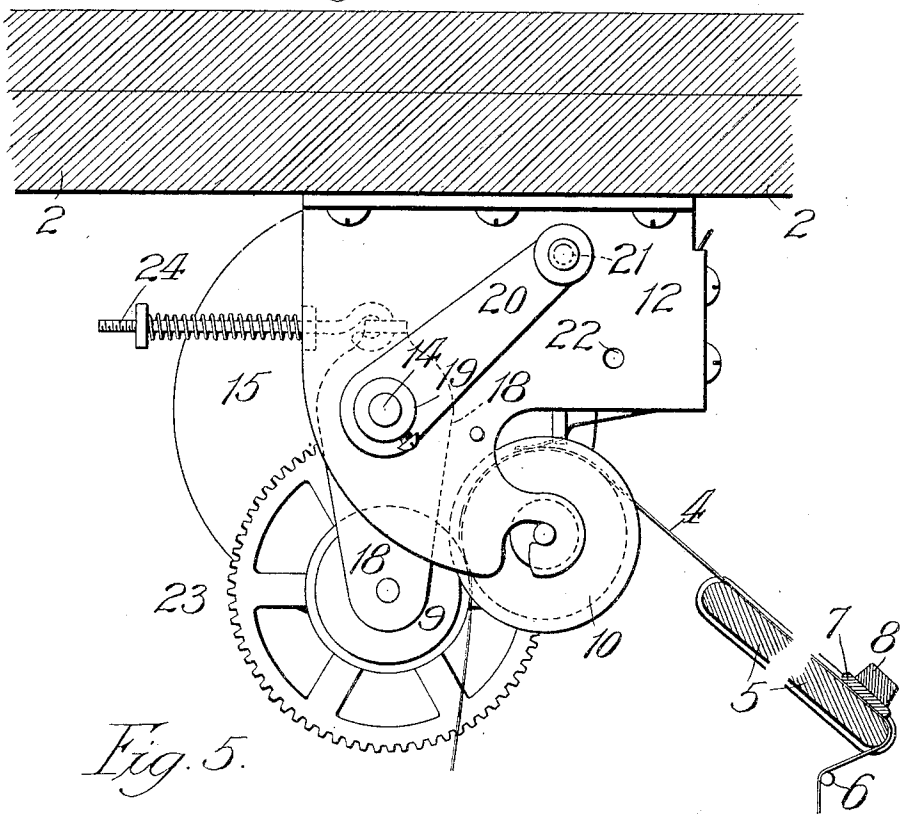
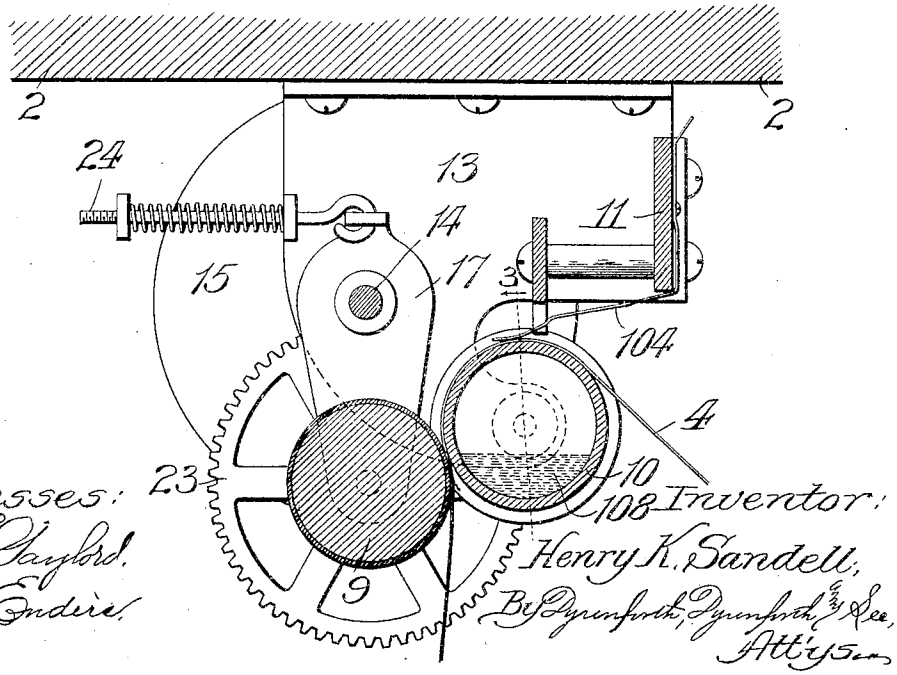


Fig. 5.



Witnesses:
Chas. E. Gaylord.
John Endicott.

Inventor:
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No. 807,871. PATENTED DEC. 19, 1905.

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10 SHEETS—SHEET 4.

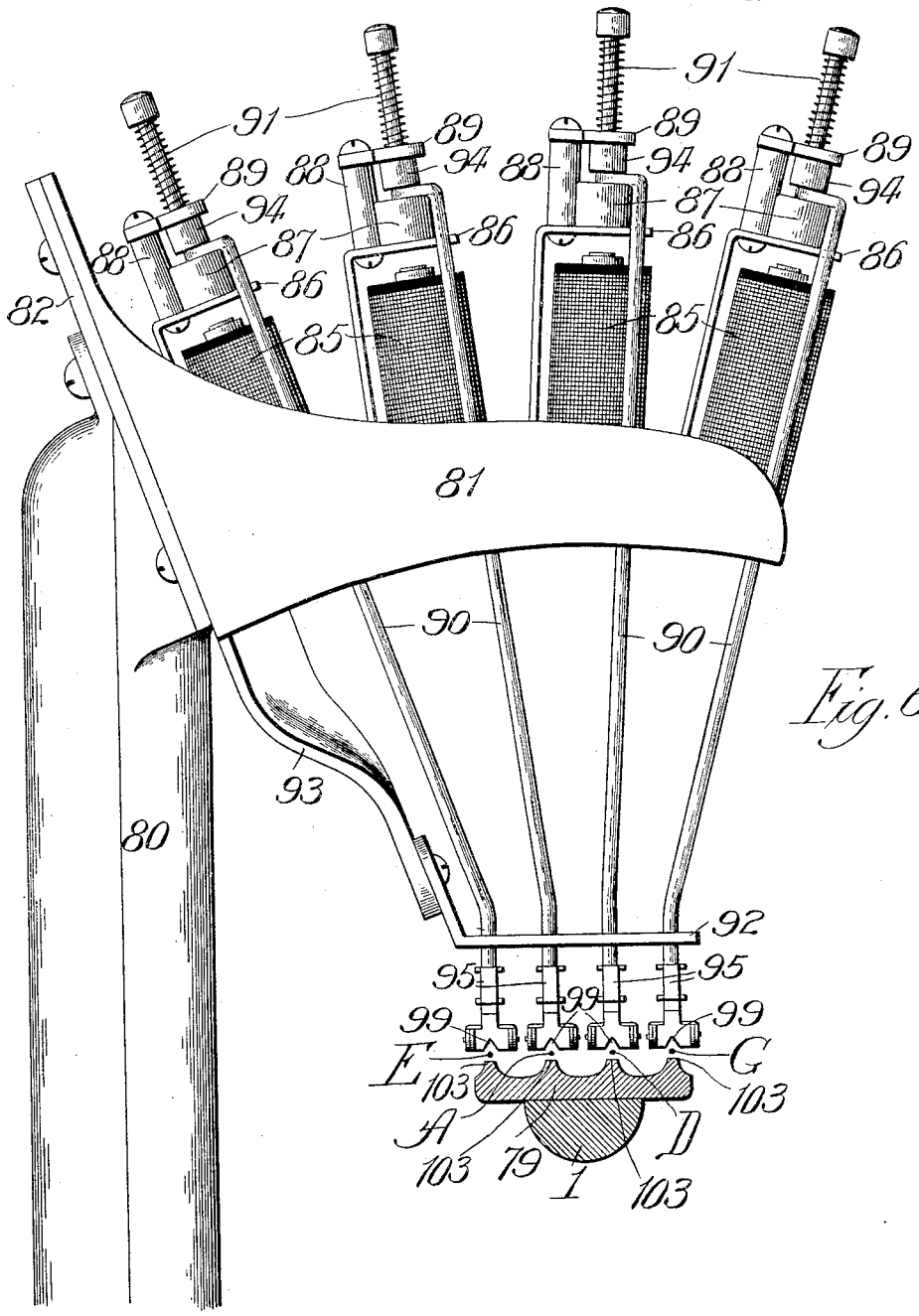

Fig. 6.

Witnesses:
C. C. Gaylord.
John Enders.

Inventor:
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Attys.

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10 SHEETS—SHEET 5.

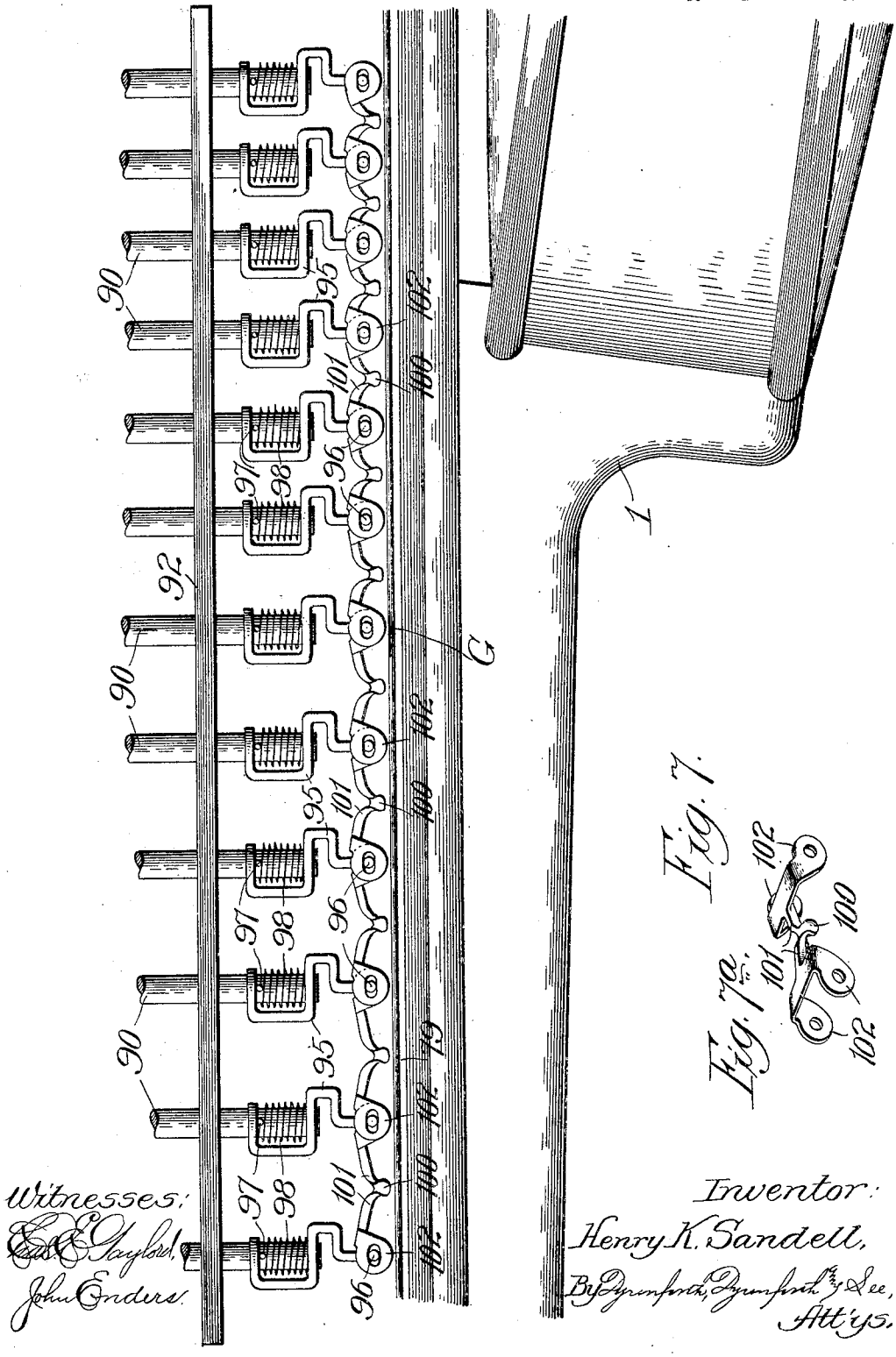

Fig. 7.

Fig. 7a.

Witnesses:
L. E. Gayford.
John Enders.

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10 SHEETS—SHEET 6.

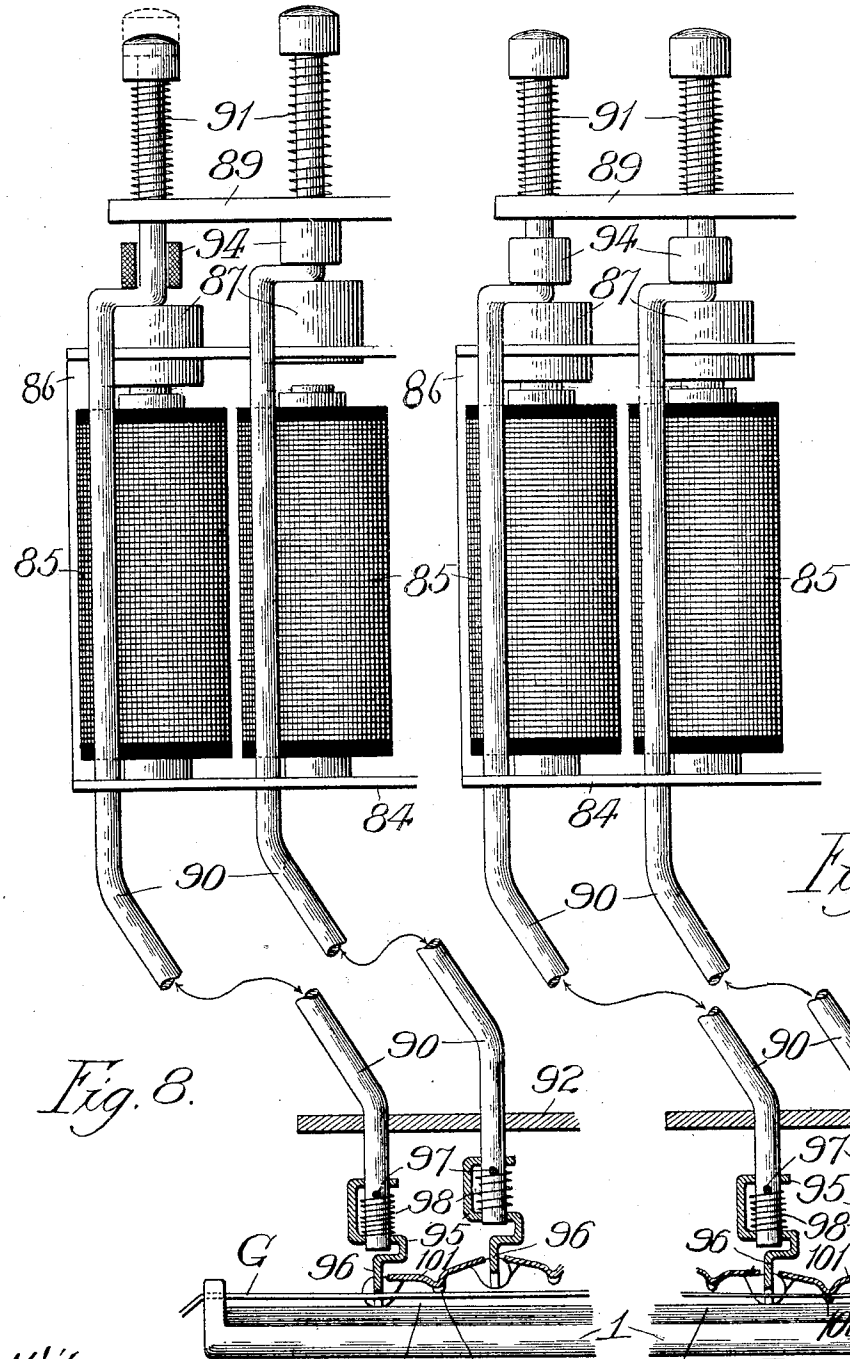

Fig. 8.

Fig. 9.

Witnesses:
Chas. E. Gaylord.
John Enders.

Inventor:
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10 SHEETS—SHEET 7.

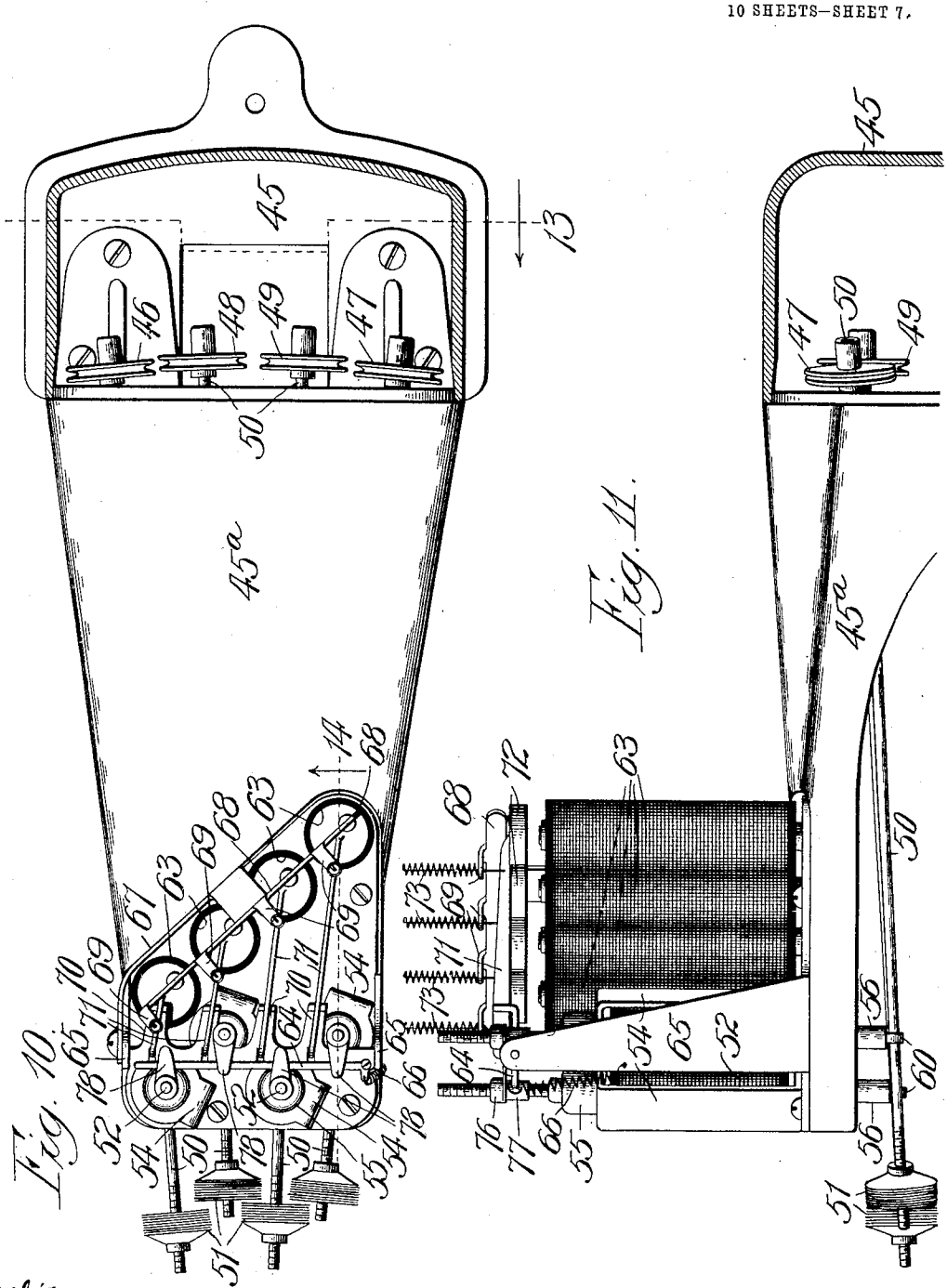

Fig. 11.

Witnesses:
Chas. E. Gaylord.
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Inventor:
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No. 807,871. PATENTED DEC. 19, 1905.

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10 SHEETS—SHEET 8.

Fig. 12.

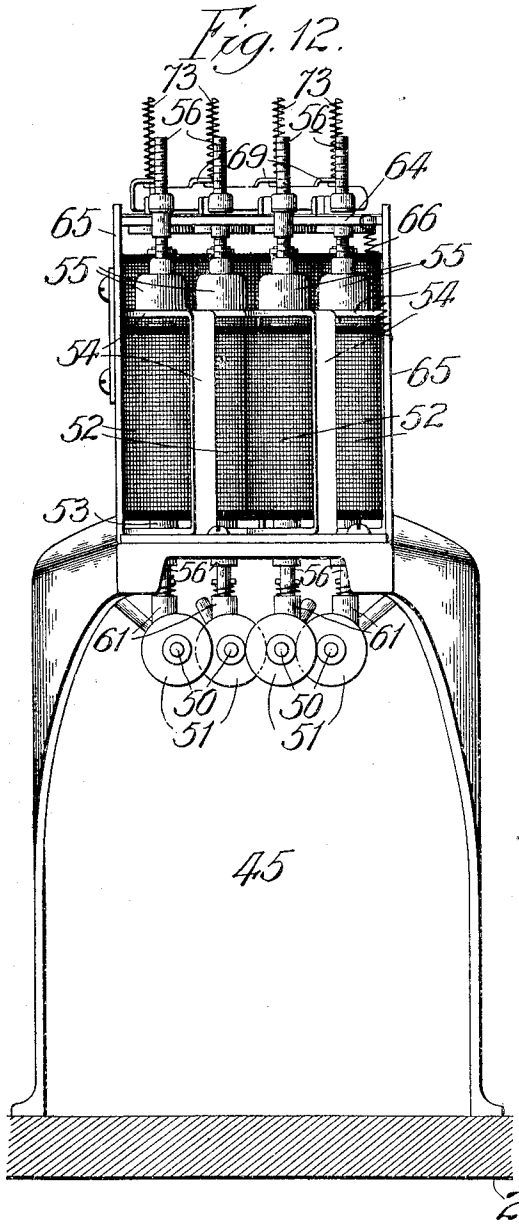
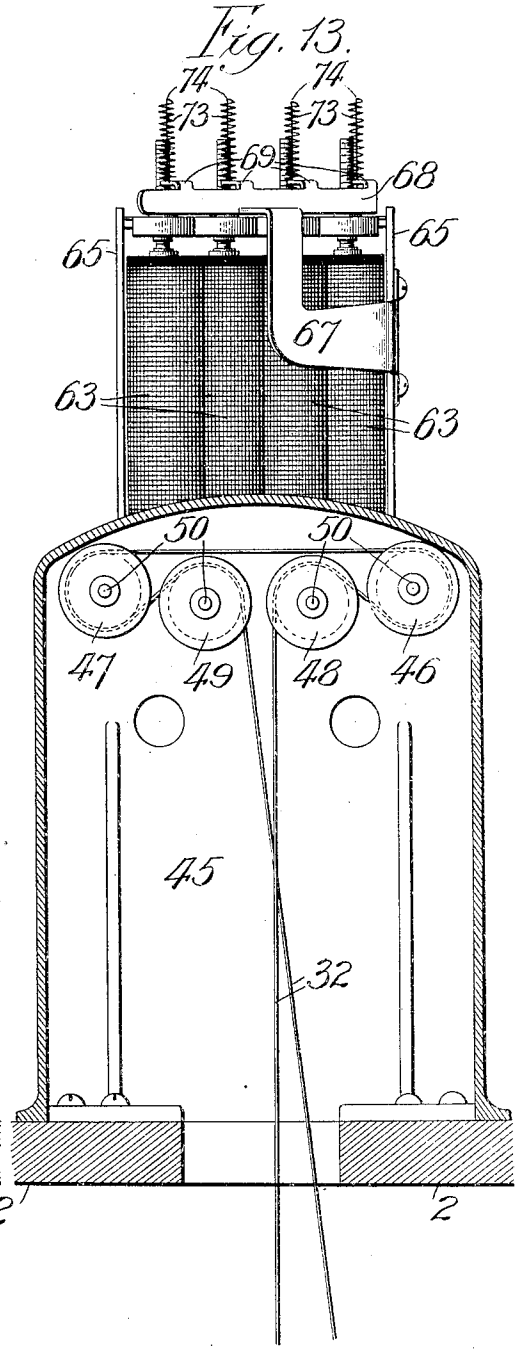


Fig. 13.



Witnesses:
Chas. E. Gayford.
John Enders.

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H. K. SANDELL.

ELECTRIC SELF PLAYING VIOLIN.

APPLICATION FILED MAR. 27, 1905.

10 SHEETS—SHEET 9.

Fig. 14.

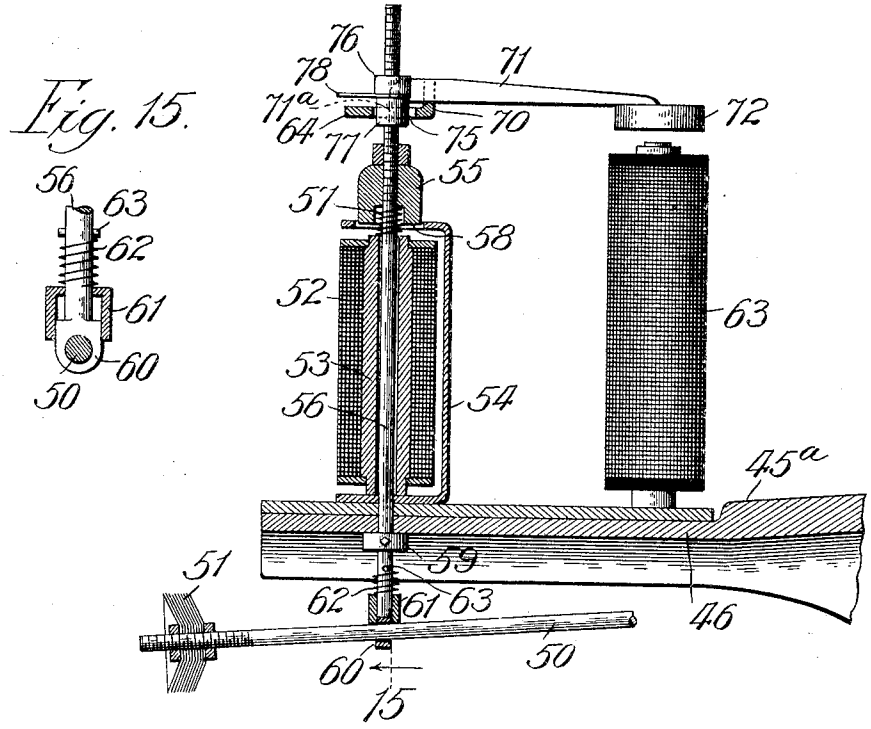


Fig. 15.

Fig. 17.

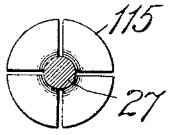
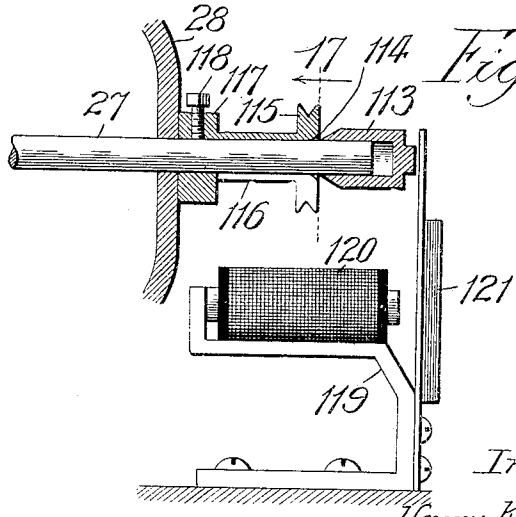


Fig. 16.



Witnesses:
Chas. E. Taylord.
John Enders.

Inventor:
Henry K. Sandell,
By Dyrenforth, Dyrenforth & Lee.
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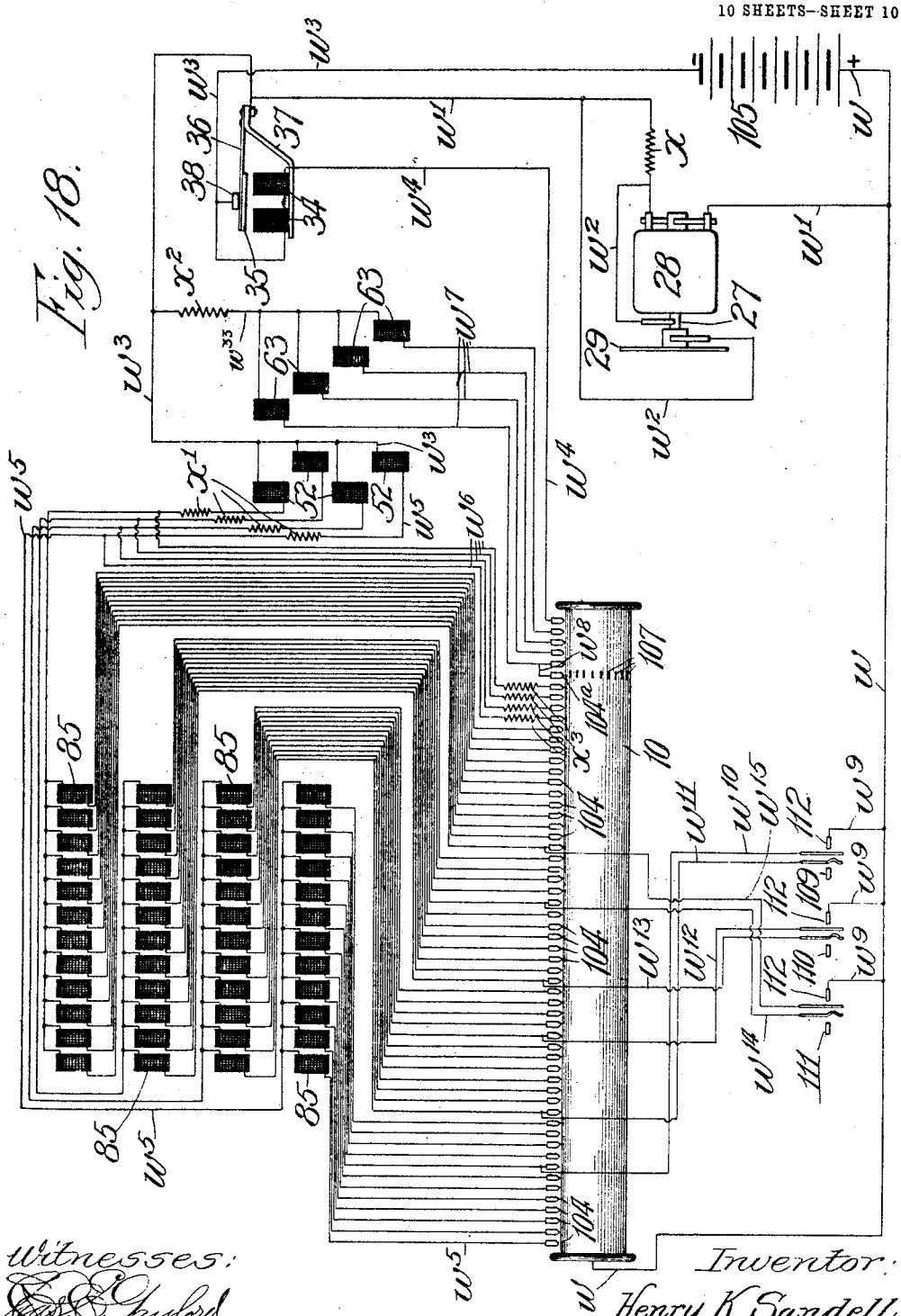
APPLICATION FILED MAR. 27, 1905.

10 SHEETS—SHEET 10.

Fig. 18.



Witnesses:
Chas. S. Gaylord.
John Enders.

Inventor:
Henry K. Sandell.
By Dyrenforth, Dyrenforth & Lee,
Att'ys.

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.

No. 807,871. Specification of Letters Patent. Patented Dec. 19, 1905.

Application filed March 27, 1905. Serial No. 252,228.

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 an improvement in the class of automatically-played musical string instruments in which electrically, pneumatically, and otherwise actuated devices for sounding the strings and similarly-actuated devices for fingering them are operated under the control of a traveling perforated music-sheet through the perforations in which the circuits or valves controlling the sounding and fingering devices are closed to cause these devices to engage and perform their functions on the strings for reproducing the music for which the sheet is cut.

This invention is primarily designed for automatically playing the viol class of instruments, and especially the violin, and the description hereinafter contained relates to that particular instrument; but features of the invention may be used with advantage for operating other varieties of string instruments, and their application thereto is intended to be included in this invention.

Referring to the accompanying drawings, Figure 1 shows the entire machine by a view in front elevation with the electric motor for operating it in dotted lines to avoid confusion in the representation of the cut-out device connected with it. Fig. 1^a is a broken plan view showing mechanical details of the cut-out device, and Fig. 1^b a section taken at the line 1^b on Fig. 1^a and viewed in the direction of the arrow. Fig. 2 is a view showing, in front elevation, the multiple contact device, the contact-roller with which it coöperates through the perforated music-sheet, and the feed-roller for the sheet with the mechanism for operating the rollers. Fig. 3 is a longitudinal section of the contact-roller, taken at the line 3 on Fig. 5 and viewed in the direction of the arrow. Fig. 4 is an enlarged end view of the parts represented in Fig. 2. Fig. 5 is a section taken at the line 5 on Fig. 2, viewed in the direction of the arrow and enlarged. Fig. 6 is an enlarged section taken at the line 6 on Fig. 1 and viewed in the direction of the arrow, showing in end elevation the four longitudinal series of fingering devices and the controlling magnets therefor in their support. Fig. 7 is an enlarged broken view showing in front elevation one of the longitudinal series of fingering devices in their normal relation to a string on a violin. Fig. 7^a is a perspective view of one of the links of the fingering devices. Fig. 8 is a broken view, in sectional elevation, illustrating the action of the fingering devices on a string; and Fig. 9 a similar view illustrating the action of two successive fingering devices in a series thereof when depressed simultaneously. Fig. 10 is a plan view, partly sectional, of the head carrying the rotatable sounding devices and the mechanisms for rotating and depressing them against the strings; and Fig. 11 is a view of the same, in elevation, regarded from the back of the machine, with the rear part of the head shown in section. Fig. 12 shows in end elevation the sounding devices and their controlling-magnets. Fig. 13 is a section taken at the line 13 on Fig. 10 and viewed in the direction of the arrow; Fig. 14, an enlarged section taken at the line 14 on Fig. 10 and viewed in the direction of the arrow, and Fig. 15 an enlarged section taken at the line 15 on Fig. 14 and viewed in the direction of the arrow, showing the means for depressibly supporting a rotatable sounder at its shaft. Fig. 16 is a broken sectional view of a speed-changing adjunct which may be used in connection with the motor, and Fig. 17 a section taken at the line 17 on Fig. 16 and viewed in the direction of the arrow. Fig. 18 is a diagram illustrating the motor-circuits containing the operating mechanisms of the machine.

At 1 is represented a violin rigidly supported by suitable means in position upon the top of an appropriate frame 2 to bring its strings E, A, D, and G under the sounding and fingering devices, hereinafter described.

In use the instrument and mechanism are inclosed in a suitable casing, though representation thereof is omitted from the drawings to avoid unnecessarily amplifying them. The tuning means shown at 3 on the violin-head are of the variety commonly used on the guitar the better to hold at their normal pitch the strings, which should be metal for the sake of durability. The music-sheet 4 represented is a suitably-perforated endless band of paper hung over a guide-board 5, Fig. 4,

supported in inclined position in the front part of the frame 2 toward its left side and to the lower end of which board the sheet passes over a guide-rod 6, extending transversely across its path from the base of the frame, where it depends in loose folds. Across the upper surface of the board 5 near its lower end extends a flat clamping-strip 7, supported in place to yield outwardly and upwardly and carrying upon its back a metal weight 8 for holding it down against the surface of the music-sheet, which passes under it in traveling for maintaining taut the sheet. This is one of various ways that may be employed for disposing of and guiding the music-sheet between a feed-roller 9 and a metal contact-roller 10, forming, with a multiple contact-device 11, hereinafter described, the means for closing the circuits to actuate the sounding and fingering mechanisms through the perforations in the sheet, all as hereinafter explained. In rigid bearing-plates 12 and 13, depending at the proper distance apart from the under side of the top of the frame 2, is immovably secured in horizontal position a fulcrum-rod 14 with its ends projecting beyond the bearings. On the right-hand end of this rod is journaled a grooved pulley 15, from the center of one face of which projects a pinion 16, Figs. 1 and 2. On the same end of the rod 14, at the inner side of the bearing 13, is journaled a hanger 17, and near the opposite end thereof is journaled at its hub or sleeve 19 a similar hanger 18 to depend at the inner side of the bearing-plate 12. The hub 19 projects through the bearing-plate 12 and carries at the outer side thereof a crank-handle 20, provided with a stud 21 near its outer end to engage an aperture 22 in the plate 12 at the lower end of the throw of the handle for retaining it there, the handle having sufficient inherent springiness to shoot the stud into the retaining-aperture when registering therewith. In the lower ends of the swinging hangers 17 and 18 is journaled at its ends the feed-roller 9, which may be composed of hard rubber and carries on its inner end a ratchet-wheel 23, meshing with the pinion 16, and this roller coöperates with the metal contact-roller 10, journaled in the bearing-plates 12 and 13 to feed the sheet 4 by clamping it between the two rollers between which it passes from the upper end of the guide-board 5, as represented in Figs. 4 and 5. Spring-rod devices 24 24, supported in engagement with the hangers 17 and 18 above their fulcrum-points, give to the lower ends of the hangers a tendency to turn toward the contact-roller and to the feed-roller to engage yieldingly therewith.

The pulley 15 is connected for driving it and the feed-roller 9 by its gear connection with the pulley, as also the contact-roller by frictional engagement with it of the feed-roller through the medium of an endless belt 25, with a smaller pulley 26 on one end of the shaft 27 of an electric motor 28, of any known or suitable variety, the shaft carrying near the same end a suitable governor, (indicated at 29,) which may be that of my pending application for Letters Patent Serial No. 237,795, filed on the 21st day of December, 1904, and a gravity-operating belt-tightener 30 is shown in Fig. 1 engaging this belt. The motor-shaft carries on its opposite end a pulley 31, having an endless-belt connection 32 with the brush-shaft pulleys hereinafter described, this belt also being shown equipped with a gravity-tightener 33.

Adjacent to the motor is shown an automatic cut-out comprising a two-spool electromagnet 34, having its armature 35 on a spring-arm 36, extending from a support 37 and tending to raise the armature against a contact 38, extending over its path from a post 39. The armature carries on its free end a spring-pressed tongue 40, Figs. 1[a] and 1[b], adapted to pass a notch 41 in a rock-shaft 42, journaled in bearings 43 and carrying on one end a weighted trip-arm 44. When the trip-arm is in its normal horizontal position with the tongue 40 under the shaft 42, the armature is locked down against the tendency of the spring 36 to raise it against the contact 38, and by tripping the arm 44 to turn the shaft 42 and register with its notch 41 the tongue 40 the latter is freed, permitting the armature to rise under the action of its spring to meet the contact 38, all for the purpose hereinafter explained.

Rising from the frame-top near one end thereof is a housing or casing 45, from the top of which extends an arm 45[a] horizontally over the rear portion of the violin. In the housing are contained a series of pulleys, the two end pulleys 46 and 47 being in the same plane and higher than the plane in which the two intermediate pulleys 48 and 49 lie. The endless belt 32 crosses in the housing and passes over the pulley 48, thence under and about the pulley 46, from which it extends over and about the pulley 47, and thence over the pulley 49 to cause rotation of the motor-shaft to drive the end pulleys correspondingly in one direction and the intermediate pulleys correspondingly in the contrary direction. These pulleys are carried on the rear ends of shafts 50, journaled in the forward wall of the housing 45 to cause each to extend lengthwise over and coincidently with a string of the violin. On the forward end of each rotary shaft 50 is secured a sounder 51, of thin hard material, adapting the sounder by rotating it against a string to perform the function of the common violin-bow. The material composing the sounders found to be especially suitable is celluloid, though the use of other material is within the scope of the invention, and the form required for the purpose to which the material is reduced is that of a disk

or wheel, preferably dished or rendered shell-like to engage the string for sounding the latter by rotating against the same at the peripheral edge of the shell. To enhance the similarity of the sounders 51 in their action and sounding effect on a string to the hair of the ordinary violin-bow, each sounder is composed of a plurality of the dished disks nested together and confined on the threaded end of a shaft 50. As represented, the sets of disks face with their dished sides in alternately-contrary directions to enable successive sets, which mutually overlap, to be in desired close proximity to each other.

Each sounder-shaft, which is adequately flexible, is supported toward its forward end, there to adapt it to be depressed for contacting the sounder upon it with the respective string by an electromagnet 52. These magnets are supported in vertical position in two rows on the arm 45^a and are all of like construction, which may be generally considered that of the ordinary one-spool magnet, though the preferable construction is that shown in the drawings and most clearly illustrated in Fig. 14 and of which the following is a description: The core 53 of the magnet-spool is tubular and is provided with an extension 54 of the same material, shown in the form of a substantially rectangular bracket with its horizontal arms extending over the opposite ends of the spool, the core bearing at its lower end against the lower bracket-arm, whereby the bracket and core are united. The armature 55 is carried on a vertically-reciprocable rod 56, passing through the tubular core, the armature being recessed in its under side to house a spring 57 for raising it when deënergized, confined against it about the rod. The armature works through an opening 58 in the upper horizontal arm of the bracket 54, the magnetism in which when energized supplements that of the core in attracting the armature. The piston-rod 56 is arrested against undue extent of rise by a stop 59 upon it engaging the under side of the arm 45^a, through which the rod passes. The lower end of the rod is expanded and formed into an eye 60 of greater diameter vertically than the shaft 50, which passes through it and is supported therein, and the rod is loosely surrounded by a thimble 61, pressed by a spring 62 against the respective shaft 50, the spring being confined about the rod between a pin 63 thereon and the top of the thimble, the open end of which surrounds the upper portion of the lower expanded end of the rod. The spring 62 cushions the stroke of the thimble against the rod to render the stroke noiseless.

An adjunct is provided to coöperate with the rotary sounders, which form the sounding devices for the violin-strings, this adjunct constituting a regulator for the degrees of and graduations in loudness of playing by regulating the pressure exerted by the sounders against the strings under the depressing action of the magnets 52 on the sounder-shafts. The preferred construction as to details of this adjunct is that illustrated, and is described as follows:

Supported in vertical position on the arm 45^a, behind each magnet 52, is a spool-magnet 63, of ordinary or any suitable construction. A flat rock-bar 64, recessed at intervals in its rear edge and having a raised forward edge, is journaled in bearings 65 at opposite ends of the bank of four magnets 52 and is yieldingly held normally in horizontal position by a spring 66, connecting it with one of said bearings, from which an angle-arm 67 extends behind the bank of magnets 63 and carries at its upper end a horizontal bar 68, provided at intervals on its upper edge with forwardly-projecting fingers 69. The row of the magnets 63 slants backward from the magnet 52, controlling the E-string sounder 51, whereby the distance of separation between each pair of magnets 52 63 increases toward the G-string of the violin. From the rear edge of the rock-bar 64 extend backwardly at intervals fingers 70, Fig. 14, having upturned bifurcated ends, and for each magnet 52 there is loosely confined between the prongs of one of these bifurcated finger ends an arm 71, having a depending tailpiece 71^a, passing through an opening 75 in the rock-bar, and thence extending over the core of the companion magnet 63, where it carries an armature 72. Each armature 72 is held resiliently away from its magnet by a spring 73, confined on a rod 74, rising from an arm 71 through a finger 69. Each piston-rod 56 of a magnet 52 has fastened upon it, between nuts 76 77, a stop-finger 78, the stop-fingers of the two forward magnets 52 projecting horizontally backward and those of the two rear magnets 52 projecting horizontally forward over the forward raised or flanged edge of the rock-bar.

As will be seen, owing to the successively increasing distances of the armatures 72 from the fulcrums of their arms 71 between the prongs of the fingers, the extent of backward tipping of the rock-bar 64 will be relatively greater when an armature 72 on a shorter arm is attracted by its magnet 63 than when that on a longer arm is thus attracted, and the higher the forward edge of the rock-bar is raised by such tilting the shorter will be the possible extent of depression of any rod 56 and of the shaft 50, carried by it, because of the encounter with that edge of the bar of the finger 78 on the piston-rod. The arrangement is such that when the armature 72 on the shortest arm 71 is drawn down by its controlling-magnet the shafts 50 cannot be depressed far enough to contact the sounders thereon with the violin-strings, whereas when the armature on the next longer arm 71 is attracted the possible contact of the sounders

with the violin-strings is slight, while the depression of the next longer arm under attraction of the armature on it by its magnet is sufficient to produce greater pressure of the sounders against the strings, and when the armature of the magnet 63 nearest in line with the G-string of the violin is attracted the rise of the forward edge of the rock-bar 64 will be the slightest and permit to the fingers 78 before encountering it a greater extent of depression, thereby enabling almost the fullest downward movement of the piston-rods to depress the shafts 50 and press the sounders against the strings. As will be explained, retention of the sounders under the highest position of the forward edge of the rock-bar 64 out of contact with the violin-strings enables the tremolo effect to be produced by a feature of the contact-roller, as hereinafter described.

With the sounding devices coöperate fingering devices, these two mechanisms constituting the more important features of the invention. The preferred construction of the fingering devices adapts them to engage the violin-strings in a novel manner to shorten their vibratory lengths for varying the tonal pitch—namely, by confining them against lateral vibration from the points at which the fingering devices engage them toward their forward ends instead of shortening the strings by depression thereof against the surface of the violin finger-board, as in ordinary violin-playing, with the advantage of materially improving the tone quality produced by the action of the sounders, which, as will be understood, by their downward pressure against the strings in rotating in contact therewith hold the latter against vertical vibration. A further function of the fingering devices in a preferred construction thereof is that of operating upon the strings at quarter-tone intervals to enable the tonal effect of slurring along the strings to be produced as also trills to be performed in close imitation of human violin-playing.

Following is the description of the fingering devices of the construction illustrated in the drawings, particular reference being had to Figs. 1, 6, 7, 8, and 9. Adjacent to the finger-board 79 of the violin at the E-string side thereof a hollow post 80 rises from the top of the frame 2 and carries on its upper end to extend over the finger-board a frame composed of curved end pieces 81, rigidly connected by a downwardly-inclined side piece or back 82 and provided with inwardly-extending base-flanges 83, and having bars 84, four in number, extending between them at intervals, the bars being secured at their ends to the curved flanges 83. On each bar 84 are seated endwise electromagnets 85 in a row extending longitudinally of a violin-string, one row being provided for each string and containing, by preference, twelve magnets to correspond with the number of half-tones in the octave. The magnets are single spools and may be of the ordinary construction involving a wire-wound core; but it is preferred to equip each, like the magnets 52, with a reinforcing bracket extension 86 of its core substantially like the extension 54 for the described influence on its armature 87. It is preferred to form all of these brackets for each row of the magnets 85 out of one continuous plate of metal, as represented. From the upper horizontal part of each of the four of these bracket-plates there rises from near each end of the plate a post 88, and on each pair of these posts is supported a longitudinal bearing-bar 89, the bar being perforated at equal intervals along its length to admit guidingly through the perforations reciprocating angular rods 90, having confined about their upper end portions springs 91, holding them resiliently in their normally raised positions. Each rod has secured to it at its upper angle extending over the core of an adjacent magnet an armature 87 and passes between its ends for guidance through an opening in a bar 84 and toward its lower deflected end through a guide-opening provided for it in a horizontal plate 92, rigidly carried by arms 93, depending from near the end of the side or back 82 of the frame supporting the fingering devices. A sleeve 94, of soft rubber or other suitable material, surrounds each rod 90 between its upper shoulder or angle, and its bearing-bar 89 for cushioning and rendering noiseless the upstroke of the rod. Each rod 90 carries yieldingly on its lower end an angular metal strip 95, forming a head of general **S** shape, with a lower stem extension of general inverted-**T** shape forming a fulcrum-bar 96, extending transversely across a violin-string. To connect a head 95 with its rod 90, the latter passes loosely through openings in the two uppermost horizontal sections of the head, which is sustained on the rod by a pin 97, extending transversely through it, between which pin and the horizontal section below it of the angular head is confined about the rod a spiral spring 98 for cushioning and rendering noiseless the stroke of the fingering device against the finger-board. The intervals between the lower ends of the rods 90 in each longitudinal series thereof are suitably graduated to register the bars 96 with the half-tone intervals on the violin-string along which the series of fingering devices extend. In the lower edge of each fulcrum-bar 96 is formed a **V**-shaped notch 99, Fig. 6. The notched fulcrum-bars on each longitudinal series of the rods 90 are connected flexibly from one to the other by yoke-shaped links, each comprising a central bar 100, Fig. 7[a], transversely arched to conform to the notches 99 and extending across a violin-string and having arms 101 extending laterally in opposite directions from it. These arms terminate in apertured ears 102, and the members of each pair of ears on the ends of the arms extending from one side of the cen-

tral arched bar 100 are somewhat farther apart than those on the ends of the oppositely-extending arms, so that the ears closer together on one link may fit overlappingly between those on the adjacent arms of the next link in the series, and the ends of the bars 96 pass through the ears 102, thus linking the bars 96 together throughout the series thereof.

The finger-board 79 is longitudinally grooved to form a ridge 103, Fig. 6, under and lengthwise of each string.

By the described construction of the fingering devices when a magnet 85 is energized and attracts its armature depression of a rod 92, and with it of a bar 96, ensues. When a pair of the link-ears 102, engaging the depressed bar embracingly, encounters a ridge 103 on the finger-board, the impact is cushioned and rendered noiseless by the respective spring 98, and the parts are so relatively arranged that when the encounter takes place the string affected will at the point acted upon be in the apex of the respective notch 99 and be therein held against the lateral vibration referred to, with the effect of producing in purity the tonal pitch of the string resulting from the shortening of its vibratory length. The same results ensue in like manner from the depression of any rod 90 singly under the attraction of an armature 94 by its magnet, this action being illustrated in Fig. 8. To cause a bar 100 to act on its string to emit a quarter-tone pitch in sounding it, two adjacent rods 90 in a longitudinal series thereof are simultaneously depressed, as represented in Fig. 9, with the result of embracing the string in the apex of the arched bar 100, which seats at its ends embracingly on the respective ridge of the finger-board and prevents the ears on the fulcrum-bars flanking the arched bar from engaging that ridge to enter the string into the apexes of the notches. This is because the arches in the bars 100 are slightly shallower than the notches in the bars 96. The same quarter-tone will obviously be produced when a single rod 90 is depressed and held in depressed condition while the next succeeding rod is being depressed, and with the first rod so held by rapidly vibrating the next adjacent rod while a sounder 51 is being rotated against the string acted upon a perfect quarter-tone trill will be performed.

It is within the invention to produce rotation of the sounders by other driving means than an electric motor and to regulate their pressure against the strings, as also to actuate the fingering devices by power other than electricity, as by pneumatic power. However, the invention is devised especially to be worked electrically, and to that end the electric contact-bar 11 is provided to coöperate with the contact-roller 10. The magnets controlling the fingering devices and those controlling the sounding devices are electrically connected in series and cause the magnets to work together under the contact making and breaking action of the music-sheet 4 in traveling between the roller 10 and the bar 11, supported to extend parallel with it and provided with spring contact-fingers 104 to the number of fifty-eight, which engage the roller through the perforations in the sheet. This number of the contact-fingers includes forty-eight to correspond and be connected with the same number of magnets 85 in the four series thereof, also a set of four of the contact-fingers to correspond and be connected with the like number of magnets 52 for the open violin-strings and another set of four of the contact-fingers to correspond and be connected with the number of magnets 63. One of the last-named set of contacts has connected with it a fifth contact to coöperate with the tremolo feature referred to as being provided on the contact-roller, and an additional spring contact-finger is provided for controlling the operation of the cut-out device of the electric motor.

The diagram illustrated in Fig. 18 represents the circuit connections of the electrically working parts of the machine with a current-generator, (indicated at 105,) and the operation may best be explained by reference to that figure, while bearing in mind the described construction of the operating parts of the mechanism and their action.

In the condition of the parts illustrated in the drawings the machine is playing. The rotating motor-shaft by its belt connection 32 with the pulleys on the shafts 50 rotates the latter constantly during the playing of the piece for which the music-sheet 4 is cut by the travel of the sheet produced by the belt connection 25 of the motor-shaft with the pulley 15, which drives the feed-roller 9 and causes it by its frictional coöperation with the contact-roller 10 to move the sheet continuously across the latter. The motor-circuit is closed and traceable as follows: from the positive pole of the generator 105 over the wire w and a branch w', leading therefrom through the motor-brushes, beyond which the branch contains a resistance-coil at x to direct a portion of the current over a shunt-line w^2 through the governor 29, and the branch w' leads to the spring 36, which conducts the current to the contact 38, connected with a wire w^3, leading back to the generator at its negative side. On the completion of a piece a perforation 106 in the music-sheet registers with the spring-contact 104 at the extreme right-hand end of the series of contacts, permitting it to bear, through the perforation, against the contact-roller, though this engagement is only momentary, since the inertia of the sheet-driving mechanism carries the perforation beyond the contact in its path to interpose the paper between it and the contact-roller. When the aforesaid momentary contact engagement takes place, the motor is cut out of the generator-circuit

by the course of the current over the wire w through the contact-roller 10 to the aforesaid final spring-contact 104, whence a wire w^4 leads through the cut-out magnet 34 to the wire w^3, which goes to the generator. The magnet 34 is thus energized to attract its armature 36 away from the contact 38, thereby stopping the motor by breaking the motor-circuit, which would immediately close again by opening the cut-out-magnet circuit as the result of the slight travel of the music-sheet referred to in interposing paper between the said final contact 104 and contact-roller were it not for the action of the lock comprising the weighted arm 44 on the rock-shaft 42 causing the latter to hold the armature 36 in its attracted position away from the contact 38. To again start the motor, the operator depresses the arm 44 to turn the shaft 42 and bring its recess 41 into registration with the tongue 40, freeing the latter and permitting the spring 36 to raise the armature into engagement with the contact 38, thereby closing the motor-circuit.

In the travel of the music-sheet the fingers 104 contact through its perforations with the roller 10 and close circuits containing the magnets 85 to actuate the fingering devices, the magnets 52 to depress or tend to depress the sounder-shafts, and the magnets 63 to control the pressure of the sounders against the strings, all in the manner described and in the order determined by the perforations in the music-sheet. As all the circuits containing the magnets 85 are alike, description of one of them will suffice, taking the one which includes the first contact-finger 104 at the left-hand end of the series, which is the particular contact-finger that controls the magnet 85 for actuating the first fingering device over the G-string to engage the latter at the G-sharp positive thereon. When a perforation in the music-sheet registers with the contact-finger last referred to, the circuit closes over the wire w, roller 10, said contact-finger, and the wire w^5 leading therefrom through a magnet 85, thence through a magnet 52 to the wire w^3, which returns to the generator through the cut-out device, as hereinbefore described. All the wires leading from the twelve contacts 104 to the magnets 85, controlling the G-string fingering devices, lead through the magnet 52, controlling the G-string sounder-shaft, and each of the three succeeding groups of twelve of the contacts 104 has its wires, all of which may be considered to be denoted by w^5 on the diagram, leading through the magnet which controls the D-string sounder-shaft, another through the magnet which controls the A-string sounder-shaft, and another through the magnet which controls the E-string sounder-shaft. Each wire w^5 contains between the bank of magnets 85, from which it proceeds, and the magnet 52, to which it leads, a resistance-coil x' to avoid overcharging the sounder-controlling magnets with current. A branch wire w^{33} connects the wire w^3 with each of the magnets 63 and contains a resistance-coil x^2.

The group of four of the contact-fingers 104 which control the action of the sounders on the open strings of the violin are identified in the diagram by resistances x^3 in the wires w^6, leading from them each to a wire w^5 near its connection with a sounder-magnet 52. As will be understood, when a perforation in the traveling music-sheet registers with any one of these last-named contacts the circuit-closure occurs, the current passing over the wire w and roller 10 to that contact and thence over the respective wire w^6 and wire w^5 through a magnet 52 to the wire w^3 returning to the generator. The resistance x^3 compensates for the lesser work required of the current in not passing through a magnet 85 to perform work.

The four contact-fingers 104 in the group immediately adjacent to the final contact which controls the cut-out are each connected by a wire w^7 immediately with a different magnet 63 for regulating the sounder-pressure against the strings, the circuit for this purpose being closed, when one of these fingers contacts with the roller 10 through a perforation in the traveling music-sheet over the wire w^7, leading through a magnet 63 and to the wire w^{33}, which connects with the return-wire w^3. The wire w^7, which proceeds from the first on the left-hand side of the group of contact-fingers controlling the magnets 63, leads to the one of said magnets the armature 72 of which has the shortest arm 71, whereby depressive attraction of that armature raises the forward edge of the rock-bar 64 so high as to prevent the armatures 55 from depressing the sounder-shafts, thus preventing contact of the rotating sounders with the strings. Connected with that wire w^7 by a wire w^8 is a single spring-contact, (indicated at 104^a in Fig. 18,) registering with a circumferential series of insulation-points 107, spaced uniformly apart about the roller 10 and inlaid therein flush with its surface. When a perforation in the traveling music-sheet registers with this ring of insulation-points, the rotation of the roller brings alternately metal and insulation against the contact-finger 104^a and causes a rotating sounder 51, the magnet 52 of which is energized, to contact vibratingly with its string. This is because the circuit over the wire w^7 and said wire leading through the magnet 63, which raises the forward edge of the rock-bar 64 to the highest point to the wire w^{33} connected with the return-wire w^3, closes each time metal between the insulation-points 107 encounters the contact 104^a, whereas when an insulation-point encounters the same the circuit is broken, deënergizing the said magnet 63 and permitting the energized sounder-shaft magnet to depress the sounder it controls against a string. The in-

laid insulation-points 107 are represented in Fig. 2 and also in Fig. 3, which latter shows in the roller 10 a supply of mercury 108 for enhancing the conductivity of the roller.

A further desirable adjunct consists of means for facilitating the tuning of the violin-strings by turning the keys 3, of which the following is a description: The tuning operation is performed while the sounders 51 are rotating under the action of the motor 28, but requires the travel of the music-sheet to be arrested, and this may be effected at any time by turning the crank 20 downward and locking it by the entry of its stud 21 into the aperture 22, thus by turning the crank swinging backward the hangers 17 18 and withdrawing the feed-roller 9 from the contact-roller 10, whereby the feed of the sheet is stopped. On the top of the frame 2 at the front thereof in line with the base of the post 80 is provided a bank of three push-buttons 109, 110, and 111, Figs. 1 and 18. Coöperating with, but normally separated from each push-button, is a contact 112, connected by a wire w^9 with the wire w. Conductors w^{10} and w^{11} lead directly from between the button 109 and its contact 112, respectively, to the wire w^5, connected with the eighth contact-finger 104 of the twelve G-string row of these fingers controlling the magnet 85, operating at the D-sharp position on the G-string, and to the wire w^5, connected with the first contact-finger 104 of the twelve D-string row of three fingers controlling the magnet 85, operating at the D-sharp position on the D-string. Thus by depressing the button 109 the conductors w^{10} w^{11} will close circuits over them from the wire w to the wires leading from the aforesaid eighth and first contacts 104 to the respective magnets 85, actuating them to depress the fingering devices they control at the D-sharp positions on the G and D strings, whereby when these strings are in tune the sounders rotating against them will cause them both to sound D-sharp, and when one string is out of tune it may be strained to the pitch of the other, which serves to guide the ear of the operator in tuning. The conductors w^{12} and w^{13}, acted on in the same way by the push-button 110, lead, respectively, to the wire w^5, proceeding from the eighth contact-finger 104 in the second series of twelve controlling the D-string magnets 85, and to the wire w^5, proceeding from the first finger 104 in the third series of twelve controlling the A-string magnets, whereby depressing the button 110 closes the circuits of the magnets 85 for actuating the foregoing devices that engage the D and A strings at the A-sharp positions on them for the described guiding purpose in tuning. The conductors w^{14} and w^{15} acted on in the same way by the push-button 111, lead, respectively, to the wire w^5, proceeding from the eighth contact-finger 104 in the third series of twelve controlling the A-string magnets 85, and to the wire w^5, proceeding from the first finger 104 in the fourth series of twelve controlling the E-string magnets, whereby depressing the button 111 closes the circuits of the magnets 85 for actuating the fingering devices that engage the A and E strings at the E-sharp positions thereon for the described guidance in tuning.

If desired, automatic tempo-varying means may be provided to be actuated by the motor 28, and a device suitable for the purpose is illustrated in Fig. 16, involving the following described construction: On one end of the motor-shaft 27 is reciprocably mounted a wedging thimble 113, engaging at its tapering end a flaring recess 114 about the center of a radially-split pulley 115, surrounding the shaft on the end of a longitudinally and correspondingly split sleeve 116 about the shaft and proceeding from a collar 117, secured on the shaft to rotate with it by a set-screw 118. The split pulley would supplant the pulley 26 and be connected by the belt 25 with the brush-shaft pulleys. Below the shaft 27 is supported in alinement therewith on a stand 119 an electromagnet 120, having a spring-armature 121, one end of which is secured to the stand to cross the magnet-core, the other end bearing against the thimble 113. The magnet will be included with a contact-finger like and additional to the fingers 104, coöperating with the roller 10 and included in a circuit of the generator. The circuit connection referred to is readily understood by those skilled in the art, and illustration thereof in the accompanying drawings is therefore unnecessary and is omitted to avoid supplementing therewith the diagram in Fig. 18, which would tend to confusion thereof. The operation will be understood, however, to be the following: When the circuit containing the magnet 120 is closed through the perforated traveling music-sheet, resultant attraction of the armature 121 will cause it to force the thimble 113 against the pulley 114, with the effect of expanding it, and thus increasing its diameter, thereby speeding its peripheral rotation and correspondingly speeding the rotation of the feed-roller 9. By energizing the magnet 120 the wedging thimble therefore increases the speed of travel of the music-sheet, and when the magnet is deënergized the springiness of the armature 121 permits it to be retracted with the unwedging retractive movement of the thimble 113 under the contractive force exerted upon the sections of the pulley 115 by the sections of the sleeve 116, which are of resilient metal.

The foregoing exact description of all the parts of the machine as illustrated and their manner of operation and coöperation is necessary to a ready understanding of the entire invention by reason of the comparatively complicated construction embodying it. Without departure from the invention, however,

the mechanism, as also the combinations of parts thereof, are susceptible of considerable modification, so that it is not intended to be limited to particular details of construction and combinations except in such of the appended claims as specify them.

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

1. In a stringed instrument, the combination with a string, of a part provided with a dished disk, the periphery of which is adapted for frictional contact with the string when said part is moved toward the same, means for rotating said disk, and means for moving the same toward and from the string.

2. In a stringed instrument, the combination with a string, of a part provided with a dished disk, the periphery of which is adapted for frictional contact with the string when said part is moved toward the same, means for rotating said disk, means for moving the same toward and from the string, and means for cushioning the movement of said disk.

3. In combination with a stringed instrument, a rotatable sounding device supported relative to a string of the instrument and comprising a dished disk presenting its edge to the string against which it is rotated.

4. In combination with a stringed instrument, a rotatable sounding device supported relative to a string of the instrument and comprising a body composed of a plurality of dished disk members nested together and presenting their edges to the string against which said body is rotated.

5. In combination with a stringed instrument, a rotatable sounding device supported relative to a string of the instrument and comprising a body composed of a plurality of dished disk members nested together and presenting their edges to the string against which said body is rotated, means for rotating said body and means for moving it toward and from the string.

6. In a self-playing stringed instrument, the combination with a string, of a sounding device including an electromagnet, a fingering device including an electromagnet, an electric circuit including said magnets in series, and a shunt across the fingering-device magnet, whereby the sounding-device magnet may be energized without energizing the fingering-device magnet.

7. In a self-playing stringed instrument, the combination with a string, of a sounding device including an electromagnet and adapted to sound said string, a plurality of fingering devices each provided with an electromagnet and adapted to finger said string when its magnet is energized, and an electric circuit having branches, 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.

8. In a self-playing stringed instrument, the combination with a string and a source of electrical supply, of a sounding device including an electromagnet and a dished disk adapted to sound said string, a plurality of fingering devices each provided with an electromagnet and adapted to finger said string when its magnet is energized, and a circuit extended from said source and having branches, each branch including one only of the fingering-device magnets and the common part including the magnet of said sounding device, whereby each of said fingering-device magnets is included in series with said sounding-device magnet.

9. In combination with a string of a stringed instrument, a fingering device therefor consisting of a notched bar supported to extend transversely of the string and reciprocate at right angles thereto, and means for depressing said bar to straddle at its notch said string and hold it against lateral vibration.

10. In combination with a string of a stringed instrument, a plurality of fingering devices therefor consisting of notched bars supported at intervals transversely of the string and a link flexibly connecting said bars, having a bar arched across said string, and means for depressing said bars to straddle the string and hold it against lateral vibration.

11. In combination with a string of a stringed instrument, a cushion-equipped fingering device therefor having a notched bar supported to extend transversely of the string and reciprocate at right angles thereto, and means for depressing said bar to straddle at its notch said string and hold it against lateral vibration.

12. In combination, a stringed instrument having its finger-board provided with a longitudinal ridge below a string, and a fingering device consisting of a notched bar supported to extend transversely of the string, and means for depressing said bar to straddle at its notch said ridge and said string to hold the string against lateral vibration.

13. In combination, a stringed instrument having its finger-board provided with a longitudinal ridge below a string, and a plurality of fingering devices consisting of notched bars supported at intervals transversely of the string and a link flexibly connecting said bars, having a bar arched across said string, and means for depressing said bars to straddle said ridge and said string to hold the string against lateral vibration.

14. In combination, a stringed instrument having its finger-board provided with longitudinal ridges, one for each string, a row of fingering devices extending along each string, each device provided with an electromagnet and with a notched bar extending across a

string to be depressed by energizing its controlling-magnet to straddle a ridge and the string above it and hold the string against lateral vibration, a sounding device for each string provided with an electromagnet, and an electric circuit having branches, each branch including one only of said fingering-device magnets, the branches for each row having a common part including one of said sounding-device magnets, whereby each of said fingering-device magnets is included in series with a sounding-device magnet.

15. In combination, a stringed instrument, rows of cushion-equipped fingering devices for the strings, each device provided with an electromagnet and with a notched bar extending across a string to be depressed by energizing its controlling-magnet to straddle the string and hold it against lateral vibration, sounding devices for the strings, each provided with an electromagnet, and an electric circuit having branches, each branch including one only of said fingering-device magnets, the branches for each row having a common part including one of said sounding-device magnets, whereby each of said fingering-device magnets is included in series with a sounding-device magnet.

16. In combination, a stringed instrument, rows of fingering devices for the strings, each device provided with an electromagnet, sounding devices for the strings, each provided with an electromagnet, an electric circuit having branches, each branch including one only of said fingering-device magnets, the branches for each row having a common part including one of said sounding-device magnets, whereby each fingering-device magnet is included in series with a sounding-device magnet, and means for regulating the depression of said sounding devices including electromagnets contained in other branches of said circuit.

17. In combination, a stringed instrument, rows of fingering devices for the strings, each provided with an electromagnet, sounding devices for the strings, each provided with an electromagnet, an electric circuit having branches, each branch including one only of said fingering-device magnets, the branches for each row having a common part including one of said sounding-device magnets, whereby each fingering-device magnet is included in series with a sounding-device magnet, and an electric tuning attachment comprising other branches of said circuit connected with different magnets of the several rows of fingering devices and operating, by their closure, to actuate the fingering devices of different strings simultaneously.

18. In combination with a string of a stringed instrument, a fingering device comprising an electromagnet provided with an armature, a rod depending from said armature to be reciprocated by its movements, and a notched bar yieldingly supported on the lower end of said rod to extend across the string.

19. In combination with a string of a stringed instrument, fingering devices comprising a series of electromagnets, each provided with an armature carrying a depending rod, spring-supported heads on the lower ends of the rods terminating in notched bars extending transversely of the string, and links connecting said bars from rod to rod and each provided with an arched bar extending transversely of the string between a pair of said notched bars.

20. In combination with a string of a stringed instrument having a longitudinal ridge on its finger-board registering with said string, fingering devices comprising a series of electromagnets each provided with an armature carrying a depending rod, spring-supported heads on the lower ends of the rods terminating in notched bars extending transversely of the string, and yokes linking said bars from one to another, terminating in perforated ears at which they are fulcrumed on said bars and each having an arched bar extending transversely of the string between a pair of said notched bars.

21. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and a feed-roller for a perforated music-sheet coöperating with said contact-roller and geared to the motor, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to said strings, electromagnet-controlled fingering devices supported to engage the strings on the finger-board of the violin, and electrical contacts coöperating with the contact-roller through perforations in said sheet, each of said branches connecting one fingering-device magnet with one of said contacts and the branches for the fingering devices of each string having a common part including a sounding-device magnet.

22. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and a feed-roller for a perforated music-sheet coöperating with and adjustable relative to said contact-roller and geared to the motor, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to the strings, electromagnet-controlled fingering devices supported to engage the strings on the finger-board of the violin, and electrical contacts co-operating with the contact-roller through perforations in said sheet, each of said branches

connecting one fingering-device magnet with one of said contacts and the branches for the fingering devices of each string having a common part including a sounding-device magnet.

23. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and motor-driven means coöperating with said roller for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to said strings, electromagnet-controlled fingering devices supported to engage the strings on the finger-board of the violin, electrical contacts coöperating with said contact-roller through perforations in said sheet, and an electromagnet-actuated regulator for the movements of the sounders, said fingering-device magnets being each connected by one of said branches with one of said contacts and the branches for the fingering devices of each string having a common part including a sounding-device magnet, and others of said contacts being each connected by a branch with one of the magnets of said regulator.

24. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and motor-driven means coöperating with said roller for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to said strings, electromagnet-controlled fingering devices supported to engage the strings on the finger-board of the violin, electrical contacts coöperating with said roller through perforations in said sheet, stop-fingers on the armatures of the sounding-device magnets and a spring-controlled rocker-bar engaged by said fingers, and a regulator comprising electromagnets supported at varying distances relative to said sounding-device magnets and arms fulcrumed on said rock-bar and each extending therefrom to a different regulator-magnet and carrying the armature thereof, said fingering-device magnets being each connected by one of said branches with one of said contacts and the branches for the fingering devices of each string having a common part including a sounding-device magnet, and others of said contacts being each connected by a branch with one of the magnets of said regulator.

25. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and motor-driven means coöperating with said roller for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to said strings, electromagnet-controlled fingering devices supported to engage the strings on the finger-board of the violin, electrical contacts coöperating with said roller through the perforations in said sheet, an electromagnet-actuated regulator for the movements of the sounders by their controlling-magnets, and a tremolo attachment on said roller, said fingering-device magnets being each connected by one of said branches with one of said contacts and the branches for the fingering devices of each string having a common part including a sounding-device magnet, and others of said contacts being each connected by a branch with one of the magnets of said regulator, one of said last-named branches having connected with it a contact which registers with said tremolo attachment.

26. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and motor-driven means coöperating with said roller for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to the strings, electromagnet-controlled fingering devices supported to engage the strings on the finger-board of the violin, electrical contacts coöperating with said roller through perforations in said sheet, an electromagnet-actuated regulator for the movements of the sounders by their controlling-magnets, and a circumferential series of spaced insulating-points about said roller and with which one of said contacts registers, said fingering-device magnets being each connected by one of said branches with one of said contacts and the branches for the fingering devices of each string having a common part including a sounding-device magnet, and others of said contacts being each connected by a branch with one of the magnets of said regulator and with one of which last-named branches said registering contact is connected.

27. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and motor-driven means coöperating with said roller for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to said strings,

a row of electromagnet-controlled fingering devices for each string to engage it at intervals on finger-board of the violin, electrical contacts coöperating with said roller through perforations in said sheet, each of said branches including one only of said fingering-device magnets, the branches for each row having a common part including one of said sounding-device magnets, whereby each of said fingering-device magnets is included in series with a sounding-device magnet, and shunts across certain of the fingering-device magnets, whereby each sounding-device magnet may be energized without energizing any fingering-device magnet connected therewith.

28. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuits having branches, an electrical contact-roller in said circuit and motor-driven means adjustable relative to said roller and coöperating therewith for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to the strings, a row of electromagnet-controlled fingering devices for each string to engage it at intervals on the finger-board of the violin, electrical contacts coöperating with said roller through perforations in said sheet, each of said branches including one of said contacts and one only of said fingering-device magnets, the branches for each row of said fingering-device magnets having a common part including one of said sounding-device magnets, whereby each of said fingering-device magnets is included in series with a sounding-device magnet, and an attachment for simultaneously actuating two fingering devices, one in each of two rows thereof.

29. In an electric violin-playing machine, the combination with a supporting-frame for the parts, of a generator-circuit and a motor therein, said circuit having branches, an electrical contact-roller in said circuit and motor-driven means adjustable relative to said roller and coöperating therewith for moving across it a perforated music-sheet, rotary shafts driven by said motor and carrying sounders for the violin-strings, electromagnet-controlled supports for said shafts for moving the sounders relative to said strings, a row of electromagnet-controlled fingering devices for each string to engage it at intervals on the finger-board of the violin, electrical contacts coöperating with said roller through perforations in said sheet, each of said branches including one only of said fingering-device magnets, the branches for each row of said fingering-device magnets having a common part including one of said sounding-device magnets, whereby each of said fingering-device magnets is included in series with a sounding-device magnet, and a set of push-buttons each controlling two of said branches and connected therewith beyond their respective contacts.

HENRY K. SANDELL.

In presence of—
L. HEISLAR,
J. H. LANDES.