(No Model.) 3 Sheets—Sheet 1.

A. L. CALDERA.

KEY BOARD MUSICAL INSTRUMENT.

No. 382,028. Patented May 1, 1888.

Fig. 2.

Fig. 1.

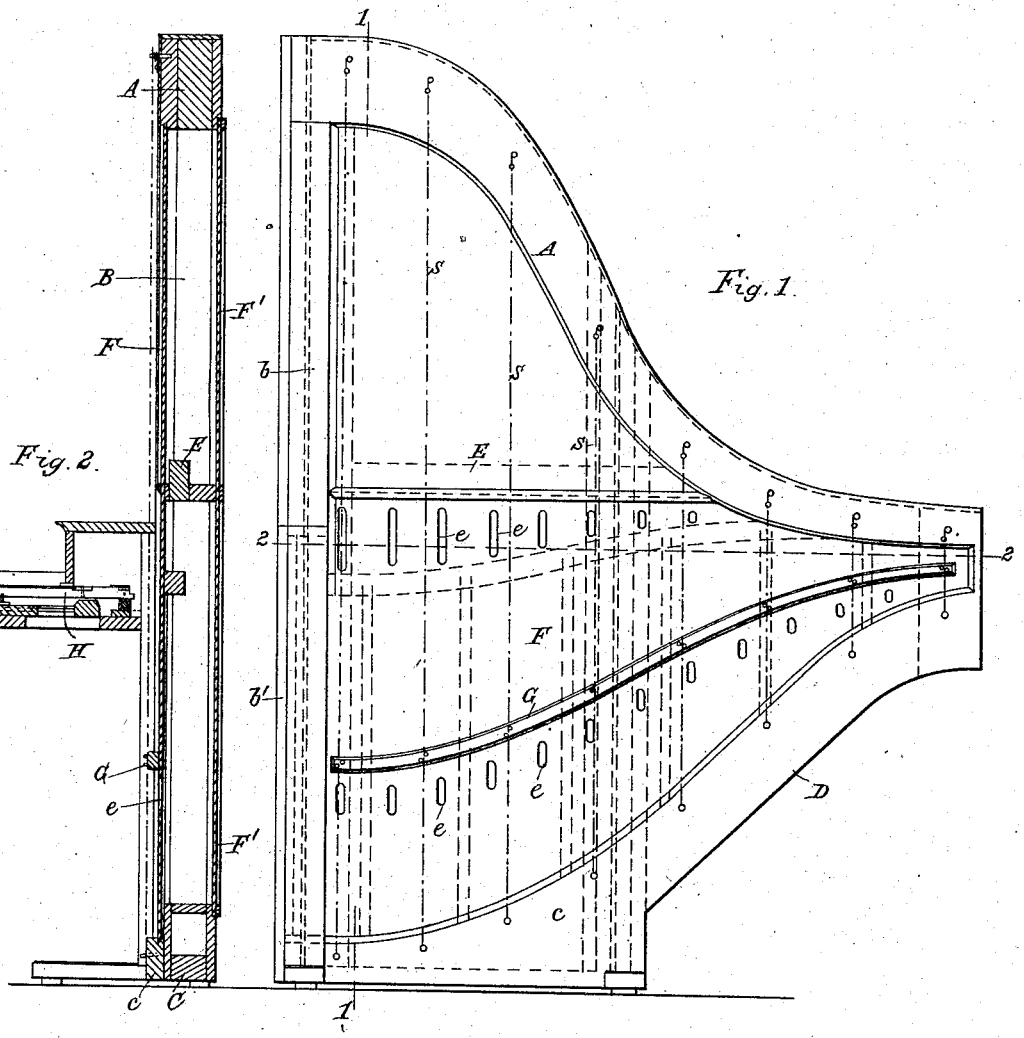

Fig. 3.

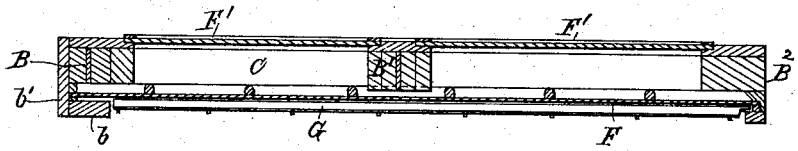

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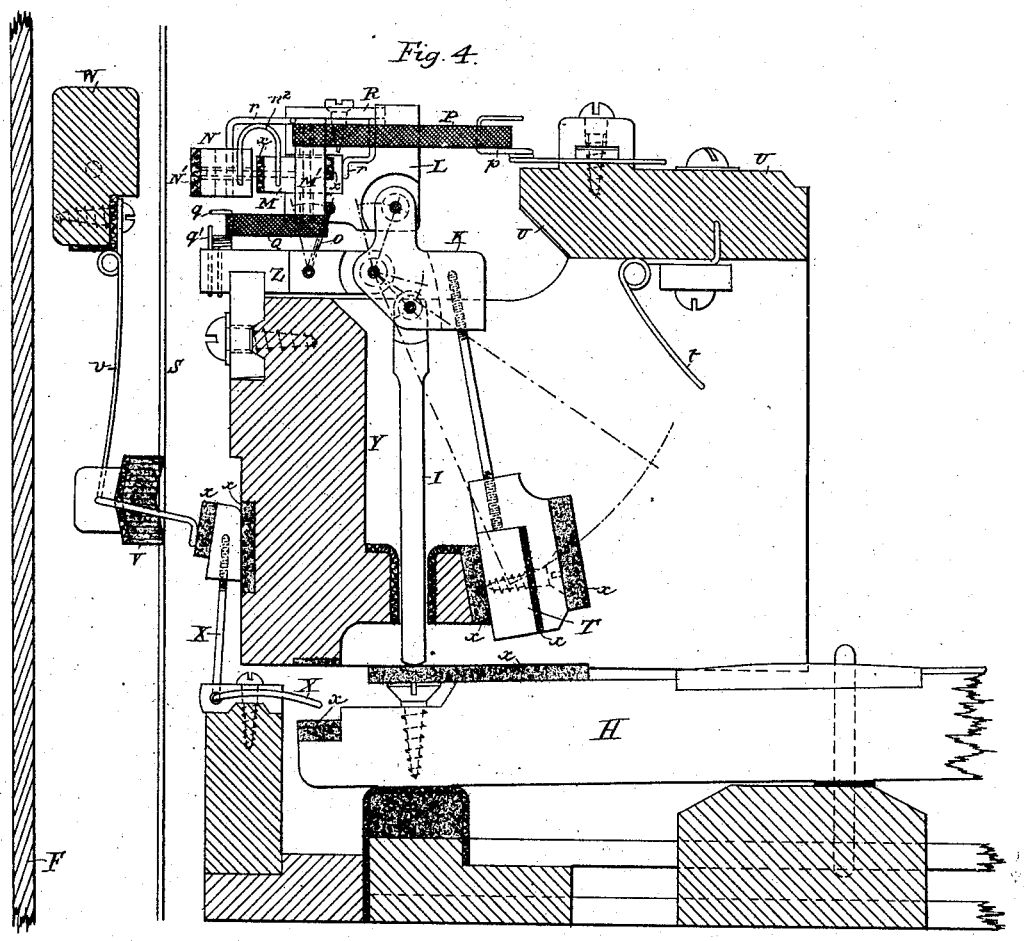
Fig. 4.



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KEY BOARD MUSICAL INSTRUMENT.

No. 382,028. Patented May 1, 1888.

FIG. 5.

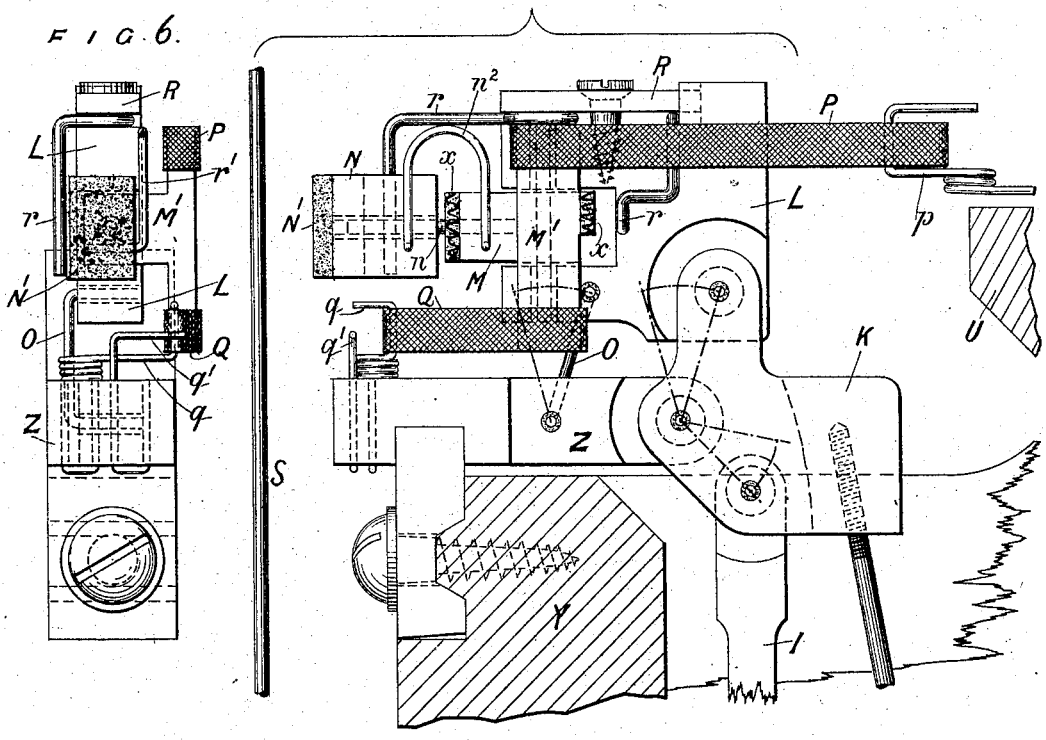
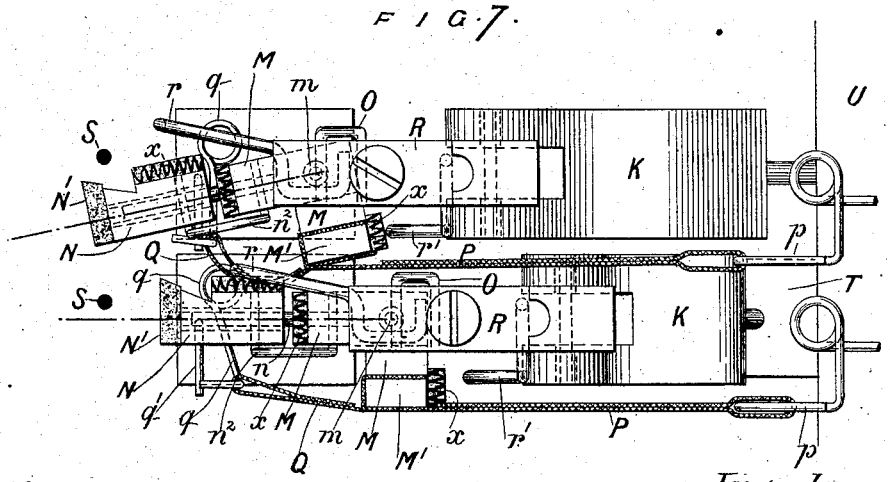


FIG. 6.

FIG. 7.



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UNITED STATES PATENT OFFICE.

ANDREA LUIGI CALDERA, OF TURIN, ITALY.

KEY-BOARD MUSICAL INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 382,028, dated May 1, 1888.

Application filed June 30, 1887. Serial No. 242,932. (No model.) Patented in Italy December 31, 1886, No. 20,950.

To all whom it may concern:

Be it known that I, ANDREA LUIGI CALDERA, of 39 Rue de Po, Turin, in the Kingdom of Italy (but at present residing at Hotel Previtali, Arundel street, London, in the county of Middlesex, England,) engineer, have invented a new and useful Improved Key-Board Musical Instrument, of which the following is a full, clear, and exact description, and for which I have obtained Letters Patent in Italy, dated December 31, 1886, the number of which is 20,950.

This invention relates to an improved key-board musical instrument producing tones having the characteristic quality of those of the harp, but fuller, richer, and more sustained, the volume of tone approaching that of a piano-forte, and being capable of as much variation or gradation.

The body or frame of this new instrument approaches in outline that of a harp; but the strings, which are metallic, are parallel to the sound-board, as in a piano-forte, and are played upon by a mechanical finger moving up against them and then rubbing sidewise past them. Many attempts have been made to produce such an instrument, but without practical result, the failure being due to the fact that the plectrum, or organ by which the strings are twanged or plucked, has always been actuated directly by the keys without any provision for assisting the player's fingers to overcome the resistance of the strings to deflection, and as the strings are of different lengths, and have consequently different degrees of tension and flexibility, each key had necessarily to be struck or depressed with a different degree of force, according to the length of string to be vibrated. Such instruments were, consequently, of no practical utility, especially as the keys could not be moved with the ease and rapidity essential to the performance of a musical composition.

In the improved instrument of this invention the key is depressed by the finger, as in playing the piano-forte, and the string is acted on by a plectrum or organ which is designed to produce the effect of the human finger upon the string of the ordinary harp, and with the action or operative mechanism of which is combined a weighted arm, whereby power is stored up during one part of the motion of the key and given out at another, so as to equalize the motion and insure sufficient pressure of the plectrum against and its rapid escape from the string.

Reference is to be had to the accompanying drawings, forming part of this specification, wherein Figure 1 is a face view of the sound-board and frame. Fig. 2 is a vertical section on line 1 1, and Fig. 3 is a horizontal section on line 2 2. Fig. 4 is a cross-section of the action (full size.) Fig. 5 is a similar view of part of the same, drawn twice full size. Fig. 6 is a face view of the action for one note, and Fig. 7 is a plan of the action for two notes, the parts being in different positions for the two notes.

The same letters of reference indicate the same parts in all the figures.

The frame of the instrument comprises the wrest-plank A, in shape somewhat resembling the neck of a harp, supported by wood bracings B B′ at the bass end and middle of the instrument, rising from the lower cross-bar, C, a third short bracing, B^2, connecting the end of the wrest-plank to a diagonal piece, D which is connected at its other end to the lower end of the bracing B′. The bracings B B′ are connected by a cross-bracing, E.

The sound-board F somewhat resembles that of an upright piano, although differing therefrom in many respects. It has resonance-holes *e*, and is barred, as represented in dotted lines. It passes the wooden plate *b*, forming part of the bracing B, and terminates at the plate *b*′, glued to B.

G is the belly-bridge, over which bear, as in a piano-forte, the strings connected to the hitch-pin plate *c* and to the wrest-pins. To avoid confusion, only the strings corresponding to the seven octaves of the note F have been represented by broken lines. The curve of the belly-bridge is continuous—*i.e.*, without breaks or angles—and is necessarily in correlation with the curve passing through the centers of the wrest-plank bridge-studs.

F′ is a second sound-board forming the back of the sound-chamber of the instrument.

The line on which the strings are acted on by the mechanical fingers or plectra of the action is also represented by the line 2 2. This line intersects the strings S at a certain proportion of their length in the same way as in

the piano-forte. The "strike" line, or line of percussion of the hammers, is at a certain fraction of the length of the string in vibration; but in order to obtain the characteristic quality of tone of the ordinary harp and to enable the string to have sufficient flexibility to allow it to yield under the pressure of the mechanical finger or plectrum, the situation of this line is very different to that in the piano. Measured on the first F in the bass, it is situated at nine-thirteenths of the length of string in vibration, reckoning from the wrest-plank bridge. From this point toward the treble it gradually approaches the middle of the strings until, on reaching the sixtieth string, or the fifth octave, it will be just at mid-length of the string, at which proportion it remains for the higher notes. The position of this line is very important, and is in fact essential to the success of the new instrument, and although I have thus specified the best position with considerable accuracy, I do not absolutely limit myself thereto, as some variation is allowable, say, between the middle and two-thirds the length of the string measured on the first-bass string.

The preferred form of the curves to be given to the line of centers of the wrest-plank bridge-studs and to the belly-bridge, which are necessarily in correlation to each other, is graphically represented in Fig. 1. The belly-bridge is fixed upon the sound-board at its mid-height, so that throughout the whole of the instrument there is as large an area of sound-board above as below the bridge. This is important, in order to obtain a uniformly sweet and harmonious tone throughout the whole scale of the instrument.

The instrument is a monochord—that is to say, each note is produced by the vibration of a single string, as in a harp; but the strings, as before mentioned, are metallic, like those of a piano, instead of being of catgut. This instrument, therefore, stands much better in tune than an ordinary harp. It is preferred that the strings should be about the same length, but of half the diameter, and consequently have a quarter of the tension, of the corresponding strings of an ordinary upright piano-forte.

The action whereby the pizzicato or twanging effect of the harp is produced is illustrated in Figs. 4 to 7. The key-board is similar to that of a piano-forte. The key H acts through a sticker, I, upon an elbow-lever, K, pivoted to a support, Z, fixed on the rail Y. To the upper member of the elbow-lever K is jointed a jack, L, in the forked end of which is pivoted an elbow-lever, M, which carries a head, N, which acts directly on the string S, as does the finger of a harpist, and which I therefore term a "finger." The jack L is also supported by a radius-link, O, constituted by a piece of wire whose ends bent at right angles are received in bushed holes in the parts L and Z. It forms with the said upper member of the lever K a sort of parallel motion whereby the jack L is guided to and fro in an approximately straight line perpendicular to the string. The elbow-lever M is pivoted on a center, *m*, which is parallel to the string S, and the finger N is connected thereto, so that it can yield under a sudden pressure. For this purpose it has a cloth-bushed hole which fits and slides upon a pin, *n*, carried by the elbow-lever M, the finger N being connected to the lever M and forced outward by a bow-spring, n^2. To the other or laterally-projecting arm of lever M is connected a cross-head, M′, to the upper end of which is connected a flexible tape or tie, P, which extends rearward, and whose other end is attached to a spring, *p*, fixed adjustably to the rear rail, U. The purpose of this tie, which I term the "escapement-tie," is to produce a lateral motion of the finger after it has been moved toward and caused to press or deflect sufficiently the string S. This lateral motion of the finger is produced by the tie P arresting the laterally-projecting arm of the elbow-lever M in its forward movement, while its center of motion, *m*, continues to move toward the string, whereby the lever M and finger N are caused to pivot on center *m*, the finger N thus slipping from in front of the string by a motion approximately at right angles to its forward motion. The elasticity of the spring *p* permits of the finger N causing the string S to be deflected from a right line to a greater extent before the finger escapes therefrom when the key is depressed more suddenly. The finger having thus escaped from and passed to one side of the string, the latter is left free to vibrate, as shown at the upper part of Fig. 7. This figure represents two of the fingers N, the one at the lower part of the figure in the normal position of rest, and the one at the upper part of the figure in the escaped position, where it remains after pressing against, deflecting, and vibrating a spring, so long as the key is kept down. To the lower end of the same cross-head of lever M is connected another tie, Q, which I term the "counter-escapement tie," and whose other end is connected to a spring, *q*, the purpose of this tie (which comes into action just before the finger N and jack L complete their return movement) being to return the finger to its normal position. (Shown in the lower part of Fig. 7.) The finger therefore remains in the deflected or inclined position during the first part of its return movement, so that it does not touch the string while returning, and it is quickly brought into position in front of the string, in readiness to act thereon again, by the tie Q acting on it, as above mentioned.

q′ is a wire stop to limit the motion of spring *q*.

r r′ are wire stops limiting the motion of the piece M N. They are fixed in place by a plate, R, and screw. It will be observed that the stop *r* altogether prevents the lateral deflec-

tion of the finger in one direction, and that the string S is toward the same side of the center line, passing through the center of motion *m*, so that the finger, when moved forward and pressed against the string, is quite rigid on its center and bears against and pushes the string with a direct thrust, and has no tendency to escape from the string until the escapement-tie P comes into operation, the joint of the plectrum or finger thus resembling a knee-joint.

The finger N is faced with felt N′ (made of rabbits' wool, beaver, or other fine wool, like that of which soft felt hats are made,) which is beveled at an acute angle at the side where it quits the string, and overhangs or extends slightly beyond the finger N, which is itself undercut, so as to leave clearance for the string to vibrate. The elasticity of the mechanical finger N obtained by the spring n^2 enables the player to modify the intensity of the sounds produced and permits of obtaining all the effects of light and shade and of musical expression obtainable upon the piano-forte. This elasticity of the fingers N is, moreover, absolutely essential, especially in the case of the upper three octaves, the strings of which have not sufficient flexibility to enable them to yield or be deflected, under the pressure of the finger N, far enough to permit the lateral deviation or escapement of the finger, which is indispensable for the vibration of the string.

In the elbow-lever K is fixed a lever-arm, which carries a lead weight, T, which fulfills the function of a fly-wheel—that is to say, it stores up power at the beginning of the movement and gives it out when the finger N is resisted by the string S, so equalizing the touch at all positions of the key. The radius of the arm carrying said weight is about five times that of the other arm of the lever K, to which the jack L is jointed, and therefore the distance moved through by the weight is correspondingly greater than that moved through in the same time by the finger N, which, in fact, moves through only about half the distance moved through by the front end of the key H when depressed by the player. The finger N is therefore pressed against the string with considerable energy, owing to the momentum or stored power of the weighted arm T, so that the forward motion of the finger is not checked on meeting the resistance of the string S, and the rapid escapement of the finger from the string is thereby insured. The motion of the weighted arm T is cushioned by a spring, *t*, fixed to the rail U, with which spring it comes in contact after the finger N has escaped from the string S, and whereby the weighted arm is thrown down quickly and all the parts of the action returned rapidly to the normal position, thereby enabling a good repetition action to be obtained.

The centers of the various parts of the action are bushed with cloth, as usual in piano-forte actions, and the abutting faces of the different members of the action are faced with cloth or felt to prevent noise, as indicated by the letter *x*.

The instrument is provided with dampers V, like those of a piano-forte, each carried by a spring, *v*, attached to a rail, W, mounted between the strings S and the sound-board and journaled at the ends to permit of all the dampers being removed from the strings in sustained or fortissimo passages, this movement being effected by means of a pedal, as in a piano. Each individual damper is raised by the corresponding key through the agency of an elbow-lever, X, acting on the damper in order to permit the string to vibrate so long as that particular key is held down. The action is mounted on a rail, Y, united by end pieces to the rail U, and pianissimo effects are obtained by moving the action slightly to the left, so that the fingers do not press so forcibly against the strings, by means of another pedal, so that when a key is depressed the corresponding finger N will be pressed very lightly against the string, and a correspondingly weak sound will be produced.

In the instrument herein described the fingers push the strings toward the sound-board, or deflect them from a right line; but it will be evident that by making the fingers hook-shaped the action might be so arranged as that the strings will be pulled or acted on in the opposite direction. It will be obvious that with but a slight modification the same action would serve for a horizontal instrument analogous to a horizontal piano-forte.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is—

1. A key-board stringed instrument in which the string is vibrated by the direct thrust of a knee-jointed plectrum or mechanical finger whose pivotal center is parallel to the string, the said center receiving a motion toward the string, and the finger or plectrum, after being so moved forward to deflect the string, receiving an oscillating motion on its center, as specified.

2. In a key-board stringed instrument in which the string is vibrated by the direct thrust of a plectrum or finger moving in two directions, as herein described, the combination, with the said plectrum or finger, of a weighted arm acting as a store of power to overcome the resistance of the string to the motion of the plectrum or finger, and as a means of quickly returning the "action" to the normal position after the string has been vibrated, substantially as specified.

3. In a key-board stringed instrument, the combination of the finger N, the pivoted arm M, the guide-pin *n*, and the spring connecting the finger N and arm M and forcing the former forward with an elastic or yielding pressure, substantially as and for the purpose specified.

4. In a key-board stringed instrument, the combination, with the yielding finger N and the elbow-lever M, pivoted on a center parallel to the string in a jack, L, having a motion perpendicular to the string, of the stop *r* on the jack for preventing the oscillation of the finger in one direction, the tie P, for producing the oscillation of the finger in the opposite direction on its forward motion, and the tie Q, for restoring it to its normal position on its return, as described.

5. In a key-board stringed instrument, the combination, with the yielding or spring finger N, and the elbow-lever M, carrying the same, pivoted in a jack, L, of the lever K, and radius-link O, for producing the longitudinal parallel motion of jack L, as specified.

6. In a key-board stringed instrument, the combination, substantially as herein specified, of the spring-finger N, elbow-lever M, carrying the same and pivoted in a jack, L, ties P Q, controlling the elbow-lever, radius-link O, and lever K, guiding and actuating the jack L, and the weighted arm T, acting as a store of power, as described.

7. In a key-board stringed instrument, the combination, substantially as herein specified, of the spring-finger N, elbow-lever M, carrying the same, and pivoted in a jack, L, ties P Q, controlling the elbow-lever, radius-link O, and lever K, guiding and actuating the jack L, the weighted arm T, acting as a store of power, and the spring *t*, acting as a cushion for the weight T and assisting it to return the action quickly to the normal position, as described.

8. In a key-board stringed instrument, the combination, with the spring plectrum or finger pivoted on a center parallel to the string supported in a jack moving in a direction perpendicular to the string and with the tapes for oscillating the finger on its center, of the springs *p* and *q*, for imparting elasticity to the action of the tapes, as specified.

9. In a key-board stringed instrument, a knee-jointed mechanical finger or plectrum acting on the string, as described, and having an acting face of felt beveled to an acute angle and projecting substantially as shown and described.

The foregoing specification of my improved key-board musical instrument signed by me this 26th day of May, 1887.

ANDREA LUIGI CALDERA.

Witnesses:
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CHAS. BERKLEY HARRIS,
Notary Public.