(No Model.) 4 Sheets—Sheet 1.

G. F. DIECKMANN.

ELECTRICAL PIANO.

No. 368,195. Patented Aug. 16, 1887.

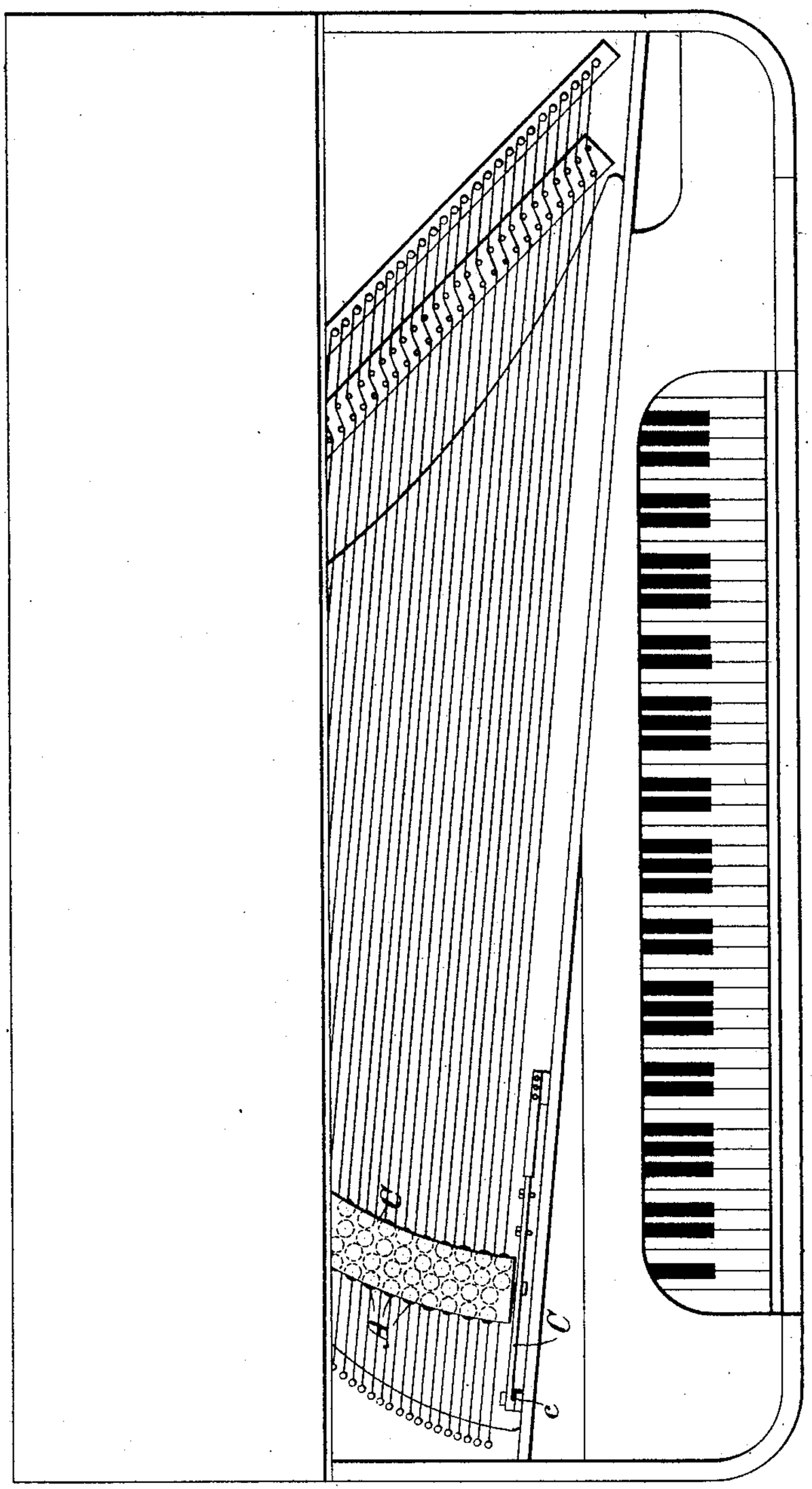

Fig. 1.

Witnesses

A. W. Cook.

F. R. Fast.

Inventor

Geo. F. Dieckmann

By his Attorneys

Curtis & Crocker

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G. F. DIECKMANN.

ELECTRICAL PIANO.

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Fig. 2.

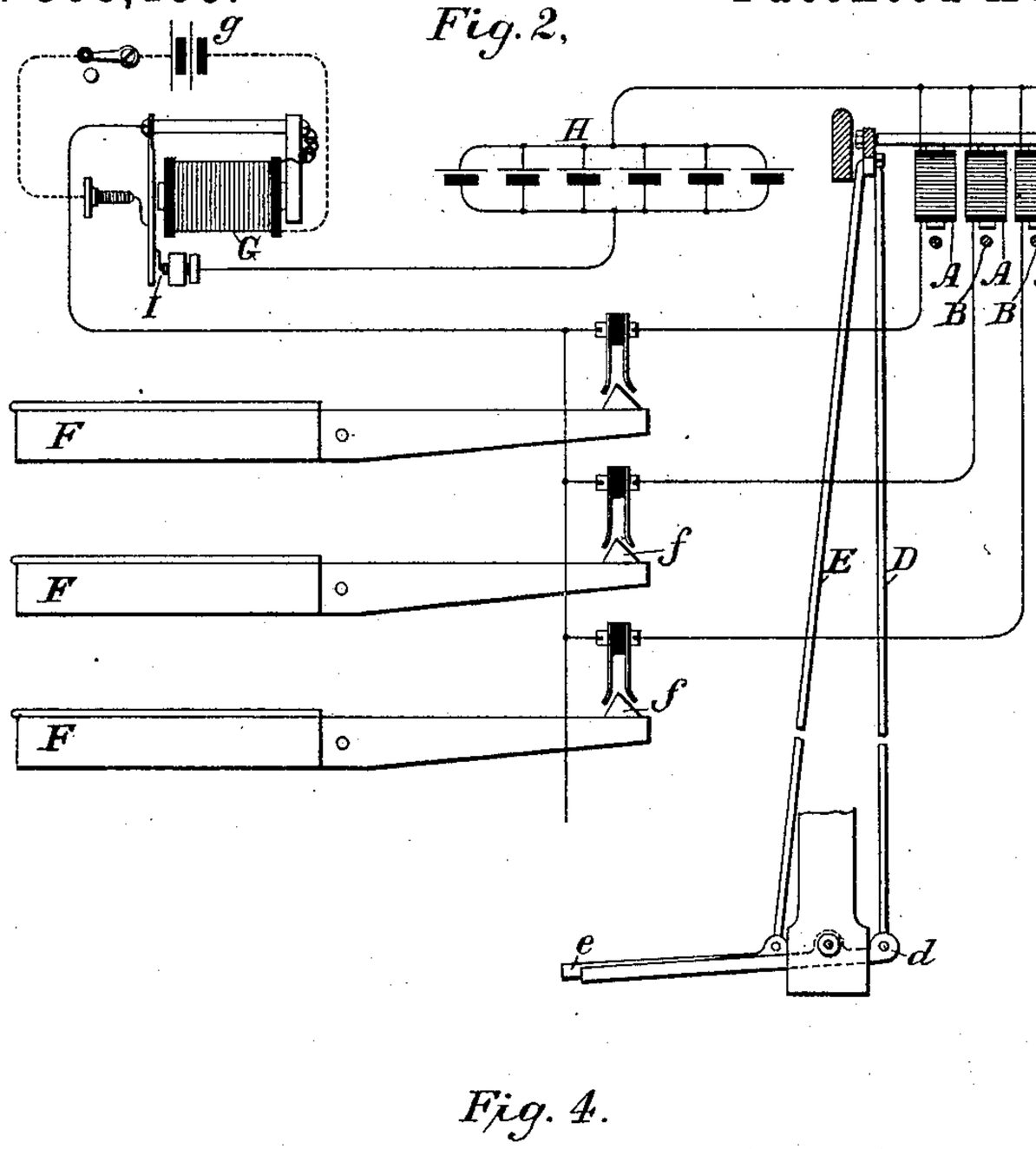


Fig. 3.

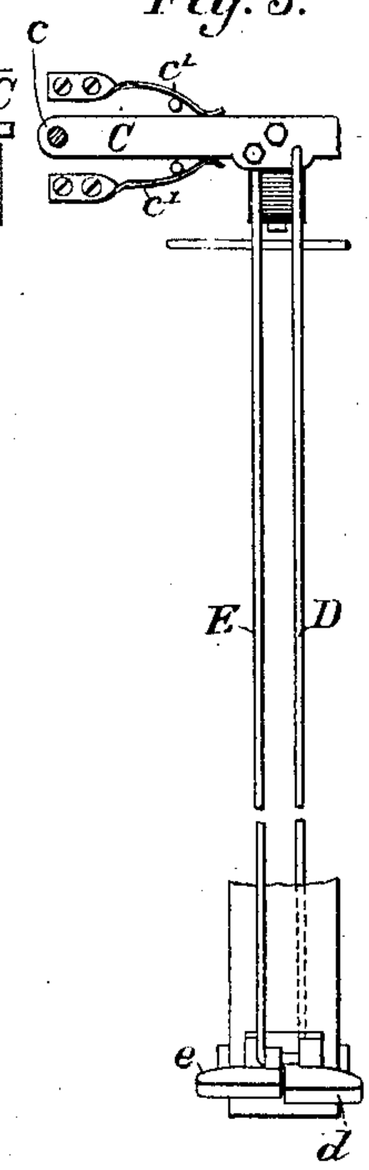
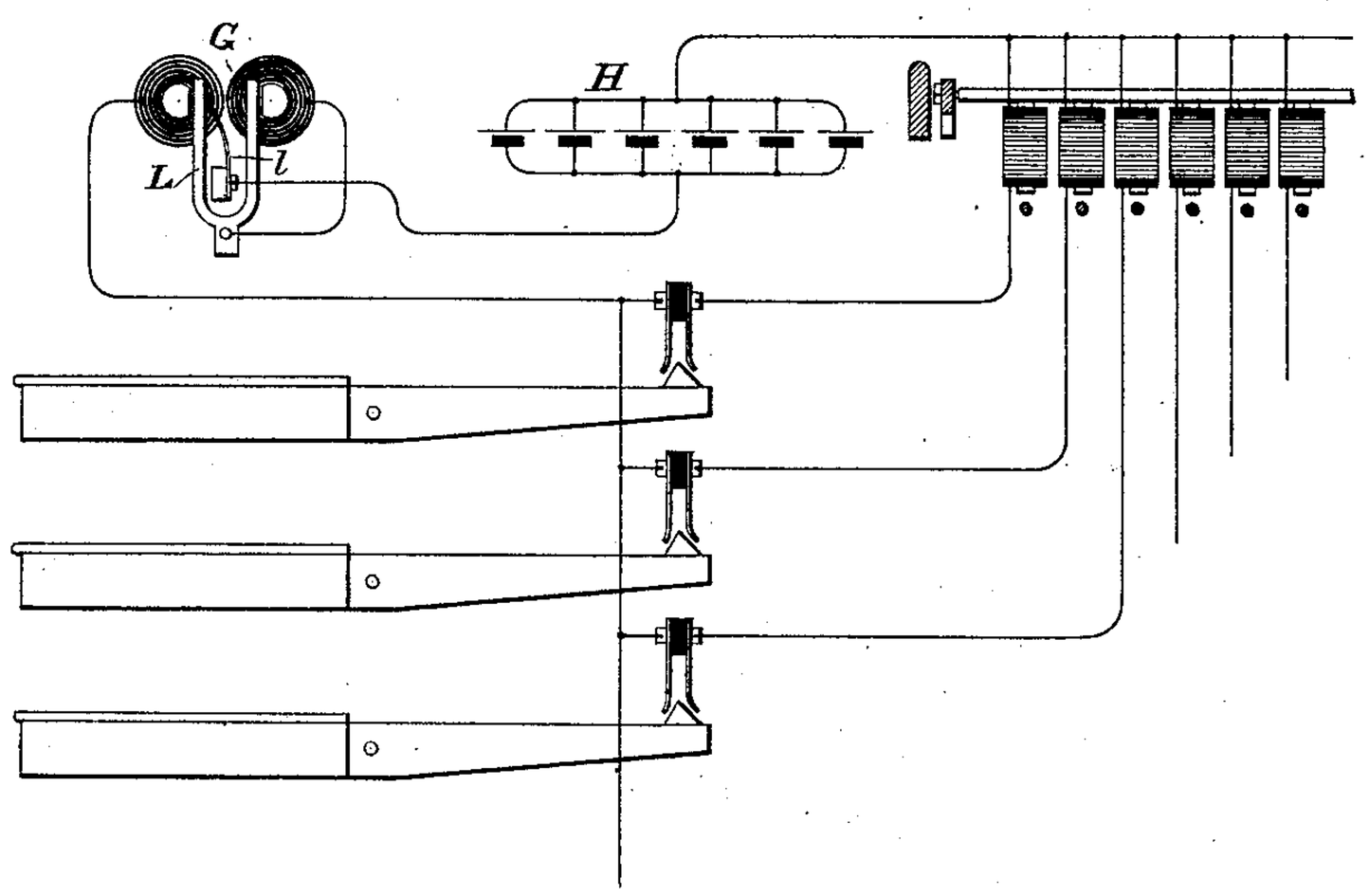


Fig. 4.



Witnesses

R. M. Cook.

F. R. Fast.

Inventor

Geo. F. Dieckmann

By his Attorneys

Curtis & Crocker

(No Model.) 4 Sheets—Sheet 3.

G. F. DIECKMANN.

ELECTRICAL PIANO.

No. 368,195. Patented Aug. 16, 1887.

Fig. 5.

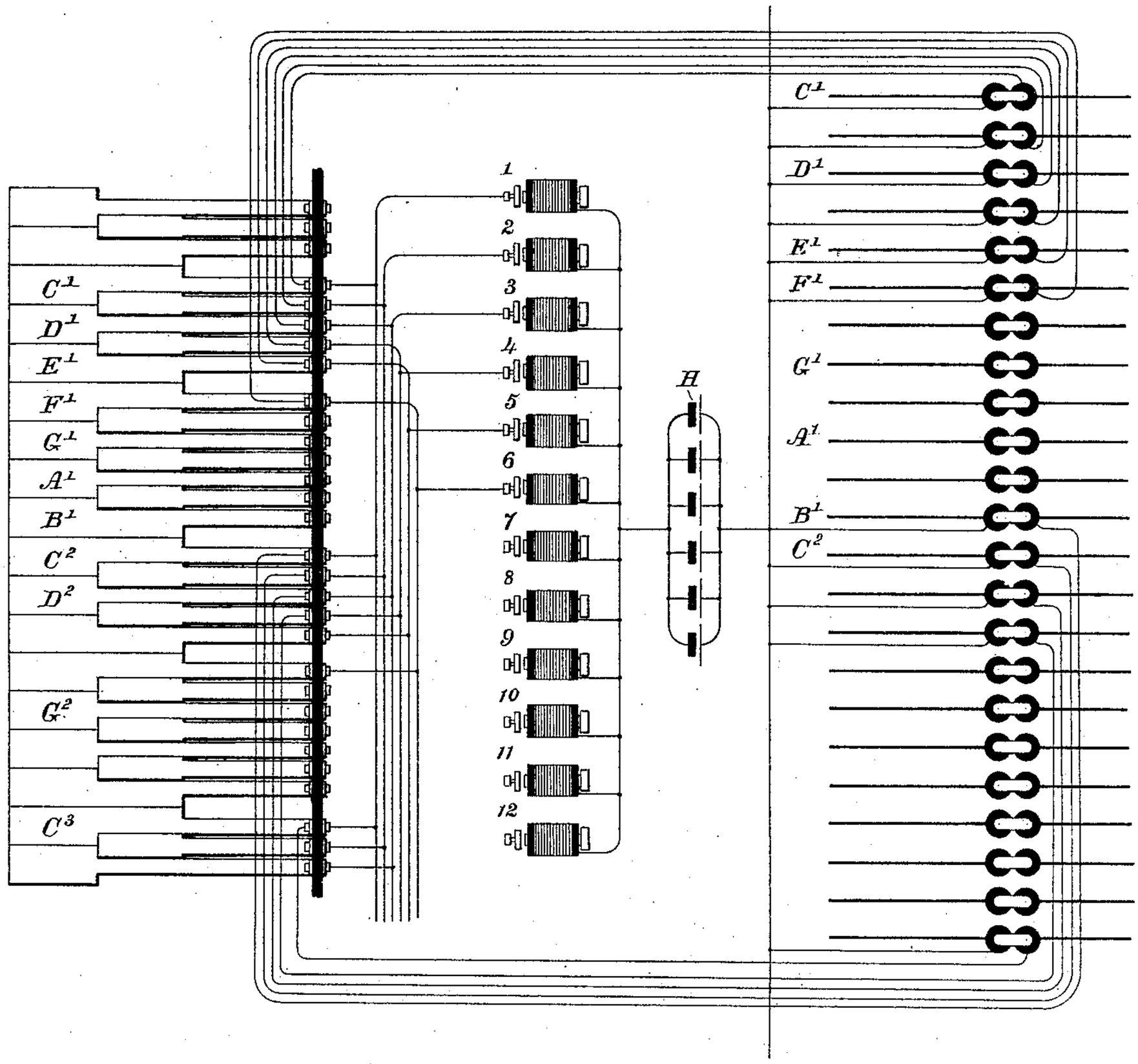
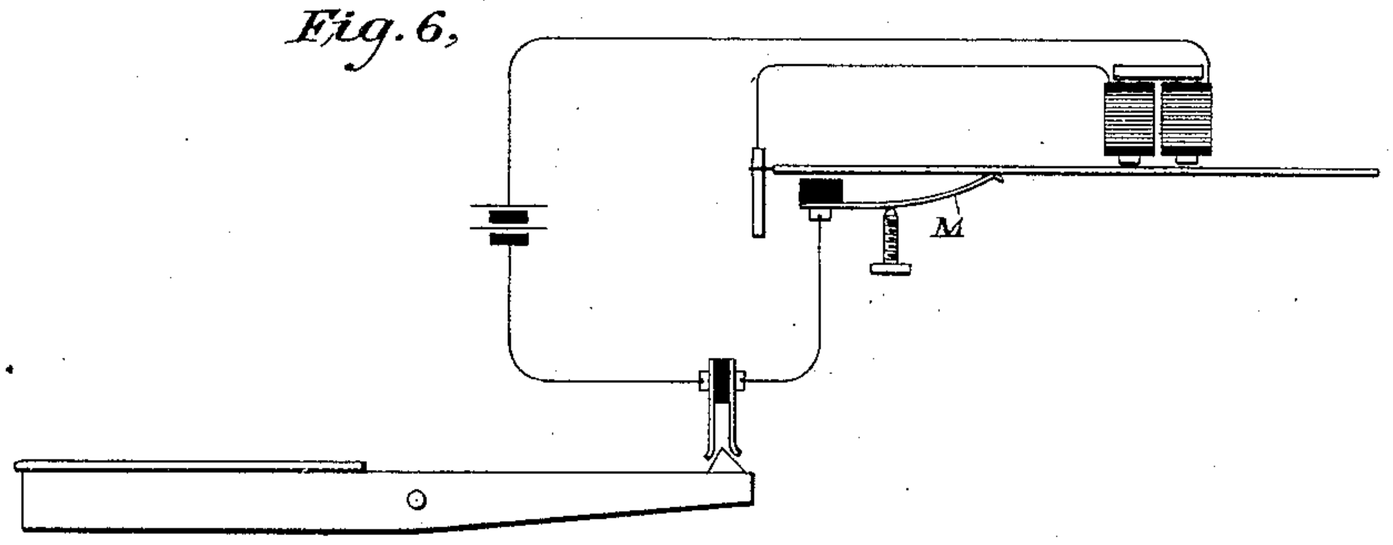


Fig. 6.



Witnesses

A. M. Cook.

F. R. Fast.

Inventor

Geo. F. Dieckmann

By his Attorneys

Curtis & Crocker

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G. F. DIECKMANN.

ELECTRICAL PIANO.

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Fig. 7,

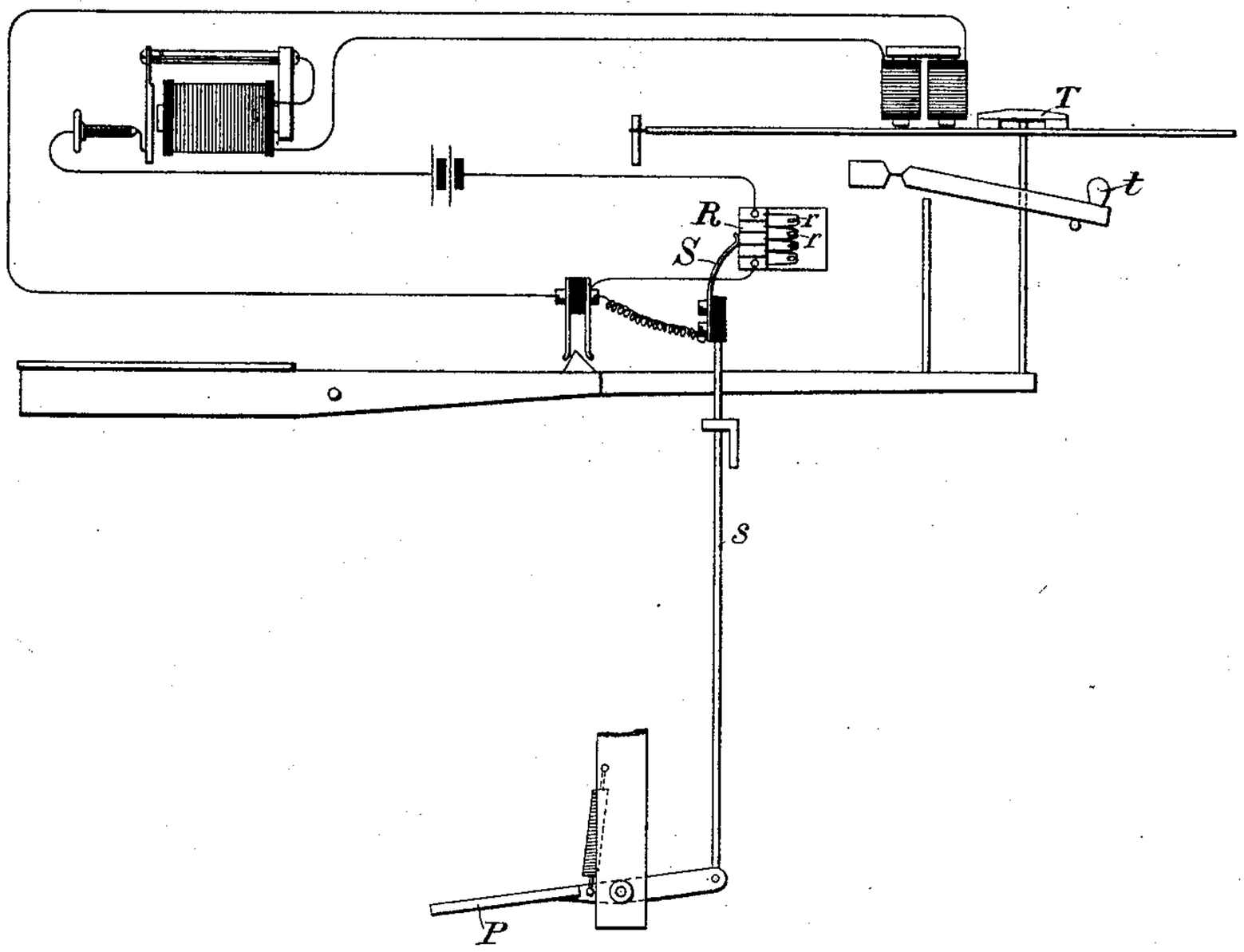
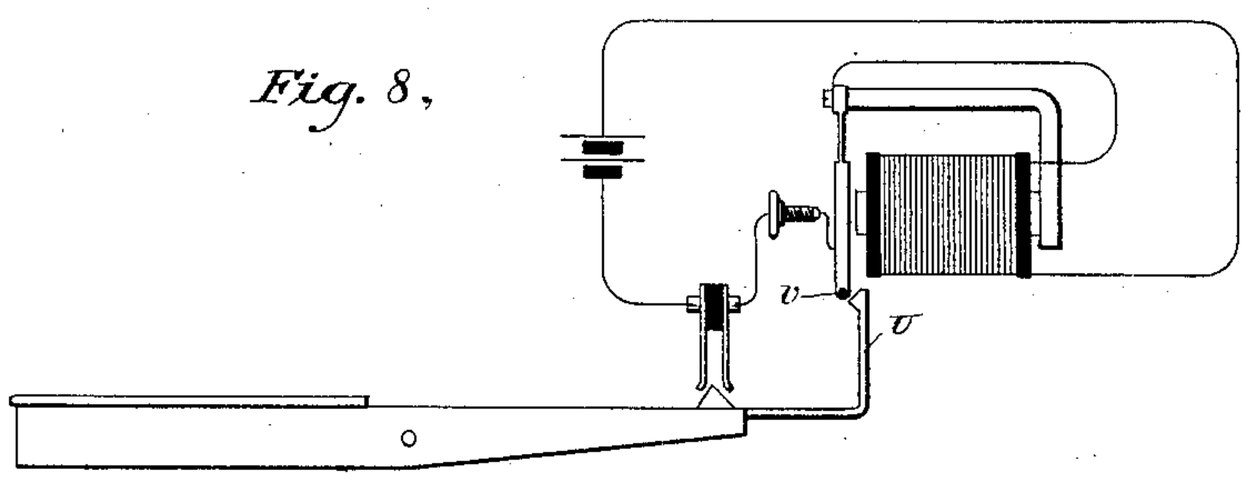


Fig. 8,



Witnesses

A. M. Cook

F. R. Fast

Inventor

Geo. F. Dieckmann

By his Attorneys

Curtis & Crocker

UNITED STATES PATENT OFFICE.

GEORG F. DIECKMANN, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO PAUL GMEHLIN, OF SAME PLACE.

ELECTRICAL PIANO.

SPECIFICATION forming part of Letters Patent No. 368,195, dated August 16, 1887.

Application filed March 2, 1885. Serial No. 157,475. (No model.)

To all whom it may concern:

Be it known that I, GEORG F. DIECKMANN, a citizen of Germany, residing at New York city, have invented a new and useful Electrical Musical Instrument or Piano, of which the following is a specification.

In pianos as they have heretofore been made the sounds are produced by striking each wire or string with a felt-covered hammer, which is driven against the wire every time a key is struck, and thus sets it vibrating with more or less amplitude, according to the force communicated to the hammer by the key by the finger. Although this mode of producing the sound admits of a great variety of beautiful musical effects not obtainable from any other instrument, depending upon the "touch" or way the keys are struck, yet the sound produced is necessarily comparatively sharp and loud at the instant of striking and quickly subsides, so that it is impossible to obtain from such an instrument a sustained tone or an increasing tone and other very desirable effects of which wind-instruments are capable.

The object of my invention is to produce an instrument capable of such sustained and varying tones, (combined, if desired, with the usual piano effects,) in which the strings are set in vibration or have their vibrations sustained without mechanical blows or impulses as long as the keys remain depressed; and the invention which forms the subject-matter of this patent consists, essentially, in causing the wires to vibrate by electrical devices, which act upon the wires electrically without mechanical contact, so as to attract or displace them from their positions of rest, and thus set them in vibration or maintain their vibrations. In order to produce a lasting sustained sound, or one swelling up to a maximum—a "crescendo" effect, if desired—I combine with such electrical devices means for causing them to impart to the wires a succession of impulses, which may be made so rapid as to be indistinguishable, giving the effect of a continuous unvarying or uniformly rising or falling sound, as if the string or wire were vibrating freely, and which may be gradually increased or diminished at the pleasure of the performer.

The electrical devices which I prefer to employ to impart vibration to the strings consist of electro-magnets arranged so close to the strings or wires as to attract them transversely when traversed by a current, but leaving them space to vibrate freely without contact with the magnet. These electro-magnets are controlled by the keys of the key-board, and are electrically connected with one or more rheotomes or circuit-breaking devices, which produce a vibratory current or currents, and these currents, when applied to any of the electro-magnets, by striking the corresponding keys impart to the wires a succession of impulses, which, if properly timed, will cause the string to vibrate and give out its normal uniformly-sustained sound, as hereinafter fully explained.

In the accompanying drawings, Figure 1 represents in plan a piano constructed according to my invention, showing the electro-magnets applied to the wires. Fig. 2 represents in elevation several of the wires and corresponding keys, showing my invention as applied thereto. Fig. 3 is a front view of the pedal arrangement, shown also in side view in Fig. 2. Fig. 4 represents a modification of my invention, showing the electro-magnets and keys applied to several wires, with a special form of rheotome provided with a tuning-fork armature. Fig. 5 represents a series of strings comprising several octaves, illustrating one way of working my invention, in which I employ a set of rheotomes equal in number and tuned, respectively, to correspond to the notes of the "chromatic scale," the several octaves of strings being operated in common by this one set of rheotomes. Fig. 6 represents another modification, in which the piano-string is its own circuit-breaker or rheotome. Fig. 7 represents another device I have invented for controlling the loudness of the sound by means of a pedal, which throws more or less resistance in the circuit of the electro-magnet, and so alters the strength of its impulses. Fig. 8 represents a mechanical starter I have also devised, which may be employed, if desired, to insure the starting of the rheotome the instant the key is struck.

Near each string or wire I arrange a suit-

able electro-magnet, A, with its poles close to the wire B, but leaving the wire space to vibrate freely. These electro-magnets I prefer to place at a distance of one-eighth of the length of the string from its end, (this point of striking the string having been found to produce the best harmonics in the mechanical action,) and immediately above the strings for convenience; and in order that all the electro-magnets may be raised and lowered simultaneously they are secured to a frame, C, which is hinged at *c*, and mechanically connected by two rods, D and E, with suitable pedals, *d* and *e*, on opposite sides of their fulcrums, as shown.

Two springs, *c' c'*, provided with fixed stops, so that only one spring can act upon the frame C at once, as shown in Fig. 3, serve to hold the frame normally with considerable rigidity in an intermediate position, so that the electro-magnets are at the proper distance from the strings to produce the normal amplitude of vibration; but at the same time they allow it to be raised and lowered and the electro-magnets are thereby made to approach or recede from their string, and the tones are thus made louder or softer to any desired degree by pressing one or the other pedal the proper amount.

F F F, &c., are the ordinary keys played upon by the performer. The rear end of each is provided with a circuit-closer consisting of two fixed insulated springs, which become electrically connected by the metal anvil or wedge *f*, as shown, when the key is struck. Each electro-magnet and its corresponding circuit-closer, as shown in Fig. 2, is included in its own circuit, and all these circuits are connected with a battery, H, and rheotome G, which are common to all the circuits, as clearly shown. This rheotome, as here shown, consists of an electro magnet provided with a reed-armature, and I prefer in some cases to keep it in continuous vibration, whether the keys are struck or not, by means of a separate battery, *g*, in order that the electro-magnets A shall respond instantly upon striking the keys, without waiting for the reed-armature to get started, which, if a slow rheotome be employed, might take objectionably long. By means of the switch shown, which may be placed at any convenient part of the piano, the circuit can be closed or opened and the rheotome started or stopped at the pleasure of the performer, and the rheotome itself may of course be made inaudible by inclosing it in a sound-tight box or compartment. The circuit from the battery H leads through a delicate spring contact-point, I, arranged in front of the reed-armature and constructed to operate in any of the well-known ways, and from the reed the circuit leads to the keys, as shown.

I will now explain the operation of these contrivances. When any one of the keys is depressed, the anvil *f* spreads the two springs and connects them, closing the circuit through the corresponding electro-magnet. The rheotome G, being in continuous vibration, a vibratory current from the battery H instantly traverses the electro-magnet and causes it to attract its string intermittently. Now, if the rheotome G be tuned to the same pitch—that is, so as to vibrate in unison with the wire—the wire will receive a succession of impulses, one of which occurs every time the wire is swinging toward the magnet, and the effect of these impulses will be to quickly bring the vibrations up to their full amplitude and cause the wire to emit a lasting sustained tone as long as the circuit remains closed. If the rheotome be tuned to vibrate a trifle slower than the string—that is, with a small interval between them—then probably the string will either not respond at all, because the succeeding impulses not being properly timed will tend to neutralize the effects of the previous ones, or else the impulses will result in perceptible "beats," which will destroy the smoothness of the tone; but I have found that if the pitch of the rheotome be made quite low compared with the string, and a strong enough current be used, the effect of each impulse is to restart the vibration, like a succession of blows; but at the same time these separate impulses can be made so rapid as to be indistinguishable as such by the human ear. This being so, it is not necessary that the pitch of the rheotome should bear any definite relation to those of the strings, and therefore, if desirable, all or a certain number of the strings at least may be operated by the same rheotome, as I have shown in Fig. 2; and in this arrangement the rheotome should be tuned to give the best effects from all the strings, which is very readily found by experiment. It may be preferable to make use of more rheotomes than one, or even to employ a separate rheotome for each string, or a group of strings, their octaves, for example, as I have illustrated in Fig. 5, and with such an arrangement, or, if a separate rheotome be used for every string, each rheotome may be tuned so that the electrical impulses of the electro magnets are of the same pitch as its strings, or are the octaves or multiples of that pitch. For the string known as "middle C," which is tuned to vibrate two hundred and fifty-six times a second, its rheotome may be tuned to transmit impulses at that rate, or at half that rate, or at one-quarter, or one-sixteenth that rate, or any number of which two hundred and fifty-six is a multiple, so that the impulses, whenever they occur, will be coincident with the movements of the string. In carrying out this plan I have also devised an arrangement which requires only as many separate rheotomes as there are notes in the octaves, and which I shall describe presently. Of course, if a separate rheotome were used for each string, it might be placed in the individual circuit of the corresponding electro-magnet.

With the circuits arranged as I have represented in the several figures, the electro-magnets are operated in "multiple arc"—that is, each on a branch circuit—so that the current

from the battery divides itself between those in operation at any one time, and therefore the more keys that are down at the same time the weaker will be the current traversing each magnet, unless the entire resistance in circuit is comprised in the individual magnets and their circuits; or, in other words, unless the resistance of the battery and the part of the circuit common to all the individual circuits is comparatively very little. I therefore connect the cells of my battery H in multiple arc, which reduces its resistance to a minimum, in the well-known way, and use enough cells of low resistance to give the necessary current-strength to operate the electro-magnets properly. With the rheotome kept in vibration by a separate battery, as I have shown in Fig. 2, it does not form any resistance in the circuit of the battery H, except the resistance of its contact-point, which is practically nothing, and therefore the only resistance common to all the individual circuits is the battery. By reducing this, as I have explained, a number of keys—as many as one or two performers will hold down at once—may be struck, and each string will respond as loudly as if only one key were depressed.

In Fig. 4 I have shown a rheotome, G, consisting of an electro-magnet, between the poles of which are placed the prongs of a tuning-fork, L, provided with a spring circuit-breaker, *l*, on the inside of the fork, this being a well-known form of rheotome. It has the advantage that it will keep its tune exactly, and vibrate only at that exact rate when once adjusted. In this figure I have also indicated how the main battery H, for actuating the strings, may also be made to operate the rheotome, and I have also shown the same feature in Fig. 5 and other figures; but I prefer to employ a separate current for this purpose, for the reasons already stated.

I will now explain the mechanism of Fig. 5. In this case I use twelve rheotomes, 1, 2, 3, 4, 5, &c., which, as in the other arrangements, may of course be constructed and operated in any desired manner. I employ twelve, because there are twelve tones in the common chromatic scale, all the other tones being the octaves of these twelve, and each is tuned so that the vibratory current produced by it has the same pitch or is a multiple of the pitch of the corresponding note. In other words, they are tuned to correspond respectively to the seven notes of the scale with their sharps or flats, and as all the other notes have pitches which are multiples of these the twelve rheotomes serve to operate the entire set of strings. These rheotomes are all connected with the battery on one side. On the other they are separately connected with the circuit-closing keys as follows: No. 1 is connected with the key called C′, from which its circuit leads through the electro-magnet of the corresponding string, C′, as shown. No. 1 is also connected with the key C^2, the octave of C′, from which its circuit leads through the electro-magnet of the corresponding string, C^2, and back to the battery. No. 1 is similarly connected with the other octaves of C′, as many as there are, so that whenever the note C is struck anywhere on the key-board the rheotome 1 is thereby connected with the proper string. Similarly, No. 2 is connected with the key C-sharp and all its octaves, as shown, so that striking any C-sharp on the key-board connects rheotome 2 with the corresponding string. All the rheotomes are connected in the same way, as can be clearly seen from the drawings, though they are not all shown as connected.

The modification of my invention shown in Fig. 6 consists in making the wire its own circuit-breaker, thereby dispensing with a separate rheotome. For this purpose I arrange a delicate contact-spring, M, on the side of the wire opposite the electro-magnet, through which the circuit leads, as shown. I prefer, however, to actuate the wire by a separate rheotome, so as to let it vibrate freely; but by placing the contact spring M at the proper point and adjusting it properly the tone may not be too materially affected.

The strength of the impulses acting on the string which determines the loudness of the sound may be regulated by introducing into the circuit of the electro-magnet more or less resistance, as I have illustrated in Fig. 7. *r r* are a set of resistances included between the metal blocks R, over which travels the spring S, carried by the rod *s*, operated by the pedal P. The spring S is electrically connected by a flexible wire with one end of the blocks R, as shown, so that when the pedal is depressed more or less of the resistances *r r r* are short-circuited by the spring S, and the resistance in circuit thereby reduced. This increases the current strength and causes the string to respond more loudly. On the other hand, lowering the spring S cuts in more of the resistances and reduces the sound.

In Fig. 7 I have also represented the usual damper, T, controlled by the key, which stops the vibrations of the string in the usual way when the finger is taken from the key. I have also represented the ordinary mechanical action in which the string is struck by a hammer, *t*, which may be employed, if desired, in conjunction with my method of sounding the strings, and operated in the usual manner. The ordinary mechanical hammer may be used to strike the string, and then the vibration will be sustained or increased or diminished at the pleasure of the performer so long as the key is held down and the electro-magnet continues to operate. Thus the two actions may be combined, and the effects of sustained and true crescendo and minuendo tones obtained at the same time with the various musical effects of the mechanical piano.

I have also devised a mechanical starter, which may be employed, if desired, to insure the starting of the rheotome the instant the key is struck in cases where the rheotomes are kept in continuous vibration. It consists, Fig.

S, of an arm, V, attached to the rear end of the key and ending in a wedge-shaped finger which engages with a pin, *v*, on the side of the armature when the key is depressed, thus momentarily forcing the armature back against its contact-point and insuring electrical connection therewith.

I have particularly described the electro-magnets as connected in multiple arc; but they may be arranged to be operated in series, if more desirable in any special case, or connected in any of the well-known ways of operating a number of electrical devices simultaneously.

I do not confine myself to electro-magnets for actuating the wires or strings, as any electrical or electro-magnetic device—such as a solenoid—performing the functions of the electro-magnets may be employed instead. It is also evident that any kind of rheotome or circuit-changing device for producing a vibratory or varying current may be employed for actuating the impulse-giving devices.

If it is desired to use strings other than steel or iron, a light iron armature may be attached to the string for the electro-magnet to act upon.

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

1. A musical instrument having in combination a series of stretched wires or strings tuned to different pitches, electrical impulse-giving devices arranged to attract said wires or act upon them electrically to cause them to vibrate, one or more rheotomes or devices for producing a vibratory current, one or more batteries or sources of electric current and circuit-connections, whereby it may be connected with the actuating devices and rheotomes, a series of keys corresponding to the wires, and means whereby the pressing of any key or keys causes the corresponding wire or wires to be acted upon by their electrical actuating devices, and thereby caused to vibrate.

2. A musical instrument having in combination a series of stretched wires or strings tuned to different pitches, electro-magnets arranged to attract them transversely, one or more rheotomes or devices for producing a vibratory current electrically connected with the electro-magnets, and also with a battery or source of current, a series of keys corresponding to the wires, and circuit-closing devices controlled by the keys and electrically connected, so that when any key is struck the corresponding electro-magnet is thereby electrically connected with the battery and a rheotome and its wire caused to vibrate.

3. A musical instrument having in combination a series of stretched wires or strings, B, tuned to different pitches, electro-magnets A, arranged to attract them transversely and included in separate circuits connected with a battery, H, circuit-closers *f*, operated by a series of keys, F, and interposed in the respective circuits of the electro-magnets, and one or more rheotomes, G, also connected in circuit, substantially as described.

4. A musical instrument having in combination a series of stretched wires or strings, electro-magnets arranged to attract them transversely, a battery or batteries electrically connected therewith and with circuit-closers controlled by a series of keys, one or more rheotomes or devices for producing vibratory currents, and means for keeping such devices in continuous operation independently of the movements of the keys.

5. A musical instrument having in combination a series of stretched wires or strings, electro-magnets arranged to act upon said strings, so as to cause them to vibrate, and means for varying at pleasure the actuating effect of the electro-magnets upon the wires, substantially as described.

6. The combination, in a musical instrument, with a series of stretched wires or strings, of a series of electro-magnets arranged to act upon said strings, so as to cause them to vibrate, and means for changing the positions of the electro-magnets with respect to the strings simultaneously, substantially as described.

7. The combination, in a musical instrument, with a series of stretched wires or strings, of a series of electro-magnets arranged to act upon said wires, and mounted upon a movable bar or frame, springs normally holding said frame in an intermediate position with respect to the wires, and a pedal, key, or stop connected with the said frame, whereby the electro-magnets may be moved closer to or farther from the wires at pleasure, substantially as described.

8. The combination, with the wires or strings B and the electro-magnets A, of the frame C, carrying the electro-magnets, the springs *c' c'*, acting to force the frame in opposite directions, but provided with stops, so that only one spring can act at once, the pedals *e* and *d*, and rods connecting them with the frame C, substantially as described.

9. A musical instrument having in combination a series of stretched wires or strings, some of which are tuned to the desired different tones of a scale—the chromatic scale, for example—and others of which are tuned to the octaves or multiples of these tones, a series of electro-magnets arranged to act upon the wires to cause them to vibrate, a series of rheotomes or devices for producing vibratory currents equal in number to the different tones of the scale, constructed and tuned so that their respective rates of vibration agree with or are multiples of the rates of vibration of the corresponding strings, one or more batteries, a series of keys corresponding to the wires, and circuit-closing devices controlled by the said keys and respectively connected with their corresponding electro-magnets, rheotomes, and battery, so that when any key is struck the corresponding electro-magnet is electrically

connected with the battery and the rheotome whose rate of vibration agrees with or is a multiple of the corresponding wire's tone, and thereby sounds that wire, substantially as described.

10. The combination, with the wires or strings of a piano provided with a mechanical action for producing the sound by striking the strings with hammers, as in the ordinary piano, of electrical devices, also arranged to act upon said strings to cause them to vibrate, substantially as described.

Signed this 28th day of February, 1885.

GEO. F. DIECKMANN.

Witnesses:
CHARLES G. CURTIS,
FRANCIS B. CROCKER.