

No. 608,415.

Patented Aug. 2, 1898.

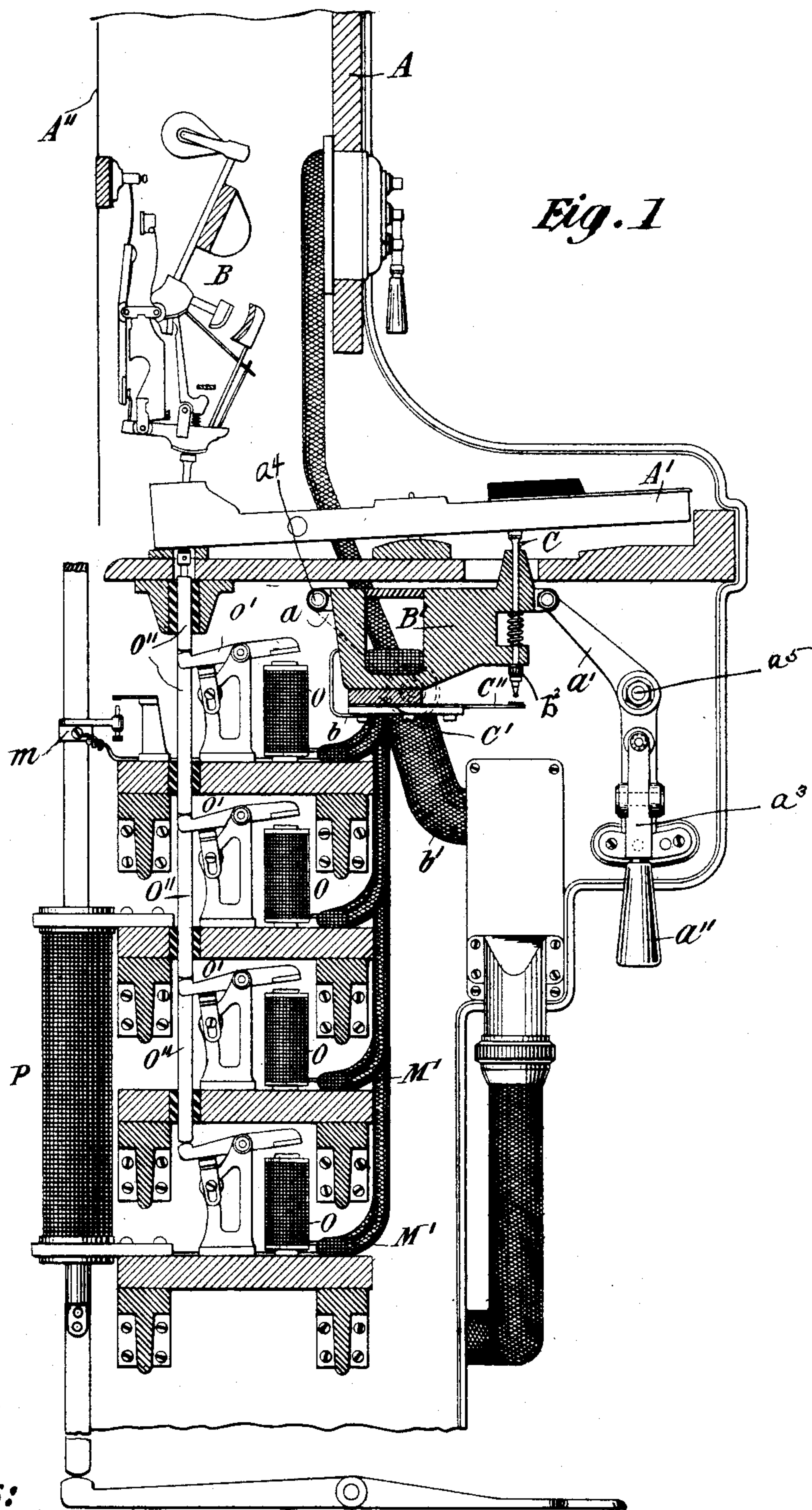
E. K. ADAMS.

DEVICE FOR RECORDING AND REPRODUCING MUSIC.

(Application filed Mar. 26, 1897.)

(No Model.)

4 Sheets—Sheet 1.



Witnesses:

Raphaël Vetter

Edwin B. Hopkinson.

Ernest H. Adams, Inventor

by Ker. Curtis & Page Attys.

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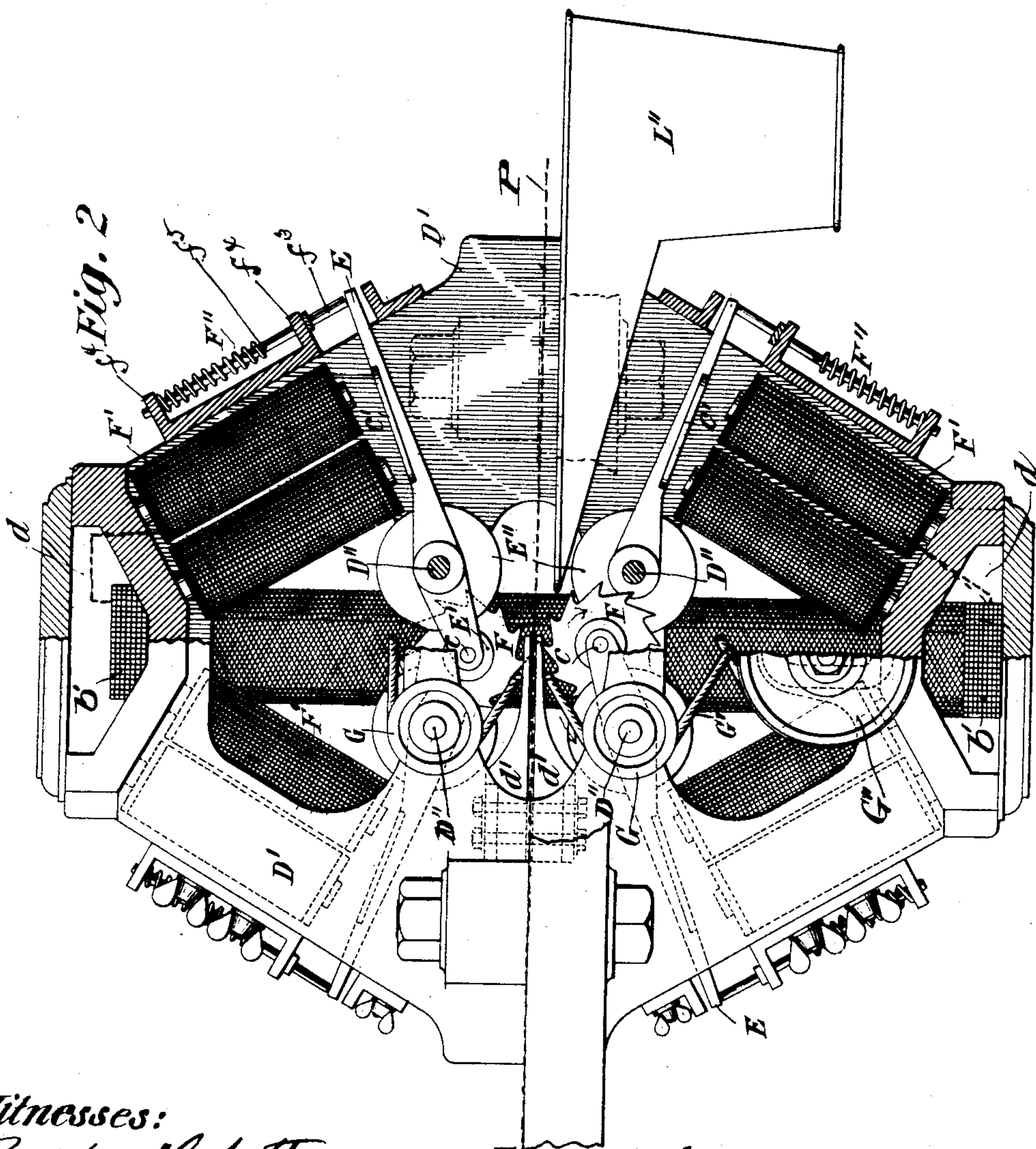
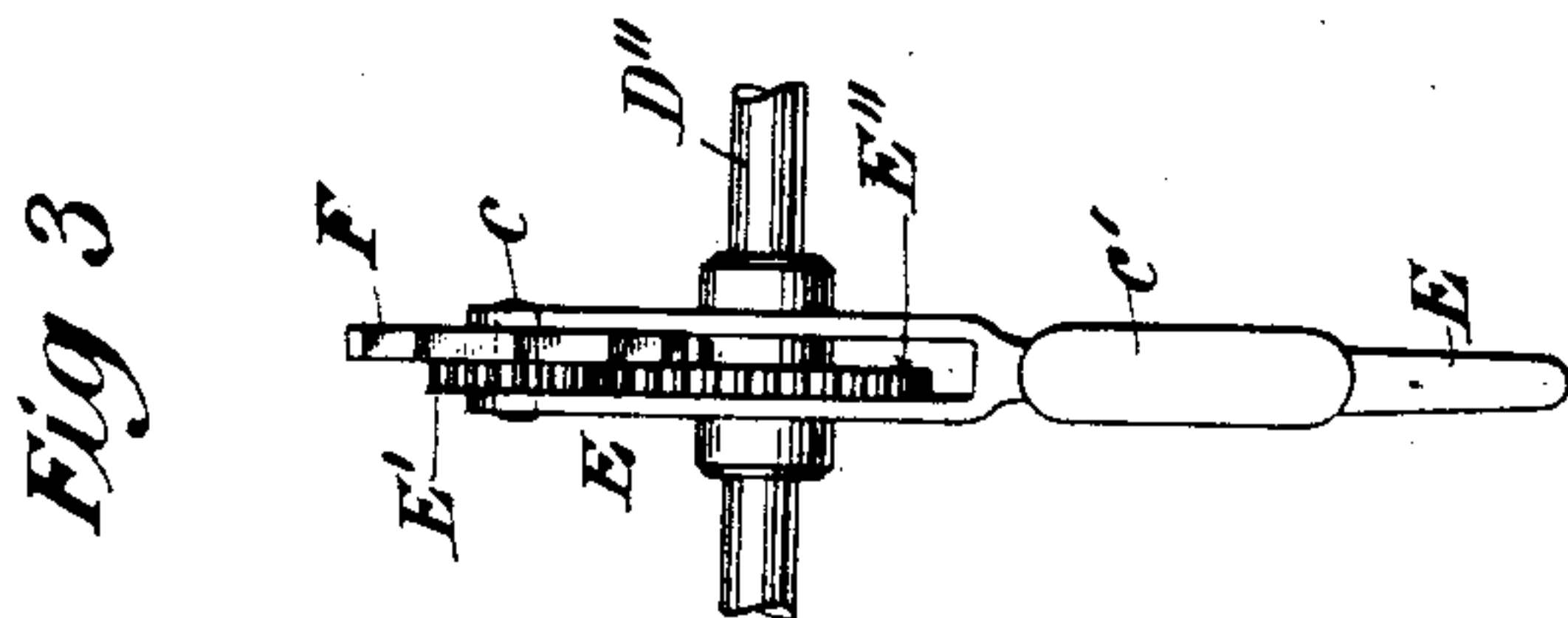
E. K. ADAMS.

DEVICE FOR RECORDING AND REPRODUCING MUSIC.

(Application filed Mar. 26, 1897.)

(No Model.)

4 Sheets—Sheet 2.



Witnesses:

Raphael letter

Edwin B. Hopkinson.

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Patented Aug. 2, 1898.

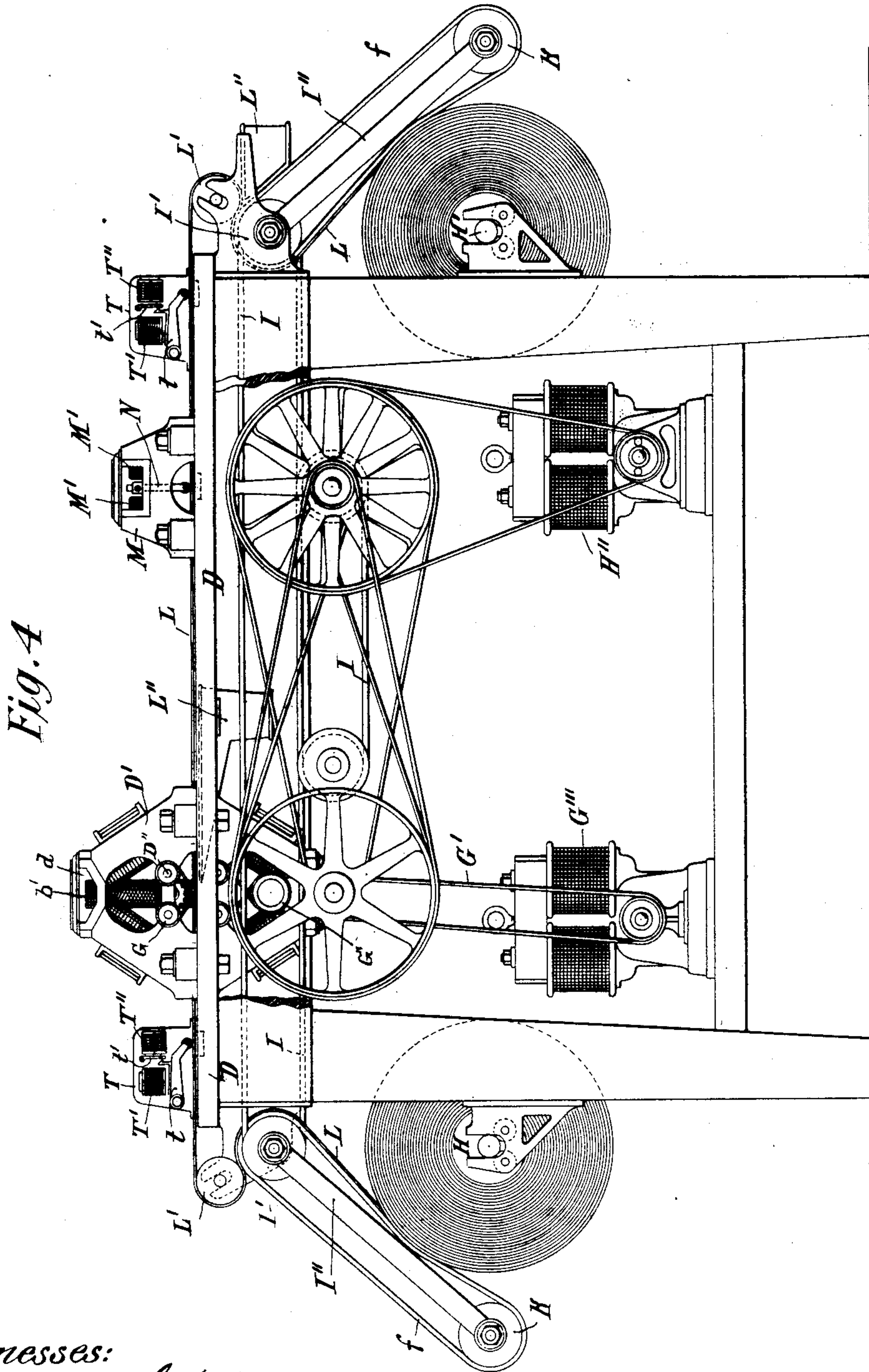
E. K. ADAMS.

DEVICE FOR RECORDING AND REPRODUCING MUSIC.

(Application filed Mar. 28, 1897.)

(No Model.)

4 Sheets—Sheet 3.



Witnesses:

Raphael Vetter

Edwin B. Hopkinson.

Ernest H. Adams, Inventor

by Rev. Curtis Hage Att'ys

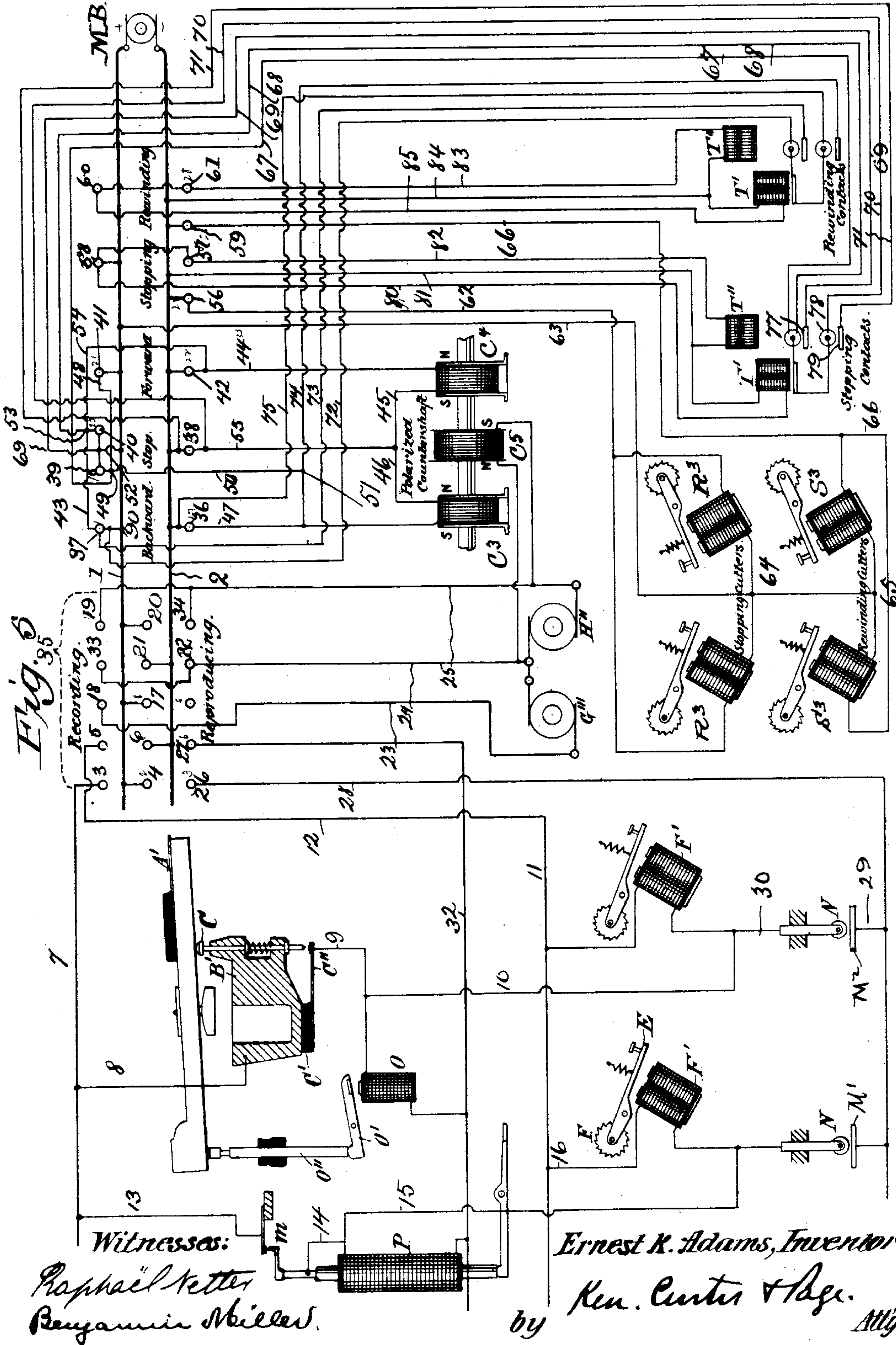
E. K. ADAMS.

DEVICE FOR RECORDING AND REPRODUCING MUSIC.

(Application filed Mar. 26, 1897.)

(No Model.)

4 Sheets—Sheet 4.



UNITED STATES PATENT OFFICE.

ERNEST K. ADAMS, OF NEW YORK, N. Y.

DEVICE FOR RECORDING AND REPRODUCING MUSIC.

SPECIFICATION forming part of Letters Patent No. 608,415, dated August 2, 1898.

Application filed March 26, 1897. Serial No. 629,289. (No model.)

To all whom it may concern:

Be it known that I, ERNEST K. ADAMS, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Apparatus for Recording Musical Compositions, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

The invention which forms the subject of this application is an improved apparatus for producing a record of any musical composition that may be played upon a keyed instrument, such as a piano or organ, and by means of which the composition may be reproduced either on the same or another instrument exactly as executed by the performer.

The apparatus comprises, essentially, a recording mechanism which produces in the form of a perforated strip of paper or like material a permanent and accurate record of the notes played and which is operated by electric circuits controlled by the keys and pedals of the instrument on which the composition is played.

The chief feature of novelty in my invention resides in the combination, with mechanism for moving a band of paper which is to receive the perforations, of a series of rotary cutters, such as circular saws, which are adapted to be interposed in the plane of the paper and thereby caused to cut the perforations in the same during the intervals when the keys of the instrument to which the saws correspond are depressed, and hence to make the perforations in lengths proportional to the length of the corresponding notes.

As a paper-slotting mechanism my improvement has a general and wide range of applicability; but in order to more clearly illustrate the nature of its construction and mode of use I have shown it in combination with a piano and the several mechanisms by means of which it is used in connection with such an instrument for recording or for reproducing a musical composition.

Figure 1 is a view in side elevation and part section of a piano with which the recording mechanism is adapted to be used. Fig. 2 is a side elevation, a portion of the end frame being removed, of the slot-cutting de-

vices of the recording mechanism. Fig. 3 is a plan view of a detail of the said mechanism. Fig. 4 is a view in side elevation of devices for guiding and moving the paper, for perforating the same, and for utilizing the perforated sheet. Fig. 5 is a diagram illustrating the circuit connections between the several parts of the apparatus.

A designates the frame of a piano, which may be of any usual form, that indicated being an ordinary upright.

A' designates the keys, A'' the strings, and B the string-striking devices.

Below the keyboard extends a bar B', to which at each end are pivoted levers a and a' . These are parallel levers and are pivoted to the sides of the frame of the instrument at the points a^4 and a^5 , respectively. From one of the levers a' extends a handle a'' , which is shifted to raise or to lower the bar B', and some means should be employed, as spring-seated plugs a^3 in a plate over which the handle passes, to retain the said handle in either of the two extreme positions to which it may be shifted. Along the forward edge of the bar B' and extending through the same is a series of spring-seated plungers C, which are electrically connected to one terminal of a source of current, usually and conveniently by making the bar B' or some portion of it with which all the plungers are in contact of metal and connecting it to one pole of a battery or other generator of electricity.

The plungers C correspond in number and position with the keys of the instrument and are depressed by engagement of the keys with them when the instrument is played. In order to insure the proper action, each plunger should be adjustable with respect to the bar B', so that it may be set to the proper height for its corresponding key. A threaded nut b^3 is shown on the plunger C as the means of adjustment.

To the under side of the bar B' is secured an insulating-bar C', on which is mounted a series of metallic strips or contact-springs C'', which lie under and are touched by the plungers C when the latter are depressed by the keys. Insulated conducting-wires b are connected to the several strips C'' and are carried into and through a recess in the bar B', from whence they are led off in a cable b' to

the magnets of the perforating mechanism, which I shall now describe by reference to Figs. 2, 3, and 4.

On a table or similar supporting-frame D is mounted a frame D'. In this latter are mounted four shafts D'' at equal distances from a center and occupying positions corresponding to the four corners of a square. On these shafts are mounted, so as to turn thereon, bifurcated levers E, carrying small wheels E' at their ends, which engage with larger wheels E'', keyed on the shafts D'', and which are fixed to spindles c, carrying circular saws F. The wheels E' E'' may be simple friction-wheels, with their peripheral surfaces in contact, as shown in Fig. 1, or may be toothed wheels, as shown in Fig. 2.

The longer ends of the levers E carry armatures c', which are in front of electromagnets F', and said levers have a limited range of oscillation and compress retractile springs F'' when attracted toward the said magnets. In the drawings these springs are shown as spiral springs F'', surrounding plungers f³, working in brackets f⁴ and intermediate to the upper arms of the bracket and pin f⁵ in the plunger.

The levers E and magnets E' are arranged in four series or rows, as shown, and alternate in position, so that the magnets and levers in one series occupy positions opposite to the spaces between magnets in the other rows and so that a large number may be brought together in small compass to act upon a comparatively narrow strip of paper.

On the ends of the shafts D' are pulleys G, and rotary motion is imparted to all of said shafts and to the gear-wheels carried thereby by means of a round belt G' running over a pulley-wheel G'', which may receive its motion from any suitable source, such as an electromagnetic motor G'''. (See Fig. 4.) The circular saws are thus maintained in rapid rotation, which is not affected by the oscillation of the levers in response to the attractive force of the magnets F'.

A cable b', containing the wires that lead to the several electromagnets F', is run through chambers or spaces d at the top and bottom of the frame D', the said wires being carried through the walls of the chambers at points in proximity to their respective magnets.

The paper P to be perforated is carried through the apparatus by any suitable means, such as is commonly used for such purposes. Its course is between two closely-approximating cheeks or plates d' d'', which are slotted at their ends at points which admit the circular saws when the levers carrying the same are attracted by their magnets. The slotted plates or cheeks thus form dies for the cutters and insure the production of perforations in exact positions and with clean edges. One or more trays L'' are secured to the table to collect the chips or particles of paper cut out by the saws.

In operation the pulleys and shafts are kept

in continuous and rapid rotation, and a strip or band of paper or like material is drawn at the proper speed through the cheeks d'. When any one or more of the magnets F' are energized, the corresponding cutter or cutters are shifted so as to cut a slot in the paper, and the length of the slots will be proportionate to the periods during which the magnets are energized.

I shall now describe the electrical and mechanical devices by means of which the above-described apparatus is caused to record a musical composition and the manner in which the scored or perforated sheet or strip operates through intermediate mechanism to reproduce the recorded composition upon either the same or another instrument.

Mounted on the table D is a transverse bar or bridge M, which affords support for a series of contacts or trailers N, constituting the terminals of electric circuits formed in part through insulated wires M', carried along the bridge M and connected with the said trailers, respectively. The trailers pass through bushings in the bridge M and carry metallic rollers at their ends, which by the weight of the trailers or other suitable means are caused to bear upon the band of paper or a metal bed-plate M'' under the paper when a perforation in the latter comes under a trailer. When a trailer comes in contact with the bed-plate M'', the circuit is closed through its corresponding key-operating magnet O, as will be more fully hereinafter described, and the note produced by that key the depression of which resulted in the cutting of the slot.

In order to move the paper band either when making the perforations therein or for reproducing the recorded musical composition, the devices shown in Fig. 4 have been devised. The paper in the form of a long band is wound upon and unwound from two reels or rolls H H', mounted in antifriction-bearings in brackets secured to the table. The proper motion is imparted to the paper by an electromagnetic motor H'', the speed of which is reduced by a series of pulleys and belts, the last pulley of the series imparting motion to a belt I, which passes around and revolves in the same direction two rollers I', on the spindles of which swing arms I'', carrying other rollers K. Endless canvas belts f f surround the rollers I' and K, respectively, and rest in contact with the surface of the rolls of paper, tending to rotate them. The paper band L is carried around the rolls I', over the canvas belts, and over somewhat smaller rollers L', across the table, and through the devices for perforating it, and utilizing it as a record for reproducing the music.

In the piano or organ, as shown in Fig. 1, four benches or shelves are shown as secured at the rear of the instrument under the key-levers. On these shelves are mounted electromagnets O, with armatures O', that operate to raise vertical rods O'', and thereby raise the rear ends of the key-levers, which pro-

duces the same result as depressing the keys. The magnets operating adjacent keys are arranged in echelon, so that the space occupied by each magnet may be nearly as great as the width of four keys.

The wires M' are connected in proper order with the magnets O and contacts or trailers N, so that the keys operated by the said trailers running over the perforated strips will be the same as those depressed to produce the perforations. One or more solenoids or electromagnets P is or are employed to operate a pedal lever or levers. This magnet is in a circuit from one of the trailers N, and the perforations in the line of said pin are made by a cutter the magnet of which is energized by a circuit controlled by a contact-maker *m* on a moving part of the pedal mechanism and which keeps the said circuit closed as long as the pedal is held down by the foot of the performer.

The direction of the motion of the paper is controlled by reversing the direction of rotation of the motor II'' or by means of any suitable form of belt-shifter. When the belt-shifter or reversing mechanism is one the action or operation of which may be controlled by electromagnetic force, automatic circuit-controllers for its regulation or control may be employed. I have devised the following mechanism for this purpose.

T T are frames or brackets secured at opposite ends of the table. In each frame are mounted two electromagnets T' T'', the armatures for the magnets T' being pivoted levers *t*, each carrying a pair of contact-rollers, while the armatures for magnets T'' are catch-levers *l*, that engage with the levers *t* when the latter are raised and hold them up until magnets T'' are energized and the catches released.

One of the interlocking contacts—that to the left of the cutters—operates to arrest the moving paper by sending an impulse to the belt-shifting devices when the lever running on the paper passes through slots therein onto a contact-plate on the table, and by means of a switch the person using the instrument may energize either magnet, so as to have the lever down upon the paper or raised and retained by the catch.

The interlocking contact to the right of the figure controls the reversing mechanism or the rewinding of the paper in a similar manner. The slots in the paper which come under these devices are made by saws controlled by special switches or circuit-controllers on the instrument upon which the original composition is played.

The circuit connections between the various parts of the apparatus and the method of using the same will be understood by reference to the diagram Fig. 5, which will be described in detail.

It may be stated that the arrangement of circuits comprises two distinct terminals—viz., the instrumental and the main—between which a cable of any desirable length

may run. Situated at the former of these is a switchboard for primarily controlling those connections which are adapted for either recording or reproducing and which consists of any suitable switch, such as a five-point double-throw switch, (represented conventionally at 35.) When this is thrown up, the points 3, 5, 18, 19, and 33 are connected with the main conductors or bus-bars 1 and 2 of a source of current M B and the circuits are in proper condition for recording. On the other hand, when the switch is turned down for reproducing the same generator is joined with points 22, 26, 27, and 34. The remaining or secondary portion of the switchboard is made up of circuit-closers, represented conventionally as plug-switches, which are for the purpose of manipulating the various devices at the main terminal. The detailed description of the wiring is as follows: When it is desired to record, the main switch 35, which has previously been standing open, is closed upward. If now any key A' should be depressed, the circuit will be completed from the point 3, which is in electrical connection with wire 1, through wires 7 and 8, to the contact-pin C' under the key, and by the depression of this latter into contact with the insulated strip C'', through wires 9 and 10, magnet F' of one of the cutters, and back to point 5 through wires 11 and 12.

The same arrangement of circuit connections exists for each key, and as each strip C'' is insulated from all others the depression of a key closes only its appropriate branch of the circuit without affecting any other branch. In the same manner if a pedal be depressed a branch circuit is completed from point 3 through wires 7 and 13, contact *m*, wires 14 and 15, cutter-magnet F', and wire 16, and back to point 6 through wire 12.

Since in recording it is requisite both that the paper band should receive continuous forward motion and the cutters be maintained in rotation, by the act of closing the switch in the manner before stated current will be sent to the respective motors G''' and H'' by connecting the points 17 and 18, 19 and 20, and 21 and 22. Wires 23, 24, and 25 form the remaining portion of the circuits. The motor G''' for driving the cutters is in parallel now with the other motor H'', which is for the purpose of moving the paper, wire 24 forming a common return for both to the negative bus-bar 2.

Assume now that a composition which has been recorded is to be reproduced. The paper having been rewound on its original spool, which action will be described presently, the main switch 35 is closed downward. This motion allows current from the source, when any one of the contacts N drops through a slot in the passing strip onto the metal plate M'' beneath, to actuate its particular key-magnet, such as O, by passing from point 26 along wires 28 29 30 10 31 and finally 32 back to 27. The pedal-solenoid will obviously

be operated in a similar manner by its appropriate contact N. It will be noted that when the aforesaid switch is down only the motor H'' for producing the movement of the paper will be operating. The course of the current is from point 34 through wire 25 to H'', then back by way of 24 to 22. Besides transforming the system this switch operates the electric motors either together or singly, as the case may be; but the actual coupling of the paper-motor H'' with the strip-operating mechanisms is controlled by a polarized counter-shaft, which will now be taken up. This consists of simply two stationary coils C³ and C⁴ and one intermediate coil C⁵, arranged as a pulley, and over which a belt passes to a counter-shaft, and which is caused to assume either of three positions longitudinally on its shaft by varying the relative polarities of the said coils, the positions at the left, middle, and right being respectively for the backward, stopping, or forward motions of the paper band. The polarity of the central coil C⁵ is constant and is maintained by tapping wires 24 and 25 of the paper-motor. This will not interfere with the motor's correct performance, however, as it would take a portion of its current at the instant that it was desired to change the movement of the paper or when the current was not required. The polarities, as shown in the drawings, are caused by the closing of the keys 38, 39, and 40, and in consequence the belt-shifting coil C⁵ has been urged from either of its previous positions and has now the connecting-belt running on an idle-pulley of the counter-shaft, thus producing a stoppage of the paper strip. In order to shift the central coil over to the left and thereby produce a backward motion of the said strip, keys 36 and 37 will have to be pressed. The direction of the current in the coil C⁴ is undisturbed; but that in C³ is thereby changed, and since the center one is constant it will be attracted by the left-hand and repelled by the right-hand members. The course of the current is along wires 43, 44, 45, 46, and 47. Any branch circuits which occur, if followed out, will be found to be open. For the forward motion keys 41 and 42 must be closed. The current will now pass from 4 through conductors 48, branch 49, wire 50, branch 51, wires 47 46 45, and finally by way of 44 to key 42. In this way the polarity of coil C⁴ is maintained constant, while that of coil C³ is reversed, and the central coil is repelled and attracted by the two, respectively. As before, branches in the circuits will be found open.

In order that the central coil shall be repelled by both outside ones and the flow stopped, the current must pass, having first closed keys 38, 39, and 40, along wire 52, dividing at its termination, one part going through key 40 to joint 53, thence along 54 44, through coil C⁴, and finally to the negative bus-bar by members 45 and 55. The

other portion, having separated, will pass through wires 39 49 50 51 47, coil C³, wires 46 and 55, to the same bus-bar. It will be noticed that in moving the central coil to its middle position the outside ones will be in parallel, whereas in the other motions those same coils are in series. This is provided so that should any "sticking" occur at the iron portion of the supports the extra current produced by reason of the coils being so grouped will be sufficient to overcome and force it into a central position.

In the operation of the apparatus it is a convenience to have automatic means for rewinding the strip and stopping it at the end of any desired composition, as on one roll many distinct pieces can be recorded; also, there should be means of rendering these devices inactive if for any reason it be so desired. When a record is to be made, key 56 on the switchboard is closed. This closes the circuit consisting of wires 62 and 63 through cutters R³ R³ and produces two slots in the paper, and when in rewinding these slots come under the stopping-contacts already referred to the same result will be accomplished as if the keys 38, 39, and 40 were pressed by the operator himself, for the wires 67, 68, 69, 70, and 71, which lead from the stopping-contacts, simply bridge over the aforesaid keys. The actual passage of the current is, starting from wire 52, along wire 69 to plate 78 of the stopping-contacts, thence to roller 76, and through 68 to junction 53, where, by way of wires 54 and 44, it reaches coil C⁴. Here it leaves by conductor 45 55, and in order to pass key 38 goes down to contact-roller 78 and plate 79 of the stopping-contact by means of connectors 70 and 71. After it passes the switch in this way it returns to the negative bus-bar 2; but it will be noted that at the point 52 the current divided. The second portion having passed key 39 by going down to contact-roller 76 and plate 77 by wires 67 and 69, it proceeds by wire 50, junction 51 to coil C³, thence by wires 46 and 55, through connectors 70 and 71, to roller 78 and plate 79 to the negative side of the generator. Should it be desired to prevent this automatic stopping, the contact-rollers 76 and 78 may be lifted off of the paper by pressing key 58, when the current would pass along wire 80 to magnet T' and then back by wire 81 to the source. For releasing this, electromagnet T'' is provided, which may be readily energized by wires 81, 82, and key 57.

The rewinding cutters and contacts are for causing the strip to automatically rewind at the termination of a selection or at the end of its length. This is produced in a manner exactly analogous to that employed in the stopping mechanism. Here when key 59 is closed the rewinding-cutter magnets S³ are energized and two slots made, which in traveling along come under the rewinding-contacts. The same

result is accomplished as if the keys 36 and 37 were pressed—that is, the belt of the counter-shaft is moved over to the backward-moving pulley and the paper is rewound. The course of the current to the magnets S^3 is along wires 63 and 66. The path of the current in producing the backward motion is from point 90, through key 37, by way of wires 72 and 73, to roller 80 and plate 81, thence to coil C^4 by wires 54 and 44. From here it proceeds to coil C' by connectors 45 and 46, passing key 36 by means of wires 74 and 75, also roller 82 and plate 83, and finally reaching the negative terminal 2. This action can be prevented by lifting rollers 80 and 81 by the electromagnet T' , which is controlled by key 59 and wires 84 and 85. To release the catch-lever T' , keys 60 and 61, in conjunction with wires 83 and 84, may be operated.

What I claim is—

1. In a paper-slotting mechanism, the combination with means for supporting a traveling band of paper, of a series of pivoted levers, a circular saw or cutter carried by each, means for transmitting power to and rotating the saws, and means for shifting the levers to bring the saws while rotating into the plane of the paper, whereby slots will be cut in the

same by the cutters while so shifted, as set forth.

2. In a paper-slotting mechanism, the combination with means for supporting a traveling band of paper, of a series of pivoted armature-levers, a circular saw or cutter carried by each, means for transmitting power to and rotating the saws, and electromagnets for shifting the levers to bring the saws while rotating into the plane of the paper, whereby slots will be cut in the same by the cutters while so shifted, as set forth.

3. The combination with a frame, of two or more shafts supported therein about a central line, levers turning on said shafts and occupying intermediate positions to each other, a circular saw carried by each lever gearing from the shafts of the saws, electromagnets for shifting the said levers, and a guide for a traveling paper band or sheet in the center of the group of shafts, whereby any of the saws may be interposed in the plane of the paper and caused to cut slots therein, as set forth.

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Witnesses:

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