No. 808,311. PATENTED DEC. 26, 1905.

H. K. SANDELL.

SHEET PERFORATING MACHINE.

APPLICATION FILED SEPT. 7, 1905.

7 SHEETS—SHEET 1.

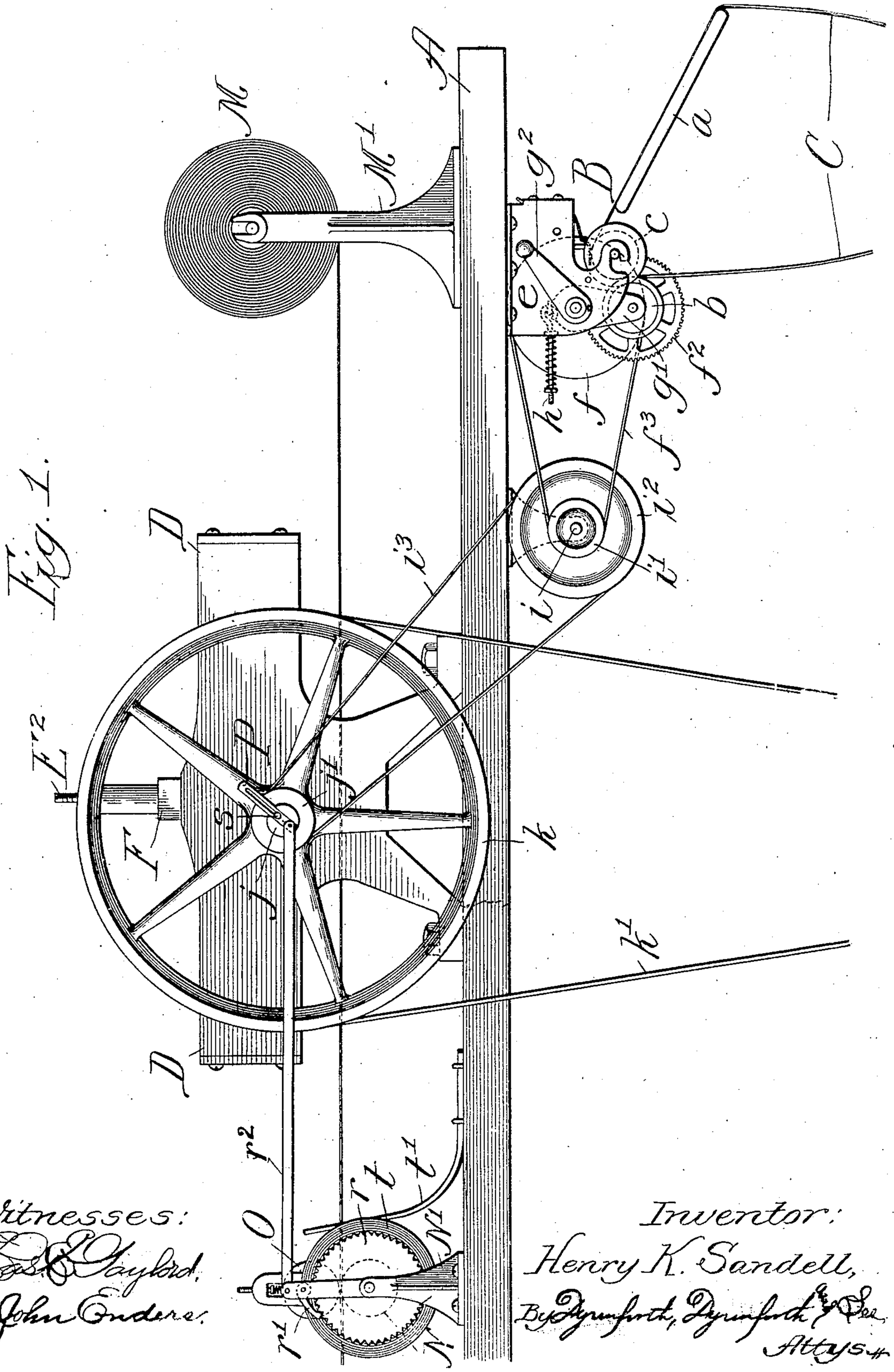

Fig. 1.

Witnesses:
Chas. L. Gaylord.
John Enders.

Inventor:
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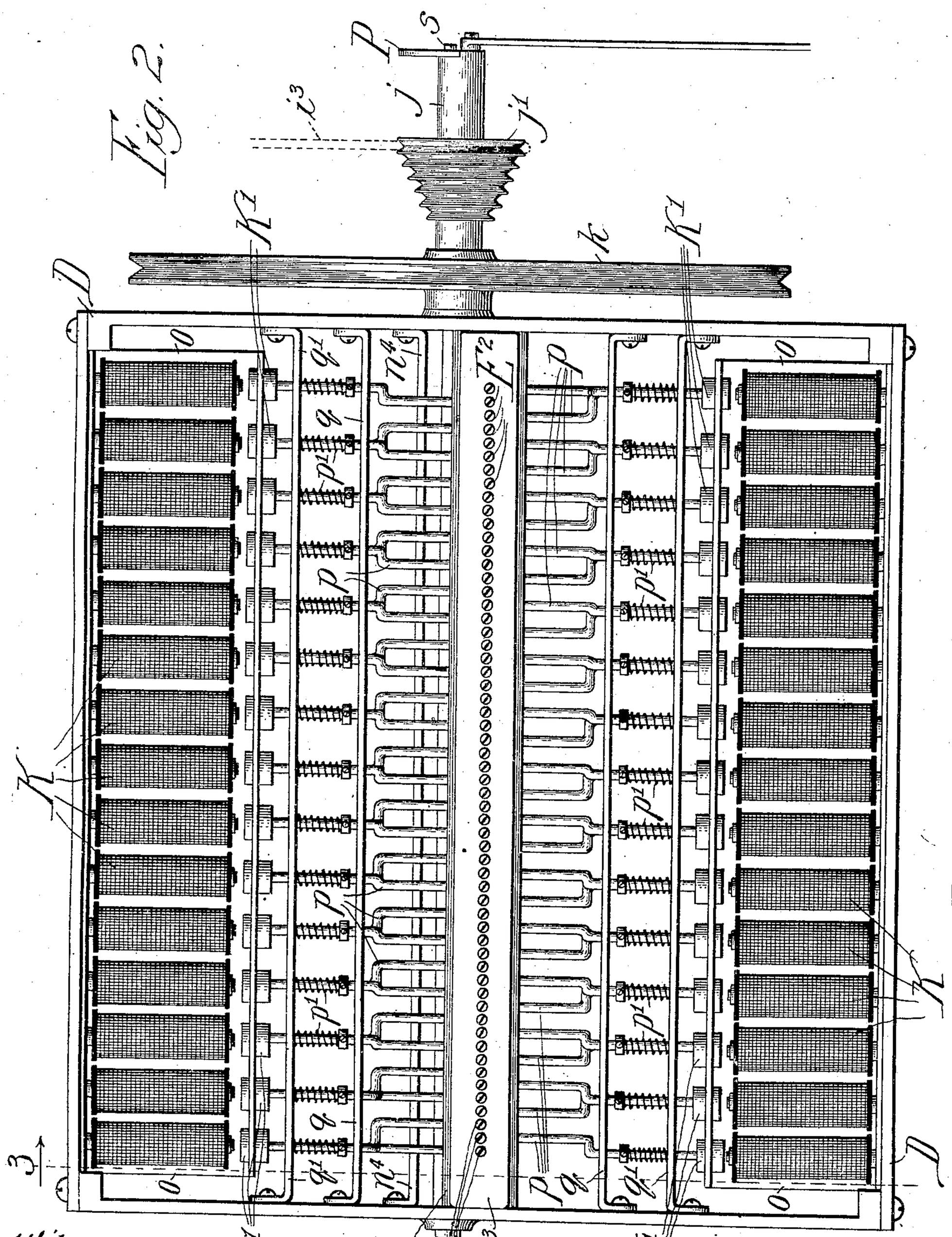
7 SHEETS—SHEET 2.

Fig. 2.



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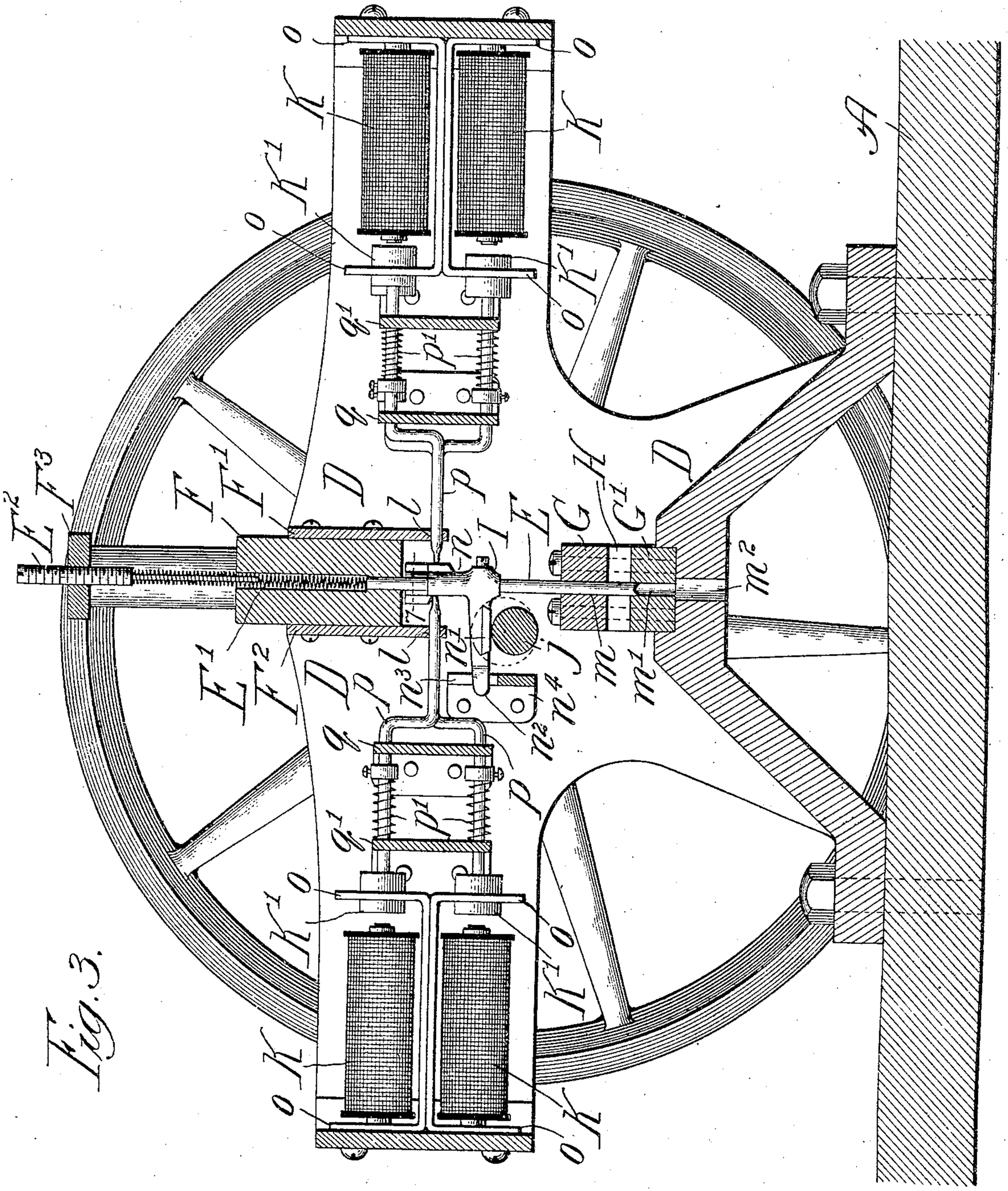

Fig. 3.

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7 SHEETS—SHEET 4.

Fig. 4.

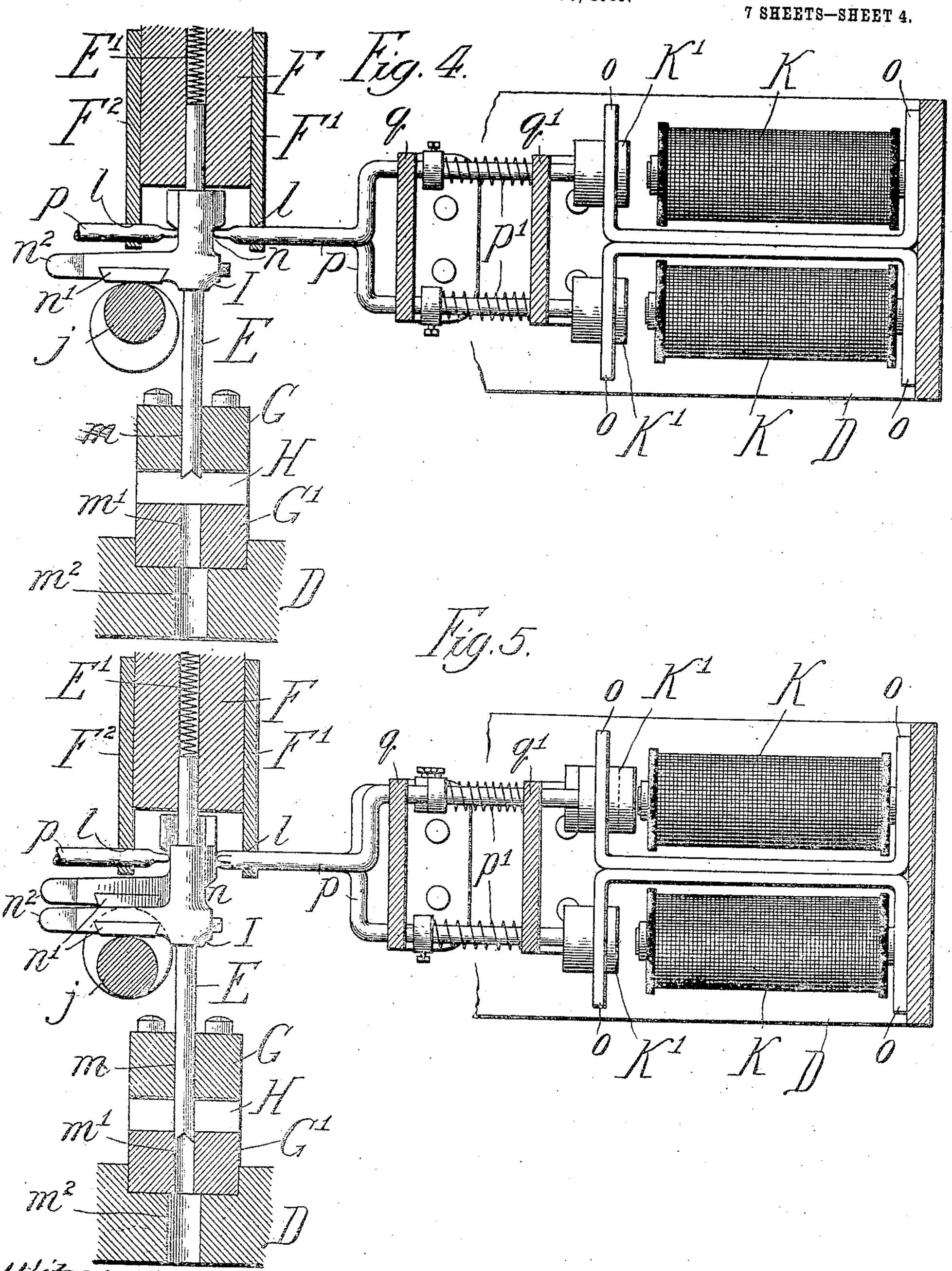

Fig. 5.

Witnesses:

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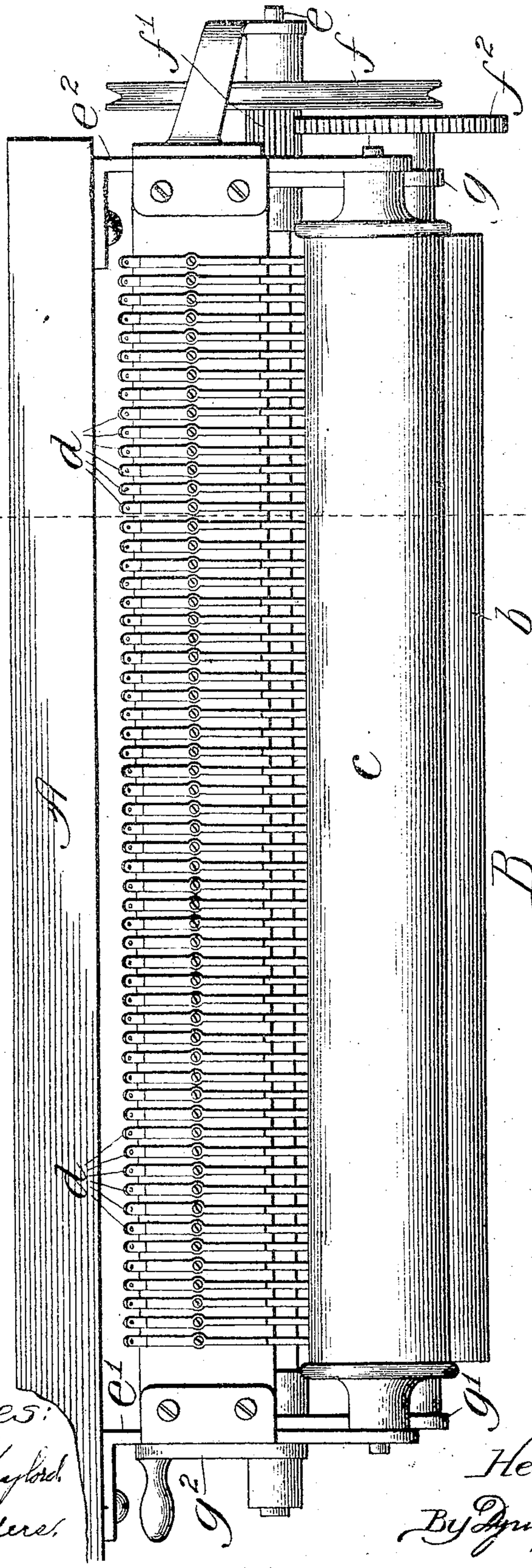

Fig. 6.

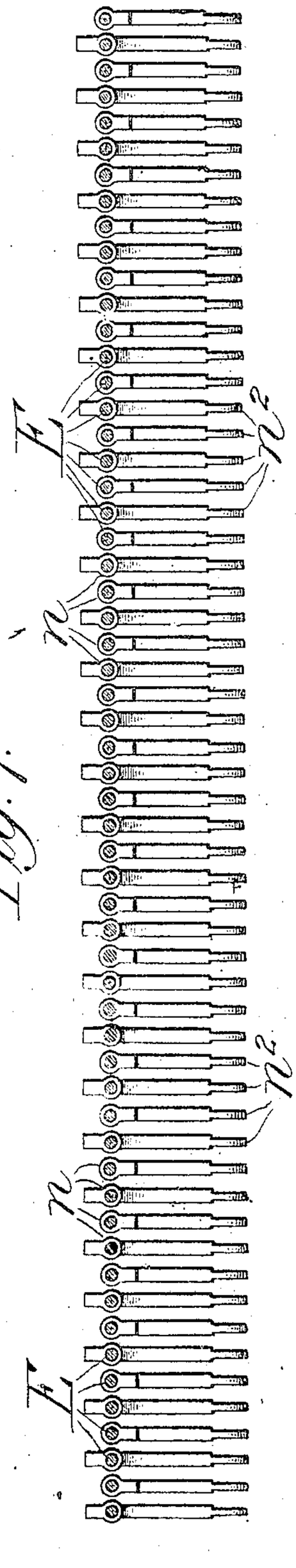

Fig. 7.

Witnesses:
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7 SHEETS—SHEET 6.

Fig. 8.

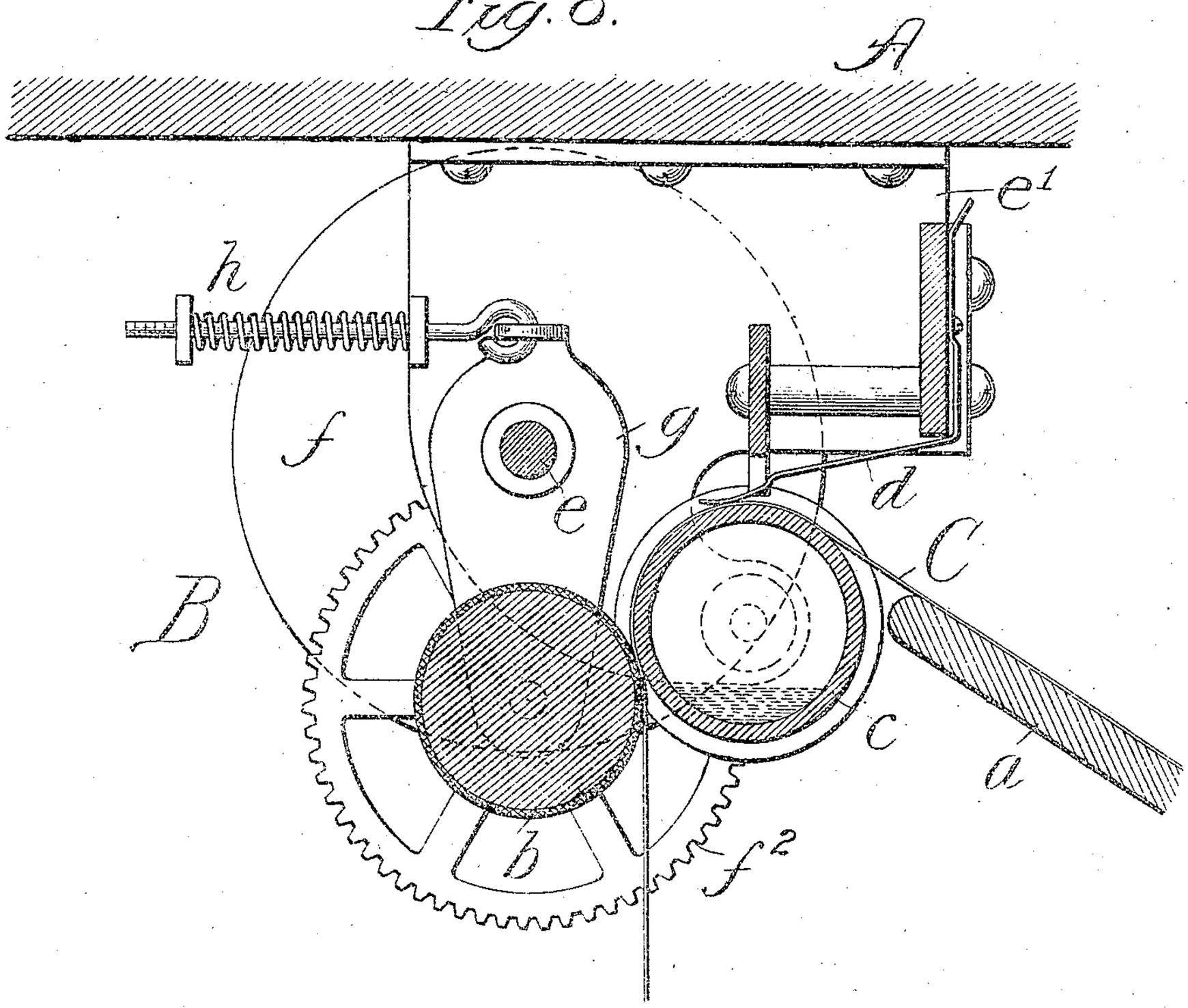


Fig. 9.

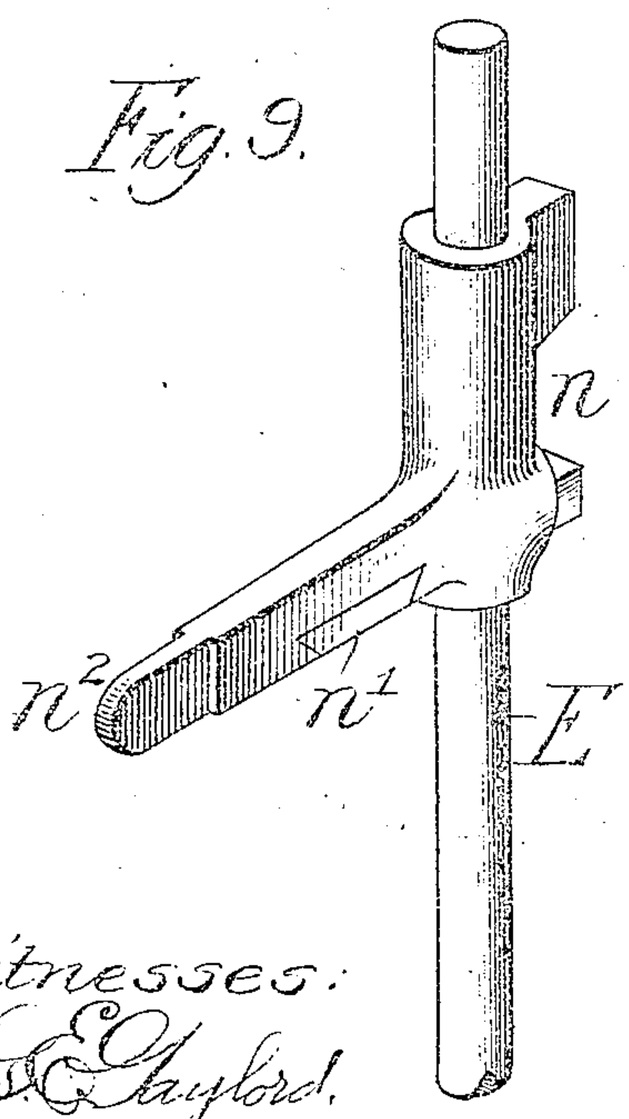
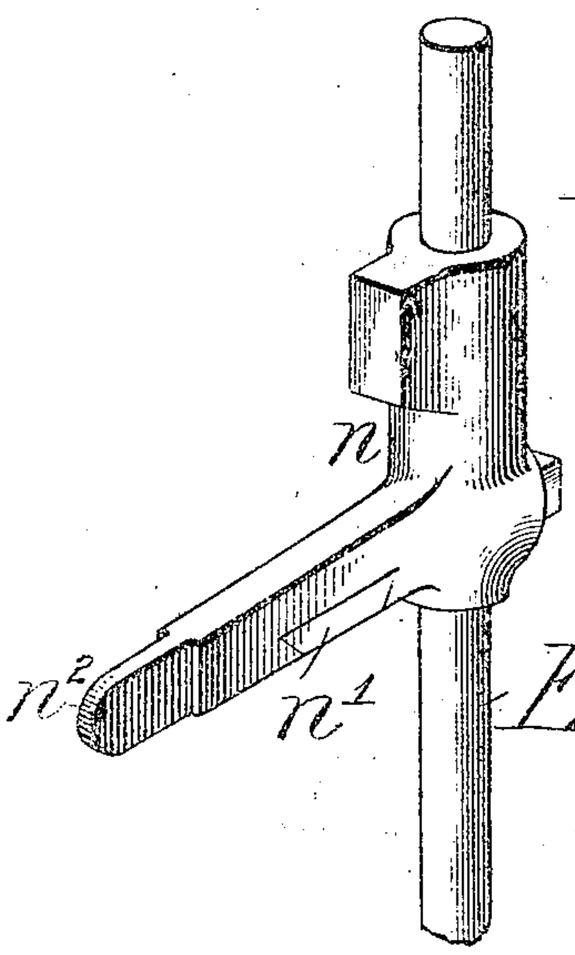


Fig. 10.



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7 SHEETS—SHEET 7.

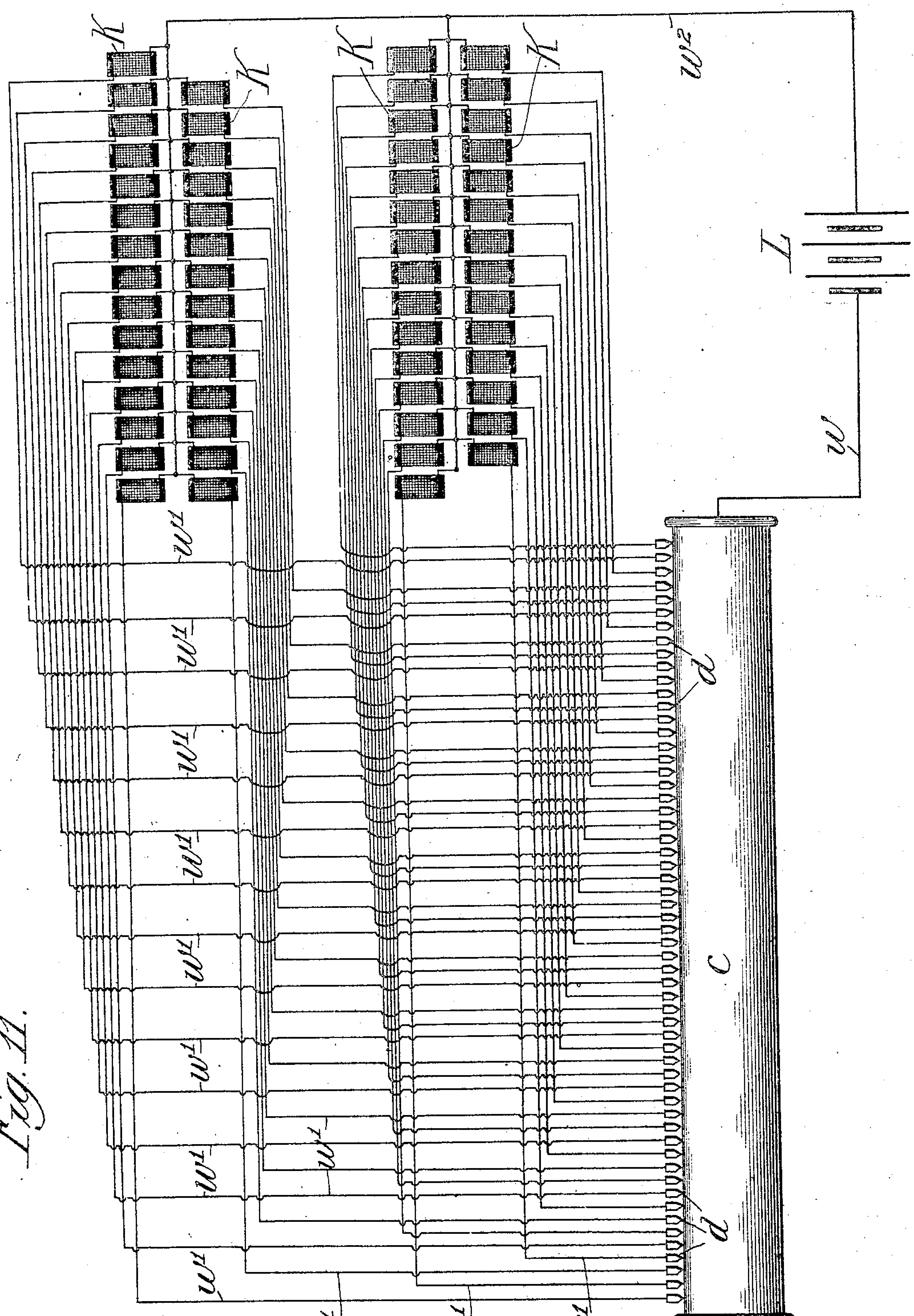

Fig. 11.

Witnesses:

Chas. E. Gaylord,

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Inventor:

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Attys.

THE ECKERT LITHOGRAPHING CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

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

SHEET-PERFORATING MACHINE.

No. 803,311. Specification of Letters Patent. Patented Dec. 26, 1905.

Application filed September 7, 1905. Serial No. 277,352.

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 Sheet-Perforating Machines, of which the following is a specification.

My invention relates more especially to an improvement in the class of perforating-machines for producing the music-sheets employed in self-playing instruments. It may, however, be used for perforating sheets for other purposes.

The primary object of my invention is to provide a construction of machine in the class referred to which shall be devoid of any lever-operated or jointed parts, and accordingly comparatively simple and durable, with the minimum liability to get out of order.

The motive power which is preferred for controlling the operation of my improved perforating-machine is electricity, although pneumatic or other motive power may be used for releasing the spring-driven punches from their normally inactive position, and as the machine has been especially designed for perforating paper sheets for use with the electric self-playing violin forming the subject of my application for Letters Patent, Serial No. 252,228, filed March 27, 1905, I employ in connection with the machine for producing the perforated sheets substantially the same electrical contact mechanism to be traversed by the master-sheet and driving mechanism for the latter as are employed in the aforesaid violin-machine to produce playing of the instrument. These last-named mechanisms and their connection with the perforating-machine are illustrated as representing one embodiment of my invention in the accompanying drawings, of which the following is a description.

Figure 1 is a view in side elevation of the entire machine, except the motor for driving it, which is omitted for lack of space on the sheet and because it is unnecessary to represent. Fig. 2 is a plan view of the perforating-machine proper with all the magnets but one deënergized and the parts they control in corresponding condition. Fig. 3 is an enlarged section taken at the line 3 on Fig. 2 and viewed in the direction of the arrow. Fig. 4 is an enlarged broken view, in sectional elevation, showing a punch in its raised position and the spring-advanced and magnet-retracted means for holding the punches in their inactive raised positions to which they are forced by a rotating cam against the springs which tend to depress them; and Fig. 5 is a similar view of the same, but showing a punch in its depressed position. Fig. 6 is a view in elevation of the feeding and contact mechanisms for the master-sheet. Fig. 7 is an enlarged plan section taken at the line 7 on Fig. 3, showing in plan the entire series of notched arrester-shoes carried by the punches. Fig. 8 is an enlarged view, in cross-sectional elevation, of the feeding and contact mechanisms for the master-sheet. Fig. 9 is a broken perspective view showing one of the arrester-equipped punches presenting the locking-notch in one side of the arrester, and Fig. 10 is a similar view of one of the same devices which presents the locking-notch on the opposite side of the arrester. Fig. 11 is a diagram illustrating the generator-circuits in which the mechanisms for arresting and releasing the punches are contained.

The generally-described operation of the electrically-actuated perforating-machine illustrated is the following: A master-sheet is fed across a set of contacts, each having in circuit with it an electromagnet, and a sheet to be perforated is fed correspondingly with the master-sheet across a row of reciprocable punches, each normally held away from the work against the tension of a spring which drives it, the punches being reciprocated by a cam actuating them in one direction and their driving-springs actuating them in the contrary direction. As a perforation in the traveling master-sheet registers with a contact the latter closes a circuit containing the respective electromagnet to attract its armature, and thereby release the punch, which is normally held out of action by the spring-pressed armature of the magnet in the deënergized condition of the latter. Upon such release of the punch a rapidly-rotating cam coacts with the punch-driving spring to reciprocate the punch rapidly, and thus cause it to cut in the traveling sheet to be perforated a perforation corresponding with that through which the circuit closure occurred.

The mechanism of the machine is sustained on a bed or table A, on the under side of which,

near one end, is supported feeding and contact mechanism B for a master-sheet C, which moves across an inclined guide-board *a* and thence between a feed-roller *b* and a contact-roller *c*, with which latter a series of spring contact-teeth *d* are supported to engage through the perforations in the master-sheet as they are brought into registration with the contacts. In rigid bearing-plates e' and e^2, depending at the proper distance apart from the under side of the table A, is immovably secured in horizontal position a fulcrum-rod *e*. On the right-hand end of this rod is journaled a grooved pulley *f*, from the center of one face of which projects a pinion f', Fig. 6. On the same end of the rod *e* adjacent to the bearing e^2 is journaled a hanger *g*, and near the opposite end thereof is journaled at its hub or sleeve a similar hanger g' to depend at the inner side of the bearing-plate e', said hub projecting through the plate e' and carrying a crank-handle g^2. In the lower ends of the swinging hangers *g* and g' is journaled the feed-roller *b*, which may be composed of hard rubber and which carries on one end a ratchet-wheel f^2, meshing with the pinion f', and the feed-roller coöperates with the metal contact-roller *c*, journaled in the bearing-plates e' e^2 to feed a sheet C by clamping it between the two rollers, which are separable for arresting the feed for any purpose by manipulating the handle g^2 to swing the hangers. Spring-rods, each like that shown at *h* in Fig. 8, are supported in engagement with the swinging hangers above their fulcrum-points to 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 details thus described are substantially like those of the contact and music-sheet-feeding mechanisms shown and described in my aforesaid pending application. However, any other suitable feeding mechanism may without departure from the invention be employed with the sheet-cutting mechanism hereinafter described.

The pulley *f* has a belt connection f^3 with a smaller pulley i' on a counter-shaft *i*, journaled in bearings depending from the table A and carrying a larger pulley i^2, which has a belt connection i^3 with a pulley j' on a cam-shaft *j*, journaled in suitable end bearings on a frame D upon the upper side of the supporting-table, the cam-shaft carrying a large drive-pulley *k*, connected by a belt k' with the driving power, (not shown,) such as an electric motor. The pulley j' is preferably of the differential-speed variety, as shown in Fig. 2, for subserving the purpose hereinafter explained.

The sheet-cutting mechanism involves a horizontal row, extending across the center of the frame D, of vertically-reciprocating punches E, of which any desired number may be provided, though for my immediate aforesaid purpose of providing perforated sheets for the said automatic violin-playing machine fifty-eight are provided, being twelve for the chromatically-operative fingering devices for each string of the instrument, one for each open string, four for the magnets controlling the pressure of the sounders on the strings, one for the tremolo attachment, and one for controlling the starting and stoppage of the motor which operates the violin-playing mechanism. The punches work through openings, one for each punch, in a bar F, extending across and supported in the frame D and having fastened to its respective sides plates F' and F^2, which project below the lower face of the punch-bar and are provided near their lower edges with horizontal series of guide-openings *l* for a purpose hereinafter described, the members of one series being in staggered relation to those in the other series. Each punch has a coiled driving-spring E' confined against its upper end in the respective vertical punch-containing opening in the bar F by a tension-adjusting screw E^2, these screws working in threaded openings in a bar F^3, supported on the frame to extend over and parallel with the bar F. Underneath the punch-bar and coincident therewith is supported on the frame D a pair of parallel die-bars G and G', having coincident vertical punch-openings *m* and m' extending, respectively, through them and with which the punches coincide, each opening m' leading to a larger opening m^2 in the bottom part of the frame through which to discharge the material cut by the punches out of the sheet being perforated, as hereinafter described, and for the passage of which latter through the perforating-machine a space H is formed between the bars G and G'. On each punch E is fastened below the bar F an arrester I, shown in its preferred form of a shoe having a recess *n* in its shank portion and a bearing-insert n', preferably of vulcanized fiber, in the sole of its foot portion to be engaged by the cam-shaft *j*. The notches *n* are provided successively in opposite sides of the arresters throughout the series thereof for the purpose hereinafter described. The arresters thus form, practically, parts of the punches and are guided by their reduced or toe ends n^2, entering vertical slots n^3 in a guide-plate n^4, extending across the frame.

In the frame D, on each of two sides thereof, are supported to project toward its longitudinal center an upper set and a lower set of electromagnets K, each having its armature reciprocably supported in a pole extension *o* and provided with a finger *p*, projecting from it toward the center of the frame and suitably bent to register its tapered extremity, which works in a guide-opening *l* in a bar F' or F^2, as the case may be, with the plane of a notch *n* in the respective shoe I when the punch carrying that shoe is in its normally raised position. Thus the fingers *p* of the

magnets on opposite sides of the frame D are adapted to engage the notches in the arresters, respectively, presented to them. Each finger works through suitable bearings q and q' and has confined about it a spring p', tending to project it in opposition to the attractive force of its controlling-magnet when energized. The number of the magnets corresponds with that of the contacts d, fifteen being provided in each upper row and fourteen in each lower row, and each magnet is connected, as represented in the diagrammatic figure of the drawings, by a separate conductor w' with a different contact d, and all the contacts coöperate with the roller c, which is connected by a conductor w with the positive end of an electric-current generator, (indicated at L,) the negative end having connected with it a return-conductor w^2, with which all the magnets are connected, as indicated in the diagram.

The material to be perforated may be provided in the form of a roll of paper M, Fig. 1, from which to pay off by the action of the feeding device on the perforating-machine, the roll being journaled in standards, one of which is represented at M', supported on the table A, and the end of the sheet being carried across the punches through the space H and gripped between feed-rollers N and O. These rollers are journaled in standards on the table A, one of which standards is represented at N', the roller N, carrying a ratchet-wheel r, engaged for driving it with an intermittent motion by a pawl r' operatively connected with one end of a pitman-rod r^2, having a crank connection at its opposite end with the cam-shaft j. This connection is represented as a slotted bar P let into the end of the shaft (see Fig. 2) and straddling a headed stud s, eccentrically mounted on the end of the shaft and on which the bar is adjustable to increase or diminish the extent of stroke of the pitman connected with said bar and accordingly vary the extent of movement of the pawl r' to adapt it to vary the feed accordingly. A stiff spring t' is shown in Fig. 1 bearing against the periphery of a pulley t on the shaft which carries the roller N to act as a brake to prevent the sheet undergoing perforation from turning by its tension the feed-rollers N and O backward in the intermission between the turning engagements of the pawl r' with the ratchet r.

The operation is as follows: With the sheet to be perforated gripped between the rollers for feeding it and the master-sheet C adjusted between the rollers b and c the driving power is caused to turn the pulley k, and with it the cam-shaft j, thereby driving from the latter the feed mechanism for the perforated master-sheet and that of the sheet to be perforated. In the normal condition of the machine while at rest all of the punches are raised above the path of the sheet to be perforated, being releasably locked in the raised position against the tension of their driving-springs E' by engagement with the notches n in the arrester-shoes I of the tapered ends of the fingers p. As a perforation in the master-sheet registers with a contact d in its path the generator-circuit is closed over the conductor w, roller c, wire w', connecting that particular contact with a magnet K, and from that magnet by the conductor w^2 returning to the generator. The circuit remains closed so long as the engagement lasts through a perforation in the master-sheet of a contact d with the roller c. Closure of the circuit energizes the respective magnet to attract its armature, with the effect of retracting the finger p it carries from engagement with the respective arrester I, thereby releasing the particular punch controlled by that arrester and permitting its driving-spring E' to force it through the space H and puncture the sheet M accordingly. In each revolution of the rapidly-rotating cam-shaft j by its engagement with the respective punch at its arrester portion I at the insert n' it raises the punch, and in the same revolution the punch-spring drives the punch, while in the interim between the cutting and receding movements of the punch the rotatory shaft j actuates the pawl r' to feed the paper. The adjustment of the parts is such that in the travel of the sheet M the perforating movements against it of a reciprocating punch occur at intervals of about three sixty-fourths of an inch, thereby causing the successive perforations to overlap one another to form the elongated openings in the paper. Of course, however, these intervals on the paper being perforated may be varied to any desired extent. The moment that the perforation in the master-sheet passes the respective contact, with the result of opening the circuit by interposing paper between the contact and the roller c, the spring-pressed finger p of that magnet shoots into the path of the arrester I to engage its notch n in the rise of the punch under the cam-shaft action and retain the punch out of operation until the magnet which controls it is again energized.

The foregoing description of the operation of one punch will suffice for all. From it will readily be understood by those skilled in the art that each perforation in the master-sheet is reproduced in the sheet undergoing perforation by the reciprocating action of the spring-driven and cam-retracted punches as they are released from their normally withheld condition to permit them to be reciprocated through the sheet in its stoppages while it is being fed across them.

The differential drive-pulley j'' serves as a ready means for lowering and raising at will the speed of feeding the master-roll, while the speed of rotation of the shaft j continues uniformly for the purpose of cutting the sheet undergoing perforation to cause the in-

strument on which it is used to play at a slower or a faster tempo. Thus with the belt i^3 on a narrower section of the pulley j' the speed of feeding the master-sheet is accordingly reduced, with the effect of producing relatively longer perforations in the sheet M and a slower tempo in playing, while the belt on a wider section of the drive-pulley increases the speed of feeding the master-roll and effects accordingly shortening of the cuts in the sheet undergoing perforation, with the result of increasing the tempo in its playing action.

The present invention is primarily characterized by driving the punches through the sheet material undergoing perforation with springs and retracting them to produce their longitudinal reciprocation relative to the sheet material through the medium of the rotatory cam-shaft or other means positively acting against the punches in opposition to their driving-springs. This construction presents the important advantage as against raising the punches by spring action and driving them by cam or lever mechanism in assuring the instantaneous driving action of each punch when released and its positive retraction from the path of the sheet in each reciprocating stroke, whereby tearing of the intermittently-traveling sheet by inaccurate or untimely withdrawal of the punch is avoided. Moreover, this principle of operation enables the construction to be simple and durable without liability to disarrangement of parts, since they contain no jointed members, and the only elements of the mechanism which ever require attention after the machine is once in working order are the punches, which require to be sharpened occasionally.

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

1. In a perforating-machine of the character described, the combination with mechanism for feeding sheet material to be perforated, of spring-driven punches having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, and means engaging the punches to positively retract them against the resistance of their driving-springs and reciprocate them transversely relative to said material.

2. In a perforating-machine of the character described, the combination with mechanism for feeding sheet material to be perforated, of spring-driven cam-retracted punches transversely reciprocable relative to said material and having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter.

3. In a perforating-machine of the character described, the combination with mechanism for feeding sheet material to be perforated, of spring-driven punches and a rotatory cam-shaft immediately engaging said punches to retract them in opposition to their driving-springs and produce their transverse reciprocation relative to said material.

4. In a perforating-machine of the character described, the combination with mechanism for feeding sheet material to be perforated, of a series of reciprocably-supported punches provided with driving-springs and carrying-arresters, a continuously-rotating cam-shaft immediately engaging said arresters to retract the punches in opposition to said springs and produce their transverse reciprocation relative to said material, means for driving said shaft, and means releasably engaging said arresters and normally locking the punches in their retracted position.

5. In a perforating-machine of the character described, the combination of mechanism for feeding sheet material to be perforated, spring-driven punches having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, a rotary cam-shaft engaging said punches to retract them in opposition to their driving-springs and produce their transverse reciprocation relative to said material, and master-sheet-feeding mechanism coöperating with said sheet-material-feeding mechanism and operating to control the action of the punches through the perforations in the master-sheet.

6. In a perforating-machine of the character described, the combination of intermittently-actuated mechanism for feeding sheet material to be perforated, spring-driven punches having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, a rotatory cam-shaft engaging said punches to retract them in opposition to their driving-springs and produce their transverse reciprocation relative to said material, and master-sheet-feeding mechanism connected with said cam-shaft to be actuated thereby and operating to control the action of the punches through the perforations in the master-sheet.

7. In a perforating-machine of the character described, the combination of intermittently-actuated feeding mechanism for the sheet material to be perforated, master-sheet-feeding mechanism including an electrical contact-roller and contacts, between which said master-sheet is fed, spring-driven punches and a rotatary cam-shaft engaging said punches to retract them in opposition to their driving-springs and produce their reciprocation relative to said material, said master-sheet and sheet-material feeding mechanisms being connected with and actuated by said cam-shaft, electromagnets having spring-actuated armatures provided with means for releasably locking said punches in their normally retracted positions, and an electric circuit containing said contact-roller and having branches, each branch including one of said contacts and one of said magnets.

8. In a perforating-machine of the character

described, the combination of spring-driven punches having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, a rotatory cam-shaft engaging said punches to retract them in opposition to their driving-springs and produce their longitudinal reciprocation, and mechanism for feeding the sheet material to be perforated across the path of said punches, comprising coöperating feed-rollers, one of said rollers being provided with a ratchet-wheel, a pawl engaging said wheel and a pitman connected at one end with said pawl and having its opposite end eccentrically connected with the cam-shaft.

9. In a perforating-machine of the character described, the combination of spring-driven punches having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, a rotatory cam-shaft engaging said punches to retract them in opposition to their driving-springs and produce their longitudinal reciprocation, and mechanism for feeding the sheet material to be perforated across the path of said punches, comprising coöperating feed-rollers, one of said rollers being provided with a ratchet-wheel, a pawl engaging said wheel, a pitman connected at one end with said pawl and having its opposite end eccentrically connected with the cam-shaft, and a brake device coöperating with one of said rollers.

10. In a perforating-machine of the character described, the combination of spring-driven punches having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, a rotatory cam-shaft engaging said punches to retract them in opposition to their driving-springs and produce their longitudinal reciprocation, means for releasably locking the punches independently of each other in their normally retracted positions, and mechanism for feeding the sheet material to be perforated across the path of said punches, comprising coöperating feed-rollers, one of said rollers being provided with a ratchet-wheel, a pawl engaging said wheel and a pitman connected at one end with said pawl and having its opposite end eccentrically connected with the cam-shaft.

11. In a perforating-machine of the character described, the combination with mechanism for feeding sheet material to be perforated, of a punch-bar supported to extend across the path of feed of said material and containing a row of punch-openings, punches reciprocably confined in said openings and driving-springs confined against the punches, a pair of bars supported to extend parallel with said punch-bar and forming between them a space for the passage of said material and provided with coincident openings registering with said punch-bar openings, means positively engaging said punches in opposition to their driving-springs to produce reciprocation of the punches, and means for releasably locking the punches in their normally retracted positions.

12. In a perforating-machine of the character described, the combination with mechanism for feeding sheet material to be perforated, of a punch-bar supported to extend across the path of feed of said material and containing a row of punch-openings, punches reciprocably confined in said openings and driving-springs confined against the punches, arresters on the punches, a pair of bars supported to extend parallel with each other and with said punch-bar and forming between them a space for the passage of said material and provided with coincident openings registering with said punch-bar openings, a rotatory cam-shaft engaging said arresters in opposition to the punch-springs, and means for releasably engaging said arresters to lock the punches in their normally retracted positions.

13. In a perforating-machine of the character described, the combination with a bed for supporting the parts, of a frame on said bed, mechanism for feeding across said frame sheet material to be perforated, a row of longitudinally-reciprocable spring-driven punches supported on said frame to extend across the path of feed of said material, and having their actuating-springs confined against them to be set for recoil action against the punches by retracting the latter, arresters on said punches, a rotatory cam-shaft engaging said arresters to retract the punches in opposition to their driving-springs and with which said feeding mechanism is connected to be operated thereby, master-sheet-feeding mechanism connected with said shaft to be actuated thereby, and operating to control the action of the punches through the perforations in the master-sheet, and means for releasably engaging said arresters to lock the punches in their normally retracted positions.

14. In a perforating-machine of the character described, the combination with a bed for supporting the parts, of a frame on said bed, intermittently-operating mechanism for feeding across said frame sheet material to be perforated, a row of longitudinally-reciprocable spring-driven punches supported on said frame to extend across the path of feed of said material, arresters on said punches, a rotatory cam-shaft engaging said arresters to retract the punches in opposition to their driving-springs and with which said feeding mechanism is connected to be actuated thereby, electromagnets supported on said frame and having spring-pressed armatures carrying fingers normally engaging said arresters to lock the punches in their retracted positions, master-sheet-feeding mechanism connected with said shaft to be operated thereby and containing an electrical contact-roller and contacts, between which said master-sheet is fed, and an

electric circuit containing said contact-roller and having branches, each branch including one of said contacts and one of said magnets.

15. In a perforating-machine of the character described, the combination with a bed for supporting the parts, of a frame on said bed, intermittently-operating mechanism for feeding across said frame sheet material to be perforated, a row of longitudinally-reciprocable spring-driven punches supported on said frame to extend across the path of feed of said material, arresters on said punches, a rotatory cam-shaft adapted to be connected with suitable driving power and engaging said arresters to retract the punches in opposition to their driving-springs and with which said feeding mechanism is connected to be actuated thereby, electromagnets, one for each punch, supported on said frame and having spring-pressed armatures carrying fingers normally engaging said arresters to lock the punches in their retracted positions, a differential speed-pulley on said shaft, master-sheet-feeding mechanism geared to said pulley to be operated by the cam-shaft and containing an electrical contact-roller and contacts between which said master-sheet is fed, and an electric circuit containing said contact-roller and having branches, each branch including one of said contacts and one of said magnets.

HENRY K. SANDELL.

In presence of—
A. U. THORIEN,
J. H. LAUDES.