(No Model.) 15 Sheets—Sheet 1.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

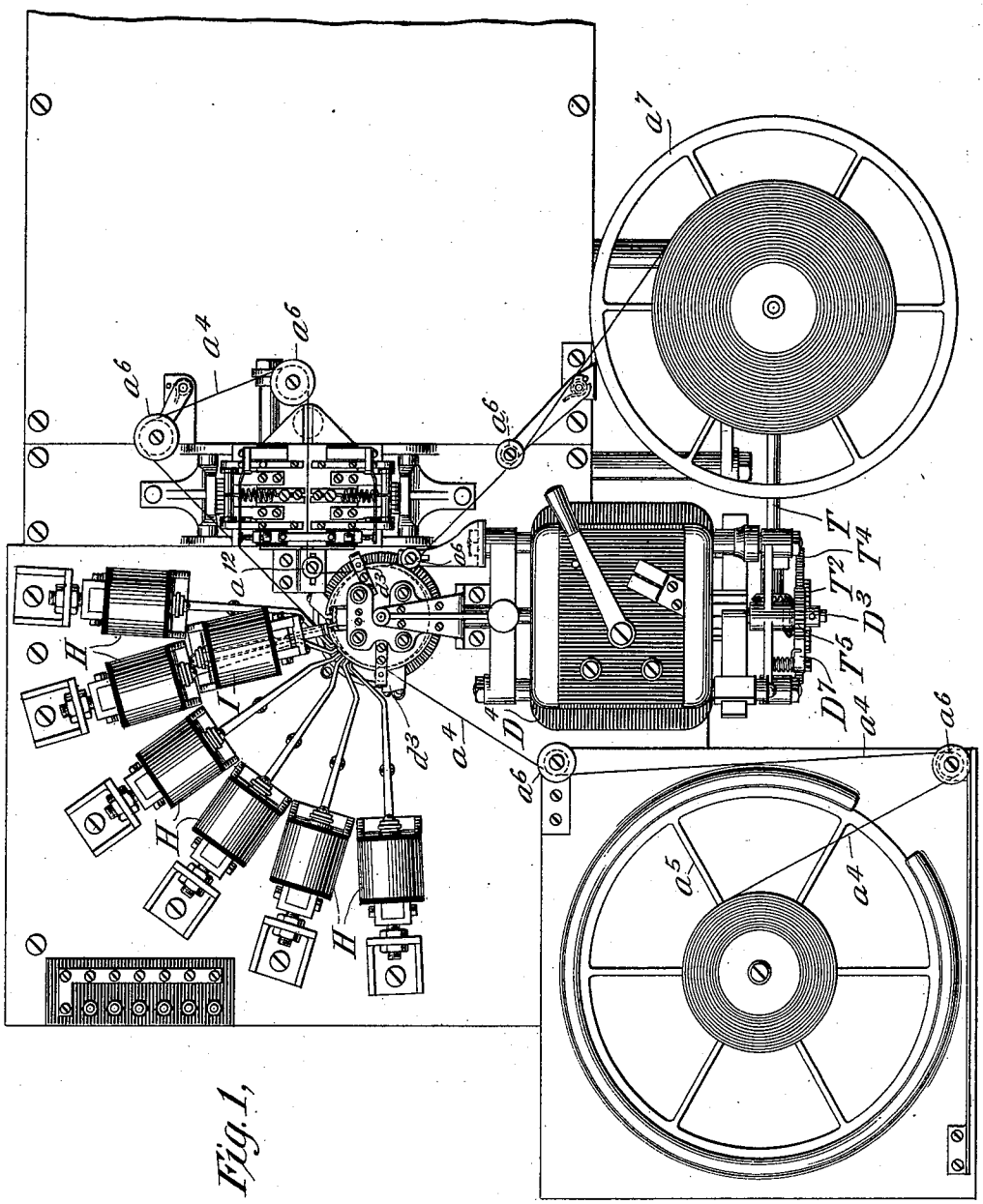

Fig. 1.

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Joseph Gardam.
INVENTORS:

WITNESSES:
C. E. Ashley
H. W. Lloyd.

By their Attorney
H. G. Townsend

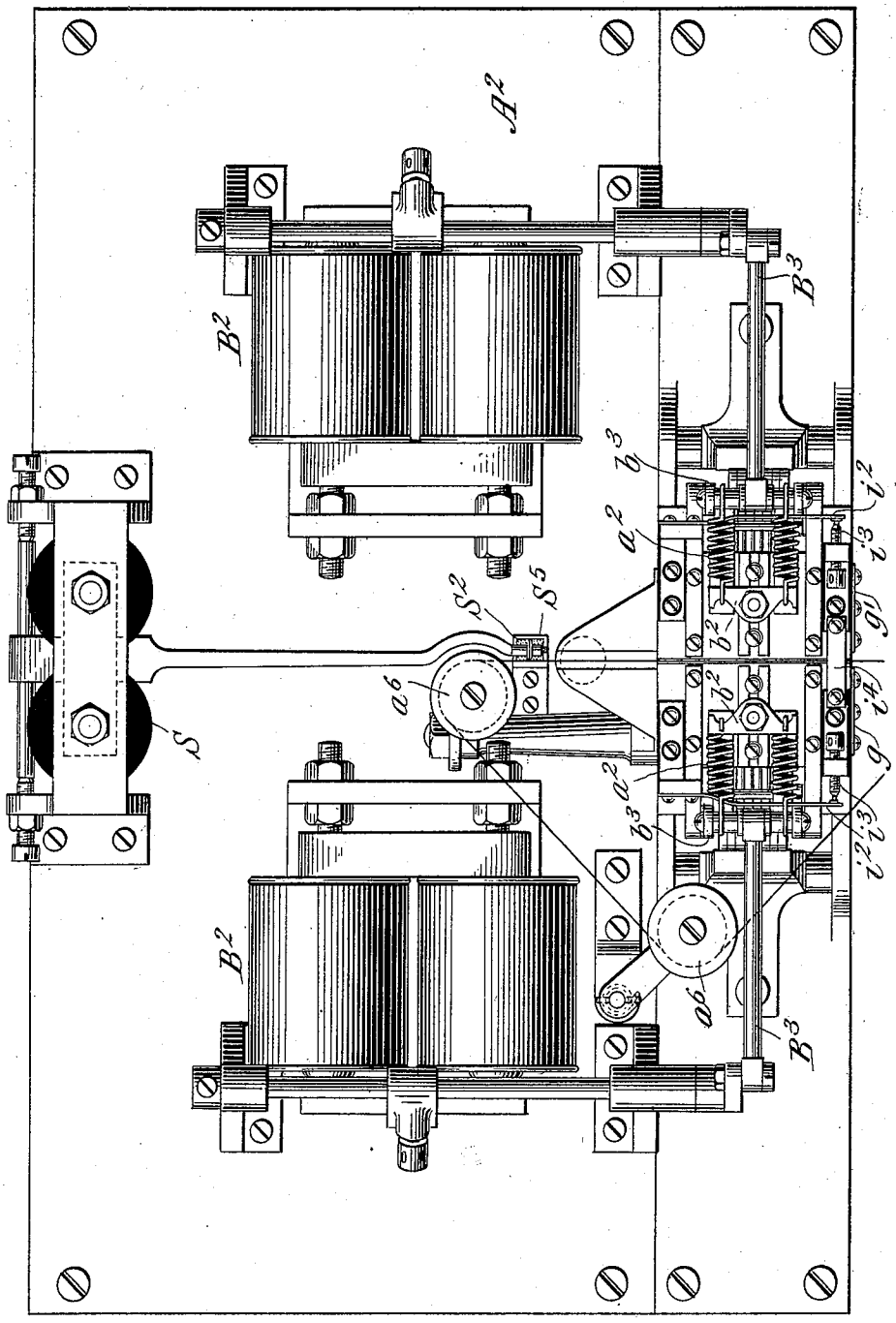
(No Model.) 15 Sheets—Sheet 2.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 2.



WITNESSES:
C. E. Ashley
H. W. Lloyd.

INVENTORS:
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Joseph Gardam.

By their Atty.
H. G. Townsend

(No Model.) 15 Sheets—Sheet 3.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 3.

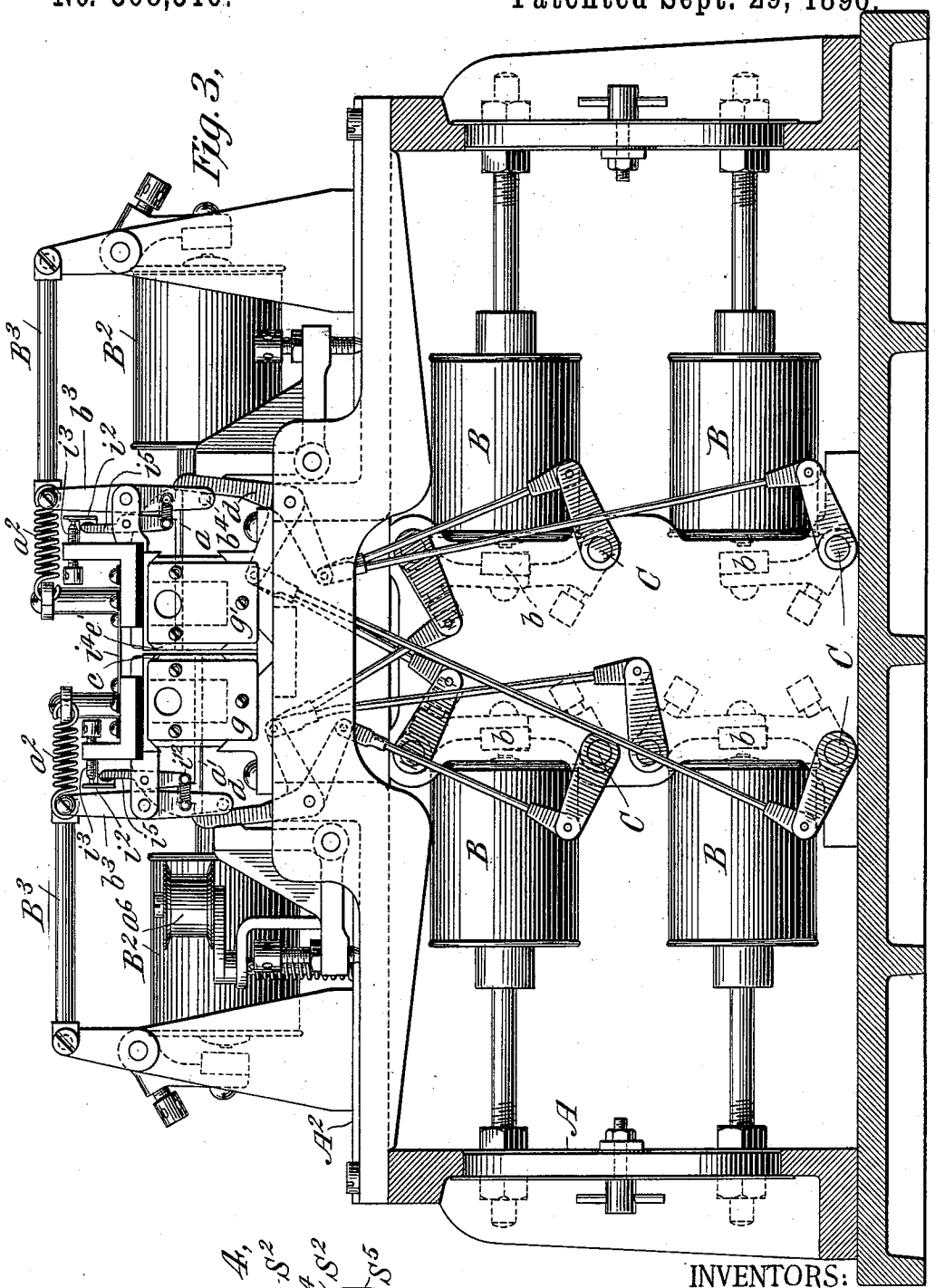
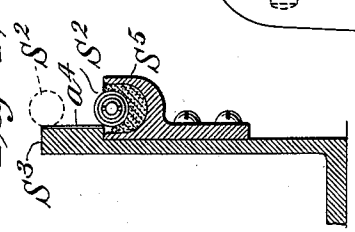


Fig. 4.



WITNESSES:

C. E. Ashley

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INVENTORS:

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Joseph Gardam.
By their Attorney
H. B. Townsend

(No Model.) 15 Sheets—Sheet 4.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

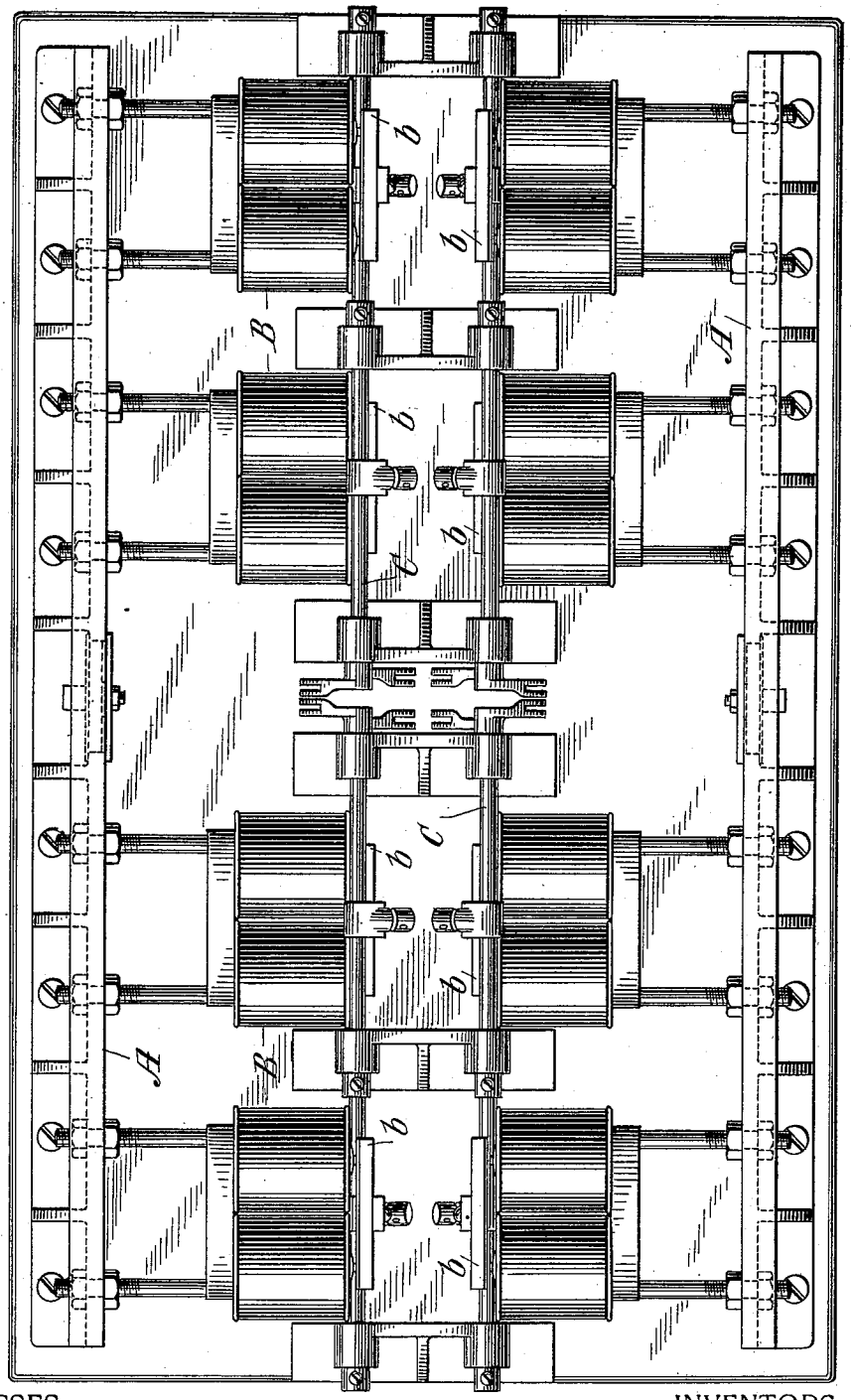

Fig. 5.

WITNESSES:

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INVENTORS:

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Joseph Gardam.

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(No Model.) 15 Sheets—Sheet 5.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 6,

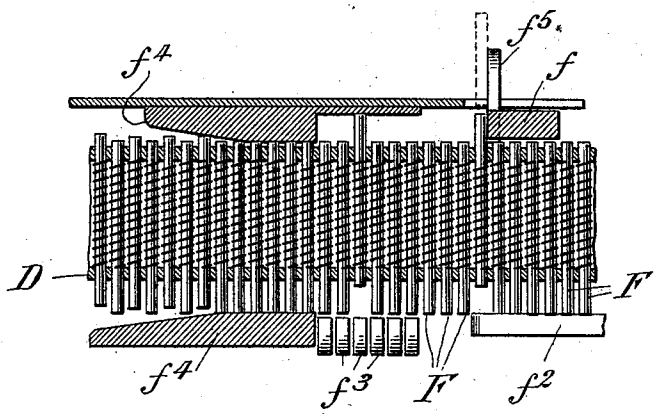


Fig. 7.

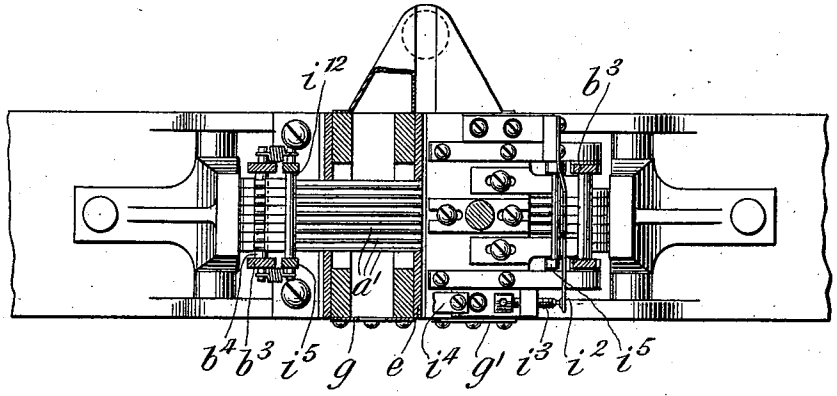
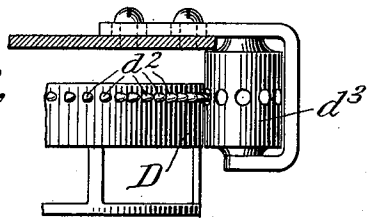


Fig. 12,



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(No Model.) 15 Sheets—Sheet 6.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 8.

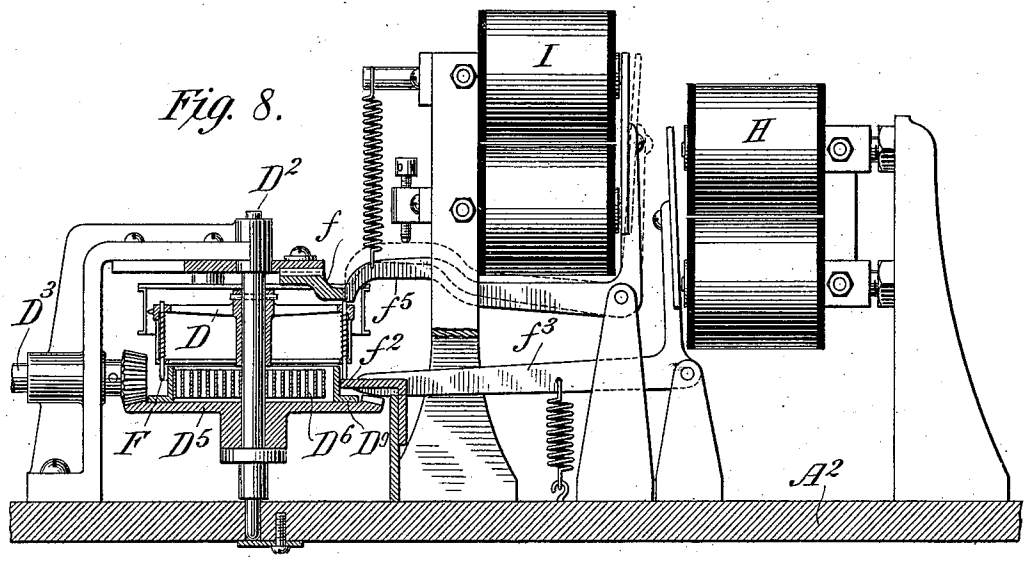
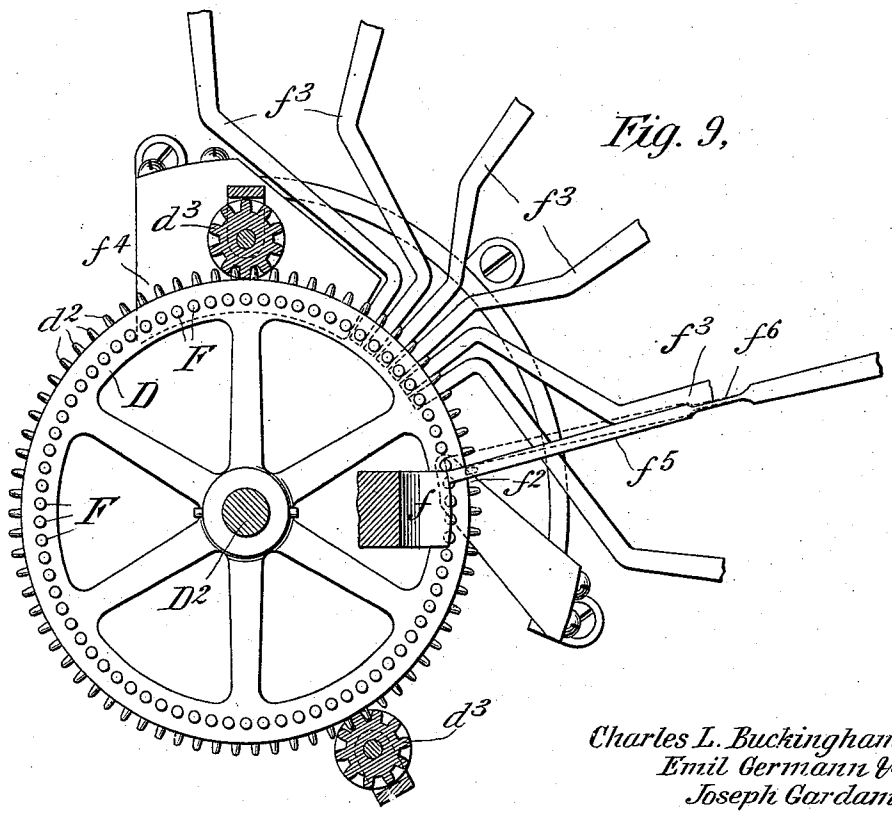


Fig. 9.



Charles L. Buckingham,
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C. E. Ashley
H. W. Lloyd.

By their Attorney
D. L. Townsend

(No Model.) 15 Sheets—Sheet 7.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896

Fig. 11,

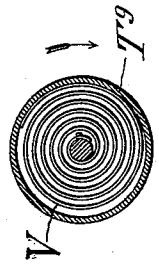


Fig. 10,

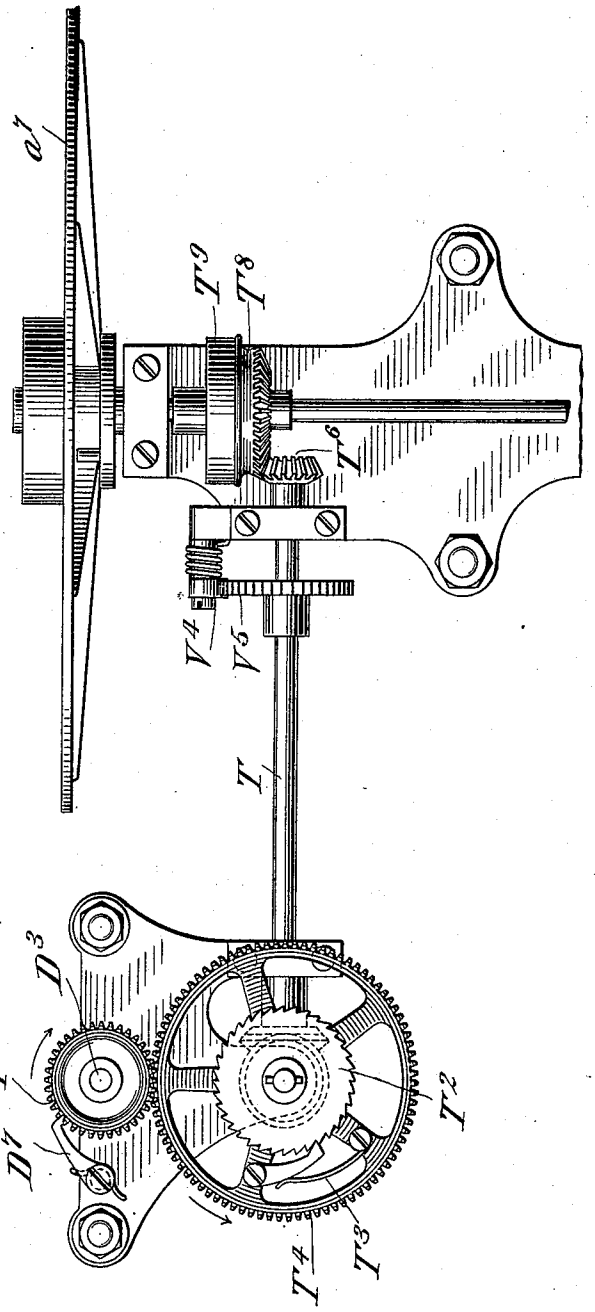
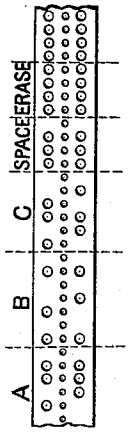


Fig. 13,



WITNESSES:

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INVENTORS:

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(No Model.) 15 Sheets—Sheet 8.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

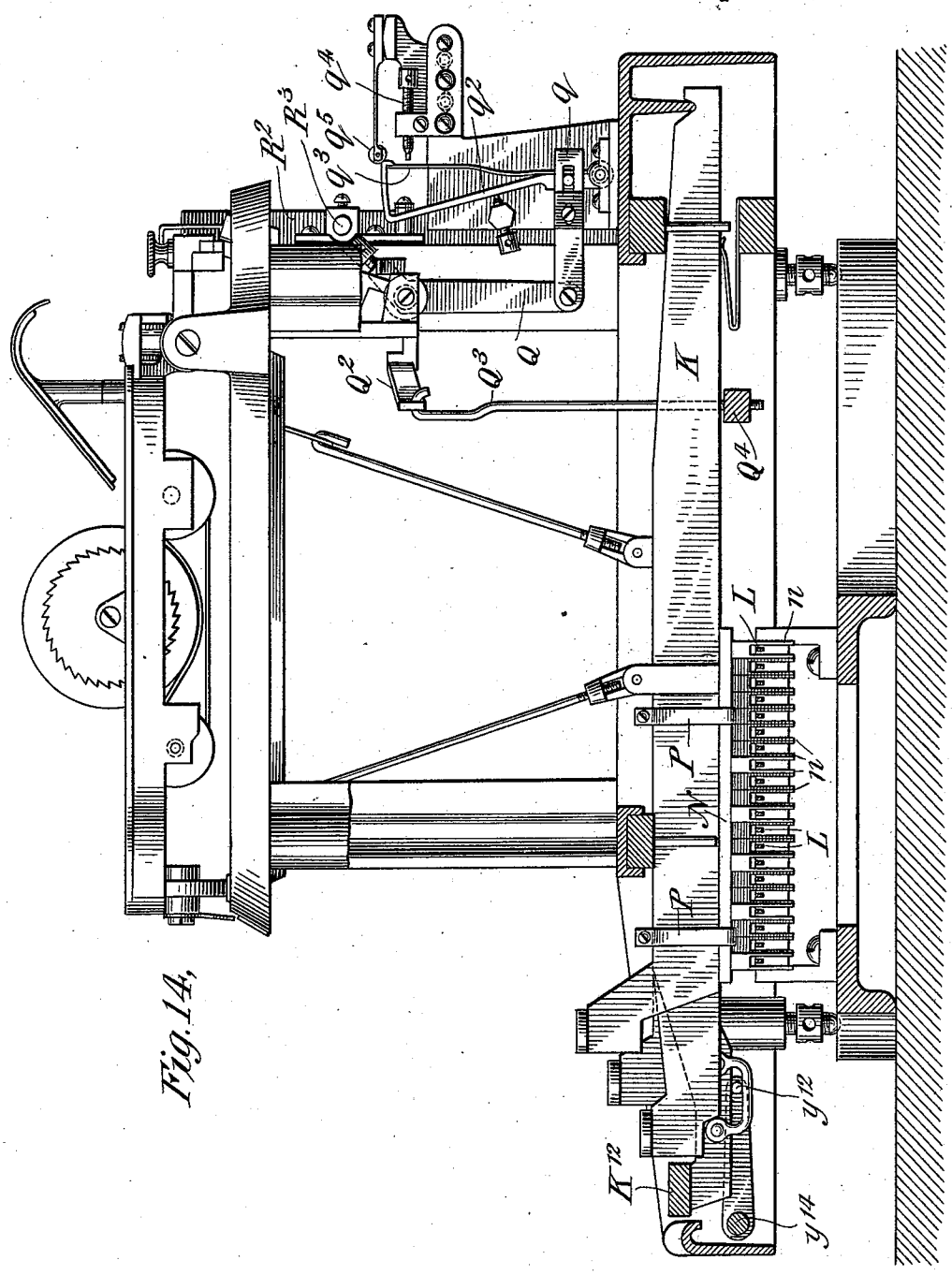

Fig. 14.

WITNESSES:

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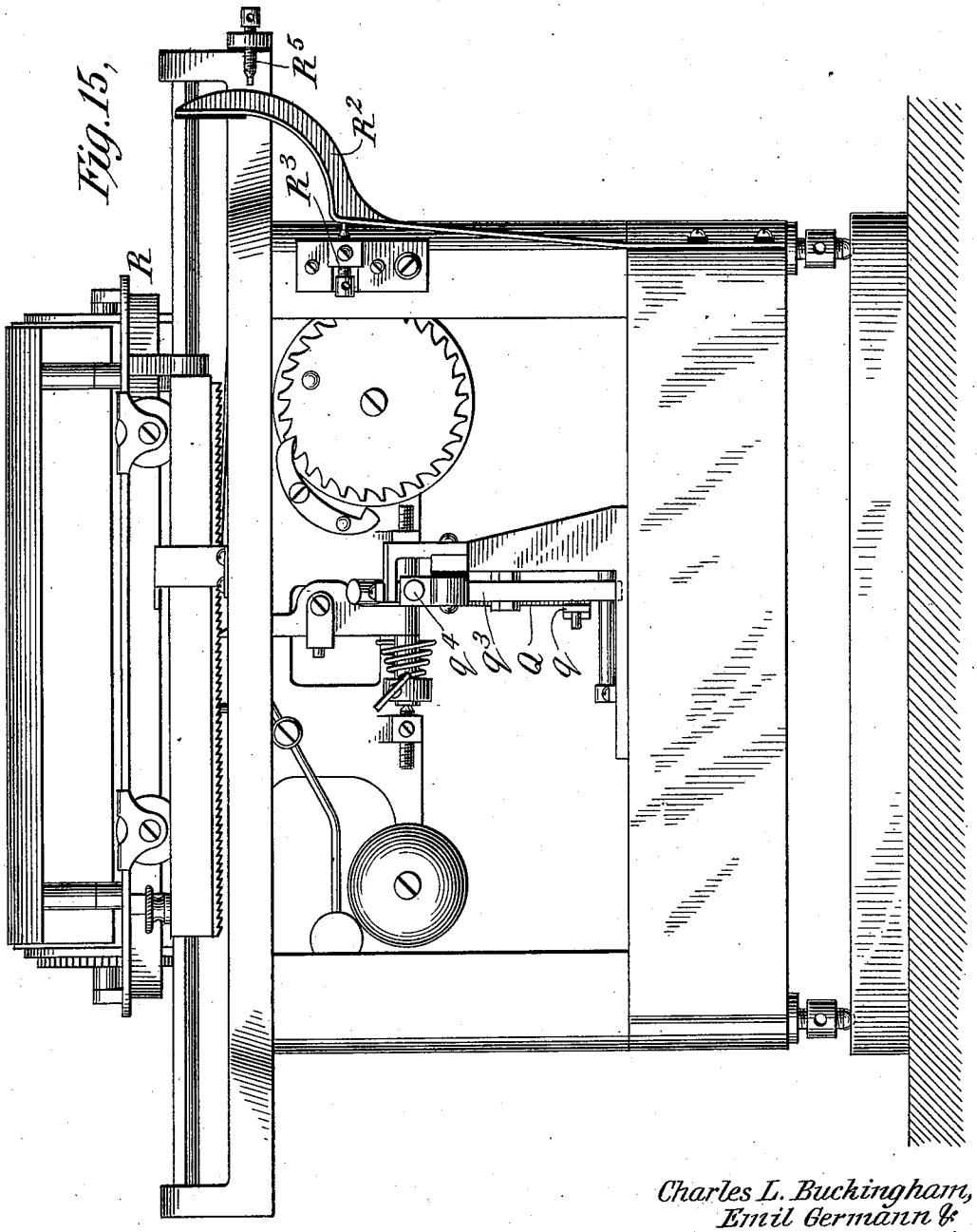
(No Model.) 15 Sheets—Sheet 9.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 15.



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INVENTORS:

WITNESSES:
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(No Model.) 15 Sheets—Sheet 10.

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PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

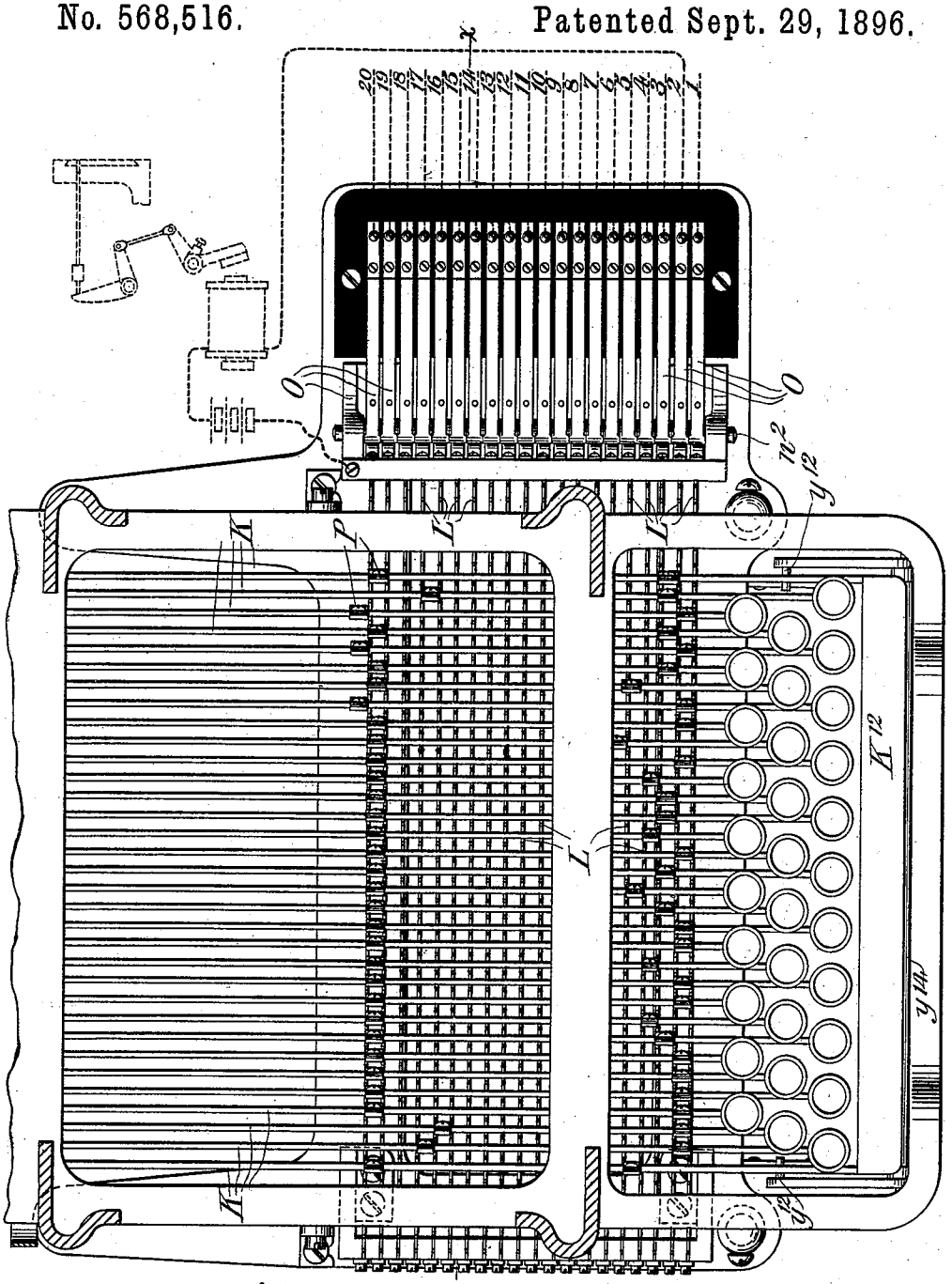

Fig. 16.

Witnesses:
W. A. Capel
D. H. Buckw

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(No Model.) 15 Sheets—Sheet 11.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 18.

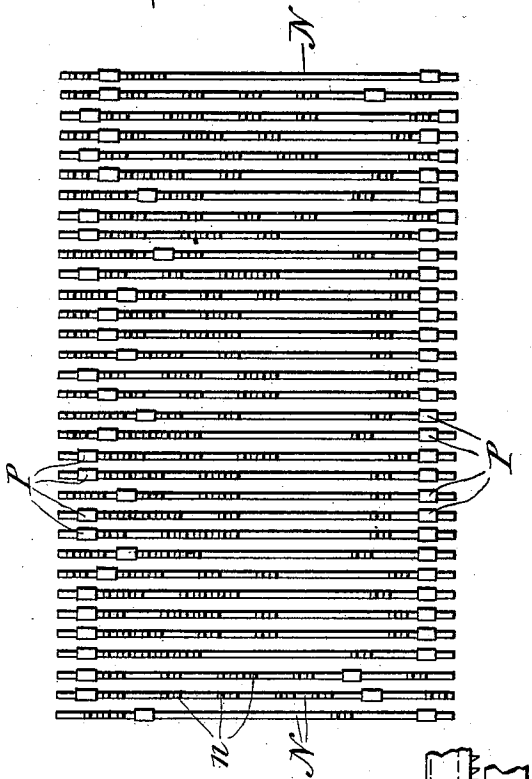


Fig. 17.

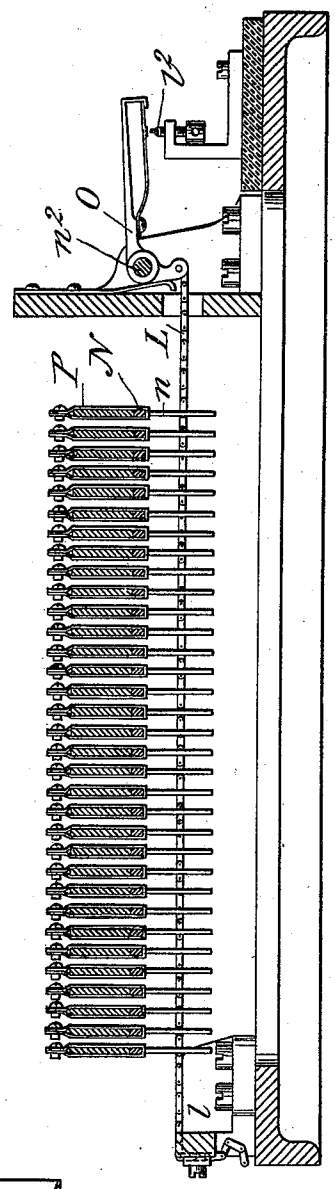
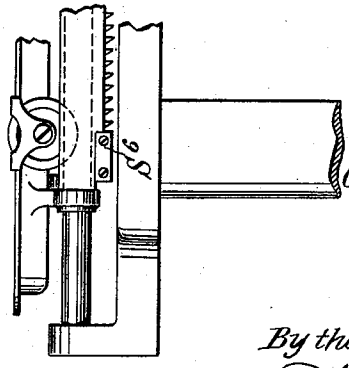


Fig. 19.



Witnesses:
Wm. H. Capel.
D. H. Decker

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Inventors:

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(No Model.) 15 Sheets—Sheet 12.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 20.

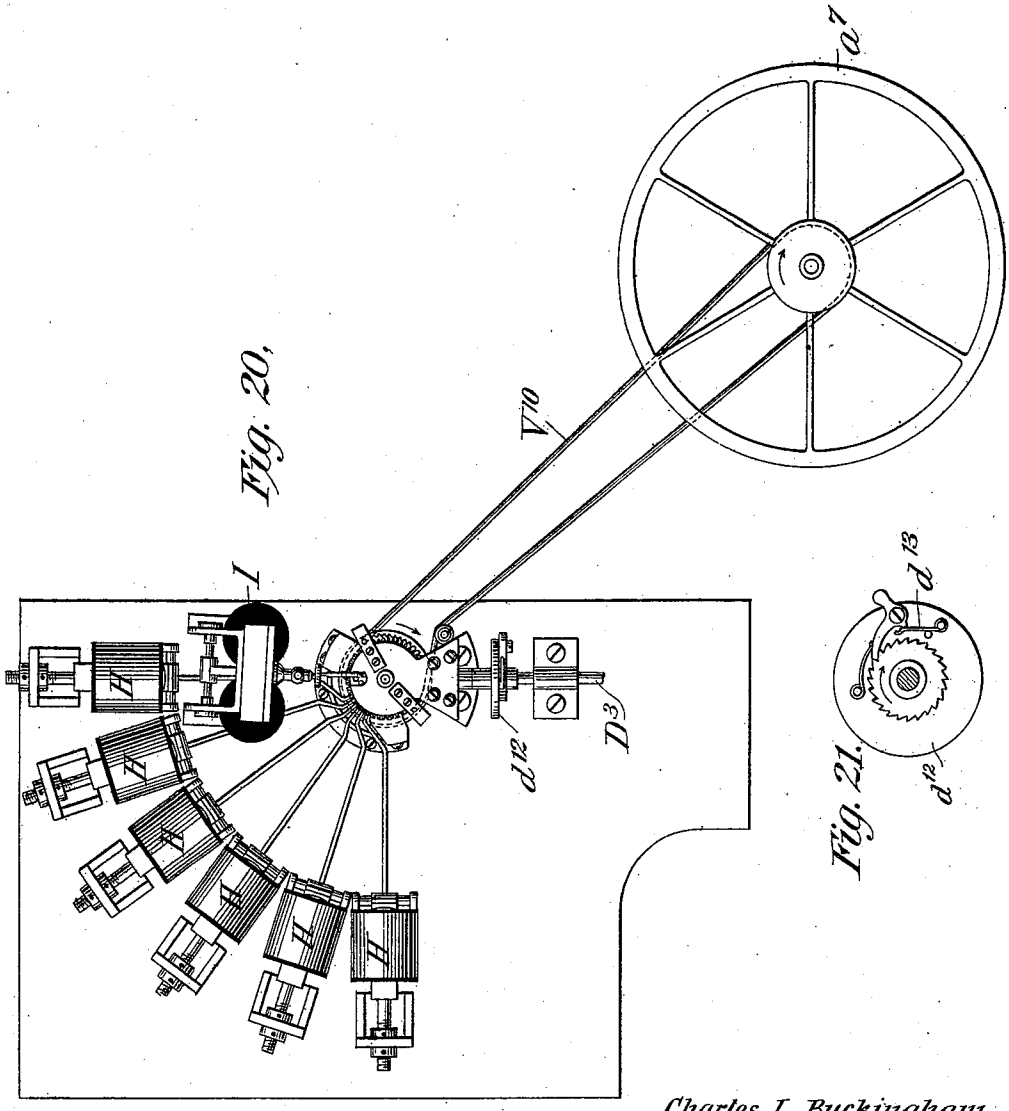

Fig. 21.

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(No Model.) 15 Sheets—Sheet 13.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

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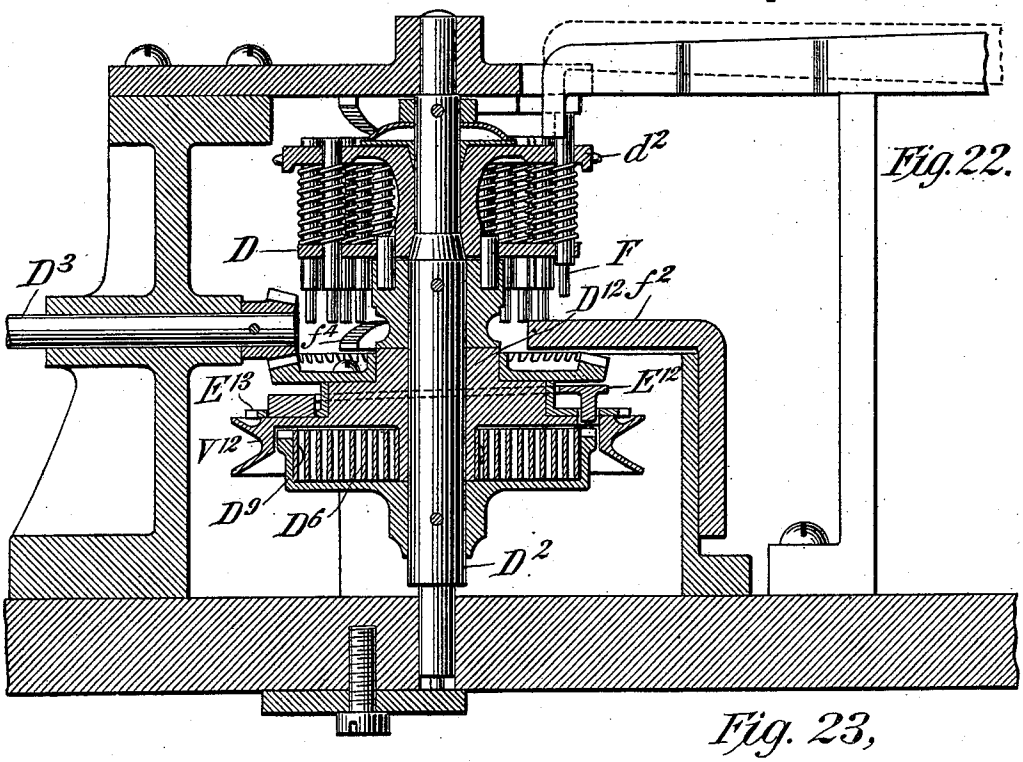
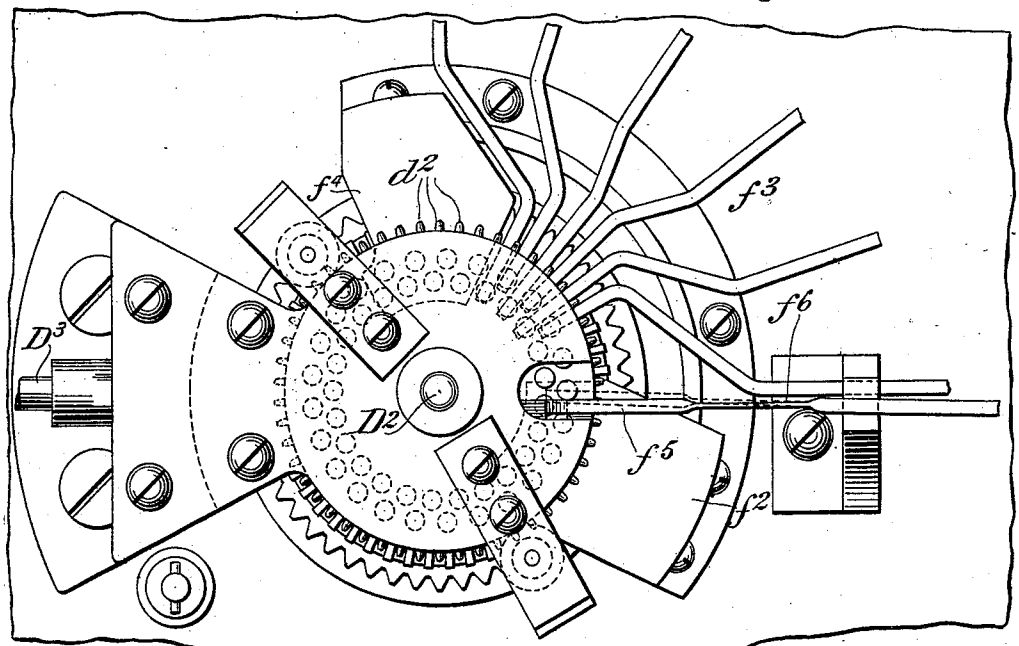


Fig. 22.

Fig. 23,



WITNESSES:
C. E. Ashley
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INVENTORS:
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Joseph Gardam.

By their Atty.
O. L. Townsend

(No Model.) 15 Sheets—Sheet 14.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 24,

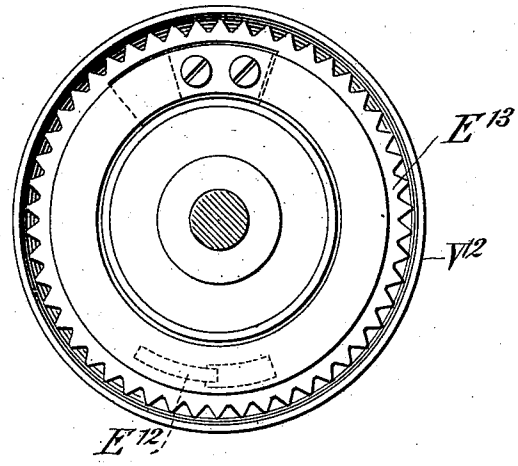
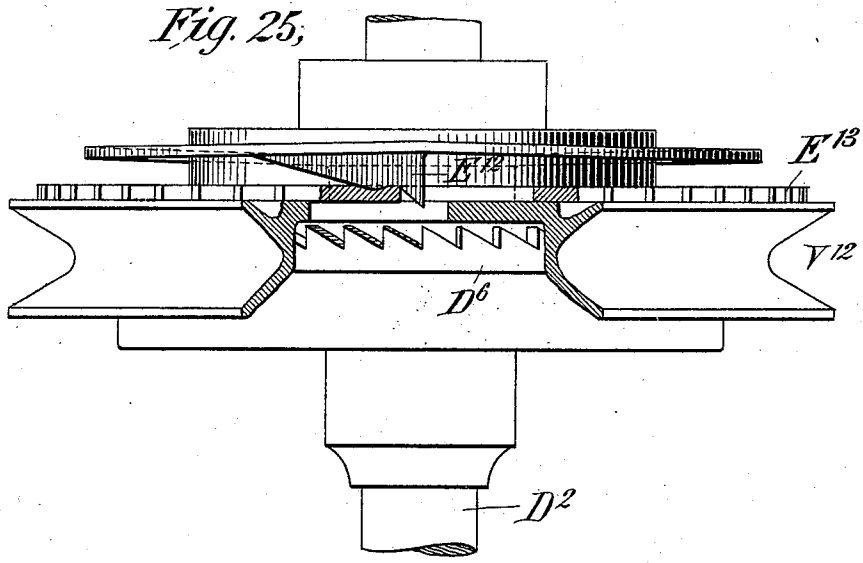


Fig. 25,



WITNESSES:
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INVENTORS:
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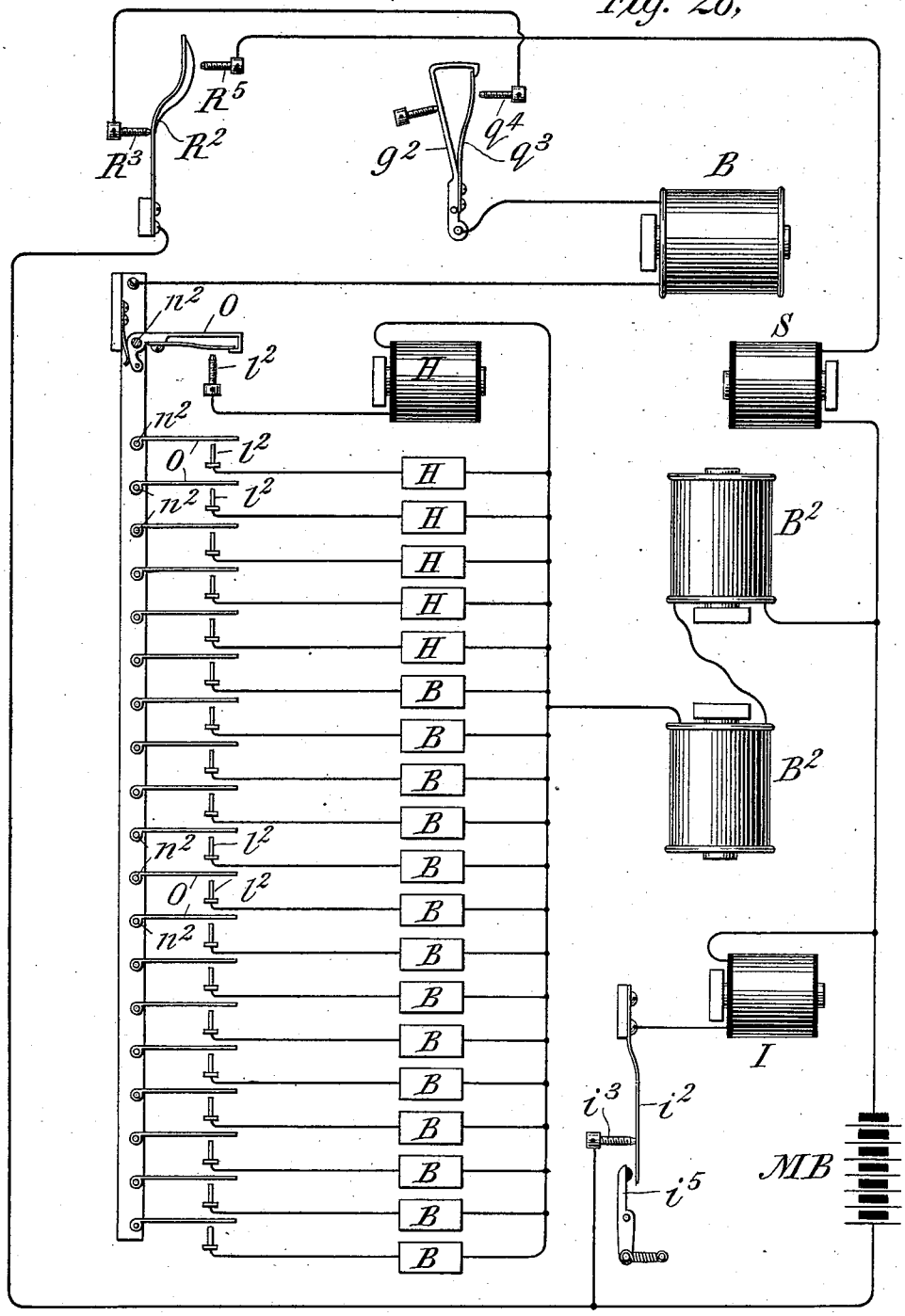
(No Model.) 15 Sheets—Sheet 15.

C. L. BUCKINGHAM, J. GARDAM & E. GERMANN.

PERFORATOR.

No. 568,516. Patented Sept. 29, 1896.

Fig. 26.



WITNESSES:

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H. W. Lloyd

By their Atty.

H. L. Townsend

INVENTORS:

Charles L. Buckingham,
Emil Germann &
Joseph Gardam.

UNITED STATES PATENT OFFICE.

CHARLES L. BUCKINGHAM, OF NEW YORK, AND JOSEPH GARDAM AND EMIL GERMANN, OF BROOKLYN, NEW YORK; SAID GARDAM AND GERMANN ASSIGNORS TO SAID BUCKINGHAM.

PERFORATOR.

SPECIFICATION forming part of Letters Patent No. 568,516, dated September 29, 1896.

Application filed May 11, 1896. Serial No. 591,075. (No model.)

To all whom it may concern:

Be it known that we, CHARLES L. BUCKINGHAM, residing at New York, in the county of New York, and JOSEPH GARDAM and EMIL GERMANN, residing at Brooklyn, in the county of Kings, State of New York, citizens of the United States, have invented certain new and useful Improvements in Perforators, of which the following is a specification.

This invention relates to perforating apparatus designed to perforate paper or other material by means of a series of punches operated in different combinations or numbers to perforate the material with groups of holes which are different in number or are differently disposed with relation to one another in the different groups.

The apparatus of the present invention is primarily designed for use in perforating a strip of paper adapted to be used in a Wheatstone or other telegraph-transmitter with groups of perforations, each group of which represents a letter of the alphabet or other character, but the apparatus may be used for other purposes.

The invention is shown as carried out in a machine provided with two gangs or rows of punches organized to perforate the material in two rows of perforations, that being the arrangement of perforations suitable for a telegraph-transmitter of the Wheatstone type, though in the following description the order of arrangement of the perforations in the two rows with relation to one another is herein shown as somewhat varied to adapt the strip for use in sending electric pulses different in order or arrangement from that used in the Wheatstone alphabet.

The general object of the invention is to provide an efficient and rapidly-operating machine in which the action is controlled by a series of selecting keys or levers one for each different group or order of perforations to be produced in the blank strip, each key operating as a selecting device to determine which of the punches shall be operated. Such punch controlling or selecting devices may be electrical in their nature when the punches are actuated by a magnetic power, or may be in the nature of mechanical coupling appliances when the punches are operated by a suitable mechanical power. The present invention will, however, be described as carried out in connection with punch-controlling devices consisting of circuit changers or controllers which control the circuits of punch-actuating magnets.

The invention consists, first, in the combination of a series of punches and actuating devices, a series of controlling or selecting keys for bringing into action at the same time different punches, whereby groups of holes may be punched which are differently disposed or are of different number in the different groups, a variable paper-feed having a series of stop-pins or devices which individually control the extent of feed, and means controlled by the keys for setting different ones of said devices into operative position according to the length of the group of perforations produced by the depression of each key.

In carrying out this invention it is preferable to use electromagnets for actuating the punches and to control their action by a series of circuit-controllers which are selected by the keys according to the character of the group or series of perforations to be produced. It is also preferable to control or set the individual pins or devices which determine the extent of feed by electromagnets, one for each device, the circuits of said magnets being closed by the keys or otherwise on the operation of the punches. It is to be understood, however, that the invention is not limited to the use of electromagnets, as the punches might be actuated by other power, whose action upon the punches could be controlled by the keys by other means—in the nature, for instance, of mechanical coupling appliances; also, that the feed-determining devices might be set by other appliances than electromagnets governed by the punch-controlling keys.

The invention consists, further, in the combination, with the series of punch-actuating devices whose action is controlled by a series of selecting-keys, of a series of variable-feed devices adapted to be set by said keys when depressed for the purpose of actuating the punches, and to thereby put the feed appara-

tus in condition to predetermine the extent of feed, and means for releasing the feed apparatus when the punches are withdrawn from the work. The releasing devices may be either electromagnetic or mechanical and may be directly controlled by or connected with the punches or may be operated or controlled by some other part of the mechanism whose action is associated with that of the punches as the latter are withdrawn from the work. Preferably the releasing device is operated by an electromagnet and a circuit-controller for said magnet.

This invention relates also to an escapement-wheel of novel principle designed for use where it is desired to produce a feed movement differing in extent for different operations of the mechanism. This part of the invention is especially useful for perforating apparatus in which groups of perforations are produced in succession in a strip or sheet of paper and the groups differ in extent, so that the paper has to be fed different distances.

The invention consists, essentially, of an escapement-wheel the stop teeth or pins of which are capable of being set into and out of position for engagement with a suitable stop.

The invention consists, further, in the combination of said escapement-wheel with a keyboard-perforator wherein the depression of one of the single keys produces the desired group or sequence of perforations and at the same time sets a pin of the escapement-wheel sufficiently far removed from the stop to permit a feed movement of the desired length to take place as soon as the perforations are made.

The invention consists also in details of construction and combinations of devices hereinafter set forth, and then specified in the claims.

In the accompanying drawings, Figure 1 is a general plan of the portion of the apparatus containing the perforating and paper-feed devices. Fig. 2 is an enlarged plan of a part of the same apparatus with certain modifications and adjuncts that may, however, be omitted. Fig. 3 is an enlarged side elevation of the perforating apparatus, the box or frame which supports the operating-magnets and the armature-levers being shown in vertical section. Fig. 4 is a vertical section through the inking device for the marking-wheel. Fig. 5 is a general plan view of the actuating-magnets and rock-shafts. Fig. 6 is a vertical section on the line of the stop-pins through the variable-feed escapement-wheel and devices controlling the position of its movable stop teeth or pins. Fig. 7 is a general plan and partial horizontal section showing the two gangs of punches and their operating mechanism. Fig. 8 is a vertical section through the variable escapement-wheel and its actuating mechanism, showing also the devices which set and release the stop-pins in side elevation. Fig. 9 is an enlarged plan view of said wheel and the operating arms or levers that operate on the stop-pins. Fig. 10 is an enlarged end view of the driving mechanism which operates the paper-reel which takes up the perforated paper. Fig. 11 is a plan showing the spring or frictional connection between said reel and its operating-shaft. Fig. 12 is a detail view illustrating the roller which keeps the paper in engagement with the feed-wheel. Fig. 13 shows a section of a perforated strip of paper produced by the action of the apparatus. Fig. 14 is a general side elevation and partial vertical section of the keyboard apparatus which is employed for controlling the mechanism illustrated in the preceding figures. Fig. 15 is a rear elevation of said keyboard apparatus. Fig. 16 is a general plan of the key-levers and the circuit-closers on which said key-levers act selectively. Fig. 17 is a vertical section taken on the line X X of Fig. 16. Fig. 18 is a plan, looking from beneath the key-levers, and shows the attached devices by which said key-levers select the circuit closers or controllers to be actuated for the purpose of bringing into operation certain ones of the punch-actuating magnets. Fig. 19 is a detail elevation of a part of the type-writer carriage, showing an attachment for locking the type-actuating levers at the end of a line. Fig. 20 is a plan of a modification of the apparatus. Fig. 21 is a side view of the clutch shown in Fig. 20. Fig. 22 is a vertical section through the escapement-wheel, Fig. 20. Fig. 23 is an enlarged plan of the escapement-wheel, showing the escapement-pins set staggering. Fig. 24 is a plan view of the device for operating the pawl which connects the two ends of the driving-springs together. Fig. 25 is an enlarged side elevation of a portion of the mechanism illustrated in Fig. 22. Fig. 26 is a general diagram illustrating the manner of connecting the various magnets and circuit-controlling appliances therefor.

Referring to Figs. 1 to 13, A is a frame or box within which are supported the operating-magnets B, which actuate the punches of the apparatus, and A^2 is a top plate supported on said frame and carrying the punches, paper-feed mechanism, and other portions of the apparatus. The punches are arranged in two rows or gangs $a\,a'$ on opposite sides of a guide-slot, through which the strip of paper a^4 to be perforated is drawn. The paper is fed from a reel a^5, and after being perforated is wound upon a reel a^7, operated by any suitable power, as will be described farther on. The gang of punches a' is guided in a box g and the gang a in a box g', arranged at opposite sides of the paper strip, and the two rows or gangs are arranged to work in different planes one above the other, so as to respectively punch holes at opposite sides of a central line in the strip of paper, as indicated in Fig. 13, where the central line is occupied by a line of smaller perforations into which teeth

or pins of the feed-wheel enter. The die-plate for the punches a' is indicated at e' and is fastened to the face of the guide-box g', while the die-plate e for the row of punches a is secured at the opposite side of the guide-slot to the box or frame g. At their rear ends the punches are engaged by the operating bell-crank levers d, which are mounted in a standard or frame on the plate A^2, and are connected with the armature-levers of the operating-magnets B by suitable connecting-rods, as clearly shown in Fig. 3, which rods are attached to arms projecting from rock-shafts C, which rock-shafts carry the armatures b for electromagnets B. The punches are retracted by means of stiff springs a^2, fastened at one end to fixed yokes b^2 on top of the apparatus and at the other end to cross-bars connecting the tops of levers b^3, pivoted in arms on top of the boxes, as clearly shown in Fig. 3, and connected at their lower ends beneath the pivots by cross rods or bars b^4, bearing against the bell-crank levers in a manner to draw them backward away from the punches. Pivoted in the same brackets with levers b^3 are pairs of levers i^5, connected at top and bottom by cross-bars, the lower ones of which latter (indicated at i^{12}) engage with blocks or projections on the punch-bars in a manner to retract the latter. The levers i^5 are connected with and actuated by the levers b^3 through short springs or links attached to the lower ends of levers i^5.

As will be readily seen, the punch-operating magnets B actuate the punches against the force of the retracting-springs a^2, and the latter serve both to withdraw the punches after operation and at the same time throw back the armature-levers, in which action they may be assisted or not, as desired, by retractors applied to the armatures or the rock-shafts. Preferably the armature-levers are so hung as to tend to fall back by gravity. In place of these retracting devices any other suitable means may be employed for retracting the punches after they have been forced through the paper.

The guide-slot for the paper formed by the spaces between the die-plates e e' should be just wide enough to easily carry the strip of paper to be perforated. The punch-operating magnets (indicated by the letter B) are preferably arranged in two horizontal planes, one over the other, and are secured to the inner side of the frame or box A, with poles projecting inwardly for operation upon the armatures b.

The apparatus, as shown, is adapted to operate sixteen punches, though the actuating bell-crank lever d and magnet for the same, which operate the last punch of one of the gangs, may be omitted where the character of the matter with which the paper is to be perforated does not require at any time a perforation in the position corresponding to that punch. It is evident, however, that a greater or less number of punches may be used, as desired, according to the complexity in the groups of perforations which it is desired to produce at a single operation of a controlling or selecting key or according to the maximum number of perforations which it is desired to produce in any group.

The rock-shafts C are mounted in suitable frames or standards within the main frame of the apparatus, as clearly indicated.

It is obvious that other means for retracting the punches might be used, and other mechanism might be employed for connecting the magnets with said punches.

Combined with the retracting devices and punch-operating magnets are electromagnets B^2 B^2, which serve the purpose of assisting the magnets B in overcoming the strain of the retractors a^2. These electromagnets have armature-levers connected by rods B^3 with the cross bars or arms to which the springs a^2 are attached. The electromagnets B are in separate branches of a circuit, so that they may be operated independently of one another. The electromagnets B^2 are preferably in a common circuit or return common to all the branches containing magnets B, so that said magnets B^2 will be energized at the same time with magnets B by the current passing through all the branches and magnets B that are at any time operated together. This manner of connection of the magnets B B^2 is illustrated in the diagram Fig. 26. By this arrangement the speed of action of the punch-actuating apparatus is very materially increased, since in the work of driving forward the punches the magnets B may operate without material opposition from the retracting-springs a^2, while said punches are withdrawn by the springs a^2, acting freely or without opposition, owing to the fact that the magnets B and B^2 are all thrown out of action together.

As will be obvious, the assisting magnet or magnets might be connected to the circuits or controlled by the apparatus in any other way proper for bringing them into action simultaneously with the punch-magnets.

To provide for the variable feed rendered necessary by the fact that the groups of perforations may take up spaces of different extent longitudinally in the tape, as indicated in Fig. 13, where six such groups are shown, the following variable-feed escapement device is employed:

In the diagram Fig. 13 the larger holes or perforations are those produced by the punches, while the central row of smaller holes are those by which the paper is engaged for the purpose of controlling its feed. The larger holes, as will be seen, are arranged so that the paper may be used in a Wheatstone transmitter to produce electric pulsations of alternately-reversed polarity, some of said pulsations being prolonged. The particular arrangements of perforations shown are adapted for use in the page-printing telegraph system described in United States Patent of Buckingham and Germann, No. 544,346, dated

August 13, 1895. The smaller holes form a rack to receive the teeth of a wheel which carries the paper forward in the Wheatstone transmitter and is in perfect coincidence with the larger holes.

In preparing messages for Wheatstone transmitters it is usual to perforate the paper with the central line of holes uniformly placed part at a time in the operation of passing the paper between punch-heads to produce the larger transmitting-perforations. Our invention consists, essentially, in preparing the strip of paper for Wheatstone transmission by first preparing it with the central row of perforations before passing it to the punch-heads or devices for feeding it between the same, and in next carrying it through the punch-heads and controlling its feed movement by means of said central row of perforations through feed devices engaging with the same preferably both before and after it leaves the punches. By this method and by using suitable uniformly-acting devices to make the central row we are enabled to produce a row of central perforations of greater uniformity than can be produced by the old method, and at the same time to furnish means whereby the feed of the paper between the punch-heads may be governed with great uniformity and exactness. This also permits an exact adjustment of the paper to secure precise alinement of the central row of perforations with the punches which produce the side perforations in the manner to be presently described, thereby securing perfect coincidence of the side and central perforations.

Preferably the paper is prepared with the central row of perforations before being placed upon the reel a^5, though such perforations might be produced in the paper on its way from the reel a^5 to the feed-controlling wheel, which is provided with movable stop pins or teeth to constitute the variable escapement-wheel, or may be a separate wheel. For simplicity, however, the movable escapement teeth or pins and the pins which enter the central row of holes in the paper are mounted on the same revolving structure.

D indicates the paper-feed wheel and variable escapement device, and d^2 the teeth or pins thereof, which enter the central line of perforations. In its course from a^5 to a^7 the strip passes over two or more guide-rolls a^6, then around one side or segment of the feed-wheel D, being pressed into engagement therewith by a suitable roll d^3, then around two or more guide-rolls a^6, one of which may be a spring-actuated take-up roll or idler, as shown, for taking up the slack of the paper between the wheel and punches, through the punch-box and between the punches, over an adjustable roll a^{12}, around another segment or side of the feed-wheel, against which it is guided and pressed by a roll d^3, over guide-rolls a^6, one of which may be a spring-actuated take-up roll for automatically taking up the slack, and onto take-up reel a^7. By thus running the paper over two sides or segments of the feed-wheel, one before it reaches the punches and the other after it leaves the punches or punch-head, the feeding of the paper along a considerable portion of its length, and when it passes between the punches, is insured at the exact speed or in exact correspondence with the movements of the feed-wheel, that is to say, the paper cannot be jerked along or moved within the punch-head or box faster than the feed-wheel is moving. The teeth d^2 project radially from the feed-wheel and the paper may be engaged thereby over a segment of said wheel of greater or less length, as desired. The rolls d^3 may be provided with teeth engaged by pins d^2, so as to be rotated thereby and in rotating to press the paper strip down over the pins d^2, or the teeth of the roll may be omitted, leaving simply a groove for the teeth d^2 to pass.

In the completely-perforated strip, and as indicated in Fig. 13, it is necessary that the larger holes near the two margins of the paper strip should be in transverse alinement with the central holes, and hence the strip must be presented to the punches with its central row of smaller holes in exact alinement with the punches themselves. Hence it is desirable to place the feed-wheel as near the egress end of the strip-perforating punch-heads as possible and provide an arrangement whereby the length of paper, from the point where it leaves the punch-heads to the point where it is taken up by the feed-wheels, may be adjusted to great nicety. This is accomplished by means of the adjustable roller a^{12}, over which the fillet of paper as it leaves the punch-heads passes. The bearing for this roller may be a slot, as shown in Fig. 1 of the drawings, whereby it may be moved to the left to increase the length of the paper between the feed-wheel and the punch, or to diminish the length and to thereby make the length of paper between the last pair of punches and the point of contact of the feed-wheel a distance just equal to a certain number of central-row perforations.

Wheel D is fastened to a suitable shaft D^2, which is mounted on suitable bearings on the plate A^2 and is driven by suitable power communicated through a shaft D^3, connected with an electric motor or other motor D^4. The horizontal shaft D^3 of the motor engages with the bevel gear-wheel D^5, Fig. 8, loose on shaft D^2, but connected therewith through a spiral spring D^6, one end of which is attached to the shaft D^2 and the other to a barrel D^9, fastened to the wheel D^5. By means of the motive power the spring D^6 is kept wound up and imparts a constant torque to the shaft and feed control-wheel D. By using the spring in this manner the difficulty which would ensue from the inertia of the prime mover itself, if it were attached or connected directly with the wheel D, is avoided. This difficulty would

arise from the fact that the paper-feed device moves intermittently, and must start and stop with great promptness.

F indicates the movable teeth or pins of the escapement-wheel. These pins or teeth may be of any desired form and mounted on the wheel in any desired manner, but preferably are so mounted as to move transversely to the plane of the wheel or parallel to its axis of rotation, being for that purpose arranged to slide in two disks or plates forming heads of the wheel, and being held frictionally in the position into which they are set or moved by means of spiral springs, as indicated, encircling the teeth or pins.

The wheel D is stopped by means of an abutment or stop f, against which the pins which have been previously set or moved up into the position indicated in Fig. 6 engage. The wheel is allowed to rotate by moving the pin engaged with said stop down out of the way thereof, so that the wheel may turn until the next pin which has been raised engages with the abutment. The stop-plate f^2 limits the downward movement of the pin under the action of the releasing device, which forces it down to free the wheel.

The stop-pin-setting devices, six in number, are indicated at f^3. These consist of arms or dogs operable singly to force a pin up into the position shown in Fig. 6, where, upon further rotation of the wheel, it will be brought into engagement with the abutment f. These setting devices, as will be obvious, provide for six different lengths of feed, that one nearest the abutment f allowing a feed of a space covered by four of the escapement teeth or pins and that at the extreme left of the range of setting devices f^3 being adapted to set a pin which will allow a feed over the space of nine pins. The intermediate setting devices give other lengths of feed, according to the distance of the pins upon which they operate from the abutment f. Before reaching the setting devices f^3 the pins pass between two cam-plates f^4, whereby they are automatically centered. In the operation of this feed-wheel one of the setting devices f^3 operates to set a pin to predetermine the length of the succeeding feed movement, after which the pin previously brought to engagement with the abutment f is disengaged or released by means of an arm or dog f^5, which drives said pin downward, whereupon the feed-wheel moves the distance predetermined by the previous action of the setting device f^3.

The releasing arm or dog f^5 is arranged as shown in Fig. 9, and is constructed so as to yield laterally, whereby, after releasing the wheel by driving a pin downward, it will not interfere with the movement of the next succeeding pin full up against the abutment-stop f. This provision is necessary, owing to the fact that the dog or arm f^5 retains its position shown in full lines until the next succeeding operation of the punches. When the next succeeding pin engages the side of the releasing arm or dog f^5, the latter will simply be moved sidewise to the position indicated in full lines in Fig. 6. When it is raised, it will automatically take its proper position over the pin, as indicated in dotted lines, so that on moving downward it will free the pin and allow the wheel to again rotate. This lateral yielding is conveniently provided for by making the arm or dog f^5 thinner, as indicated at f^6 in Fig. 9.

The stop-plate f^2 may be mounted on a bracket, as indicated in Fig. 8, and the abutment f upon the bracket or plate in which the upper end of the shaft D^2 is mounted. The cam-plates f^4 may be similarly mounted and the upper one of them provided with a lateral projection which forms a stop to limit the upward movement of the pins when driven up by the setting devices f^3.

The setting devices composed of the arms f^3 are operated by means of the electromagnets H, one for each arm, or by similar actuating means governed in their operation by the controlling mechanism which brings the punching devices into action. There being six setting-arms f^3, six magnets H are provided, and different ones of said magnets are operated at the time a group of perforations is made, according to the distance on the paper strip covered by said group and the consequent length of feed which it is necessary should take place before a new group is perforated. If the group of perforations made covers a space of four central holes, then the magnet connected to the arm at the right-hand end of the set of arms f^3, Fig. 6, is actuated, so that after said perforations are effected and the releasing device f^5 drives down the stop-pin by which the wheel is held from rotation said wheel will rotate four spaces of the tape. If, for instance, the group of perforations covers nine spaces, then the magnet acting on the arm f^3 at the left of the set is actuated, and so on for any intermediate length of feed required before a new group is perforated.

The releasing arm or dog f^5 is operated by an electromagnet I or other device, which is brought into operation on the completion of the punching action through connection with some device moving with the punches or associated in movement therewith.

It is preferred to use an electromagnet I for operating the releasing arm or dog, though it would be within the invention to use other devices connected with or controlled by the apparatus, so as to come into action when the punches are withdrawn from the work.

As will be seen, the arms f^3 are normally retracted by suitable springs, as indicated, whose power is overcome by the action of magnets H, and in a similar way the arm f^5 is operated in one direction by the magnet I and in the other by a suitable lifting-spring.

A circuit closer or controller for bringing magnet I into action when the punches are retracted is shown in Fig. 3. As therein

shown one of said circuit-controllers is employed for each gang of punches. The circuit of the magnet I may pass through one of said circuit-controllers or through both in series, so that the magnet cannot operate until the punches in both gangs have been fully retracted. This circuit-controller consists simply of a spring i^2, normally making connection through its own bias with a contact-stop i^3. The two circuit-controllers are connected in series by a strap i^4, connecting the brackets which carry the stops i^3, said brackets being suitably insulated, as shown in side elevation.

Normally the circuit is closed through the circuit-controllers when the magnet I is excited, so that arm or dog f^5 is in the position indicated in the full lines, Figs. 6, 8, and 9. When the punches are moved forward through the paper, the springs i^2 are drawn off the stops i^3 by means of the levers i^5, suitably pivoted and connected with levers b^3, as already described. The ends of levers i^5, where they engage with springs i^2, are armed with insulating material, as indicated. When the punches move forward and the circuit is broken for magnet I, the arm or dog f^5 is permitted to move up, so as to free itself from the pin which is against the abutment, and said arm or dog assumes the position indicated in the dotted lines. As the punches move back they permit the circuit to be again closed, whereupon the magnet I becomes excited and the arm f^5 drives down the stop-pin, thus permitting the feed-wheel to move and feed the punched portion of the paper away from the punches. The circuit-closers are so adjusted that the circuit cannot be closed to produce this action until the punches are fully retracted from the paper. Other forms of circuit closer and breaker connected with the punches or with other portions of the punch-actuating mechanism might obviously be used for the same purpose.

To control the action of the punch-actuating magnets B, a keyboard circuit changer or controller composed of a series of key-levers acting upon and selecting the proper circuit changers or closers for the circuits of said magnets is employed.

Preferably, also, the circuits of the setting-magnets H are controlled by circuit-closers which are actuated or governed by the same key-levers which select or govern the circuits of the punch-magnets. By these means the said key-levers individually act upon different ones of the setting-dogs, according to the key depressed, and predetermine the extent of the feed movement which shall ensue after the said key has, through the punching-magnets, punched the paper.

For convenience the key-levers of an ordinary type-writing machine are employed for operating upon and selecting the several circuit-closers which govern the action of the magnets H and B. This utilization of a type-writer is of advantage in several ways. Any person used to a type-writer can, without further instruction, operate the machine, and by putting a sheet of paper in the type-writer a copy of the matter perforated can be made as a record or as a check upon the manipulation of the perforating apparatus.

Referring to Figs. 14 to 19, K indicates the key-levers of an ordinary type-writer, such as the "Remington," each lever being constructed and mounted in any suitable way, as usual in the art. L indicates a series of yielding chains or cords or similar devices corresponding in number to the number of circuits which it is desired to control. In the present instance the apparatus is constructed to control circuits 1 to 14, inclusive, Fig. 16, which are connected to punch-operating magnets B, and circuits 15 to 20, inclusive, connected to the stop-setting magnets. These cords L extend transversely beneath the levers, in position to be engaged by parts projecting from said levers when the same are depressed. The projections on the levers are properly spaced to select the circuit-closers of the circuits which it is desired to operate on the depression of any key. The chains or cords L are at one end suitably fastened to a bridge-piece l, and at the other are connected to devices which keep them under tension or serve to take up the slack when they are relieved from the pressure of the key-levers. These tension devices may be springs, as will be presently described, which serve also as springs which restore the circuit changers or controllers or other punch or circuit controlling devices to position of rest.

Attached to each lever K is a selecting device N, composed of a bar attached to the lever and provided with downwardly-extending forks n, which straddle the chains or cords L. By the spacing of the projections or forks n the particular chains or cords to be operated upon are selected or determined. The several circuits may be closed through operation of the key-levers by connecting the cords or chains to circuit-changers of the form to be now described or of any other suitable form. The circuit changers or closers are here shown as consisting of bell-crank levers O, mounted on a rod n^2, secured in a suitable frame attached to the base-plate or other support. One arm of each of said elbow-levers is attached to one of the cords L, the opposite end being connected, as described, to the bridge-piece l. The cords are secured to the bridge by any suitable means, as, for instance, by clamp-screws, as indicated. To keep the yielding connections L taut and the levers O out of engagement with the circuit-closing contacts l^2, suitable blade-springs are applied to bear against the short arms of the levers O. The contacts l^2 are mounted in blocks secured to an insulating-piece and thereby insulated from one another, while the circuit-closing levers O are all in electrical connection with one another and with the frame of the apparatus.

As a convenient manner of attaching the selecting-bars N, straps P, passing around the levers K, may be employed. Each selecting device is provided with a certain number of forks *n*. If the group of perforations to be produced contains five holes, then the key-lever K, which is depressed to produce said group, would have five of the forks arranged to operate upon those five chains L which are connected to the circuit-closers O, governing the circuits of the proper punch-magnets. If it be required to operate all of the punch-magnets, then all of the circuit-closers O (numbered 1 to 14) would be operated upon.

When this apparatus is used for perforating matter in which the same perforation appears in the same position in each group, and other perforations differently arranged for different groups, one of the punch-magnets may be placed in or connected to the circuits either in series or in multiple with the other devices, but at such point as to be operated whenever said other devices are operated. It may be, therefore, placed, as indicated in the diagram, in the common circuit for all the others, so that it will be operated no matter which key-lever is depressed. In perforating the letters of the Wheatstone or other alphabet the key-lever bearing the letter "A" would carry a selecting device which will cause a group of perforations to be punched representing the letter "A," and so on. If it is desired to produce a group of perforations to represent a space, then the two outside levers K, which carry the space-bar K^{12}, Fig. 16, are provided with selecting-bars N, which will serve to bring into action the proper punches.

The selecting-bars on the key-levers carry also a supplemental projection adapted to operate upon one of the circuit-closers 15 to 20, inclusive, so as to bring into action one of the stop-setting magnets H, as already explained.

When an error has been made in perforating the tape, it may be desirable to cross out or erase the error by filling the tape with a series of holes uniformly spaced. In this case there is provided a rub-out key, whose selecting-bar N is provided with projections which will operate upon all of the circuit-closers O from 1 to 7, inclusive, thereby producing, by the seven magnets in the several branches and the one magnet in the common connection, four perforations on each side of the central line, as shown by the group of perforations marked "erasure" in Fig. 13, where the result of the depressions of said key is shown. The same rub-out key will of course control the proper feed-setting magnet H to set the feed mechanism so as to feed four spaces when the punches are withdrawn. The rub-out key obviously might be made to produce a greater number of perforations at each depression or even a less number if the feed devices are arranged to produce a corresponding shorter feed.

When perforated in this way and run through a Wheatstone transmitter, a series of short pulsations only will be produced, and which, in a receiving instrument of the kind described in the aforesaid patent of Buckingham and Germann, will simply cause a rotation of a part of the apparatus to zero position, when the action of the apparatus as a whole will cease and the paper tube on which the message is printed will remain at rest until a long or unison pulse is sent, thus releasing the apparatus. The feed movement of the paper tube and the printing of the message may then be resumed, but should be resumed at the beginning of a line; otherwise the long or amplified feed-space automatically produced at the end of a line would come at an intermediate point in the next line of printing. Hence in erasing an error in the paper strip it is desirable to cut out all the perforated matter which corresponds to a line of printing in a receiver and to reperforate it in the strip following the line erased. To assist in the correction, it therefore becomes desirable to mark the point in the paper strip where the groups of perforations which begin a line of printing in the receiver is located on the strip, so that it my be readily found by the eye. This may be done by perforating at the beginning of each line one or more groups, which will not materially affect the printed matter, since they will cause short main-line pulses or short pulses followed by a long pulse, which only has the effect of releasing the unison device. These characteristic groups may be two "space" groups of perforations or one or more rub-out groups. These will simply cause the printing in the receiver to begin one or more feed-spaces farther along the margin of the paper-cylinder. The point at which to insert them will be known to the operator by knowing the number of characters, including spaces, which will feed the paper-cylinder of the receiver one whole revolution to the point where the amplified space-feed takes place.

By means of adjusting or leveling screws under the base of the machine the proper distance between the selecting-forks and the chains may be obtained. The number of circuit-changers and the number of flexible or yielding connections L may be varied according to the number of punching-magnets or other magnets which are to be controlled from the type-writer.

When space-bar K^{12} of the machine is touched at or near one end, the lever K near that end will be depressed, but the lever at the opposite end may not be depressed fully enough to cause the proper action upon the chains or cords L controlled by said space-bar. To obviate this difficulty and secure the proper action of both levers K no matter where the bar K^{12} is struck, the two extreme

levers K may be connected, as indicated in Fig. 14, by means of a transverse rod y^{12}, passing through stirrups or hangers, one in each lever, and attached at its opposite ends to rockers y^{14}.

Many changes may be made in the construction of the different parts of the device and the manner of operating the circuit-changers from the keys or key-levers. The circuit-changers may operate to make or break the circuits, and various well-known relay connections may be inserted between the circuit-changers and the branch-controlling magnets.

In combination with the circuit-closing devices just described, a circuit maker and breaker common to them and placed in a common connection for them all is provided. This supplemental or common circuit maker and breaker is constructed to be operated whenever any one of the key-levers is depressed, and is adjusted so as to break the common connection before the individual circuit-controllers already described break circuit, and is adjusted, also, to close the common connection after said circuit-closers close circuit. By this device the make and break of circuit or other action of each of the individual circuit-closers may be readily timed and made uniform for all of the key-levers. In other words, any want of uniformity in the action of the circuit-controllers operated upon by the selecting key-levers will be corrected by the single or common circuit maker and breaker whose action is the same for all. Moreover, an adjustment of the action of this single circuit maker and breaker will serve as an adjustment of the electric action of all the circuit-controllers. This common circuit maker and breaker may be also readily constructed to have a snap action in breaking and making circuit, thereby permitting the use of heavier currents without unduly complicating the apparatus by introducing the snap action into each of the individual circuit-controllers. By the use of this common circuit maker and breaker all spark or burning is transferred to one point of the apparatus, where it may readily be taken care of by a condenser or other device, whereas without such common circuit-breaker a condenser or other device would be necessary for each of the circuit breakers and makers of the apparatus, or else the volume or strength of current which it would be possible to employ in connection with them would be limited. One way of connecting this common circuit maker and breaker to the key-levers, so that it will be actuated whenever any one of said levers is operated, is to connect it to the space-feed device of the type-writer. Thus, as shown more particularly in Fig. 14, the rock-shaft which carries the feed-escapement for the type-writer is provided with a depending arm Q, which serves to reciprocate a bar q, that connects by a device having lost motion with an upright lever q^2, pivoted at its lower end upon the frame of the apparatus, as shown, and provided with a blade-spring q^3, normally engaged with a hook on the end of the upper or free end of the lever q^2.

The bar q has an elongated slot into which projects a pin on the lever q^2. The lever is rocked by this connection, which connection provides a lost movement. The spring q^3 is adapted to engage with and make contact upon a stop q^4, mounted upon but insulated from a standard or bracket, as shown. When any one of the key-levers K is depressed, the rock-shaft-carrying arm Q is rocked by means of the operating-bar Q^2, to which are connected the rods Q^3, joined at their lower ends by a bar Q^4, upon which the key-levers bear when depressed. By this means the bar q is moved and the circuit is closed between q^3 and q^4. There is, however, a certain amount of lost movement provided, as just described, which is adjusted so that circuit will be closed at the point q^4 only after the circuit closers or controllers which are actuated by the selecting devices have closed circuit. When the lever K rises, the bar q moves back, but with a lost motion, but so adjusted that the connection will be broken between q^3 and q^4 before it is broken at the contacts l^2 of the individual circuit closers and breakers. Hence any arc or sparking that occurs will take place at the common circuit-breaker q^3 q^4. The action resulting from lost motion in this device also causes spring q^3 to be moved from contact q^4 suddenly, as by a blast.

A snap action or quick make and break is also effected by the roller q^5 upon the end of a blade-spring, which roller bears against the edge or corner of the hook upon lever q^2, and is adjusted to assist in forcing the arm q^2 backward by a spring action and cause its spring q^3 to move quickly out of contact with q^4.

It is obvious that this common circuit maker and breaker might be of any other desired construction and operated by connection with other parts of the apparatus, so as to come into action in the manner described to break the circuit before any of the individual circuit-closers break, and also preferably to make the circuit after said individual circuit-closers make circuit.

It will also be apparent that other constructions of devices for giving a snap action might be employed, as well understood in the art of circuit makers and breakers.

When it is desired to produce in a paper strip a group of perforations having a particular character or arrangement periodically, or after a given number of groups have been produced therein, it is desirable to give the operator some means whereby the number of characters perforated shall be indicated to him. In order, however, to obviate the possibility of his perforating more than the predetermined number of groups before perforating the characteristic or periodically-repeated group, we provide a circuit-breaker adapted to be engaged by a traveling device,

which is moved step by step with the action of the selecting key-levers, and upon moving to a predetermined point will operate upon said circuit-breaker and open the circuits of the perforating-magnets. When this is done, no further operation of the keys or key-levers will produce any action until the operator has moved the traveler back, and the failure of the apparatus to operate will of course give him the required warning.

As a traveler moving step by step to accomplish this work, we propose to utilize the traveling paper-carriage of the type-writer. R indicates the traveling carriage, and R^2 a circuit-breaking arm or spring which projects into the path of the carriage, so as to be operated when the carriage has traveled the distance corresponding to the operation of a predetermined number of the key-levers, which may be a number required to produce the extreme travel of the carriage from one end of its movement to the other.

The circuit-breaking arm R^2 is a spring-arm attached at its lower end to any part of the apparatus, but preferably insulated, and said arm or spring normally engages with a contact (indicated at R^3) which is also preferably insulated. The circuit of the operating-magnets being carried through said spring and contacts, it is obvious that no action of the same can be produced after the carriage has engaged and moved the arm or spring R^2.

As already stated, it is sometimes also desirable to mark the paper strip periodically or after perforating it with a predetermined number of groups of perforations. Where such number of groups corresponds to the number of letters and spaces in a line of printing on the type-writer, the marking can be readily and automatically effected by allowing the arm R^2 to make contact when engaged by the carriage with a contact-screw R^5. By this means a circuit of an electromagnet S may be closed, which magnet can be made to operate a marker or pencil which will mark the strip of paper a^4. As shown in Figs. 2 and 4, magnet S carries a marking-roll S^2, which normally rests in a cup S^5, containing some absorbent material moistened with an ink. When the magnet is energized, the roller is moved up to the position indicated in dotted lines in Fig. 4, and as its edge rolls over marks the paper a^4, which, in such operation, is backed or supported by the block S^3.

To further lock the apparatus against operation after a predetermined number of groups of perforations have been made, the carriage of the type-writer may be provided with a locking-plate S^6, attached to the escapement-bar, as indicated in Fig. 19, and so arranged that at the end of the line it will be engaged by the escapement-teeth of the rocking arm, which plays between the teeth of the escapement or rack bar. The feed-escapement lever being thereby locked, it is impossible to depress any of the key-levers, as will be well understood from consideration of the construction of the form of type-writer to which the device is applied.

The take-up reel a^7 is preferably actuated by the same motor which by its shaft D^3 applies power to the actuating-spring of the paper-feed wheel D. When it is desired to turn the paper-feed wheel backward in order to move the perforated tape a^4 back between the punches for the purpose of erasing matter already perforated, as before explained, it is desirable to free the wheel by taking the power off the spring connected to the feed-wheel shaft D^2 and allowing the spring to run down. The paper-feed may be freed also from the motor, as will be described farther on. This is effected by throwing the electric power off the motor and by lifting the retaining-pawl D^7, Fig. 10, out of engagement with the toothed wheel secured to the motor-shaft, so that the latter may run backward under the action of the spring in unwinding.

In order that the take-up reel may not be disturbed or run backward at the same time, but may keep the proper tension on the paper, its driving-shaft is connected with the shaft D^3 by a ratchet-and-pawl connection, as shown in Fig. 10. T is a transmitting-shaft connected at one end by a bevel-gear (shown in dotted lines) with a ratchet-wheel T^2, which in turn is driven by a pawl T^3, carried by a wheel T^4, which can turn freely on the shaft of wheel T^2, and is geared with a wheel T^5 on the motor-shaft. At its opposite end shaft T, by a bevel-gear at T^6, drives a gear-wheel T^8, which turns loosely on an upright shaft carrying reel a^7, and is supported on said shaft by a collar secured to the shaft, as shown. To the hub of the wheel T^8 is secured one end of a spring V. The free end of said spring rubs upon the inside of a barrel T^9, fastened to the shaft carrying the reel. By means of this spring thus applied the reel is frictionally driven and no sudden variations of driving power which would be liable to break the paper strip can take place. This frictional driving connection also provides for increase in the size of the paper roll, as it is wound upon the reel, by allowing a slip of the driving power as the roll increases in size and tends to take up the paper more rapidly than it is fed by the escapement-wheel. At V^4 a pawl is applied to a ratchet-wheel V^5, carried by the shaft T, to prevent the spring from unwinding. The frictional connection thus provided also permits the paper to be unwound from the reel in the act of moving the paper backward between the punches.

When the paper is to be drawn back, the current is cut off from the motor and the pawl D^7 is then lifted. The spring in the barrel on the feed-wheel then runs down, the wheels T^5 and T^4 turning freely, because the pawl T^3 can move backward over the teeth of the wheel T^2. The shaft T and connected

spring for the paper-reel remains at rest and are held against backward movement by the pawl V^4. The paper strip may be now drawn back. In this operation the take-up reel is turned backward, but owing to its frictional connection with the driving-spring it is permitted to do so, the spring, however, remaining under tension ready to turn the wheel and take up the paper strip when the paper is permitted to feed by the feed-wheel. To resume operations, the pawl D^7 is dropped, and the current being turned onto the motor the latter immediately winds up the spring in the barrel on the shaft of the paper-feed wheel.

A preferred construction of mechanism for driving the paper-feed or escapement wheel and take-up reel and at the same time permitting the strip of paper to be readily moved backward or forward into any desired position while still engaged with the feed-wheel is illustrated in Figs. 20 to 25. The driving-shaft D^3, operated by any motor, is geared by a bevel-gear with wheel D^{12}, loose on the shaft D^2. The motor may be an electric motor in a branch from the circuit of the electric generator, which supplies power for operating the various magnets of the apparatus. If desired, a separate generator might be used for the motor, but for simplicity it is preferable to use the source W. The power obtained from the shaft is communicated from wheel D^{12} to the spring D^6 and shaft D^2, carrying the escapement-wheel, by simply attaching one end of the spring D^6 to the hub of wheel D^{12} and the other end thereof to the barrel D^9, which is fixed to the shaft D^2. As will be seen, the motor, as before, will serve to keep the spring wound up and the power of the latter will turn the shaft and attached feed and escapement wheel. A suitable retaining-pawl may be applied to the wheel D^{12} to prevent the spring from unwinding.

In order that the paper-feed wheel D may be moved freely backward or forward without interference from the spring or motive device when it is desired to move the perforated tape backward or forward between the punches, suitable means are employed for locking or connecting the drum D^9 and the wheel D^{12} together, thus connecting the two ends of the actuating-spring together and freeing the shaft of the tension thereof. When this is done and the retaining-pawl is moved out of engagement with its wheel, it is obvious that the shaft D^2 and connected parts may be moved freely in either direction. This is desirable in order that the paper may be drawn back to position for erasing matter already perforated when an error is discovered, the erasure being made by perforating the strip full of holes, as indicated in Fig. 13, by the group of perforations at the right.

To free the paper-feed wheel from resistance to rotation due to connection with the driving-shaft and motor, a clutch d^{12}, adapted to be moved at will to couple or uncouple the motor, may be employed. This clutch may be of any suitable description and interposed in the shaft D^3, as indicated in Figs. 20 and 21. That shown consists of a ratchet-wheel on one section of the divided shaft and a spring-pawl mounted on a disk on the other section and provided with a knob by which it may be lifted from the ratchet. A dog or projection on the hub of the pawl is arranged to pass a projection on a blade-spring d^{13}, whereby the pawl will be held raised or depressed.

The locking or connecting of the two ends of the spring D^6 together may be effected by providing the edge of the drum D^9 with ratchet-teeth and by mounting over said drum and upon the wheel D^{12} a suitable spring-pawl E^{12}, which may be dropped into engagement with the ratchet on wheel D^9, thus holding the spring from unwinding and taking its tension off the shaft. The spring pawl or lock E^{12} may be normally held out of engagement with the drum by means of a cam-plate E^{13}, mounted and turning on the hub of wheel D^{12}, as indicated, and consisting, if desired, of a disk or wheel having a notched edge by which it may be operated from any side.

The take-up reel a^7 is driven by direct connection with the wheel D^{12}, which carries a pulley-wheel V^{12}, over which runs a band V^{10}, which passes around the wheel or hub corresponding to the wheel T^8. This belt V^{10} might engage with a wheel secured to the shaft of the take-up reel, the slip of the belt on the wheel affording a compensation for the tendency of the reel to take up paper with increased rapidity as the size of the roll of paper increases.

In order that heavier pins may be used within a given circumference of the feed-wheel, the said pins are placed in staggered arrangement, as shown in the plan view, Fig. 23. The releasing arm or dog f^5 works over the two rows of pins, so as to engage a pin of either row that may be in engagement with the stop-plate or abutment f. The width of the dog f^5 is somewhat less than the space occupied by the pins radially, and the stop-plate is provided with a recess, as shown, into which the dog may retire when it is struck by a pin, thus permitting the latter to move up to the abutment, as already explained.

When it is desired to move the paper backward between the punches, the circuit of the motor is opened and the spring-pawl E^{12} is dropped to lock the two ends of the springs together, so as to take the strain of the spring off the feed-wheel. The clutch may also be operated to disconnect the motor-shaft. As will be seen, the paper may be then moved freely, as the toothed wheel engaging with the central line of perforations may then move without opposition.

The manner in which the devices may be electrically connected is indicated in Fig. 26,

where M B indicates any suitable source of electric energy, preferably of constant potential. Connections are made between the various parts, so that circuits may be traced as follows: From one pole of generator M B to the spring or contact arm R^2, and thence to the contact R^3, (while the apparatus is in condition for perforating,) thence to the insulated plate carrying the contact q^4, to the contact-lever q^2, to the frame of the apparatus, then to the punch-magnet, which may be designated as the "No. 1" punch, or the one which is brought into action by the operation of any one of the levers, thence to the frame carrying the contact-levers O, thence by any one or more of the circuits which may be closed through the contacts l^2, to the punch-magnets and stop-magnets, thence to a common connection of the same through assisting-magnets B^3, and back to the other pole of the source M B.

When the spring R^2 is thrown over to make contact with stop R^5, then the circuit is from generator M B through R^2 R^5, marker-magnet S, and back to the opposite pole of the generator. In this case the circuit for the stop and punch magnets and their circuit-controllers is broken at the contact-point R^3 and remains broken until the paper-carriage is drawn back.

The feed-releasing magnet I may be included in an independent branch or circuit traced as follows: From one pole of generator M B through contact i^3, spring i^2, magnet I, back to the opposite pole of the generator.

It will of course be understood that the various magnets are wound or the resistance of their branches otherwise adjusted to the potential of the source M B.

In the normal condition of the apparatus the circuit of the generator M B is broken at contact q^4 of the common circuit-breaker and at the contacts l^2 of the individual circuit-breakers. The circuit of the generator is, however, normally closed through the release-magnet I, its armature-lever being thereby held depressed in the position indicated in full lines in Fig. 8. There being no circuit through the magnets B or H, the punches are retracted and the armature-levers of magnets H and the setting arms or dogs f^3 occupy the positions indicated in full lines in Figs. 8 and 3. Upon the depression of any key-lever the connection is first closed for the corresponding punch-magnets and proper stop-magnet at the contacts l^2, but no action is produced because the circuit is still open at the contact q^4. On further depression of the key-lever connection is closed at q^4 and the magnets B and the one magnet H, which predetermine the extent of feed, are operated. A twofold action is thereby produced. The punches operate the paper and one of the stop-pins is thrown up. At the same time, also, the circuit of the release-magnet I is broken at i^3, and the releasing arm or dog rises above the stop or abutment with which the escapment-wheel pin last operated is in engagement and takes the position indicated in dotted lines, ready to throw down said pin and thereby to allow the wheel to move until the pin which has been set by the magnet H strikes the abutment.

Owing to the fact that in the downward movement of the key-lever the contact at q^4 is closed after contacts l^2 are closed, it is obvious that no sparking or electrical action can take place at contacts l^2, but it will all take place at contact q^4, and the time of action of all the magnets B and H will be determined by the time of closure at q^4. As the key-lever rises at the beginning of the movement, no action is produced on the contact q^4; but, finally, at the lost part of the movement the circuit is broken at the contact q^4, thereby breaking the circuits of all the magnets B or H, whose connections still remain closed at contacts l^2. Any spark or arc produced by the opening of the circuits, therefore, takes place at contact q^4, and the break of the connections at l^2 as the key-lever moves upward further produces no deleterious effect.

An additional advantage in the common breaker is found in the fact that the various punch-magnet branches will remain closed together in multiple arrangement just prior to the action of said common breaker. By this means the punch-magnet branches may mutually discharge into one another, thereby avoiding much of the spark that would otherwise be produced.

When the magnets B lose their power, the punches are retracted by the action of the retracting-springs, which are unopposed by magnets B and B^2, and in moving back cause the connection to be closed for the release-magnet, which thereupon drives down the stop-pin and the feed takes place, the wheel being stopped by the pin which was set on the depression of the selecting-key lever.

After a predetermined number of actions of the key-levers the actions already explained as taking place through the operation of a circuit closer and breaker R^2 will occur.

What we claim as our invention is—

1. The combination, substantially as described, of a series of punch-actuating magnets, a series of circuit-selecting keys for operating said punches, a paper-feed, and a series of feed-controlling magnets different ones of which are brought into action by said keys according to the extent of feed required.

2. The combination in a perforator, of a gang of punch-operating devices, a series of controlling-keys, a variable paper-feed provided with a series of setting devices for predetermining the extent of feed, means controlled by said keys upon the depression thereof for bringing different ones of said setting devices into action according to the length of feed required, a motor for imparting a continuous rotary tendency to said feed-wheel, a fixed stop for arresting said wheel, and means for releasing said setting devices.

3. The combination with a series of punch-actuating magnets, of a series of circuit-selecting keys, a variable-feed device having a series of stop-pins, a series of stop-pin-setting magnets, and circuit-controllers therefor governed or operated by said keys.

4. The combination with a series of punch-actuating magnets, of a series of circuit-selecting keys, a variable-feed device having a series of stop-pins, a series of stop-pin-setting magnets, a series of circuit-controllers therefor connected to the keys, a stop-pin-releasing device, and means for actuating the same when the punches are withdrawn from the work.

5. In a perforator, the combination, substantially as described, of a series of punch-actuating devices, a series of controlling-keys for selecting the punches to be actuated, a feed mechanism, a series of dogs operating on the same to set and prepare said mechanism for a feed movement different in extent for the different dogs, actuating devices controlled by said keys for actuating different ones of said dogs according to the key depressed, a releasing device for said feed mechanism, and means for actuating the same when the punches are withdrawn from the work.

6. The combination of a series of punch actuating or controlling magnets, a series of key-levers, a series of chains or cords transverse thereto and engaged thereby in different groups or combinations according to the perforations desired, a series of circuit-closers connected with said chains, paper-feed devices, a series of stop-setting magnets for the paper-feed, and circuit-controllers for said magnets connected to a set of supplemental chains or cords engaged by said key-levers, as and for the purpose described.

7. The combination with a keyboard-perforator wherein the depression of one of the keys produces the desired group or sequence of perforations, an escapement-wheel having a series of movable teeth or pins, a fixed stop or abutment for arresting said teeth or pins, and means controlled by each of said keys whereby when the same is depressed to actuate the desired punches it at the same time sets or moves a pin sufficiently far removed from said fixed stop or abutment to permit a feed movement of the desired length to take place.

8. As a means for obtaining any desired intermittent rotation of irregular steps, a variable-feed escapement-wheel having a series of sliding stop pins or teeth each adapted to be set into and out of position for engagement with a stop, and means for setting these pins at any required position with reference to said stop.

9. The variable-feed escapement-wheel herein described provided with a series of movable stop-pins, a series of setting arms or levers having stationary supports operating on said pins singly or one at a time for each step of rotation, a stationary stop, and a detent arm or lever adapted to engage with and reset the pin which for the time being is in engagement with the stationary stop.

10. A variable-feed escapement-wheel having a series of movable stops, pins or teeth normally out of the path of a stop, means for independently setting said stop pins or teeth into and out of operative position one at a time for each step of rotation, a stop for arresting said pins, said pins being adapted to be moved in the wheel in a direction transverse to the plane of the wheel and means for holding said pins in the position in which they are set.

11. A variable-feed escapement-wheel having a series of movable stop pins or teeth adapted to be independently set into and out of operative position one at a time for each step of rotation, a stop for arresting said pins, a series of setting devices for setting said pins, and a pair of centering cam-plates between which the pins move before reaching said setting devices.

12. The combination with the escapement-wheel, having movable stop pins or teeth, of a releasing arm or dog adapted to yield when engaged by a pin, as and for the purpose described.

13. The combination with the escapement-wheel having movable stop-pins, of a series of setting arms or dogs, and a releasing-arm for engaging with the pin which engages with a fixed stop or abutment, said arm being adapted to yield and move past the abutment when engaged by the pin which has been set to next engage with said abutment.

14. The combination, substantially as described, of an escapement-wheel carrying a number of movable stop pins or teeth, a series of stop-setting magnets acting on pins at different distances from a fixed stop, and a stop-pin-releasing magnet for actuating the pin by which the wheel is held from movement.

15. The combination of a series of actuating-magnets operated in different combinations, a variable feed-wheel carrying a series of movable stop-pins, a series of setting-magnets different ones of which are operated according to the combination of actuating-magnets operated and length of feed required, a stop-pin-resetting magnet, and a circuit-controller therefor governed by the said actuating-magnets and adapted to act only when all of the actuating devices return to normal position.

16. The combination, substantially as described, of a series of punches, a series of actuating-magnets therefor, feed mechanism provided with an escapement-wheel whose teeth or pins are adapted to be set into and out of position to engage a stop, a series of actuating-magnets for setting said pins one at a time, a tooth-resetting magnet for releas-

ing the wheel, and a circuit-controller therefor engaged by the punch mechanism or part moving therewith.

17. The combination in a perforator, of a series of punches, a paper-feed mechanism having a variable-feed wheel, a series of stop-setting devices for predetermining the extent of feed, a releasing-magnet for resetting said stops and freeing the wheel to allow the feed to take place, and a circuit-controller therefor connected with the punches.

18. The combination with a type-writer, of a series of circuit-controllers actuated by the type-writer levers, and a circuit-breaker engaged by the type-writer carriage at the end of a line for opening the circuits of said circuit-controllers.

19. The combination of a series of punch-operating magnets, a series of circuit-selecting keys, a magnetically-actuated marker, and means controlled by said keys for closing a circuit of said marker after a predetermined number of operations of said keys.

20. The combination with a series of punch-operating magnets, of a series of circuit-selecting key-levers, an escapement connected with said levers, a traveler moved step by step thereby, and a circuit-breaker adapted to be engaged by said traveler to open the circuit of the magnets after the operation of a predetermined number of keys.

21. The combination with a series of punch-operating magnets, of a series of circuit-closers, a type-writer whose keys or key-levers are provided with selecting devices acting on said circuit-closers, and a circuit-breaker engaged by the paper-carriage for opening the circuit at the end of a line.

22. The combination, substantially as described, of a series of punch-actuating magnets, a series of circuit-controlling keys or levers therefor, and mechanism for opening the circuit of said magnets upon the operation of a predetermined number of keys equal to the number of spaces or characters in each of the lines of the message.

23. The combination with a series of independent actuating-magnets and their retractors, of one or more magnets placed in a common return-circuit for said actuating-magnets, and connected to the mechanism so as to assist the actuating-magnets in overcoming the retractor.

24. The combination, substantially as described, of a series of punches and independent actuating-magnets therefor, of retracting devices operating on the armatures of said magnets, and an assisting magnet or magnets for assisting the said actuating-magnets in overcoming their retracting devices.

25. The combination, substantially as described, of the paper-feed wheel, the take-up reel and a driving-motor common to the two wheels, a spring between said motor and paper-feed wheel, and a ratchet-and-pawl connection between the motor and take-up reel whereby the motor may be turned backward without affecting the take-up reel and its driving connections.

26. The combination of a paper-feed wheel having a series of independent movable teeth or pins, and a fixed stop, substantially as described, whereby the said feed-wheel shall have a definite predetermined irregular step rotation, a take-up reel on which the paper is wound as fast as fed from said feed-wheel, a driving-motor for said wheel, and an intermediate frictional driving connection for compensating for increase in the size of the roll of paper.

27. A paper-feed wheel having on its periphery teeth adapted to engage with perforations in the paper to be fed, and provided with stop pins or teeth adapted to be set into and out of position to engage with a suitable stop.

28. In a perforator, the combination with the paper-feed wheel having teeth entering perforations in the paper, of means for freeing said wheel from its driving power to permit the paper to be adjusted freely in front of the punches while engaged with said wheel.

29. The combination, substantially as described, with the feed-escapement wheel and its driving-spring, means for mechanically connecting the two ends of said spring to prevent the same from unwinding, as and for the purpose described.

30. The combination, substantially as described, of a paper-feed escapement-wheel having movable stops or pins for determining irregular steps of rotation, a stop for arresting said wheel in definite positions, an actuating-spring for driving said wheel, a driving-motor for winding up said spring, a take-up reel, and a belt connection between said reel and the paper-feed wheel or driving-wheel therefor.

31. The combination, substantially as described, of the driving-wheel connected at one end to a spiral spring, a drum connected at the other end to said spring, and a locking device connecting said driven wheel and drum together at will as and for the purpose described.

32. A variable-feed escapement-wheel having adjustable movable stop pins or teeth set staggering, and a stop for arresting said wheel, as and for the purpose described.

33. The combination with the punches and the feed-wheel over which the paper strip is fed, of means for adjusting the length of paper strip between the feed-wheel and the egress side of the punch box or head, as and for the purpose described.

34. The combination with a series of punch-actuating devices and a series of controlling-keys for bringing the same into operation in different combinations, of a rub-out key for bringing said punch-actuating devices into operation so as to produce a continuous series of holes uniformly spaced.

35. In a perforating system, the combination, substantially as described, of a fillet of

paper with a central row of perforations, a mechanism for perforating holes in the borders of said fillet, a feed-wheel whose teeth engage with the central row of perforations for moving said fillet of paper, and a means for adjusting the length of paper between said feed-wheel and a punch-head for perforating the outer holes of the fillet whereby the outer perforations in the fillet are brought into transverse alinement with those of the central row, as and for the purpose set forth.

36. As a means for automatically transmitting messages for reproduction by a page-printer at a distant station, a tape in which said messages are perforated, one line following another in series upon said tape and each line consisting first of groups of distinctive perforations for so marking each line of character as to produce pulsations that shall not materially affect the receiving instrument.

37. The combination, substantially as described, of a series of punch-actuating magnets, a feed mechanism, a series of feed-controlling magnets governing the extent of feed, a series of controlling-keys governing the circuits of said punch-actuating and feed-controlling magnets, and a circuit making and breaking device placed in a common circuit of said magnets and controlled or operated by said keys in common.

38. The combination, substantially as described, with a series of punch-actuating mechanisms and their controlling-keys, of a variable-feed mechanism, a series of feed-controlling magnets in separate circuits governed by said keys according to the length of feed required, and a circuit maker and breaker common to said circuits and governed by said keys in common.

39. In a perforator, the combination of a variable-feed-controlling wheel, having a series of movable stop pins or teeth adapted to set into and out of position for engagement with a stop, a series of magnets operating respectively on pins located at graduated distances from the stop, a series of circuit controlling and actuating devices for operating different ones of said circuit-controllers according to the length of feed required, and a circuit maker and breaker placed in a common circuit of said magnets and operated by said actuating devices in common.

40. The combination, substantially as described, of the paper-feed wheel having pins or teeth engaging a line of perforations in the paper both before and after it passes the punches, and a pivoted take-up wheel or idler bearing on the paper between the feed-wheel and the ingress side of the punch box or head for stretching the paper fillet within said punch-head, as and for the purpose set forth.

41. The combination in a perforator, of a series of magnets, punch-actuating mechanism operated thereby, a paper-feed wheel having pins or teeth engaging a line of perforations in the paper, and provided also with a series of movable stop-pins, a series of magnets for adjusting different ones of said pins into position to engage with a stop, a magnet operating on said pins to adjust them into position to be freed from the stop, and a circuit-controller therefor connected to the punch-actuating mechanism.

42. The combination with the variable-feed wheel having stop-pins set staggering, of a releasing-dog, and a stop-plate provided with a recess into which the dog may be retired when struck by a pin, as and for the purpose described.

43. A feed-wheel for feeding a fillet of paper, a motor for applying a continuous propelling force to said feed-wheel for effecting rotation, escapement teeth or stops moving with the wheel which are movable relatively to said wheel for releasing the same and a stop for arresting said escapement teeth or stops in a definite position, as and for the purpose set forth.

44. A feed-wheel for feeding a fillet of paper moving through steps of various length, a motor for applying a continuous propelling force for rotating said wheel, a series of escapement teeth or stops moving with said wheel which are movable relatively thereto, and a stop for arresting said wheel in definite positions.

Signed at New York, in the county of New York and State of New York, this 5th day of May, A. D. 1896.

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