

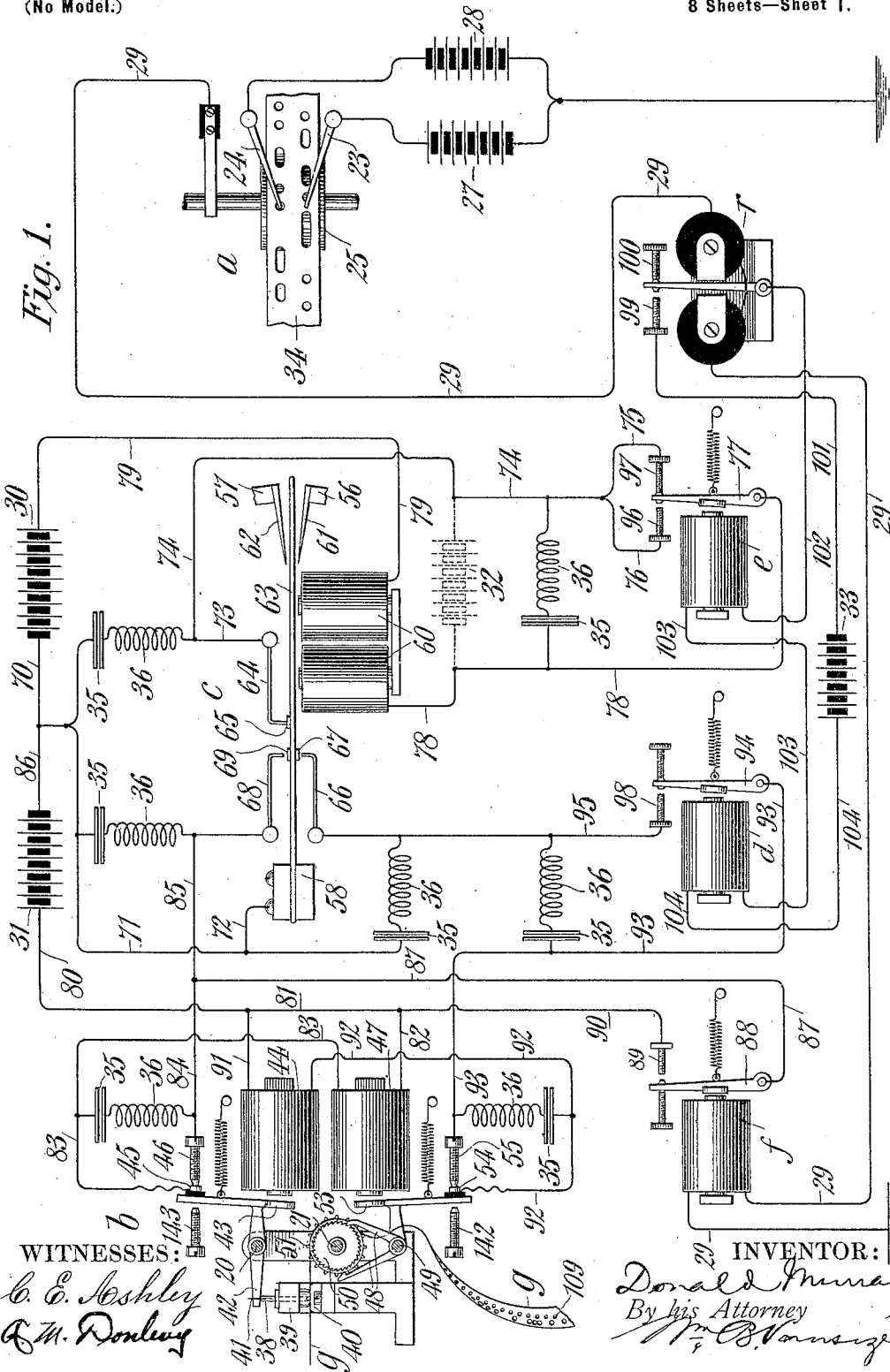
D. MURRAY.
PAGE PRINTING TELEGRAPH.

(Application filed Feb. 27, 1900.)

(No Model.)

8 Sheets—Sheet 1.

Fig. 1.



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C. E. Ashley
G. M. Donley

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By his Attorney
W. B. Vansize

No. 653,936.

Patented July 17, 1900.

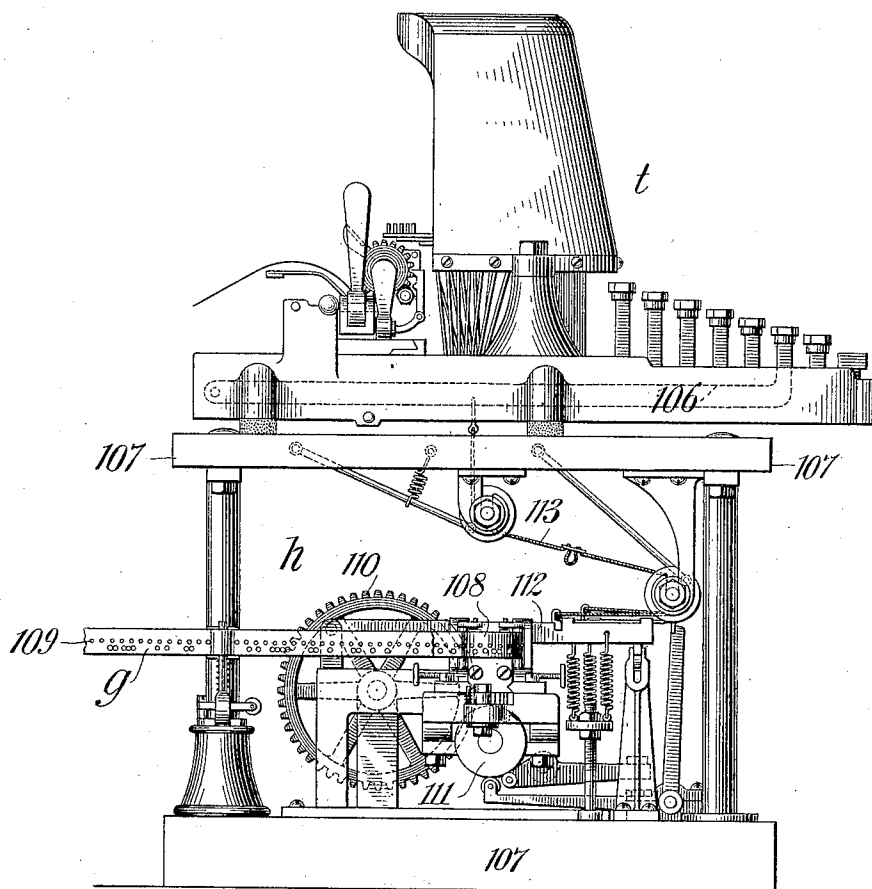
D. MURRAY.
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(Application filed Feb. 27, 1900.)

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8 Sheets—Sheet 2.

Fig. 2.



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D. MURRAY.
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Fig. 3.

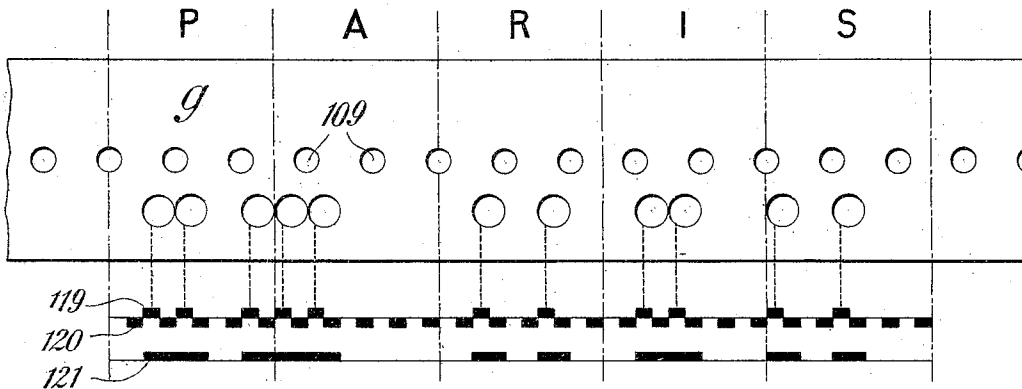


Fig. 4.

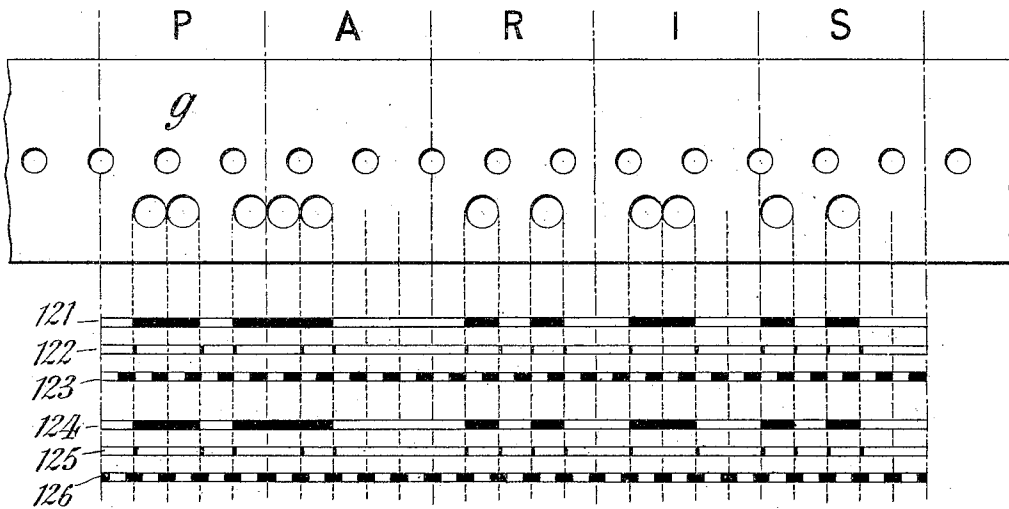
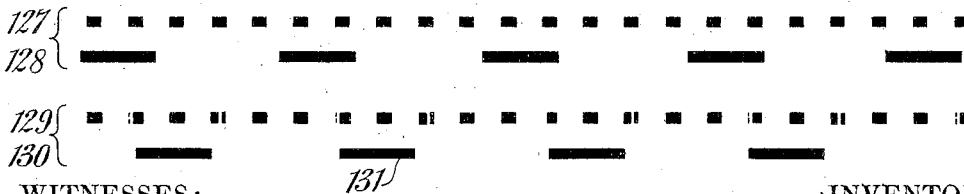


Fig. 5.



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D. MURRAY.
PAGE PRINTING TELEGRAPH.

(Application filed Feb. 27, 1900.)

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Fig. 6.

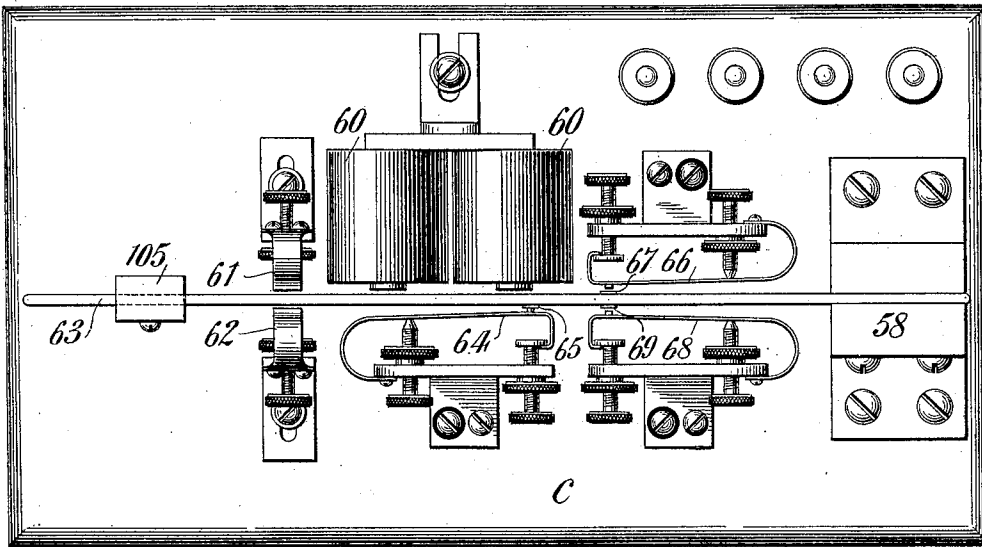


Fig. 7.

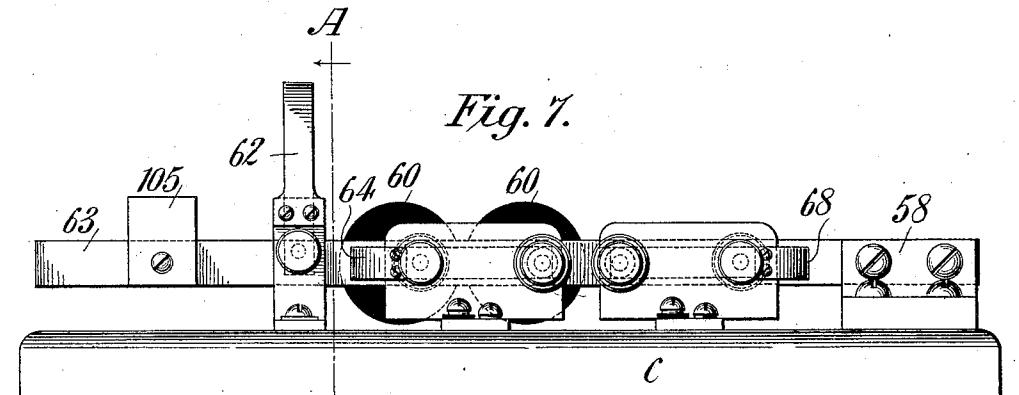


Fig. 9.

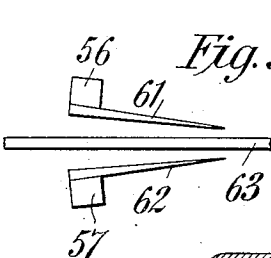
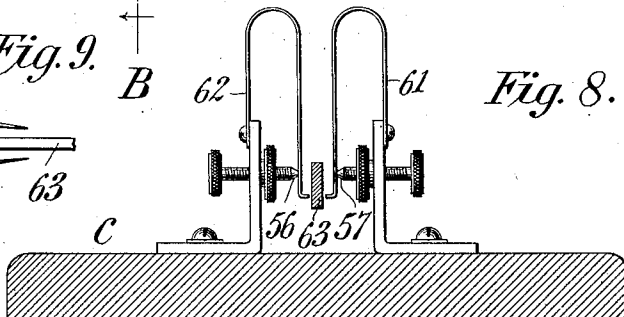


Fig. 8.



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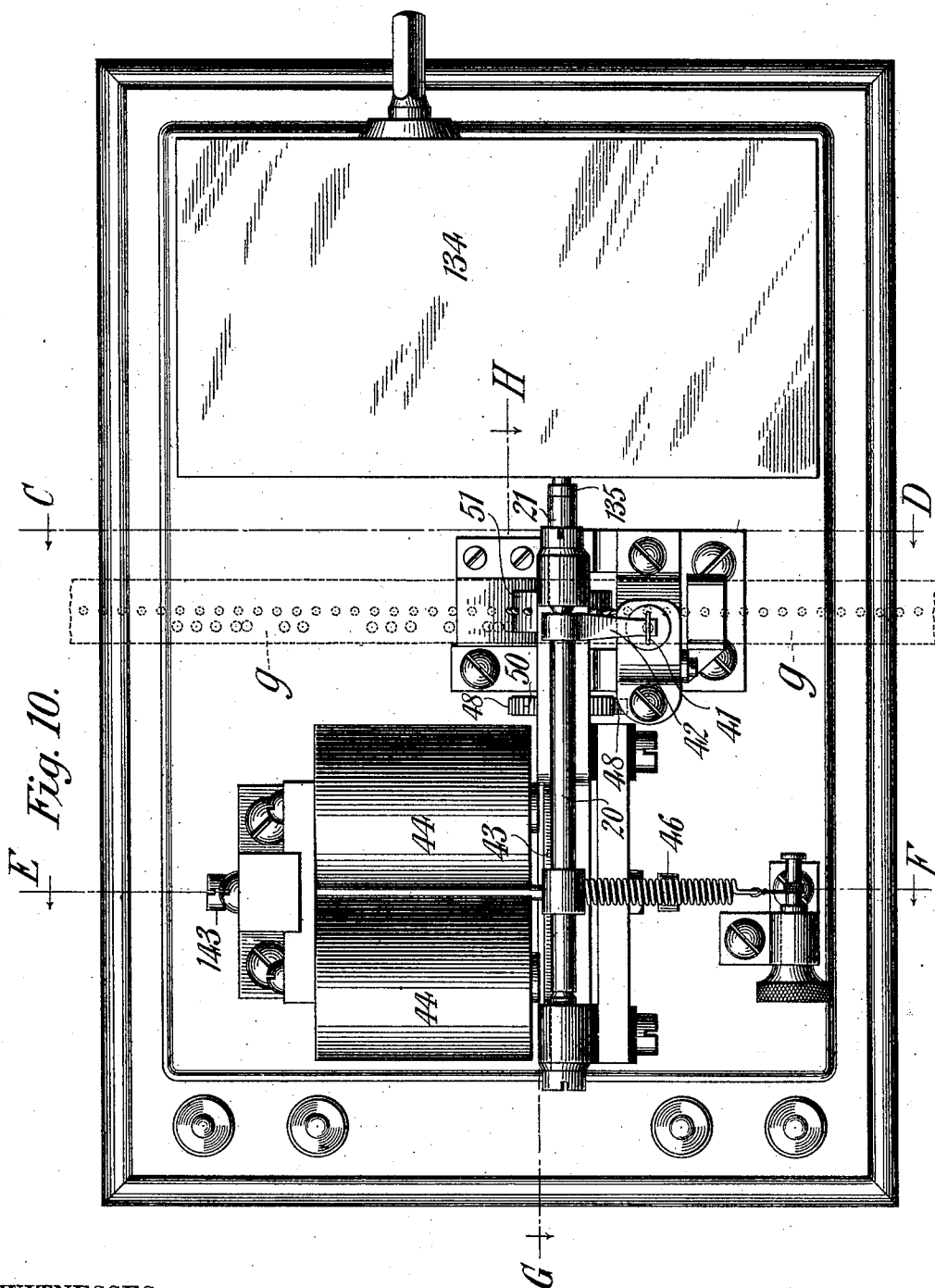
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(Application filed Feb. 27, 1900.)

(No Model.)

8 Sheets—Sheet 5.



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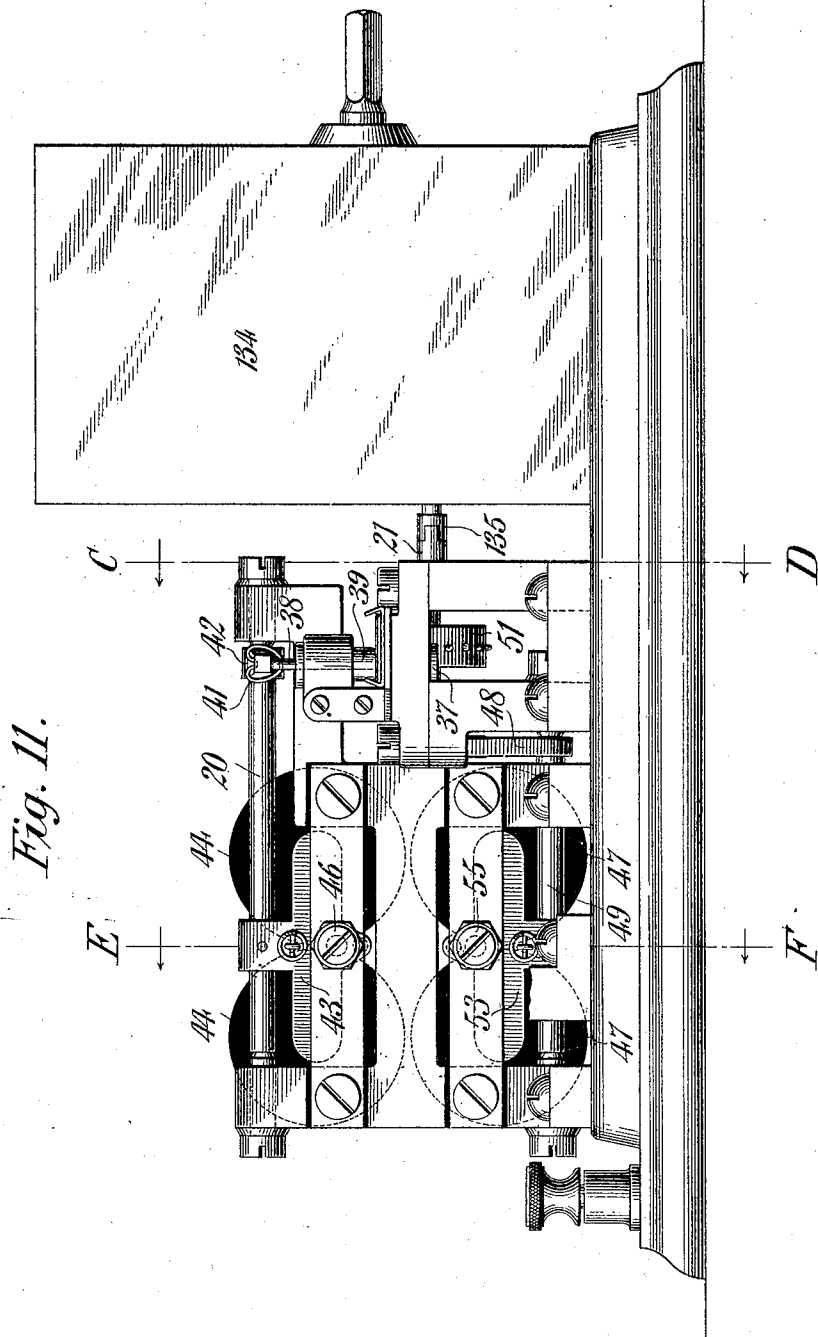
Patented July 17, 1900.

D. MURRAY.
PAGE PRINTING TELEGRAPH.

(Application filed Feb. 27, 1900.)

(No Model.)

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D. MURRAY.
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(Application filed Feb. 27, 1900.)

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Fig. 12.

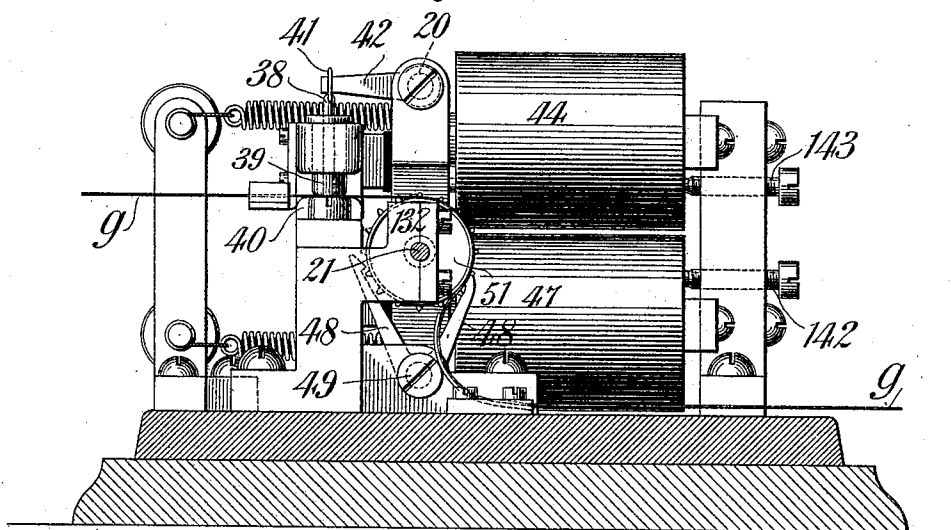
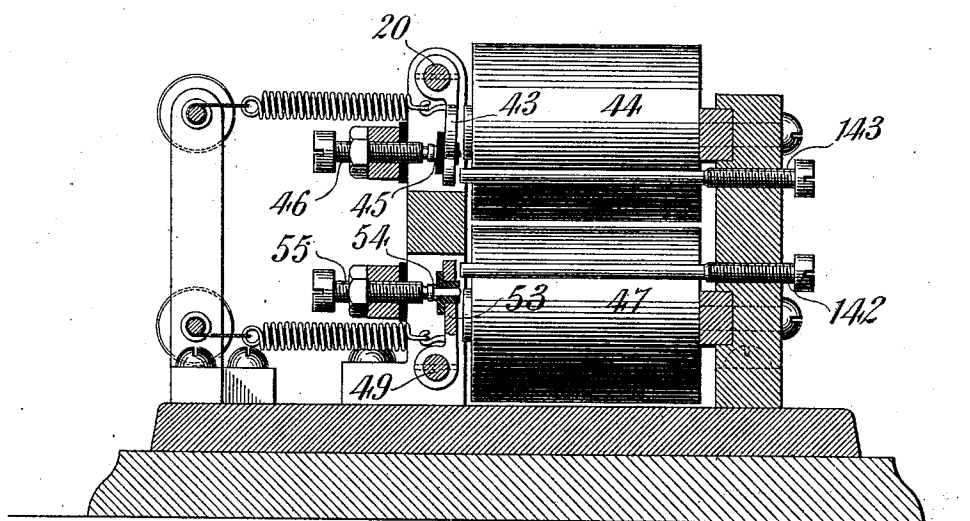


Fig. 13.



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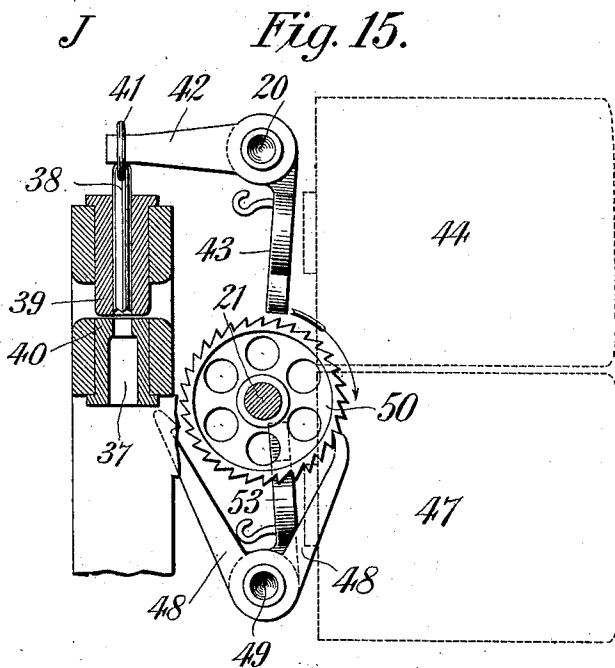
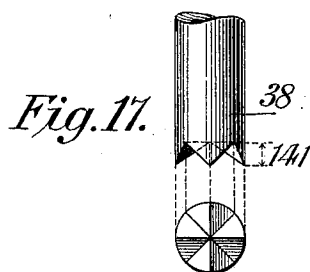
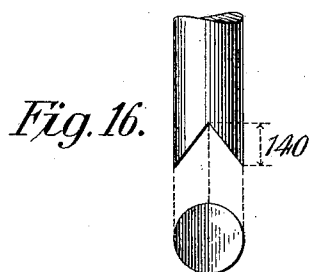
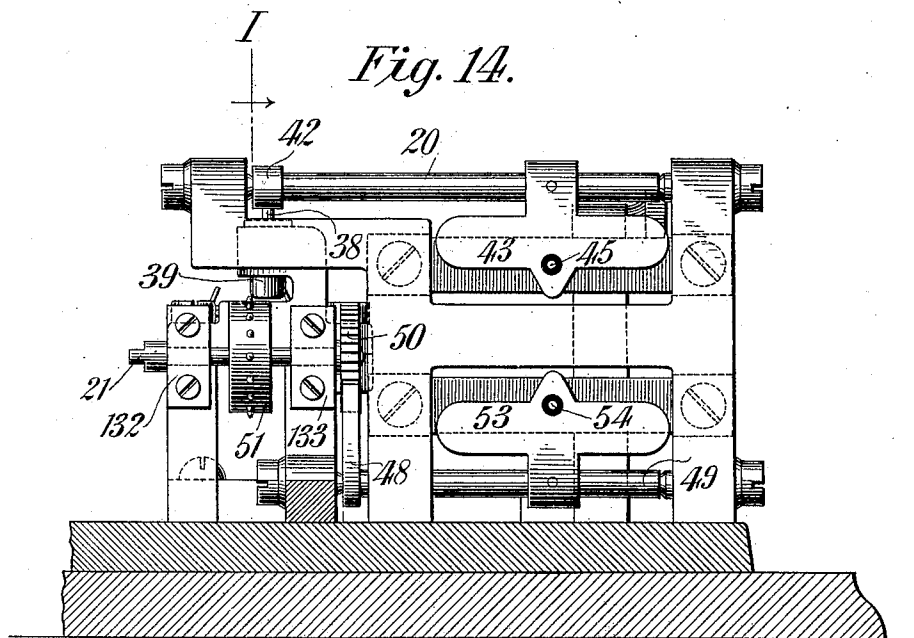
Patented July 17, 1900.

D. MURRAY.
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(Application filed Feb. 27, 1900.)

(No Model.)

8 Sheets—Sheet 8.



WITNESSES:

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INVENTOR:

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UNITED STATES PATENT OFFICE.

DONALD MURRAY, OF NEW YORK, N. Y., ASSIGNOR TO THE POSTAL TELEGRAPH-CABLE COMPANY, OF SAME PLACE.

PAGE-PRINTING TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 653,936, dated July 17, 1900.

Application filed February 27, 1900. Serial No. 6,656. (No model.)

To all whom it may concern:

Be it known that I, DONALD MURRAY, a subject of the Queen of Great Britain, residing in the city of New York, county and State of New York, have made certain new and useful Improvements in Page-Printing Telegraphs, of which the following is a specification.

My invention relates to page-printing telegraphs of the class in which a perforated strip controls an actuating mechanism to operate a type-writer or type-casting machine.

My improvement relates more particularly to the apparatus and connections for perforating the tape or strip at the receiving-station. I provide an electromagnetic perforator having a spacing device and a punching device, each being operated by an electromagnet in a local circuit. The spacing-magnet advances the tape step by step and the punching-magnet perforates the paper one, two, or more times in succession, each magnet operating alternately in response to current variations or impulses. I avoid transmitting all the necessary impulses over the main line by creating locally a continuous series of uniform current impulses, causing said impulses to actuate the spacing and punching device alternately and throwing upon the main line at the transmitting-station either makes and breaks or reversals, each variation being automatically of uniform duration or a multiple thereof, whereby I determine the duration of action of the punching device. There is an automatic circuit-breaker at the receiving-station operating alternately in the spacing and punching circuits. It is driven by an electromagnetic device in a separate local circuit, and to secure unison between the periods of current change in this local circuit and in the main-line circuit, due to the action of the automatic transmitter, I place a special form of circuit-changer in this local motor-circuit, and this circuit-changer is controlled by an electromagnet in the main line. The special circuit-changer referred to is shown as a movable contact vibrating between two fixed contacts connected to the same circuit-terminal, so that the moving contact in going from one to the other operates to open the circuit during its time of transit

only. If the arriving impulses are coterminous with impulses in the local circuit, the transmitter and the local circuit-changer are in unison. In case of failure in unison the operation of the circuit-changer exercises a correcting influence upon the local motor-circuit. I also provide a suitable device for stopping the operation of the spacing-circuit during cessation of main-line current.

The accompanying drawings illustrate my invention.

Figure 1 is a general diagram showing the connection of the apparatus at the receiving-station with the main line and transmitter at the distant station. Fig. 2 shows a type-writer and a form of actuating device controlled by the perforated tape after it has passed through the perforator shown in Fig. 1. Fig. 3 is a section of tape perforated by the apparatus at the receiving-station, and immediately below it are graphically represented the current impulses in the local circuits and in the main-line circuit which cooperate to produce the tape shown. Fig. 4 shows the same section of tape arranged for comparison with a graphic representation of the condition of the main and local circuits and the influence of a correcting device operated to maintain unison. Fig. 5 is a graphic representation of the main-line and local-circuit impulses and the effect of the correcting device operating to secure unison. Fig. 6 is a plan view of the local-circuit breaker with its motor-magnet and resilient limiting-stops for securing variations in the rate of vibration of the reed circuit-breaker responsive to varying current conditions in the motor-circuit. Fig. 7 is a side elevation of the vibrating reed shown in Fig. 6. Fig. 8 is a transverse section on the line A B, Fig. 7. Fig. 9 is a modification of the limiting-stops shown in Fig. 8. Fig. 10 is a plan view of the spacing and perforating device. Fig. 11 is a side elevation of the same. Fig. 12 is a transverse section on the line C D, Figs. 10 and 11. Fig. 13 is a transverse section on the line E F, Figs. 10 and 11. Fig. 14 is a section on the line G H, Fig. 10. Fig. 15 is a section on the line I J, Fig. 14. Fig. 16 shows a common form of cutting-punch, and Fig. 17 shows my improved form of same.

In Fig. 1, *b* is a perforating apparatus consisting of a step-by-step spacing-magnet 47 and a punching-magnet 44. Punch 38 reciprocates in guide-block 39 and engages die 40, over which paper tape *g* passes. Punch 38 is operated by pivoted lever 42, which is connected to the punch by an elastic detachable connection 41. (Shown in Fig. 11.) This connection 41 is made elastic to prevent lost motion and is made elastic and detachable to facilitate removal of the punch. Lever 42 is fixed to the armature 43 through the medium of spindle 20. Break-points 45 and 46, controlled by the armature 43, are in a local circuit with magnet 47. Magnet 47 operates an escapement consisting of pawls 48 and toothed wheel 50 on motor-driven shaft 21. Pawls 48 are on spindle 49, to which is connected armature 53, operating break-points 54 and 55 in a local circuit which includes punching-magnet 44. Motor-driven shaft or spindle 21 carries star-wheel 51, which engages the row of feed-holes 109 in paper tape *g*. There is a separate local circuit for each magnet 44 and 47. In the circuit of magnet 44 are break-points 66 and 67. In the circuit of magnet 47 are break-points 68 and 69. These break-points are alternately closed and opened by a vibrating reed 63, the elements of which are shown in Fig. 1 and the details of which appear in Figs. 6, 7, and 9. Reed 63 is firmly supported in the vise 58 and carries an adjustable weight 105 to secure any required rate. The reed is operated by an electromagnet 60 in a local circuit containing break-points 64 and 65, operated by the reed. I have provided means whereby the rate of vibration of this reed is varied in harmony with the variations in current in its motor-circuit. Under normal conditions, with a motor-magnet and circuit operated by break-points carried by the reed, an increase of current resulting in increased magnetic effort will decrease the rate of vibration, and conversely a decrease of current resulting in decreased magnetic effort will accelerate the rate of vibration. This is believed to be due to eddy-currents generated by the magnetic field of force and the movement of the reed in such field. The action described has a damping effect, but is of no practical use as a means of regulation for the work to which the reed is here put because of its exceedingly limited range. It is necessary to have an extensive range of possible variations in the speed of this reed, and to secure this I place at or near the free end of the reed 63 limiting-stops 56 and 57, fixed upon opposite sides thereof, each of which includes a resilient device, like springs 61 and 62, (see Figs. 6, 7, 8, and 9,) which cooperate to impart an initial return movement to the reed. Upon the opposite side and upon the return movement the reed is received with a cushioning effect. The result is that I am enabled to regulate the vibration of the reed in substantial harmony with the variation of

the current in the motor-circuit. In explanation of this novel result it is to be understood that the rate of vibration of the reed varies with its length, mass, and the distribution of such mass. Increase of current in the motor-magnet widens the arc of vibration without varying the speed beyond the slight electromagnetic damping effect already described. The energy imparted to the reed by the motor-magnet is dissipated by the air resistance and molecular friction in the reed. An increase in the propelling energy brings a corresponding increase in the dissipation noted. Therefore while the arc of vibration is widened the speed is not increased; but by placing fixed stops to limit the arc of vibration the energy of the reed cannot then be dissipated in the manner first described to the same extent. The result is an increase in the rate of vibration. With rigid limiting-stops a portion of the energy imparted to the reed is dissipated by heat generated at the points of impact. To avoid this loss and increase the rate still further, I store the energy which would be lost at a rigid contact in the resilient device 61 and 62, already referred to, which cushions the impact of the reed and imparts an initial return movement. This device further renders the movement of the reed smooth and uniform, freeing it from the interference due to the impact with a rigid stop which acts to jar and disturb the normal rate of vibration.

It is known that within the limits of elasticity a helical spring varies in length in arithmetical ratio with the force extending it—that is to say, if a helical spring extends one inch with a weight of one pound it will extend two inches with a weight of two pounds, and so on. Within restricted limits the same rule holds good with simple flat springs of uniform thickness. For instance, the flat contact-springs shown at 64, 66, and 68 in Fig. 6 obey this law within the limits of motion possible to them. I have found by experiment that springs of this kind, whether arranged for tension or for compression, do not vary the rate of vibration of an electromotor-driven reed to any appreciable extent in response to variations of current strength in the motor-magnet circuit. If, however, resilient limiting-stops are provided with means to graduate their action more in the nature of a geometrical than an arithmetical ratio, then, as I have found by experiment, a wide range of variation—as much as fifty per cent.—in the rate of vibration of the reed is possible as the result of a corresponding variation of current strength in the motor-magnet circuit. In other words, if the resilient limiting-stops are so constructed or arranged as to rapidly compound their resistance to the impact of the reed, then, and not otherwise, are they practically operative for the purpose intended in the invention here described and claimed by me. The limiting-stops shown in Figs. 8 and 9 I have found by

actual trial to be operative, the form shown in Fig. 9 being specially advantageous. The form shown in Fig. 8 is so arranged as to operate beyond the limits within which a flat spring will bend in arithmetical ratio to the force exerted against it. The means employed consist in locating the adjustable stops 56 57 near the free end of the springs 61 62 to serve as a fulcrum upon one side of which the spring will bow or bend under the unequal leverage.

I will now describe the local punching and spacing circuits and the operation of the motor-driven reed circuit-breaker.

15 Battery 31 is common to both the punching and spacing circuits. The spacing-magnet circuit may be traced from 31 via 80, 81, 82, and magnet 47, 83, 45, 46, 84, 85, 68, 69, 72, 71, and 86. The circuit of the punching-magnet extends from battery 31 via 80, 91, magnet 44, 92, 54, 55, 93, and circuit-breaker 94, 98, 95, 66, 67, 72, 71, and 86. The circuit-breaker 94 98 is operated by magnet *d*, responsive to impulses in the main line. The reed 63 alternately makes and breaks the local circuits of the spacing and punching magnets, and the circuit-breaker 94 98 determines the action of the reed circuit-breaker in the punching-magnet circuit. The circuit-breaker 45 46, controlled by magnet 44, is in the circuit of magnet 47, and the circuit of magnet 47 can only be closed when magnet 44 is deenergized. The same is true of circuit-breaker 54 55 in the circuit of magnet 44, which is controlled by magnet 47. The object of this arrangement is to prevent interference.

Referring now to the motor-magnet circuit operating the reed 63, the circuit passes from battery 30 via the element 70, 71, 72, 63, 65, 64, 73, 74, 75, 97, 77, 78, and coils of magnet 60 to 79. *e* is a relay having a magnet operating a movable contact 77. Contact 77 engages front contact 96 or back contact 97. Both contacts are connected together and to the circuit-terminal 74 by connections 75 and 76. The function of relay *e* is to maintain unison between current impulses due to the action of the reed circuit-breaker and current variations due to automatic transmitter *a* at the distant station. This is done by employing the transit time of armature 77, which may be varied by adjustable limiting-stops 96 and 97. A change in current conditions on the main line produces a transit of the movable contact 77, and consequently an interval of break in the motor-magnet circuit. The automatic transmitter *a* is operated at a substantially-uniform rate to produce a determinate number of current variations per second. The vibrating reed 63 is operated to produce current variations slightly in excess of those due to the operation of the transmitter *a*. For instance, if transmitter *a* throws upon the main line current variations of unit extent at the rate of forty per second the reed 63 is caused to produce in the motor-circuit, say, forty-one

complete variations of current per second. At each variation of main-line current movable contact 77, operated by relay *e*, changes its position and during its transit momentarily opens the motor-magnet circuit. With the difference in the rate of current variations between the two circuits described this operates to cut off a fragmentary part of one or more of the series of the current impulses in the motor-magnet circuit. The result is the establishment of a dynamic balance between the conditions in the main line due to the operation of the transmitter and the condition of the local circuit due to the operation of the vibrating reed, and unison is thus maintained. The transit time of the armature 77 therefore acts as a correcting impulse. Every letter transmitted requires at least one main-line impulse. The reed may be set to run during the time of transmission of at least three or four letters without getting out of step with the main-line impulses, and it will thus be seen that there is afforded means for securing a practically perfect dynamic balance. The magnets of the relays *e* and *d* may be placed in the main line and operated directly by main-line variations of the current; but I have shown them in a local circuit with the battery 33 and break-points 99 and 100, operated by polarized relay *r*, the coils of which are in the main line 29. This local circuit passes from the fixed contact 99 via the element 101, battery 33 104, relay *d* 103, and relay *e* 102 to the movable contact of relay *r*.

I have provided a relay *f* in the main line which operates to cut out of circuit the coils of the spacing-magnet 47 when no current is present for a sufficient interval in the main-line circuit. The circuit connections are from the movable contact 88 via 87 to the wire 84 on one side of the magnet 47 and from the contact 89 via 90 to the wire 82 upon the opposite side of the magnet 47. The transmitter *a* has been arranged to throw upon the line alternate positive and negative impulses of unit duration or multiples of such unit impulses, by which I mean two, three, or more unit impulses in the form of one extended impulse. There are two grounded batteries of opposite polarity 27 and 28, each connected to a trailing contact-finger 23 24 in position to follow lines of perforations like that shown in the transmitting-tape 34, which is carried along by its contact with a motor-driven cylinder 25, connected to the main line 29.

I have shown each break-point of the receiving apparatus bridged by a device to obviate sparking, which consists of a suitable condenser 35, connected in series with a resistance-coil 36.

The operation of the apparatus is as follows: The transmitter *a* is motor-driven at a uniform speed, directing upon the line positive and negative impulses of unit duration or multiples thereof at the rate of, say, forty

unit impulses per second. The reed 63 at the receiving-station is motor-driven to produce, say, forty-one corresponding vibrations per second. This provides for the establishment of unison, while operating to make and break the spacing-magnet circuit and the punching-magnet circuit alternately. The makes and breaks of the reeds in the punching-magnet circuit are not effective except at such time as the relay *d* is upon its front contact 98. Let us assume that a positive impulse from transmitter *a* operates the relay *r* to close its local circuit and energize the relay *d*. When finger 23 of transmitter *a* passes over a perforation in the tape 34 of unit extent, the relay *r* responds, the relay *d* closes upon its contact 98, completing the circuit of the punching-magnet, and the vibrating reed 63 during the interval of closed circuit at 98 completes the circuit at the break-points 66 67, and the punch is operated to perforate once. When the finger 23 of the transmitter *a* traverses a perforation in the tape 34 two units in extent, the same condition exists for double the length of time and the vibrating reed 63 makes and breaks the circuit of the punching-magnet twice. In its excursion, however, and alternating with the intervals of closed circuit in the punching-magnet circuit, reed 63 closes the circuit of the spacing-magnet and tape *g* is fed along one space. During the time that finger 23 of transmitter *a* is passing from one perforation to that succeeding, finger 24 is traversing a perforation, there is directed upon the line a current impulse of opposite polarity, and relay *r* assumes its normal position. The act of spacing is continuous and independent of the main-line conditions, except as controlled by relay *f*. In Fig. 3 I have shown a section of the tape *g* perforated with the word "Paris." There is a central line of feed-holes 109 to be engaged by the teeth of a star-wheel, and there is a parallel line of perforations which by their relative position and number within a longitudinal section of the tape determine the character to be printed by the actuating device *h* of the type-writer *t*, Fig. 2, as shown and described in my Letters Patent No. 638,591, dated December 5, 1899. In Fig. 3 I have shown in line 119, arranged parallel with the line of perforations in the tape, a graphic representation of current impulses effective in the punching-magnet circuit, and in line 120 the current impulses effective in the spacing-magnet circuit. In line 121 I have shown the main-line impulses of unit duration or multiples thereof, which coöperate with the local-current impulses in the punching-magnet circuit shown at 119 to produce the perforation shown. In Fig. 4 is the same section of tape with parallel lines, showing main-line and local current conditions and the operation of the circuit-breaker controlled by the relay *e* in its effort to establish and maintain unison. The line 122 graphically represents the transit time of the armature and

the relative position of its operation with respect to the main-line-current variations shown at 121 and the motor-magnet impulses shown at 123. At 125 I have shown the operation of the circuit-breaker of the relay *e* and the relation of its operation with respect to the current impulses in the motor-magnet circuit 126, the latter being shown as somewhat displaced or out of step with respect to the main-line impulses shown at 124. In Fig. 5 I have shown at 127 a graphic representation of current impulses in the motor-magnet circuit and at 128 main-line-current impulses effective under proper conditions to perforate the letter *n* successively, the two classes of impulses being uncontrolled by the unison device and out of step. At 129 I have shown the effect of the operation of the circuit-breaker controlled by the relay *e* in cutting or clipping the impulses in the motor-magnet circuit, and at 130 I have shown the main-line-current variations which operate in the coil of relay *e* to produce the regulating or controlling action. In the latter instance it will be noted that at 131, for instance, upon the occurrence of a change in the main-line conditions the transit of the armature-bar 77, with the consequent break in the circuit, has interfered with the development of the motor-magnet impulse generated by contact between 64 and 65, and the same is true at the main-line-current change appearing at the end of the impulse 131. In Fig. 4 at 121, 122, and 123 there is represented a theoretically-perfect unison between the impulses 121 and 123, the armature-transit time represented in the line 122 occurring at the interval of break at the points 64 65, operated by reed 63 in Fig. 1 of the drawings. Consequently no interference appears with the impulses 123 of the motor-magnet circuit. The other extreme condition is represented in the three lines given below—124, 125, and 126—where the two classes of impulses are completely out of step and the armature 77 breaks the circuit of the motor-magnet at or about the center of the interval when 64 or 65 are closed. The graphic representation in Fig. 4 while showing these extreme instances is placed in contrast with the representation shown at 129 and 130, Fig. 5, where the continuous operation of the circuit-breaker 77 clips a sufficient amount from the initial or final portions of a motor-circuit impulse to maintain a steady dynamic balance.

The tape is continuously perforated in the manner described, passing directly from the perforator shown in Fig. 1 into the actuating device *h*, controlling the type-writer *t*, in Fig. 2. This is the usual arrangement of type-writer, having a suitable platen and a series of type presented at the recording-point by the operation of a series of independent key-levers 106. It is located upon a frame 107, forming part of the actuator *h*. This actuator consists of a series of notched bars or combs arranged in parallel relation and capa-

ble of a reciprocating motion individually and collectively. The ends or terminals are pointed and presented at the rear of the feed-wheel 108, around which the tape *g*, having a series of central feed-holes 109, passes. The wheel 108 has a series of pins in its periphery spaced to present themselves coincidentally with the feed-holes 109. Motive power is supplied by any suitable motor, which may be either manually operated or driven by any mechanical power. Such a motor is connected to the shaft carrying the driving-wheel 110, which is geared to the cam-shaft 111, through which the operation of the actuator is effected. There is a series of parallel levers 112 arranged side by side transversely above the combs, and each of the bars 112 is connected with a key-lever 106 by some flexible connecting device, like 113, which passes around suitable pulleys, as shown. The levers 112 are allowed to drop into effective operative position whenever the tape 109 in its progressive movement, section after section, has allowed the arrangement of combs in such a position that a series of notches, one in each comb, presents itself to one of the series of levers, and when this occurs that particular one of the series of levers 112 which is over a completely-aligned series of slots in the combs is allowed to drop, and through the intermediate mechanism operates its key-lever 106 and a letter is imprinted. This apparatus is fully described and illustrated in my prior-granted patent, No. 638,591, above referred to.

In Fig. 1 I have shown a modification of the arrangement of circuits for controlling the unison apparatus, in which the battery of the motor-magnet 60 is arranged in two sections, 32 being the added section, (shown in dotted lines.) The circuit-breaker 77 operates to shunt the section 32, so that the effect of the operation of the circuit-breaker 77 is to break the shunt around the section of the battery 32 during the transit time of the armature, and thus control the motor-circuit by an increase of current under the same conditions that the break is employed to control the motor-circuit with the apparatus first described. When the modified arrangement is employed, the controlling-relay *e* operates to accelerate the speed of the reed 63, and it is then necessary to drive the transmitter *a* at, say, forty impulses per second, while the reed is caused to operate to produce, say, thirty-nine corresponding impulses.

The electromagnetic perforator employed by me embodies improvements in structure and arrangement. (Shown in Figs. 10 to 17.) There are two pairs of electromagnets 44 47, fixed one above the other and arranged in parallel planes. There is a transverse arbor 20, located in proximity to the magnet 44, to which is fixed an arm 42, in line with the reciprocating punch 38. The arm 42 is connected with the punch 38 by means of an elastic detachable connection 41. The punch

38 reciprocates in a guide 39 and engages a die 40, having a delivery-tube 37 for the punchings. (See Fig. 15.)

Parallel with the shaft or spindle 20 is a similar spindle 49. Both spindles extend across the poles of the magnets. The spindle 20 carries the armature 43 of the magnet 44. The oscillation of this armature is limited by the stops 143 and 46. The spindle 49 carries the armature 53 of the magnet 47. The oscillation of this armature is limited by the stops 142 and 55. At one side of the magnets and in front thereof is a spindle 21, journaled in suitable standards at 132 and 133. On the spindle 21 is a toothed ratchet-wheel 50, and on the shaft or spindle 49 are fixed holding-pawls 48, taking in the teeth of the wheel 50. There is a suitable motor, like the spring-motor 134, connected with the shaft 21 by a suitable coupling 135. On the spindle 21 is a star-wheel 51, the teeth of which are suitably spaced to engage the feed-holes in the paper tape to be perforated. By the arrangement described the perforator and paper-feeding apparatus are made conveniently accessible for adjustment, cleaning, and repair, while the punch, striking downward, forces the punchings down the delivery-tube 37, and thereby prevents them clinging to the paper tape or the punching mechanism, a trouble heretofore encountered due to frictional electricity developed by the rapidly-moving tape.

The punch 38 is of improved construction and is provided with a serrated cutting edge—that is, the circular cutting edge is divided into three or more angular teeth or serrations, as shown in Fig. 17 in elevation and corresponding plan view. In Fig. 16 I have shown for purposes of comparison a form of punch which has heretofore been known and used. The distance which this punch must reciprocate to produce a clean perforation is shown by the dotted line 140, which is double the distance which the punch shown in Fig. 17 must reciprocate to produce a clean perforation, although the angle of shear in both cases is the same. In Fig. 16 the cutting edges are curved, and therefore do not perforate the paper so easily as the sharp angles of the cutting edges shown in Fig. 17. I may employ a single transmitting-battery, like 27, and in this case the transmitting-tape has only one row of perforations for the make and break impulses instead of reversals of current directed onto the main line. A neutral relay, like *d* or *e*, may be used in the main line in place of the polarized relay *r*.

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

1. The combination of a main telegraph-line, an automatic transmitter at one station, an electromagnetic perforator at a second station, said perforator including a spacing-magnet and a punching-magnet, a local circuit for each of said magnets, an automatic circuit-breaker operating to make and break

said circuits alternately and a main-line relay operating break-points in said punching-magnet circuit.

2. The combination of a main telegraph-line, an automatic transmitter at one station, an electromagnetic perforator at a second station, said perforator including a spacing-magnet and a punching-magnet, a local circuit for each of said magnets, an automatic circuit-breaker operating to make and break said circuits alternately, an electromagnet in a local circuit controlling break-points in the punching-magnet circuit, and a main-line relay controlling break-points in said last-named local circuit.

3. The combination of a main telegraph-line, an automatic transmitter in said line at one station, an electromagnetic perforator at a second station, said perforator including a spacing-magnet and a punching-magnet, a local circuit for each of said magnets, an automatic circuit-breaker controlled by a local circuit to make and break the punching and spacing circuits alternately and a main-line relay operating break-points in the circuit of the automatic circuit-breaker.

4. The combination of a main telegraph-line, an automatic transmitter in said line at one station, an electromagnetic perforator at a second station, said perforator including a spacing-magnet and a punching-magnet, local circuits for each of said magnets, an automatic circuit-breaker controlled by a local circuit to make and break the punching and spacing circuits alternately, an electromagnet operating break-points in the local circuit controlling the automatic circuit-breaker, a local circuit for said magnet and a main-line relay controlling break-points in the last-named local circuit.

5. The combination of an electromagnetic perforator including a spacing-magnet, a punching-magnet, local circuits, one for each of said magnets, an automatic circuit-breaker in a local circuit operating to make and break the punching and spacing circuits alternately, a magnet controlling break-points in said punching-circuit, a magnet controlling break-points in the local circuit operating the automatic circuit-breaker, an automatic transmitter at a distant station directing upon the main line a series of current variations of unit duration or undivided multiples thereof, and means whereby said current variations control the two last-named electromagnets.

6. In a printing-telegraph the combination with a main line of an electromagnetic step-by-step recording apparatus, a local controlling-circuit therefor, a uniformly-operating circuit-breaker in said circuit, a magnet, circuit and break-points to operate said circuit-breaker, a circuit-breaker in the last-named circuit consisting of a pair of contact-points electrically connected together and a complementary contact, and an electromagnet to control said circuit-breaker connected with an automatic transmitter at the distant station

throwing upon the main line a series of current variations.

7. In a printing-telegraph the combination with a main line of an electromagnetic step-by-step recording apparatus, a local circuit therefor, an automatic circuit-breaker in said circuit, means for operating said circuit-breaker at a uniform rate including a local motor-controlling circuit, a circuit-breaker in said circuit consisting of a pair of contacts electrically united and a complementary contact, a relay in the main line controlling break-points in said local circuit and an automatic transmitting device throwing upon the line a series of current variations.

8. In a printing-telegraph the combination with a main line of an electromagnetic step-by-step recording apparatus, a local circuit therefor, an automatic circuit-breaker in said circuit, a magnet operating said circuit-breaker, a separate motor-controlling circuit therefor, a circuit-breaker in the motor-controlling circuit consisting of a pair of contacts electrically united and a complementary contact, and an automatic transmitter throwing upon the line a series of current variations.

9. In a printing-telegraph the combination of an electromagnetic step-by-step recording apparatus, a local controlling-circuit therefor, a vibrating-reed circuit-breaker in said circuit, a motor-magnet and circuit for said reed, a circuit-breaker in the reed motor-magnet circuit consisting of a pair of contacts electrically united and a complementary contact, and an automatic transmitting device directing upon the main line a series of current variations of unit duration or multiples thereof.

10. In a printing-telegraph the combination of an electromagnetic step-by-step recording apparatus consisting of a punching-magnet, a spacing-magnet, local circuits, one for each of said magnets, a vibrating-reed circuit-breaker, a motor-magnet, circuit and break-point for operating said reed, a second circuit-breaker in said circuit consisting of a pair of contacts electrically united and a complementary contact, and an automatic transmitting device directing upon the main line a series of current variations.

11. In a printing-telegraph the combination with a main line of an electromagnetic step-by-step recording apparatus, a local controlling-circuit therefor, a vibrating-reed circuit-breaker in said circuit, a motor-magnet for said reed, a circuit in which said magnet is included with a circuit-breaker operated by said reed, resilient limiting-stops fixed upon opposite sides of said reed, a second circuit-breaker in said motor-magnet circuit consisting of a pair of contacts electrically united and a complementary contact, and an automatic transmitting device directing upon the line a series of current variations.

12. In a printing-telegraph the combination with a main line of an electromagnetic spacing and recording device, local-circuit connec-

tions therefor, an automatic circuit-breaker in said circuit, an automatic transmitter at the distant station directing upon the line a series of current variations, a relay in the
5 main line controlling break-points in the circuit of said recording device and means for stopping the operation of said spacing device upon cessation of main-line variations.

13. In a printing-telegraph the combination
10 with a main line of electromagnetic spacing and recording devices, a local circuit for each such device, an automatic circuit-breaker in said spacing-circuit, an automatic transmitter directing upon the main line a series of
15 current variations, a main-line relay controlling break-points in the local recording-circuit responsive to said current variations and a main-line relay controlling break-points in a branch of the local spacing-circuit responsive to a cessation of said current variations.

14. In an electromagnetic punching device or perforator, two pairs of electromagnets fixed one above the other in parallel planes, a transverse arbor for each magnet to which
25 its armature is fixed, said arbors extending across the poles of the magnets and to one side thereof, a star-wheel and a motor-driven ratchet-wheel on a shaft or spindle controlled by holding-pawls fixed to one of said arbors
30 at one extremity thereof, an actuating-bar for the punch fixed to the second arbor at its corresponding extremity in the line of movement of the paper and a reciprocating punch.

15. In an electromagnetic perforator the
35 combination of a magnet, an arbor to which an armature is fixed, a reciprocating punch, an actuating-arm therefor fixed to said ar-

bor and an elastic connection between said punch and arm.

16. An automatic circuit-breaker consisting
40 of a vibrating reed, a motor-magnet and circuit therefor, a circuit-breaker in said circuit, operated by said reed, and resilient limiting-stops having means for rapidly compounding resistance to impact fixed in posi-
45 tion upon opposite sides of said reed.

17. The combination of an electromagnetic perforator, a local circuit therefor, an automatic circuit-breaker in said circuit and means for controlling the action of said cir-
50 cuit-breaker.

18. The combination of a suitable recording instrument, a local controlling-circuit therefor, an automatic circuit-breaker in said circuit, a main circuit, an automatic trans-
55 mitter in said circuit dividing the current into unit impulses and multiples thereof and means whereby the impulses in the first circuit are controlled by the variations in the main circuit.

19. The combination of a suitable step-by-
60 step recording instrument, a local controlling-circuit therefor, an automatic circuit-breaker producing uniform current variations in said circuit, a main line, an automatic trans-
65 mitter in said line producing therein unit current variations and multiples thereof and means whereby any current variation in the main line renders effective corresponding current variations in said local circuit.

DONALD MURRAY.

Witnesses:

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